The Eighth Federal Forecasters Conference -1996

and

The Seventh Federal Forecasters Conference -1994

Combined Papers and Proceedings

Edited by
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National Center for Education Statistics

U.S. Department of Education
Office of Educational Research and Improvement

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The Eighth Federal Forecasters Conference

Papers and Proceedings

Bureau of Labor Statistics
2 Massachusetts Avenue, NE
Washington, DC
May 2, 1996

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Foreword

In the tradition of past meetings of federal forecasters, the Eighth Federal Forecasters Conference (FFC/96) held on May 2, 1996 in Washington, DC provided a forum where forecasters from different federal agencies and other organizations could meet and discuss various aspects of forecasting in the United States. The theme was “Federal Forecasters Look 10 Years Ahead,” highlighting our roles as developers of forecasts.

One hundred forecasters attended the day-long conference. The program included opening remarks by Howard N Fullerton, Jr. and welcoming remarks from Ronald Kutscher, Associate Commissioner for Employment Projections of the Bureau of Labor Statistics. Debra E. Gerald of the National Center for Education Statistics, and Karen S. Hamrick of the Economic Research Service presented awards from the 1995 and 1996 Federal Forecasters Forecasting Contests. Presentations were made by forecasters from the Federal Government, private sector, and academia.

In lieu of a conference in 1995, the Federal Forecasters Committee issued Federal Forecasters Directory, 1995 and conducted the 1995 Federal Forecasters Forecasting Contest.

In addition to the papers and proceedings of FFC/96, this report includes the papers of the Seventh Federal Forecasters Conference (FFC/94) held on November 15, 1994 at the Best Western Rosslyn Westpark Hotel in Arlington, Virginia. The theme of FFC/94 was “Issues of Coordination and Networking for Federal Forecasters in the Information Highway Era.” Also included are the awards for the 1994 Federal Forecasters Forecasting Contest.

The views expressed in the papers presented at the 1996 and 1994 conferences are those of the authors, not of the National Center for Education Statistics, U.S. Department of Education, or of any of the sponsors or organizers of the conference.

Acknowledgements

Many individuals contributed to the success of the Eighth Federal Forecasters Conference (FFC/96). First and foremost, without the dedication and overwhelming commitment of the Federal Forecasters Organizing Committee, FFC/96 would not have been possible. Debra E. Gerald of the National Center for Education Statistics served as lead chairperson, organized the panel presentation, and developed the conference materials. Stephen M. MacDonald of the Economic Research Service (ERS) prepared the announcement and call for papers and provided conference materials. Karen S. Hamrick of ERS organized the afternoon concurrent sessions and conducted the Federal Forecasters Forecasting Contests. Howard N Fullerton, Jr. of the Bureau of Labor Statistics (BLS) secured conference facilities and handled logistics. Norman C. Saunders of BLS organized the morning session and provided conference materials. Peg Young of the Department of Veterans Administration contributed to the panel presentation and provided mailing lists. Andy Bernat of Bureau of Economic Analysis secured a presenter for the panel presentation. Stuart Bernstein of the Bureau of Health Professions recruited sessions for the conference. Paul Campbell of the U.S. Bureau of the Census organized a session and contributed suggestions for formatting the conference report.

Also, appreciation goes to Maurice LeFranc and Gabriella Lombardi of the Environmental Protection Agency, Jeffrey Osmint and Ethan T. Smith of the U.S. Geological Survey, and David Costello and Ronald Earley of the Energy Information Administration for their support of the Federal Forecasters Conference.

In addition, many thanks go to Linda D. Felton and Patricia A. Saunders of the Economic Research Service for preparing the conference name tags and staffing the registration desk. An appreciation goes to Ruth Harris of the National Center for Education Statistics for preparing the conference materials and conducting the mailings.

A special appreciation goes to David Costello of the Energy Information Administration for organizing the papers presented at the Seventh Federal Forecasters Conference (FFC/94).

Special thanks go to all presenters, discussants, and participants whose participation made FFC/96 and FFC/94 very successful conferences.

FFC/96 Papers

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STATE AND REGIONAL FORECAST METHODOLOGY

FFC/94 Papers

TOPICS IN FORECASTING

1996 FEDERAL FORECASTERS FORECASTING CONTEST

WINNER

Larry Sink
Bureau of the Census

HONORABLE MENTION

Thomas D. Snyder, National Center for Education Statistics
Joel Greene, Economic Research Service
David Torgerson, Economic Research Service
Betty W. Su, Bureau of Labor Statistics
Bill Hussar, National Center for Education Statistics
Leslie A. Meyer, Economic Research Service
William Miller, U.S. Department of State
Peggy Podolak, U.S. Department of Energy

CONTEST ANSWERS

U.S. Civilian Unemployment Rate 5.6%
Treasury Bond Ask Yield 6.87%
Cash Price of Brazilian Coffee $1 .23%
Average Temperature 49.5°
Washington Bullets Winning Percentage 0.500

1995 FEDERAL FORECASTERS FORECASTING CONTEST

WINNER

Fred Joutz
Energy Information Administration

HONORABLE MENTION

Thomas D. Snyder, National Center for Education Statistics
John Kitchen, U.S. Department of Treasury
Peggy Podolak, U.S. Department of Energy
David Lynch, Joint Warfare Analysis Center
Stephen MacDonald, Economic Research Service
Paul R. Campbell, Bureau of the Census
David Torgerson, Economic Research Service
Bill Hussar, National Center for Education Statistics
W. Vance Grant, National Library of Education, OERI, ED
Sal Corrallo, National Center for Education Statistics
Douglas A. Rhoades, Economic Research Service
Timothy S. Parker, Economic Research Service

Special Mention

Consistently Accurate Forecasts, 1991-1995
Thomas D. Snyder, National Center for Education Statistics

CONTEST ANSWERS

U.S. Civilian Unemployment Rate 5.5%
Bank Prime Rate 8.75%
Cash Price of Hard Wheat $5.2350
Low Temperature 53°
Number of World Series Games Played 6

1994 FEDERAL FORECASTERS FORECASTING CONTEST

WINNER

Alan Eck, Bureau of Labor Statistics

HONORABLE MENTION

David Torgerson, Economic Research Service
Elliot Levy, U.S. Department of Commerce
Betty W. Su, Bureau of Labor Statistics
William Miller, U.S. Department of State
Paul Sundell, Economic Research Service
Janet Pfleeger, Bureau of Labor Statistics
Thomas D. Snyder, National Center for Education Statistics
John Golmant, Administrative Office of the U.S. Courts
Douglas A. Rhoades, Economic Research Service
Tai A. Phan, National Center for Education Statistics

Special Award

Consistently Accurate Forecasts, 1991-1994
Thomas D. Snyder, National Center for Education Statistics

CONTEST ANSWERS

U.S. Civilian Unemployment Rate 5.8%
Bank Prime Rate 7.75%
Value of German Mark 1.5043
High Temperature 73°
Redskins October Average Score 22.0

Panel Presentation

Federal Forecasters Look 10 years Ahead

Panel Presentation

Federal Forecasters Look 10 Years Ahead

Moderator: **Michael O'Grady**
Congressional Research Semite, Library of Congress

Panelists:

Charles Bowman, Chief
Division of Industry Employment Projections
Bureau of Labor Statistics, Department of Labor

Debra E. Gerald, Mathematical Statistician
National Center for Education Statistics, Department of Education

John Kort, Chief
Regional Economic Analysis Division
Bureau of Economic Analysis, Department of Commerce

Rip Landes, Team Leader
Commercial Agriculture Division
Economic Research Service, Department of Agriculture

Gregory Spencer, Chief
Population Projections Branch
Bureau of the Census, Department of Commerce

Herbert Traxler, Senior Economist
Office of Research and Planning
Bureau of Health Professions
U.S. Public Health Service, Department of Health and Human Services

This panel looked at various federal forecasts 10 years ahead,' offering a look at the world 10 years from now as seen by forecasters from six federal agencies. The panelists spoke of the characteristics of the forecasts in their organizations and also discussed the role of their forecasts in shaping the future. Questions about how forecasts depend on other supporting forecasts and how public and private decisions rely on federal forecasts were addressed.

Labor Force and Employment Trends to 2005: Highlights of BLS Projections to 2005

Charles Bowman, Chief
Division of Industry Employment Projections
U.S. Bureau of Labor Statistics

The BLS projections program began in the late 1940s to provide information to help World War 11 veterans plan their careers. While the scope of the projections has been broadened over the years, career guidance remains its major focus. The ***Occupational Outlook Handbook,*** now in its 50th year, is without doubt the most widely used source of information about future job prospects in the United States.

Currently, the Bureau develops a new set of projections every other year. The most recent was released in late 1995 and covers the 1994 to 2005 period. Included are projections of the labor force by age, sex, and race and employment by industry and detailed occupation.

Due both to slowing population growth and to a slower rate of increase in labor force participation, the expansion of the labor force is expected to slow considerably relative to the 1983-1994 period, with percentage annual gains below 1 percent by the end of the period. Labor force participation of younger women is expected to grow more slowly than in the past, while large increases are expected among women 40-59. Participation rates for men of all ages are expected to drop.

Employment is projected to expand by 18 million over the 1994-2005 period, a sharp slowdown from the 24 million job gain of the preceding 11-year period. Almost all of the projected job growth centinues to be in the service sector. Employment in the goods-producing sector declines by about 1 million jobs as losses in mining and manufacturing offset gains in agriculture and construction. Over half of the employment growth in services is accounted for by health care and business services, particularly computer-related services and personnel supply (temporary workers).

Professional specialty occupations are expected to have the largest numerical growth, followed by service workers, gains of 5.1 and 4.6 million respectively. Clerical workers are expected to show a net increase of only 1 million as a result of the expected impact of office automation. Clerical occupations expanded by over 4 million in the 1983-1994 period. Continued expansion of the health care and business services sectors is reflected in very rapid growth of many health and computer-related occupations, From an educational perspective, occupations requiring the most education and training will be increasing at well above average rates.

Projections of Education Statistics to 2006

Debra E. Gerald
National Center for Education Statistics
U.S. Department of Education

The Projections Program of the National Center for Education Statistics (NCES) develops projections of key education statistics for policy planning. Other activities include ongoing model improvement, annual an d ten-year evaluations of past projections, and consultation on projection methodology. In April 1996, NCES released ***Projections of Education Statistics to 2006,*** the 25th edition. Education statistics projected are enrollments, graduates and earned degrees conferred, classroom teachers, and expenditures of educational institutions. The projections are based on data from NCES institutional surveys, National Education Association, the Census Bureau's estimates and projections of the population, and the macroeconomic data and projections from DRI/McGraw-Hill Economic Forecasting Service.

The demographic assumptions underlying the education projections are consistent with the Census Bureau's middle alternative projections which assume a fertility rate of 2.09 births per woman by the year 2006, a net immigration of 820,000 per year, and a further reduction in the mortality rate with the life expectancy rising gradually to 76.9 years. Over the projection period, the school-age and traditional college-age populations will increase from 5 percent to 23 percent. The 25 and older populations will decrease by as much as 20 percent or remain unchanged.

The economic assumptions underlying the middle alternative education projections are consistent with the DRI/McGraw-Hill trend scenario projections for disposable income and unemployment rate by age group--annual percent changes for disposable income will range between 1.2 percent and 1.7 percent and unemployment rates for young adults will range between 8.3 percent and 17.8 percent. Annual percent changes for education revenue receipts from state sources will range between 0.0 percent and 2.8 percent.

The general projection methodology starts with developing projections of enrollments in American schools and colleges. These enrollment projections along with projections of other independent variables are then used to develop projections of graduates, classroom teachers, and expenditures . Various forecasting techniques are employed such as cohort survival, single and double exponential smoothing methods, and multiple linear regression.

Increases in annual births since 1977, often referred to as the baby boom echo or baby boom let, will generate growth in school enrollment over the projection period. Elementary and secondary school enrollment will reach 51.6 million in the Fall of 1996, surpassing its peak level of 51.3 million reported in 1971. Over the projection period, this level will continue to increase to around 55 million by the year 2006, an increase of 10 percent. Growth in high school enrollment will be greater than growth in elementary enrollment (21 percent versus 5 percent). The number of public and private high school graduates is projected to increase by 21 percent to 3.0 million in 2006. Total classroom teacher s will increase by 16 percent to 3.4 million in 2006. Current expenditures per pupil are projected to increase 24 percent over the projection period.

Enrollment in institutions of higher education is projected to rise to 16.4 million by 2006, an increase of 16 percent. The enrollment of wome n will continue to outpace the enrollment of men in higher education. The growth rates of men and women are projected to be somewhat similar over the projection period, unlike in the **past.** Bachelor's degrees are projected to be 1.3 million by 2006.

Projections customers span the Nation. They come from federal, state, and local governments, business and industry, the education community, the media, and of course the general public.

At the federal level, during the budget battles, congressional subcommittees used the enrollment projections to determine education policy. The Secretary of Education had three press conferences emphasizing the coming enrollment surge and resulting need to stave off large cuts in the education appropriation. State and local officials often used national projected trends as a yardstick against which to argue their positions at legislative sessions and school board hearings.

For business and industry, projections of education statistics serve this sector whose many interests include producing caps, gowns, and class rings, publishing textbooks, monitoring the production of new college graduates for hiring purposes, identifying the pool of applicants for the armed forces, etc.

For the education community, projected statistics on schools and colleges help shape its education policy by identifying emerging trends in such areas as enrollment, degree production, and instructional staff.

For the media, projections are a source for articles that inform their readers about emerging issues.

Regional Projections of Economic Activity and Population to the Year 2005 from the Bureau of Economic Analysis

John R. Kort
Chief, Regional Economic Analysis Division
Bureau of Economic Analysis
U.S. Department of Commerce

History. Every five years, BEA prepares a consistent set of geographically detailed projections within a national framework. Projections are prepared for States, metropolitan statistical areas, BEA economic areas, and on occasion, counties under contract. The projections have been used by many Federal agencies such as the U.S. Army Corps of Engineers in their infrastructure planning program, by the Tennessee Valley Authority and the Department of Transportation in dam and highway construction projects, respectively, by the EPA as inputs to their regional projections of pollution, and by other Commerce agencies such as NOAA and the International Trade Administration (ITA) for public policy issues such as locating ports and the NAFTA trade agreement.

Methodology. Projections are prepared for total personal income, the non-earnings components of personal income, per capita personal income, population by broad age group, and for earnings, employment, and gross state product by industr y -- at the two-digit level for states and at the one-digit level for geography below the state level. The most recent set provides projections at roughly five-year intervals for the years 2000, 2005, 2010, 2015, 2025, and 2045. Projections from 1995 to 2000 were derived from an annual econometric model, and these mid-term projections were used t modify the first year of the long-term projections period, beginning in 2000. The long-term projections beyond 2000 were prepared on the basis of historical trends in economic relationships among variables.

Consistency with other agencies. BEA's value-added in the federal establishment projections business is in putting a regional dimension on the projections. BEA's regional projections are made consistent with projections for the Nation of population from the Bureau of the Census, of the labor force from the Bureau of Labor Statistics, of the fill-employment unemployment rate from the Congressional Budget Office, and of mining output from the Department of Energy. The projections for metropolitan areas and BEA economic areas are then made consistent with the State projections.

Projected Growth Trends to the Year 2005. For the Nation, we've projected employment in all industries to increase by about 27 million jobs between 1993 and 2005, or at an annual rate of 1.5 percent, down from an average annual rate of 2.0 percent during 1983-93. Three-fourths of the projected increase is in three private service-type industries -- services, retail trade, and the finance, insurance, and real estate group. We project employment to decline in durable goods manufacturing, fining, Federal civilian government, Federal military government, and mining. By region, we project economic growth to be above the U.S. rate in four regions in the South and the West, and below the U.S. rate in four northern and central regions. We project per capita personal income for the Nation to increase 1.2 percent per year fro 1993 to 2005, down slightly from a 1.4-percent increase during 1983-93. The projected slowdown in personal income growth reflects a slight slowdown in the growth of the labor force, which partly results from demographic changes such as the aging of the population.

Future of the Projections. We will publish the metropolitan area and the BEA economic area projections in a June 1996 *Survey of Current Business* article, and they will be released in a press statement later this month on May 29. At this time, it looks as though the budget environment will necessitate the phasing out of BEA's regional projections program and these projections will be our final ones pending a surge in federal funding of statistical agencies. The few resources devoted to producing these consistent regional projections will be reshuffled to other parts of the regional program within BEA and to parts of the national program, to aid in the implementation of BEA's mid-decade improvement strategy for the national economic accounts.

Long Term Projections for International Agriculture to 2005

Rip Landes
Commercial Agriculture Division
Economic Research Service, U.S. Department of Agriculture

Projections of strong global economic growth, particularly in developing countries, combined with freer foreign markets and the emergence of China as a major bulk commodity market, support strong projected gains in U.S. farm exports through 2005. The value of total U.S. agricultural exports is projected to rise from $54.2 billion in FY 1995 to nearly $80 billion in 2005. The projections are a conditional scenario, assuming the continuation of 1990 U.S. farm legislation, no shocks, average weather, and specific macroeconomic and foreign country policy assumptions.

The U.S. trade projections were derived with long-term projections for international supply, demand, and trade for major agricultural commodities to 2005. The projections were completed based on information available as of January 1996 and reflect a composite of model results and analyst judgment. These projections were reproduced for limited distribution to the research community outside the U.S. Department of Agriculture and do not reflect an official position of the Department.

The principal model used in the foreign projections is the multi-region, multi-commodity, Country-Link System maintained and used by regional and commodity trade analysts in the Commercial Agriculture Division of the Economic Research Service. Analyst judgment is provided by ERS regional and commodity analysts, as well as by analysts from the World Agricultural Outlook Board and the Foreign Agricultural Service.

Long-term international projections are typically made in conjunction with the detailed U.S. sector analysis and the President's Budget analysis. The scenario presented in this report is not a USDA forecast about the future. Instead, it is a conditional, long run scenario about what would be expected to happen under an extension of 1990 agricultural law, as amended, and specific assumptions about external conditions.

Macroeconomic assumptions represent expected future trends in key variables, but exclude any variations due to business cycles. Supply projections assume average weather conditions in each year. Foreign country economic and agricultural policies are assumed to continue to evolve along recent trends based on analyst judgment. U.S. domestic farm policy assumptions are based on the continuation of 1990 legislation, and assumptions on bilateral and multilateral policies affecting agriculture and trade are based on formal agreements as of January 1996. Although new U.S. farm legislation has been enacted since these projections were completed, the long-term outlook for non-U.S. supply, demand, and trade remains largely unchanged by the new U.S. legislation.

Summary of Trade Projections

World trade in most major bulk agricultural commodities is projected to expand more rapidly during 1995-2005 than during the 1980s or early 1990s. Trade in grains, particularly coarse grains, is expected to show the most significant recovery and fastest growth among bulk commodities, driven primarily by prospects for relatively strong economic growth in China and other developing countries. Combined trade in soybeans and meal is also expected to strengthen, benefiting from the same expansion of developing country feed-livestock sectors that will push up coarse grain trade. Trade in soybean oil, however, is projected to slow from the early 1990s as its price rises relative to competing oils. Raw cotton demand and trade are projected stronger than in the early 1990s, but lower than the 1980s when there was increased substitution of cotton for synthetic fibers.

U.S. export growth is also expected to strengthen for most bulk commodities. U.S. wheat and coarse grain exports are projected to expand fastest during 1995-2000, with wheat export growth slowing after 2000 due to slower U.S. area growth and anticipated unsubsidized competition from the European Union (EU) as world prices rise. U.S. rice export volume is expected to continue to decline because of little expansion of U.S. rice

area and steady increases in U.S. demand. Exports of U.S. soybeans and products are projected to rise faster than in the 1980s, but foreign competition and slowing U.S. acreage gains are likely to constrain export growth relative to competitors. In contrast, U.S. raw cotton exports are projected to strengthen throughout the 1995-2005 period, benefiting from rising demand and reduced competition.

Projected U.S. crop market shares generally follow historical trends, U.S. wheat is projected to earn a larger share of world trade during 1995-2002, but show a decline roughly consistent with historical trends after 2002 because of anticipated unsubsidized EU competition. Reduced competition is expected to lead to a continued rise in the U.S. share of world coarse grain and cotton trade, although the emergence of nontraditional competitors could limit U.S. gains in coarse grains after 2000. U.S. rice market share, however, is projected to decline as exportable surpluses dwindle. U.S. market shares in soybeans and products are also projected to continue to decline as a result of competition from South American producers, as well as anticipated U.S. acreage constraints.

The generally favorable world macroeconomic outlook is expected to spur growth in meat demand and trade during 1995-2005. In addition, less restrictive trade barriers will create new opportunities for exporters. In particular, several countries in the Pacific Rim, Central and South America, and the Middle East are expected to expand meat consumption.

Recent declines in meat consumption in the Former Soviet Union (FSU) and parts of Central and Eastern Europe (CEE) are projected to slow and turn upward by the end of the forecast period. Increased domestic meat production is also expected in these regions, with some impact on U.S. meat exports. U.S. exports to the FSU of both red meat and poultry products grew sharply in 1995 due to reduced livestock inventories, declining production, and the competitive price of imports. However, in the longer term, growth in import demand is expected to be limited in both the FSU and CEE, with the CEE also likely to increase exports of beef and pork.

U. S. Bureau of the Census Products: Issues and Challenges

Gregory Spencer, Chief
Populations Projections Branch
U.S. Bureau of the Census

The current U.S. Bureau of the Census products are(l) national and State population projections by age, sex, race, and Hispanic origin; (2) national household projections, by age, household type, race, and Hispanic origin; and (3) State voting-age projections by age, sex, race, and Hispanic origin. Most likely, the new products by 2006 will be (1) county and/or metropolitan area projections by age, sex, race, and Hispanic origin; (2) foreign-bom projections; (3) projections of individual Hispanic origins; and (4) State household projections. Some of the major challenges or issues that will be confronting the Census Bureau are (1) compensating for degradation of data sources and or declines in data quality; (2) adjusting all products for 2000 census population coverage errors; (3) adjusting many historical data series for the uncounted and overcounted populations in past censuses; and (4) adjusting all products including historical series for any changes in the Office of Management and Budget, Statistical Directive No. 15 on race-ethnic categories.

The Census Bureau projections show a number of major demographic shifts in the coming decade. The U.S. will have the slowest population growth since the 1930s. All workforce-age population growth is concentrated in the 45 to 64 age group. The 16 to 44 years of age population does not grow. All growth in the 65 years and over population is concentrated in the 75 years and over population. Aging voters--45 years and over--make up 51 percent of the population in 2006 compared to 45 percent now. This will be the first decade in centuries when Black and White, non-Hispanic groups together account for less than half of the total growth. Each year, more Hispanic people are added to the population than are contributed by any other race-ethnic group.

Forecasting Workforce Supply and Requirements in the Rapidly Changing Trillion-Dollar Health Care Sector

Herbert Traxler, Ph.D.[1]
Senior Economist
Bureau of Health Professions, U.S. Department of Health and Human Services

Health professions modeling in the United States has a long history, using a variety of approaches. These are influenced by (1) the complexity of and the data availability for the health profession to be modeled (e.g. physicians vs. nurses' aides), (2) selection of an econometric, interactive equilibrium model or the separation of the supply side from the demand / requirements side, and (3) selection of a specific methodological basis for the analysis (e.g. the adjusted multivariate trends-based analysis, such as demand-utilization, versus a "needs" base, heavily reliant on expert judgment). The major data bases used are mostly federal (Census, CDC/NCHS, HCFA, NCES) or from associations (ADA, AHA, AMA, AAMC...). The Bureau's modeling program has been an analytical foundation for major reports (Reports to Congress on health personnel, Council on Graduate Medical Education and National Advisory Council on Nurse Education and Practice), and was used in assisting policy making and discussions, e.g., the [Clinton] health care reform debate and legislative initiative. Though the Health Security Act was not enacted, much of the debate surrounding it led to many professional presentations and peer-reviewed publications, especially focusing on the physician workforce: what size and composition will we need / will we get under various likely and policy scenarios?

The current integrated requirements model (IRM) for the primary health care (PC) workforce goes beyond individual professions to forecasting requirements for PC physicians, physician assistants (PAs), nurse practitioners (NPs), and certified nurse midwives (CNMs) -- it allows testing of the effect of substitution, managed care penetration, and State practice acts. Currently, the IRM is being expanded in two directions: to major physician specialties nationally and to enhanced use at the sub-national level. Two workshops of a State user-friendly version will meet the strong interest expressed by many States in the IRM. Thus, we are assisting the States in health professions analysis, planning, modeling, and forecasting, as they get involved in "re-engineering" the health care delivery process (cost reduction and quality improvement), in "re-regulating / de-regulating" the health care workplace (State practice acts - accreditation and licensure...), and re-assessing State support for specialty training.

The influence of the market, technology, and of epidemiological / disease developments can be gauged with our health professions modeling and forecasting tools, such as managed care's changing incentives for inpatient/outpatient services, use of generalists versus specialists (downsizing), moving cataract surgery from the inpatient to the outpatient setting, or the unforeseen research, resource, and service needs due to AIDS. Similarly, the influence of politics and policy decisions can be simulated with our modeling tools (e.g., aforementioned health care reform; coverage of the uninsured; changes in reimbursement by setting and provider).

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[1] Traxler, H., "Physician Modeling in the United States and its Uses in Assisting Policy Making," *World Health Statistics Quarterly,* vol. 47, no. 3/4, 1994, pp. 118-125; special issue on Health Futures Research (based on the author's presentation at the World Health organization in Geneva, July 1993).

To sum: modeling and forecasting is alive and well in the health workforce arena. The electronic revolution and the vastly increased speed and capacity in computing have facilitated the development of interactive and user-friendly models which allow scenario analysis onawide rangeof variables by the policy analyst, thus increasing the power ofmodeling in assisting informed decision making stall levels. We are in the midst ofthis exciting process.

Concurrent Sessions I

WORLD AGRICULTURE TO 2005

Chair: Stephen A. MacDonald
Economic Research Service, U.S. Departmen tof Agriculture

Global Oilseeds Outlook: Prospects and Issues for 2005,
Jaime A. Castaneda, Economic Research Service, U.S. Department of Agriculture

The World Outlook for Cotton: The Next 10 'Years,
Stephen MacDonald, Economic Research Service, U.S. Department of Agriculture

World Coarse Grains and Rice Outlook and Issues for 2005,
Carolyn L. Whitton, Economic Research Service, U.S. Department of Agriculture

World Wheat Trade: 1996-2005,
Mark V. Simone, Economic Research Service, U.S. Department of Agriculture

Global Oilseeds Outlook: Prospects and Issues for 2005

by

Jaime Castaneda[1]

Summary

Major assumptions used to **developed** USDA outlook **projections**

The hypothesis underlying the exercise includes 1) declining real prices for soybeans, soybean meal, wheat, and com over the projection period, following the long term trend, 2) a major recovery and expansion in the world economy from the sluggish performance of the 1980's, 3) gradual debt relief for developing countries, 4) slow real growth in petroleum prices, 5) a slow-down in production growth of other oilseeds from the rapid growth in the 1980s, 6) implementation CAP reform in the European Union, but not expansion of the EU was included, and 7) a continuation of the existing trade and agricultural environment and policies achieved at the Uruguay Round.

This article presents a brief overview of the world **oilseeds** and soybean market. Soybeans, at about 77 percent of **oilseeds** exports, and soybean meal, at 67 percent of protein meal exports, are the primary determinants of global oilseed and protein meal trade. However, world oil trade contains only about 20 percent soybean oil, while palm oil and sunflowerseed oil account for more than 50 percent. Therefore, this paper will emphasize and **identify** only prospects for world soybean, soybean meal, and vegetable oils especially soybean oil through the year 2005. Also the study highlights issues and uncertainties that have the potential to significantly affect the world oilseed outlook, especially world soybean trade.

Despite forecasts of strong economic growth through the year 2005, world oilseed production and consumption, especially of soybeans, are expected to grow at a slower rate than in the 1970s and the 1980s. Developing countries will likely generate most of the consumption and import growth, while stagnant demand for protein meal in most developed countries will slow overall consumption growth. World share's of soybeans, soybean meal and edible oil exports will be heavily influenced by oilseed market **fundamentals, oilseed** production and consumption growth in major producing countries, and policy developments in key trading nations.

Furthermore, policy and economic uncertainties cloud the outlook for world **oilseed** supply and demand. Some of the factors affecting demand are the agricultural reforms in the European Union, the **FSU's** lack of purchasing power, and the economic uncertainties in Eastern Europe and developing countries. Factors affecting supply include the price outlook for soybeans and other oilseeds, constraints on yield and area expansion by the U.S. and competitors, increasing domestic consumption and policy reforms in major producing and exporting countries. A continuation of these uncertainties could prolong the relatively stagnant trade of the 1980s. On the other hand, if import demand strengthens around the world, countries with greater capacity to expand production will benefit the most.

An Overview **of the World Oilseed Market**

While most countries of the world cultivate one or more of the various **oilseeds,** their demand for **oilseed** products generally surpasses the domestic supply. World trade in the **oilseed** market is dominated by soybeans, accounting for approximately three-quarters of the total. The EU presently accounts for approximately half of world soybean and soybean meal imports.

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Five countries account **for about 90 percent of total** soybean production: the United States, Brazil, Argentina, India, and China. Until 1970 the U.S. captured almost 90 percent of world soybean trade. However, in the 1970's and 1980's, expansion by the major oilseed producers in South America--Brazil and Argentina--eroded the U.S. share of both **world** production and trade.

Growing world production of other oilseeds, meals and oils, such as sunflowerseed, palm oil, and rapeseed, has also increased competition in the **oilseed** and product markets. While various types of oilseeds have different protein and oil content, and meals have different degrees of digestibility and therefore usage, vegetable oils are highly substitutable. Consequently, slight price differences among oils **often** significantly affect demand for individual oils.

The Outlook for Global Prospects Through 2005

Methodology

The trade forecasts through 2005 presented here result from an annual-forecast modeling exercise conducted by USDA's Economic Research Service. The exercise generates forecasts of world soybean, soybean meal, soybean oil, and other **oilseeds** production, consumption, and trade for a 10 year period through the year 2005. **Country-**specific and regional projections are produced by ERS economists using a combination of country models and judgmental analysis. The results of the country-specific projections are incorporated into a world net-trade **framework** which is balanced by projections of U.S. trade.

Supply Growth

Despite falling real prices, world oilseed production is forecast to grow about 27 percent **from** 1996 to the year 2005. Most of the gains will be in developing countries such as Brazil, **Argentina, India,** China, and Malaysia. In The U. S., the 1990 Farm Bill and the 1990 Omnibus Budget Reconciliation Act introduced market oriented reforms in U.S. agricultural policy as target price and income supports were cut back on acreage of competing grain and cotton crops providing **oilseeds** with a competitive edge on the basis of relative market prices. These market oriented policies will be enhanced under the FAIR Act legislation passed in April of 1996.

In 2005/06, the various **oilseeds** share's of output are not expected to differ from the base year, indicating that oilseed production growth is expected to spread equally among the different commodities. Nonetheless, total world oilseed expansion measured in volume will be more significant in soybeans, because of soybeans predominance in the world oilseed markets.

On average, foreign soybean production is projected to climb 2.4 percent annually and reach 86.1 million tons in 2005. Foreign supply growth will be sharply slower than during the 1970's (9 percent annually) and 1980's (6 percent), when Brazil and Argentina added large amounts of land to soybean production. Soybean yields are forecast to rise at a modest 1.2 percent annually, slightly below the 1980's, because no major technological breakthroughs that would support rapid yield increases are anticipated.

Area is expected to expand in South America, primarily in Brazil, while slightly higher yields will drive production growth in Argentina, Brazil, India and China. Area expansion in Brazil, Paraguay, and Bolivia will come from opening new land areas, while in other countries an increase in area will likely come at the expense of other crops.

Consumption Growth

World oilseed crush is forecast to grow at about 2 percent, slightly below the level in the 1980's. Stable levels of consumption growth in the next decade contrasts sharply with prospects for economic recovery and higher income growth **during the projected period. Soybeans account** for about half of world oilseed crush and 85 percent of world oilseed stocks. Therefore, world **oilseed** and soybean consumption generally move parallel indicating that changes in soybeans largely affect world **oilseed** movements.

The slower consumption growth rate in soybeans and soybean meal is linked primarily to slower consumption growth in developed countries. For example, consumption growth in the EU will continue to slow as demand for meat products stabilizes and grain consumption increases, as a result of Common Agricultural Policy (CAP) reforms. Annual consumption growth in the EU is expected to remain nearly unchanged during the projected period. EU soybean meal consumption in the 1970's, accounted for nearly 60 percent of total foreign meal consumption. This share is projected to decline to approximately 30 percent by the year 2005.

Future growth in soybean meal consumption will be driven mainly by developing countries, particularly in China, Southeast Asia, and Latin America. For example, growth in China will expand dramatically as growing demands for meat products, combined with market reforms, stimulate increased demand for feed grains and protein meals.

The strong consumption growth in China will be partially offset by reductions in consumption by the former Soviet Union. Annual average growth in the FSU is projected to decline from 8.4 percent in the 1980's to roughly no growth in the 1990's, recovering somewhat after the year 2000. Economic turmoil and financial and credit difficulties, combined with widespread liquidation of livestock herds, are projected to dampen overall meal consumption growth. Similarly, consumption growth in Eastern Europe is forecast to be restored although very slowly, as high consumer prices stifle demand for livestock products over the remainder of the 1990's and through the year 2005. Projections for Eastern Europe could be altered significantly, if individual countries in Eastern Europe join the European Union during the projected period.

Trade

World soybean trade is projected to increase faster during 1996-2005 than during the 1980's, but sharply slower than in the early 1990's. Growth in soybean meal trade is projected to be slower than both the 1980's and the early 1990's. Both global soybean and soybean meal exports are expected to rise 2.1 percent annually during 1996-2005, reaching 36.3 and 37.8 million tons, respectively, by 2005. Combined exports of soybeans and soybean meal, on a soybean equivalent basis, are projected at 75.7 million metric tons by 2000 and 83.5 million tons in 2005. Increases in soybean trade drive these gains until the end of the decade, while soybean meal account for most of the growth after 2000. World soybean trade is projected to move from an annual average downturn of 0.5 percent in the 1980's to a positive growth rate of approximately 2 percent annually during 1996-2005.

U.S. exports of soybeans and soybean meal are projected at 23.0 and 5.8 million tons, respectively, in 2005. U.S. soybean market share is projected to drop from 66 percent to about 63 percent by 2005, while U.S. soybean meal market share remains virtually unchanged at 15 percent. These projected U.S. shares contrast with significantly higher shares for soybeans (75 percent) and soybean meal (25 percent) achieved in the 1980's. Small domestic production gains, combined with rising livestock numbers, especially poultry, are expected to constrain U.S. exports of soybeans and soybean meal.

Under CAP reform, the Uruguay Round, and the U.S.-EU Oilseed Agreement, EU imports of soybeans and soybean meal, in soybean equivalents, are projected to rise marginally through 2005. This compares with a small decline in imports during the 1980's. The U.S.-EU Oilseed Agreement which altered EU oilseed support mechanisms and established area bases for producer payments is expected to limit the expansion of oilseed area. This will partially offset the potential decline in import demand for soybeans and products that could have occurred under CAP reform. Although the EU has consistently increased soybean meal consumption since 1988, EU feed grain prices are expected to fall relative to meal prices, thus driving down consumption and imports of soybean meal. Most of the projected decline in soybean meal consumption occurs in 1995 and 1996, with growth resuming in 1997 as the grain substitution effects subside. Soybean meal imports are forecast at 16.8 million tons by 2005, while soybean imports are projected at 14.6 million tons (both including EU intra-trade).

The extent to which higher feed grain prices in the longer term will increase soybean meal use is a key uncertainty in the outlook for soybean and meal trade, particularly since the EU accounts for about half of world soybean and meal imports. The degree of substitution that occurs will hinge on a number of factors, including the extent to which internal grain prices rise with world market prices, the relative strength of the U.S. dollar, livestock

production in the EU, and supplies of other proteins.

Mexico's soybean imports are expected to recover as economic growth strengthens following the deep recession resulting from the peso crisis. Despite the expected recovery, projected soybean imports in 2005 are below pre-crisis projections. PROCAMPO reforms are expected to support slight gains in soybean production at the expense of other crops. However, brisk soybean meal consumption triggered by income growth and reduced import tariffs under NAFTA will maintain high levels of soybean import demand over the projection period. Soybean imports are projected to grow 5.3 percent annually, reaching 3.7 million tons by 2005.

FSU soybean meal imports are projected to resume growth after 1999, as market reforms in the FSU begin to yield small economic gains, a modest recovery in the livestock sector, and growing demand for soybean meal. However, the projected 2 percent annual import growth is dramatically below the 14 percent gains seen in the 1980's. Soybean imports are expected to rise only marginally through 2005 because of gains in domestic soybean production and capital constraints on investment in new crushing facilities. A weak balance of payments situation means import volume will depend significantly on credit availability and on barter trade, at least in the near term. Rigorous debt and credit management guidelines provided by the IMF will also hinder any debt increase by the FSU. Imports of soybeans and soybean meal are projected at 0.2 million tons and about 1 million tons, respectively, in 2005, considerably lower than in the 1980's and early 1990's.

Imports of soybean meal into Eastern Europe, one of the top three soybean meal import markets in the late 1980's, are projected to climb throughout the period. The growth will occur from the low levels reached in the early 1990's. Economic reforms are likely to stimulate income growth and meat consumption, allowing livestock inventories to rebuild. Nonetheless, soybean meal consumption will remain well below the levels attained in the 1970's and 1980's, as governments in most countries have ended consumer meat subsidies, raised prices, and reduced demand.

Import demand for soybeans and meal in Eastern Europe will depend heavily on how rapidly economic conditions improve in these transition economies. Faster than anticipated growth in domestic and export demand for the region's livestock products could stimulate even more imports of soybeans and soybean meal.

China is projected to become a net importer of soybeans and meal by 1998, as market reforms continue to boost per capita incomes and meat consumption. Poultry production is expected to continue to rise rapidly due to strong domestic demand and increasing exports to other Asian countries, especially to Japan. It is expected that China will maintain import tariffs that restrict imports of soybean meal in favor of soybean imports. Moreover, increasing shortages of vegetable oils and protein meals are likely to prompt further investment in new soybean processing facilities along China's Central and southern coastal cities.

The pace of future growth in China's soybean and meal imports is highly uncertain and dependent on assumptions regarding economic growth, the rate of growth of livestock production, the evolution of feed rations, and the government's trade policy response to rising imports of soybeans and meal. Most factors support the outlook for rising imports of soybeans and meal.

Japan is expected to reduce its imports of soybean meal substantially, while imports of soybeans drop slightly. Increased liberalization of livestock product imports and reduced competitiveness of the domestic livestock industry are anticipated to depress domestic livestock production and demand for protein meal. In addition, rapeseed imports are expected to rise as vegetable oil prices remain strong.

Soybean imports by South Korea are projected to show modest increases through 2000, but decline thereafter. Soybean meal imports, on the other hand, are projected to show strong growth. Tariff reductions for soybean oil and soybean meal imply a shift in the mix of imports from soybeans to soybean meal and soybean oil.

Exporter Developments for Soybeans

The major foreign exporters of soybeans and meal are Brazil, Argentina, China, India, and Paraguay. Trade from these countries accounts for 95 percent of total foreign exports of soybeans and soybean meal. World soybean and soybean meal exports are estimated to experience an average compound growth rate of 2.1 percent from 1996 to 2005. While U.S. soybean exports are expected to experience a positive growth rate in the 1990's in contrast to declines during the 1980's, forecast growth of foreign soybean exports is estimated at 2.8 percent per year. This sharply contrasts with the impressive growth in foreign exports attained during the 1970's and 1980's

World soybean meal exports are estimated to grow an average of 2.1 percent during the projected period. This compares to a 4.8-percent growth rate during the 1980's and a 17-percent growth rate during the 1970's. The expected increase in meal exports is a result of greater supply from Brazil, Argentina, and India, and stronger demand from developing and newly industrialized countries.

The U.S. market share for soybean and soybean meal exports (in soybean-meal-equivalent) since the early 1960's has been consistently eroded by increasing foreign competition, particularly from Brazil and Argentina. The long-term decline in the U.S. market share of bean and meal exports will end as a result of a projected slowdown in world production, an overall increase in demand for soybean and soybean products, and stronger consumption growth, particularly in exporting countries. This outcome is highly dependent on several issues and uncertainties which are discussed in the following section.

Strong export growth for soybeans and soybean meal is expected from both Brazil and Argentina. Chinese soybean and soybean meal exports are projected to decline as strong domestic feed demand reduces export availabilities. India's soybean meal exports likely will rise as soybean meal production increases faster than domestic consumption, though at a slower rate than in the past.

South American (Brazil, Argentina, Paraguay and Bolivia) production growth is projected to drop from 6 percent annually in the 1980's to 3 percent during 1996-2005. Annual export growth for soybeans and soybean meal is expected to slow to 3 and 2 percent, respectively. Although domestic policies in Argentina and Brazil will continue to favor exports of soybean meal over soybeans, the influence of these policies on the export mix is expected to be less than in the past decade. Greater domestic consumption in Brazil will restrict the growth of soybean meal available for export. Soybean production and exports in both Paraguay and Bolivia will expand steadily throughout 2005 due to increased irrigation and improved infrastructure. South America's combined market share for soybeans is projected to rise from 28 percent in 1995 to 33 percent by 2005, while the soybean meal share remains unchanged at 62 percent.

The potential response of farmers and traders in Brazil and Argentina to economic reforms and the privatization of ports, highways, and grain handling facilities, provides further uncertainty in the trade outlook for soybeans and meal. In either country, improved infrastructure can significantly lower producer costs and enhance competitiveness. Prospects for expanding Brazilian production rely heavily on new production in the outskirts of the Center-West. Transport costs now hinder area expansion, but the Center-West region could expand area and production dramatically if transport costs are reduced, or if soybean prices rise sufficiently.

Although major reductions in the volume of soybean and soybean meal exports have already occurred in China, exports are assumed to continue to decrease through 2005. An increasing share of soybean production is expected to be used to meet the growing demands of its livestock sector.

Despite a likely slowing of government support for oilseeds, India will continue to increase soybean and soybean meal production, although at a moderate 4 percent growth rate. Increasing production of soybean meal combined with relatively limited domestic demand is projected to push soybean meal exports to about 3.9 million tons in 2005.

World Vegetable and Marine Oils

Edible oils are grown in almost all regions of the world, in developed as well as developing countries. Production

of edible oils comes from a variety of sources, such as perennial crops (palm oil), annual crops (soybean oil), and marine origins (fish oil). The primary markets for vegetable and marine oils are human consumption (cooking oils) and industrial use (soap and candles). Unlike protein meals, edible oils are highly interchangeable and industries can substitute one oil for another with great flexibility. USDA projections include 9 different sources of oils[2]

Although demand for edible oils is relatively price sensitive, supply is highly inelastic for most vegetable and marine oils. Tree crops are locked into a level of production regardless of short-term price signals. Oils that come from annual crops are usually joint-products and influenced as well by the co-products (soybean meal, cotton fiber).

World production and use of vegetable oils is expected to continue to expand during 1996-2005, but at a slower rate than in the 1980's. While projected growth in vegetable oil trade of 3.3 percent annually is lower than the 4.4 percent rate observe id the 1980's, vegetabl eoil trade is expected to continue to expand faster than trade in protein meals. Prospects for faster trade growth in oils relative to meals could provide greater support to the production of high-oil content oilseeds, including oil palm, rapeseed, and sunflowerseed.

Soybean Oil Trade

Soybean oil accounts for about 28 percent of global vegetable oil production and consumption--the largest share among the nine major edible oils--but accounts for only 20 percent of world trade, second to palm oil. World soybean oil trade is projected to grow 1.3 percent annually during 1996-2005, reaching 5.4 million tons by 2000 and 5.8 million by 2005. Projected growth is down sharply from the 1989-94 period, when soybean oil trade expanded 8 percent annually in response to U.S. and EU subsidies, and rising demand from developing countries. Slower trade growth during 1996-2005 is expected as a result of reduced U.S. export subsidies and negligible oilseed expansion in the EU, combined with higher relative soybean oil prices that are expected to shift demand toward competing oils. In addition, many vegetable oil markets are subject to import duties and state trading, and market access gains stemming from the Uruguay Round agreement are expected to be negligible.

Although the soybean oil share of world vegetable oil trade is projected to decline, the U.S. share of the soybean oil export market share is virtually unchanged through 2005. Reduced export subsidies, sharp output gains in other vegetable oils, especially palm oil, and limited growth in domestic soybean oil production, are expected to prevent growth in U.S. market share. U.S. soybean oil exports are projected to remain at.9 million tons through the projection period.

World disappearance of soybean oil is projected to expand 2.2 percent annually during 1996-2005, virtually unchanged from the 1980's, but slower than the 4.1 percent growth achieved during 1989-94. Consumption gains are expected to be concentrated in Asia and South America, with little growth expected in the Middle East, North Africa, Central America, and the Caribbean. Foreign soybean oil production is projected to rise 2.5 percent annually and reach 16.2 million tons by 2005. Growth in soybean processing in Mexico, Brazil, Argentina, India, and China is expected to account for most of the projected gains in foreign soybean oil production.

Importer Developments for Soybean Oil

Income growth in China, India, and Pakistan, which together account for more than a third of total world population, is expected to be a significant determinant of vegetable oil trade growth during 1996-2005. Despite high internal prices and import controls in these countries, consumption of vegetable oils is expected to expand considerably. However, soybean oil imports are expected to play a lesser role because of higher relative market prices compared to other oils, particularly palm oil reflectin insufficient global soybean oil supplies. Palmoil is expected to meet the largest share of this consumption growth. Indonesia, a major producer, will consume much of its own palm oil, while China, India, and Pakistan are expected to import palm oil because of relative prices and proximity to producers.

[2] Soybean, Palm, Cotton, Coconut, Rapeseed, Sunflowerseed, Peanut, Fish and Olive .

Since the projected growth in vegetable oil demand during 1996-2005 is highly dependent on expected economic growth in developing countries, the projections are sensitive to the macroeconomic outlook for these countries. The import demand projections are also sensitive to the assumption that no major changes in market access for vegetable oils. Since a number of major markets, including China, India, and Pakistan have significant access barriers, unanticipated unilateral **reforms** could have a significant impact on the trade projections.

India's gains in per capita income will boost oil demand, but imports of soybean oil will be restrained by increasing domestic production, continue state trading, and limited consumer acceptance of soybean oil as a pure cooking oil. Palm oil is expected to account for the bulk of Indian imports due to better consumer acceptance and low delivered price relative to other oils.

Strong economic growth in China combined with limited gains in domestic soybean production, are projected to raise soybean oil imports. However, growth is expected to be moderated by rising soybean imports, greater consumption of other vegetable oils, and the relatively high level of vegetable oil use already achieved in urban areas. Despite internal soybean oil production based on imported soybeans, soybean oil imports are expected to resume growth **after** 2000 and reach 1.4 million tons by 2005. China is also expected to increase consumption of rapeseed, palm oil and cottonseed through domestic production and larger imports.

China's per capita consumption of vegetable oil is projected to slow because of the relatively high level of use already achieved in urban areas. However, strong economic growth in China, combined with limited gains in domestic soybean production, are projected to lead to modest growth in soybean oil imports. China's soybean oil import growth is also expected to be moderated by rising imports of soybeans and greater consumption of other vegetable oils. Despite internal production increases based on imported soybeans, soybean oil imports are expected to resume growth **after** 2000 and reach 1.4 million tons by 2005.0 China's is also expected to increase consumption of rapeseed, cottonseed and palm oil through domestic production and larger imports.

Assessment of China's **future** vegetable oil consumption and trade growth given the size of the market, constitutes a major uncertainty in the world trade outlook. While it is unlikely that the recent high growth in consumption and imports will be sustained because of an evident built of stocks and the levels of per capita use already achieved in urban areas. The **future** responsiveness of demand to income and prices will be critical to the trade outlook. Small adjustments in projected rates of **oilseed** area or yield growth can also have a significant impact on trade. Finally, China's vegetable oil trade remains a monopoly, with import decisions subject to arbitrary change that are necessarily based on market forces.

Import demand for soybean oil in the Middle East and North Africa is projected to decline as a result of the gradual reduction of U.S. export subsidies and the limited gains in EU **oilseed** production. Consumer preferences, higher relative soybean oil prices, and tight balance of payments positions likely will also induce shifts to substitute oils, such as palm and sunflower.

In Latin **America,** total soybean oil imports are expected to grow steadily through 2005. While Mexico, Central **America,** and the Caribbean show almost no growth, South American imports are projected to expand sharply during 1996-2005. Mexico's soybean oil imports will decline, because most demand will be met by soybean imports. In Central America and the Caribbean, higher relative soybean **oil** prices are expected to dampen growth through 2000, with higher incomes revitalizing demand growth thereafter. The non-producing countries of South America are projected as the fastest growing soybean oil market during 1996-2005. South American demand is expected to stems from robust economic growth, consumer preference for soybean oil, and proximity to the major producers. The U.S. is expected to gain share in this market with increasing commercial sales.

Most soybean oil trade during 1996-2005 is anticipated to be in the form of commercial sales. Under these conditions, demand in markets such as **Sub-Saharan** Africa, Eastern Europe, and the FSU is expected to remain suppressed. In the FSU and Eastern Europe, expansion of soybean oil trade may also be hindered by increasing production of high-oil-content seeds, such as sunflowerseed and rapeseed.

Exporter Developments for Soybean oil

Unlike imports, exports of soybean oil are concentrated in the United States, Argentina, Brazil and the EU, which together account for more than 90 percent of world soybean oil exports.

Growth in Argentine soybean oil exports is expected to slow as land constraints limit annual growth in soybean production to 2 percent, compared with nearly 18 percent during the 1980's. Nevertheless, Argentina is projected to remain the largest exporter of soybean oil due to its small domestic market. In Brazil, on the other hand, keen domestic demand is expected to prevent any growth in soybean oil exports despite gains in domestic production.

U.S. soybean oil exports are projected to fall marginally by 2000, as export subsidies are reduced and commercial sales play an increasing role in world and U.S. exports. Beyond 2000, the United States is expected to regain price-competitiveness, but tight domestic supplies will limit the U.S. response to higher prices and growing world demand for soybean oil.

CAP reform and the U. S.-EU Oilseed Agreement are expected to restrain expansion of oilseed (soybean) production in the EU by limiting the area available for production. Higher soybean oil production from larger soybean imports will likely meet any increase in domestic consumption, resulting in roughly constant EU soybean oil exports during 1996-2005.

The World Outlook for Cotton: The Next 10 Years

by

Stephen MacDonald[1]

Summary

USDA's baseline estimates for cotton show world cotton consumption rising 2.3 percent annually through 2005, reaching more than 108 million bales. World trade in cotton is expected to remain at more than 30 percent of consumption, a significant slowing of the long-term trend of a declining importance of trade. The United States is expected to maintain a share of world trade of about 25 percent, and U.S. cotton exports grow to more than 8.5 million bales.

Introduction

The cotton trade forecasts through 2005 presented in this paper result from an annual projection exercise conducted by the Economic Research Service (ERS), in cooperation with other USDA agencies, for USDA's budget projections. The baseline presented here is a scenario, based on a set of assumptions, rather than a forecast. Policy assumptions include a continuation of 1995 U.S. farm policies through 2005. New farm legislation in 1996 means this assumption will not be realized, but projections based on the new legislation are not complete. Changes deriving from the new legislation are expected to have only a small impact on the international cotton outlook. Other policy assumptions include a continuation of current policies or current policy trends in other countries. Economic liberalization is expected to continue in Latin America, Eastern Europe, Africa, India, and China. World Trade Organization (WTO) commitments by member countries are assumed to be met, including, a reduction in subsidized grain exports, and gradual liberalization of textile imports. Finally, it is assumed that the European Union adds no new members, and that China, Taiwan, and the Former Soviet Union's republics do not become members of the WTO.

The economic assumptions underlying the baseline estimates include average growth in gross domestic product (GDP) for the industrialized countries during 1997-2005 of about 2.5 percent. China's GDP growth is expected to range from 10 percent at the beginning of the period to about 7 percent at the end. The Former Soviet Union is expected to average a 3 percent GDP growth. Inflation is expected to be a little higher than currently--about 4 percent during 1997-2005 for the U.S. consumer price index--and oil prices are assumed to rise 2.2 percent annually. Normal weather is assumed over the entire forecast period, and the historical long-term trend of declining real costs of production and prices for field crops is expected to continue.

USDA's annual baseline exercise is overseen by USDA's World Agricultural Outlook Board, and includes contributions from other agencies, including ERS and the Foreign Agricultural Service for the international estimates. ERS has developed models for every major agricultural producing or

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consuming country or region of the world that area key analytical input to the baseline exercise . These country models are linked and solved simultaneously across countries and commodities to ensure consistent and economically sound results. Macro-economic assumptions are based on forecasts by DRI-McGraw Hill, the International Monetary Fund, and Project Link forecasts. The oil price forecasts are from the U.S. Department of Energy. The assumptions and methodology of the baseline are more fully described in the WAOB'S Staff Report WAOB-96- 1, Long-term Agricultural Projections to 2005.

Results

World cotton trade is expected to average 1.8 percent annual growth during 1996-2005, largely reversing the declines suffered during the previous 10 years. World cotton trade fell from a peak of 33.4 million bales in 1986 to as low as 25.6 million in 1992, in large part due to declining Russian imports. Import growth is foreseen in Russia and elsewhere after 1995 and, by 2005, world exports are projected at about 33 million bales.

U.S. exports are expected to trend up during the 1990's and beyond, growing to 8.6 million bales by 2005. The U.S. share of world trade is likely to average about 25 percent, as many foreign producers reduce raw cotton exports by channeling production toward consumption and value-added textile products. U.S. exports are expected to rise 1.8 percent annually during 1996-2005, about the same as world trade.

Both foreign consumption and production growth have slowed to negligible rates during the last 10 years, but are both expected to rebound to about their long-term average growth of 2.2 percent per year. The projection for world cotton consumption to expand at an annual rate of approximately 2.3 percent during 1996-2005 underpins the outlook for relatively strong rate of import growth. However, a key uncertainty in the projection is the extent to which the recent gains in cotton consumption associated with a shift in consumer fiber preference toward cotton, and away from synthetics, can be sustained.

Foreign production has stagmted in recent years, as smaller harvests in China and the FSU have offset gains elsewhere. High levels of input use and poor water management have rendered useless much of the area abandoned in Central Asia during the 1990's, and pesticide resistance has hampered production in China. Further losses in these regions are not expected, and China's and Central Asia's production is expected to resume growth, although not as quickly as elsewhere.

The rapid consumption growth of the early 1980's, spurred by prolonged economic expansion and sharp share gains versus other fibers in some markets, is not expected to resume. In the short term, consumption growth in the traditional developed cotton importers is likely to be constrained by relatively sluggish economic performance, and in Eastern Europe and the FSU by economic restructuring. In the long term, the liberalization of textile trade under the Uruguay Round Agreement will also constrain cotton imports by the most developed traditional importers, such as the EU and Japan. In contrast, rapid consumption growth is expected in many developing countries and steady growth is expected to continue in major cotton producing countries. However, the pace of this structural shift will depend on the implementation of the phase out of the Multifiber Arrangement. While it is anticipated that the most significant changes will probably be delayed until the end of the

implementation period, large uncertainties remain about the timing of liberalization and shifts in garment production both to and among developing countries.

Importer Developments for Cotton

Global cotton trade to 2005 will depend largely on consumption patterns in importing countries. World trade contracted for two reasons beginning in the late 1980's--the virtual collapse of Russia as a consumer and importer of cotton, and the continued shift of spinning from traditional importers to cotton producing countries. Russia's cotton consumption fell almost 80 percent between 1989 and 1994, to 1.2 million bales, during the restructuring of Russia's political, economic, and foreign trade systems. Elsewhere, other traditional cotton importing countries found it less expensive to purchase cotton yam and fabric for their textile industries as inexpensive textile imports flooded their markets, particularly from Pakistan. These imports took the place of imported raw cotton.

With Russian and East European consumption projected to rebound, world cotton trade is likely to grow during the next 10 years. Also, pest and disease control problems have severely constrained Pakistan's ability to maintain its earlier growth rates in cotton consumption and textile exports, thus strengthening prospects for raw cotton demand by some cotton-importing textile exporters who will face less competition. Finally, several countries that were sources of cotton exports during the 1980's are expected to be growing importers instead. In past years, increasing consumption in Mexico, Brazil, and China in part represented shifts in consumption from importing countries to non-importing producers. As consumption gains have steadily out paced production in all three countries, they have begun to drive world trade higher rather than lower as in the past.

- In the traditional cotton importers (Japan, South Korea, Taiwan, and the EU) consumption is expected to decline steadily after a short pause during the mid- 1990's. Strong competition from emerging Asian textile suppliers and comparative production disadvantages again accelerate declines in their raw cotton consumption after 2000.

- China is expected to raise both production and consumption, but, in the long-run, consumption is expected to grow more rapidly. China's imports have risen in the last few years and China is expected to remain a growing net importer. Intransigent bollworm infestations in the North Chim Plain have hampered the crop in China's pre-eminent growing region. Also, rapid economic growth has increasingly turned land over to non-agricultural pursuits and robbed agriculture of investment funds for inputs and improvements. Soaring grain prices and an increasingly affluent population's demand for a greater variety of foods have increased the area of other crops at the expense of cotton.

  China's future production and consumption prospects are both subject to considerable uncertainty. Since China is projected to be the world's largest importer over much of the projection period, differing assumptions on supply and use developments could significantly influence world trade and U.S. exports. Specific areas of uncertainty include the extent to which current insect control problems that have hampered production can be solved and the extent to which cotton consumption, which has apparently stagnated since the late 1980's, will respond to sustained economic growth.

- Indonesia and Thailand resume rapid consumption and import expansion through 2005 as they

benefit from comparatively cheap labor, favorable exchange rates, and foreign investment in their textile industries.

- After 4 years of significantly lower cotton consumption, some Eastern European countries and the FSU are beginning to increase consumption again. Gains in consumption and imports will begin slowly and from a much lower level than historically. In most of these countries, cotton consumption and imports are expected to remain well below historical levels.

  Future demand prospects in the non-producing Republics of the FSU and Eastern Europe are a major uncertainty in the trade outlook. As their economies recover, it is not clear if their textile sectors will expand at the same rate as the overall economy, grow faster as a result of promotion aimed at achieving quick gains in export earnings, or be abandoned due to import competition.

Exporter Developments for Cotton

Foreign export growth is expected to recover during the period, but still remain below the long term trend. By 2005, foreign exports are expected to total 24.5 million bales. Foreign export growth will be supported by some resumption of trade relations between cotton-producing and noncotton-producing countries of the FSU, and by growing import demand from Chim and Latin America.

- Australia, the French-speaking countries of West Africa, and Paraguay will continue to channel the vast majority of their cotton output into the export market throughout the period.

- Pakistan is expected to maintain some regulation of raw cotton exports, favoring domestic producers of products for export over exports of raw cotton. However, restrictions on raw cotton exports are expected to be less severe than in the past, leading to some growth in raw cotton exports, as well as some strengthening of domestic producer and consumer prices, during 1996-2005.

- India, with much potential for yield improvement, is expected to raise exports moderately. However, as with Pakistan, India's export growth will be limited by strong growth in domestic consumption, and in exports of yarns, cloth, and garments.

- The Central Asian countries of the FSU will continue exporting cotton to non-FSU markets at higher levels than during the 1980's. These countries are also expected to increase their exports within the FSU. The mix between FSU and non-FSU sales will depend on the willingness and ability of importers elsewhere in the FSU to offer either hard currency or other compensation sufficient to offset lost hard currency earnings. Long-standing transportation and other links among the FSU countries may help facilitate trade. Central Asia's ability to export, however, will be heavily dependent on yield gains. Past environmental darnage is expected to keep some land out of production indefinitely and efforts to diversify agricultural production will sustain area for grains and other crops at the expense of cotton. However, supply prospects in Central Asia are an important uncertainty in the world trade outlook.

- Some traditional cotton exporters, such as Brazil, Mexico, Central America, and Turkey have substantially reduced cotton exports while increasing imports to meet more rapidly expanding

consumption needs. These trends will continue, and with theexception of Turkey, these countries will be growing net importers of cotton.

World Coarse Grains and Rice Outlook and Issues for 2005

by

Carolyn L. Whitton[1]

USDA's annual agricultural outlook projections are a conditional scenario, with no shocks, based on specific assumptions. These projections are presented in USDA's outlook publication, Long-term Agricultural Projections to 2005. The projections are not intended to be a Departmental forecast of what the future will be, but instead a description of what would be expected to happen with an extension of the 1990 U.S. agricultural law, as amended in mid-January 1996, and with very specific external circumstances .The projections do not reflect major agricultural policy decisions made after mid-January 1996, including passage by the Congress of a new U.S. farm bill. The short-term projections for 1996/97 also incorporate the long-term assumptions and do not reflect short-term conditions and have not been updated to match forecasts in the most current issue of the World Agricultural Supply and Demand Estimates.

Normal (average) weather is assumed Also assumed is strong global macro economic growth averaging about 3 percent per year and well above the growth during the first half of the 1990s. Growth in developing countries, particularly, is somewhat faster than in the past decade. Although real prices generally continue to decline, as in the past, the decline slows for many crops, including grains, as nominal prices throughout the decade remain slightly higher, particularly for grains, than in the 1980s and early 1990s. Further enlargement of the European Union (EU) beyond the current 15 members is not assumed, although some East European countries could become members during the projection period. Additional EU member countries will be incorporated into the projections for the EU after they have actually joined .Likewise, China and Hong Kong remain separate countries in these projections.

Global trade is anticipated to be liberalize in accordance with the Uruguay Round (UR) agreement. Thus, for many countries, agriculture responds more to signals from the marketplace and less to government programs than in the past. The United States' annual quantity and expenditure levels for the Export Enhancement Program (EEP) are assumed to be in compliance with UR reductions and utilized to the full extent. The EU also is assumed to utilize export subsidies to the full extent permitted, except EU coarse grain exports are unlikely to reach the maximums allowed in the agreement before the year 2000. Credit assistance finding provided through the U.S. GSM program s assumed to continue at current levels. And current PL480 funding levels also are maintained, implying declining quantities available under of PL480.

Some of the assumptions focus on the most likely scenarios for countries which contribute a high degree of uncertainty to the projections. Alternative progress for these countries, of course, could dramatically affect the results. Chim's agricultural policy is expected to continue to move gradually towards greater liberalization, increasing the role of market forces in China's production, consumption, prices, and trade, while central government planning declines for most crops. China's economic growth is forecast to continue at a rapid rate, but to decline from its recent highs. Present FSU policies of market reform are expected to continue, but the transition to a market economy, particularly in agriculture, will occur slowly. Positive, but slow, rates of economic growth are expected to occur in Russia--and in the FSU as a whole–by 1998, even though recovery is expected to occur later in most republics other than Russia. In addition, the projections do not take into account the possibility that Chim or any of the FSU countries will become members of the WTO because negotiations are ongoing

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and it is impossible to predict either a date of entry or provisions of the final agreement.

Rice Trade

Rice trade is projected to grow 1.9 percent annually during 1995-2005, with growth strengthening after 2000. Anticipated growth about the same as in the 1980's and the early 1990's, but slower than in the 1970's. World trade is forecast to reach 17.4 million tons by 2000 and 19.6 million tons by 2005. Trade is expected to continue to consist predominantly of long grain varieties, despite anticipated gains in medium-grain (japonica) rice trade in Japan, South Korea, and Taiwan under the UR agreement. Nominal prices are expected to rise throughout the projection period, while real prices continue to fall--although less rapidly than in the past. Global medium-grain prices are expected to rise relative to long-grain prices due to limited world japonica production capacity.

Foreign production is forecast to rise gradually, growing about 1.3 percent per year. Growth in the 1990's is expected to slow relative to the 1970's and 1980's when irrigation expanded more rapidly in Asia, and Green Revolution technology was widely adopted. Slower production growth stems primarily from a projected slowdown in yield increases. Global acreage growth is expected to remain negligible, as it has since 1975.

Foreign consumption also is projected to rise about 1.2 percent per year, markedly slower than during the 1980's. Consumption in higher income Asian countries has been, and is expected to continue to, decline as larger portions of the population achieve middle class incomes and consumption of rice declines in favor of other foods, such as wheat products and meat. Per capita rice use in other countries, including China and India, is projected to reach the stage where it flattens or declines during the coming decade as consumers primarily shill from lower-quality to higher-quality rice varieties and some diets begin to diversify in response to higher incomes. These developments are expected to offset consumption gains in other regions, primarily lower income rice-producing countries and higher income non-producing countries, where per capita rice use is still rising.

The rice export market share for the United States between 1990 and 1995 varied from 15 to 18 percent. It is expected to remain at about 17 percent during 1996-1999 before declining gradually to about 14 percent by 2005. Minimal U.S. production gains, strong domestic use, and high prices relative to competitors are expected to limit the volume of U. S. rice exports. Total U.S. exports are projected to drop to 2.7 million tons, while total imports rise to 0.6 million tons, leaving net U.S. exports of 2.1 million tons in 2005.

As a major exporter of medium-grain rice, the United States will benefit significantly from the UR agreement. But, despite significant market access gains in East Asian medium-grain markets under the UR agreement, total U.S. rice exports do not expand in the baseline. The extent of U. S. gains in medium-grain markets depends on U.S. capacity to expand production and exports on a sustainable basis. California, the most efficient U.S. producer of japonica rice, faces environmental restrictions on expanding acreage and yields. The outlook for a widening long-grain export price premium implies that the U.S. will lose some of its long-grain exports in the more "price-sensitive" markets. Further, under freed budget levels, higher domestic prices imply lower program-assisted exports.

Historically, rice trade and prices have exhibited greater volatility than the other cereals. This volatility stems from the dependence of many large producers and traders, including Burma, India, Thailand, and Vietnam, on rainfall during the Asian monsoon season, and from the fact that only a small share (less than 5 percent) of world rice production is traded. These factors will continue to affect the world rice market during 1995-2005, with the potential to create dramatic annual swings in

trade and prices that could deviate significantly from the trends projected in this baseline.

Importer Developments for Rice

Rice import growth will be fueled by the needs of China, Indonesia, the Middle East, and Central America and the Caribbean. For the first time, Indonesia is expected to be a steady net rice importer, but its imports are projected to decrease over time as consumption growth slows and yields continue to rise. China is also projected to becomes a small net rice importer. Developing countries, particularly in Asia, continue to account for the bulk of the gains in import demand.

Until recently, Indonesia was self-sufficient in rice. But, in 1993/94, Indonesia became a net rice importer when population and income growth increased rice demand faster than output. Through 2001, as supply growth slows and population and incomes continue to rise, imports of 0.8- 1.3 million tons a year are expected. However, the Indonesian government maintains a goal of rice self-sufficiency and plans an expansion of rice area off Java that, along with increased diet diversification, is expected to reduce imports after 2002.

Indonesian rice trade has historically been volatile, ranging from the world's leading importer during the 1970's, to self-sufficiency in the late 1980's, and back to significant imports in recent years. Significant imports are projected to continue, but the outlook is heavily dependent on government trade and producer policies, and the progress of rice technology off Java.

In 1994/95, China also became a net rice importer, and annual net imports of 450,000-700,000 tons are projected to continue through 2005. Rice area is forecast to continue to fall, as demand growth slows, prices for competing crops rise, and other uses absorb more agricultural land. Southern China's lower-quality indica rice will likely account for much of the area decline because imports from Vietnam or Thailand are an attractive option in this region. At the same time, demand will likely strengthen for higher-quality japonica rice produced in northern China, even as rice land in this region is also pressured by competing uses. Japonica demand is expected to be driven by increased quality consciousness among higher income Chinese consumers and the lucrative Japanese and Korean export markets.

China's future rice trade will be affected by policy and technology factors. The extent to which China becomes a net importer of low-cost Southeast Asian rice depends on whether future policies are guided by self-sufficiency or comparative advantage goals. Further, because of China's size and the fact that its rice trade is a very small portion of production or consumption, only small adjustments in supply or demand projections can yield globally significant changes in trade.

Other Asian countries are projected to lead the gains in developing country rice imports during the next decade. In the Philippines, production growth is expected to continue to fail to keep pace with income-generated consumption growth. Malaysia's rice imports are projected to rise as declines in rice area more than offset productivity gains due mechanization and irrigation. In these countries, however, potential import gains are likely to be moderated as diet diversification begins to lead to declining per capita rice use.

Under the terms of the UR agreement, minimum access in the high-valued japonica markets of Japan and South Korea will grow from an initial 490,000 tons in 1995 to 963,000 tons by 2005, straining the world's japonica supplies. Judging from Japan's 1994 experience, there is a near-total lack of consumer acceptance of substitute long-grain rice varieties for food use in these countries.

The already large Middle Eastern import demand is projected to grow steadily, driven by per capita

income growth and steady or rising per capita consumption levels. Income growth in most Middle Eastern countries is expected to be faster than during the 1980's and early 1990's.

Central American and Caribbean consumption growth is expected to outpace the slipping production, resulting in strong import gains through 2005. Imports are projected to rise from 0.7 million tons to 1.2 million tons.

Brazil's import demand is projected to remain steady near 1 million tons through 2005. Growth in domestic production is expected to offset a rapid increase in consumption driven by population growth and an improving economy.

Import demand for rice in Canada, the EU, Other Western Europe, and Eastern Europe is projected to expand from 1 to 1.2 million tons during the decade, a slow, but steady, average annual rate of growth of just over 1 percent.

FSU rice imports, mainly into Central Asian republics, are projected to recover to about 400,000 tons during 2000-2005, but remain well below their 1978-81 peak.

Relatively high prices are expected to dampen growth of commercial sales of rice to developing markets with limited resources, preventing conversion of all of their potential demand into effective demand. Limited import growth by Sub-Saharan African countries, as well as the FSU, stem largely from limited commercial import capacity. Growth in consumption and imports for these and other low-income countries often depends on availability of credit or food aid, particularly from the United States. Given the outlook for U.S. rice to sell at an increasing premium in the world market, U.S. market share could decline further if the availability of U.S. credit and food aid is less than assumed.

Exporter Developments for Rice

Exports from many of the major rice producers are projected to increase as demand for rice rises and prices strengthen. Thailand is projected to remain the largest exporter, but with slow export growth. Exports from India are expected to show the largest gains, with India projected to consolidate its position as the third largest exporter by 2005. Although Burma and Pakistan are expected to expand exports, they slip slightly in importance as India rises. While Vietnam is likely to remain a large exporter, more of its rice is expected to be consumed domestically. And, although China's exports are expected to show no growth, only Australia, China, and the United States are likely to be viable long-run sources of supply for the medium-grain japonica rice for Japan and South Korea's UR market openings.

Thailand's production growth is expected to exceed its flat consumption, enabling exports to rise slightly. While rice area is projected stable, yield growth is projected above trend in response to stronger prices. Projected exports keep pace with gains in world trade, keeping Thailand's share of world trade at about one-third.

Since the mid-1970s, with the exception of a couple of poor years, India has been a net exporter of less than 1 million tons of rice each year. During the projection period, India is expected to continue increasing its net rice exports, becoming a steady exporter of 2 million tons of rice by 2005 and raising its' world market share from 4 percent in 1994 to 10 percent in 2005. In 1995 and 1996 India sought to establish new export markets to dispose of a large surplus stock of rice. But India's future rice exports are expected to remain below the surplus-generated peaks now estimated for 1995 and 1996 while it works on improving its transportation infrastructure and exportable rice quality in order to insure a consistent supply for its' newly-established markets. As in the 2 recent years, even though

exports of aromatic basmati rice (comprising nearly 50 percent of exports in 1994) are projected to rise, exports of non-basmati varieties are expected to account for most of India's gains by 2005.

India's ability to supply the projected level of exports is dependent on two key factors. First, government policy must be consistently supportive of an export orientation by maintaining producer incentives and promoting improved standards and grading. Second, it is uncertain how India's own rice consumption will respond to the relatively high sustained growth in incomes that is projected during 1995-2005, and the extent to which the government will use subsidized public distribution to moderate domestic rice prices.

Burma's second-crop rice harvest, principally destined for export markets, has been revived and exports have increased in recent years. But, in 1995, exports occurred before domestic production was assured, causing unrest. In the near future, as problems with the second crop are ironed out, it is expected that rice will be exported only after domestic needs are filled. However, exports are expected to expand rapidly and reach 2 million tons by 2005, with most of the gains occurring between 2000 and 2005.

Burma's agricultural policy is not market-oriented and future developments are highly dependent on domestic policy developments. While it is assumed that policies will continue to promote both expanded production of the irrigated second-crop and rice exports, actual policies could result in rice exports that are significantly higher or lower than is projected.

Pakistan's rice exports are projected to rise to 1.7 million tons by 2005. Yield growth is expected to be slowed by the expansion of area of lower-yielding basmati rice. Basmati's share of rice exports is projected to rise.

In Vietnam, exportable surpluses are expected to be eroded by rising consumption generated by population and income growth. Limited increases in arable land, combined with already high levels of input use, are projected to prevent rice production from maintaining the same pace of growth achieved in the late 1980s and early 1990s. Rice exports are projected to drop from recent levels to 1.8 million tons by 2005, but better milling facilities are expected to raise export quality.

Higher production is expected to generate increased exports by South America. However, most of these exports are intra-Latin American, going to Brazil, Peru, and Mexico from Uruguay, Argentina, Paraguay, and other producers. Guyana is the principal exception exporting rice to Central America, the Caribbean, and the EU.

Despite the poor acceptance of China's japonica rice in Japan in 1994, China is still expected to be a small, but important supplier of japonica rice to Japan and South Korea. While China's disadvantages in this market are numerous, including inadequate infrastructure for reliable delivery and poor-quality processing, its advantage is the proximity of north China production to the Japanese and South Korean markets.

In Australia, as in California, constraints on expanding rice area are expected to limit increases in exportable supplies of japonica rice to those that can be achieved through higher yields. As a result, like the United States, Australia will likely be forced to shift exports away from existing markets in order to respond to the high prices offered by Japan and South Korea.

Coarse Grains Trade

Reversing a decline that began in the early 1980's, world import demand for coarse grains is projected to strengthen through 2005, with annual growth averaging 3.2 percent. Global coarse grain trade is projected to grow to near 117.4 million tons by the year 2005, exceeding the record of 107.9 million tons reached in 1980/81. Higher coarse grain imports by China and developing countries in Asia and Latin America are expected, along with modest import growth for the FSU--one of the world's largest importers during the 1980's. The limited availabilities of competitively priced feed wheat will add to coarse grain imports during the projection period.

Corn trade is expected to show the most growth among the coarse grains, with trade expanding 43 percent to 87.5 million tons between 1996 and 2005. The largest gains in corn imports are expected to occur in China and Southeast Asia, where demand for feed for livestock is expected to continue expanding rapidly. Although Argentina's corn exports are expected to rise by about 5 million tons, the United States will be the major beneficiary of robust import demand for corn. U.S. exports of coarse grains are projected to grow 3.8 percent annually over the projection period. By 2000, U.S. coarse grain exports are likely reach 70 million tons with corn exports accounting for 61.6 million tons. By 2005, U.S. coarse grain exports are projected to increase to 79 million tons, well above the record 71 million tons of 1979/80, with corn accounting for 69.9 million.

Barley trade is projected to remain virtually unchanged, while trade in sorghum and other coarse grains is projected to rise by 3 million tons, or 29 percent, during the projection period. Barley trade is expected to be constrained by the relatively higher prices of other grains, as Canada and Australia expand area of wheat, canola, and malting barley at the expense of feed barley. In addition, the UR agreement limits on EU coarse grain exports also will reduce exportable supplies of feed barley. Growth in demand by barley importers, particularly in North Africa and the Middle East, is expected to be slowed by tight supplies, high prices, and substitution of other feeds. Future responses by barley exporters to expected higher relative prices for competing crops (wheat and canola), and by barley importers to expected increases in the price of barley relative to other feeds, will be major factors in the outlook for coarse grain trade.

The U.S. share of the world coarse grain market is projected to maintain its recent high levels, 67-68 percent throughout the period. Projected market share is only slightly below the 1979/80 record of 72 percent and well above the 58 percent average of 1990-95. The U.S. share of the world corn market in 2005 is projected at 80 percent, compared with the 1990-1995 average of 72 percent.

Foreign coarse grain production is projected to rise through 2005, as higher yields and small gains in area reverse the downward trend of the 1980's and early 1990's. Foreign corn and barley production, in particular, are expected to respond to higher prices after 2000. However, projected annual coarse grain yield growth of 1.4 percent, is a little less than the nearly 2 percent average annual growth of the previous decade. Foreign corn production is projected up about 2.3 percent per year during the projection period, nearly the same as growth expected for foreign corn consumption.

Growth in foreign coarse grain consumption is expected to be stronger than during the 1980's, but projected annual growth of 1.8 percent through 2005 is only about 75 percent that of the 1970's. Corn is expected to account for most of the growth, with foreign consumption projected to grow 2.5 percent annually. Most consumption growth is expected to be in China and in developing countries in Latin America and Asia where livestock output and feed demand are expanding rapidly as incomes rise. Growth in foreign barley use is expected to be constrained by tight supplies.

Competitor coarse grain exports have dropped sharply since the early 1990's, as lower foreign production and China's sharply lower exports pulled down foreign market share from a recent high of 53 percent in 1993 to only 31 percent in 1995. Foreign coarse grain exports are projected to rise,

particularly after 2000 when import demand and prices strengthen, but remain below the highs of the early 1990's.

Importer Developments for Coarse Grains

About two-thirds of global coarse grain supplies are used as animal feed, and coarse grain that is traded is mainly used as feed. Thus, projected gains in coarse grain use and trade are linked closely to higher incomes that stimulate more meat consumption, along with population growth. Industrial uses, such as starch production and malting, are relatively small but growing. Food use of coarse grains is concentrated in parts of Latin America, Africa, and Asia, and has generally declined over time as consumers tend to increase consumption of wheat or rice as their incomes rise. However, the decline in coarse grain food use will have little effect on trade.

Imports of coarse grains for livestock feeding are projected to strengthen dramatically in the baseline, fueled by strong per capita income growth in developing countries, such as China, southern Asia, Mexico and South America, and the Middle East and North Africa. Korea and Taiwan are also expected to remain important importers, but import growth slows. Japan's imports are likely to wane as increasing meat imports reduce domestic demand for feed grains; but Japan is expected to remain the largest single coarse grain importer.

Japan's coarse grain imports are expected to decline because of a contraction in feed use as meat imports increase. The projected drop in feed demand is expected to be only partially offset by rising imports of industrial-use corn in response to minimum access requirements under the UR agreement. Projected imports in 2005 are 19.5 million tons.

China shifted to a net com import position in 1994/95 and net imports are expected to continue to rise through 2005. China is expected to overtake Korea as the second largest coarse grain importer in about 2004. Strong economic growth is expected to raise meat demand and push up corn imports. China is expected to import feed grains in order to support growth in meat production and moderate the pressure of rising incomes on meat prices. In 2005, China's net corn imports are projected at 10.7 million tons. Substantial growth in malting barley imports to produce beer is also anticipated, with barley imports reaching 2.1 million tons in 2005.

The expected emergence of China as a large and growing corn importer is, perhaps, the key development in the projections for U.S. and global coarse grain trade. However, the size and pace of future Chinese imports is very uncertain because they are dependent on policy developments and supply and demand uncertainties.

South Korea is projected to continue moderate growth in coarse grain imports, reflecting a buoyant economy, a growing livestock sector, and strong feed demand. By 2005, South Korean corn imports are expected to reach 12 million tons, up about 80 percent from the 1990-94 average. Limited availability of competitively priced feed wheat contributes to this strengthening demand for corn.

Mexico's corn and sorghum imports are projected to grow sharply as rising incomes boost demand for meats. Corn imports are projected at 5.1 million and sorghum at 4.6 million in 2005. Mexico is expected to continue to allow duty-free corn imports above the NAFTA TRQ level (3.46 million tons in 2005). Sorghum imports are projected to expand more rapidly between 1996 and 2000, despite gains in Mexican sorghum area under PROCAMPO. Growth in corn imports is expected to strengthen slightly after 2000, when growth in demand begins to outstrip production gains. Corn food use is also projected higher, reflecting relatively strong population growth among the poorest consumers.

Taiwan's coarse grain imports are projected to rise to 7.5 million tons in 2005, making it the fifth largest coarse grain importer, after Mexico. Incentives for diverting rice land to coarse grain production were eliminated in 1995, and other measures protecting domestic coarse grain output are also being phased out. The expected decrease in coarse grain production, coupled with growth in meat production to keep pace with stronger growth in meat demand, are expected to raise import demand for coarse grains.

North Africa and the Middle East, South America, Central America and the Caribbean, and Southeast Asia are just beginning to expand livestock production, following the pattern of East Asia during the 1980's. Income growth through 2005 is projected to be stronger than during the 1980's in North Africa, the Middle East, and much of Latin America. Continued strong economic growth in Southeast Asian countries, such as Malaysia, the Philippines, Indonesia, and Thailand is projected to push up meat production and feed grain demand.

The FSU is responsible for most of the drop in global coarse grain trade in recent years. Coarse grain imports by the countries of the FSU are projected to rise only modestly through 2005, constrained by lower than historical livestock inventories, the impact of higher prices on consumer demand, and lack of foreign exchange and credit. FSU imports, which ranged between 11 and 28 million tons in the 1980's and early 1990's, are projected to continue to decline through 1997, then respond to resumed economic growth and rise to 3.8 million tons by 2005.

The timing and extent of any recovery in coarse grain imports by the FSU are uncertain because they are dependent on the pace of economic and farm sector reform, and on the availability of financial assistance from exporters. Changes in the outlook for economic growth, improvements in infrastructure which reduce waste, or gains in farm productivity, could alter the trade projections significantly.

Saudi Arabia, the world's largest barley importer, is projected to maintain annual imports of 3.1-3.4 million tons through 2005, as import growth is constrained by limited global feed barley supplies. Current Saudi policy reforms are also expected to sharply reduce producer subsidies and limit growth in barley production. With constrained global and domestic barley supplies, meeting the projected livestock sector growth will be difficult, and a rising share of feed demand will be met by imported corn.

The response of barley importers, including Saudi Arabia and other North Africa and Middle East countries, to tight global supplies and rising prices relative to other feed grains is an important area of uncertainty in the coarse grain projections. Slowed growth in feed demand and more substitution of com and other feeds is expected, but the relative size of these adjustments is difficult to assess.

Other North African and Middle Eastern nations also import significant quantities of barley, and imports will be restricted by the expected tight global supplies and high grain prices. Limited supplies of barley is expected to constrain growth in feed demand and stimulate imports of substitute feeds in the region. For some of the countries in the region, the ability to pay the high costs will be another source of constraint, particularly if exporter subsidization remains reduced.

Exporter Developments for Coarse Grains

Corn will account for the bulk of the projected sharp rise in coarse grain exports through 2005. Increases in sorghum and other coarse grain exports are expected to be relatively small, and virtually no growth is projected for barley exports. The United States, Argentina, and Eastern Europe are expected to expand com exports, with Argentina becoming the largest competitor as exports by China,

South Africa, and Thailand decline. U.S. sorghum meets nearly all growth in sorghum trade, mostly by Mexico and Japan. The FSU and Eastern Europe are expected to export as much barley as possible in response to higher prices. EU barley exports are expected to remain below UR limits on subsidized exports due to limited supplies. Canada's barley exports are expected to remain near current levels because of strong competition for area from wheat and canola. While Australia is projected to shift some barley area to malting barley to meet China's demand, exports of feed barley are expected to slow because of rising domestic feed demand, as well as area competition with wheat.

Argentina, with an abundance of good crop land, is expected to respond to higher coarse grain prices by sharply increasing corn area. Strong production gains are projected to push corn exports to 10.7 million tons by 2005 and make Argentina the world's second largest coarse grain exporter. In addition to gains in area planted, much of production growth is expected to be driven by improved yields aided by lower input prices that have already contributed to more use of fertilizer and chemicals. With even higher prices, additional land could be brought into production; but the more expansion of com area, the further production moves from traditional marketing channels and the greater the need to improve infrastructure as well.

Significant coarse grain export gains also are projected for Eastern Europe in response to higher world com and barley prices. Corn exports are projected to rise to 4 million in 2005 and barley exports are projected to rise to 1.9 million, making the region the world's fourth largest coarse grain exporter by 2005. Growth in domestic feed demand is expected to be relatively slow as higher prices resulting from market reforms weaken demand for meat products and increase feeding efficiency. Export growth will, however, depend on prices remaining firm because several of these countries support domestic prices at relatively high levels.

With barley exports by other suppliers expected to be constrained, the potential for exports of both com and barley from Eastern Europe and the FSU is an important factor in the outlook. Exports from Eastern Europe are expected to emerge more rapidly than from the FSU because market reforms are more advanced, the region has a history of exporting large amounts of coarse grain, and it recently exported in response to higher world prices. While the projections incorporate the expected growth of future trade, actual exports could be significantly higher or lower depending on domestic supply response to world market prices.

China's coarse grain exports are projected to decline through 2005 as strong internal com demand limits export availabilities. As noted above, however, the rate of decline of China's com exports is key uncertainty in the projections.

Exports from South Africa and Thailand are already significantly less than historical levels and are projected to nearly cease. Both countries are projected to be net corn importers throughout the projections. Thailand's domestic feed use of com is expected to maintain rapid growth. South Africa is not expected to increase corn area and demand is likely to eventually overtake supply as per capita income and feed demand rise.

The EU is projected to remain the world's third largest coarse grain exporter with exports of 8 million tons, including 6.1 million of barley, in 2005. EU feed demand is expected to increase in response to lower internal grain prices. Exports reflect limits specified for EU coarse grains under the UR agreement. The exception is barley, where tight supplies resulting from set-aside requirements and , higher feed use are expected to hold exports below UR subsidized export limits during the first few years of the projection period. No unsubsidized EU coarse grain exports are projected.

Despite higher world prices, EU barley exports are projected to remain in the 6-7 million ton range

through 2005. Even though world prices are expected to rise, they are projected to remain below the barley support price and, thus, will not be transmitted to the EU market. Barley area is expected to be limited by competition with wheat and other crops, and higher internal feed use to limit the amount available for export. However, the magnitude of future area and yield response in the EU to changing prices is a key uncertainty in the coarse grain projections.

Canada's barley production and exports are projected to remain relatively unchanged because of area competition with wheat and canola. In Australia, stronger domestic feed demand is projected to constrain its exports to mainly malting barley.

WORLD WHEAT TRADE: 1996-2005

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World wheat trade (including the wheat equivalent of wheat flour) is projected to grow 26 percent between 1995 and 2005. Projected average annual growth of 2.2 percent is well above that of the 1980's, but is less than that of the 1970's. Most world import growth is expected to occur in developing countries and China. Developing economies (excluding China and the Former Soviet Union) are projected to account for two-thirds of the gain in world wheat imports through 2005. The developing economies' share of imports is expected to rise from the 1990-95 average of 60 percent to more than 65 percent by 2005. This increase is driven by population growth and rising per capita incomes. Larger imports are projected in most developing regions, including Latin America, North Africa/Middle East, and Asia.

In the past, the developing countries have benefited from exporter subsidies, credit, and food aid. Under the UR agreement, subsidized exports are expected to fall from about 40 percent of world trade in 1994 to about 25 percent by 2000. Many of the developing countries will face significantly higher wheat prices as subsidies decline, and some will also be affected by the outlook for no increase in the nominal value of credit and food aid during the baseline. Wheat imports by the least developed countries, particularly the Sub-Saharan Africa region, are likely to decline relative to the higher income developing countries.

U.S. wheat exports are expected to grow faster than world trade until 2002 for several reasons. First, EU wheat exports are constrained by UR limits on subsidized exports until after 2001, when world wheat prices are projected to be high enough to enable the EU to export without subsidies. Second, price incentives are not sufficient for Argentina, Australia, and Canada to significantly increase exports until after 2000. Finally, fewer wheat acres are assumed to remain in the U.S. Conservation Reserve Program (CRP) beginning in 1997, allowing the U.S. to expand production relative to competitors. As world prices rise after 2000, however, the EU is expected to begin exporting without subsidy, and Argentina, Australia, and Canada are likely to find it increasingly profitable to increase wheat production and exports.

Wheat area is projected to expand at a slow rate, reversing the trend of the early 1990's when foreign area dropped sharply, particularly in the FSU. Higher world prices are expected to encourage this area expansion. Foreign consumption growth for wheat is projected to be slower than in previous decades, expanding 1.6 percent annually. Both population and per capita consumption are expected to grow more slowly than in the 1980's. Per capita wheat feed use is expected to fall, particularly in the FSU and Eastern Europe. Per capita food use of wheat is projected to rise, as growing demand in the high income developing countries and China offsets declines in the poorest nations, particularly in Africa.

Importer Developments for Wheat

Developing countries and China provide most of the gains in world wheat imports projected for next decade, fueled by higher incomes, urbanization, and population growth. Gains in incomes and urbanization will continue to shift consumer preferences away from coarse grains, rice, and tubers, and toward wheat-based foods. China is the largest source of uncertainty regardin gwheat import prospects. FSU imports are expected to increase slightly between 1995 and 2005, with most FSU import demand being met by trade among FSU countries.

- China's imports of wheat are projected to rise during 1995-2005, reaching 18.2 million tons by 2005 in response to rapid income growth, population increases, and the outlook for higher relative prices for competing crops to limit expansion in wheat area. Also, China's policy makers have recently de-emphasized the importance of food self-sufficiency, and it is now expected that China's future wheat imports will be based more on economic factors than self-sufficiency goals.

  The projections of China's future trade create, perhaps, the greatest amount of uncertainty in the wheat trade outlook. There is considerable uncertainty regarding such factors as water constraints and future yield improvements, foreign exchange earnings, the pace of dietary

shifts towards meats, the impacts of China's potential accession to the WTO, and the pace of market liberalization. The baseline projections represent what is considered the most likely path of future trade, but uncertainty surrounding each of these variables suggests that a wide range of trade outcomes are plausible.

In the FSU, political and economic transformations will continue to constrain imports, compared with the 1980's and early 1990's. The FSU is expected to be nearly self-sufficient in wheat, importing some wheat for blending purposes and exporting feed wheat when there is excess production. Because the FSU has a significant comparative disadvantage in meat production, it is likely that more of its meat needs will be satisfied by imports as reforms continue. The continued consolidation of livestock inventories and low economic growth cause both food and feed use of wheat to stagnate until economic growth strengthens during 2000-2005. FSU net imports of wheat are projected at 1.6 million tons by 2005, with only relatively small imports from outside the FSU.

Future developments in the FSU are an important source of uncertainty in the wheat market outlook. Key uncertainties include the pace of future economic growth, and the extent to which farm sector reforms that stimulate productivity growth are achieved.

The Southeast Asian region (Indonesia, Malaysia, the Philippines, and Thailand) is expected to show strong growth in wheat imports as rising per capita incomes and urbanization bolster food demand and lead to dietary shifts from rice, coarse grains, and tubers to wheat-based foods. Per capita wheat consumption is expected to continue to increase relative to rice. Wheat imports by thes efour countries are projected to reach 13 million tons in 2005.

Brazil's import growth is projected to continue over the next decade, with limited production prospects, strong population growth, and economic recovery driving import demand. Brazil's wheat imports will likely be increasingly met by Argentina as a result of the MERCOSUR trade agreement between Argentina, Brazil, Paraguay, and Uruguay providing duty-free access between these four countries.

- Wheat imports will compose a larger proportion of wheat supplies i Egypt and the North African countries o Algeria, Morocco, and Tunisia during the projection period. Resource constraints and population growth will make it exceedingly difficult for wheat self-sufficiency to be attained in this region. In addition, import access has been improved in Egypt and Tunisia since private traders, rather than state monopolies, are permitted to import wheat.

Exporter Developments for Wheat

Compared with the 1980's and early 1990's, the EU is expected to be a less significant competitor in world wheat trade, particularly during 1996-2000, because of internal policy reforms and the Uruguay Round agreement. Australia, Argentina, Central/Eastern Europe, and the United States all gain market share as a result of reduced EU exports.

- EU policy changes implemented in 1992-93 CAP reform and the Uruguay Round commitments on reductions in subsidized exports mean that the EU can be expected to be less prominent in wheat trade until after 2000. Lower internal wheat prices from CAP reform are expected to cause increased feed use of wheat, while area remains constrained under the CAP reform set-aside requirement. The set-aside rate is assumed to rise from 10 percent in 1996/97 to 12 percent for 1997/98-1999/2000, and 15 percent after 1999/2000 to avoid building stocks. Subsidized EU wheat and flour exports (excluding food aid) will fall from 19.1 million tons in 1995 to 13.4 million tons in 2000. The EU is projected to export wheat without subsidy when projected world wheat prices exceed the fob equivalent of the EU internal price after 2000. However, the timing of when the EU will be able to export wheat without subsidy is a major uncertainty in projections of U.S. wheat trade.

- Australian wheat exports are projected to rise as a result of export subsidy disciplines affecting competitors under the Uruguay Round agreement, and strong import growth by China, Indonesia, and Egypt--three major

markets for Australian wheat. However, exportable supplies will be somewhat restricted as domestic feed use of wheat is expected to rise with more cattle feeding. Wheat area growth will also be limited during the next few years as higher relative returns to wool are forecast.

- Wheat exports by Argentina are projected higher as stronger world prices cause area to expand beginning in 2000. Argentina's market share is expected to rise from its 1990-95 average of 6 percent to 7 percent by 2005, expanding in growing markets in Brazil and other Latin American countries.

- Canada's share of world wheat trade is expected to fall to 17 percent in 2005 from the 1990-95 average of 20 percent. Although wheat area is expected to increase compared with recent levels, future supplies are likely to be constrained by area competition with higher-valued crops such as canola and specialty crops. Canadian farmers also now face significantly higher transportation costs with the removal of the Western Grain Transportation Act rail subsidy in 1995/96. This is expected to induce exports of higher-valued crops and livestock products at the expense of lower valued crops, such as wheat and barley.

- The Central and Eastern Europe region is projected to become a significant wheat exporter, with net exports reaching 6 million tons by 2005. Production is expected to expand in response to higher world prices and productivity gains. Wheat demand is expected to remain level as greater food use of wheat is offset by reduced feed use. Although livestock production is expected to expand in the region, feeding efficiency is likely to improve and more feed demand is expected to be met by com and barley.

TROUBLED NATION STATES: ANTICIPATION AND PREVENTION

Troubled States: Anticipation and Prevention,
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Panelists: James N. Rosenau
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Ted Woodcock
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'Troubled States': Anticipation and Prevention

Charles J. Jefferson PhD
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The following are solely the views of the author and do not represent of the Bureau of Intelligence and Research, the Director of Central Intelligence, the US Department, of state, or the US government.

Background. We live in whet has been for centuries a world or states. Both the international political system and the international legal order are founded on the presumption of sovereign nation-states possesing a near-monopoly on the legitimate use of force within tiack bordem Since the end of the Coid War, howmr, the hwscapabk fact that this situation does not ebtaio h ● number of piacea around the world has forced kseif on pubik attedon hJ the form of seemhrgiy intrwtabk ethnic conflicts, other forms of civil war, and the Inability of some governments to cope with disasters--all generally with catastrophic humanitarian consequences. This is symptotnatic of the fact that ninny Third Worid countries (1 include most of the central Asian former USSR) are engaged In either state- or nation-building, or both. Thus, it is easy to understand the prevalence of one-party rule in the Third World, to see why the peaceful transfer of power from one regime to *smother has been the* exception rather than the rule in many regions, and why political turmoil and instability are to be expected.

Against this backdrop, we chose the phrase 'troubled states' as our theme to ● votd confusion associated with the terms 'falled' and 'collapsed' state while at the same time including them in 8 larger, policy-oriented construct along with the notion of a 'failed' regime.' A troubled *state is one which for internal masons engages what we shall call the* 'interventionary attention' of the international community. Failed or collapsed state are terms generally associated with multi-ethnic states, whether empires or artificial products of decolonization or postwar reconstruction. It is the vety essence of these states that they include substantial populations which acknowledge neither the legitimacy of the state nor the regime which rules it.

Regardless of its cause, failure or collapse *is a* situation in which there either is no internationally recognized government or the exisiting one manifestly does not control a large part of the state's territory and cannot or will not care for a substantial part of the population. International concerns generally relate 'CNN phenomena such as civillian deaths, refugee flows, human rights violations, and the like, though regional spillover (Liberia into Sierra Leone, for example) can be a legitimate concern. In the past, successful authoritarian regimes have been able to prevent outside examination of such internal affairs. But a number of trends of undermining this seeming invulnerability, meaning that regimes in no danger of being overthrown, or even of having their authority significantly challenged, must now be treated as 'troubled' for policy purposes.

In other cases, 'Interventionary attention' arises from more specific policy concerns. From the viewpoint of many OAS member states, for example, political instability in Venezuela threatens to devalue what has been considered a model Latin American democracy and also to damage important economic relationships. The (unsuccessful) Indian military intervention in Sri Lanks appears to have stemmed largely from domestic political considerations involving southern (Tamil) India.

As the US and the rest of the international community have grappled with these developments, several basic points have emerged: 1) it is very difficult and costly to intervene once a situation has gone downhill for any lenth of time, and may ultimately require troops--something most governments are very anxious to avoid, 2) there is neither the will nor the resources to cope with all of the emerging 'troubled states'; and 3) that as a consequence it k critical to identify likely problems that the US and its allies will have to address eventually *and* do something early on 80 prevent the worst. This observation points directly to two elements of the foreign affairs community, both charged with looking ahead. Time are the planners and the warners (for this discussion, I include the estimators with the warners), that is to say the operators and the intelligence analysts.

This paper will focus primarily on the Warning aspects of the situation. In practice there is

a significant overlap, with the king-range planners looking to the intelligence community for input but also for budgetary reasons having to project ahead far beyond any reasonable ability to predict. Operational planners, of course, must develop basic military (and increasingly, 'complex humanitarian emergency' or 'operations other than war') scenarios. They would like them to be as realistic as possible and count on intelligence input to help accomplish that.

The Warning Problem. Intelligence has long been asked to warn of an impending enemy attack, or even of an adverse outcome to a political crisis in another country. What is being sought now, though, is fairly long-range (certainly counted In years) of developments that would threaten significant damage to US national interests, or could reasonably be expected to excite the 'inventionary attention' of the international community, should they occur. An important adjunct to this problem is that warning, as we in intelligence understand it, has not been accomplished unless and until competent decision makers have heard, understood, and made decisions with regard to it. This means that the warner must have trusted access to senior decision makers, and it means that for the decision maker the warning process carries with it resource allocations.

Under present circumstances especially, with well-known pressure to cut back on foreign assistance and other foreign affairs spending, investments in prevention arc hard to sell on the basis of murky forecasts about places of which no one has heard (e.g., Nagorno-Karabakh, Kazakhstan). Nonetheless, at State the Policy Planning Staff and the Bureau of intelligence and Research have formed an "Early Warning and Preventive Measures Team" which is currently working on the problem. Similarly, a quantitative look at the problem of 'failed states' directed by the Office of the Vice President has been under way under CIA auspices for more than a year. The *Carnegie* Corporation of New York has funded a senior-level Commission on Preventing Deadly Conflict, which is well into a three-year study Intended to support national policy making. Additionally, conferences touching on various aspects of this vast subject are multiplying around the world. Aside from the warning dilemma mentioned above, however, there are some even more basic problems to be addressed *in* forecasting *on* "troubled states.'

Unanswered basic questions. There is no generally accepted explanatory paradigm in the social sciences, much less in international politics. At this point, our basic unit of analysis--the state--is even open to question. Given these two assertions, it should not be surprising that approaches to forecasting (at this conference in particular, I hesitate to use the term 'forecasting methodologies') vary widely as do the data that are considered relvant Then, too, the nature of the events(s) to be forecast vary. At the simplest level. regimes can be overthrown in many different ways, often with significantly different 'downrange' results (circulation of elites versus class warfare or zero-sum ethnic struggles).

What *is our unit of analysis?* Taken together, the effects of certain transnational trends, the existence of so many 'nationaless states,' and the end of the Cold War (or, rather, of the 'authoritarian era' which began with the Bolsheviks and the Fascist regimes of the '20s), suggest to some scholars that we are now in a transition from the Westphalian international system of nation-states to a qualitatively different one. A particularly comprehensive exigesis of this position is contained in Professor James N. Rosenau's 1990 work, Turbulence in World Politics, in which he argues that the fundamental parameters which underlay the existing system are in a process of dynamic change.

Significant developments--accompanying but not necessarily stemming from the end of the Cold War--that will greatly affect both the shape of the international system and the nature of appropriate [warning] indicators have emerged in recent years. Among the transnational trends widely cited as undermining state sovereignty are 1) increasing world economic and financial interdependence, together with the increased influence of multi- and trans-national corporations; 2) the extent to which intra- and international criminal activity has infiltrated or actually gotten control of governments; 3) the greatly increased role of transnational--especially Islamic--military and paramilitary elements; 4) the greatly Increased mobility of persons; 5) the enormously widened scope of mass communications and data transfer in comparison the world of even a few decades ago; and 6) the increased role of terrorism directed against foreigners, and the extent to which it is

conducted by, or at lead in the name of, more or less mainstream guerrila groups.

The general thrust of the literature pointing to a radically different international system on the horizon is that states are no longer capable of performing their basic economic and political functions, and thus have lost or are rapidly losing their legitimacy as a fundamental organizing unit, A variation on this theme is to point to the legal transfer of some previous sovereign powers to para-statal entities (notably the European Union in consonance with the Maastricht Treaty); to the voluntary abnegations to the international community or to other states of what are normally considered soveign rights; or to the existence of non-Or trans-state entities [so-called 'region states') that are in reality the fundamental units of the international economy.

Other analysts, while sometimes acknowledging the reality of weakened state sovereignty, nonetheless maintain that the Westphalian system based on the nation-state remains essentially intact, and that the real issues have to *do* with *the structure* of that state-centric system (i.e., multipolarity versus bipolarity or even unipolarity). Those taking this approach tend to see problems with 'troubled states' as falling within the *realpolitik* of national interest. They point out that justifications for military intervention are inevitably couched in terms of 'threats to peace and security' blessed, if only in fig leaf form, but some multilateral organization. Even the most potent states resist involvement unless there are concrete interests at stake. For maay military authors, US involvement in operations other than war (OOTW) is seen mainly as a detraction from preparations to fight 'major regional contingencies,' such as renewed war in Korea or the Persian Gulf.

To the extent there is overlap between these rather different conceptualizations, it comes in the notion of a transitional period through which we are now passing. The length of that period, and its ultimate outcome, are unclear. From a policy making viewpoint, however, this issue may be moot. Decisions to intervene, whether responding to a developed situation which has become intolerable or in an effort to prevent an anticipated crisis, are almost always fairly short-run. Thus, what scholars and analysts see as a transition phase will be the international system that actually confronts policy makers.

Methodological and data issues. There is an enormous gap in the study of International politics between the 'quantifiers' and everyone else. Relatively few can successfully bridge the gap between the two camps. Aside from 'knee-jerk' negative reactions to statistical analyses, however, there are real questions about a) the quality of the available data, and b) the appropriateness of the statistical techniques being applied (notably, multiple regression analysis} In any case, it is becoming apparent to both scholars and practitioners that information on what h going on around the world--especially in 'troubled stated--is going to be critical for decisions made in a wide variety of institutions, *he* they public or private, national or international Whether one is a 'quantifier' or not, therefore, it is in everyone's interest to insure that there is data and that it is comparable, valid, and timely. Establishment of an 'information carousel' approach to data sharing in support of humanitarian operations is currently being explored under the 'relief web' project on the Internet

Approaches to International Political Forecasting. Revolutions are clearly one sort of 'troubled state' event that we are being asked to forecast. Revolution has been written on extensively in the academic world, but so far as I am aware without fundamental agreement. One example of the theories in the literature is the so-called "J-curve," which represents the idea that revolutionary sentiment is most prevalent not when things are at their worst but when there has been an improvement in conditions. A classified quarterly journal published some years ago by the CL&called the Political Instability Quarterly, tried to take some of the revolution theory and related work and transform it into 'indicator lists.' These were not quantitative variables as such, but rather were activated on the basis of judgments by experienced analysts. Presumably working much as movement detectors along geological fault lines, if enough of these indicators were 'active' it would suggest trouble was brewing. Occasional analytic articles in the back of the journal gave one a much better sense of causal relationships believed to be at work in a particular situation, but the indicator lists with their blinking green, yellow, and red lights did not really convey anything to the reader convincingly. Senior people didn't read the PIQ, and eventually it was killed. A similarly-formatted weekly warning product has emerged under the auspices of the

National Intelligence Officer for Warning in recent years. It, too, has found little acceptance at senior levels in the State Department.

Military warning also employs indicator lists, but the lists are (hopefully) based on a much more detailed and authoritative causal understanding of the scenario to which they apply (e.g., a North Korean attack on South Korea, to cite a very active warning problem which is in the news a Jot). The Defense Intelligence Agency has been working to develop indicator lists for Low Intensity Conflict scenarios for several years now, but without an underlying causal model. In any case, the DIA approach identifies some 70 at-risk countries, which is too many for planners to handle.

Slightly different 'indicators' have been employed in the academic world. The World Event Interaction Survey (WEIS), for example, tried to link behaviors (events) with each other using a statistical technique called factor analysis. The data on events in various countries was culled from leading newspapers, then coded and loaded into the number cruncher. Aside from the enormous expense of doing this on a routine basis for lots of countries, the approach was undermined significantly when it was demonstrated that coding news accounts from the regions where the countries were located rather than the New York and London Times gave substantially different results. Actual content analysis of regime-controlled or influenced media has a long history in warning, with some notable successes (though mostly In after-the-fact explanation), but its applicability to most 'troubled states' is questionable. Psychoanalysis of key foreign leaders, which is said to have been employed from time to time, also seems of limited applicability to the 'troubled state' problem.

Another tool, normally used more for heuristic purposes than for actual forecasting, is the simulation. The Inter-Nation Simulation (INS), for example, was pretty successful in forcing different kinds of state behaviors on the participants according to whether a 'tight' or 'loose' bipolar, or a multipolar, international system was employed Simulated runnings of anticipated scenarios using country experts is a well-established practice In DoD. This approach lends Itself to looking closely at the motivations and perceptions of the actors, examining analyst and decision maker beliefs about causal relationships in the situation, and trying to work out alternative courses of action. Its limits are fairly obvious, though: 1) you need real experts; 2) it's expensive and time-consuming; and 3) you're pretty much limited to a set scenario which has been developed beforehand. Mathematical modeling, and man-machine simulations, are still primarily focused on tactical situations as I understand it. Ideally, this approach provides explicitness about assumptions (they have to be coded and loaded into the computer) while getting some richness into the play with the human element.

The details of commercial 'political risk' assessment are obviously proprietary, and doubtless vary according to the size of the firm and the geographic scope of its coverage. Some firms appear to use indicators, perhaps supplemented with analysis from local contacts. Some of the more region- or country-specific appear to operate in much the same manner that political analysis based primarily on human-source information does in the Intelligence community. That is, knowledge (especially over time) about the source(s) access, possible biases, and veracity are a key component to weighing the information they provide. There are of course many other ways to sniff out trouble, but they all tend to be based on 'old hand' understandings of how things work in the particular country. These kind of sensings can be helpful, but we often don't start picking up on them until we're getting closer to the event(s) than we want to be. I'm not sure, for example, that these methods picked up soon enough on "Les Evenements de Mai" (France, 1968) or on what very rapidly produced Tianamen Square in China some 21 years later. There are still a number of commercial firms offering these kinds of services, especially in the Far East, but judging by the sharp drop in articles devoted to the approach. it appears that the vogue enjoyed by risk assessment in the late '70s has passed.

For many new countries, sociological-type analysis focused on cross-cutting or reinforcing 'cleavages' and on economic and demographic data will provide the best bask on which to anticipate trouble. Places like Lebanon, Northern Ireland, former Yugoslavia, etc., are classic cases of reinforcing vertical cleavages in which one variable such as religion is a good predictor of many others. Cross-cutting horizontal cleavages, on the other hand, refer to circumstances like those obtaining near the Lincoln Memorial on summer weekends, where persons of all ages, genders, races, and political persuasions go to play volleyball and amuse the tourists.

CURRENT METHODOLOGIES FOR FORECASTING HEALTH PROFESSIONS REQUIREMENTS

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The Nursing Demand Based Requirements Forecasting Model (NDBR),
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Bureau of Health Professions' Integrated Requirements Model,
Evelyn Moses and Ted Sekscenski, Bureau of Health Professions,
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Forecasting the Need for Physicians in the United States:
The Health Resources & Services Administration's Physician Requirements Model (abstract),
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NURSING DEMAND BASED REQUIREMENTS FORECASTING MODEL (NDBR)

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Background

The NDRM is part of a continuing process to keep current the nurse requirements forecasting ability of the Division of Nursing. This began in the early 1970's with the implementation of the Historical Trend Based Requirements Forecasting Model **(HTBR)** [1] which addressed the future requirements for Registered Nurses **(RNs),** Licensed **Practical/Vocational** Nurses **(LP/VNs),** and Nursing Assistants/Aides **(NAs)** for all of the major health care provider sectors in the health care system, and for each of the States of the United States. This model required several sets of consistent time series data for each of the States and, unfortunately, both the availability and quality of the such data eroded to the point where this **modelling** approach was no longer viable.

The Nursing Demand Based Model **(NDM)** [2] was implemented to maintain the Division's forecasting capability using the data sets that were available in the late 1980's and early 1990's. This forecasting model depended on cross-sectional data sets which permitted the use of a richer data base needed to support the socioeconomic relationships incorporated in this model. The NDM retained the workforce, health care system sector, and State level of detail addressed in the HTBR, while permitting a broader inclusion of economic factors into the model. The NDM became available in early 1992 and relied on data gathered principally in 1988-89.

To this point the models had forecast both the **future** demands for health care services and the **workforce** utilization per provided service. However, the Bureau of Health Professions sponsored the next step in the development of the health workforce models which focused solely on the future demand for services. The General Services Demand Model **(GSDM)** [3] did explicitly address the demand for services in more health care sectors than did either the HTBR or NDM. While this provided a richer mosaic upon which to gauge the **future** requirements for the health care workforce, it did not provide an analytical model that accomplished that objective. The GSDM became available in late 1995 and relied, for the most part, on data collected in 1991-92.

The Division of Nursing is **currently** developing such **a** model - the Nurse Demand Based Requirements Forecasting Model - and the first major stage of that effort is reviewed below. This initial work is designed to forecast the utilization of Registered Nurses and, in conjunction with the future demand for health care services identified by the GSDM, forecast the Full-Time Equivalent **(FTE)** requirements for Registered Nurses. Subsequent stages of this **modelling** task will incorporate the GSDM **modelling** capability directly within the operating purview of the NDBR, and complete the NDBR by incorporating the **LP/VN** and NA components of the nursing **workforce.**

Approach

There are several steps involved in the model production process - (1) specification of information objectives, (2) data base construction, **(3)** model hypothesis and estimation, (4) model adjustment and revision to reflect both health care sector performance constraints and scenario requirements, (5) implementation, refinement and documentation of the computer based model, and (6) model application: information product generation. The emphasis here will be on those steps which deal with the analytic descriptions of the health care system components.

Information Objectives

The information objectives of the NDBR remain much the same as those of its predecessors: forecast the **future** requirements for RNs, **LP/VNs,** and NAs for a detailed (and consistent as possible) set of health care sectors which represent the complete system of health care provision, for each State of the United States. It should be stated that the partition (health care sectors) chosen to represent

the health care provider system has data for RNs available in a much greater number of sectors than data for LP/VNs and NAs. The emphasis is placed on provider aspects of the entire health care system, because the models do not explicitly include areas that are not essentially devoted to direct patient care. Therefore, such important areas as drug manufacturers and distributors, equipment (medical and otherwise) manufacturers and suppliers, etc. cannot be explicitly identified in the model. The health care system is partitioned into 13 sectors and is aggregated into 8 others for information purposes (Table 1). The number of sectors is essentially dictated by the level of detail captured by data systems that measure the levels of provided service, the manpower used to provide them and the consistency among the systems collecting that data. While a great number of data sources are melded to form the analytical data base used in the model, estimates derived from the 1992 National Sample Survey of Registered Nurses (NSS92) [4] were used as the baseline and set of control values for all FTE RN estimates used as initial (end of 1991) values.

Table 1. NDBR Health Care Service Sectors

Index*	Type [2]	Description
1	b	Short-term hospital inpatient
2	b	Short-term hospital outpatient (non-er) dept.
3	b	Short-term hospital emergency room
4	c	Short-term hospital: all outpatient (2+3)
5	c	Short-term hospital: total (1+2+3)
6	b	Long-term/Psych/Other hospital
7	c	Hospitals: total (1+2+3+6)
8	b	Nursing Homes
9	a	Board & Care Homes
10	c	Nursing Care Facilities: total (8+9)
11	c	All Institutional: total (1+2+3+6+8+9)
12	b	Ambulatory Care (non-institutional)
13	b	Home Health Care
14	b	Occupational Health Care
15	b	School Health
16	b	Public Health
17	c	Public Health Care: public sector (15+16)
18	c	Public/Community Health Care: total (13+14+15+16)
19	a	Nursing Education Programs
20	a	Other Nursing Employment
21	c	Total all sectors: (1+2+3+6+8+9+12+13+14+15+16+19+20)

1 Index is a computer based model sector/sector summary reference number.

2 Type of sector:
- a NDBR sector only
- b NDBR and GSDM sector
- c NDBR summary sector

Workforce Full-Time Equivalence

The definition of an FTE member of the workforce can vary dramatically between analyses as well as organizations. The FTE RN requirements for the NDBR are defined from the perspective of the amount of labor consumed by the provider of service organizations - that is the levels of FTE RN labor an organization will use, under the prevailing market conditions and RN availability, to provide health care service. The measure is based upon all RN labor consumed in any given sector irrespective of the mode of employment: normal employee, part-time, consultant, contract, per-diem, temporary,

on-call, etc. It is assumed that any health care sector is essentially able to purchase the number of hours of RN labor it requires through some combination of these hiring mechanisms. The definition of a fill-time equivalent RN is that number of hours worked in one year by a RN employed full-time in that sector, as reported by RNs working in that sector, without regard to any leave the individual may take. This value may differ considerably from the 2080 hours per year (40 hours/week for 52 weeks)sometimes applied in this circumstance. For example the average number of hours worked by an FTE RN in occupational health care would be approximately 2210, in short-term general hospitals about 2115, nursing education (colleges and universities) about 1955, and in school health care 1615 hours per year. Then from a formula point of view, the number of FTE RNs required in any particular sector is defined as:

$$\frac{\text{total number of hours worked per year in the sector by all RNs}}{\text{(average number of hours worked per year by RNs employed full time in that sector)}}$$

Model Hypothesis and Estimation

The modelling process itself has been approached from the standpoint of developing an analytic structure which represents the changes that will take place in RN per service utilization over time. The absolute level or total FTE RN requirement is not being modelled at this specific point - only the movement of one determinant of those requirements. A general form of the equation specifying the FTE RN requirement, $FTE_{R,H,S}$ for a given State, S, and a given health care sector; H, as a function of time , t, is:

$$FTE_{R,H,S}(t) = POP_{H,S}(t)PCD_{H,S}(t)UPS_{H,S}(t)$$

where: $POP_{H,S}$ is the population provided service by health care sector H in State S,

$PCD_{H,S}$ is the per capita demand for health care services provided by health care sector H in State S, and

$UPS_{H,S}$ is the utilization per service of RNs in health care sector H in State S.

The variable t actually stands for the fact that the three entities on the right-hand side of the above equation take on their values as a result of the value of their influencing or determining variables at the time in question. The forecast of the future population depends on behavior of the population at some point in time (e.g., mortality, birth rate, migration, etc.) while the other two functions may involve several independent variables. The product $POP_{H,S}PCD_{H,S}$ is the total volume of services that is provided in health care sector H in State S and is the output of the GSDM. The utilization per service is treated with two components:

$$UPS_{H,S}(t) = B_{H,S}UC_{H,S}(t)$$

where: $B_{H,S}$ is a benchmark factor which is used to set the estimate of FTE RN requirements to the number of FTE RNs determined to be employed initially in health care sector H and State S by the NSS92 at $t=t_o$.

$UC_{H,S}(t)$ describes the proportional changes in the behavior of the FTE RN utilization per service rates over time, t, in health care sector H and in State S.

The function $UC_{H,S}(t)$ is the core of the model as constituted above, and in its expanded form:

$$UC_{H,S}(t) = UC_{H,S}(v_1(t),v_2(t),\ldots, v_n(t))$$

demonstrates the role of the independent variables which determine the relative values of the per service utilization over time. The use of state based cross-sectional data assumes this function reflects the behavior of each state as reflected in the independent variables, vi, that appear for each health care sector. In other words, this form of model states that the forces causing change in the per service utilization of FTE RNs in this health care sector can be expressed in a common, fundamental form for all States of the U.S. and that common form will reflect changes in the behavior of that health care sector in a particular State when controlled by the values of the independent variables peculiar to that State. Keeping in mind the health care system's history of largely unrestrained growth, what phenomena or circumstances currently represent the significant controlling or influencing forces of that system? What measures are available that are representative of these forces, or what measures can be used to represent those forces?

To facilitate the selection of variables that are candidates for estimating the $UC_{H,S}$, the available field of variables were partitioned into sets of variables that represent health status, economic, social and geographic forces, etc. These categories may not be unique (mutually exclusive), but they serve as a useful device for categorizing the possible determinants of the changes in per service utilization.

1. Health Care Status: Measures of health related characteristics of the population, such as numbers or levels of disabilities, deaths per population, changes in morbidity/mortality rates.

2. Income or Economic Well-being: Per capita income, nominal or real, for the entire population or population subgroup, a particular occupation or groups of occupations. Cost of living indices. Changes in rates of or in totals for earnings by industry, occupation or groups of industries or occupations.

3. Public or Shared Support: Percentage of the population covered under Medicaid. Percentage of the population over age 65 as a measure of the population covered by Medicare. Measures or population percentages of the population under welfare of some type, or dollars per capita derived from welfare funds.

4. Health Care System Access: Measures which demonstrate levels of access in terms of established "reservation" or predisposed access to the health care system such as percentage of uninsured (compliment of access). The degree of HMO/PPO enrollment or penetration - i.e., relative levels of managed care.

5. Population, General Demographics: Population trends, by sex, race, age-groups, rural-urban.

6. Employment: Employment rates for population groups which may be defined as totals or subtotals of populations, groups defined by specific characteristics (e.g., educational attainment). Rates of change for an industry, occupation or groups of industries or occupations.

7. Health Care System Performance: Measures which monitor the output or organizational aspects of the health care sector, Services provided per population or population subgroup, levels of the workforce employed per unit of service provided, cost per unit of service, or perhaps, the variety/scope of the types of service provided.

The logical selection of variables and their resultant statistical roles can, to say the least, be unanticipated. In short, an hypothesis that contains what seems to be a perfectly reasonable relationship - indeed, a "natural" or inescapable conclusion - will often turn out to be nonsense from a statistical point of view. The general process used here was to attempt to identify the best candidate(s) (if available) from the groups identified above that supported a reasonable representation of the changing FTE RN utilization per service picture as supported by a logical set of connections between the dependent and independent variable(s). The use of the variable categories permits some latitude of choice if independent variables are to be chosen on a consistent basis. This means that the impact of policy changes or systemic changes in health care need not necessarily be represented by the same variable irrespective of the health care sector being modelled. Rather, other variables may be explored as reasonable substitutes without serious degradation of the models logical fabric. For example, changes in the per service utilization in hospitals may be related to the intensity of care needed for a "sicker" admitted population as represented by a decrease in the per capita hospital inpatient days provided by short-term hospitals. However, the concomitant rise in the per capita physician office visits supplied to that population may not relate well to the hospital inpatient day demand measures, but more to changes in the hospital outpatient visit rates. Furthermore, it may be possible to see from the characteristic of the groupings that some measure in a related group may express the policy or system change better than one reflecting an element of a sectors performance.

The actual choice of the model is made using a combination of statistical and logical tools. The independent variables must bear some relationship to the dependent variable {particular RN utilization) in question. The analysis normally offers regression results (which usually will be a weighted least squares regression to compensate for heteroscedasticity) which are then culled on the basis

of goodness of fit, reasonable assurance that the estimated coefficients are different from zero, the resulting model has a suitable graphical relationship to the pertinent data (excluding **outliers),** and, to begin with, the independent variables employed are not highly correlated.

Model Adjustment and Revision

A baseline forecast consists of specifying a set of conditions, usually based on recent historical behavior of the health care system, which controls the overall performance of the forecasting model - a kind of operational envelope. The analytical descriptions incorporated into the model will dictate the direction and trajectory of the individual forecasts that make up the model as a whole. The assumptions for the baseline case may limit the expanse of those trajectories in accordance with observed constraints that exist within the system that may not or could not be captured in the analytical constructs used to build the model. Past trends or current and impending legislation or regulation can provide or dictate the basis for rules governing the contraction or expansion of service volume or level of manpower utilization which are considered necessary but not consistent with the analytical picture of the health care systems' evolution. Certainly, any **future** effect that has not been (and would not be expected to be) incorporated in any measurement of past health care system performance will not be entrained in the estimation process used to **specify** the analytical models and must be dealt with as a superimposed constraint (assumption controlling the model's behavior). For example, the health care services forecast shows a spectacular increase in the levels of home health services that will be provided over the forecast period. These increasing levels of services were apparently due to an intense expansion of home health visits which began in the very late 1980's as a result of regulatory interpretations. However, when the number of RNs employed in home health agencies are compared between the 1988 and 1992 National Sample Surveys of Registered Nurses, a substantial growth in the RN employment by these agencies is shown, but considerably below the increases in services. The conclusion drawn here -i.e., the assumption made for the **future** behavior of the model - is to ensure that the RN utilization per visit patterns evidenced by the home health industry during the initial phase of this service expansion do not foster unreasonable results over time.

The most important limitation of the assumptions must be recognized: they are nothing more than interpretive bounds imposed on the model. While there may be vast amounts of anecdotal information available to support those observations, and, indeed, even have sporadic statistical or analytic support, they are still assumptions. Those areas of greatest concern should be explored by running the model with variations of the assumptions of concern and the output compared and analyzed to establish the assumptions leverage on the model's results.

The factors which influence the behavior of the health care system overall must be examined **from** the sector perspective because laws, regulations and administrative processes generally impact the sector level even though they may be created on behalf of a substantial portion of the general population. Common sense dictates that the complexity and variety of sector influences need to be isolated in context. In many instances, more than one force may be at work in shaping the characteristics of a sector. For example, the web of regulation and administrative impact cast by Medicare is now being combined with the economic behavior of managed care organizations. The general process applied to the development of baseline scenario assumptions is that forecast RN utilization rates will not cause a **future** FTE RN requirement to decrease while volume of services in that sector increase and vice versa. The generation of forecasts using such an articulated model (given the numbers of states and sectors, some 676 forecasts are made) will produce a few such forecasts which demonstrate extreme, and therefore unacceptable, behavior. The usual procedure is to institute a bounding process whereby the movement increase (decrease) of the forecast is controlled. The NDRM has a choice of two methods of **specifying** bounding values for each year of the model's forecast. The first method is absolute in that a annual growth or contraction in the utilization rate is allowed. The

second specifies the annual growth or contraction as a **fraction** of the growth or contraction demonstrated by the movement of the model's behavior for the United States.

Model Results

The requirements for FTE RNs are based on three major factors which were summarized above:
1. The magnitude of the population receiving the provided services,
2. The average number of services provided per person, and
3. **The** average number of FTE RNs required to provide a service. Each of these principal components varies according to factors peculiar to the component itself. Any one of these factors can have a significant impact on the resultant Level of FTE RN requirements. The changes in the total **future** population of the States (as forecast by the Bureau of the Census) are shown on Figure 2a. The increases to the year 2020 run from under 10 percent (8 States) to between 40 percent and 50 percent (6 States), or between 30 percent and 50 percent for some 15 States. The increase for the nation is 24 percent. This means that if nothing were to change in the terms of the number of **services** provided per person, and nothing were to change in terms of the number of FTE RNs utilized to provide any of those services, then the number of required FTE RNs should increase substantially simply in response to an increase in population. In addition to the increase in the forecast population, if the change in the rate of service provided is also considered, then the combined effect is shown in the change in services column of Figure 2b. The **major** health care sectors (each sector has its own spectrum of services) show increases of from 21.9 percent to over 106 percent. The last column of Figure 2b demonstrates the impact on the levels of FTE RN requirements for all sectors of the health care system if the number of RNs required to provide each of the health care services were to remain fixed at the levels recorded early in this decade (1991), and varied only according to changes in the population and the rate of service provision. The net result would be an increase in FTE RN requirements of nearly 700,000 or increase in requirements of 38 percent.

Figure 2a. Relative Changes in the General Population of the States of the United States, from 1995 to 2020

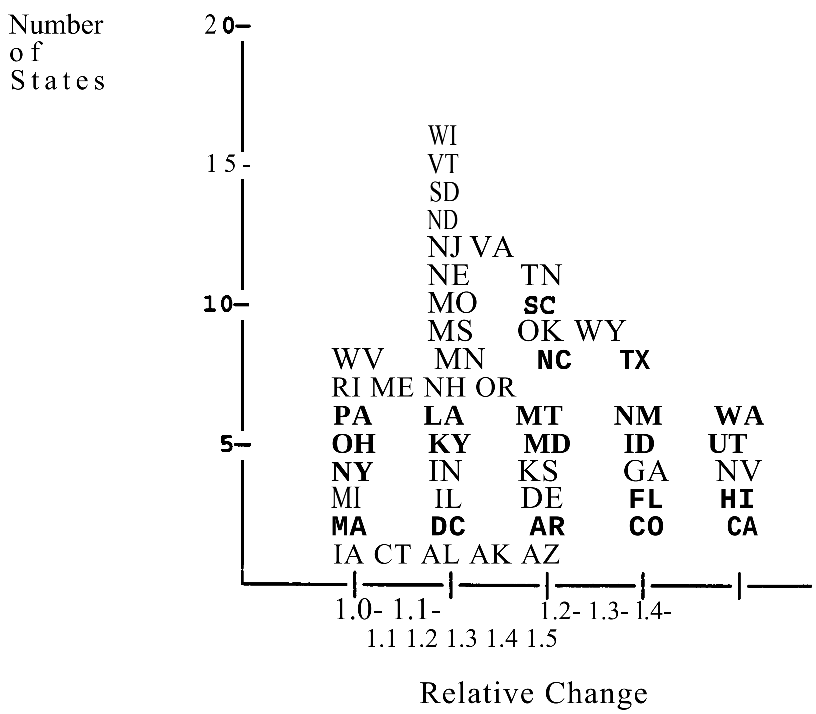

Figure 2b. Changes in the Forecasted Demand for Services in the United States and the Changes in the Requirements for FTE RNs for the period 1995 to 2020 with fixed (199 1) RN per Service Utilization Rates

Sector Group	1995 to **2020** Percent Change in Services	**1995 to 2020** Change in FTE RN Requirements
All Hosp Inpatient	27.2%	272,700
All Hosp Outpatient	**35.7%**	40,200
Nursing Homes	59.2%	66,100
Other Ambulatory	**60.6%**	82,600
Home Health Care	106.2%	159,100
Other **Pub/Comm** Hlth	21.9%	32,200
Other	______	32,500
Total	______	**685,400**

The changes in the population, levels of service and the socioeconomic conditions influencing the levels of FTE RN utilization are available to play a role in determining the analytic description of that utilization. The changes in the sector specific rates of utilization are summarized in Table 3. The minimum and maximum 25 year annualized rates forecast for all of the States on a sector by sector basis are given. The annualized rates of change, based on a compounded growth rate, show a considerable state by state range in some sectors, but relatively little in others. The small percentages shown should be interpreted in the light of the 25 year period which is the basis of the annualized rates. The effects of managed care in the ambulatory sector can be seen in terms of a diminishing utilization per visit, a similar pattern exhibited by the school health sector rather reflects a sector which, in the recent past, has not shown an overall growth in FTE RN employment that is proportional to the growth in the client base (students).

The combined effect of the population growth, changes in the levels of per capita services provided, and the changes in the FTE RN per service utilization is demonstrated by the growth of FTE RN requirements given in Tables 4 and 5. Table 4 presents the annualized growth rates of the FTE RN requirements in a form similar to Table 3. These growth rates are seen to be more robust than those representing FTE RN utilization per service because they incorporate the escalating demands for services evidenced by a growing population.

There are still a few States that have sectors that are contracting (the maximum decrease is 13 percent over 25 years), however, out of a total of 663 sector by state level FTE RN per service utilization forecasts there were some 145 that decreased; there are only 14 sector by state FTE RN requirements forecasts that decrease.

Table 5 presents the summary forecasts of the FTE RN requirements for the United States for each of the sectors used in the NDBR. While all sectors continue to grow, they do so at widely different rates with school (student) health programs having the lowest rate of growth and home health care having the highest. The results here are aggregates of each of the States' forecasts so that specific State or regional impacts on overall sector behavior should be resolved at the State level.

Table 3. FTE RN Utilization per Service:
Annualized Growth Ranges of the States by Sector
During the Period 1995-2020

Description	Growth Range Minimum	Growth Range Maximum
Hospitals		
Short-term inpatient	0.0001	0.0041
Short-term outpatient (non-er) dept.	0.0011	0.0035
Short-term emergency room	0.0016	0.0088
Long-term/Psych/Other	-0.0002	0.0052
Nursing Facilities		
Nursing Homes	**-0.0004**	0.0008
Board & Care Homes	**0.0**	0.0‘
Ambulatory Care (non-institutional)	-0.0198	0.0
Public/Community Health		
Home Health Care	-0.0003	0.0029
Occupational Health Care	-0.0004	0.0013
School Health	-0.0007	0.0
Public Health	-0.0047	0.0063
Nursing Education Programs	-0.0004	0.0094
Other Nursing Employment	0.0005	0.0221

‘ Board and Care Homes have many unstable characteristics (e.g. definition of such a home, large numbers of homes with only a few residents) which result in an inconsistent set of measurements that do not yield a coherent analytical picture of the FTE RN per resident utilization. The estimation process used was based on a fixed nurse to population (over age 64) ratio.

Table 4. FTE RN Requirements:
Annualized Growth Ranges of the States by Sector
During the Period 1995-2020

Description	Growth Range Minimum	Growth Range Maximum
Hospitals	0.0023	0.0220
Short-term inpatient	0.0003	0.0234
Short-term outpatient (non-er) dept.	0.0099	0.0251
Short-term emergency room	0.0050	0.0230
Long-term/Psych/Other	0.0061	0.0194
Nursing Facilities	0.0078	0.0329
Nursing Homes	0.0080	**0.0329**
Board & Care Homes	0.0045	**0.0373**
Ambulatory Care (non-institutional)	0.0015	0.0215
Public/Community Health	0.0098	0.0404
Home Health Care	0.0151	0.0540
Occupational Health Care	0.0067	0.0268
School Health	-0.0049	**0.0147**
Public Health	-0.0027	**0.0192**
Nursing Education Programs	0.0003	0.0118
Other Nursing Employment	0.0057	0.0348
All Sectors	0.0043	0.0248

Table 5. FT RN Requirements:
Total Requirements of the States by Sector
For the Years 1995, 2005, and 2020'

Description	1995	2005	2020
	Total FTE RN Requirements		
Hospitals	1,171,500	1,305,200	1,595,600
Short-term inpatient	867,200	949,000	1,168,500
Short-term outpatient (non-er)	54,700	72,000	83,000
Short-term emergency room	73,500	91,600	103,600
Long-term/Psych/Other	176,000	192,600	240,000
Nursing Facilities	117,900	138,000	185,800
Nursing Homes	110,900	130,500	175,000
Board and Care Homes	7,000	7,600	10,800
Ambulatory Care (non-institutional)	126,500	142,600	168,700
Public/Community Health	285,300	387,700	481,900
Home Health Care	143,500	230,600	304,000
Occupational Health Care	18,100	20,400	27,000
School Health	48,000	52,400	53,800
Public Health	75,800	84,300	97,100
Nursing Education Programs	39,200	41,500	46,300
Other Nursing Employment	60,100	80,200	97,100
All Sectors	1,800,000	2,095,000	2,575,000

' Estimated numbers may not sum to totals because of rounding.

NDBR Status

Currently the analytical and computer implementation of the Licensed Practical/Vocational Nurse and Nursing Assistants/Aides portions of the NDBR is becoming operational. These latter two components of the nursing workforce have less data, both in scope and quality, than does the Registered Nurse component. There exists no data collection activity that is directed, in detail, toward the specific description of all of the those individuals that legitimately are LP/VNs or NAs. The data available are general employer based surveys which have a number of shortcomings in terms of identifying the amounts of labor contributed by a workforce. These data shortcomings are worth a brief note here so that the major differences between the component forecasts can be clearly anticipated by NDBR user. The employer based surveys are likely to identify those individuals who are considered employees by the employer but yet ignore temporary, contract, per diem, etc. workers who are regularly work, but fall into a non-traditional employment category. The type of employment of the individual in terms of holding more than one job, number of scheduled hours of employment, and overtime hours employed are not either usually or consistently captured. The forecasts based on these data will exhibit patterns which lack several dimensions of resolution that are available to the RN forecasts. The computer based implementation of the NDBR will be based in FORTRAN, will run on IBM compatible PCs, and will have both data editing capabilities as well as several different display alternatives. As in the past with other requirements models sponsored or developed by the Division of Nursing, it is anticipated that all aspects of the NDBR will be made available to the public through the NTIS.

[1] U. S. D. H.H.S. Seventh Report to the President and Congress on the Status of Health Personnel in the United States. (March 1990), Chapter VIII, 31-34.

[2] Vector Research, Inc., Final Report on the Nursing Demand Model (Washington, D. C., in NTIS Order #PB94-504370GEI, 1991)

[3] Vector Research, Inc., General Services Demand Model: Technical Summary of Model Development (Washington, D.C., in NTIS Order #PB96-500863, 1995)

[4] Moses, E.B., 1992 The Registered Nurse Population (Division of Nursing, BHPr, HRSA, USDHHS, 1994)

[5] Vector Research, Inc., General Services Demand Model: Data Sources and Documentation (Washington, D. C.,in NTIS 0rder#PB96-500863, 1995)

[6] American Hospital Association, Annual Survey of Hospitals data tapes for 1991, 1992 and 1993 (Chicago, 111, 1993, 1994, and 1995).

[7] Note: The Current Population Surveys used in the data base analyses are available on one CD-ROM and consisted of the following four citations:

(a) Current Population Survey, March 1991 on CD-ROM [machine-readable data file], conducted by the Bureau of the Census for the Bureau of Labor Statistics (Washington, Bureau of the Census [producer and distributor]), 1991.

(b) Current Population Survey, March 1992 on CD-ROM [machine-readable data file], conducted by the Bureau of the Census for the Bureau of Labor Statistics (Washington, Bureau of the Census [producer and distributor]), 1992.

(c) Current Population Survey, March 1993 on CD-ROM [machine-readable data file], conducted by the Bureau of the Census for the Bureau of Labor Statistics (Washington, Bureau of the Census [producer and distributor]), 1993.

(d) Current Population Survey, March 1991-1993 on CD-ROM Technical Documentation prepared by the Data User Services Division, Data Access and Use Branch, Bureau of the Census (Washington: The Bureau), 1993.

[8] Note: The population projections used in the NDBR are based on projections contained in the Current Population Reports series P-25, Nos. 1053 and 1111. The July 1, 1990 values were taken from P-25, No. 1106. The complete citations for the three are:

(a) U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 1053, Projections of the Population of the States, by Age, Sex. and Race: 1989 to 2010, (Washington, DC, U.S. Government Printing Office), 1990.

(b) Campbell, Paul R., Population Projections for States. by Age, Race. and Sex: 1993 to 2020, U.S. Bureau of the Census, Current Population Reports, P25-1111, (Washington, DC, U.S. Government Printing Office), 1994

(c) Byerly, Edwin R., State Population Estimates by Age and Sex: 1980 to 1992, U.S. Bureau of the Census, Current Population Reports, P25-1106, (Washington, DC, U.S. Government Printing Office), 1993

[9] National Center for Health Statistics (1993). National Health Provider Inventory: Nursing Home and Board and Care Home Facilities, 1991 (preliminary machine readable data file), National Center for Health Statistics, Hyattsville, MD. Unpublished.

[10] National Center for Health Statistics (1993). National Health Provider Inventory: Home and Hospice Care Agencies, 1991 (preliminary machine readable data file), National Center for Health Statistics, **Hyattsville,** MD. Unpublished.

[11] National Center for Health Statistics (1994). National Home and Hospice Care **Survey,** 1992 (preliminary machine readable data file), National Center for Health Statistics, **Hyattsville,** MD. Unpublished.

[12] Bureau of Economic Analysis (1995). Regional Economic Information System 1969-93 (data files and documentation on CD-ROM), Bureau of Economic Analysis, Washington, DC.

[13] Division of Research, National League for Nursing, 1995 **Nursing** Data Review (National League for Nursing, New York, NY), 1995.

[14] Division of Nursing, BHPr, HRSA, DHHS, Preliminary forecasts of graduations from nursing education programs. (Division of Nursing, **Rockville,** MD) Unpublished.

Bureau of Health Professions' Integrated Requirements Model

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The Integrated Requirements Model (IRM) forecasts requirements for primary care physicians, physician assistants, nurse practitioners, and certified nurse-midwives for delivery of primary care services, using varying assumptions about the practitioner mix used, according to the insurance or managed care status of the population. Conceptually, the IRM uses a capitated approach, forecasting practitioner requirements per 100,000 people, by assigning given populations (by gender, age and rural/urban location) to various fee-for-service, managed care, or uninsured delivery modes and applying estimates of practitioner staffing by delivery mode. Summary reports are produced of the estimated population by insurance/delivery mode status, practitioner staffing of delivery mode, and practitioner requirements for years 1995 through 2020. All projections are reported on national, urban, and rural bases.

Background of Model Development: In spring 1994, the Bureau of Health Professions (BHPr) of the Health Resources and Services Administration implemented a plan to consider integrated workforce requirements for primary care physicians (PCPs), nurse practitioners (NPs), physician assistants (PAs), and certified nurse midwives (CNMs). As part of this activity a contract was awarded to Vector Research, Inc. (VRI) to develop a computerized model for estimating and projecting integrated requirements for these practitioners. A joint workgroup of representatives from the Council on Graduate Medical Education (COGME) and the National Advisory Council on Nurse Education and Practice (NACNEP) was also formed to interface with the contractor, guiding its assumptions, providing feedback on the data and results, and to discuss other issues surrounding an interdisciplinary primary care workforce.

BHPr has been involved in workforce analysis and development of tools to project the nation's supply and requirements for health professionals since its inception. COGME and NACNEP have also been involved in these activities with respect to their own discipline responsibilities. COGME has examined the requirements for physicians in its periodic reports, A recent report, *Physician Assistants in the Health Workforce 1994 (1994),* prepared by the Advisory Group on Physician Assistants and the Workforce established by COGME, addressed requirements for Pas. NACNEP, in its *Report to the Secretary of Health and Human Services on Workforce Projections for Nurse Practitioners and Nurse Midwives* (1994) addressed requirements for Nps and CNMS. Subsequently, COGME and NACNEP, recognizing the need for determining overall workforce requirements for primary care providers, agreed to participate in a joint effort to examine integrated requirements for Nps, CNMS, Pas, and primary care physicians for all the primary care service needs of the U.S. population. In addition to development of the IRM, the joint effort produced the *Report on Primary Care Workforce Projections, Council on Graduate Medical Education and National Advisory Council on Nurse Education and Practice December 1995* (Bureau of Health Professions, HRSA, USDHHS, 1996).

IRM Concepts and Methodology: Conceptually, the IRM uses a capitated approach, forecasting requirements for primary care practitioners per 100,000 people. Primary care practitioners are defined as family practice, general internal medicine, general pediatrics, and obstetrics/gynecology physicians (MDs and DOS); and primary care PAs, NPs, and CNMs. The model produces summary reports of national staffing requirements for all four practitioner groups by delivery mode and urban and rural status, annually for years 1995 through 2020. A number of considerations were taken into account in deciding on this approach. Among these were issues concerning practitioner competencies for delivering the variety of services that constitute primary care and the proportion of these services each group could deliver. One issue that was of particular concern to the work group was that of measuring practitioner productivity.

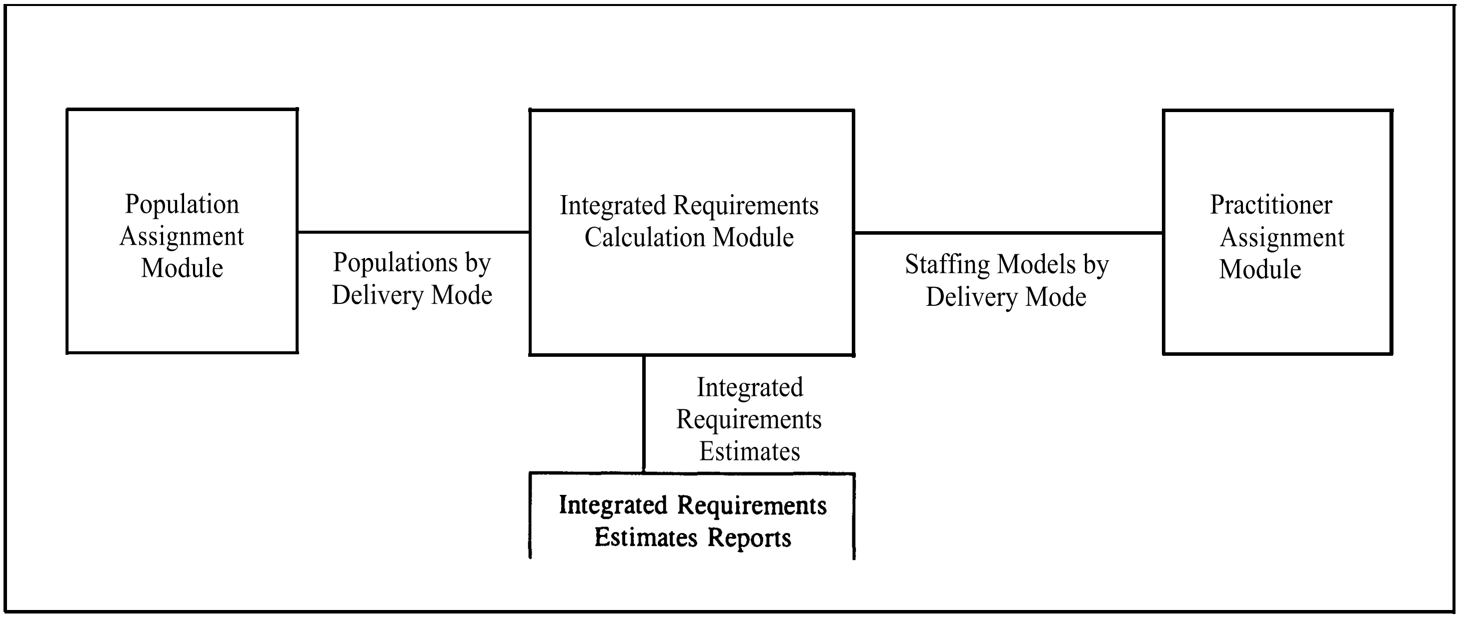
Approaches to measuring productivity relying on patient visit information were considered problematic due to inconsistent units of measure, widely varying content, and varying service intensities provided in patient visits. Other factors that were determined to affect productivity include size of practice, practitioner reimbursement methods and physician delegator style in care delivery. In general, groups were found to be more productive than single

practitioners (although small groups are often more productive than larger groups, fee-for-service practitioners were often more productive than salaried ones. Greater delegation of tasks for which NPPs were deemed qualified increased the efficiency of services provided. Related issues complicating practitioner productivity and requirements analyses include defining and measuring services outcome and quality; defining and estimating appropriate care; roles of generalist nurses and auxiliary workers in care delivery; and provider/ comrnunit y linkages in care delivery, such as linkages to public health nursing and case management services.

An extensive literature search provided little evidence of consistency on these issues. Given these concerns, the working group endorsed a macro-level approach to measuring practitioner requirements based on estimates of numbers of practitioners required to provide aggregate levels of services to macro-level groupings of the population. Aggregate patient visit information was used indirectly to distribute practitioners across these population groups. Baseline staffing levels were estimated using empirical evidence from varying data sources. The IRM is designed to allow model users to vary practitioner mix within certain parameters estimated from these empirical data sources.

Model Structure: The IRM is divided into three distinct modules as shown below:

Exhibit 1: Model Overview



The capitated methodology assigns populations to specific health care delivery modes, then chooses a staffing configuration for each mode. “Health care delivery modes” are essentially population insurance status categories, although in the case of staff HMOS the mode might represent a center where primary health care is delivered. The health care delivery modes are delineated by gender, age, and location groupings and then combined with eight aggregated health care staffing mode categories within the model:

Exhibit 2: Health Care Delivery Mode Characteristics

Description	Categories	Category Count
Sex	Male, Female	2
Age	O-4, 5-17, 18-44, 45-64, 65-74, 75-84, 85+	7
Location	Urban, Rural	2
Insurance Type	Staff HMO, IPA HMO, Fee-for-Service (FFS), Medicaid Staff HMO, Medicaid IPA HMO, Medicaid FFS, Medicare Staff HMO, Medicare IPA HMO, Medicare FFS, No Insurance	10

Exhibit 3: Aggregated Health Care Staffing Modes

Urban	Rural
Staff HMO	Staff HMO
IPA HMO	IPA HMO
Fee-for-Service	Fee-for-Service
No Insurance	*No* Insurance

The above modules feed resultant data into the integrated requirements calculation module, which assigns compensation levels to practitioner type and uses statistical algorithms to produce the forecasts of integrated practitioner requirements. The model also produces reports summarizing the population by insurance and managed care status, and a report on the practitioner staffing models associated with the scenario being run.

MODEL INPUTS AND PARAMETERS

Population Distribution by Insurance/Delivery Mode: The 1992 National Health Interview Survey **(NHIS)** was the starting point for estimating baseline primary care services for the population by insurance/health care delivery mode. First, the **NHIS was** used to estimate numbers of individuals by age group, sex, place of residence **(MSA/non-MSA), and** insurer and provider type. Age-sex-location groupings were then distributed across insurance/delivery modes and these distributions were calibrated to agree with outside sources. Included in these source materials were: GHAA's *National Directory of **HMOs*** and *HMO Industry Profile,* **HIAA's** *Source Book of Health Insurance Data,* and Decision Resources, Inc.'s ***Interstudy** Competitive Edge Industry **Report** 4.2.* Input was also sought from members of **Lewin-VHI's** Managed Care Practice Group. The final step was to project the distributions for each year 1995 through 2020. Trends affecting population distributions across delivery modes over time were identified and measured from several sources.

A spreadsheet model was developed that allows users to adjust insurance, managed care, and uninsured growth differences by insurer type, urban/rural setting, and I PA vs. Group/Staff HMOS annually through year 2020. Based on analysis of managed care penetration increases in the Medicare, Medicaid, and privately insured populations, these categories are projected over time, Policy scenarios may be analyzed by replacing baseline projections with

alternative distributions. For example, a universal coverage scenario was developed by redistributing the uninsured population group into one or more of the insured/managed care categories. The user can develop an unlimited number of scenarios within the specified parameters of the model.

Estimation of 1992 Staffing Models: Aggregate practitioner staffing level ratios were estimated in terms of numbers of physicians, PAs, NPs, and CNMS required to provide primary care services for 100,000 persons in each of the eight health care delivery modes: insured FFS population, Group/Staff HMOS, IPA/Network HMOS, and the uninsured, separated into urban (MSA) and rural (non-MSA) locations. (Although the ultimate objective was to determine staffing ratios for the 8 broad categories defined above, actual analysis was done with 20 more-detailed categories. For both urban and rural locations, the following 10 subcategories were defined: **Fee-for-Service:** 1) Medicare; 2) Medicaid; 3) Privately Insured; and 4) Uninsured; **Managed Care — Group/Staff: 5)** Medicare; 6) Medicaid; and 7) Privately Insured; **Managed Care — IPA & Network: 8)** Medicare; 9) Medicaid; and 10) Privately Insured. This more detailed categorization takes into account the demographic composition of the more broadly-defined categories.) Each of these population groups was determined to be mutually exclusive, and every person in the US was placed in one of these health care delivery modes. Empirical estimates of practitioner supply were gained from various sources.

For physicians, both non-Federal and Federal medical doctors () and doctors of osteopathy (DOS) who were actively involved in direct patient care were included. The main data sources were the 1992 Area Resource File (ARF) and an American Osteopathic Association (AOA) file, each by specialty and MSA/non-MSA setting. Primary care specialties were defined as general and family practice, general internal medicine, general pediatrics, and obstetrics/gynecology. Several data sources were used to examine physician productivity by insurance and MSA/non-MSA setting and adjustments were made to the NHIS data to account for these differences. Physicians were then distributed across delivery modes by numbers of visits in each setting. OB/GYNs and other primary care physicians were distributed separately. For OB/GYNs, the type of visits used were obstetrical/gynecological visits. For other primary care physicians, total primary care visits (including OB/GYN visits) were used.

Two national databases were the main sources used for estimating 1992 NP supply: the Certified Nurse Practitioner and Clinical Nurse Specialist (CNP/CNS) Survey and the Fifth National Sample Survey of Registered Nurses (RN-V). For purposes of the model, NPs identified in the survey were defined as those who were both functioning as NPs and offering patient care in ambulatory settings. Because the vast majority of NPs provide primary care services, no adjustment to these estimates were made for specialty. Information from both the RN-V survey and the literature were used to estimate the number of CNMS who had completed a formal nurse-midwifery education program of at least 9 months, were certified, and provided direct patient care. Numbers of both NPs and CNMS in urban and rural areas were also estimated from these and other sources. NPs and CNMS were distributed across delivery modes largely according to NHIS patient visit information adjusted to each mode based on specific knowledge about each practitioner group in specific delivery modes.

American Academy of Physician Assistants 1992 annual survey data were used to estimate numbers of practicing primary care PAs. Of the total, about 47%, were in primary care specialties as defined for physicians, plus public health, and preventive medicine. Rural/urban location of PAs were estimated from other sources. (Dr. Gary Hart, personal communications, University of Washington, Seattle, WA, 1995). The primary information used in distributing PAs across delivery modes was the number of total primary care NHIS visits in each mode adjusted by specific knowledge about the number of PAs practicing in a given delivery mode.

Estimating Practitioner Requirements by Population Age and Sex for Each Location and Insurance/Delivery Modes: The next step in the analysis made use of a statistical algorithm, called the *iterative proportional fitting* algorithm (IPF), that estimates cross-products of type desired, given the totals for each dimension. (The IPF is discussed in *Discrete Multivariate Analysis: Theory and Practice,* Bishop, Fienberg and Holland, MIT Press, Cambridge, Massachusetts, 1977, pp. 83-102.) Once the IPF estimated the required number of practitioners by type, age, and sex for each location and delivery mode, the output was divided by the base year population corresponding to each location,

delivery mode, age, and sex. This number was then multiplied by 100,000 to compute the ratio of practitioners required per 100,000 for each level of detail.

Input files to the BHPr Physician Requirements Model (PRM), i.e. physician utilization and productivity rates for the defined primary care specialties were used in calibrating the physician requirements estimates. The basic steps involved: multiplying 1992 populations by primary care utilization rates to determine the level of primary care services required; multiplying the average number of physician minutes required for each service to determine total physician time required; and dividing the time required by the average number of minutes physicians spend working each year to obtain the physicians required.

Prior to being input into the IPF, the physician requirements by age and sex were resealed so that the sum of requirements across all age and sex combinations match the sum of requirements across physician types for each delivery mode and location. The importance of the information obtained from the PRM is that relative differences in requirements from one age/sex category to another are adequately reflected in the estimated numbers for each age/sex category. A number of differences in the models needed to be addressed in order to use the PRM data as input to the IRM: the age groups employed in the PRM differ from those adopted for the IRM; the PRM uses three insurance categories, whereas the IRM uses four; the PRM does not distinguish between urban and rural locations, while the IRM does; and the PRM focuses on requirements for physicians, while the IRM also incorporates non-physician practitioners.

These issues are discussed further in the final report of the model's development published by Vector Research, Inc. (Roerhig C, Bedford D, and Alexcih L, Development of Integrated Requirements for PAs, NPs, CNMs, and Physicians (MDs and DOS), Final Report, Vector Research, Inc., September 20, 1995.)

Adjustments of staffing models to 1995: As noted earlier, there were insufficient data available to implement the methodology described above in the development of 1995 staffing models. Thus the 1995 staffing models were estimated by a series of adjustment factors applied to the 1992 staffing models that were developed from empirical data. These factors are designed so that the 1995 staffing models, when applied to their counterpart 1995 populations, result in requirements estimates that are identical to best estimates of the numbers of primary care practitioners actually providing patient care in 1995. The approach to adjustment factor development consists of the following two steps: 1995 initial requirements estimates are generated by applying the 1992 staffing models to the 1995 populations; and the adjustment factor is computed as the ratio of the 1995 "actual" practitioner number to the initial requirement estimated in the first step above. All elements of all 1995 staffing models are then multiplied by the appropriate adjustment factor:

Exhibit 3-24: Computation of 1995 Staffing Model Adjustment Factors

	1995 Initial Estimate	1995 Actual	Adjustment Factor
Physicians	199,856	205,870	1.03
PAs	10,572	11,960	1.13
NPs	23,210	25,300	1.09
CNMs	4,155	4,155	1.00

ILLUSTRATIVE HEALTH INSURANCE/DELIVERY MODE SCENARIOS

Scenario Definitions: As noted above, the IRM produces annual forecasts for years 1995 through 2020 dependent upon varying assumptions about future developments about the health insurance status of the population and the staffing patterns associated with insurance status delivery modes. All scenarios incorporate U.S. Bureau of Census projections of the U.S. population by age and sex. The distribution of the population by setting (urban/rural and insurance status) and the staffing patterns associated with each aggregated setting were estimated by the project team for 1995. The model software was developed to allow the user to produce requirements according to stipulated scenarios. Six scenarios are provided with the model software as illustrations of the model. In these, the distribution of the population by setting and staffing patterns associated with each have been modified to fit the scenario.

The six scenarios are defined below:

1. **Status quo:** The 1995 insurance distributions and staffing models are applied in all projection years to measure the effects of changing population demographics only; all else held constant.

2. **Baseline insurance projections:** In addition to shifts in population demographics, estimated shifts in insurance coverage are incorporated for each possible projection year, making this scenario the "best estimate" baseline forecast.

3. **High managed care:** Populations are shifted into HMO settings to a greater degree than in the baseline insurance projection scenario. This scenario is modeled for the year 2005.

4. **Universal coverage:** Building on the high managed care scenario, the uninsured population is then shifted into other insurance delivery modes, particularly HMOS. This scenario also assumes increases in preventive care in fee-for-service, thus increasing fee-for-service staffing levels. This scenario is modeled for year 2005.

5. **Equal access under universal care:** Building on the universal coverage scenario, staffing models are increased as required to provide parity for underserved populations in access to primary care. This scenario is modeled for the year 2005.

6. **High PA, NP, and CNM:** Insurance delivery modes are forecast the same as for the baseline insurance projection scenario. Staffing patterns are shifted by doubling the use of PAs, NPs, and CNMS, assuming a "substitution factor" of 0.5 (i.e., non-physician providers trade off for physicians at a rate of .5 physicians per 1 non-physician provider). This scenario is modeled for the year 2005.

Only in scenarios 4, 5, and 6 are both the 1995 staffing ratios assigned to each health care delivery modes and population groupings in insurance/delivery mode status modified. Therefore, although scenario 2 is considered the "best estimate" baseline forecast, it assumes there will be no change in either the primary care services provided or in the mix of the providers within each population group. Scenario 2 does assume some shifts of the population between delivery care modes. Staffing level changes in scenario 1 are due strictly to changes in gender-age-location subgroups of the population within the same delivery modes.

Model Outputs: Exhibit 4 displays aggregate staffing ratios for each of eight delivery modes, standardized to the total 1995 population. One of the key features of the IRM staffing models is that they adjust automatically to changes in the age/sex composition of the population. Thus, to make fair comparisons among these ratios, they must be applied to a standard population. The 1995 national population was chosen for this purpose.

Examination of these standardized staffing models suggests that:

- Primary care staffing ratios are not affected nearly as much by managed care as they are by differences between insured and uninsured and between urban and rural populations.

- NPs and PAs are used somewhat more extensively under managed care.

- With the exception of NPs, staffing ratios are less for uninsured populations.

- PAs treat a disproportionate share of rural populations.

Exhibit4: Primary Care Practitioners perlOO,OOO Population: Year 1995

Setting	PCPS	PAs	NPs	CNMs
Urban Staff HMO	84	5.5	12.0	1.9
Urban IPA HMO	92	3.9	10.8	1.4
Urban Fee-for-Service	86	3.4	9.5	1.7
Urban Uninsured	46	1.9	9.0	0.8
Rural Staff HMO	55	12.9	7.8	2.0
Rural IPA HMO	66	9.3	8.2	2.0
Rural Fee-for-Service	61	8.4	6.9	2.1
Rural Uninsured	31	4.7	6.3	0.8
TOTALU.S.	78	4.5	9.6	1.6

Based on these observations ,thespread ofmanaged care alone can be expected to have relatively small effect on primary care physician requirements, but this effect would be somewhat more pronounced for PAs and NPs. On the other hand, changes in the size of the uninsured population could significantly impact requirements for all practitioners except NPs. These deductions are supported by the scenario results described below.

Exhibit 5 summarizes findings from the six illustrative scenario analyses. It shows the percentage increase in practitioner requirements for the year 2005, relative to 1995 levels, under each of the six scenarios. The U.S. population is projected to increases by 9.4 percent over the same period.

The results of the status quo scenario show that, in the absence of changes in insurance distributions and staffing models, the requirements for PCPs, PAs, and NPs do little more than keep pace with population growth by gender, age, and location. Because of the lack of growth in the population of females of childbearing ages, the status quo changes for CNMS are less than the growth in the population.

The baseline insurance projection and high managed care scenarios represent varying degrees of increase in HMO penetrations, with emphasis on IPA model HMO growth. Given current staffing model estimates, the spread of managed care has little impact on PCP-or CNM requirements, but does result in a significant increases in PA and NP requirements. For example, in the high managed care scenario, PCP requirements grow by about 12 percent from 1995, but grew by over 10 percent with no growth in managed care. On the other hand, PA requirements grow by over 20 percent under high managed care and by less than 12 percent with no managed care growth.

Under universal coverage, requirements for all practitioners except NPs increase significantly. The lack of significant change for NPs can be predicted from examination of the staffing models. As noted earlier, unlike the other practitioner groups, empirical evidence showed that NPs had comparatively high staffing ratios for uninsured populations. Many of these NPs were employed in clinics that served disproportionate levels of the uninsured. Although not shown in the exhibit, the detailed scenario results show that covering the uninsured results in an increase of about 7 percent in PCPS, 8 percent in PAs, 2 percent in NPs, and 11 percent in CNMs. Augmenting universal coverage with a program to equalize access to care for otherwise underserved populations results in an estimated increase in practitioner requirements of 2 percent above the straight universal coverage scenario.

Exhibit 5: Changes in Year 2005 Practitioner Group Requirements Compared to 1995 Levels According to the Six Illustrative Projection Scenarios

Provider	Status Quo	Baseline Insurance	High Managed Care	Universal Coverage	Equal Access under Universal Coverage	High NP/PA /CNM Use
Physicians	10.4%	11.5%	12.1%	20.3%	22.7%	-2.2%
PAs	11.4%	15.1%	20.6%	30.7%	33.3%	130.0%
NPs	12.3%	15.4%	19.2%	21.2%	23.6%	130.4%
CNMS	1.8%	-0.3%	-1.4%	9.5%	11.7%	99.3%

The final scenario shows that a hypothetical increase in the productivity ratio ofNPPs to physicians from .40 to .50, combined with a doublingin the useof NPPs, would reduce physician requirements to slightly under 1995 levels in year 2005. The reduction in physician requirements would be greater if either the NPP to physician productivity ratio were greater or NPP use were increased. The model's software provides the ability to adjust either the productivity ratio or the ratios for a particular provider group or groups, or both the productivity ratio and the provider group ratios can be adjusted. Review of the literature suggests that while it is feasible to organize a practice in which NPPs are nearly as productive as physicians (a substitution ratio near 1.0), this is not the norm. Instead, NPPs tend to spend more time with their patients and therefore care for smaller patient populations than do physicians. A wide variation was found in substitution ratios in current practice, with the value of .40 falling within the middle of the range of these estimates.

It was postulated that because PA and NP salaries are about 40 percent those of a primary care physician, they can spend a little more than twice as much time with their patients and still be cost effective. It seems possible that aggressive, bottom-line-oriented HMOS may ultimately push for greater productivity from their NPPs and drive the substitution ratio upward. (If this were to occur, however, NPP salaries might also be expected to rise relative to those of PCPs.) However, no empirical evidence of trends in this direction was found. The high PA/NP/CNM use scenario is, therefore, hypothetical rather than a firm prediction of where the market is heading at this time.

The model outputs also include summaries of estimated direct "costs" that might be associated with predicted practitioner staffing levels utilized. The base data in the model for this aggregated cost figure are the "average salaries" in 1995 for each practitioner group. Other factors that would go into "true" costs are not included, nor does the model address changes that might occur in comparative salaries should productivity rates for any practitioner group change. No empirical studies were found upon which the determination of total costs or the changes in relative salaries could be based. Use of cost estimate output from the model is therefore cautioned.

Conclusion: It is widely agreed that the spread of managed care and other competitive pressures in the health care arena are having an impact on the workforce requirements of the US health care system. The research conducted in the development of the Integrated Requirements Model, and the six illustrative scenarios to which it has been applied, shed light on how requirements for primary care practitioners might be affected by the many changes now taking place in care delivery.

The user-friendly personal computer implementation of the IRM allows for varying model inputs and parameters. It is designed so that national requirements can be forecast under an unlimited number of scenarios through careful importation of information reflecting possible combinations of alternative changes. The model is a significant begiming approach to modeling primary care workforce requirements. The Bureau of Health Professions plans to refine and improve upon the use of this important model as improved and updated data become available to input into it's three main modules and alter the model's assumptions.

DATA SOURCES USED IN ESTIMATION OF MODEL INPUTS AND PARAMETERS

NCHS's *National Health Interview Survey* and *National Ambulatory Care Survey* (1992)

GHAA's *National Directory of HMOs* and *HMO Industry Profile*

HIAA's *Source Book of Health Insurance Data*

Decision Resources, Inc.'s *Interstudy Competitive Edge Industry Report 4.1*

Lewin-VHI's Managed Care Practice Group

Bureau of Health Professions' 1992 *Area Resource File (ARF), Certified Nurse Practitioner and Clinical Nurse Specialist Survey, Fifth National Sample Survey of Registered Nurses,* 1994, and *BHPr Physician Requirements Model* data inputs

American Medical Association's *Physician Master File* and *AMA Physician Characteristics and Distribution (PCD)*, 1992

American Osteopathic Association's Annual Survey Data

Jonathan Weiner's *Forecasting the Effects of Health Reform on US Physician Workforce Requirement,* JAMA, 1994

American College of Nurse-Midwives membership survey (ACNM, 1992)

American Academy of Physician Assistants' *1992 Census Report on Physician Assistants*

United States Bureau of the Census Population Estimates, 1992.

IRM MODULAR STEPS

1) Population assignment module assigns estimates of population grouped by age-sex-location into specific health care delivery modes.

2) Practitioner assignment module assigns staffing level configurations for each of the four practitioner groups to each delivery mode delineated above.

3) Resultant data from above two modules are fed into the integrated requirements calculation module, which assigns compensation levels to practitioner type and uses statistical algorithms to produce the forecasts of integrated practitioner requirements.

4) Computerized model produces reports summarizing the population by insurance and managed care status, and a report on the practitioner staffing models associated with the scenario being run using the parameters assigned by user.

Forecasting the Need for Physicians in the United States: The Health Resources and Services Administration's Physician Requirements Model

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The Health Resources and Services Administration's Bureau of Health Professions has developed a national model of physician specialty requirements to explore the consequences of a broad range of scenarios pertaining to the nation's health care delivery system on need for physicians. The model developed is a demographic utilization model capable of adjusting for changes in overall population growth and demographic composition, physician productivity, and insurance coverage. This model would appear to offer improvements over other data-driven methodologies that rely on staffing ratios and similar supply-determined bases for estimating physician requirements.

Note: Presentation is not available. A full-text version of the paper will appear in Health Services Research, forthcoming.

Discussant Comments

Mark Freeland, Health Care Financing Administration

The Bureau of Health Professions (BHPr) analysts and presenters should define or explain “requirements” up front which would save having to explain it afterwards. Another suggestion is for BHPrto engage regularly in "backcasting," that is validating the models by making the assumptions of20-25 years ago. Then, they should forecast to the present to see how well the models work. BHPr should also put more effort on publicity into documenting and publishing the amazing accuracy ofits physician supply model. This will the model additional credibility.

Also, the BHPr should explicitly state the analytical and policy purposes and uses for its forecasting activitiesto make clear that they are not just an academic exercise.
For presentations and dissemination, I urge the increased use of graphics in showing the results ofBHPr forecasts and analyses.

Finally, The BHPr should continue connecting and reconciling their figures with Bureau of Labor Statistics (BLS), whose *Occupational Outlook Handbook* is probably the most widely read and used federal publication. Were differences exist, they need to be explicitly explained and acknowledged. This is essential since BLS has a much larger customer base and visibility than BHPr. In general, it is important to share methods, information, and findings with states and outside groups.

FORECASTING TECHNIQUES

Chair: Karen S. Hamrick
Economic Research Service, U.S. Department of Agriculture

Discussant: William J. Lawrence
Pace University

Forecasting Farm Interest Rates: Point and Prequential Approaches,
David A. Bessler, Texas A&M University
Ted Covey, Economic Research Service
Mark Denbaly, Economic Research Service

A Phase Plane Model of the Business Cycle,
Foster Morrison and Nancy L. Morrison, Turtle Hollow Associates,Inc

Monitoring Changes In Federal Budget Outlays With Forecasting Models and Tracking System,
Peg Young, Department of Veterans Affairs

FORECASTING FARM INTEREST RATES: POINT AND PREQUENTIAL APPROACHES

by
David A. Bessler, Ted Covey, & Mark Denbaly
David A. Bessler is professor of agricultural economics at Texas A&M University. Ted Covey and Mark Denbaly are agricultural economists for ERS-U.S. Dept. of Agriculture. The usual disclaimers apply.

Introduction

This paper will examine out-of-sample forecasts of interest rates on two farm loan series using conventional point forecasts and Dawid's prequential approach to statistical analysis.

Prequential Analysis

The motivation for making probability forecasts is the authors' belief that many decision makers exhibit utility functions which are only approximately linear in wealth and that agents are risk non neutral. Following standard expected utility theory, choosing among various specifications requires modeling the entire probability structure.

Given data arriving in sequence, prequential analysis involves using currently available data in order to produce a specific probability distribution for the next observation. Prequential forecasting systems (PFS) are judged on the basis of their forecast performance (an observable outcome) rather than any a priori consideration (Dawid) or standard methods which focus on unobservable parameters. Dawid suggested the calibration criterion as a means of assessing and comparing sequences of probability forecasts in light of the outcomes of forecasted events.

Calibration acts as a long-run assessment of a PFS ability to issue realistic probability forecasts. In predictive situations, the extent to which probability assessments are realistic may be determined by considering the degree to which the forecasted assessments are matched by the empirical relative frequency of the events assessed. All events assigned a probability of n% are considered similar because they generate the same probability. Unlike classical probability theory's definition of relative frequency, calibration does not require the unrealistic assumption of repeated trials under identical conditions.

A well-calibrated PFS is one for which events assigned a probability of n% are observed to occur after-the-fact with n% relative frequency. A graphical representation of calibration performance plots the relative frequency of observed events (y-axis) against the issued (i.e. forecasted) probabilities or fractiles (x-axis). A well-calibrated PFS would yield a plot with slope equal to unity. Deviations of the calibration plot from a 45-degree line (i.e. miscalibration) indicate where the relative frequency of particular events are either greater (indicating model under-confidence) or less than (indicating model over-confidence) their assigned probabilities. Dawid suggested using a chi-squared goodness-of-fit test at a particular level of significance in order to test a null hypothesis of well-calibration for a particular PFS.

Previous Uses of Prequential Analysis

Kling used prequential analysis to predict turning points in several business and economic time series. Kling extended earlier stochastic simulation estimates of future probability distributions by including additional explanatory variables and incorporating the uncertainty in coefficient estimates as well as the residual errors. Kling found that while unadjusted probability assessments did not calibrate well, debiased assessments calibrate well for most events.

Kling and Bessler demonstrated and applied a sequential method for debiasing (recalibration) predictive distributions based on previously issued distributions and outcomes and tested their estimated sequences of unadjusted and recalibrated distributions for calibration. They found the calibration hypothesis cannot be rejected for most of the time-series and forecast horizons when the recalibration procedure was applied. Their results were sensitive to the assumption regarding the variance of the regression equation error process. Allowing for nonconstant residual variance resulted in significantly fewer rejections of the calibration hypothesis.

Bessler and Kling conducted a prequential analysis of cash and futures cattle prices using probability calibration metrics to judge the adequacy of the models. They found that the multivariate PFS provided more information than the univariate PFS on the predictive distributions of cattle cash prices, while the multivariate model on futures prices did not offer any additional information than that contained in the univariate model of futures prices. Using the overconfidence or underconfidence in forecasts of an earlier period to adjust the forecasts of a later period was not successful.

Covey and Bessler used prequential analysis to test for a fully-causal relationship between two economic variables. A fully-causal relationship was inferred from

X to Y if addition of X to Y's information set reduced the level of miscalibration &/or reduced the degree of uncertainty in contrast to the distributions forecasted by Y's univariate PFS.

The **Prequential** Forecasting Systems

Two time series are used: quarterly, short-term nonreal estate farm loans and intermediate nonreal estate farm loans made by commercial banks in the 9th (Minneapolis) Federal Reserve District for the period 1969 through 1993 (see Figure 1). This survey is conducted at the end of each quarter and reported in the *Agricultural Finance Databook.* Maturities were about 6 months for the short-term and 22 months for the intermediate term loans on loans for the same designation of the Fed's larger nation-wide survey of agricultural banks.

Each of the two series of 100 observations were divided in order that models or PFS fitted over the first period might be used to forecast out-of-sample over the realizations's latter period. The PFSS identified and estimated in each series earlier period (observations 1-6$ or 1969:1 through 1984:1) were then used to make one step-ahead probability and one through 12 step-ahead point forecasts of quarterly interest rates over each series' latter period (observations 62-100 or 1984:2 through 1993 :4).

Stationarity tests showed the two series were both nonstationary in levels but stationary in 1st differences (see Table 1). The two series are cointegrated (see Figure 2).

Autoregressive models were identified over the first 6 1 observations of each series using Hsiao's recursive fit procedure with both the Final Prediction Error (FPE) and Bayesian Information Criterion (BIC) as the two statistical loss functions. Both series identified identical lag lengths (6) used to fit a VAR in 1st differences and an Error Correction Model (ECM).

Coefficients were estimated using MLE. The Box-Pierce diagnostic test failed to reject a null hypothesis of white noise residuals in all models.

Point and probability forecasts were made by VARS in 1st differences and with the ECM.

The general model is given as:

$$\phi(B)_t \; X_t = e_t$$

Here, $\phi(B)_t$ refer to the 2x2 autoregressive parameter matrix, whose elements are individually polynomial functions of the lag operator, B. The elements of the parameter matrix are allowed to change over time throughout the forecast interval, thus they are indexed by t. X_t represents a 2x I vector of interest rates observed in period t. e_t represents a 2x 1 vector of residuals, which are uncorrelated through time, but may be correlated in contemporaneous time.

Forecasts from this model are generated over the second portion of each data set. Two sources of uncertainty are used to generate the probability forecasts-uncertainty due to lack of knowledge of ϕ_t and uncertainty in the one-step-ahead forecasts (call this u_{t+1}, a 2x 1 vector). We evaluate probability forecasts one-step ahead but we evaluate point forecasts one- through 12-steps ahead.

At each date the elements of $\phi(B)_t$ are assumed normally distributed with mean $\hat{\phi}(B)_t$ and covariance $\hat{V}_t = P'_t P_t$. $\hat{\phi}(B)_t$ and $\hat{V}_t$ are the simulated parameter and covariance matrices, found from updating the general model with the Kalman filter at each date t. Uncertainty in $\phi(B)_t$ is modeled by making draws from the probability distribution used to describe $\phi(B)_t$. A particular draw, $\phi(B)_t^*$ is obtained as:

$$\phi(B)_t^* = \hat{\phi}(B)_t + P_t e$$

where e is a vector of standard normal draws.

Uncertainty due to the one-step-ahead probability forecast errors is modeled by drawing (call this draw $u^*_{t+1} = O + D_t e$) from the normal distribution with mean vector of zero and 2x2 covariance matrix equal to the empirical covariance matrix ($\Sigma_t = D'_t D_t$) on one-step-ahead forecast errors, u_{t+1}. These latter errors are obtained from the historical forecast performance on earlier data points. Thus an initial period is required to obtain estimates of Σ_t. To accomplish this, each series is divided into 3 intervals. The first 20 observations in each period are used to obtain the MLE of $\phi(B)_t$, the next 41 observations are then used to simulate one-step-ahead forecasts. By recursively forecasting X_{t+1} and updating $\hat{\phi}(B)_t$ over this second internal, we obtain a sample of41 one-step-ahead forecast errors from which we form our initial $\hat{\Sigma}_t$. The last 39 observations in each series are used to model and evaluate the one-step-ahead probability forecasts.

The one-step-ahead forecast for X_{t+1} is given as follows:

$$X_{t+1}^* = \hat{\phi}(B)_t^* X_t + u_{t+1}^*.$$

Repeating draws on e (500 times for $\phi(B)^*_t$ and 500 more times for u^*_{t+1}) again at each data point yields 500 point forecasts of X_{t+1} at each t in the latter periods of each series. The model is then moved forward one data point or quarter. The Kalman filter is applied to obtain new estimates, $\hat{\phi}(B)_{t+1}$ and $\hat{V}_t$. [n addition, the actual observed X_{t+1} and the mean forecasted $\hat{X}_{t+1}$ are used to update $\hat{\Sigma}_{t+1}$. The above equation is then reapplied 500 times to obtain the forecast distribution for X_{t+2}. This procedure is repeated by each PFS for each of the two series' final 39 data points.

Following each quarter's forecast. the actual outcome (interest rate observed for the forecast quarter) is compared to its forecasted distribution in order to determine the observed fractile for that quarter. For

example, suppose that the interest rate observed on t+ I was 8°/0 and that 20°/0 of the forecasted interest rates for that quarter were less than or equal to 8%. An event or fractile of 0.20 would have been observed. A total of 39 observed fractiles are created by each PFS for each series.

Given the null hypothesis of a well-calibrated PFS, the observed fractiles should be uniformally distributed over the unit interval (by the probability integral transform). The 78 (39 for each of the two forecasted interest rate series) observed fractiles are placed into one of 5 equally-sized classes in the unit interval. The number of fractiles observed in each of the 5 classes are then contrasted to the number expected (20% or 15.6) of a well-calibrated model.

A chi-squared goodness-of-fit test of whether the frequencies of the observed fractiles in each class equals the expected frequencies in each class can be performed with 4 degrees of freedom.

Modeling the Data

Table 1 shows the results of 3 tests for unit roots--Dickey-Fuller, Durbin- Watson, and HEGY Seasonal Unit Root tests (Hylleberg et aL). For Dickey-Fuller, the calculated values are -0.89 for short-term interest rates and -0.94 for intermediate-term interest rates. The 5°/0 critical value on the Dickey-Fuller test is approximately -2.89. Given a decision rule to reject unit roots for calculated values less than the critical value, we fail to reject the null hypothesis of a unit root in either series and conclude the two series are nonstationary. For Durbin-Watson, the 5% critical value is approximately 0.25 with a decision rule to reject the unit root for calculated values greater than the critical value. Given the calculated values, 0.08 for short-term and 0.07 for intermediate-term interest rates, are both less than their critical value, we fail to reject the null hypothesis of a unit root and conclude both series are nonstationary in their levels.

In addition, HEGY tests for seasonal unit roots were conducted. These are quasi t-statistics on unit roots at ail seasonal frequencies (seasonal unit roots requires differencing every 4th observation). $\pi 1$ tests for unit root at the zero frequency and has a Dickey-Fuller type distribution under the null--reject for quasi-t-statistics less than -2.9. $\pi 2$ has a 5% critical value of -1.95 (reject for calculated quasi-t-value less than the critical). F on $\pi 3 = \pi 4 = 0$ has 5% critical value of 3.04, reject a seasonal root for calculated F greater than this 5°/0 value. We reject the hypothesis of seasonal unit roots in both series.

Figure 2 shows the test results for cointegration for the 4 quarters of 1983. These are trace tests on eigenvalues on the long-run matrix of an error correction representation derived from Johansen (1988). Tests are normalized by 0.5 critical values taken from Johansen and Juselius (1990). The result shows one cointegrating vector (i.e. r=1).

Based on these results, we model the two series as an error correction model with r= 1 cointegrating vectors. However, for comparison we also consider a VAR in first differences as a competing model; that is a VAR with no long-run relationship.

The Forecast Results and their Evaluation

Table 2 gives the RMSE of the out-of-sample point forecasts for the 2nd quarter of 1984 through the 4th quarter of 1993. Forecasts were for 1 through 12 steps (quarters) ahead. The ECM forecasted both series better than the VAR in first differences over all horizons for both interest rate series.

The calibration results showed that the forecasts from both models were similar (Figure 3). For example, events assigned a 20% or less probability of occurrence were never observed to occur. Events assigned a probability of 30% or less were observed to barely occur for the cointegrating model and about 15% of the time for the model in 1st differences. The cointegrated model's most accurate performance, in a calibration sense, was for events assigned a 40% or less probability of occurrence, while for models in first differences this was true for events assigned a 3 5% or less probability of occurrence. Events assigned about a 50% or less probability of occurrence (about as likely to occur as not) occurred over 90°/0 of the time. In fact, events assigned a probability of occurrence of at least 60% probability by both models were observed to occur all the time

Both models showed underconfidence when issuing probability forecasts. This is perhaps due to both model's inability to adequately deal with the large run-up in interest rates in the late 1970 and early 1980 period. Perhaps ARCH-like effects should have been directly incorporated into the models. It's clear that in terms of linear forecasts the ECM outperforms the first difference VAR (Table 2). However, both do badly in terms of higher moment forecasts (Figure 3).

The chi-squared test on (5 classes, 4 degrees of freedom, 5% level of significance) rejected the null hypothesis of well-calibrated PFS for both models. With a critical value = 9.49. the estimated chi-square was 70.2 for the VAR in 1 st differences and 72.2 for the ECM.

Conclusions

The ECM considered in this paper issued point forecasts that were better than those issued by a first difference VAR model. The probability forecasts from both models were not well calibrated and were considerably underconfident. Whether accounting for this peculiarity can improve future probability forecasts for these series remains to be seen.

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Table 1. Unit Root Tests

			HEGY Seasonal Unit Root Tests[3]				
Series	**D-F[1]**	**D-W[2]**	**π1**	**π2**	**π3**	**π4**	F-test
STIR	-0.89	0.08	-.43	-7.94	-7.29	-4.16	51.36
A STIR	-3.05	2.18					
ITIR	-0.94	0.07	-.42	-8.06	-7.24	4.12	50.26
A **ITIR**	-3.03	2.17					

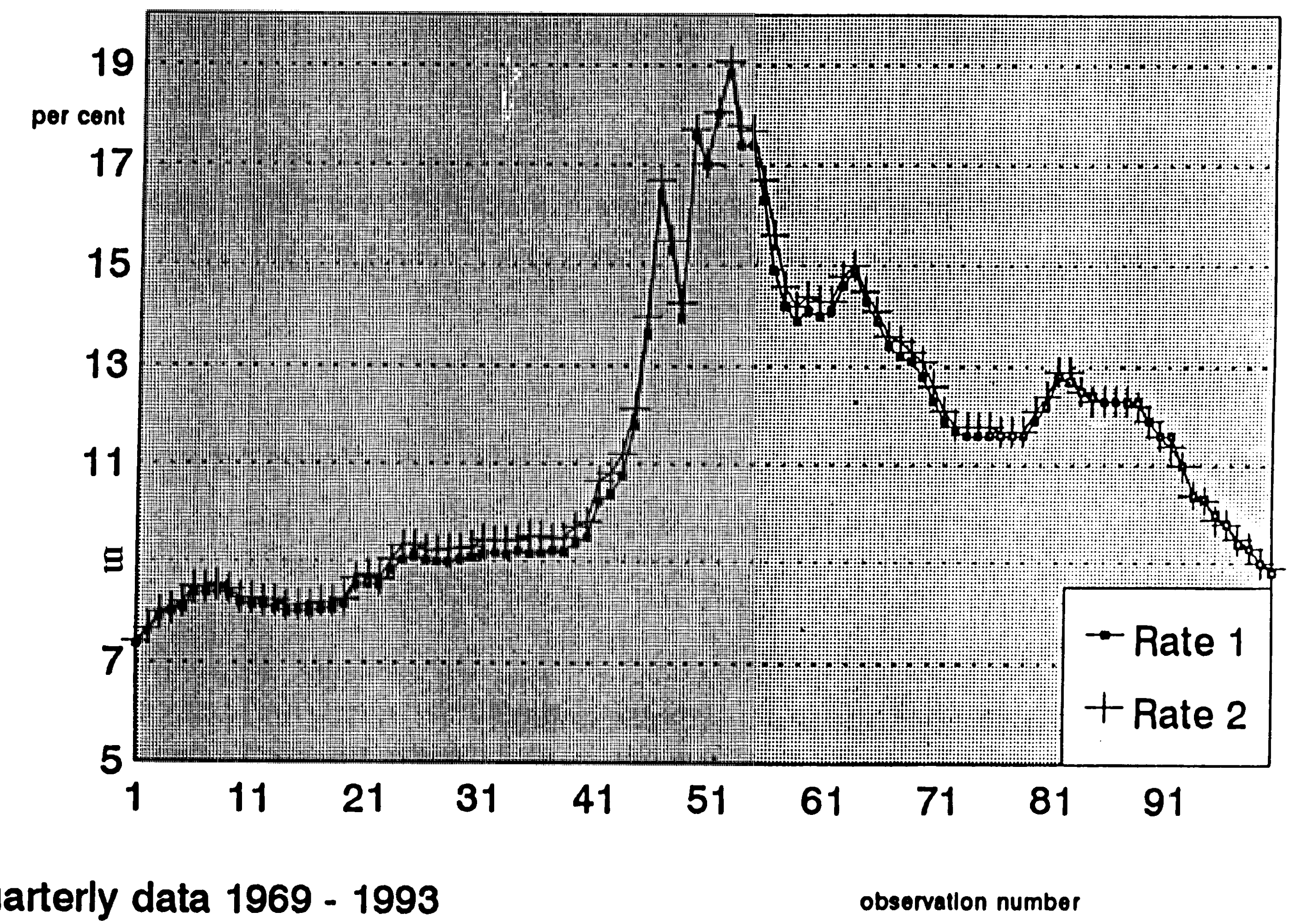
STIR: short-term interest rates.
A STIR: 1st differences of STIR.
ITIR: intermediate-term interest rates.
A **ITIR: 1st** differences of **ITIR.**
[1]**5%** critical value on the Dickey-Fuller (D-F) test is approximately -2.89. Reject unit roots for calculated **values** less than the critical value.
[2]5°/0 critical value on **Durbin-** Watson (D-W) test is approximately .25, reject unit root for calculated values greater than the critical value.
‘Seasonal unit roots: **π** 1 tests for unit root at zero frequency and has Dickey-Fuller type distribution under the null-reject for less than -2.9. **π2** has 5°/0 critical value of-1.95 (reject for calculated t-value less than critical). The F-test on **π3** and **π4** has a 5% critical value of 3.04; reject seasonal unit roots for calculated F greater than this **5%** value (see **Hylleberg** et al).

Table 2. RMSE on Out-of-Sample Point Forecasts 1984:2-1993:4

	Short-term Interest Rates		***Intermediate-term Interest*** *Rates*		
Horizons	**VAR**	**ECM**	VAR	**ECM**	OBS
1	0.45	0.43	0.42	0.41	39
2	0.77	0.67	0.72	0.65	38
3	0.89	0.77	0.84	0.76	37
4	**1.13**	**0.91**	**1.06**	0.90	36
5	**1.31**	**1.01**	**1.23**	**1.01**	35
6	1.53	**1.12**	**1.44**	**1.11**	34
7	**1.76**	**1.22**	**1.69**	**1.22**	33
8	**1.90**	**1.31**	1.86	**1.32**	32
9	2.06	**1.44**	2.01	**1.47**	31
10	**2.17**	**1.55**	2.08	**1.57**	30
11	**2.31**	**1.62**	**2.23**	**1.63**	29
12	**2.46**	**1.67**	2.38	1.70	**28**

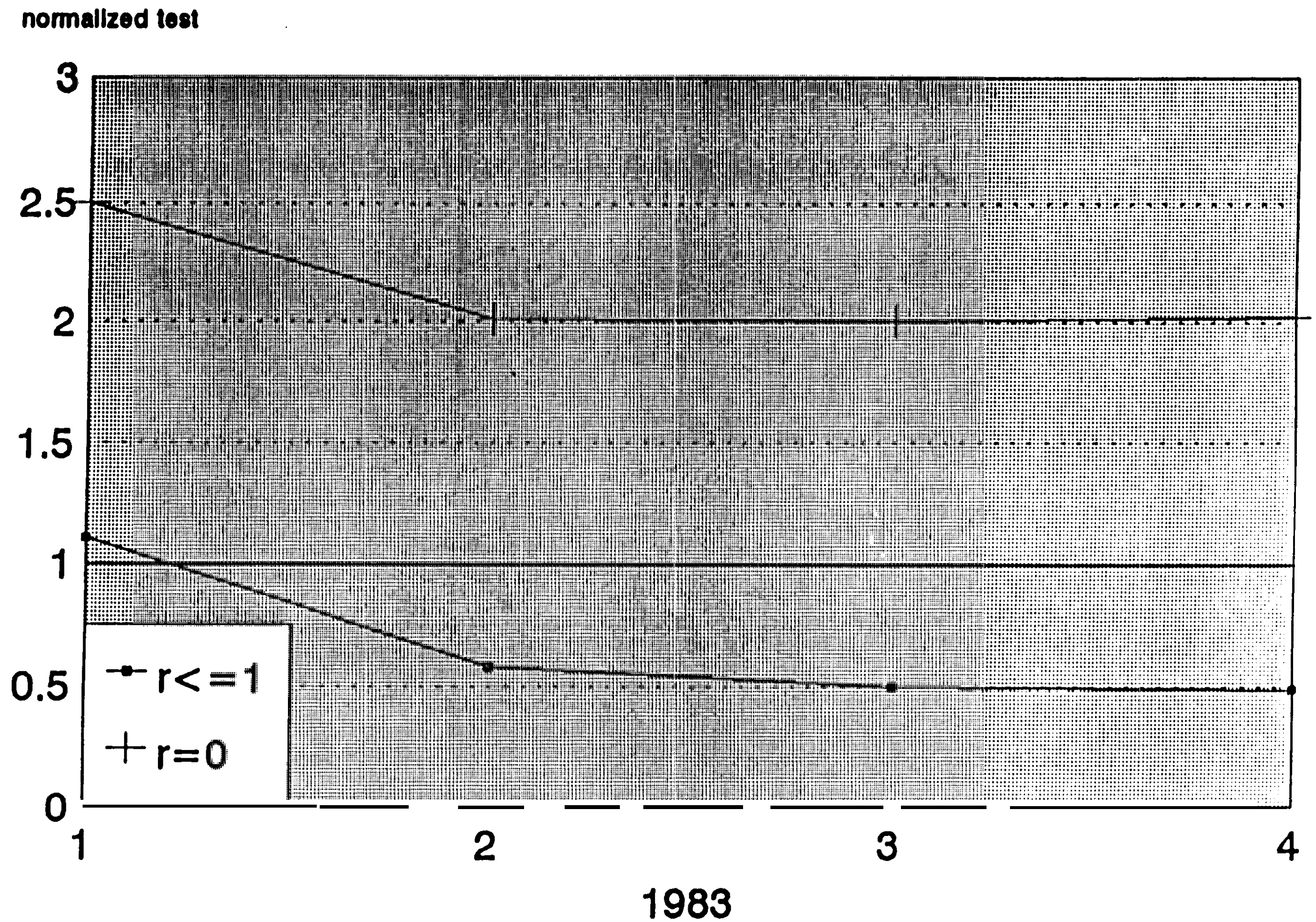
Root Mean Squared Error statistics are on out-of sample forecasts from 1 to 12 steps (quarters) ahead. VAR is a vector autoregressive **model in first differences. ECM is a cointegrating vector error correction** model with **r=** I **cointegrating** vectors. OBS is the number of forecasts.

Figure 1 Data on Interest Rates



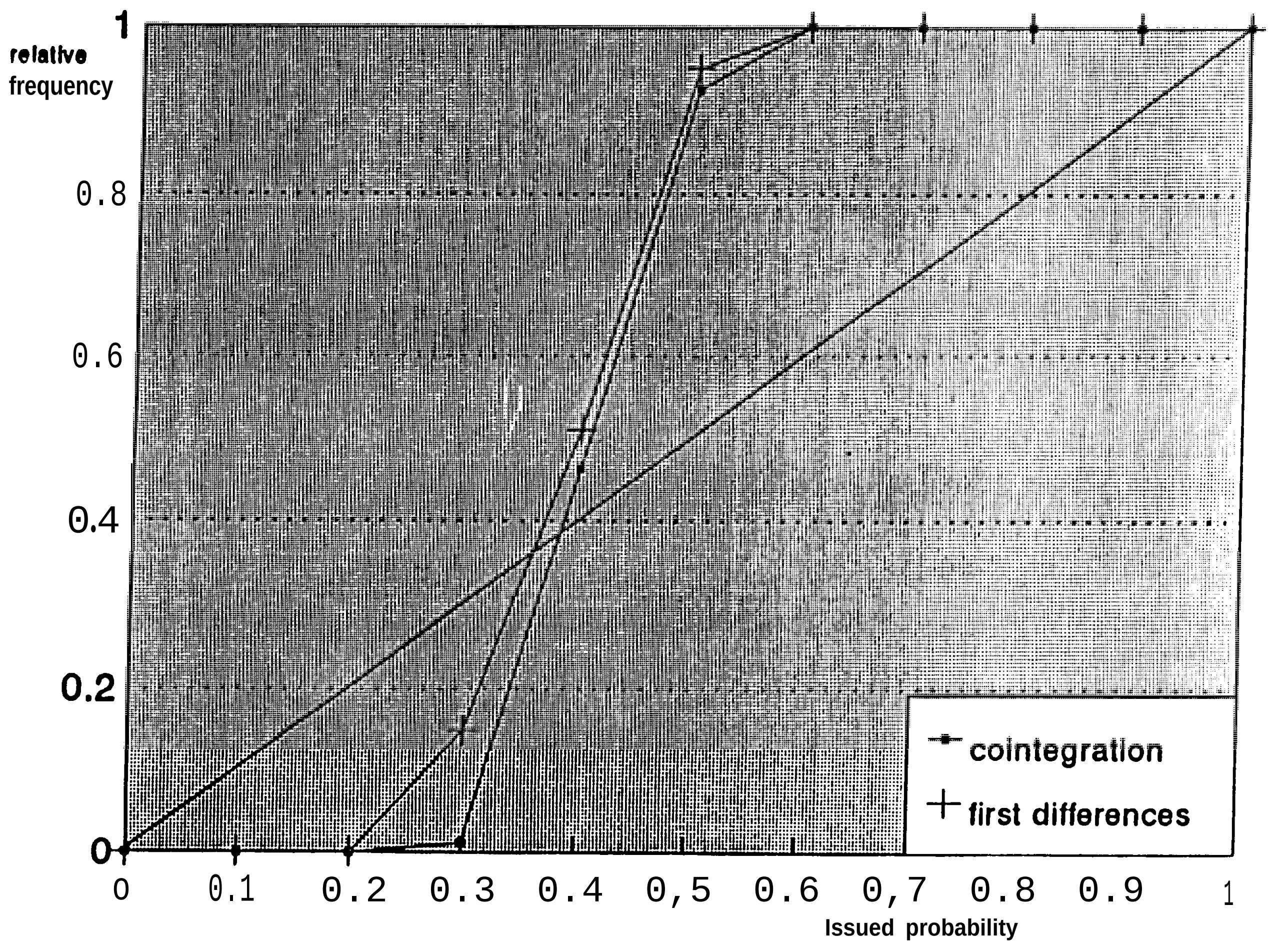
quarterly data 1969 - 1993

Figure 2. Tests for Cointegration



tests are normalized by .05 critical values.

Figure 3. **Calibration Plots on Out-of-sample Probability** Forecasts



A PHASE PLANE MODEL OF THE BUSINESS CYCLE

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EXECUTIVE SUMMARY

- A trend model separates the effects of growth and inflation from the "cyclical" variations in economic, stock market, and many other kinds of data. Most forecasting methods require that the data have the trend removed.

- The moving average is a good trend model, but its proper reference time is the middle of the interval being averaged; it is not up-to-date.

- The RAMP FILTER is similar to the moving average (it is a weighted average and low-pass filter), but it has been designed to have a reference time at the end of the interval being averaged. (See Figure 10.)

- The RAMP FILTER is suitable for a wide variety of scientific and technical problems, as well as economic analysis. To facilitate the research of others the RAMP FILTER formulas are provided.

- The U.S. Department of Commerce (DoC) indices of leading and coincident indicators provide a fairly reliable, NEARLY CURRENT measure of the state of the economy, IF interpreted carefully. The trick is to detrend them.

- Important structures, such as the BUSINESS CYCLE, become visible only AFTER the trend is removed. A phase plane plot of detrended indices shows exactly where we are in the business cycle and gives a numerical measure of how robust it is. (See Figures 1-8 and Appendix I.)

- Revisions to the DoC indices made on December 3, 1993 reduced the size of the radial coordinate of the cycles to about half of what they were previously. But the shapes and angular coordinates are essentially UNCHANGED. This provided a good confirmation of the integrity of the model.

NOTATION: Within the text algebraic symbols are placed within brackets, e.g., [X]; if they have subscripts, they are indicated by parentheses, e.g., X(1).

1. THE ECONOMY: A DYNAMIC SYSTEM

Ask a dozen economists about the state of the economy and you'll get a dozen (or more) different answers. This is not a satisfactory situation for the businessman, investor, or civil servant who needs to make a decision, or even the politician who has to run a reelection campaign.

But there is a tool that is more objective than the consensus of economists and more timely than the official announcements of the National Bureau of Economic Research (NBER) or even the quarterly Gross Domestic Product (GDP) reports from the U.S. Department of Commerce (DoC). It shows exactly where we are

in the business cycle and gives a numerical measure of how robust it is.

The economic system is actually fairly simple. There are two principal mechanisms at work.

1. Growth and inflation (trends) are the dominant phenomena. Over periods of decades the values of most economic variables will double, and in a similar period, double again. Of course there are "limits to growth," but nobody now knows exactly what they are or when they will curtail economic expansion or population increases. Feedbacks cannot be calibrated precisely until their effects are rather severe, even if the system is as simple as the classic logistic ("Hubbert's pimple").

2. Cyclical variations are produced by the aggregate action of the law of supply and demand. These fluctuations are kept alive by many factors, such as late and inaccurate data, incorrect forecasts, excessive optimism or pessimism, other errors of judgment, and other deficiencies in knowledge. These "cycles" do not have a regular period or shape, but peak (and trough) at intervals of 4-10 years. Usually the peaks and troughs are fairly shallow, but every 40-75 years a big one comes along in the form of a depression or "long wave."

More questions are raised by this dynamical analysis than are answered. Is the business cycle controllable? And if so, to what degree? Could the concepts of Keynes or the monetarists work in principle? If so, are they politically feasible? These are important policy issues and they should be approached in a systematic way. Whether the business cycle should be dampened and who should do it are matters of ideology and political choice; how well it can be done, if at all, is the province of economic modeling.

The system dynamics school has worked for decades to model the large-scale structure of the national and global economies. Their approach of using huge systems of nonlinear ordinary differential equations, numerically "solved" on a powerful computer, put the cart before the horse. Such models can emulate the behavior of a complex system qualitatively, but are useless for policy analyses.

What happens is that the (unknown and virtually unknowable) unstable equilibria in the huge system interact with the errors in parameters, initial conditions, and floating-point arithmetic to create "noise." The model contains a not very good random number generator using chaos and also various smoothing filters. The output is "filtered noise" generated by a very inefficient algorithm, but it can be manipulated with trial-and-error parameter adjustments to look like any economic time series.

Before attempting to answer the cosmic policy issues, it is first necessary to look at the much simpler question of short-term forecasting. Adequate forecasts can be generated by all sorts of ad hoc methods and these are fine for immediate applications. But the forecasting method should model the dynamics of the exchange economy if it is to be used for long-term forecasting and policy analysis. This paper provides no answers to these important policy questions, but it does the first essential step, skipped over by the system dynamics school and many other economic modelers: creating the simplest possible quantitative model.

In mathematical terms, these "business cycles" can be modeled by "filtered noise" or a damped linear oscillator with "noise" input ("right-hand side"). The damped oscillator can be interpreted as a "cobweb" model of the aggregate ex-

change economy. So the theoretical background is just the usual equilibrium model, but with the dynamics added so that the system never dampens down completely.

Time series methods are the usual means of modeling and forecasting such systems. Originally conceived as a mathematical model without any theory, time series methods implicitly assume such an ODE (ordinary differential equation) model. When the long-term behavior of a system is dominated by exponential growth, it is necessary to use logarithms of the data and then detrend them.

If the U.S. economy were a very simple system and totally isolated, it might be possible to use an exponential growth model as the trend (a linear regression on the logarithms). Or perhaps a logistic curve or other simple dynamical model. Historical and technological factors come into play and make things very complicated. Detailed economic data have been collected in the U.S. only since 1947 or so. What there is from the period 1620-1947 is sparse and not uniform. So the best feasible trend model for analysis and forecasting is not one or even a system of ODES, but a low-pass filter.

The period 1947-date is long enough to determine the basic statistical properties of the business cycle for the purposes of forecasting. Earlier data might be of limited value, since these statistics can change gradually. However, departures of economic data from stationarity might be useful in policy analysis and studies of technological change.

The DoC indices of leading and coincident indicators provide a fairly reliable, NEARLY CURRENT (2-month lag) measure of the state of the economy, IF interpreted carefully. The trick is to detrend them and use the results to create a phase plane plot. Then the state of the business cycle can be read off the graph in terms of phase angle and "energy level." Unlike the selective and arbitrary pronouncements of economists, this business cycle model is reasonably objective, as well as up-to-date.

Forecasts of the DoC indices are usually reliable for 2 months or more, so the current state of the business cycle is available with a somewhat larger error of estimation than those of the past 2-12 months. The indices are revised for 3 months after release and then again after one year, so the most precise values are at least 14 months old. The horizon of predictability typically is 12-18 months for these indices, so the final values are a bit stale and mostly of historic interest.

Before plunging into the details of how these graphs are construtted, look at the figures. Trends (principal mechanism #1) for the S&P 500 are shown in Figure 10. Figures 1-8 show cyclical variations (principal mechanism #2). Note that all the cycles are roughly elliptical, with variable amplitude and irregular period. (Not all points are at an equal distance from the center. The time it takes for a complete cycle varies from 4-10 years.)

VERY IMPORTANT POINT: The basic elliptical structure becomes visible only after the trend is removed.

2.' ACTUAL BUSINESS CYCLES

How can one model the entire exchange economy with only two variables? Fortunately, most of the work has been done for us already by the DoC, which provides the Composite Index of 11 Leading Indicators and

the Composite Index of 4 Coincident Indicators (now maintained by The Conference Board since December 1995).

The DoC indices may or may not be the best possible variables to use in constructing a business cycle model, but they are the best readily available. They are tabulated on a monthly basis, while the GDP itself is evaluated only quarterly. Having to evaluate "everything" makes GDP determinations slow and uncertain, so that final values are released only 3 years after the fact. This is rather disturbing, since the horizon of predictability for most macroeconomic series is not much more than one year.

Economists have worked for decades to improve these indices and a number of others. Better ones may become available in the future, but the current ones give a far more revealing picture of what is and was happening than is generally understood. The overall success of these indices comes through much better in a phase plane plot than in the usual plots of them against time, with recessions indicated by dark vertical bands. In fact the structure of the cyclical variations in the phase plane plots demonstrates that the DoC indices of leading and coincident indicators are scientifically meaningful and highly useful for practical purposes.

What exactly is a phase plane plot? When there are 2 data series, instead of plotting each against a (horizontal) time scale, use one series as the horizontal coordinate [X] and the other as the vertical coordinate [Y]. Time sequence information may be discarded entirely or retained by connecting the sequence of points with lines. [Smooth, continuous data (produced only by mathematical simulations) would require breaks or markers at intervals of equal time.]

To create a model of the business cycle we first remove the trend with a 60-point ramp filter (see Section 5). The detrended leading index is used for the X-coordinate and the detrended coincident index for the Y-coordinate (for why, see Section 3). Standard conventions set the positive horizontal axis to zero degrees and count phase angle counterclockwise. With these definitions the "business cycle" runs counterclockwise with occasional stalls and reversals.

The phase angle [21 provides a kind of ECONOMIC TIME SCALE. Expansions occur in the first quadrant ([Z] between 0 and 90 degrees) and contractions (or recessions) in the third quadrant ([Z] between 180 and 270 degrees). Other angles (second and fourth quadrants) denote transition periods. The phase plane plots obtained are perfectly consistent with what one expects from a system seeking equilibrium, as postulated by economic theory, but disturbed by high-frequency noise.

Existing data allow the analysis to begin in December 1952. By April 1996, a full 7 cycles had been completed. The DoC indices are available back to 1947, but the 60-point ramp filter used for the trend discards the first 5 years. No effort has been made to create a compatible trend model for the period January 1947 - November 1952.

Dates for recessions as determined by the NBER agree fairly well with the phase plane analysis. An "official" beginning of a recession is indicated by a label "B" and an end by "E" (see Figures 1-8). All these periods exhibit one "official" recession, except 1976-1984, which had a "double dip." This was a case where the expansion stalled, went backward, and then proceeded the way it should have. Sometimes contractions stall and the plot wanders around before returning to its gener-

Time Frame	Begin	R	Z	End	R	Z
1953-55	07/53	2.9	180 deg	05/54	6.3	257 deg
1955-59	08/57	3.6	186	04/58	7.8	235
1959-63	04/60	2.4	83	02/61	1.5	259
1963-72	12/69	2.0	210	11/70	4.7	238
1972-76	11/73	2.9	95	03/75	11.6	219
1976-84	01/80	5.2	204	07/80	7.1	228
1976-84	07/81	2.0	264	11/82	3.8	307
1983-96	07/90	2.0	221	03/91	4.0	241

Table 1. Official recessions, as recognized by the NBER, compared with dynamical phase plane plot parameters R (radius) and Z (phase angle). See also Figures 1-8 and Appendix 1.

BUSINESS CYCLES (1953 - 1996)

Figures 1-8. The bus ness cycle model is a phase plane plot of detrended leading and coincident indicators, as X- and Y-coordinates, respectively. Normal cycles follow a counterclockwise rough y elliptical path with occasional stalls and reversals. Time Is indicated along the cycle path. Expansions occur in the first quadrant (between 0° and 90°) and contractions in the third quadrant (between 180° and 270°). Other angles (second and fourth quadrants) denote transition periods. An "official" (National Bureau of Economic Research) beginning of a recession is Indicated by a label "B" and an end by "E." Note that the 1976-1984 cycle had an official "double dip" recession.

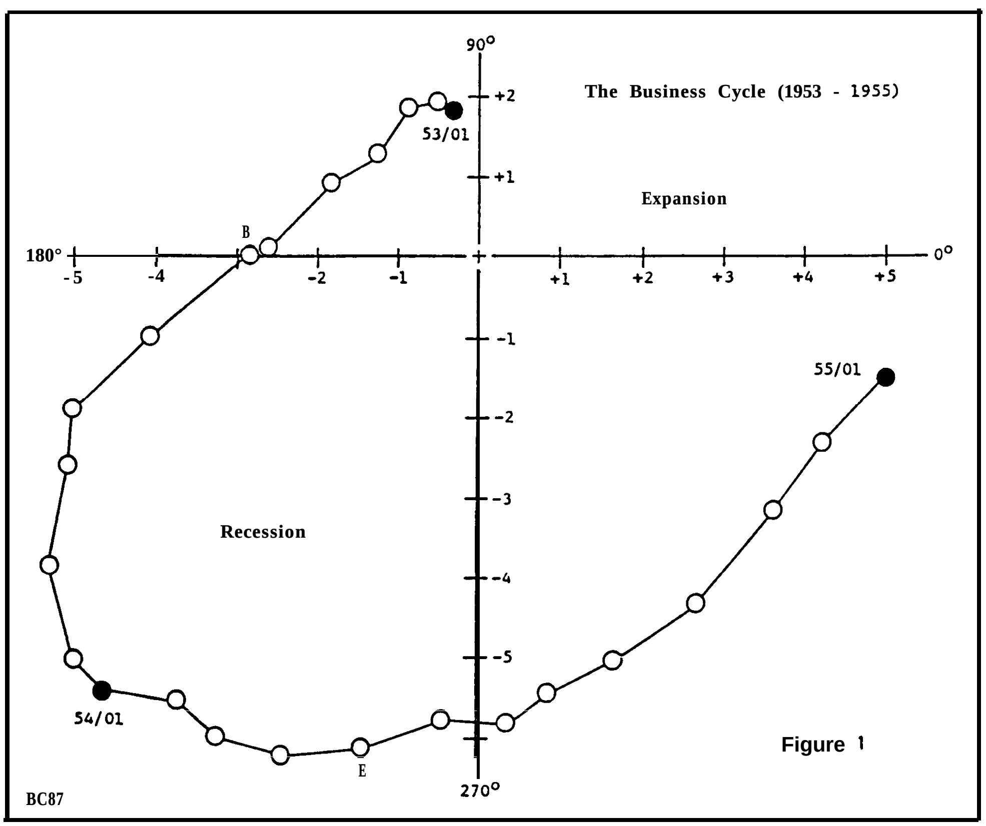
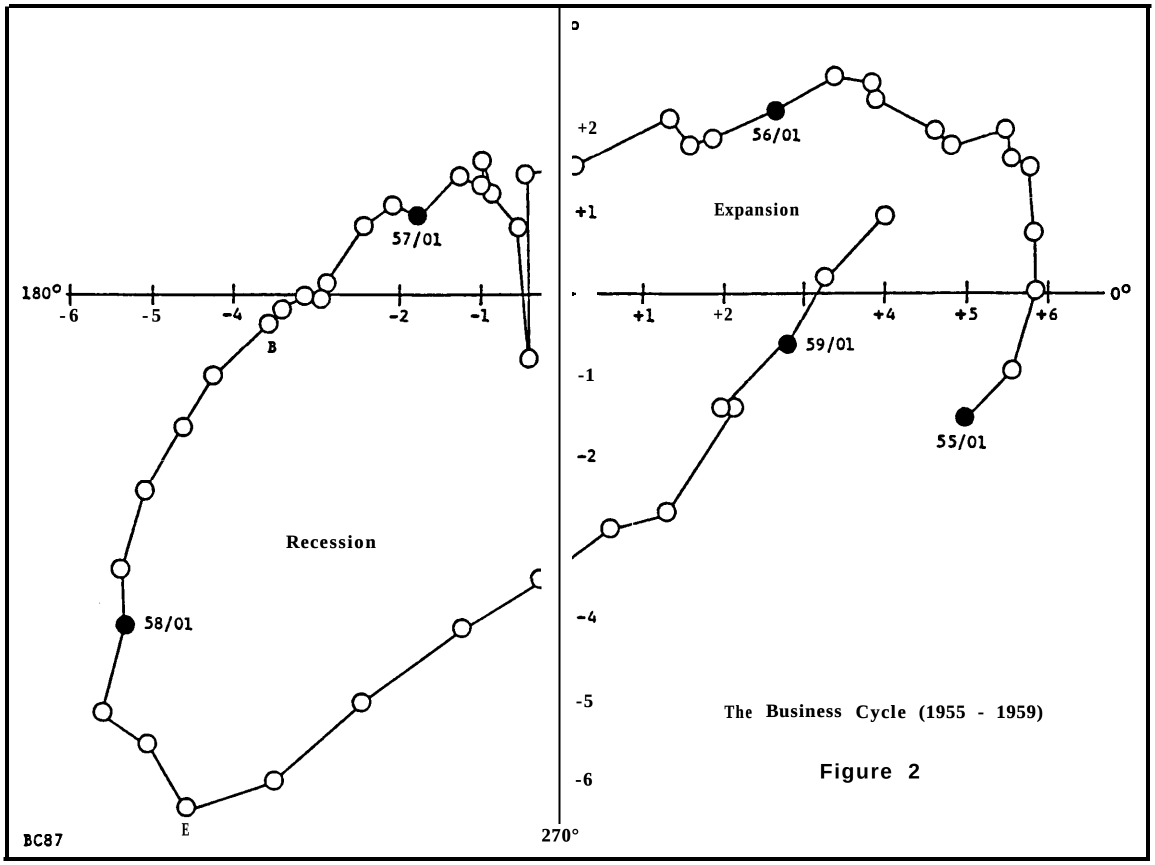


Figure 1



The Business Cycle (1955 - 1959)

Figure 2

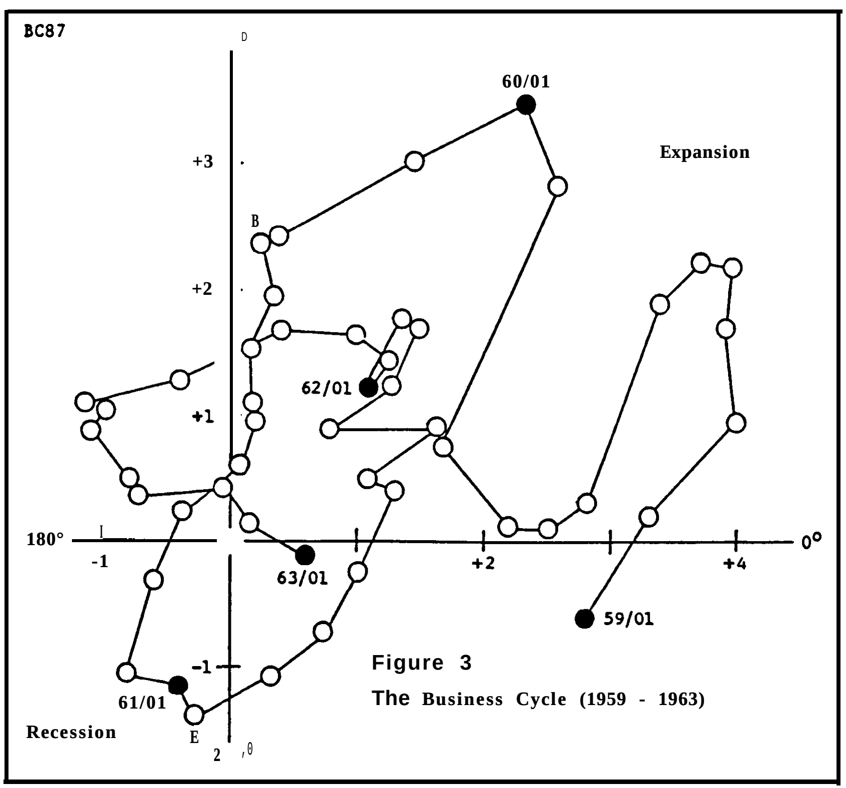
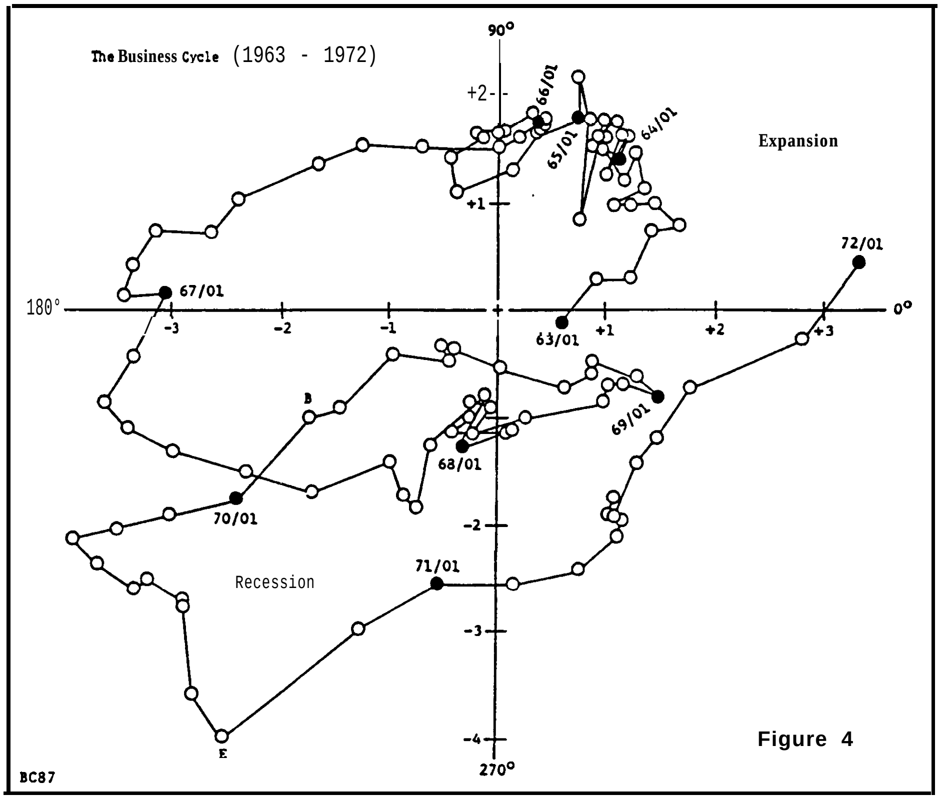
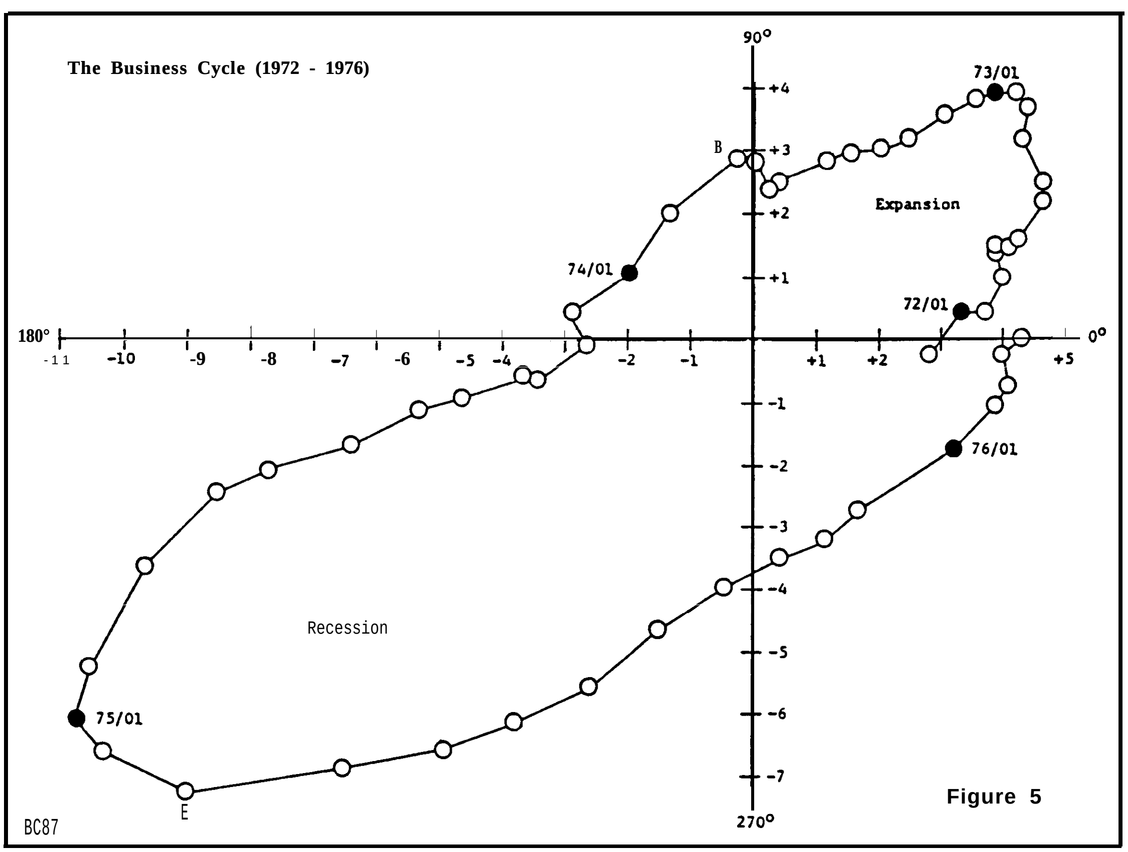
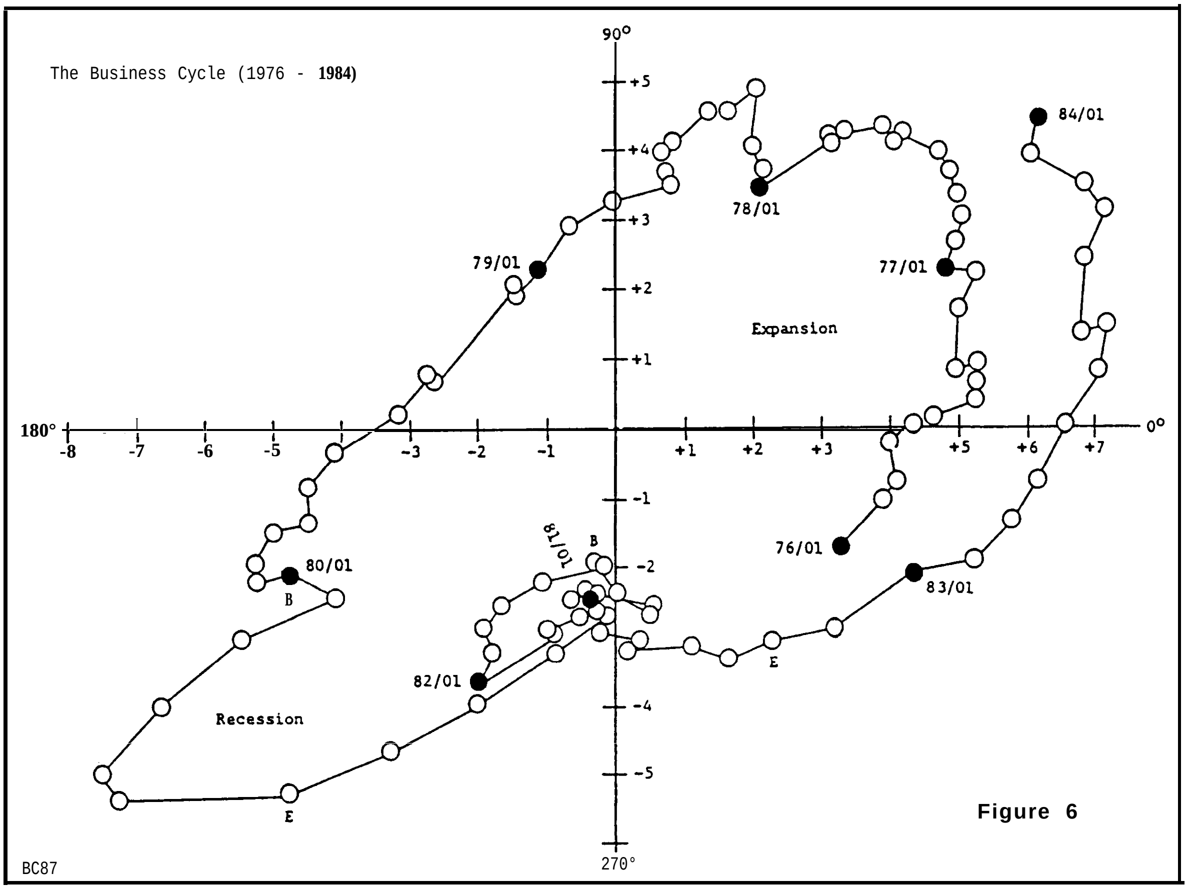


Figure 3

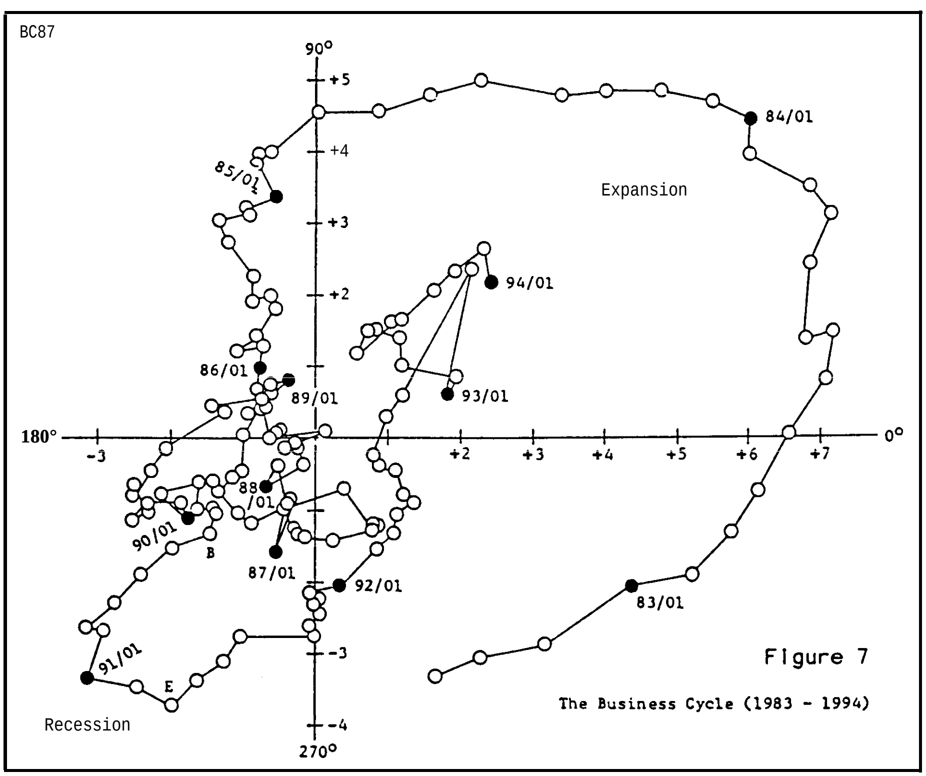
The Business Cycle (1959 - 1963)


The Business Cycle (1963 - 1972)
90°
+2
+1
-2
-3
-4
270°
180°
0°
-3
-2
-1
+1
+2
+3
66/01
65/01
64/01
Expansion
72/01
67/01
63/01
69/01
68/01
70/01
B
71/01
Recession
E
Figure 4
BC87

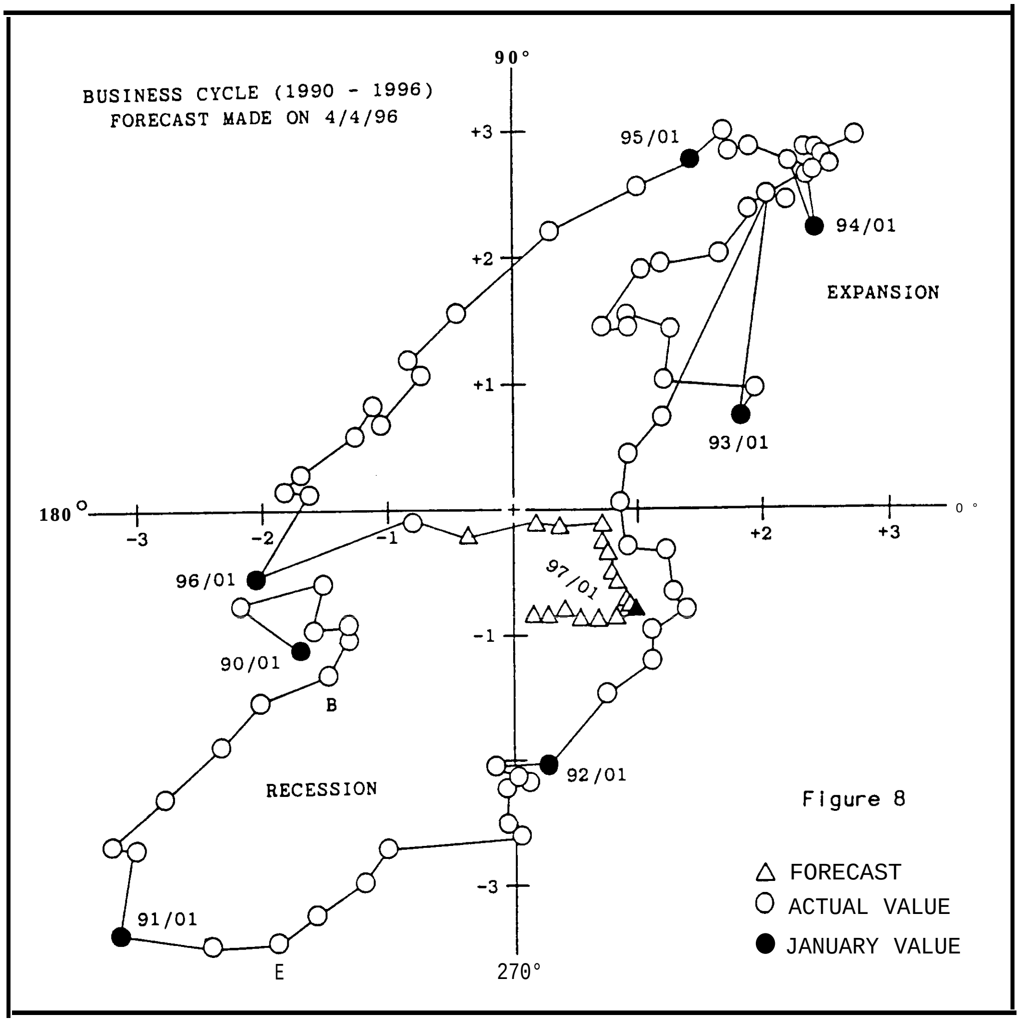

The Business Cycle (1972 - 1976)
90°
+4
+3
+2
+1
-1
-2
-3
-4
-5
-6
-7
270°
180°
0°
-11
-10
-9
-8
-7
-6
-5
-4
-2
-1
+1
+2
+5
73/01
B
Expansion
74/01
72/01
76/01
Recession
75/01
E
Figure 5
BC87



The Business Cycle (1976 - 1984)
90°
+5
+4
+3
+2
+1
-1
-2
-4
-5
270°
180°
0°
-8
-7
-6
-5
-3
-2
-1
+1
+2
+3
+5
+6
+7
84/01
78/01
79/01
77/01
Expansion
76/01
80/01
B
81/01
B
83/01
82/01
E
Recession
E
Figure 6
BC87



BC87
90°
+5
+4
+3
+2
84/01
85/01
Expansion
94/01
86/01
89/01
93/01
180°
0°
-3
+2
+3
+4
+5
+6
+7
88/01
90/01
B
87/01
92/01
83/01
-3
91/01
E
Figure 7
The Business Cycle (1983 - 1994)
Recession
-4
270°



ally elliptical pattern. These also are "quiet periods" during which the economy slowly spirals toward an equilibrium of little or no growth.

A rough measure of ENERGY or STRENGTH is given by the SQUARE of the radial coordinate [RI (straight line distance from the origin -- see Section 3). This is a dynamical analogue of physical energy. During strong expansions or contractions the energy level can run into the 60-150 range. The maximum value for the "Reagan boom" was 60.3; for the full 40 years the absolute maximum of 154.3 was attained during the recession of 1974-75. That period exhibited a nearly ideal business cycle, with a smooth trajectory and no stalls or reversals.

The most recent business cycle has an energy level of only 4.6 for Jan. 1996. This confirms that the U.S. has been experiencing a recovery since 1991, but with the most feeble start in the past 40 years. For Feb. 1996 this dropped to an incredibly low 0.7, but this may be due to the coincidence of bad weather, a major General Motors strike, and other negative events.

The phase plane plot clearly indicates where the business cycle is and how it has been progressing. The time delay is no more than two months, whereas the "official" recognition of the beginnings and endings of recessions may not come until a year or more (e.g., 21 months) after the fact. Events such as the "double

dip" recession of 1980-82 are revealed clearly, as are other stalls and irregularities.

The DoC indices of leading and coincident indicators can be forecast with some reliability about one to 1.5 years ahead; this has been our experience since starting numerical forecasts in April 1989. So the state of the business cycle for the next year is usually fairly clear. We suspect the values of Feb. 1996 are indeed anomalies and that the cycle will follow previous forecasts.

The graphs suggest that the efforts of government to manipulate the economy via deficit spending and money creation are just part of the background noise that keeps the cycle going. If financial problems are indeed curbing economic growth, it is a decades long process (part of the trend). And there are many other factors, including environmental constraints, demographic changes, and expanded competition.

3. THE IDEALIZED BUSINESS CYCLE: THE HARMONIC OSCILLATOR

Why select the leading indicator as the X-coordinate and the coincident indicator as the Y-coordinate in the phase plane plot? Quite simply to test the following hypothesis: The Composite Index of 11 Leading Indicators is a leading indicator and the Composite Index of 4 Coincident Indicators is a coincident indicator. (In other words, does the DoC practice truth in labeling?)

What pattern would be traced out if the indicators were perfect and the business cycle were of uniform period? A circle, or at least an ellipse, if the scale on one variable is off. The simplest phase plane plot is the one for uniform circular motion, or simple harmonic motion in dynamical jargon. (Figure 9 shows this highly idealized cycle.) The variable P(C) is a detrended coincident indicator and P(L) a detrended leading indicator, as modified by formula (4.10). In this simple case, P(L) is always 90 degrees ahead of P(C).

Even if the motion is not uniform in time, but goes the same places, the phase plane plot will not change. This is why phase plane plots are essential for studying cycles of irregular period. The radial coordinate [R], where

$$R = \sqrt{P_L^2 + P_C^2} \qquad (3.1)$$

remains constant, even when the angular coordinate [Z] does not increase uniformly. In fact, the motion could reverse and go backwards for a while without changing the graph.

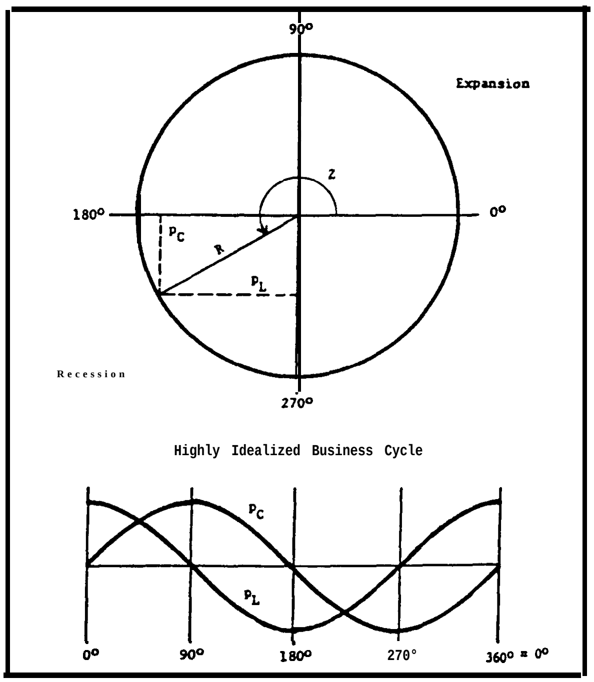


Figure 9. The idealized business cycle.

In some cases the plot may be a different sort of closed loop. An ellipse can be obtained by changing one of the scales on the plot or making the phase difference other than 90 degrees. Nonlinear mathematical

models may produce closed loops far more complex than a circle or an ellipse.

Real data usually produces a ragged loop, if it produces any pattern at all. When the indices of leading and coincident indicators published by the DoC are detrended and used for P(L) and P(C), the plots obtained have definite patterns, but with significant irregularities (Figures 1-8).

The phase angle [Z] provides a kind of economic time scale. When [Z] is between 0 and 90 degrees deviations from the trend of both indicators are positive; the economy is expanding. Values of [Z] between 180 degrees and 270 degrees indicate a recession; deviations from the trend of both indicators are negative. Other angles denote transition periods.

[R] and [Z] are POLAR COORDINATES, where [R] is given by (3.1) and

$$z = \arctan(P_C, P_L) \quad (3.2)$$

One must use the two-argument arctangent function to get the full range 0 to 360 degrees for [Z].

4. BUILDING THE MODEL AND FORECASTING

Both growth and inflation are expressed in percent per unit time (usually per year). Population growth and capital investment are roughly proportional to the existing stocks of people and capital goods. Inflation also is best expressed the same way. So the first thing to do with most economic data is:

1. Convert to logarithms. Recall that logarithms replace multiplications with additions, thus

$$\log x + \log y = \log xy \quad (4.1)$$

In a graph, the sudden, steep rise of exponential growth (or equivalently, compound interest) is converted to a straight line. This is useful and actually essential for graphics, mathematical analysis, and forecasting.

2. The next step is to create a trend model. There are many ways to do this, but the easiest and often the best is to use a WEIGHTED AVERAGE (a low-pass linear filter). For a sequence of data points

$$y_1 = \log x_1$$
$$y_2 = \log x_2$$
$$\ldots \quad (4.2)$$
$$Y_n = \log X_n$$

the trend is then given by

$$\langle y_k \rangle = w_1 y_k + w_2 y_{k-1} + \ldots + w_j y_{k-j} \quad (4.3)$$

or

$$\langle x_k \rangle = \exp(\langle y_k \rangle) \quad (4.4)$$

Note that [exp y] is the number whose natural logarithm is [y]. The weights should sum to 1,

$$w_1 + w_2 + \ldots + w_j = 1 \quad (4.5)$$

so that the trend of a constant value is itself.

For the popular moving average, the weights are equal and sum to 1

$$w_1 = w_2 = \ldots = w_j = 1/j \quad (4.6)$$

The moving average is a good smoothing filter, but for forecasting applications it has significant drawbacks. We designed the ramp filter to eliminate these; it is ideal for economic analysis. [Figure 10 shows our trend model (40-point ramp fil-

ter) and the popular 39-week moving average for recent values of the S&P 500 (weekly geometric averages).]

Many people apply moving averages to irregularly spaced data, which is **sloppy,** but usually acceptable. Elaborate weighted averages require more care. We convert the daily closing values of the S&P 500 to WEEKLY GEOMETRIC AVERAGES. This means

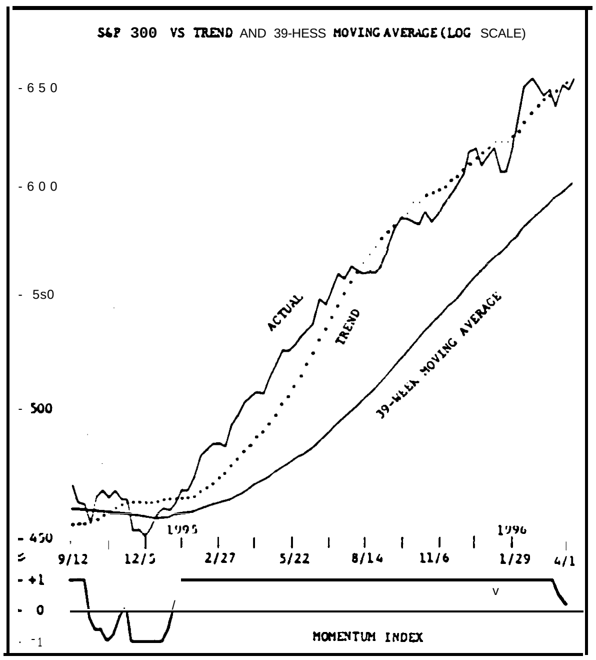


Figure 10. S&P 500 vs trend (40-point ramp filter) and 39-week moving average.

$$\langle X \rangle_{wk} = (x_M x_{Tu} x_W x_{Th} x_F)^{1/5} \quad (4.7)$$

for a full five-day week. Equivalent is

$$\langle X \rangle_{wk} = \exp(S/5) \quad (4.8)$$

$$S = \log x_M + \log x_{Tu} + \log x_W + \log x_{Th} + \log x_F$$

Most forecasting techniques also require data uniformly spaced in time. There are ways to fill in weekends and holidays for market prices , but the gain from forecasting daily values would be very slight for practical purposes. The business cycle is based on monthly data and the resulting irregularities in the time scale are ignored as negligible.

3. Next form the deviations from the trend as

$$v_k = y_k - \langle y_k \rangle \quad (4.9)$$

For visualization or graphics, one may convert these to percent deviations using the formula

$$P_k = 100[\exp(v_k/\langle y_k \rangle) - 1] \quad (4.10)$$

Most forecasting techniques work best with deviations from a trend, v(k), as given by formula (4.9). These mathematical devices assume the data is STATIONARY. That means it does not change character much with time; there is about the same amount of rapid variation as gradual variation for the time span covered. In most cases, using logarithms and detrending makes the data suitable for forecasting.

4. Creating the final forecast requires that one first generate the predictions for the deviations from the trend and error estimates for them. These are then used to extrapolate the trend. Finally, the results , including error estimates, are converted from logarithms back to actual values.

5. THE RAMP FILTER

For a number of years we considered ways of detrending time series, for both geophysical and economic data, actual and simulated. By looking at the dynamical implications and making computer simulations we **always** found what was in current use to be very unsatisfactory.

In 1990 we finally decided that

the best approach was to design a trend model rather than search for one. The resultant ramp filter is suitable for a wide variety of scientific and technical problems, as well as economic analysis.

The most basic requirement for a trend model is that it map a constant into the same constant. In other words, if all values of the data are 5, then the trend should be 5 too. This implies (4.5). Note that the simple moving average (4.6) does satisfy this condition.

A second requirement is that it should map a straight line into a straight line, which the moving average also does. However, the moving average maps any non-horizontal straight line into a parallel straight line rather than the same one. This other line of points is also displaced, unless one associates the moving average with the middle of the sampling interval of the moving average of an odd number of points. In other words, the moving average is not up-to-date.

To get a weighted average (low-pass filter) that can be associated with the last point of the sampling interval, another equation must be added to (4.5). To solve for a large number of weights, we would need an equal number of equations. To make this underdetermined problem (too few equations) solvable, we pick an OPTIMIZATION CRITERION, specifically the sum of the squares of the filter coefficients is a MINIMUM.

$$w_1^2 + w_2^2 + \dots + w_j^2 = \min. \qquad (5.1)$$

There are a number of justifications for selecting (5.1), not the least of which is that it makes for easy solution. Another is that (5.1) combined with (4.5) alone, yields the moving average (4.6).

If the middle of the interval rather than the end were chosen as the reference time, then the moving average would be the result. This is just the mathematical expression of the fact that the trend is in some sense better defined after sufficient future information becomes available. The moving average is a "better" trend model than the ramp filter, but it is not current enough to be practical for forecasting. However, the future "noise" input to the dynamics of the business cycle (or other economic time series) does not affect the current or past states, so the ramp filter is recommended for historical analysis too. After all, a primary use of historical analysis is the statistical functions for forecasting.

We omit the second equation and other details of the solution of the optimization problem, which requires the method of Lagrange multipliers. The system of [j] linear equations to be solved is very sparse and easily solved with trivial algebra; the results are

$$w_1 = [2(2j-1)]/[j(j+1)]$$

$$(5.2)$$

$$w_i = w_1 - [6(i-1)]/[j(j+1)], \quad 1 < i \le j$$

There is a distinct set of weights w(1), ... w(j) for each integer [j] > 2 and they start at a positive maximum and decrease in uniform steps to negative values; hence the name "ramp filter." Table 2 illustrates a few cases, but for most applications we have used [j] in the range 32 to 60.

The ramp filter is a versatile trend model eminently suited for business forecasting and a wide variety of other problems in time series analysis and signal processing. It provides a superior method of adapting linear systems theory to business

j	w_1	w_2	w_3	w_4	w_5	w_6
2	1	0	--	-(useless)-		--
3	5/6	1/3	-1/6	--	--	--
4	0.7	0.4	0.1	-0.2	--	--
5	0.6	0.4	0.2	0.0	-0.2	--
6	11/21	8/21	5/21	2/21	-1/21	-4/21

Table 2. The first few ramp filters.

and economic data or any other time series (uniformly spaced) observations of systems with trends.

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APPENDIX I

Tabulation of the Business Cycle 1953-1996

On December 3, 1993, the Department of Commerce revised the indices of leading and coincident indicators back to 1948 and reset the base year (average value = 100) from 1982 to 1987. The same components are being used in the revised indices, but the weights and trend manipulations as done by DoC have been changed. For details see the Oct. 1993 issue of SURVEY OF CURRENT BUSINESS ($11 at a government bookstore), which is available at many libraries.

These revisions reduced the size of the radial coordinate of the cycles to about half of what appears in Bulletin No. 7. But the shapes and angular coordinates are essentially UNCHANGED. This, in fact, provides a good confirmation of the integrity of the model.

BUSINESS CYCLES (1953 - 1996)

Date	P(L)	P(C)	R	Z	Quad
52/12	-0.586	2.181	2.259	105.0	II
53/01	-0.361	1.828	1.863	101.2	II
53 /02	-0.493	1.978	2.039	104.0	1 1
53 /03	-0.877	1.858	2.055	115.3	II
53 /04	-1.263	1.265	1.788	135.0	1 1
53 /05	-1.836	0.922	2.054	153.3	II
53 /06	-2.645	0.100	2.647	177.8	II
53/07	-2.892	0.016	2.892	179.7	1 1
53 /08	-4.088	-1.005	4.209	193.8	11 1
53/09	-5.048	-1.957	5.414	201.2	11 1
53/10	-5.066	-2.614	5.701	207.3	III
53/11	-5.301	-3.898	6.580	216.3	11 1
53/12	-4.973	-5.077	7.107	225.6	11 1
54/01	-4.613	-5.444	7.136	229.7	III
54/02	-3.725	-5.523	6.662	236.0	III
54/03	-3.226	-6.019	6.829	241.8	1 1 1
54 /04	-2.455	-6.221	6.687	248.5	II I
54/05	-1.442	-6.133	6.301	256.8	11 1
54 /06	-0.448	-5.781	5.799	265.6	I I I
54/07	0.351	-5.843	5.853	273.4	IV
54/08	0.833	-5.431	5.495	278.7	IV
54/09	1.641	-5.036	5.296	288.0	IV
54/10	2.665	-4.319	5.074	301.7	IV
54/11	3.607	-3.179	4.808	318.6	IV
54/12	4.216	-2.317	4.810	331.2	IV
55/01	5.005	-1.498	5.225	343.3	IV
55/02	5.597	-0.924	5.672	350.6	IV
55/03	5.872	0.054	5.873	0.5	I
55 /04	5.847	0.730	5.893	7.1	I
55/05	5.775	1.569	5.985	15.2	I
55 /06	5.553	1.636	5.789	16.4	I
55/07	5.526	2.097	5.910	20.8	I
55/08	4.786	1.792	5.111	20.5	I
55/09	4.592	1.986	5.003	23.4	I
55/10	3.882	2.391	4.560	31.6	I
55/11	3.824	2.546	4.594	33.7	I
55/12	3.369	2.648	4.285	38.2	I
56/01	2.634	2.276	3.481	40.8	I
56 /02	1.827	1.930	2.658	46.6	I
56 /03	1.551	1.816	2.388	49.5	I
56 /04	1.310	2.145	2.513	58.6	I
56/05	0.119	1.564	1.569	85.7	I
56 /06	-0.474	1.459	1.534	108.0	II
56/07	-0.397	-0.811	0.903	243.9	III
56 /08	-0.538	0.806	0.969	123.7	II
56/09	-0.908	1.221	1.522	126.6	II
56/10	-1.008	1.605	1.895	122.1	11
56/11	-0.970	1.304	1.625	126.6	II
56/12	-1.293	1.456	1.947	131.6	II
57 /01	-1.833	0.953	2.065	152.5	II

Date	P(L)	P(C)	R	Z	Quad
57 /02	-2.101	1.104	2.373	152.3	11
57 /03	-2.455	0.819	2.588	161.5	11
57 /04	-2.897	0.131	2.900	177.4	11
57/05	-2.941	-0.081	2.942	181.6	111
57 /06	-3.126	-0.038	3.126	180.7	111
57 /07	-3.410	-0.171	3.415	182.9	III
57 /08	-3.577	-0.366	3.596	185.8	III
57 /09	-4.254	-1.016	4.374	193.4	111
57/10	-4.622	-1.641	4.905	199.5	111
57/11	-5.077	-2.439	5.632	205.7	111
57/12	-5.378	-3.413	6.369	212.4	111
58/01	-5.300	-4.111	6.708	217.8	111
58/02	-5.583	-5.202	7.631	223.0	111
58/03	-4.979	-5.593	7.488	228.3	111
58/04	-4.515	-6.375	7.812	234.7	111
58/05	-3.443	-6.039	6.952	240.3	III
58/06	-2.403	-5.067	5.607	244.6	111
58/07	-1.164	-4.162	4.322	254.4	111
58/08	-0.197	-3.507	3.513	266.8	111
58/09	0.639	-2.872	2.942	282.5	IV
58/10	1.322	-2.688	2.996	296.2	IV
58/11	2.117	-1.413	2.545	326.3	IV
58/12	2.018	-1.452	2.486	324.3	IV
59/01	2.801	-0.617	2.868	347.6	IV
59/02	3.284	0.177	3.289	3.1	I
59/03	3.989	0.949	4.101	13.4	I
59/04	3.911	1.692	4.261	23.4	I
59/05	3.948	2.188	4.514	29.0	I
59 /06	3.724	2.235	4.343	31.0	I
59/07	3.381	1.882	3.870	29.1	I
59/08	2.816	0.301	2.832	6.1	I
59/09	2.518	0.099	2.520	2.2	I
59/10	2.214	0.127	2.218	3.3	I
59/11	1.660	0.774	1.832	25.0	I
59/12	2.585	2.842	3.842	47.7	I
60/01	2.320	3.498	4.197	56.4	I
60 /02	1.436	3.054	3.375	64.8	I
60/03	0.345	2.407	2.431	81.9	I
60 /04	0.283	2.411	2.427	83.3	I
60/05	0.333	1.971	1.999	80.4	I
60 /06	0.127	1.556	1.561	85.3	I
60/07	0.156	1.150	1.160	82.3	I
60/08	0.183	0.980	0.997	79.4	I
60/09	0.071	0.604	0.608	83.3	I
60/10	-0.397	0.233	0.460	149.6	II
60/11	-0.613	-0.332	0.697	208.5	111
60/12	-0.823	-1.078	1.356	232.6	III
61 /01	-0.418	-1.154	1.228	250.1	III
61 /02	-0.277	-1.427	1.454	259.0	III
61 /03	0.321	-1.069	1.116	286.7	IV

Date	P(L)	P(C)	R	Z	Quad
61 /04	0.743	-0.755	1.059	314.6	IV
61 /05	1.033	-0.249	1.062	346.4	IV
61 /06	1.304	0.418	1.369	17.8	I
61 /07	1.060	0.497	1.171	25.1	I
61 /08	1.651	0.920	1.890	29.1	I
61 /09	0.777	0.881	1.175	48.6	I
61/10	1.249	1.222	1.747	44.4	I
61/11	1.435	1.731	2.249	50.3	I
61/12	1.369	1.776	2.242	52.4	I
62/01	1.077	1.212	1.621	48.4	I
62 /02	1.269	1.460	1.934	49.0	I
62 /03	0.985	1.677	1.945	59.6	I
62 /04	0.383	1.682	1.725	77.2	I
62 /05	-0.409	1.281	1.345	107.7	II
62 /06	-1.141	1.086	1.575	136.4	II
62/07	-1.000	1.089	1.478	132.6	II
62 /08	-1.088	0.885	1.402	140.9	11
62/09	-0.792	0.507	0.940	147.4	II
62/10	-0.721	0.356	0.804	153.7	II
62/11	-0.047	0.426	0.429	96.3	11
62/12	0.153	0.137	0.205	41.9	I
63/01	0.589	-0.106	0.598	349.8	IV
63 /02	0.914	0.288	0.958	17.5	I
63 /03	1.221	0.301	1.258	13.8	I
63 /04	1.400	0.741	1.584	27.9	I
63 /05	1.665	0.782	1.840	25.1	I
63 /06	1.435	0.996	1.747	34.8	I
63/07	1.190	0.992	1.549	39.8	I
63 /08	1.051	0.977	1.436	42.9	I
63 /09	1.357	1.142	1.773	40.1	I
63/10	1.278	1.485	1.960	49.3	I
63/11	1.178	1.206	1.686	45.7	I
63/12	0.972	1.512	1.798	57.3	I
64/01	1.091	1.400	1.775	52.1	I
64 /02	1.179	1.640	2.020	54.3	I
64 /03	1.002	1.278	1.624	51.9	I
64 /04	1.164	1.647	2.017	54.8	I
64/05	1.074	1.777	2.076	58.8	I
64/06	0.872	1.515	1.748	60.1	I
64/07	1.014	1.635	1.924	58.2	I
64/08	0.931	1.609	1.859	60.0	I
64/09	0.964	1.772	2.017	61.4	I
64/10	0.776	0.846	1.148	47.5	I
64/11	0.832	1.756	1.943	64.7	I
64/12	0.736	2.167	2.288	71.2	I
65/01	0.752	1.798	1.949	67.3	I
65 /02	0.352	1.627	1.665	77.8	I
65 /03	0.336	1.822	1.853	79.6	I
65 /04	-0.001	1.636	1.636	90.0	II
65/05	0.116	1.633	1.637	85.9	I
65/06	-0.197	1.629	1.641	96.9	II
65/07	-0.166	1.624	1.633	95.8	II
65/08	-0.457	1.443	1.514	107.6	11
65/09	-0.400	1.108	1.178	109.8	II
65/10	0.101	1.309	1.313	85.6	I
65/11	0.366	1.676	1.715	77.7	I
65/12	0.414	1.704	1.754	76.3	I
66/01	0.346	1.735	1.769	78.7	I
66 /02	0.177	1.610	1.620	83.7	I
66/03	0.427	1.817	1.867	76.8	I
66 /04	0.012	1.510	1.510	89.6	I
66/05	-0.702	1.536	1.688	114.6	11
66 /06	-1.270	1.537	1.994	129.6	II
66/07	-1.688	1.373	2.176	140.9	II
66 /08	-2.412	1.044	2.629	156.6	11
66/09	-2.639	0.737	2.740	164.4	II
66/10	-3.177	0.755	3.266	166.6	II
66/11	-3.369	0.432	3.396	172.7	II
66/12	-3.439	0.122	3.441	178.0	11
67/01	-3.071	0.160	3.075	177.0	11
67/02	-3.363	-0.444	3.393	187.5	111
67/03	-3.626	-0.862	3.727	193.4	111
67 /04	-3.425	-1.102	3.598	197.8	111
67/05	-2.991	-1.318	3.268	203.8	III
67/06	-2.336	-1.515	2.784	213.0	III
67/07	-1.713	-1.701	2.414	224.8	111
67/08	-1.008	-1.412	1.735	234.5	111
67/09	-0.874	-1.740	1.948	243.3	111
67/10	-0.738	-1.888	2.027	248.6	III
67/11	-0.621	-1.269	1.413	243.9	111
67/12	-0.083	-0.832	0.837	264.3	III
68/01	-0.326	-1.313	1.353	256.0	111
68 /02	0.080	-1.166	1.169	273.9	IV
68 /03	0.139	-1.171	1.179	276.8	IV
68 /04	-0.440	-1.179	1.259	249.5	111
68 /05	-0.244	-1.031	1.059	256.7	III
68 /06	-0.259	-0.891	0.928	253.8	III
68/07	-0.049	-0.899	0.900	266.9	III
68/08	-0.266	-1.190	1.219	257.4	111
68/09	0.267	-1.018	1.052	284.7	IV
68/10	0.980	-0.859	1.303	318.8	IV
68/11	1.015	-0.695	1.231	325.6	IV
68/12	1.161	-0.689	1.350	329.3	IV
69/01	1.502	-0.817	1.710	331.5	IV
69 /02	1.287	-0.649	1.441	333.3	IV
69 /03	0.878	-0.474	0.997	331.6	IV
69 /04	0.906	-0.604	1.089	326.3	IV
69 /05	0.613	-0.726	0.951	310.2	IV
69 /06	0.027	-0.543	0.544	272.8	IV
69/07	-0.425	-0.373	0.566	221.2	111

Date	P(L)	P(c)	R	Z	Quad
69/08	-0.535	-0.351	0.640	213.3	111
69/09	-0.432	-0.472	0.640	227.6	111
69/10	-0.965	-0.408	1.047	202.9	111
69/11	-1.468	-0.931	1.738	212.4	111
69/12	-1.730	-1.009	2.002	210.2	III
70/01	-2.400	-1.767	2.980	216.4	III
70/02	-3.017	-1.907	3.569	212.3	111
70/03	-3.487	-2.039	4.040	210.3	111
70/04	-3.915	-2.152	4.467	208.8	III
70/05	-3.678	-2.393	4.388	213.0	III
70/06	-3.334	-2.613	4.235	218.1	III
70/07	-3.220	-2.535	4.098	218.2	111
70/08	-2.885	-2.730	3.972	223.4	III
70/09	-2.890	-2.756	3.993	223.6	III
70/10	-2.799	-3.613	4.570	232.2	III
70/11	-2.505	-4.001	4.721	237.9	111
70/12	-1.262	-2.967	3.225	247.0	111
71/01	-0.532	-2.552	2.607	258.2	111
71/02	0.150	-2.573	2.577	273.3	IV
71/03	0.769	-2.456	2.574	287.4	IV
71/04	1.132	-2.196	2.470	297.3	Iv
71/05	1.160	-1.951	2.270	300.7	IV
71/06	1.088	-1.723	2.038	302.3	Iv
71/07	1.029	-1.921	2.179	298.2	Iv
71/08	1.102	-1.957	2.246	299.4	IV
71/09	1.284	-1.427	1.920	312.0	Iv
71/10	1.475	-1.209	1.907	320.7	Iv
71/11	1.770	-0.721	1.912	337.8	IV
71/12	2.802	-0.258	2.814	354.7	IV
72/01	3.326	0.445	3.355	7.6	I
72/02	3.716	0.428	3.741	6.6	I
72/03	3.984	0.972	4.100	13.7	I
72/04	3.909	1.346	4.134	19.0	I
72/05	3.825	1.426	4.083	20.5	I
72/06	3.937	1.369	4.169	19.2	I
72/07	4.228	1.593	4.518	20.6	I
72/08	4.676	2.197	5.167	25.2	I
72/09	4.657	2.496	5.284	28.2	I
72/10	4.308	3.180	5.354	36.4	I
72/11	4.384	3.652	5.706	39.8	I
72/12	4.213	3.929	5.761	43.0	I
73/01	3.839	3.922	5.489	45.6	I
73/02	3.668	3.898	5.352	46.7	I
73/03	3.079	3.597	4.735	49.4	I
73/04	2.434	3.174	3.999	52.5	I
73/05	2.019	3.025	3.637	56.3	I
73/06	1.522	2.998	3.362	63.1	I
73/07	1.143	2.829	3.051	68.0	I
73/08	0.384	2.539	2.568	81.4	I
73/09	0.259	2.380	2.394	83.8	I

Date	P(L)	P(c)	R	Z	Quad
73/10	0.007	2.855	2.855	89.9	I
73/11	-0.242	2.889	2.899	94.8	II
73/12	-1.394	2.013	2.448	124.7	II
74/01	-1.990	1.063	2.256	151.9	11
74/02	-2.950	0.416	2.979	172.0	11
74/03	-2.642	-0.078	2.643	181.7	111
74/04	-3.461	-0.668	3.525	190.9	III
74/05	-3.624	-0.598	3.673	189.4	111
74/06	-4.658	-0.921	4.749	191.2	111
74/07	-5.310	-1.114	5.426	191.8	111
74/08	-6.412	-1.675	6.627	194.6	111
74/09	-7.742	-2.079	8.016	195.0	III
74/10	-8.561	-2.463	8.909	196.1	111
74/11	-9.705	-3.669	10.376	200.7	111
74/12	-10.552	-5.282	11.800	206.6	III
75/01	-10.792	-6.146	12.420	209.7	111
75/02	-10.348	-6.692	12.324	212.9	111
75/03	-9.042	-7.309	11.627	219.0	111
75/04	-6.596	-6.880	9.531	226.2	III
75/05	-4.886	-6.575	8.191	233.4	III
75/06	-3.776	-6.137	7.206	238.4	111
75/07	-2.592	-5.584	6.156	245.1	III
75/08	-1.455	-4.665	4.886	252.7	111
75/09	-0.459	-4.030	4.056	263.5	III
75/10	0.398	-3.508	3.530	276.5	IV
75/11	1.116	-3.227	3.415	289.1	IV
75/12	1.665	-2.721	3.190	301.5	IV
76/01	3.254	-1.739	3.689	331.9	Iv
76/02	3.866	-1.047	4.005	344.8	IV
76/03	4.099	-0.758	4.169	349.5	IV
76/04	3.983	-0.227	3.990	356.7	IV
76/05	4.306	0.030	4.306	0.4	I
76/06	4.612	0.155	4.614	1.9	I
76/07	5.223	0.422	5.240	4.6	I
76/08	5.252	0.692	5.297	7.5	I
76/09	5.271	0.947	5.356	10.2	I
76/10	4.959	0.820	5.027	9.4	I
76/11	4.978	1.701	5.261	18.9	I
76/12	5.277	2.271	5.745	23.3	I
77/01	4.776	2.290	5.297	25.6	I
77/02	4.923	2.687	5.609	28.6	I
77/03	5.033	3.045	5.883	31.2	I
77/04	4.905	3.367	5.949	34.5	I
77/05	4.873	3.663	6.096	36.9	I
77/06	4.710	3.939	6.140	39.9	I
77/07	4.206	4.185	5.933	44.9	I
77/08	4.113	4.141	5.837	45.2	I
77/09	3.889	4.325	5.816	48.0	I
77/10	3.342	4.215	5.379	51.6	I
77/11	3.109	4.200	5.225	53.5	I

Date	P(L)	P(C)	R	Z	Quad
77/12	3.171	4.152	5.224	52.6	I
78/01	2.062	3.479	4.044	59.3	I
78/02	2.134	3.668	4.244	59.8	I
78/03	1.975	4.063	4.517	64.1	I
78/04	2.015	4.886	5.285	67.6	I
78/05	1.619	4.557	4.836	70.4	I
78/06	1.334	4.570	4.761	73.7	I
78/07	0.843	4.084	4.170	78.3	I
78/08	0.682	3.955	4.014	80.2	I
78/09	0.706	3.689	3.756	79.2	I
78/10	0.801	3.502	3.592	77.1	I
78/11	-0.034	3.283	3.283	90.6	II
78/12	-0.703	2.951	3.034	103.4	II
79/01	-1.133	2.300	2.564	116.2	II
79/02	-1.522	1.906	2.440	128.6	II
79/03	-1.421	2.080	2.519	124.3	II
79/04	-2.593	0.686	2.682	165.2	II
79/05	-2.713	0.791	2.826	163.7	II
79/06	-3.189	0.217	3.196	176.1	II
79/07	-4.100	-0.334	4.114	184.7	III
79/08	-4.516	-0.851	4.596	190.7	III
79/09	-4.453	-1.336	4.649	196.7	III
79/10	-5.023	-1.472	5.235	196.3	III
79/11	-5.285	-1.888	5.613	199.7	III
79/12	-5.256	-2.224	5.707	202.9	III
80/01	-4.767	-2.075	5.199	203.5	III
80/02	-4.060	-2.430	4.732	210.9	III
80/03	-5.469	-3.032	6.253	209.0	III
80/04	-6.622	-4.001	7.736	211.1	III
80/05	-7.512	-4.989	9.018	213.6	III
80/06	-6.204	-5.368	8.204	220.9	III
80/07	-4.753	-5.284	7.108	228.0	III
80/08	-3.276	-4.675	5.708	235.0	III
80/09	-1.982	-3.988	4.454	243.6	III
80/10	-0.864	-3.227	3.341	255.0	III
80/11	-0.120	-2.705	2.708	267.5	III
80/12	-0.244	-2.416	2.428	264.2	III
81/01	-0.289	-2.467	2.484	263.3	III
81/02	-0.650	-2.515	2.597	255.5	III
81/03	-0.255	-2.440	2.453	264.0	III
81/04	0.545	-2.575	2.632	281.9	IV
81/05	0.562	-2.688	2.746	281.8	IV
81/06	0.053	-2.459	2.460	271.2	IV
81/07	-0.230	-2.020	2.033	263.5	III
81/08	-0.178	-2.015	2.023	265.0	III
81/09	-1.072	-2.205	2.452	244.1	III
81/10	-1.686	-2.564	3.069	236.7	III
81/11	-1.940	-2.902	3.491	236.2	III
81/12	-1.758	-3.213	3.663	241.3	III
82/01	-1.993	-3.693	4.197	241.7	III
82/02	-0.826	-2.968	3.081	254.5	III
82/03	-1.016	-2.914	3.086	250.8	III
82/04	-0.549	-2.746	2.801	258.7	III
82/05	-0.220	-2.580	2.590	265.1	III
82/06	-0.234	-2.949	2.958	265.5	III
82/07	0.410	-3.072	3.100	277.6	IV
82/08	0.145	-3.172	3.175	272.6	IV
82/09	1.085	-3.149	3.331	289.0	IV
82/10	1.646	-3.327	3.712	296.3	IV
82/11	2.275	-3.048	3.804	306.7	IV
82/12	3.168	-2.882	4.283	317.7	IV
83/01	4.345	-2.043	4.801	334.8	IV
83/02	5.200	-1.903	5.537	339.9	IV
83/03	5.758	-1.341	5.912	346.9	IV
83/04	6.135	-0.729	6.178	353.2	IV
83/05	6.569	0.070	6.570	0.6	I
83/06	7.050	0.809	7.096	6.5	I
83/07	7.152	1.504	7.308	11.9	I
83/08	6.785	1.379	6.924	11.5	I
83/09	6.820	2.456	7.249	19.8	I
83/10	7.113	3.119	7.766	23.7	I
83/11	6.838	3.500	7.682	27.1	I
83/12	6.039	3.945	7.213	33.2	I
84/01	6.091	4.458	7.548	36.2	I
84/02	5.492	4.700	7.229	40.6	I
84/03	4.785	4.884	6.838	45.6	I
84/04	4.026	4.852	6.305	50.3	I
84/05	3.389	4.784	5.862	54.7	I
84/06	2.278	5.022	5.514	65.6	I
84/07	1.550	4.801	5.045	72.1	I
84/08	0.867	4.577	4.659	79.3	I
84/09	0.115	4.562	4.563	88.6	I
84/10	-0.674	3.995	4.051	99.6	II
84/11	-0.711	3.971	4.034	100.1	II
84/12	-0.842	3.826	3.917	102.4	II
85/01	-0.585	3.347	3.398	99.9	II
85/02	-0.953	3.196	3.335	106.6	II
85/03	-0.947	3.154	3.293	106.7	II
85/04	-1.372	3.027	3.324	114.4	II
85/05	-1.221	2.730	2.991	114.1	II
85/06	-0.899	2.261	2.433	111.7	II
85/07	-0.916	1.921	2.128	115.5	II
85/08	-0.672	1.982	2.093	108.7	II
85/09	-0.574	1.810	1.899	107.6	II
85/10	-0.804	1.416	1.628	119.6	II
85/11	-1.138	1.219	1.667	133.0	II
85/12	-0.770	1.309	1.518	120.5	II
86/01	-0.810	0.986	1.276	129.4	II
86/02	-0.834	0.675	1.073	141.0	II
86/03	-0.771	0.371	0.855	154.3	II

Date	P(L)	P(c)	R	Z	Qua d
86 /04	-0.642	0.663	0.923	134.1	II
86 /05	-1.000	0.058	1.001	176.7	II
86 /06	-1.031	-0.424	1.115	202.4	III
86 /07	-1.141	-0.512	1.251	204.1	III
86 /08	-1.334	-0.793	1.552	210.7	III
86/09	-1.474	-0.581	1.585	201.5	111
86/10	-1.097	-1.040	1.511	223.5	111
86/11	-0.903	-1.173	1.480	232.4	111
86/12	-0.328	-0.907	0.964	250.1	111
87/01	-0.604	-1.575	1.687	249.0	111
87 /02	-0.406	-0.996	1.075	247.8	111
87 /03	-0.378	-1.198	1.256	252.5	111
87 /04	-0.342	-1.289	1.334	255.2	111
87 /05	-0.199	-1.370	1.385	261.7	111
87 /06	0.240	-1.421	1.441	279.6	IV
87 /07	0.843	-1.264	1.519	303.7	IV
87 /08	0.878	-1.279	1.552	304.5	IV
87 /09	0.812	-1.273	1.510	302.5	IV
87/10	0.382	-0.685	0.784	299.1	IV
87/11	-0.392	-0.944	1.022	247.4	111
87/12	-0.565	-0.340	0.659	211.0	111
88/01	-0.746	-0.688	1.015	222.7	III
88 /02	-0.185	-0.351	0.397	242.2	III
88 /03	-0.233	-0.118	0.261	206.9	III
88 /04	-0.289	-0.077	0.299	194.9	III
88 /05	-0.449	-0.131	0.468	196.3	III
88 /06	0.125	0.086	0.152	34.7	I
88/07	-0.563	0.013	0.563	178.6	11
88/08	-0.461	0.057	0.465	172.9	11
88/09	-0.659	-0.011	0.659	181.0	111
88/10	-0.776	0.455	0.900	149.6	II
88/11	-0.989	0.346	1.048	160.7	II
88/12	-0.627	0.771	0.994	129.1	11
89 /01	-0.403	0.794	0.891	116.9	II
89 /02	-0.752	0.538	0.925	144.4	11
89 /03	-1.352	0.467	1.430	160.9	11
89 /04	-1.262	0.397	1.323	162.5	11
89 /05	-2.094	-0.114	2.097	183.1	III
89 /06	-2.296	-0.427	2.336	190.5	111
89/07	-2.469	-0.807	2.598	198.1	111
89 /08	-2.428	-0.633	2.509	194.6	111
89/09	-2.366	-1.003	2.570	203.0	111
89/10	-2.555	-1.161	2.807	204.4	111
89/11	-2.263	-0.875	2.427	201.1	III
89/12	-1.886	-0.873	2.079	204.8	111
90 /01	-1.722	-1.124	2.056	213.1	111
90 /02	-2.199	-0.751	2.324	198.9	111
90 /03	-1.528	-0.582	1.635	200.9	111
90 /04	-1.617	-0.948	1.875	210.4	III
90 /05	-1.322	-0.939	1.621	215.4	111

Date	P(L)	P(C)	R	Z	Qua d
90 /06	-1.323	-1.006	1.662	217.2	111
90/07	-1.500	-1.317	1.996	221.3	III
90 /08	-2.038	-1.523	2.544	216.8	III
90 /09	-2.352	-1.883	3.012	218.7	111
90/10	-2.818	-2.292	3.633	219.1	III
90/11	-3.236	-2.667	4.194	219.5	III
90/12	-3.067	-2.675	4.070	221.1	111
91/01	-3.180	-3.358	4.625	226.6	111
91/02	-2.426	-3.468	4.232	235.0	111
91 /03	-1.901	-3.469	3.956	241.3	III
91 /04	-1.598	-3.216	3.591	243.6	111
91/05	-1.203	-2.956	3.191	247.9	III
91/06	-1.018	-2.690	2.877	249.3	111
91/07	0.021	-2.606	2.606	270.5	IV
91/08	-0.047	-2.512	2.512	268.9	111
91/09	-0.006	-2.251	2.251	269.9	111
91/10	0.120	-2.160	2.164	273.2	IV
91/11	0.044	-2.150	2.151	271.2	IV
91/12	-0.141	-2.055	2.060	266.1	111
92/01	0.274	-2.023	2.041	277.7	IV
92 /02	0.753	-1.480	1.661	297.0	Iv
92 /03	1.104	-1.221	1.646	312.1	IV
92 /04	1.141	-0.969	1.497	319.6	Iv
92 /05	1.361	-0.812	1.585	329.2	Iv
92 /06	1.260	-0.657	1.421	332.5	IV
92/07	1.236	-0.335	1.280	344.8	Iv
92 /08	0.915	-0.289	0.959	342.5	IV
92/09	0.898	0.022	0.898	1.4	I
92/10	0.985	0.474	1.093	25.7	I
92/11	1.185	0.734	1.394	31.8	I
92/12	2.049	2.530	3.255	51.0	I
93/01	1.801	0.730	1.943	22.1	I
93 /02	1.929	0.956	2.153	26.4	I
93 /03	1.274	0.985	1.611	37.7	I
93 /04	1.234	1.446	1.901	49.5	I
93 /05	0.811	1.529	1.731	62.1	I
93 /06	0.964	1.509	1.791	57.4	I
93/07	0.736	1.403	1.584	62.3	I
93 /08	1.087	1.905	2.194	60.3	I
93/09	1.125	1.939	2.242	59.9	I
93/10	1.632	2.033	2.607	51.2	I
93/11	1.909	2.374	3.046	51.2	I
93/12	2.331	2.664	3.540	48.8	I
94/01	2.413	2.231	3.286	42.8	I
94 /02	2.195	2.761	3.527	51.5	I
94 /03	2.752	2.982	4.058	47.3	I
94 /04	2.398	2.831	3.710	49.7	I
94 /05	2.364	2.858	3.709	50.4	I
94 /06	2.514	2.791	3.756	48.0	I
94 /07	2.178	2.474	3.296	48.6	I

Date	P(L)	P(C)	R	Z	Quad
94/08	2.509	2.828	3.781	48.4	I
94/09	2.338	2.651	3.535	48.6	I
94/10	1.897	2.892	3.459	56.7	I
94/11	1.748	2.841	3.336	58.4	I
94/12	1.680	3.022	3.457	60.9	I
95/01	1.416	2.767	3.109	62.9	I
95/02	0.994	2.581	2.766	68.9	I
95/03	0.296	2.217	2.237	82.4	I
95/04	-0.450	1.547	1.611	106.2	11
95/05	-0.791	1.147	1.394	124.6	II
95/06	-0.747	1.083	1.315	124.6	11
95/07	-1.069	0.696	1.275	146.9	II
95/08	-0.985	0.807	1.273	140.6	II
95/09	-1.166	0.591	1.307	153.1	11
95/10	-1.677	0.235	1.694	172.0	II
95/11	-1.853	0.147	1.859	175.5	II
95/12	-1.641	0.140	1.647	175.1	11
96/01	-2.061	-0.552	2.134	195.0	111
96/02	-0.814	-0.093	0.819	186.5	III

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1996/04/05 Business Cycle Forecast:
March 1996

Date	P(L)	P(C)	R	Z	Quad
96/03	-0.383	-0.207	0.436	208.4	III
96/04	0.203	-0.084	0.220	337.5	I V
96/05	0.382	-0.129	0.403	341.3	IV
96/06	0.732	-0.098	0.739	352.4	IV
96/07	0.757	-0.221	0.789	343.8	IV
96/08	0.786	-0.332	0.853	337.1	IV
96/09	0.814	-0.438	0.924	331.8	IV
96/10	0.840	-0.531	0.994	327.7	IV
96/11	0.962	-0.686	1.181	324.5	IV
96/12	0.995	-0.746	1.244	323.1	IV
97/01	1.018	-0.791	1.289	322.2	IV
97/02	0.847	-0.838	1.192	315.3	IV
97/03	0.767	-0.879	1.167	311.1	IV
97/04	0.513	-0.913	1.047	299.3	IV
97/05	0.449	-0.863	0.973	297.5	IV
97/06	0.214	-0.883	0,909	283.6	IV
97/07	0.175	-0.900	0.917	281.0	IV

MONITORING CHANGES IN FEDERAL BUDGET OUTLAYS WITH FORECASTING MODELS AND TRACKING SIGNALS

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INTRODUCTION

Forecasting in federal government often evokes images of massive econometric models to estimate impacts of political policy over the next four years, or sophisticated time series models to project, for example, prices of agricultural commodities for the next quarter. But it should be realized that forecasting techniques can also be used in the federal sector as a monitoring mechanism, applied to time series data. These tracking practices can be used to oversee stock prices (DeSaix and Young, 1989), healthcare outcomes (Young, 1994), as well as monthly federal budget outlays for key social programs.

Often Total Quality Improvement (TQI) techniques, originally derived from work by Deming (1985, 1986) to aid operations and production management in manufacturing (Montgomery, 199 1), are used to monitor and track data. Deming stressed the use of 'statistical process control' methods, which could improve processes by the identification and elimination of 'common causes' and 'special causes' of quality problems. To control the process, Deming used techniques generally labeled as control charts to determine if the process is in or out of control.

The traditional control charts have met with success, but the assumptions behind the techniques are often violated to "fit" the data to the models (Alwan & Roberts, 1988). These types of basic techniques are appropriate for some procedures, but the assumptions behind the techniques may not be appropriate for data sets whose pattern could be described as 'time series.' Control charts, such as the p-chart or the run chart, assume that the samples collected over time are independent of one another. Techniques do exist that accommodate time series data and, rather than ignore the dependence, employ the correlation between data points to forecast and monitor the data under study. This paper demonstrates several techniques of tracking signals for time series and shows how they can be employed in the federal budget environment.

BACKGROUND

The original direction of this study was to develop monthly time series forecasts of key federal social programs. Five years on monthly data were drawn from Monthly Treasury Statement (MTS) for over twenty social program budget outlays; examples of these programs are Social Security, Medicare, Food Stamps, and so on. In the process of gathering the data, for the purposes of forecasting the the social programs, a request was made as to whether this reporting could be taken one step further. In addition to forecasting, a mechanism for monitoring for "unexpected" behavior, from a statistical point of view, was also requested.

The first task in creating a tracking system was to gather the data and to develop a forecasting model of each time series. The forecast model can then be used to calculate one-step-ahead predictions. These estimates then serve as the "expected" values, against which the actuals can be compared and forecast errors can be calculated. If the actual and expected values for that time period are significantly different, then the actual value is considered "unexpected," and thereby subject to a more indepth review to determine the cause. This paper illustrates some of the results realized to forecast and track these budgets, period by period.

FORECASTING AND TRACKING: EXAMPLES

Food Stamp Program

Figure 1 provides a graph of the monthly budget outlays, over five years, of the dollars spent (y_t) on the food stamp program. This particular time series shows evidence of both trend and seasonal behavior. The data set was best fit with an ARIMA(1,1,0)(1,0,0)$_{12}$ model. The tracking system chosen for demonstration on this time series was the application of prediction internals on the forecasts of the y_t values; the results are shown graphically in Figure 2. If the actual exceeds the prediction limits, then a possible pulse or step intervention could have occurred to cause that deviation. [It should be realized, however, that 5% of

the **observations** will exceed the 95% prediction limits, simply due to random behavior.] This particular technique requires the recalculation of the prediction internals for each new data point required; **otherwise** the several-period-out prediction **intervals** are too wide to be of practical use. However, this approach does reflect the expected long-term behavior of the time series and is not difficult, provided the forecasting software is available.

Medicaid

Figure 3 provides the monthly time series of the budget outlays for Medicaid. The data exhibit a strong **long-**term trend; the seasonal behavior is marginal. For this particular program, double exponential smoothing was used to forecast the data; a standardized forecast error (SE) was used to track the data against the **one-step-**ahead forecast errors from the smoothing model.

Confidence, or control, limits can be created around the forecasts themselves, as shown in the previous example, or around the errors of the forecasts. Since the standard deviation of the forecast errors is rarely known, expressions for control limits need to incorporate estimates of standard error. Let us define $Var[e_1(T)] = \sigma_e^2$, which is the variance of the single-period-ahead forecast error, e_1 (T). Because it is conceptually simpler and somewhat easier to calculate, a smoothed form of the mean absolute deviation of the e_t**'s,** called the smoothed absolute error, is **often** used to estimate σ_e. The Mean Absolute Deviation **(MAD_t)** can be approximated by:

$$\hat{MAD}_t = \eta \cdot |e_t| + (1-\eta) \cdot \hat{MAD}_{t-1}$$

where η is the smoothing constant.

For the normal and other common distributions, it has been shown that the mean absolute deviation is about **80%** of the standard deviation, or, conversely, that the standard deviation is about 1.25 times the mean absolute deviation. We may, therefore, approximate σ_e by using, in the expressions for control limits:

$$\hat{\sigma}_e(t) = 1.25 \cdot \hat{MAD}_t$$

Using the **MAD_t** relationship in the equation, the resultant standard error of the forecast error for simple exponential smoothing becomes:

$$\hat{\sigma}_\varepsilon(t) = \sqrt{(^2; \ a)} \ (1.25 \ . \ \hat{MAD}_t) \ .$$

For double exponential smoothing, the calculation becomes:

$$\hat{\sigma}_\varepsilon(t) = {(1.25 \cdot \hat{MAD}\ )}\Big/{c_1} \ ,$$

where c_1 is a **function** of α (see Montgomery et al, 1990, p. 211, for table of values).

For ease of tracking (as well as for ease of interpretation), the above standard error for double exponential smoothing can be used to standardize the forecast error. If we let

$$SE(t) = {e_{t^\iota}}\Big/{\hat{\sigma}\hat{\sigma}(t)}$$

which is termed the standardized forecast error (SE), then these standardized values of the residuals can be graphed as a time series. Figure 4 provides a graph of the SE values for Medicaid's monthly budget outlays. If the values of the SE(t) exceed the absolute value of 2.0, then we can be **95% confident** that the values are 'out-of-bounds.' This particular technique performs as a control chart on the standardized residuals of the forecast process.

It should be noted that the SE signals require a **warm-**p, or start-u, phase to initialize the values and drive the signals to a steady state. Therefore, the first 12 months of the data sets are treated as start-up, and tracking signals that are calculated over that time period are ignored.

The SE tracking procedure is appropriate for ascertaining pulse interventions or step interventions; but it is not strong in depicting **interventions** that change gradually, such as **slope** changes. **For** these types of behaviors, we turn to **Trigg's** tracking signal.

Civil Service Retirement & Disability Fund

The two most popular signals for tracking exponential smoothing schemes are the smoothed error ratio **(Trigg's)** and the simple **cusum** ratio (Brown's) to the smoothed mean absolute error. To discuss these measures, we again need to define some terms.

As a measure of aggregate **performance,** it is natural to consider the sum of **all** past errors, referred to as the cumulative sum or the simple 'cusum;' i.e.:

$$SUM_t = \sum_{1}^{t} e_t$$

which can be written in updating form

$$SUM_t = et + SUM_{t-1}$$

Since the errors are as likely to be positive as negative when the system is in control, the simple **cusum** should not **drift** too **far** from zero.

Exponential smoothing may also be used to compute an average that discounts older errors. The (exponentially) smoothed error, **Et,** is computed in the same **fashion** as for simple exponential smoothing forecasts. That is, using smoothing constant η:

$$E_t = \eta \cdot e_t + (1-\eta)E_{t-1}\text{ , or}$$

$$E_t = E_{t-1} + \eta(e_t - E_{t-1}) \text{ ,}$$

which results in exponentially diminishing weights as with simple exponential smoothing forecasts. To start the smoothing process, an initial value E_{init} is needed. It is reasonable (and common) practice to use E_{init} = O.

Using these definitions, **Trigg's** smoothed ratio and Brown's **cusum** ratio become E_t / MAD_t and SUM_t / MAD_t, respectively.

When using these signals, the signal smoothing constant η is usually chosen to be the same as the series smoothing constant a. Several studies, both theoretical and by simulation, have been conducted with the purpose of determining control limits for these signals when tracking simple and double exponential smoothing models (e.g., Gardner, 1983 and 1985; Harris & Ross, 1991; **Montgomery** & **Mastrangelo,** 199 1). Experimentation with both tracking signals resulted in superior performance of Trigg's signal over the Brown's cusum. So Trigg's tracking signal will be used in this paper.

Figure 5 shows the monthly time series for Civil Semite Retirement and Disability Fund budget outlays. Again, the data exhibit strong linear behavior, with some **seasonality**. However, the **seasonality** is stronger in the early years and not as evident in the latter years. So double exponential smoothing was employed as the forecast model; figure 6 shows the results of the smoothed forecasting with double exponential smoothing. An alpha of a=O. 132 was found to be optimal; this value of alpha was then used in the calculation of Trigg's tracking signal as applied to the one-step-ahead forecast errors.

The **Trigg** tracking signal is particularly strong in detecting slope changes in the underlying constant model. The approximate control limits should give approximations adequate for most practical purposes when η = a is less than about 0.40. The approximate 95'% control limits for **Trigg's** Tracking Signal **(TS)** for simple exponential smoothing, when $\eta=\alpha$ is small, are $\pm(1.3\sqrt{\eta})$. For double exponential smoothing, the approximate 95% control limits would be $\pm(1.2\sqrt{\eta})$. Figure 7 illustrates the **Trigg's** tracking signal **(TS)** as applied to the Civil **Service** Retirement And Disability Fund data; since double exponential smoothing to forecast the data, the critical values are $\pm 1.2\sqrt{(0.132)}$.

Again, it should be noted at this time, however, that tracking signals require a start-up phase to initialize the values and drive the signals to a steady state. Therefore, the first 12 months of the data sets are treated as start-up, and tracking signals that are calculated over that time period are ignored.

SUMMARY

Time series can be monitored in variety of fashions. The Food Stamp monthly budget outlays illustrate how to use the prediction internals of the forecasted values to monitor for interventions that are either step or pulse functions. By using standardized forecast errors, step or pulse interventions can be highlighted in a fashion similar to traditional control charts, as demonstrated with Medicaid Fund monthly budget outlays. Slope changes can be picked up through the application of **Trigg's** tracking signal to forecast errors, as evidenced by the Civil Service Retirement and Disability Fund example. Depending upon what forecast models are appropriate, and what types of interventions are of interest, monitoring systems can be created to work with a variety of time series data sets. The more complex the forecast model, the more **difficult** are the calculations of the appropriate standard error for tracking purposes. But the analysis of the **one-step-**ahead forecasts and their errors allow for swift response to potential changes in the data under consideration.

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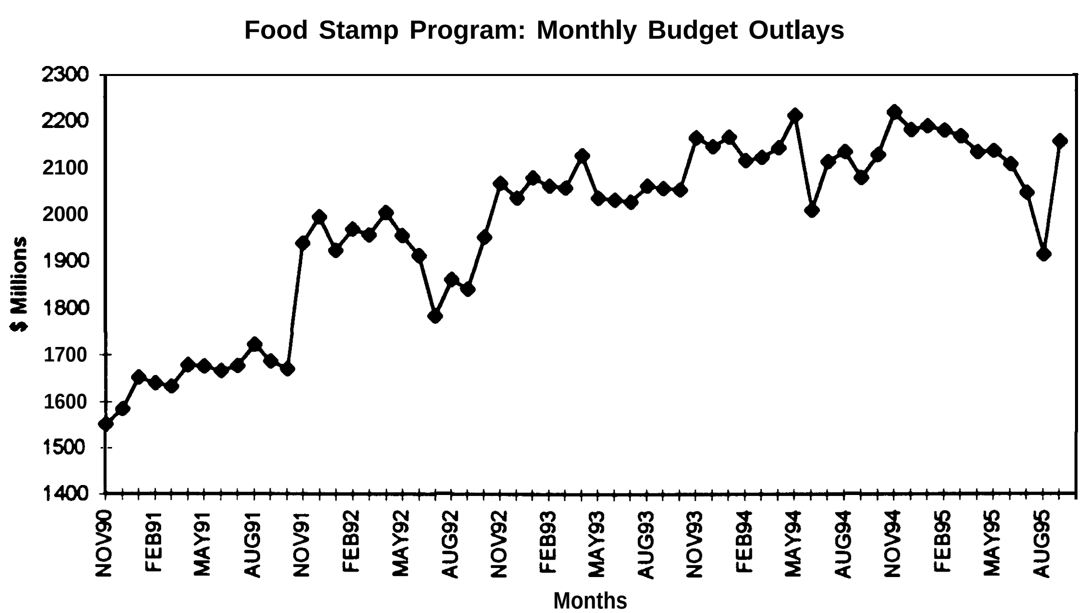


Figure 1. Food Stamp Program: Actual monthly budget outlays

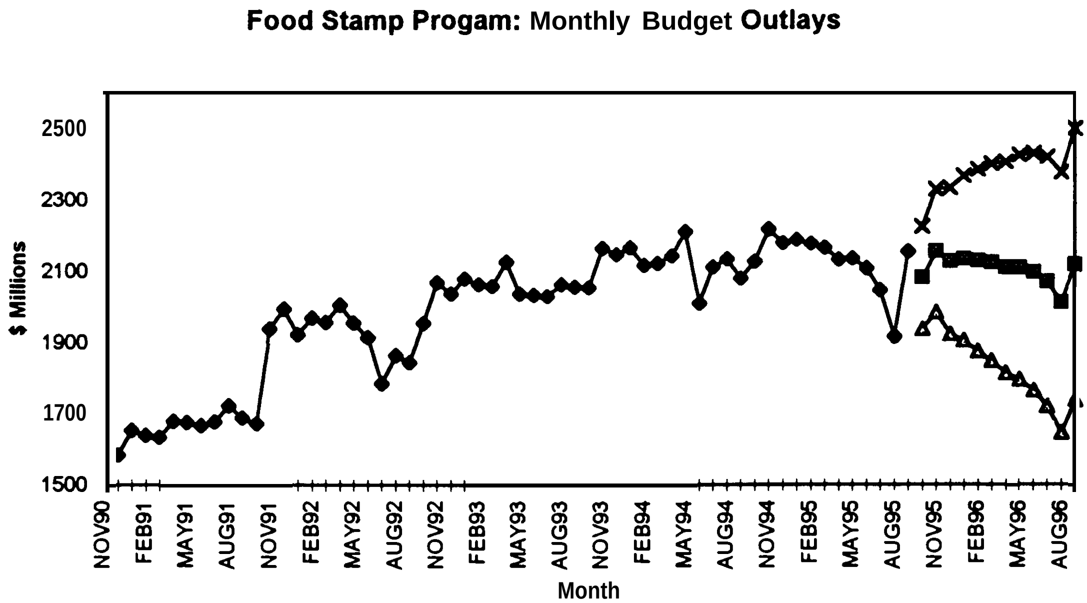


Figure2. FoodSta.mp Program: **Prediction** internal **of monthly** budgetoutlays

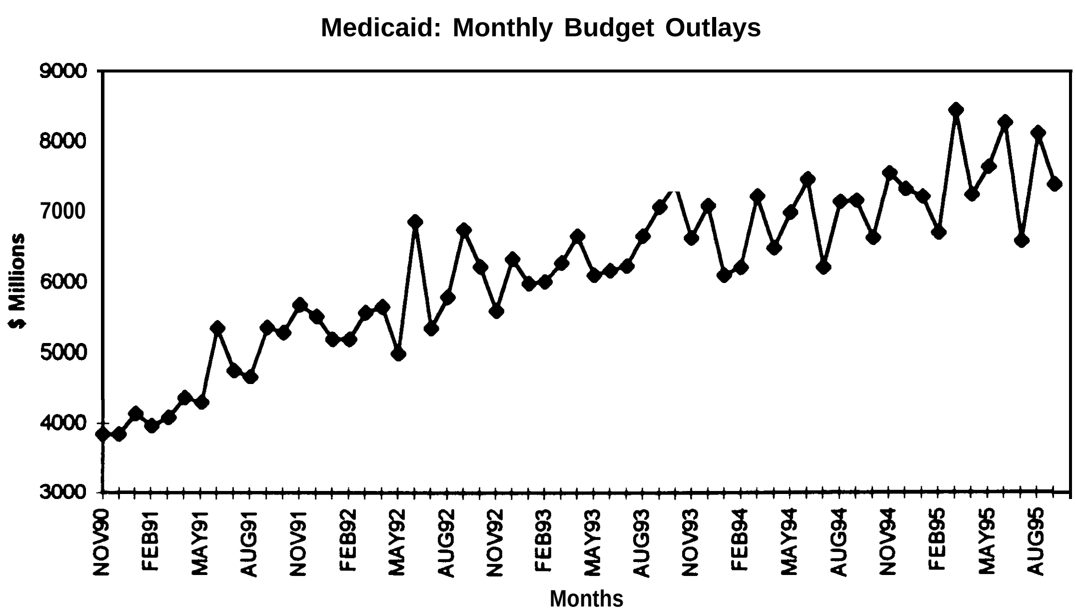


Figure3. Medicaid: Actual monthly budget outlays

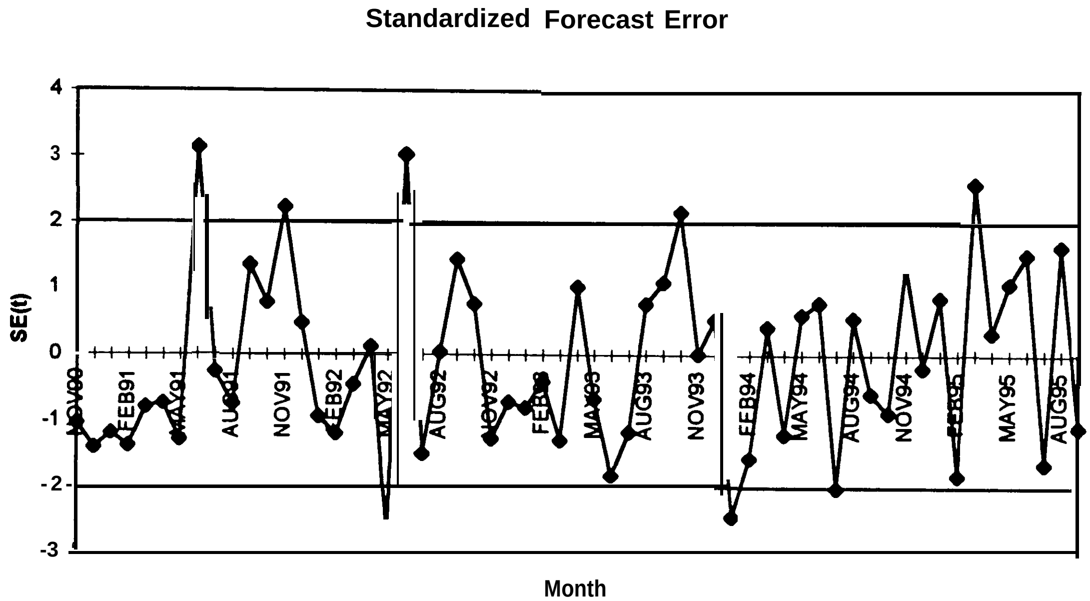


Figure 4. Medicaid: Standardized forecast errors of monthly budget outlays

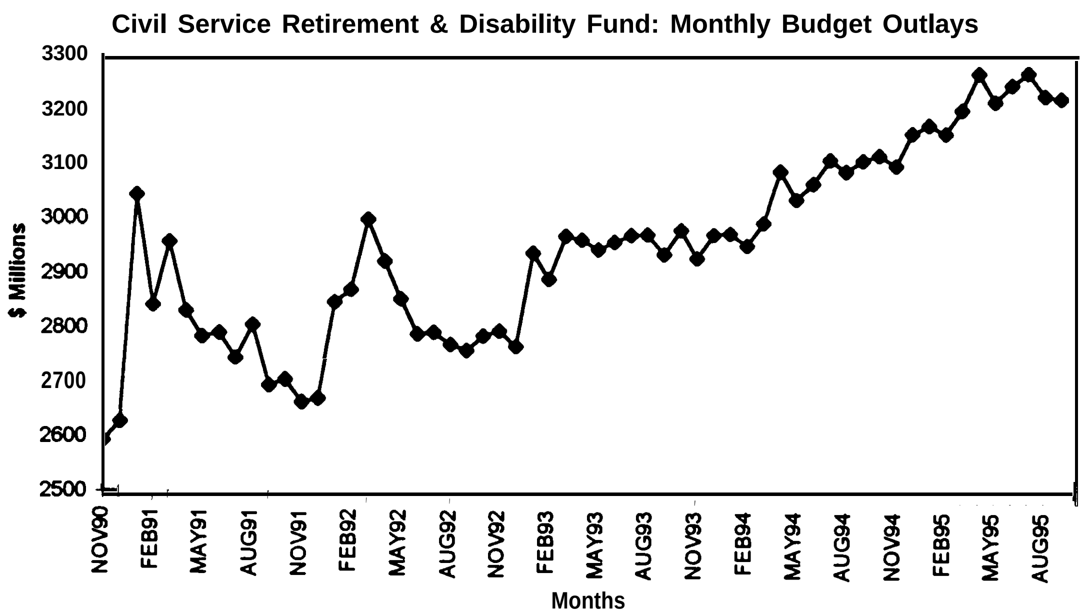


Figure 5. Civil Service Retirement& Disability Fund: Actual monthly budget outlays

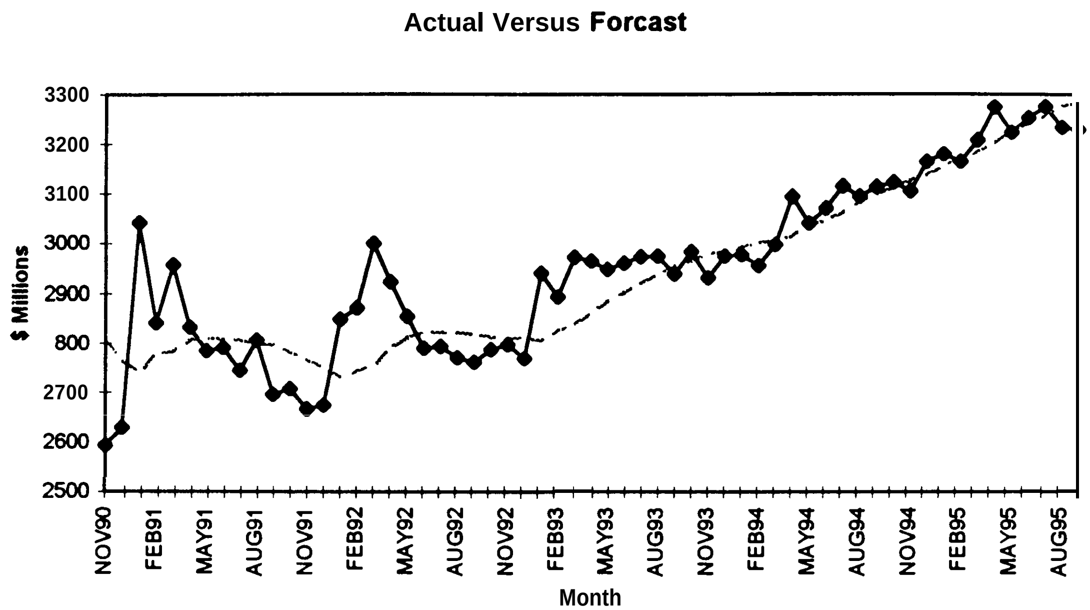


Figure 6. Civil Service Retirement&Disability Fund: **Forecast of** monthly budget outlays

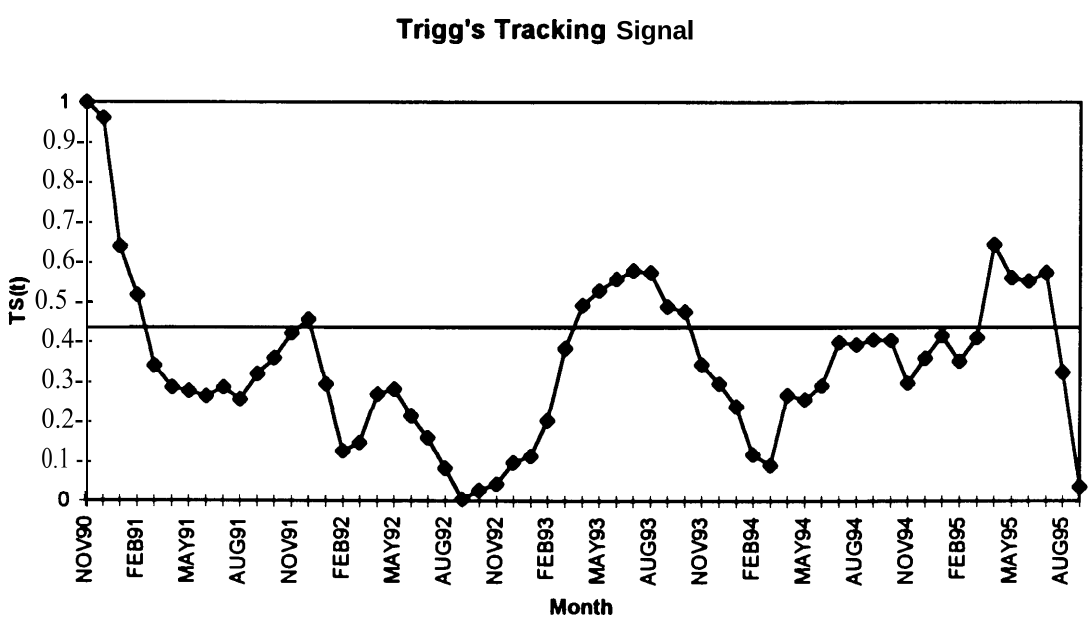


Figure 7. Civil Service Retirement&Disability Fund: **Trigg's tracking** signal

Concurrent Sessions II

ISSUES IN ECONOMIC FORECASTING

Chair: Norman C. Saunders
Bureau of Labor Statistics, U.S. Department of Labor

Industry Sensitivity to Business Cycles,
Jay Berman and Janet Pfleeger, Bureau of Labor Statistics, U.S. Department of Labor

Earnings of College Graduates in 1993,
Daniel E. Hecker, Bureau of Labor Statistics, U.S. Department of Labor

Assessment of Royalty Reduction for Heavy Oil Produced on Federal Lands,
Brian W. Keltch, BDM-Oklahoma
R. Michael Ray, Department of Energy

INDUSTRY SENSITIVITY TO BUSINESS CYCLES

Jay Berman and Janet Pfleeger, Bureau Of Labor Statistics

Every two years, the Office of Employment Projections (OEP) develops projections of the labor force, gross domestic product (GDP) and its components, output, and industry and occupational employment. Following the release of the 1994-2005 projections in November 1995, an analysis was conducted to identify industries in which demand and employment are most sensitive to business cycle movements over time. The information will be used in future projections rounds for two purposes:

. To identify industries that are projected to move differently with the business cycles over the 1994-2005 period than in the 1977-1993 historical period, and for those industries that do behave differently, identify the structural change causing this break from the past or review our projections model and make appropriate modifications.

. To identify industries and the occupations concentrated in these industries that are most susceptible to business cycle swings for use in preparing future issues of the Career Guide to Industries and the Occupational Outlook Handbook, career guidance publications developed biennially by OEP.

In identifying which industries fluctuate with GDP (business cycle movements over time) and which do not, two factors were analyzed: the correlation between industry employment and GDP, and the correlation between industry final demand and GDP. The second factor-industry final demand-was analyzed in two different ways. First, the historical period was used as a benchmark to measure the correlation of industry demand and total GDP over the 1977-1993 period, with the expectation that the demand/GDP relationship over the projected period should be the same as that over the historical period. Second, the recession years alone, rather than the entire historical and projected time periods, were examined. This method measured, on a yearly percent change basis, how aggregate industry groups (the 183 individual industries were aggregated into 12 groups for computational purposes) responded to and recovered from the 1980, 1982, and 1991 recessions of the historical period. These results were then compared to those for the two recessions assumed in the projected period to determine whether the projected behavior was consistent with that of the historical period. These results are not presented in this article, but are available upon request.

The principle statistical measure used to quantify both the industry final demand and industry employment relationship to GDP was the Pearson product moment coefficient of correlation (*r*). This statistic provides an empirical measure of the degree of association between the movement of industry final demand/employment and GDP. As *r* approaches 1 or -1, the degree of correlation increases, with coefficients closer to 1 showing cyclical industries, and coefficients closer to -1 showing countercyclical industries.

It is important to note that this analysis highlights only those cyclical industries whose movements coincide with GDP movements. Our ability to identify cyclical industries that lead or lag GDP is limited by the fact that the OEP projections are done by year, not quarter. Because annual data is used, the leading and lagging industries can be masked. Despite the lack of quarterly data, we attempted to identify lagging cyclical industries by lagging employment in each of the industries by one year. The results of the analysis were basically unchanged-no additional industries were found to be cyclical using the lagged data. The coincident cyclical industries became, as would be expected, less cyclical (the *r's* were closer to O), while the industries that were not coincidentally cyclical (those with *r's* close to O) became more cyclical (*r* increased). However, the *r's* did not increase enough to consider these industries to be cyclical with a lag-they remained close to O.

Employment

The table at the end of this article presents the results of the analysis. Column 2 of the table is used to determine those industries in which employment has been the least and most sensitive to business cycles in the past. The following two boxes highlight these most and least sensitive industries.

Industries with the most business cycle prone employment (correlation coefficients closest to 1 or -1) and the dominant occupations in these industries:

industry	Occupations Specific to this industry
Household furniture	Upholsterers; Precision woodworkers such as cabinetmakers, furniture finishers, and wood machinists
Miscellaneous plastics products, net.	No additional occupations
Personnel supply services	Adrninstrative support occupations, including clerical; Helpers, laborers, and material movers, hand
Plumbing & nonelectric heating equipment	No additional occupations
Stone, clay, & miscellaneous mineral products	Machinery and related mechanics, installers, and repairers
Electric lighting & wiring equipment	No additional occupations
Metal coating, engraving, & allied services	No additional occupations
Concrete, gypsum, & plaster products	Truck drivers; Mechanics, installers, and repairers; Construction trades
Partitions & fixtures	Precision woodworkers, including cabinetmakers and wood machinists
Cutlery, handtools, & hardware	Machinists

(NOTE: in many of the above mentioned manufacturing industries, the dominant occupations are operators, fabricators, & laborers such as machine operators and tenders, hand workers, including assemblers & fabricators, and helpers, laborers and material movers, as well as precision production occupations such as inspectors, testers, and graders, precision metal workers, and blue collar worker supervisors. The occupations mentioned in this tabulation are those that dominate the industry in addition to or instead of these occupations)

Industries with the least business cycle prone employment (correlation coefficients closest to O) and the dominant occupations in these industries:	
Industry	Occupations Specific to this industry
Accounting, auditing, & other services	Accountants and auditors; general managers and top executives; bookkeeping, accounting, and auditing clerks; secretaries; and general office clerks.
Agricultural chemicals	Chemical plant & system operators; blue collar worker supervisors; industrial machinery mechanics; chemical equipment controllers; crushing and mixing and packing and filling machine operators and tenders; and truck drivers.
Beverages	Packing and filling machine operators and tenders; truck drivers; industrial truck and trailer operators; industrial machinery mechanics; and administrative support occupations, including clerical.
Personal services, nec	Photographers; management support occupations.
Educational services	Teachers, librarians, and counselors; teacher aides and educational assistants; janitors and food preparation and service workers
Commercial sports	Ushers, lobby attendants, and ticket takers; guards; food counter, fountain, and related workers; janitors and cleaners; and cashiers.
Security & commodity brokers	Brokerage clerks; secretaries; general office clerks; securities and financial services sales workers; general managers and top executives; financial managers; and management support workers.
Communications equipment	Precision electrical and electronic equipment assemblers; inspectors, testers, and graders; electrical and electronic assemblers; electrical and electronics engineers and computer engineers.
Membership organizations	Clergy, musicians, teachers, and directors, religious activities and education; secretaries, general office clerks;, bookkeeping, accounting, and auditing clerks; janitors and cleaners; bartenders; and child care workers.
Museums, botanical, zoological gardens	Service occupations such as janitors and cleaners, food preparation and service workers, and protective service occupations; cashiers; curators, archivists, museum technicians, and restorers; teachers and instructors.

Final Demand

Columns 3 and 4 of the table at the end of this article are compared to highlight the industries in which final demand is projected to respond differently to the business cycle than in past [1]. The historical and projected correlation coefficients in the industry final demand analysis are compared to test if the industry final demand to GDP relationships are similar in the two periods. If they do behave similarly, one would expect the ***r*** value of the projected period to be equal to the ***r*** value of the historical period for each industry. To determine whether the ***r*** values for the historical and projected periods are significantly different, the Fisher (z) transformation is used to convert the correlation coefficients to a standard normal distribution and then the difference between the correlation coefficients is tested by referring to the Normal probability distribution.

Using a **95%** confidence level, we found 13 industries to have a different projected industry final demand/GDP relationship than that of the historical period. These industries are listed in the box that follows. The correlation coefficients in columns 3 and 4 are presented so that the differences between the historical and projected correlation **coefficients** can be observed. Note that some industries may appear to have different correlation coefficients for the historical and projected periods. However, using our criteria and confidence interval, they are not deemed to be significantly different.

Industries which are projected to respond differently to business cycles relative to the **past:**
Hydraulic cement
Nonferrous rolling and drawing
Meat products
Bakery products
Sugar and confectionery products
Miscellaneous food and kindred products
Converted paper products except containers
Tires and inner tubes
Trucking and warehousing
Pipelines, except natural gas
Insurance carriers
Advertising
Hospitals

[1] When comparing an industry's projected correlation to the business cycle to its historical correlation, industry final demand is used instead of employment because annual employment projections for the years **1995-** 2004 are not available.

Correlation Coefficients **for Industries.**

Industry name	Employment Historical Correlation with GDP		Industry Final Demand Historical Correlation with GDP	Industry Final Demand Projected Correlation with GDP
Household furniture..........	0.9591		0.7713	0.8589
Miscellaneous plastics products, net	0.9388		0.4235	0.5224
Personnel supply services	0.9381		0.2487	-0.0829
Plumbing & nonelectric heating equipment.	0.9307		-0.0523	0.1370
Stone, clay, & misc. mineral products	0.9253		0.1351	0.2985
Electric lighting & wiring equipment	0.9151		-0.0252	0.2948
Metal coating, engraving, & allied services	0.9131		-0.0016	0.2960
Concrete, gypsum, & plaster products	0.9096		0.0713	0.2664
Partitions & fixtures	0.9093		0.6743	0.4637
Cutlery, h& tools, & hardware	0.9036		0.5510	0.4680
Millwork, plywood, & structural members..	0.8955		-0.3770	-0.6968
Nonferrous foundries	0.8893		0.2886	0,3796
Refrigeration & service industry machinery.	0.8860		0.6312	0.6659
Converted paper products except containers.	0.8784	“	-0.1651	0.6429
Sawmills & planing mills	0.8764		-0.4131	-0.4216
Carpets & rugs	0.8752		0.8036	0.4460
Construction	0.8635		0.8975	0.9248
Metal forgings & stamping	0.8559		0.5096	0.6708
Household appliances	0.8545		0.7248	0.8324
Retail trade exe. eating & drinking places.	0.8504		0.9175	0.9760
Paints & allied products	0.8490		0.4824	0.6556
Manufactured products, net	0.8476		0.4394	0.6048
Motor vehicles & equipment	0.8400		0.7575	0.8826
Paperboard containers & boxes	0.8381		0.4725	0.6980
Screw machine products, bolts, rivets, etc.	0.8247		-0.2177	-0.3737
Rubber products, plastic hose & footwear.	0.8245		0.0965	-0.1186
Miscellaneous fabricated textile products..	0.8191		0.8101	0.7430
Wood containers & misc. wood products	0.8189		0.5066	0.6325
Trucking & warehousing	0.8149		0.5432	0.9179
Miscellaneous petroleum & coal products..	0.7621		0.3579	0.6586
Electrical industrial apparatus	0.7581		0.3513	0.4352
Nonferrous rolling & drawing	0.7541		0.0292	0.7099
Iron & steel foundries	0.7514		0.0990	-0.1886
Office & misc. furnitur e&fixtures ...	0.7311		0.5227	0.3861
Eating &drinking places	0.7310		0.4917	0.6203
Bankbooks & bookbinding	0.7155		-0.3473	-0.4786
Wood buildings & mobile homes	0.7005		0.5045	0.6881
Miscellaneous fabricated metal products	0.6858		0.2144	0.4183
Miscellaneous electrical equipment	0.6653		0.5526	0.8443
Fabricated structural metal products	0.6619		0.5459	0.7210
Glass &glass products	0.6605		0.0784	-0.0081
Wholesale trade...........................	0.6603		0.8412	0.7831
Electric distribution equipment	0.6599		0.6813	0.3868
Real estate................................	0.6527		0.7142	0.8366
Apparel	0.6426		0.2993	0.4862
Knitting mills............................	0.6333		0.5705	0.7327
Metalworking machinery & equipment	0.6313		0.7745	0.4696

Correlation Coefficients for Industries.

Industry name	Employment: Historical Correlation with GDP	Industry Final Demand: Historical Correlation with GDP	Industry Final Demand: Projected Correlation with GDP
All other primary metals	0.6272	-0.1135	0.1330
Books..	0.6240	0.5240	0.7996
Commercial printing & business forms	0.6240	0.5827	0.7323
Railroad equipment	0.6223	0.2708	0.5282
Passenger transportation arrangement	0.6158	0.3843	0.5218
Metal cans & shipping containers	0.6057	0.1271	0.5825
Miscellaneous textile goods	0.6053	0.5701	0.5360
Engines & turbines	0.5954	0.4452	0.6886
Weaving, finishing, yam, & thread mills.	0.5875	0.1498	-0.0382
Research & testing services	0.5859	-0.6139	-0.0115
Miscellaneous chemical products	0.5796	0.3506	0.2078
Air transportation	0.5785	0.6625	0.3963
Miscellaneous business services	0.5781	0.1706	0.1229
Water & sanitation	0.5769	0.3268	-0.0365
Services to buildings	0.5747	0.6348	-0.0778
Household audio & video equipment	0.5712	0.0537	-0.1685
Miscellaneous publishing	0.5708	0.6307	0.7232
Industrial machinery, net	0.5566	0.4390	0.4522
State & local govt enterprises, net..	0.5503	0.7375	0.2057
Special industry machinery	0.5493	0.5002	0.7018
Beauty & barber shops	0.5415	0.5303	0.4358
Ophthalmic goods..........................	0.5373	0.2167	0.7369
Measuring & controlling devices	0.5365	0.3627	0.5435
Ordnance & ammunition	0.5360	0.1353	-0.1044
Nondepository; holding & investment offices	0.5296	0.0209	0.5583
Hotels & other lodging places	0.5238	0.7391	0.2311
Miscellaneous transportation services	0.5225	-0.0171	0.2957
Blast furnaces & basic steel products	0.5202	-0.3551	0.0074
Luggage, h&bags, & leather products, net.	0.5133	-0.4494	-0.2407
Automotive rentals, without drivers	0.5066	0.6321	0.4427
Meat products	0.5058	-0.4986	0.3840
Service industries for the printing trade..	0.5034	-0.2253	0.0411
Miscellaneous equipment rental & leasing.	0.4986	0.4063	-0.0015
Engineering & architectural services	0.4882	0.2891	0.6077
Plastics materials & synthetics	0.4844	0.4717	0.4313
Soap, cleaners, & toilet goods	0.4797	0.6822	0.7699
Electronic components & accessories	0.4672	-0.2562	-0.5644
Advertising	0.4630	0.5293	-0.4852
Automobile parking, repair, & services...	0.4591	0.8210	0.5638
State & local general govt, net	0.4561	0.2935	-0.2691
Farm & garden machinery & equipment	0.4502	0.4571	0.4073
General industrial machinery & equipment.	0.4484	0.7198	0.5392
Railroad transportation	0.4460	0.7389	0.7707
Miscellaneous repair services	0.4400	0.0788	0.1512
Miscellaneous transportation equipment	0.4243	-0.2168	0.0207
Medical equipment, instruments, & supplies.	0.4139	0.0190	0.5812
U.S. Postal Service	0.4017	0.5271	-0.2449

Correlation Coefficients for Industries.

	Employment		Industry Final Demand	
Industry name	Historical Correlation with GDP		Historical Correlation with GDP	Projected Correlation with GDP
Watches, clocks, & parts	0.4008		0.1701	0.5734
Jewelry, silverware, & plated ware	0.4006		0.4240	0.3416
Laundry, cleaning, & shoe repair	0.3992		0.6142	0.3402
Computer & data processing services	0.3957		0.1723	0.3213
Tires & inner tubes	0.3944		-0.3310	0.7768
Producers, orchestras, & entertainers	0.3787		0.1915	0.4708
Job training & related services	0.3738		0.5851	0.5114
Sugar & confectionery products	0.3712		0.0583	0.8021
Management & public relations	0.3704		-0.3863	-0.2485
Logging	0.3593		-0.0640	0.1299
Hydraulic cement	0.3584		-0.1628	0.6071
Primary nonferrous smelting & refining	0.3580		-0.0368	-0.2199
Metal mining	0.3268		-0.0675	0.4464
Newspapers	0.3242		0.1271	0.3531
Ship & boat building & repairing	0.3117		0.4702	0.6495
Toys & sporting goods	0.2981		0.2014	-0.0553
Aerospace	0.2900		-0.4403	-0.5737
Periodicals	0.2852		0.5646	0.7968
Video tape rental	0.2734		0.6558	0.5176
Drugs	0.2726		0.0858	-0.2178
Search & navigation equipment	0.2714		0.1245	0.4409
Bowling centers	0.2679		-0.0043	0.4442
Insurance agents, brokers, & Semite	0.2673		0.0706	0.2957
Dairy products	0.2597		0.1599	0.1290
Construction & related machinery	0.2522		0.6281	0.1677
Miscellaneous food & kindred products	0.2441		-0.0639	0.7034
Water transportation	0.2375		0.6726	0.6613
Pulp, paper, & paperboard mills	0.2275		0.5161	0.1464
Federal general govt	0.2127		-0.0236	-0.0533
Motion pictures	0.2123		0.2498	0.7991
Depository institutions	0.2074		0.5092	0.0109
Preserved fruits& vegetables	0.2059		-0.3385	0.3057
Electrical repair shops	0.2054		0.4157	0.4692
State & local govt education	0.1992		0.2706	-0.2047
Offices of health practitioners	0.1984		0.4048	0.1398
Nonmetallic minerals, except fuels	0.1926		0.1998	-0.5380
Federal electric utilities	0.1851			no fd
Computer & office equipment	0.1672		0.2862	0.5878
Insurance carriers	0.1527		-0.1723	0.6195
State & local electric utilities	0.1475			no fd
Child day care services	0.1393		0.7278	0.4479
Revidential care...........................	0.1318		0.6324	0.5774
Local & interurban passenger transit	0.1245		0.5736	0.5425
Individual & miscellaneous social services.	0.1169		0.4786	0.5565
Legal services	0.1159		0.7205	0.1138
Private households	0.0962		0.5167	0.1775
Funeral service & crematories	0.0920		0.1937	0.3881

Correlation Coefficients for Industries.

	Employment		Industry Final Demand	
Industry name	Historical Correlation with GDP		Historical Correlation with GDP	Projected Correlation with GDP
Health services, net	0.0899		0.1602	0.3031
Footwear, except rubber & plastic	0.0757		-0.2338	-0.7587
Grain mill products & fats& oils	0.0602		-0.0917	0.5411
Bakery products	0.0594		0.1295	0.7945
Museums, botanical, zoological gardens	0.0543		0.4276	0.5693
Membership organizations	0.0512		0.4169	0.5735
Communications equipment	0.0425		0.1868	0.6389
Security & commodity brokers	0.0416		0.0299	0.1840
Commercial sports	0.0385		-0.2027	0.3931
Educational services	0.0343		0.3000	-0.0129
Personal services, net	0.0186		0.2572	0.5577
Beverages	0.0091		0.3927	0.7475
Agricultural chemicals	-0.0246		0.3604	0.3187
Accounting, auditing, & other services...	-0.0314		0.5102	-0.2437
Agricultural Semites	-0.0647		0.4539	0.1332
State & local govt hospitals	-0.0741		-0.1599	-0.0617
Petroleum refining	-0.0764		0.4276	0.5892
Watch, jewelry, & furniture repair	-0.0771		0.4046	0.1051
Electric utilities	-0.1025		0.2739	0.2471
Industrial chemicals	-0.1448		0.5277	0.3206
Greeting cards	-0.1634		0.2016	0.0699
Communications	-0.1878		0.1107	0.4218
Oil & gas field services	-0.1947		-0.0585	-0.4111
Coal mining	-0.1953		-0.1486	0.3290
Gas utilities	-0.2023		0.0653	0.0310
Forestry, fishing, hunting, & trapping	-0.2168		-0.5862	0.0610
Amusement & recreation services, net	-0.2168		0.50571	0.6335
Tobacco products	-0.2244		0.0489	0.0139
Local govt passenger transit	-0.2443			no fd
Nursing & personal care facilities	-0.2589		0.3980	0.2438
Photographic equipment & supplies	-0.2851		0.3095	0.4319
Agricultural production	-0.3036		0.3913	-0.1532
Pipelines, except natural gas	-0.3079		0.1137	0.8710
Crude petroleum, natural gas, & gas liquids	-0.3745		0.4985	0.7708
Federal govt enterprises, net	-0.4072		0.3899	-0.0890
Hospitals, private	-0.5253		-0.4714	0.4637
Royalties			-0.0647	0.2020
Owner-occupied dwellings			0.2900	0.4964
Noncomparable imports			0.4828	0.4856
Scrap, used & secondh& goods			0.4558	-0.0730
Rest of the world industry ....…"				no fd
Inventory valuation adjustment				no fd

EARNINGS OF COLLEGE GRADUATES IN 1993

Daniel E. Hecker, Bureau of Labor Statistics

Why present a paper on 1993 earnings at a forecasting conference? BLS forecasts more graduates entering the labor force than job openings in college level jobs through 2005 -- based on NCES degree projections and BLS projections of employment growth, by occupation. This should result in a quarter to a fifth of graduates entering non college-level jobs. In fact, Current Population Survey (CPS) data show a steady 20 percent in non college-level jobs, most at well below average earnings--or unemployed since 1979. Data on low earners in 1993 should give some idea of which graduates will be in this one fifth through 2005. They can also identify those more likely to be high earners as well.

CPS data show degree level and age affect earnings and that women earn much less than men. We assume general skills, personal characteristics, and luck also play a part, but can not quantify these. Surveys limited in size or scope show major field of study greatly affects earnings. The CPS covers all graduates, but does not ask field of study. The 1993 National Science Foundation Survey of College Graduates did ask major field of study; and, with more than 150,000 usable responses for full time wage and salary workers, permits a very detailed analysis of earnings. This paper presents data from that survey.

Table 1, with data for women and Table 2, for men, show the effect of major on earnings as well as the part of earnings not explained by major. The median for all women was $31,800. However, the medians for pharmacy and engineering majors, at about $47,000 were two thirds higher than for social work, home economics, education, agriculture and theology & philosophy majors, at about $28,000. Liberal arts graduates, those with majors in liberal arts/general studies, foreign languages, political science, psychology, English language, history, and sociology have medians clustered closely around the median for all graduates. Medians for business, except accounting majors were only slightly higher than for liberal arts graduates. Those with low ranked majors were not much below median, while pharmacy and engineering at the top, were way above the median for all women.

For the middle 60 percent of all graduates, those at the top had medians twice as high as those at the bottom, $45,400 vs. $22,300. However, the range of the middle 60 percent varied by major. Top economics and mathematics graduates earned 2.4 times as much those at the bottom of the range, while for pharmacy and health technology majors, high earnings were only about half again as much as low. This is probably because most pharmacy and health technology majors enter a single directly related occupation, while economics and mathematics majors enter a broad range of occupations. So major field of study “explains” less of the earnings of economics and mathematics graduates. Furthermore, even among the lowest ranked majors, those at the top of the range earned above the median for all workers, and at the bottom quintile, only pharmacy majors were significantly above the median for all graduates. In every major besides pharmacy, at least 20 percent had below-median earnings. In other words, upper quintile social work majors earned more than lower quintile engineering majors. So geographic location, general skills, personal characteristics, luck, or other factors also matter.

For all men, median earnings were $43,200. However, the medians for engineering, mathematics, and physics majors, in the $52 thousand to $53 thousand range, were about two thirds again as high as those for theology, social work, and foreign language majors, which were in the $30,000-32,000 range. Business majors were above the median and the 7 liberal arts fields shown had medians spread out somewhat below the median for all men. Fields ranked near the bottom, such as theology and social work, had medians well below the median for all majors, while those near the top were much closer to the median. For the middle 60 percent of all graduates, those at the top had medians 2.2 times as high as those at the bottom, $65,200 vs. $29,400.

However, the range of the middle 60 percent varied by major. Top economics and liberal arts general graduates earned 2.7 times what those at the bottom earned; top majors in all 4 health majors, about 1.5 times and top criminal justice majors, 1.8 times. So major field of study "explains" less of the earnings of economics than of **health** majors. Graduates at the top of the theology major range earned more than the median for all graduates and mathematics, engineering, and pharmacy majors at the bottom of their range were below the median for all graduates. Therefore top theology majors earned more than bottom engineering and pharmacy majors. As for women, much of the difference is not explained by major.

There is a noticeable pattern in the rankings for both men and women: All top earning majors require mathematics courses or at least some quantitative methods, while bottom majors generally don't require any mathematics.

Occupational data (shown in published sources) indicate that graduates who were engineers, mathematical scientists, physicists, managers, sales workers (except retail), and, among women, nurses and therapists, were at the top. Those in human service college-level jobs -- teachers, social workers, counselors, and clergy were near the bottom, as were graduates in production, food service, clerical, retail sales and other non college-level jobs.

Major **field** of study affects chances for high or low earnings, largely because it channels people into occupations with different pay scales. Not only do some majors, such as engineering and education, prepare graduates for specific occupations, but also it is **difficult** to become an engineer or public school teacher without having studied engineering or education. Liberal arts and business curriculums are much less directed, and entry requirements for many sales and management related occupations are much more flexible. Nevertheless it is not obvious how much difference is due to choice of major, and how much is a screen. Perhaps it's only the most able students who get degrees in mathematics, engineering, physics, or, economics, or those who most value high earnings. Furthermore, education, social work, and theology generally attract people who are much less interested in high earnings. However, no degree, even one in a high median earnings field, guarantees high earnings.

Table 1.
Earnings distribution of female college graduates, by major field of study, 1993
(sorted by median)

	1st quintile	median	4th quintile
All major fields	$22,339	$31,848	$45,397
Pharmacy	36,493	47,567	56,342
Engineering	32,683	46,389	59,717
Computer and information sciences	30,035	41,559	53,786
Physical therapy and related services	32,114	40,491	52,882
Nursing	30,891	40,096	49,194
Economics	25,882	39,684	63,312
Engineering-related technologies	27,901	39,494	52,185
Accounting	26,427	37,702	51,411
Geology	30,050	36,790	51,297
Mathematics	23,719	36,256	56,115
Chemistry	24,459	35,803	50,678
Architecture/environmental design	25,359	35,718	51,953
Health/medical technologies	29,594	35,321	44,644
Liberal arts/general studies	24,723	33,383	47,207
Business, except accounting	23,258	33,373	48,677
Biological/life sciences	23,861	33,107	45,943
Other fields (not listed)	22,419	32,176	45,987
Foreign languages and linguistics	22,453	32,112	44,638
Communications	22,182	31,699	48,736
Political science and government	22,690	31,538	51,404
Psychology	22,731	31,393	44,525
English language and literature	21,426	30,483	44,432
Criminal justice/protective service	23,163	30,146	40,563
History	20,034	30,144	43,047
Sociology	21,062	30,115	42,307
Audiology and speech pathology	21,638	29,494	41,720
Visual and performing arts	19,667	29,250	42,054
Education, including physical education	20,387	28,696	38,799
Theology, philosophy, and religion	18,086	28,375	42,057
Agriculture	18,821	28,178	43,469
Social work	19,885	27,619	36,454
Home economics	18,863	27,496	40,358

Table 2.
Earnings distribution of male college graduates, by major field of study, 1993
(sorted by median)

	1st quintile	Median	4th quintile
All major fields	$29,373	$43,856	$65,193
Engineering	38,726	52,998	71,470
Mathematics	33,877	52,316	76,129
Physics	35,084	51,819	78,750
Pharmacy	42,377	50,805	62,077
Economics	30,578	50,360	81,777
Physical therapy and related services	38,700	49,730	57,009
Accounting	33,446	49,632	76,229
Chemistry	32,643	49,615	71,644
Computer and information sciences	35,068	47,303	61,434
Engineering-related technologies	32,085	45,286	61,399
Business, except accounting	29,717	44,672	70,085
Nursing	34,142	44,022	56,653
Political science and government	27,310	43,311	69,625
Architecture/environmental design	29,650	42,657	60,675
Psychology	27,914	41,986	60,447
Geology	31,682	41,925	61,512
Biological/life sciences	28,378	40,675	60,049
Sociology	27,495	39,574	60,624
English language and literature	26,398	39,385	63,342
Liberal arts/general studies	26,012	39,249	71,423
History	26,159	39,052	58,789
Criminal justice/protective service	28,359	38,818	51,602
Other fields (not listed)	26,594	38,408	57,240
Communications	26,003	38,131	61,492
Agriculture	25,410	37,292	53,185
Health/medical technologies	29,777	36,086	47,908
Education, including physical education	25,508	35,216	50,310
Visual and performing arts	22,517	33,571	52,373
Foreign languages and linguistics	23,141	32,346	52,943
Social work	23,200	31,507	47,843
Theology, philosophy, and religion	19,335	29,966	45,934

ASSESSMENT OF ROYALTY REDUCTION FOR HEAVY OIL PRODUCED ON FEDERAL LANDS

BRIAN W. KELTCH, BDM-OKLAHOMA AND
R. MICHAEL RAY, BARTLESVILLE PROJECT OFFICE, DEPARTMENT OF ENERGY

INTRODUCTION

The Department of Energy's Bartlesville Project Office was requested to participate in a Department of the interior, Bureau of Land Management (BLM) analysis to assess the impact of proposed Federal Royalty Reduction on Future Oil Recovery from Federal Lands. This paper describes some of the study activities over a two year period and includes the final BLM rule change. The rule change incentive is designed to offer economic relief to producers of heavy crude oil operating on Federal Lands. Heavy Oils are viscous (i.e. have low API gravitates and have relatively high sulfur contents and impurities resulting in an low refinery yield. These oils are generally recovered by steam injection processes which add to the operating cost relative to lighter oils. These economic drivers have made production of these reservoirs unattractive. Standard royalty payments are one eight of production (12.5%) unburdened by any cost. BLM collects these payments for oil and natural gas production onshore on federal lands. Generally the proceeds from these payments are equally divided between the Federal government and the State where the wells are located.

Several royalty reduction scenarios were evaluated. Each scenario offered greater royalty relief for heavier oil based on the industry accepted API gravity. Key evaluation parameters were the impact on reserve additions, local, state and federal revenues. These were evaluated using the analytical models and databases available in the Total Oil Recovery Information System (TORIS). These studies contributed to BLM issuing its final rule change on 2/1/96 under 43 CFR Part 3100 which provides for reducing the royalty payments for producers of heavy oil on Federal Lands.

TORIS BACKGROUND

The TORIS models have been used by Fossil Energy primarily for justification of research programs, determination of metrics, analysis of policy issues, and evaluation of the effects of environmental and other regulatory programs on domestic production and reserves. The major components of this system were developed in 1984 by the National Petroleum Council (NPC) as a tool for accessing the potential for enhanced oil recovery in the U. S.. At this time the system consisted of six predictive and economic modules for estimating tertiary enhanced oil recovery. The six processes modeled were polymer flooding, alkaline flooding, surfactant flooding, miscible CO_2 flooding, steamflooding, and in-situ combustion. A database consisting of about 51 data elements for each of about 3,500 reservoirs was constructed. This data was screened using a set of screening criteria for each of the EOR processes.

The basic mode of operation for TORIS was to run each reservoir through every process model for which it passed the screening criteria. The output of these models consisted of 50 years of incremental production, revenues, costs, taxes, investments, etc. for each project. A cash flow analysis produced a discounted cash flow rate of return for each project. A project which passed a pre-determined hurdle rate was said to be economic. An "assignment" model selected the most attractive EOR process for each reservoir based on a pre-determined selection criteria. Finally, a "timing" model was used to determine the timing of these selected EOR projects and provide projections of incremental oil recovery into the future. The timing was based on an approach which ranked the selected projects in order of their investment efficiency, the number of new projects allowed to start in a given year was determined by constraints on footage drilled, availability of technology, capital investment, and EOR injectants. The TORIS system provided a future stream of incremental EOR production along with projected revenues and costs for a specified "flat" oil price.

The next major component added to the system in 1989 was a conventional recovery model. A major data collection effort resulted in a "production file" containing about 20 years of annual production and well count data for a large majority of the TORIS reservoirs. The conventional recovery model performed a decline curve analysis on each reservoir in the production file. A decline rate was fit to each set of production data and production extrapolated into the future. A cash flow analysis then determined the point

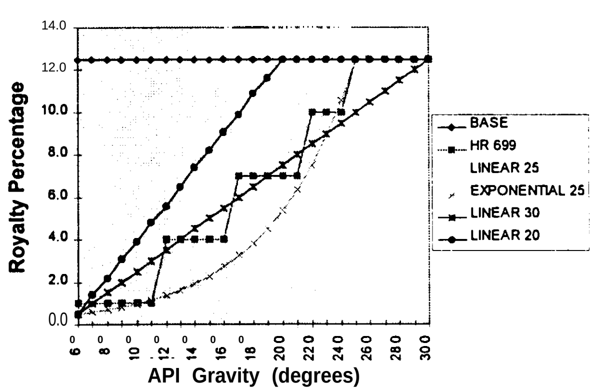
in the future when revenues fell below costs and the reservoir abandoned. This allowed TORIS to model reservoir abandonment which was a critical factor in strategic planning. It also provided an additional constraint for the timing of EOR projects. Once reservoirs were abandoned there was considered to be a limited period of time in which an EOR project could be initiated.

The remaining component of TORIS was installed in 1993. It is the Advanced Secondary Recovery (ASR) component. The ASR component is based on an infill drilling and predictive model developed for DOE by Scientific Software lntercomp. The processes modeled are polymer flooding, profile modification, infill drilling, infill/polymer combination, and infill/profile combination. The ASR system is run in much the same manner as the EOR system in order to provide future estimates of production, revenues, costs, investment, etc. for incremental advanced secondary recovery. All of these characteristics allow TORIS to determine the optimal technology path to pursue for specific reservoir conditions at different oil prices.

ROYALTY REDUCTION SCENARIOS

In mid 1994 the Bureau of Land Management began considering actions to encourage lease operators to return marginal wells to production and extend the life of wells that would otherwise be shut in. Several different royalty reduction were developed as a function of API number as shown below.

Royalty Reduction Scenarios



Each royalty reduction scenario was evaluated against a base case reduction. Scenarios were developed by BLM staff with the exception of the HR 699 scenario which was a Amendment offered by Congressman Calvert (California) in the summer of 1995. This amendment was eventually defeated. Other reduction scenario were considered as rule charges to the Code of Federal Regulations.

ANALYTIC APPROACH

The merits of the three incentives were evaluated by comparing the reserves and revenues generated by the incentives to those associated with a "no-incentive" or base case. The TORIS models were run at six oil prices: $12, $16, $18, $20, $22, and $24. The oil prices represent 1993 dollar/barrel prices for West Texas Intermediate Crude. The oil price is adjusted for each individual field/reservoir based on the quality of the oil as indicated by API gravity. The results of the model are reported directly without extrapolation to fields outside the database.

The analysis evaluates the impact of the scenarios on future reserves, net royalty to the Federal Government and jurisdictional states, and public sector revenues by various recovery techniques. These techniques include conventional recovery, tertiary recovery, and advanced secondary recovery.

For both the California and Wyoming field/reservoirs BLM provided the information necessary to identify the aerial extent of each field with is located on the Federal Lands.

The key revenue components of these analyses are:

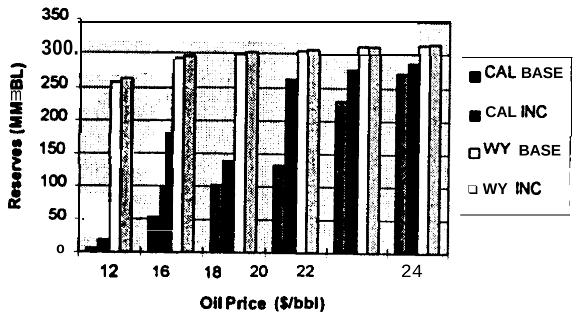
- Federal Taxes. The sum of Federal corporate and personal income taxes.
- Federal and state royalties. Royalty payments made to state and Federal treasuries on oil produced on Federal lands.
- Total Federal Revenues. The sum of Federal taxes and Federal royalties.
- State taxes. The sum of state severance, corporate, personal income, and sales taxes.
- Total state revenues. The sum of state taxes and state royalties.
- Total Public Sector revenues. The sum of total Federal revenues and total state revenues.

RESULTS

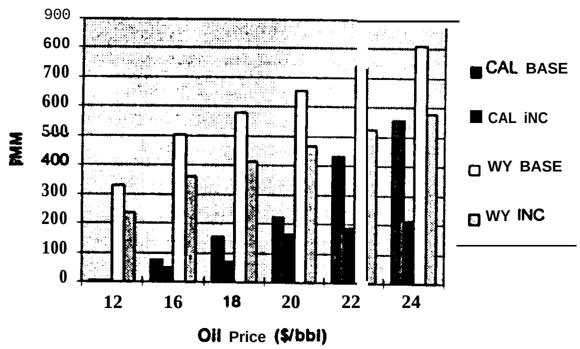
Results are shown below are for the first analysis done, the Linear 30 scenario. These graphs provide a summary and show sensitivities to oil price changes. Summaries such as these as well as more

detailed data were provided to BLM staff to assist in their analyses of each scenario.

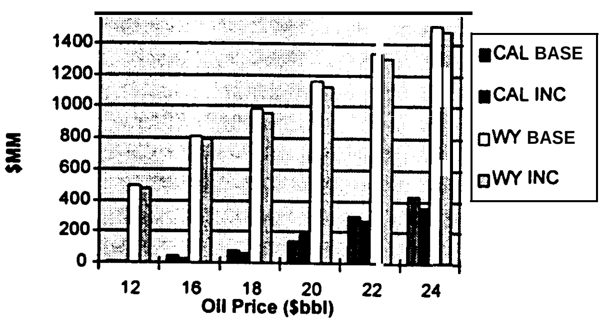
RESERVE ADDITIONS



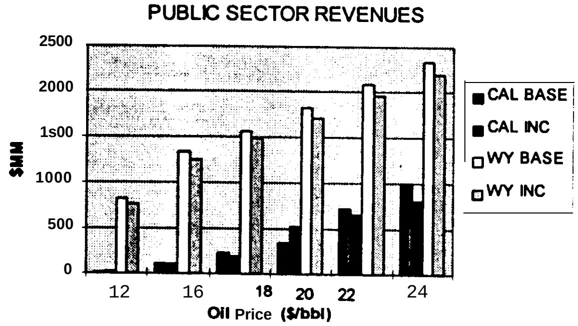
TOTAL ROYALTY



TOTAL FEDERAL REVENUES



PUBLIC SECTOR REVENUES



These results for the Linear 30 scenario indicated that significant reserves become economic at about **$20/bbl.** due to some potentially large projects becoming economically viable so reserve increments are great enough to offset the loss in royalty revenue due to the incentive. They also show a large difference between California and Wyoming responses.

CONCLUSIONS

The Total Oil Recovery Information System **(TORIS)** can bean effective tool to evaluate the impact of policy and technology changes on oil reserve additions and local, state and federal revenues. Results presented here contributed to the BLM **rule** change as indicated below.

BLM RULE CHANGE TEXT

DEPARTMENT OF THE INTERIOR
Bureau of Land Management 43 CFR Part 3100
[WO-31O-OO-131O-2411]

RIN 1OO4-AC26
Promotion of Development, Reduction of Royalty on Heavy Oil

AGENCY: Bureau of Land Management, Interior.

ACTION: Final rule.

SUMMARY: The Bureau of Land Management is issuing this final rule to amend the regulations relating to the waiver, suspension, or reduction of rental, royalty, or minimum royalty. This action is being taken to promote the production of heavy oil. The amendment establishes the conditions under which the operators of properties that produce “heavy oil” (crude oil with a gravity of less than 20 degrees) can obtain a reduction in the royalty rate. The amendment should encourage the operators of Federal heavy oil leases to place marginal or uneconomical shut-in oil wells back **in** production, provide an economic incentive to implement enhanced oil recovery projects, and delay the plugging of these wells until the maximum amount of economically recoverable oil can be obtained from the reservoir or field.

DATES: This rule will be effective March 11, 1996.

ADDRESS: Inquiries should be sent to: Director (140), Bureau of Land Management, Room 5558,

Main Interior Building, 1849 C Street, N. W., Washington, D.C. 20240.

FOR FURTHER INFORMATION CONTACT: Dr. John W. Bebout,
Bureau of Land Management, (202) 452-0340.

SUPPLEMENTARY INFORMATION:

I. Introduction
II. Summary of Rule Adopted
III. Responses to Public Comments
IV. Procedural Matters
V. Regulatory Text

I. Introduction

A proposed rule to provide royalty relief for producers of heavy oil was published in the Federal Register notice of April 10, 1995 (60 FR 18081) with the comment period ending June 9, 1995. The comment period was reopened June 16, 1995 (60 FR 31663) and closed July 17, 1995.

On March 30, 1995, an outdated version of this proposed rule was published in the Federal Register (60 FR 16424) by mistake. That proposed rule publication was withdrawn, and the Federal Register notice of April 10, 1995 (60 FR 18081) was published in its place as the proposed rule.

The following are questions and answers designed to provide an introduction to this rule.

When does the Department of the Interior (Department) consider granting royalty relief?

In order to encourage the greatest ultimate recovery of oil and in the interest of conservation, the Secretary, upon a determination that it is necessary to promote development, may reduce the royalty on an entire leasehold or any portion thereof (Section 39 of the Mineral Leasing Act, 30 U.S.C. 209).

Existing section 3103.4-1 of Title 43, Code of Federal Regulations, provides two forms of Federal oil and gas royalty reduction--on a case-by-case basis upon application and for stripper wells. The provision concerning stripper well properties allows royalty reduction for properties that produce an average of less than 15 barrels of oil per eligible well per well-day.

The Bureau of Land Management (BLM) believes that royalty relief for producers of heavy crude oil is needed to promote the development of heavy oil.

Why is heavy oil royalty relief needed?

Above all, this royalty relief is needed to promote the development of heavy oil. Eliminating all royalties would be the most effective way to promote development, but that would jeopardize the Department's efforts in securing a fair return for public land resources. Royalty relief has to be considered in light of all the Department's responsibilities and objectives. The balance this rule strikes is to have a royalty rate that promotes development while ensuring the public receives reasonable compensation.

Cyclical swings in the price for crude oil are common. BLM believes that future price decreases are possible, or even likely. The effect of this rule will provide a buffer against these decreases for heavy oil produced from Federal land. As many as two-thirds of all marginal properties (including non-heavy oil properties) could be lost during a period of sustained low oil prices (Marginal Wells, A Report of the National Petroleum Council, 1994, p. 3). The danger in losing the marginal wells is that, although production from individual wells may be small, their collective production is significant, accounting for one-third of lower-48 State onshore domestic production. Heavy oil production, from both Federal and non-Federal lands, makes up almost one-half of this third (Marginal Wells, A Report of the National Petroleum Council, 1994, p. 50). Heavy oil wells typically incur higher production costs, thus increasing their vulnerability. Were these heavy oil wells abandoned, the United States would lose this significant portion of domestic production.

What will happen as a result of this rule?

This rule should encourage the operators of Federal heavy oil leases to place marginal or uneconomical shut-in oil wells back in production, provide an economic incentive to implement enhanced oil recovery projects, and delay the plugging of these wells until the maximum amount of economically recoverable oil can be obtained from the reservoir or field.

According to a Department of Energy (DOE) analysis of its TORIS (Tertiary Oil Recovery Information System) data, the size of economically recoverable reserves from Federal lands will be significantly enhanced by this amendment. For instance, at a West Texas Intermediate **(WTI)** crude oil price of $16 a barrel, DOE projects that this rule will increase recoverable reserves of about 54 million barrels to about 87 million barrels for the State of California. At $18 a barrel, DOE projects that this rule will increase recoverable reserves of about 103 million barrels to about 130 million barrels for the State of California. At $20 a barrel, DOE projects that this rule will increase recoverable reserves of about 133 million barrels to about 229 million barrels for the State of California. A proportionately larger increase in recoverable reserves is anticipated when oil prices range toward $20 a barrel because major recovery projects may become economically feasible. Were this rule not promulgated, DOE projects these increases in recoverable reserves would most likely not occur.

Since the State of California produces almost 91 percent of lower-48 State onshore heavy oil production, the vast **majority** of recoverable reserve increases stemming from this royalty relief will most likely come from this State. Significant recoverable reserve increases are not anticipated in the other States since fewer properties will qualify for the relief.

When will this rule apply?

The rule will take effect [insert 30 days after date of publication]. However, the BLM may suspend or terminate all royalty reductions granted under this rule and terminate the availability of further relief under this rule--

1 upon 6 month's notice in the Federal Register when BLM determines that the average WTI oil price has remained above $24 per barrel over a period of 6 consecutive months or

2.after September 10, 1999, if the royalty rate reductions authorized by this rule have not been effective in reducing the loss of otherwise recoverable reserves.

How will this royalty relief affect royalties and revenues?

According to the DOE **TORIS** analysis, although oil royalties may decline in some instances, the effects to overall Federal and State revenues should be largely neutral except in the State of California. (Revenues include all forms of income including royalties.) Slight decreases in overall revenue could be possible at some oil prices for States with moderate levels of heavy oil production. In California, the DOE analysis projects small decreases or sizable increases in State revenues depending on the price of oil (Letter Report from Department of Energy dated July 29, 1994).

II. Summary of Rule Adopted

The final rule establishes a sliding scale royalty rate for qualifying heavy-oil-producing properties. The sliding scale is intended to somewhat offset the reduced prices paid for oil as oil gravity decreases. The reduced royalty rate applies to **qualifying** heavy oil properties rather than individual wells, because production is normally not reported for individual oil wells, and is based on the average gravity of the oil weighted by the production of heavy oil from each well within the property. A weighted average gravity is used to prevent gravity manipulation by selectively producing wells on a property with heavier gravity crude. Using a weighted average of oil gravity encourages maximum recovery from all wells within a property by removing the economic advantage of selective production.

The rule provides that either the operator (as defined at 43 CFR 3100.0-5) or the payor (as defined at 30 CFR 208.2) must calculate the weighted average gravity of the oil--measured on the American Petroleum Institute (API) scale--produced from a property every 12 months to determine the appropriate royalty rate. In no case, however, would the royalty rate exceed the rate established by the terms of the lease.

The section amended by this rule also provides for royalty rate reductions for stripper oil wells. Some provisions of this final rule are similar to the provisions of the existing regulations that pertain to stripper wells.

The final rule was modified in response to comments and for clarification. Section 3103.4 was redesigned to aid the reader in distinguishing the various forms of royalty reduction and accompanying provisions. Separate sections were established for the stripper oil and heavy oil royalty reduction provisions. The

discussion of royalty rate determinations in $3103.4-3(b)(5) was modified by adding two examples and clarifying the text. Section 3103.4-3(b)(6) was modified to extend the review period until 1999. Cross references were modified where appropriate throughout Part 3100 to reflect the redesign of § 3103.4.

III. Responses to Public Comments

A total of 209 comments were received on the proposed rule. An overwhelming majority supported the proposed rule. A few commenters recommended changes.

Comments suggested that the review period be extended for a period of 4 or 5 years rather than the 2 years stated in the proposed rule. It was always the BLM's intention that the rule be in place at least 4 years before it was evaluated. Unanticipated delays in the rulemaking process, however, have rendered the original 1997 deadline unreasonably short. Therefore, the BLM concurs with this suggestion and the rule has been modified to extend the review period until 1999.

A comment stated that the $24 trigger for rule suspension was too high while another comment stated that $24 was too low. Based on data developed from DOE's TORIS database, the BLM believes that $24 is an appropriate trigger to suspend the rule. The data indicate that State and Federal Royalty reductions are offset by increased recoverable reserves up until the point that WTI crude oil prices reach approximately $24/bbl. Past that point, recoverable reserve increases appear to taper off. In addition, the TORIS data show that when WTI prices climb above $24/bbl the royalty reduction is no longer a determining factor for decisions regarding investments in enhanced oil recovery techniques.

Comments suggested that the CFR 3103.4-1 regulations be revised for clarity and simplicity. The BLM agrees and has revised the section for clarity.

A comment suggested that the qualifying period for a heavy oil royalty rate reduction coincide with the one established for a stripper oil property royalty reduction. While the BLM agrees that there is value in making the stripper and heavy oil royalty rate reduction processes as similar as possible, this is not always practicable. The heavy oil rule qualifying period was made flexible in order to acknowledge the fact that many qualifying, low-production properties may not remove or sell oil every month even if their production is continuous. Thus, many properties may require even more than a calendar year (the stripper property qualifying period) to accumulate 3 months of sales or oil removal.

One comment requested that the notification period for requesting a reduced royalty rate be extended beyond the proposed 60 days. The BLM believes that 60 days is sufficient time for an operator to notify the BLM of a new royalty rate. The stripper property royalty reduction program has a similar notification period which appears to be working well.

Some comments stated that a greater royalty rate reduction was necessary. They suggested that this be accomplished by using a power curve rather than a straight line to calculate royalty rates. The BLM considered calculating royalty rates by both power curves and straight-line methods. The DOE's TORIS data, however, indicated that neither method was clearly advantageous over the other in terms of increasing recoverable reserves except within a narrow range of WTI crude oil prices. Because it is not possible to predict future oil prices, the BLM has chosen to remain with a straight-line royalty reduction for purposes of simplicity as well as to parallel the stripper property royalty reduction rule.

Some comments stated that the rule should use 25 degrees as a "heavy oil" cutoff (rather than the 20 degrees proposed) in order to maximize the rule's effects and to provide the rule's benefits to as many operators as possible. Although there is no single accepted definition for "heavy oil, " standard academic and industry practice is to reserve the term for crude oils of less than 20 degrees API. The U.S. tax code also uses a 20 degree definition. One comment stated that BLM should evaluate the stripper oil royalty reduction before granting heavy oil royalty relief. The BLM is in the process of evaluating the stripper well provisions. The stripper well provisions have not been in place long enough to make a substantive assessment.

One comment strongly opposed heavy oil royalty relief, stating that the BLM has no data which demonstrate that the leases eligible for the relief cannot be operated successfully under the lease terms or that the continued operation of each heavy crude lease is in serious, unavoidable jeopardy. Although this is an important consideration, this is not the criterion for relief that is serving as the basis of this determination. The Secretary, acting through the Assistant Secretary--Land and Minerals Management,

concludes, based on the DOE analysis cited in the introduction, that this rule is necessary to promote the development of heavy oil. Recoverable reserves are projected to be significantly less in the absence of the royalty relief provided by this rule.

One comment stated that this rule will provide insufficient relief on leases in true jeopardy and windfalls for those without need. The BLM believes that there are enough similarities in terms of the economic pressures on producers of heavy oil that any such relative disparities in levels of relief should be inconsequential. Furthermore, the rule is sensitive to the particular gravity of the heavy oil being produced, so that producers of less valuable heavy oil receive a higher proportion of royalty relief.

One comment stated that even if State revenues increase, royalty reductions will hurt State services. (Revenues include all forms of income including royalties.) According to the DOE analysis, the effects to Federal and State revenues should be largely neutral. Slight royalty decreases could be possible at some oil prices for States with moderate levels of heavy oil production.

In California, where almost 91 percent of the heavy oil production takes place, the DOE analysis generally projects small to moderate decreases in royalties. For instance, at $16 a barrel (WTI), DOE projects that this rule will decrease California royalties by about $3.5 million, while increasing California public sector revenue by about $15 million. At $18 a barrel (WTI), DOE projects that this rule will decrease California royalties by about $24 million, while decreasing California public sector revenue by about $1 million. At $20 a barrel (WTI), DOE projects that this rule will increase California royalties by about $1 million, while increasing California public sector revenue by about $104 million. The wide variations in sensitivity to the price of oil are due to numerous variables, including the propensity for oil companies to invest in major recovery projects at certain oil prices. (Letter Report from Department of Energy dated July 29, 1994).

IV. Procedural Matters

This rule is not a major Federal action significantly affecting the quality of the human environment and that no detailed statement pursuant to Section 102 (2)(C) of the National Environmental Policy Act of 1969 (42 U.S.C. 4332(2)(C)) is required.

This rule has been reviewed under Executive Order 12866.

The BLM has determined that this final rule will not have a significant economic impact on a substantial number of small entitities under the Regulatory Flexibility Act (5 U.S.C. 601 et seq.). The BLM has prepared a regulatory flexibility analysis. It is available upon request from the address listed at the begiming of this rule. Additionally the BLM has determined, under Executive Order 12630, that the rulemaking will not cause a taking of private property.

The BLM has certified that these regulations meet the applicable standards provided in sections 2(a) and 2(b)(2) of Executive Order 12778.

The information collection requirements of this rule have been approved by the Office of Management and Budget under 44 U.S.C. 3501 et seq. and assigned clearance numbers 1010-0090 and 1004-0145.

The principal author of this final rule is Dr. John W. Bebout, Senior Technical Specialist, Fluids Group, assisted by Charles Hunt of the Regulatory Management Team, Bureau of Land Management.

List of Subjects for 43 CFR Part 3100

Land Management Bureau, Public Lands - mineral resources, Oil and gas production, Mineral royalties

For the reasons stated in the preamble, and under the authorities cited below, Part 3100, Group 3100, Subchapter C, Chapter II of Title 43 of the Code of Federal Regulations is amended as set forth below:

V. Regulatory Text

PART 31OO--OIL AND GAS LEASING

1. The authority citation for part 3100 continues to read as follows:

AUTHORITY: 30 U.S.C. 181, et seq., 30 U.S.C. 351-359.

Subpart 3103--Fees, Rentals and Royalty

2. The table of contents for Group 3100, Part 3100, Subpart 3103 is revised to read as follows:

§ 3103.4 Production incentives.

§ 3103.4-1 Royalty reductions.

§ 3103.4-2 Stripper well royalty reductions.

§ 3103.4-3 Heavy oil royalty reductions.

§ 3103.4-4 Suspension of operations and/or production.

3. Section § 3103.2-2 is amended by removing the cross reference "$ 3103.4-2(d)" and adding in its place the cross reference "§ 3103 .4-4(d)."

4. $3103.4 is amended by revising the heading to read as follows:

§ 3103.4 Production incentives.

5. $3103.4-1 is amended by removing paragraphs (c) and (d), redesignating paragraph (e) as (c), and revising the heading and paragraph (b)(1) to read as follows:

§ 3103.4-1 Royalty reductions.

(b)(1) An application for the benefits under paragraph (a) of this section on other than stripper oil well leases or heavy oil properties must be filed by the operator/payor in the proper BLM office. (Royalty reductions specifically for stripper oil well leases or heavy oil properties are discussed in $3103.4-2 and § 3103.4-3 respectively.) The application must contain the serial number of the leases, the names of the record title holders, operating rights owners (sublessees), and operators for each lease, the description of lands by legal subdivision and a description of the relief requested.

6. Former $3103.4-2 is redesignated as § 3103.4-4.

7. Paragraphs (c) and (d), formerly of $3103.4-1, are redesignated as paragraphs (a) and (b) and inserted under the new § 3103.4-2, paragraph (b) is amended by removing the cross reference "(do)" in (3)(iii)(A) and adding in its place the cross reference "(be)," and the heading is to read:

$3103.4-2 Stripper well royalty reductions.

8. A new § 3103.4-3 is added to read as follows:

§ 3103.4-3 Heavy Oil Royalty Reductions.

(a)(1) A heavy oil well property is any Federal lease or portion thereof segregated for royalty purposes, a communitization area, or a unit participating area, operated by the same operator, that produces crude oil with a weighted average gravity of less than 20 degrees as measured on the American Petroleum Institute (API) scale.

(2) An oil completion is a completion from which the energy equivalent of the oil produced exceeds the energy equivalent of the gas produced (including the entrained liquefiable hydrocarbons) or any completion producing oil and less than 60 MCF of gas per day.

(b) Heavy oil well property royalty rate reductions will be administered according to the following requirements and procedures.

(1) The Bureau of Land Management requires no specific application form for the benefits under paragraph (a) of this section for heavy oil well properties. However, the operator/payer must notify, in writing, the proper BLM office that it is seeking a heavy oil royalty rate reduction. The letter must contain the serial number of the affected leases (or, as appropriate, the communitization agreement number or the unit agreement name); the names of the operators for each lease; the calculated new royalty rate as determined under paragraph (b)(2) of this section; and copies of the Purchaser's Statements (sales receipts) to document the weighted average API gravity for a property.

(2) The operator must determine the weighted average API gravity for a property by averaging (adjusted to rate of production) the API gravities reported on the operator's Purchaser's Statement for the last 3 calendar months preceding the operator's written notice of intent to seek a royalty rate reduction, during each of which at least one sale was held. This is shown in the following 3 illustrations:

(i) If a property has oil sales every month prior to requesting the royalty rate reduction in October of 1996, the operator must submit Purchaser's Statements for July, August, and September of 1996;

(ii) If a property has sales only every 6 months, during the months of March and September, prior to requesting the rate reduction in October of 1996, the

operator must submit Purchaser's Statements for the months of September 1995, and March and September 1996; and

(iii) If a property has multiple sales each month, the operator must submit Purchaser's Statements for every sale for the 3 entire calendar months immediately preceding the request for a rate reduction.

(3) The following equation must be used by the operator/payer for calculating the weighted average API gravity for a heavy oil well property:

$$\frac{(V1 \times G1)+(V2 \times G2)+(Vn \times Gn)}{V1 + V2 + Vn} = \text{Weighted Average API gravity for a property}$$

Where:
V1 = Average Production **(bbls)** of Well #1 over the last 3 calendar months of sales
V2 = Average Production **(bbls)** of Well #2 over the last 3 calendar months of sales
Vn = Average Production **(bbls)** of each additional well (V3, V4, etc.) over the last 3 calendar months of sales
G1 = Average Gravity (degrees) of oil produced from Well #1 over the last 3 calendar months of sales
G2 = Average Gravity (degrees) of oil produced from Well #2 over the last 3 calendar months of sales
Gn = Average Gravity (degrees) of each additional well (G3, G4, etc.) over the last 3 calendar months of sales

Example: Lease "A" has 3 wells producing at the following average rates over 3 sales months with the following associated average gravities: Well #1, 4,000 **bbls,** 13° API; Well #2, 6000 **bbls,** 21° API; Well #3, 2,000 **bbls,** 14° API. Using the equation **above--**

$$\frac{(4{,}000 \times 13)+(6{,}000 \times 21)+(2{,}000 \times 14)}{} = 17.2 \text{ Weighted Average API gravity for property}$$

(4) For those properties subject to a **communitization** agreement or a unit participating area, the weighted average API oil gravity for the lands dedicated to that specific communitization agreement or unit participating area must be determined in the manner prescribed in paragraph (b)(3) of this section and assigned to all property subject to Federal royalties in the communitization agreement or unit participating area.

(5) The operator/payer must use the following procedures in order to obtain a royalty rate reduction under this section:

(i) Qualifying royalty rate determination.

(A) The **operator/payor** must calculate the weighted average API gravity for the property proposed for the royalty rate reduction in order to verify that the property qualifies as a heavy oil well property.

(B) Properties that have removed or sold oil less than 3 times in their productive life may still **qualify** for this royalty rate reduction. However, no additional royalty reductions will be granted until the property has a sales history of at least 3 production months (see paragraph (b)(2) of this section).

(ii) Calculating the **qualifying** royalty rate. If the Federal leases or portions thereof (e.g., communitization or unit agreements) **qualify** as heavy oil property, the **operator/payor** must use the weighted average API gravity rounded down to the next whole degree (e.g., 11.7 degrees API becomes 11 degrees), and determine the appropriate royalty rate from the following table:

Royalty Rate Reduction for Heavy Oil

Weighted Average API Gravity (degrees)	Royalty Rate (percent)
6	0.5
7	1.4
8	2.2
9	3.1
10	3.9
11	4.8
12	5.6
13	6.5
14	7.4
15	8.2
16	9.1
17	9.9
18	10.8
19	11.6
20	12.5

(iii) New royalty rate effective date. The new royalty rate will be effective on the first day of production 2 months after BLM receives notification by the operator/payor. The rate will apply to all oil production from the property for the next 12 months (plus the 2 calendar month grace period during which the next 12 months' royalty rate is determined in the next year). If the API oil gravity is 20 degrees or greater, the royalty rate will be the rate in the lease terms.

Example: BLM receives notification from an operator on June 8, 1996. There is a two month period before new royalty rate is effective--July and August. New royalty rate is effective September 1, 1996.

(iv) Royalty rate determinations in subsequent years.

(A) At the end of each 12-month period, beginning on the first day of the calendar month the royalty rate reduction went into effect, the operator/payer must determine the weighted average API oil gravity for the property for that period. The operator/payor must then determine the royalty rate for the following year using the table in paragraph (b)(5)(ii) of this section.

(B) The operator/payor must notify BLM of its determinations under this paragraph and paragraph (A) of § 3103 .4-3(b) (5)(iv). The new royalty rate (effective for the next 12 month period) will become effective the first day of the third month after the prior 12 month period comes to a close, and will remain effective for 12 calendar months (plus the 2 calendar month grace period during which the next 12 months' royalty rate is determined in the next year). Notification must include copies of the Purchaser's Statements (sales receipts) and be mailed to the proper BLM office. If the operator does not notify the BLM of the new royalty rate within 60 days after the end of the subject 12-month period, the royalty rate for the heavy oil well property will return to the rate in the lease terms.

Example: On September 30, 1997, at the end of a 12-month royalty reduction period, the operator/payer determines what the weighted average API oil gravity for the property for that period has been. The operator/payor then determines the new royalty rate for the next 12 month using the table in paragraph (b)(S)(ii) of this section. Given that there is a 2-month delay period for the operator/payor to calculate the new royalty rate, the new royalty rate would be effective December 1, 1997 through November 30, 1998 (plus the 2 calendar month grace period during which the next 12 months' royalty rate is determined--December 1, 1998 through January 31, 1999).

(v) Prohibition. Any heavy oil property reporting an API average oil gravity determined by BLM to have resulted from any manipulation of normal production or adulteration of oil sold from the property will not receive the benefit of a royalty rate reduction under this paragraph (b).

(vi) Certification. The operator/payor must use the applicable royalty rate when submitting the required royalty reports/payments to the Minerals Management Service (MMS). In submitting royalty reports/payments using a royalty rate reduction authorized by this paragraph (b), the operator/payer must certify that the API oil gravity for the initial and subsequent 12-month periods was not subject to manipulation or adulteration and the royalty rate was determined in accordance with the requirements and procedures of this paragraph (b).

(vii) Agency action. If an operator/payer incorrectly calculates the royalty rate, the BLM will determine the correct rate and notify the operator/payor in writing. Any additional royalties due are payable to MMS immediately upon receipt of this notice. Late payment or underpayment charges will be assessed in accordance with 30 CFR 218.102. The BLM will terminate a royalty rate reduction for a property if BLM determines that the API oil gravity was manipulated or adulterated by the operator/payor. Terminations of royalty rate reductions for individual properties will be effective on the effective date of the royalty rate reduction resulting from a manipulated or adulterated API oil gravity so that the termination will be retroactive to the effective date of the improper reduction. The operator/payor must pay the difference in royalty resulting from the retroactive application of the non-manipulated rate. The late payment or underpayment charges will assessed in accordance with 30 CFR 218.102.

(6) The BLM may suspend or terminate all royalty reductions granted under this paragraph (b) and terminate the availability of further heavy oil royalty relief under this section--

(i) upon 6 month's notice in the Federal Register when BLM determines that the average oil price has remained above $24 per barrel over a period of 6 consecutive months (based on the WTI Crude average

posted prices and adjusted for inflation using the implicit price deflator for gross national product with 1991 as the base year), or

(ii) after September 10, 1999, if the Secretary determines the royalty rate reductions authorized by this paragraph (b) have not been effective in reducing the loss of otherwise recoverable reserves. This will be determined by evaluating the expected versus the actual abandonment rate, the number of enhanced recovery projects, and the amount of operator reinvestment in heavy oil production that can be attributed to this rule.

(7) The heavy oil well property royalty rate reduction applies to all Federal **oil** produced from a heavy oil property.

(8) If the lease royalty rate is lower than the benefits provided in this heavy oil well property royalty rate reduction program, the lease rate prevails.

(9) If the property qualifies for a stripper well property royalty rate reduction, as well as a heavy oil well property reduction, the lower of the two rates applies.

(10) The operator/payer must separately calculate the royalty for gas production (including condensate produced in association with gas) from oil completions using the lease royalty rate.

(11) The minimum royalty provisions of $3103.3-2 will continue to apply.

9. Section § 3140.1-4(c)(3) is amended by removing the cross reference "$ 3103.4-1" and adding in its place the cross reference "$ 3103.4. "

10. Section § 3165. l(b) is amended by removing the cross reference "$ 3103.4-2" and adding in its place the cross reference "§ 3103 .4-4."

Bob Armstrong
Assistant Secretary of the Interior

THE USE OF ENVIRONMENTAL FORECASTING FOR POLICY DEVELOPMENT

Chair: Alan Porter
Georgia Institute of Technology

The Use of Environmental Forecasting for Policy Development: Compilation of Environmental Trends,
Robert E. Jarrett, U.S. Army Environmental Policy Institute

A Real-Time Environmental Monitoring System,
Alan L. Porter and Molly J. Landholm, U.S. Army Environmental Policy Institute

Panelists: Peter Rzeszotarski
University of Houston - Clear Lake

Maurice LeFranc
U.S. Environmental Protection Agency

THE USE OF ENVIRONMENTAL FORECASTING FOR POLICY DEVELOPMENT: COMPILATION OF "ENVIRONMENTAL TRENDS"

Robert E. Jarrett
U.S. Army Environmental Policy Institute

Only by constantly peering toward the future can one properly recognize its form and content as it arrives. Whether physically or mentally, traveling backwards into the future with eyes fixed only on the past is an invitation to constant disaster. By analyzing trends rooted in the past and springing from the present one can produce a working set of reasonably probable futures upon which to plan preferred action options.

BACKGROUND

Since its establishment in September 1990, the Army Environmental Policy Institute's (AEPI) central charter responsibility has been development of anticipatory environmental policy. An explicit supporting responsibility is evaluating environmental trends as a basis for:

identifying areas of probable future concern to the Army;

defining and tracking issues of possible/probable impact on Army; and

hypothesizing the nature of the potential impacts, and

estimating how, when and how intensely the impacts may arise.

Accomplishment requires sponsorship of activities to find and assess basic trends in environmental economics, legislation, natural phenomena, philosophy, politics, science, and social action. These efforts must be relatively continuous to ensure that policy-making wi 11 be timely and directed at the right issues.

For the purpose of understanding the following discussion of AEPI's environmental trends work and of some of the outcomes, the following definitions guide and shape the choice, validation and statement of the trends themselves. Trends:

Reflect measures of direction and intensity of change

May derive from subjective or objective data, but reflect disciplined evaluation

Are made on the basis of some form of time series evaluation

Are not forecasts, which are projections of possible futures.

(Attachment 1 provides examples of statements.)

A prototype, consultant assisted analysis performed in the Summer of 1991, served as the centerpiece for a workshop to identify high priority topic areas for AEPI to study intensely for their policy implications. Using the 41 trends identified in the 1991 analysis and the knowledge the panel experts brought to the table, participants forecasted four focus areas would achieve national importance. Three subsequently proved to be correct, having become significant concerns in both private and civil sector thinking: integration of environmental considerations throughout an "enterprise," pollution prevention and risk prioritization. The latter is now a major factor in legislative and regulatory philosophy.

Additional, broad reviews occurred in 1992, 93 and 94. The unabridged consultant reports were issued to key environmental policy- and decision-making offices. The four annual analyses serve to show the directions in which Army host societies (U.S. and foreign) are moving, so that both broad and specific anticipatory actions may be taken. The 1992 effort added evaluation of foreign nation situations, as an aid to HQ Department of the Army and to overseas commands. It also extended the 1991 evaluation of public attitudes on a variety of environmental issues to help Army executives gauge the direction and intensity of future individual and societal behaviors. And, new coverage provided summaries of the principal governmental and non-governmental environmental advocates' philosophies and programs to assist Army managers in working with those groups. The three latest (1992, 93 and 94) analyses served to improve contractor and in-house methodologies, to strengthen the historical roots of the analysis series and to make the analyses more factually and judgmentally robust.

The entire series of annual analyses:

indicates newly emerging issue areas needing attention;

helps define individual policy study projects to be programmed;

suggests directions to look for solutions; and

provides basic information for inclusion in specific studies.

The core activity has been intensive literature review across many fields by environmentally trained researchers using electronic databases and primary and secondary sources. The 1994 analysis added the element of additional expert consultation for validation. That aspect is further strengthened with more such input, plus peer review at the **draft** stage, in the 1995 analysis to be finished in Summer ' 96.

This work does not itself produce forecasts of future issues, but provides the information base upon which AEPI has done some forecasting and intends to do more. Products should be foundations for AEPI strategic planning and for program project selection, and should also become feeder information to others' long range planning - rather than simply being interesting information. Naturally, there is some practical limitation to the diversity of topical coverage. The focus has had to be on those of most probable import to the Army. Given the broad range of substances, activities and sites used by the Army, that necessary coverage is still considerable. Thus, the information should find fairly wide applicability in other governmental and private sector organizations.

As a result of the developmental nature of the work to this point, it is only in Summer, 1996 that it may become possible to put the 1994 Environmental Trends Update and all of its graphics on the AEPI Internet home page. Not only can one **find** all 57 trends with their detailed write-ups, but also: short papers on 10 potentially important emerging issues, an analysis of public attitudes, trends in nations hosting significant numbers of Army personnel, non-analytical capsule descriptions of major environmental interest groups and an extensive bibliography. Attachment 2 provides the 1994 trend and emerging issue statements.

EPA's January, 1995 publication, **Beyond the Horizon: Using Foresight to Protect the Environmental Future says:**

> "The value of **futures** research and analysis lies not in making predictions, but in analyzing information that can help shape decisions and actions."

AEPI, though lacking such a succinct statement, has been developing its program on this principle.

(It was **gratifying** that the Science Advisory Board's **(SAB)** Futures Sub-Committee used AEPI's 1994 Environmental Trends Update as a resource for deliberations leading to publication of **Beyond the Horizon**.)

To determine how well AEPI has progressed toward being able to help with that shaping, it commissioned a 1995-96 study of its trends analyses, scanning techniques and product usage. Parts of that study looked at the five years of completed and on-going trends analysis and others' similar work in the 1991-95 period. The reviewers compiled 69 trends as being significant and ranked them into quartiles of importance. Looking at the top quartile (17 trends, Attachment 1), one is struck by the way they can be clustered to suggest these strong currents:

a. Nationally and worldwide, citizens are developing a sense of the mortality of Man as a species, threatened by Man's own power to **modify** the environment. This realization raises a conflict of values within cultures. How it will affect attitudes toward prevention, genesis, planning, conduct and termination of hostilities is yet to be gauged, especially against the backdrop of uncertainties over true rates of environmental degradation and amelioration. The EPA study speaks of a policy gridlock owing to lack of societal consensus. This entire area should be watched for indicators of what societies will accept in the way of environmental costs for development, defence or warfare, within the totality of all human activity.

b. Sustainable use of resources, pollution prevention, energy conservation and similar conservational philosophies and programs are **all** growing in strength, individually and in combination. Integration of energy and environmental quality policy continues. This composite trend puts pressure on organizations to constantly invest in new infrastructure capable of meeting ever tightening environmental protection expectations. Pressures also mount for modification of systems, activities and substance uses lying at the heart of organizations' existence: for example, chemicals, high energy usage, and rain forest elimination. Slow investment payoff times for conservational, preventive programs (compared to those applied under normal business investment criteria) suggest that the world continues to experience strong demand for resources for traditional development approaches to economic growth compared to sustainable approaches.

c. Interest in and worry about a widening range of environmental media and factors is outstripping the

already slow growth in public "scientific literacy" (compared to the accelerating rate at which scientific knowledge is accumulating). These two trends operate simultaneously to confound smooth progress on defining, prioritizing and managing environmental issues. On one hand, growing interest and concern suggests that demands for improvement will deepen and broaden. On the other, one would expect that weak scientific understanding would exacerbate lack of consensus on priorities, methods and timing. Further, in some topic areas like climate change (science based) and bio-diversity (values and science based) controversy is mounting steadily. These trends at cross purposes to each other work against predictability, planning, decision making and implementation. Controversy appears to be a permanent hallmark of environmental issue management.

d. Risk assessment, prioritization and management, as ideas, are embraced in many quarters of U.S. society as real or fancied solutions to currently weak political and scientific consensus. Application of such disciplines offers promise of providing a means of balancing various forms of risk (ecological, economic, human health). The methodologies themselves are **sufficiently** based on opinion and shifting societal values that many expectations are likely to not be met. The current challenge lies in determining how to apply what is now mature in risk management "technology," while avoiding disillusionment as better tools are being developed. Government agencies will have to participate in continuing application and development of risk based approaches, though results may appear unrewarding at times.

e. "National and international environmental issues are rapidly becoming a matter of **strategic** national interest," said the expert EPA Futures Sub-Committee. Environmental stresses on the land, in the air, in the seas and on the biological life of the U.S. and other nations are increasing. They reduce freedom of national options. This raises the specter of increased use of military forces to exercise one nation's options over another nation's. Societies need to constantly track and weigh these environmental developments very carefully to ensure scientific, economic and political maturity of policies intended to rationally prevent or resolve environmentally driven conflicts.

These five trends portend important opportunities and dangers in attempts to write policy for managing environmental issues.

FIVE YEAR REVIEW OF ARMY ENVIRONMENTAL **POLICY INSTITUTE**
ENVIRONMENTAL TRENDS ANALYSES

[illegible]

Emphasis on developing, sharing and exporting environmental technology is swiftly picking up

State and local government involvement in environmental programs has continued to increase, but strong counter-forces arc rapidly building

Public **understanding/perception** of environmental problems and risk will improve only slightly in the next decade.

Biodiversity is rapidly becoming a polarizing subject

Pollution prevention is continuing to gain momentum

Ecological risks are continuing to increase rapidly in importance as **factors** in environmental decision-making

Air quality standards are steadily becoming stricter

Sustainable development is rapidly being integrated into economic and environmental policy

Emphasis on combined sewer overflow control issues is continuing to build steadily at the local level

Environmental auditing is **evolving rapidly**

Concern over noise pollution is continuing to build **steadily**

Waste flow control **remains** a **hotly** debated topic

Attention to the cumulative environmental impacts of activities is escalating

Climate change is receiving more attention and **generating** more controversy than before

Natural resource damage **is rapidly gaining** attention

Integration of energy policy and environmental quality is continuing steadily

Energy **conservation** programs are quickly gaining popularity

1994 ENVIRONMENTAL TRENDS - UPDATE

THE TRENDS

Enforcement and Administration

Trend 1. **Federal environmental enforcement (both criminal and civil) continues to increase significantly.**
- *Overall enforcement*
- *Federal Facility Enforcement*
- *Sentencing*
- *EPA Reorganization*

Trend 2. **Federal environmental oversight remains fragmented.**

Trend 3. **State and local government involvement in environmental programs continues to increase, but strong counter-forces are building rapidly.**
- *Primacy*

Trend 4. **Consolidation of environmental laws, regulations and programs is progressing slowly.**
- *Federal Activity*
- *State Activity*
- *International Activity*

Trend 5. **Multi-media regulatory efforts are growing quickly.**
- *Federal Activity*
- *State Activity*

Trend 6. **Environmental auditing is rapidly becoming a common practice.**
- *Property Assessments*
- *Process Auditing*
- *Development of International Standards*

Trend 7. **Coordination of federal environmental data collection and analysis efforts remains slow.**
- *Environmental Indicators*
- *Data Quality*

Trend 8. **Industry Cautiously continues to increase its voluntary environmental activities.**
- *Pollution Prevention*
- *Sustainable Development*
- *Energy Conservation*
- *Cleanup*
- *Auditing*

Trend 9. **The federal judiciary continues to shift gradually towards more conservative interpretation of federal environmental legislation.**

Enforcement and Administration

Trend 10. **Environmental requirements are hemming increasingly common and stringent worldwide.**
- *International Agreements*
- *Foreign Environmental Legislation*
- *Enforcement*

Trend 11. **"Solid waste flow control" remains a hotly debated topic.**

Trend 12. **Implementation of Total Quality Environmental Management principles is picking up pace steadil,**
- *Private Sector*
- *Public Sector*

Trend 13. Pollution prevention continues to gain momentum.

- *Public Sector*
- *Private Sector*
- *Non-Profit Sector*

Emphasis on specific Areas

Trend 14. The number of landfills continues to decrease sharply.

- *Waste Generation*
- *Landfill Usage*
- *Landfill Availability*
- *State Regulation*

Trend 15. *Recycling is continuing to grow steadily.*

- *Federal Action*
- *State Legislation*
- *Municipal Action*
- *Paper*
- *Plastic*
- *Metals*
- *Comporting*
- *Product Stewardship*

Trend 16. *Incineration usage, still* facing stiff public opposition, is beginning to drop off.

- *Incineration Usage*
- *Federal Action*
- *State Activity*

Trend 17. Implementation of stricter water quality standards continues steadily.

- *Water Quality Programs*
- *Watershed Protection*
- *Groundwater Protection*
- *Water Quality Indicators*
- *Congressional Action*

Trend 18. *Control* of nonpoint source pollution continues to get more focused attention.

Trend 19. Emphasis on combined sewer overflow control issues continues to build steadily at the local level.

Trend 20. Wetlands are steadily approaching the point of "no net loss."

Trend 21. Coastal areas are facing increasingly severe environmental problems.

Trend 22. Air quality standards are steadily becoming stricter.

- *National Air Quality*
- *Sources of Emissions*
- *Control of Transportation Sources and Pollutants*
- *control of other Sources and Pollutants*
- *congressional Interest*
- *International Developments*

Trend 23. Indoor air pollution continues to be recognized as *a significant* risk, with action still being taken slowly.

- Public *Sector*
- *Private Sector*

Trend 24. *Concern over* noise pollution continues to build steadily.

- *Urban Noise*
- *Occupational Noise*
- *Aircraft Noise*

Trend 25. Criticisms over the pace and costs of **hazardous waste cleanups are still increasing** steadily.

Superfund
Department of Energy
Department of Defense
Department of the Interior

Trend 26. **Emergency response programs continue to grow slowly.**

Farming Practices
Pesticides Residues
Pesticide Control Reforms
International Developments

Trend *28.* **Concern over lead exposure is still increasing.**

Trend *29.* **Although classification of hazardous waste is slowly becoming more standardized, it is still controversial.**

Hazardous Waste Identification Rule
Toxicity Characteristics Leachate Procedure
Recycling
Transportation

Evaluation and Management of Risk

Trend 30. Public policy development is shifting **steadily towards** the use of **comparative** risk **analysis** and risk **management.**

Trend 31. *Human health risks are still the predominant* **factor** *in* **environmental** *policy* development

Trend 32. Ecological risks are rapidly increasing in importance 8s **factors** in environmental decision-making.

Ecosystem Protection *Policy*
Ecological Risk *Assessment*

Trend 33. Attention to the **cumulative** environmental impacts of activities **is escalating.**

Ecology/Global Patterns

Trend 34. **Natural resource damage is** gaining attention **rapidly.**

Trend 35. Competition **for land,** water, and other resources continues to increase steadily.

Land
Waler

Trend 36. Population growth is **placing exponential pressure on natural resources.**

Trend *37.* *Integration* of retainable development into **economic and** environmental policies is **occurring** rapidly.

International Developments
Federal Action
Private *Sector Response*
Natural Resource Accounting

Trend *38.* **Biodiversity is rapidly becoming ● polarizing subject.**

Genetic Diversity
Species Diversity
Ecosystem Diversity

Trend 39. *Climate change is receiving* more **attention** and **generating more controversy** than ever **before.**

Global Change Research
Scientific Debate
Domestic Action
International Developments

Economics

Trend 40. **Compliance costs continue to rise significantly.**

Federal Spending
Unfunded Mandates
Private Sector Expenditures
Industry Growth

Trend 41. **Although still rising, cleanup spending is poised to level off.**

Superfund
Department of Energy
Department of Defense
Department of the Interior

Trend 42. **Waste disposal and recovery costs are still rising rapidly.**

Landfill costs
Incineration Costs
Recycling costs

Trend 43. **Environmental market incentives continue to gain popularity steadily.**

Federal Activity
Permit Trading and Banking
Green Fees

Trend 44. **Governments are steadily privatizing.**

Trend 45. **Emphasis on developing, transferring, and exploring environmental technology is picking up swiftly.**

Technology Development
Technology Transfer
Technology Export

Trend 46. Support for the use of environmental cost-benefit analysis continues to vacillate.

Trend 47. Integration of international trade and environmental considerations continues to increase rapidly.

Basel Convention
North American Free Trade Agreement
General Agreement on Tariffs and Trade

Environmental Interests of the Public

Trend 48. Public support of environmental protection has plateaued.

Public Opinion
Public Behavior
Voluntarism

Trend 49. Environmental interest groups continue to grow stronger.

Membership
Counter-Movement
Funding
Cooperative Efforts

Trend 50. **Interest in environmentally friendly products continues to grow steadily.**

Consumer Preference
Environmental Labels
Environmental Claims
State Initiatives
International Initiatives

Trend S1. Environmental equity is increasing in priority rapidly.

Grassroots Support
State Support
Federal Support

Education and **Employment**

Trend 52. **Environmental Education** program **are** growing **steadily.**

Federal Action
Faculty Qualifications
Environmental Literacy
College and University Programs
Technical Training

Trend S3. **Demand for environmental professionals has softened significantly.**

Shifts in Workforce Composition
Educational Supply and Demand
Industrial Requirements
Non-Technical Requirements
Recruitment

Trend S4. **Certification and registration of environmental professional** is **proliferating.**

Safety and Health
Engineering
Earth and Atmospheric Sciences
Hazardous Waste
General Environmental

Energy

Trend 55. **Integration** of **energy policy** and **environmental quality continues steadily.**

Federal Policy
Shift in *Energy Sources*
Cogeneration

Trend 56. **Waste-to-energy capacity has leveled off.**

Trend 57. *Energy* **conservation** program **are** gaining *popularity* again.

Voluntary Programs
Mandatory Programs

THE EMERGING ENVIRONMENTAL ISSUES IN 1994

Ten phenomena, substances or ideas that appeared to be headed for prominence. The actual degree of prominence will be enhanced or retarded by interplay of many trends and factors. However, these items bear watching, since they could result in the need for major policy, fiscal and physical actions, perhaps 011 short time lines.

- Biotechnology Regulation
- Chlorine
- Electromagnetic Fields
- Environmental Hormones
- Fibers - Glass and Ceramic
- Life-cycle Assessment
- Light Pollution
- Methyl-tertiary-butyl-ether
- Sulfonylurea Herbicides
- Ultraviolet Exposure

A REAL-TIME ENVIRONMENTAL MONITORING SYSTEM

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The Army Environmental Policy Institute (AEPI) has established a Futures Group, other facets of which are described in the companion papers by Robert Jarrett and Peter Rzeszotarski. A key mission of the group is to scan "the environment" (i.e., external information sources) for information on potential environmental (i.e., natural systems) issues. This paper describes this still evolving environmental monitoring process initiated in 1995.

The AEPI monitoring process can be conceived in five steps:

1. Gather information
2. Filter information
3. Expand information
4. Report
5. Pursue actions

Information gathering combines internal Futures Group and distributed AEPI staff scanning. To date, most of the nominations for candidate emerging issues have been generated internally by the four-person Futures Group. We have, however, instigated a broader process involving the 30 or so participants in the AEPI professional community. Early meetings presented our idea for a monitoring system for group suggestions and modifications. We surveyed AEPI professionals to identify the newsletters and journals to which they subscribe -- an impressively broad set! We then established a process by which anyone in AEPI can submit an idea to the Futures Group for us to research. As described below, we also instituted mechanisms to share candidate issue suggestions, determine appropriate modes of probing them, and provide feedback.

We see benefits in a distributed monitoring system. First, this provides a larger set of eyes and ears to pick up signals of potentially important issues. The combined set of literature and contact sources is considerably greater than that of our four-person group. Second, involvement in the monitoring process enhances attention to the issues and prospects for effective follow up. Third, costs are minimal. Participants are simply asked to provide items to the core group who will do the further digging required. The system makes it easy to share items -- in person or electronically. It is also expendable to involve other Army and non-governmental parties at interest. This offers prospects of a wider network able to move quickly on early warning signals of possible environmental concerns.

Information filtering involves determining whether an issue relates to Army interests and whether it warrants further attention. Determining relevance to the Army entails simple screening by the Futures Group. Can we imagine a potential tie to Army interests or processes? Importance reflects the combination of likelihood and magnitude. How likely is this issue to become significant? Over what time frame? The AEPI charter provides responsibility for long range planning. So, in general, we are more interested in issues that are "over the horizon" than those well-recognized as current or imminent. Magnitude of an issue concerns its significance, particularly (but not exclusively) to the Amy. If a given issue were to develop in certain ways, would it seriously impact Army operations or interests? We also determine whether the issue is currently tracked in the AEPI ***Environmental Trends Update*** *(see* Jarrett's accompanying paper).

We enlist the larger AEPI community in reviewing issues for relevance and importance. We have established a Steering Committee (six AEPI senior staff and two external Army senior staff) whose guidance is particularly valued. Periodically (e.g., quarterly) we distribute an ***Emerging Issues Response Form*** to the Steering Committee and the AEPI staff at large.. This lists topics and specific trigger items, and requests a response on each item as to:

* ignore it
* enter it in a database for possible future investigation
* get me the source item for my personal review
* monitor the topic and assess policy implications
* profile the topic to identify the extent of activity
* analyze in some depth (prepare white paper)

We then cumulate responses and prioritize the candidate issues for further investigation.

Information expansion entails various possible activities. We seek expertise within, or outside, AEPI and key literature sources. In addition, we search pertinent electronic databases (e.g., en vironmentally oriented sources, technical databases, military databases, popular press) and scan the Worldwide Web for activity addressing the topic.

By using software being developed at Georgia Tech called the ***Technology Opportunities Analysis Knowbot (TOA Knowbot)*** (porter and Detampel, 1995), we are able to efficiently and effectively process large numbers of abstracts. The software allows us to count, filter, and relate key concepts. For instance, a current exploration of noise concerns uses the TOA Knowbot to facilitate understanding of the issues and their emergence:

- Search of target databases (e.g., ***NTIS, Engineering Index, DTIC Technical Reports)*** yields hundreds of noise-related abstracts
- Tabulation of the key words (subject index terms, title words) quickly indicates various related technologies and issues
- Co-occurrence matrices show how terms associate (i.e., when two terms often occur together in given records, there is evidence of association). Analysis of these matrices provides relevance scores (e.g., a ranking of how closely various terms associate with noise) that can aid in further searching on the target issue or specific related issues.
- Co-occurrence patterns can be translated into issue and/or technology maps. In the noise case, this helps sort related issues into domains such as noise abatement technologies, legal initiatives, health research, and so forth.
- One can readily identify who is actively engaging particular topics (e.g., noise abatement); this can serve to initiate networking with particular institutions or individuals
- Issue tracking over time is achieved by profiling how issue maps vary over time (e.g., in the mid-1980's perhaps most of the discussion linked to noise concerns legal initiatives; in the mid- 1990's perhaps one sees new considerations such as particular mitigation approaches. Such contextual trends can inform forecasting as to what to anticipate in the coming years.
- Issue profiling over regions or nations is also accomplished by categorizing the records and their attendant terms by locale (e.g., European articles concerning noise emphasize certain aspects differently than in America).

Interpretation of such information aids in ascertaining the potential course of development of an issue. It also provides away to determine how issues interlink which can be suggestive of potential policy actions.

Reporting can take several guises. Our simplest is a 1-2 page synopsis of what seems to be going on. To date, these seem the best form for feedback to AEPI and our Steering Committee, allowing them to grasp the issue quickly and suggest appropriate further actions (or inaction). The next stage is to pursue in-depth analyses tailored to the topic and its particular sensitivities. Inclusion in the ongoing ***Environmental Trends Update is*** a recourse. Generation of focused forecasts or impact assessments is another possibility.

Pursuing actions entails consideration of policy options and implications. In other words, examination of alternative actions, to varying degrees of detail, can lead to policy recommendations. At a simple level, our interpretation of the issue of chemicals inducing hormonal reactions is to issue a brief issue alert to the Army Secretariat. This alleges that the issue could vitally affect Army interests and suggests major analysis is warranted to identify specific chemical issues and potential remedial actions before legislative or regulatory impositions.

Performance of the AEPI environmental monitoring system to date is modestly successful. AEPI, a young agency, has been under diverse pressures that make it difficult to establish robust procedures. Nonetheless, initiation of the monitoring process has facilitated consideration of emerging issues that otherwise could "fall between the cracks" as no one's responsibility. Tuning of the monitoring process will be needed to engage busy professionals within, and outside, AEPI. We see significant potential payoffs from accomplishing this.

Reference

A.L. Porter and M.J. Detampel, "Technology Opportunities Analysis," ***Technological Forecasting and Social Change 49,237-255, 1995.***

STATE AND REGIONAL FORECAST METHODOLOGY

Chair: Paul R. Campbell
U.S. Bureau of the Census

An Interactive Exert System for Longterm Regional Economic Projections,
Gerard Paul Aman, Bureau of Economic Analysis

How Accurate Were the Census Bureau's State Population Projections
for the Early 1990's?,
Paul R. Campbell, U.S. Bureau of the Census

California's Growing and Changing Population: Results from the Census
Bureau's 1996 State Population Projections,
Larry Sink, U.S. Bureau of the Census

AN INTERACTIVE EXPERT SYSTEM FOR LONGTERM REGIONAL ECONOMIC PROJECTIONS

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I. Introduction

The Bureau of Economic Analysis (BEA) publishes longterm regional economic projections for a variety of economic data, including gross state product, employment, and earnings by industry, population by three broad age groups, and total personal income. These projections, which are based upon extrapolations of historical trends, are updated every five years. The most recent set of State and national projections was published in July 1995./[2]/ Substate projections (Metropolitan Statistical Areas and BEA Economic Areas) consistent with these projections are due to be published in June 1996.

An ongoing effort within BEA seeks to improve the methodologies upon which the longterm projections are based. As a part of this ongoing effort. the longterm projections now use a midterm econometric model known as N RIES II/[3]/ to establish the projected paths to the year 2000 for all projected variables./[4]/ This report describes recent improvements made to the other major part of the longterm projections system: the development of an expert system that was used to identify and quantify trends in historical data series, and to extrapolate the trends from 2000 to 2045.

In the past, BEA's preliminary, mechanically-generated projections have been reviewed and, when necessary, adjusted, by a team of very experienced analysts using powerful computerized tools for the graphical review and adjustment of the huge quantities of historical and projected data. This intensive review and adjustment of the preliminary projections mitigated the occasionally unsatisfactory performance of the relatively naive extrapolation algorithms that generated the preliminary projections. The team of regional economists that produced the 1990 edition of BEA Regional Projections/[5]/ had an aggregate century of experience, with individual analysts having an average of more than fifteen years of experience in preparing longterm projections. Moreover, analysts were assigned continuously to specific multi-State regions that they got to know in detail, often establishing professional relationships with university or State government economists in their assigned regions. After the 1990 edition of longterm projections was published, however, a combination of retirements. resignations. and reassignments caused the aggregate experience of the team of projection analysts to fall from nearly a century to just twenty years, *all* of which was represented by a single remaining experienced analyst, with the rest of the team made up of newly-hired economists with no projections experience whatsoever.

The development of the current expert system was a response to this diminished experience level. Before the acquired experience of the veteran team of regional economists was forever lost to BEA, an attempt was made to capture at least part of that valuable expertise by constructing a computerized expert system that would attempt to analyze historical timeseries data the way an experienced analyst would. Such an expert system would serve several valuable purposes. First, and most obviously, the expert system would serve as a repository, however crude, of analytical experience that would otherwise be lost, only to be regained through years of error-prone "learning by doing." (Psychologists have estimated that "in virtually any complex activity, it takes a minimum of five thousand hours to turn a novice into an expert. That is about two years of full time effort."/[6]/ The relevance of this for the regional

projections is significant, given that newly-hired analysts are immediately assigned to tasks that had previously been handled by experienced veterans.)

Second, by systematically evaluating historical dataseries according to a set of mathematical judgement algorithms, the expert system **could** have great heuristic value by showing inexperienced analysts what to look for in noisy regional **timeseries data,** and how to weigh the often conflicting information the data contain. That is, the expert system **could** be used as a training tool to teach new analysts how to look at data the way a veteran of long experience might, thereby enabling them more quickly to achieve the level of competence needed to review and adjust preliminary projections.

Third, the expert system **could be** used to generate a high quality set of preliminary **longterm** projections. Higher quality preliminary projections requiring less frequent adjustment **would** allow the **less-**experienced reviewers the time they need to focus on, and to delve more deeply into, the remaining anomalous cases (by examining comment files containing special information about plant openings and closings, strikes, droughts, floods, and other nonperiodic events; searching newspaper and magazine databases; calling State-level analysts; and so on) to specify reasonable projections for the difficult cases that mechanical techniques are still unable to handle satisfactorily.

II. Longterm Regional Projections System/'/

BEA's **longterm** regional economic projections system is a top-down system. This means that any data to be projected for the States (or, at later stages in the projections process, for Metropolitan Statistical Areas or BEA Economic Areas) must first be projected for the Nation. These national totals are then distributed to the States on the basis of extrapolated State shares-of-the-Nation and various relatives-to-the-Nation, rather than absolutes. Preparation of the national totals that serve as controls on the State-level projections is a long and detailed process that, while very interesting in its own right, is not direct l y germane to the issues covered in this paper. For our **current** purposes, we can simply assume that a consistent set of national totals for all data to be projected for the States has already **been put into place.**

The flow diagram **(figure I) on** the next page is a schematic representation of the **longterm** projections system. Three types of objects are displayed in the diagram:

1. Data contained in boxes that look like a sheet of paper with a IiRed-up comer are projected national totals that need to be in place before the State-level projection system can be run. These data are commonly referred to as ***national control totals.***

2. **Data** in the heavy-bordered rectangles are **shares-**of-the-nation and relatives-to-the-nation that express the relationship between a State-level datum and a national-level datum. These data are common l y **referred to as** ***linkage variables,*** because they I ink **State** data **to** the nation and/or to other State data.

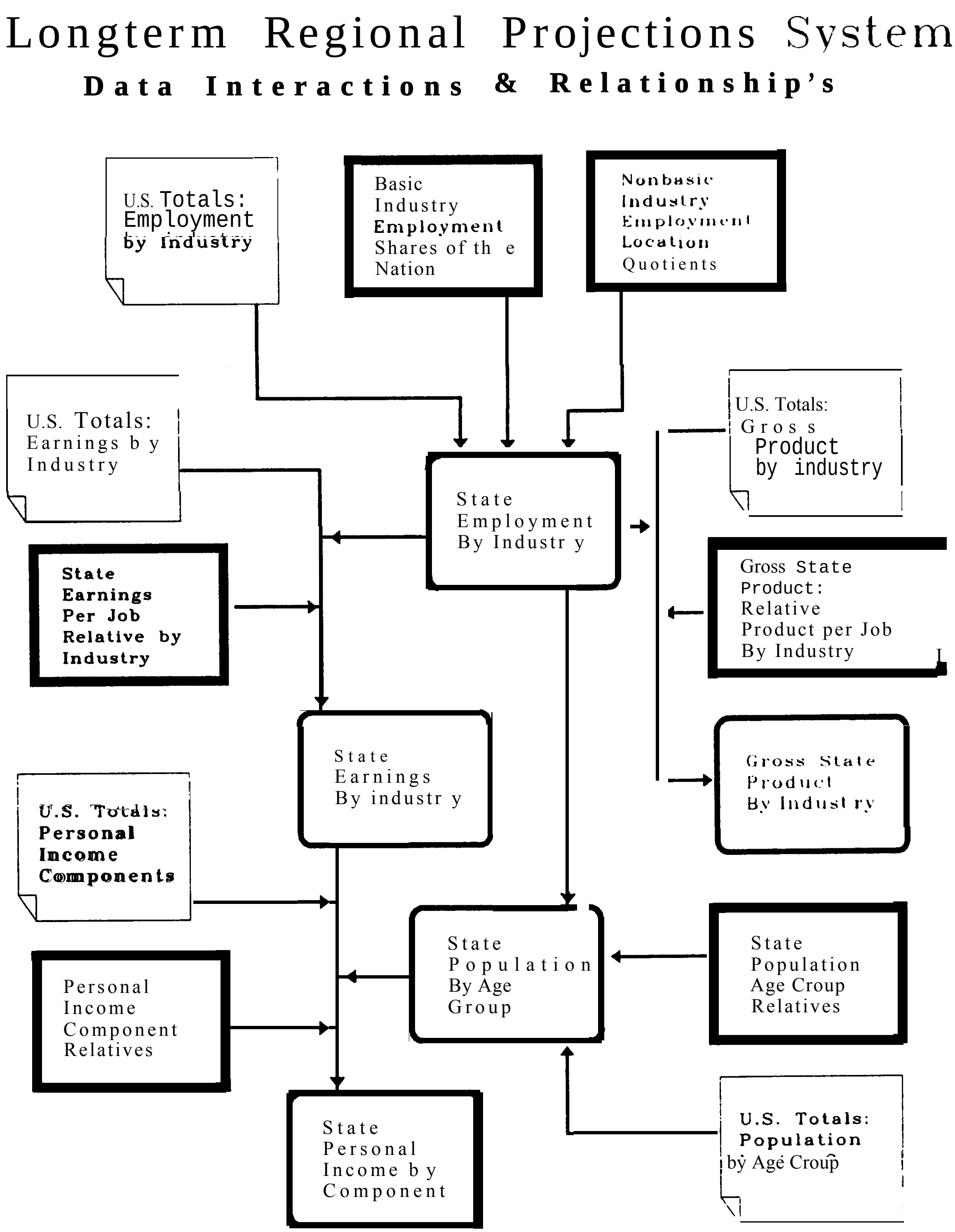
3. Data contained in boxes with dark gray borders and rounded comers are the projection system's output. These are the projection system's ***output data,*** not to be confused with the fact gross state product, a measure of ***output*****, is** itself one of the projection system's output variables.

Given a set of national control totals for all **data,** a set of extrapolated linkage variables allows the system to be solved for the set of output data. The function of the expert system is to generate the extrapolated set of linkage variables that are used to distribute the previously-projected national control totals to the States.

The following list enumerates in more detail the information contained in the flow than. The five types of output data are produced by the projections system are listed below as subheadings I through 5. Beneath each of the five output data are the I inkage variables that need to be extrapolated in order to derive the State-level value of the output datum from the national control total.

1. Employment by industry:
   Basic industry shares of the nation.
   Nonbasic industry location quotients.

Figure 1.


Longterm Regional Projections System
Data Interactions & Relationship's
U.S. Totals: Employment by Industry
Basic Industry Employment Shares of the Nation
Nonbasic Industry Employment Location Quotients
U.S. Totals: Earnings by Industry
State Employment By Industry
U.S. Totals: Gross Product by industry
State Earnings Per Job Relative by Industry
Gross State Product: Relative Product per Job By Industry
State Earnings By industry
Gross State Product By Industry
U.S. Totals: Personal Income Components
Personal Income Component Relatives
State Population By Age Group
State Population Age Croup Relatives
State Personal Income by Component
U.S. Totals: Population by Age Croup

2. Earnings by industry:
   Earnings per job relative to the nation.
3. Gross State Product by industry:
   Gross product per job relative to the nation.
4. Population forthree broad age-groups:
   Population (18-64)ratioto total employment relative to the nation.
   Population (O- 17) ratio to population (18-64) relative to the nation.
   Population **(65+)** ratio to population (O-64) relative to the nation.
5. Total personal income
   Contributions ratio to total earnings relative to the nation.
   Net earnings residence adjustment ratio.
   Relative per capita property-type income.
   Relative per capita personal transfer payments.

III. A Generalized Extrapolation Equation

The **longterm** projection system uses a generalized nonlinear equation to extrapolate historical timeseries into the projection period, except in relatively rare cases where some other system constraint comes into play. A brief discussion of this extrapolation equation is necessary before describing the workings of the expert system.

The extrapolation equation that we need is one that expresses projected values of an extrapolated variable as a **function** of information contained in the historical timeseries for the variable (together with a counter indicating the projected time period). In its most general form, the extrapolation equation takes the form:

$$1: \quad X_{t+n} = f(X_1, X_2, X_3, \ldots, X_t, n)$$

where:

X_{t+n} = a value of X extrapolated n time periods into the future.

$X_1, X_2, X_3, \ldots X_t$ = the historical values of X.

n = a counter indicating the number of time periods forward from t.

This very general function can be restated in a more usable form by formulating it in terms of information derived from (and thus entirely contained within) the historical timeseries values, instead of the actual values themselves. In this more useful formulation, we replace the **timeseries** values themselves with three arguments that are themselves functions of the historical timeseries values: a ***slope*** by which the value will be extrapolated, a ***damping factor*** which determines the degree of nonlinearity of the extrapolated path, and an ***initial value*** (common l y referred to as the "jump off" value) for the extrapolation. where:

$$2: \quad X_{t+n} = f(X_j, B, D, n)$$

X_j = a "jumpoff" value for datum X.

B = a slope to be extended into the projection period,

D = a "damping factor" between zero and unity,

n = number of time periods.

It is important to note that this function's arguments (X_j, B, and D) are themselves functions of the historical **timeseries** values that we want to extrapolate, so that equation 2 is in fact equivalent to equation 1.

The final step in making the extrapolation equation into a usable tool rather than just a theoretical generality is to give it a specific form that will enable us to compute the extrapolated values. There are, of course, an infinite number of possible ways to specify the form of equation 2. The form that is given below has been used in a number of applications in BEA both for extrapolation and (with some algebraic rearrangement of terms) for nonlinear interpolar ion. The explicit form of the extrapolation equation is derived as follows:

Let X_j, B, and D be defined as above. The next period value for X can be found simply by applying a constant slope value to the jumpoff value:

$$X_{j+1} = X_j + B = X_j + B * D^0 \quad \{ 0 \leq D \leq 1.0 \}$$

And extrapolated values for succeeding time periods can be derived in similar fashion by always adding the constant slope value times a geometrically shrinking darnping factor:

$$X_{j+2} = X_{j+1} + B * D^1 = X_j + B * D^0 + B * D^1$$

$$X_{j+3} = X_j + B * D^0 + B * D^1 + B * D^2 = X_j + B * (D^0 + D^1 + D^2)$$

$$\cdots$$

$$X_{j+n} = X_j + B * (D^0 + D^1 + \ldots + D^{n-1})$$

Which leads to the generalized extrapolation:

3: $$X_{j+n} = X_j + B * \sum_{i=0}^{n-1} D^i$$

equation:This equation allows any datum to be extrapolated indefinitely into the projection period, given a **jumpoff** value (X_j), slope (B), and damping factor (D). It is easy to see that in the limiting cases, if D = O, then the resulting extrapolation is a horizontal line with all values equal to the **jumpoff** value X_j. **and** if D = 1 then the extrapolation is a straight line with slope = B. The application of this extrapolation equation in the **longterm** projection system has been described **elsewhere,/[8]/** but **suffice** it to say that by judicious specification of the few parameters upon which the **function** depends, an infinite family of nonlinear extrapolation lines can be generated.

IV. Expert System for Longterm Projections

The function of the expert system for **longterm** projections is to examine historical dataseries according to a number of evaluation rules and, on the basis of those rules, **identify** the slope (B) and damping factor (D) to use in extrapolation equation 3, in the previous section. **The** expert system can also be configured to identify the **jumpoff** value, but in its current application, the jumpoff values for all **projected variables are determined by a separate, but l inked, midterm econometric** model, **NRIES** 11.

Expert Systems

An *expert system* is a computer program that approaches a specific, usually **compl icated, task** the way a human expert would, bringing **to** bear **on** a problem the sorts **of judgments** and insights that a human usually acquires only **after** years of training and experience.

> An expert system is a program that relies on a body of knowledge to perform a somewhat difficult task **usually** performed by a human expert. The principal power of an expert system is derived from the knowledge the system embodies rather than from search algorithms and specific reasoning methods. . . . Expert systems have been **particularly** welcome in fields where existing experts are expensive and in short supply./[9]/

Expert systems have achieved a wide degree of acceptance in the fields of accounting and **finance,/[10]/** but they have also been applied in such widely diverse areas as awarding environmental **permits,/[11]/** processing federal tax returns/[12]/ and Social Security **claims,/[13]/** controlling the casting processes in an aluminum **foundry,/[14]/** trouble-shooting malfunctioning commercial jet **engines,/[15]/** designing object-oriented databases,/[16]/ and performing medical **diagnoses./[17]/** What these and other applications of expert systems typically have in common is that they deal with complex, but narrowly focused, problems that can be analyzed logically and algorithmically, given a knowledge base upon which to evaluate a (sometimes, but not *necessarily) large* set of formal rules. In the case of an environmental permit, for example, the rule set may consist of a statutory, and therefore well defined, collection of bureaucratic standards, forms, and procedures. The sorts of problems that are amenable to solution by expert system technology, according to one commentator. are characterized by the **following:/[18]/**

(1) There are recognized experts.

(2) The experts are probably better than amateurs.

(3) The task takes the expert a few minutes to a few hours.

(4) The task relies on logic.

(5) The skill is routinely taught to neophytes.

These five characteristics describe quite well the sort of work performed by the veteran projections analysts in BEA, so the development of an expert system appeared to be a reasonable response to the impending replacement of a team of wizened veterans of long experience by a team of newly-hired analysts with no experience in the preparation of longterm regional economic projections.

An expert system is built upon a set of decision rules that determine the outcomes that should result from a given set of facts. The field of expert systems, one of the more plebeian and workaday branches artificial intelligence, has developed a specialized jargon of its own. For example, the knowledge base upon which the decision rules depend is called the "domain knowledge," and the experts who have that knowledge is called the "domain experts." Developing an expert system requires a "developer" to CO I lect and organize the domain knowledge by interviewing domain experts and gathering whatever secondary documentation may exist, such as manuals, flow charts, notes and memos, sometimes even scraps of paper taped to walls or buried in desk drawers. This information gathering process, called "knowledge capture" or "knowledge acquisition," quantifies the domain knowledge upon which the expert system relies, and so it is clearly a crucial part of the development process. This transfer of knowledge from human experts (who may not completely understand or be able precisely to articulate the internal processes by which they form their judgments) to a computer program (which requires these processes to be stated with mathematical precision) often represents a major bottleneck in the development of expert systems./[19]/

Developers range from very experienced programmers, to skilled knowledge engineers with nominal programming experience, to experts with little computer experience wishing to implement their knowledge. While one individual may have all of these skills -- expertise in a domain, abstract representation abilities. and programming experience -- a more likely scenario is the formation of a team with a combination of these ski lls./[20]/

In the current case, the developer. the author of this paper. was both a domain expert (the sole remaining veteran projections analyst in BEA after the other experienced anal ysts were replaced by new hires) and an experienced programmer who has developed many large graphical and interactive computer systems for BEA, all of which considerably facilitated the development of the present expert system.

Evaluation Rules

The expert system for regional economic projections evaluates at least nine, and as many as fourteen, criteria, or "rules." for each data series to be extrapolated. These rules are an expression of what sorts of things veteran projection analysts take into account in the extrapolation of any historical timeseries. The actual number of evaluations performed for each series varies according to the type of data being extrapolated (mainly, whether it is a share or a relative), and the evaluation of some rules may require the further evaluation of other sub-rules. As the system is used and our experience with it grows, it is expected that additional rules may be added and existing rules may be modified as we discover cases not adequately handled by the current rule set. The enumeration of these rules represents the first part of the "knowledge acquisition" phase of the expert system development. (The second part of the process. discussed below. required that values be specified for the more than twenty parameters that determine the way in which the rule set is evaluated.) The evaluation rules were developed through many hours of discussion with. and observation of, expert regional economists as they looked at and considered the reasonableness of hundreds of individual projection lines (using powerful graphical review computer software also developed by BEA), combined with both empirical research/[21]/ and some amount of trial and error experimental ion. It is also important to remember that the current system is not portrayed as a

final and finished product that will never need to be expanded or modified. Although the system as currently configured performs remarkably well in most cases, it is both hoped and expected that as it is used and as our experience with it grows. areas for improvement will be discovered. The nine main evaluation rules in the system are the following:

1. Identify the **outliers** or level **shifts** in the historical dataseries. This identification depends upon a **user-settable** parameter.

2. Determine the overall "noisiness" of the historical dataseries, based upon the evaluation of the **outliers** and level shifts .

3. Find the trends in the remaining data values **after** accounting for **outliers** and level shifts. This is accomplished by the ***optimum segmentation*** of the remaining data values. The process of optimum segmentation is described in a later section.

4. Evaluate how well the optimum segmentation performed in identifying trends in the historical data. That is, **after** accounting for **outliers** and **level-shifts,** are the remaining data segments still relatively noisy or are smooth trends identifiable?

5. Combine the identified historical trends into an overall slope value to be used in the extrapolation equation, taking into account both the persistence (length) of the trends and the vintage (age) of the trends. The combination of individually identified segment trends into an overall slope is determined by a weighting scheme that can be modified by the system user.

6. Determine whether the most recent historical trend in the series confirms or contradicts the assessment of the overall slope of the series as determined in step 5, and adjust the overall trend assessment accordingly.

7. Determine the type of data series being considered:

a. If it is an employment series, then determine whether the industry is a basic industry or a normally nonbasic **(residentiary) industry./22/** If it is a nonbasic industry, **thevalue** of the industry's location quotient is evaluated to determine whether the industry to be treated as a basic industry rather than as **residentiary**.

b. If the data series is to be extrapolated as a relative (such as earnings per job relative to the nation), determine which special rules may apply for this particular relative.

8. **Determine whether the overall slope** of the series relatively steep or relatively flat when compared to the recent levels of the data, and adjust the nonlinearity of the extrapolation accordingly.

9. if the series is to be extrapolated as a relative (such as earnings per job relative to the State). then

a. **Determine whether the value is diverging from or converging toward unity** in the projection period, and adjust the projection ' nonlinearity factor appropriately.

b. Determine whether the historical values have usually been within in a relatively small neighborhood of unity. If so, adjust the projection nonlinearity factor to force the extrapolation to remain near that neighborhood of unity.

c. Determine whether recent historical values are on the opposite side of unity from where they have usually been historically. If so, adjust the extrapolate ion non **linearity** factor to constrain the further divergence of the relative from unity.

Evaluation Rule Parameters

Each of the above expert system evaluative rules is associated with at least one. but as many as eight, **user-settable** parameters that determine the **rule's** impact on the extrapolation of a particular dataseries. **While** the evacuation **rules** determine ***what*** is examined by the expert system, ***how*** the **rules** are **evaluated** depends upon the **values** assigned to a set of twenty parameters associated with the evacuation rules. The task of assigning **values** to the parameters associated with the evaluation rules constitutes the second half of the knowledge acquisition process for **the** expert system.

The following iist briefly describes the parameters that are associated with the expert system's evacuation **rules:**

Base_Serv_Tol.-- This sets the cutoff level for LQ's, above which normally nonbasic industries will be treated as basic instead of residentiary. This parameter applies only to employment projections.

Outlier_Factor.-- This is the tolerance factor for identifying outliers and level-shifts in the historical series. The application of this parameter is described below in the discussion of the process of optimum segmentation.

Max_Seg_Num --- This parameter sets the maximum number of segments that may be included in the computation of the overall historical slope for any timeseries.

Min_Seg_Len.-- This determines the minimum length that a segment must have before it can be included in the computation of the overall slope. This parameter also determines whether a particular segment can be subdivided into smaller segments in the search for historical trends, as will be described in the section on optimum segmentation.

φ_1, φ_2, φ_3, φ_4.-- The age-weights assigned to the slopes identified in historical timeseries segments. These weights are required to sum to unity. These weights cause the more recent segments of the timeseries to be more heavily weighted than earlier segments.

γ_1, γ_2, γ_3, γ_4--- The persistence weights assigned to the slopes identified in historical timeseries segments. These weights also are required to sum to unity. These weights cause the longer segments of the timeseries to be more heavily weighted than shorter segments.

NumSegs_Factor. -- This determines the degree to which the presence of outliers and level shifts in a historical series reduces the value of the damping factor that is applied in the extrapolation equation.

Noise_Factor.-- This determines the degree to which the noisiness of the optimized historical segments (*after* accounting for outliers and level-shifts) reduces the damping factor. The previous parameter accounts for major swings in the overall timeseries. This parameter accounts for the noisiness within individual timeseries segments.

RelSlope_Factor.-- This parameter adjusts the nonlinearity factor that is applied in the extrapolate ion equation so that very rapidly growing or declining projected values will be damped more severely than relatively flatter extrapolations.

RecentHist_Factor.-- This parameter determines the degree to which a contrary most-recent-historical slope causes the damping factor in the extrapolation to be adjusted downward to reflect a conflict in sign (direction) between the expert system's assessment of the overall slope of the historical timeseries and the slope of the most recent historical segment.

Divergence_Penalty --- This parameter applies only to variables extrapolated as relatives that would not be expected to diverge very greatly from unity in the long run. The parameter determines the degree to which these relatives are allowed to continue to diverge from unity. Continued divergence from unity by these relatives is not eliminated, but only restricted by reducing the damping factor in the extrapolation equation. This parameter is not applied to the extrapolation of gross product per job.

Convergence_ Boost. -- This parameter is somewhat the inverse of the previous one. In the case of relatives that would be expected to converge toward unity in the long run, this parameter reduces the effects of other parameters that might have dampened the tendency of the extrapolation equation to dampen the convergence. Like the previous parameter, this does not apply to relative product per job in the extrapolation of gross state product.

Unity_Horizon. -- This parameter identifies a range in a small neighborhood of unity. In cases where relatives have historically been mainly within this range, the damping factor of the extrapolation equation is adjusted to discourage the relative from leaving the range in the projection period, although it could still do so in the case of a strong enough trend. This does not apply to GSP extrapoiations.

Unity_ Fence--- This parameter determines the number of times a relative needs to be on the other side of unity from the jumpoff value in order to be severely discouraged from diverging from unity. That is. if a relative has almost always been above (or below, in the

opposite case) unity, but the jumpoff value (first projected value) is below (or above, in the opposite case) unity, the relative is discouraged to diverge further from unity.

Last_3_Years_Jumpoff_Factor.-- This parameter is used to set the jumpoff (first extrapolated) value for a variable. The jumpoff value can be constructed as a weighted average of the last three normal values (where "normal" means that none of the three values can have been identified as an outlier), and this parameter determines the relative weights given to the three values. This parameter was used only in early versions of the expert system, because the jumpoff values for all variables were ultimately determined by a midterm econometric model (NRIES II).

Assigning Values to Evaluation Rule Parameters

Specific values were assigned to the evaluation rule parameters by the veteran team of projections analysts. The analysts were given working copies of the expert system that allowed them to specify parameter values interactively, and to see immediately what extrapolation resulted from any parameter values that were specified. Through a long process, first of trial and error and then of successive refinement, using an informal Delphi approach/[23]/ with each of the experts trying alternative parameter values and viewing the results, a parameter set was finally arrived at that yielded extrapolations that were agreeable to all veteran team members. (It should also be noted that during the process of setting parameter values, the set of evaluation rules itself was also being altered, as the team of experts suggested additions, deletions, and modifications to both the evaluation rule set and to the parameter set.) The ability to get the opinions of a group of experts, both with regard to the evaluation rules and (perhaps more importantly) with regard to the parameter values that govern the rules' operation, was an important part of the design and implementation of the current expert system. Indeed, the ability to draw upon the expertise of a group of experts, rather than having to rely upon the judgement of just a single individual, has been viewed as a significant resource for expert systems. It has the following benefits:

- Using multiple experts will increase the validity of the knowledge base and, as a result, the consistency of inferences will be provided.
- The understanding of the domain knowledge increases because of the reliability provided by consensus across experts.
- The content of the knowledge base is more complete. Most relevant subdomains, and most specialized knowledge in the subdomains is included.
- Assurance that the facts that are included in the knowledge base are relevant and important.
- The understanding of the domain knowledge is enhanced through group discussion and clarification.
- Group productivity can be both quantitatively and qualitatively superior to that of an average individual (provided the group process is properly managed).
- Groups can usually recognize and reject incorrect solutions and suggestions to a higher degree than individuals.
- A group of experts can be used in solving problems where the domain is so broad that no one individual's expertise spans the entire domain.
- More complex problems can be solved. /[24]/

The Graphical User Interface

The process just described, in which a team of experienced regional analysts used the expert system interactively to set the systems parameters, was made possible by an intuitive graphical user interface/[25]/ that allowed the analysts to adjust any of the system's parameters and to see immediately the effect of the changes on the resulting projections. Figure 2 shows the main screen that is displayed to the user when he first starts the system./[26]/ From this screen the user can select any of a series of scrolling menus that enable him to display a graph (either logarithmic or linear) of the current projection any industry or region and for any datatype (earnings, employment, gross product. population, personal income). The user can also scan forward or backward through either regions, industries, or datatypes by clicking on left and right arrows attached to the graphical boxes across the top of the screen.

The group of graphical controls at the bottom of the screen is a collection of mouse-operated sliders and buttons that enable the user to

change the values assigned to some of the system's parameters. Additional sets of controls are presented to the user when he clicks on the button containing a ***wrench*** icon, in the button panel on the left of the screen. By clicking several times on the wrench-icon button, the user can cycle through a series of w indows containing the **full** set of controls available to him for altering the systems parameters. Figures 3 and 4 present the same screen that is shown in figure 2, except that the wrench-icon button has been clicked, so different sets of parameter-control devices have been displayed at the bottom of the screen.

By using the mouse to manipulate the parameter-control devices on the screen, the user can alter any of the twenty parameters that determine the way the system's evaluation rules operate. Moreover. the reaction of the system to parameter changes is immediate. That is, the user sees right away the impact of any parameter changes, as the projection for the current industry, region, and datatype is recomputed on the basis of the new parameters, and redisplayed.

The analysts using the expert system can also suggest changes in the set of evaluation rules that are included in the system. Altering the system's set of evaluation rules, however, is not quite so automatic as is changing parameter values. Adding, deleting, or **modifying** the operation of evaluation rules requires the system developer to alter the program's computer code, a process that never required more than a few minutes.

The characteristics of the graph window are controllable by the user in a number of ways. Figure 5 shows a graphical control menu that pops up when the user clicks on the axis-icon button, just below the wrench-button in the button control panel on the right of the screen. This menu allows the user to display the graph in either linear or logarithmic mode, to turn tic-marks on or off, and to control the length of the x-axis of the graph.

Figures 6 and 7 display the scrolling menus that enable the system user to go directly to any selected industry or region. These menus pop up when the user clicks on the words ***State*** or ***Industry*** in the graphical boxes across the top of the screen. The State, industry, datatype, and extrapolation variable currently being plotted on the graph are displayed in the boxes across the top of the screen. Clicking on the small white left and right arrow buttons allows the user to scroll forward or backward through the States, industries. and datatypes.

Figures 8 and 9 both display the same information, a graph of the historical timeseries for Alabama farms employment share of the nation. (Two projected values appear just as dots, because the length of the X-axis has been set to extend just to 2000.) In figure 9, however, the ***OLS Slopes*** feature of the program has been turned on by clicking the ON button under the label "OLS Slopes" in the button panel on the right of the screen. The resulting graph display now shows the same information as before, but now a number of OLS regression lines through the historical data are superimposed over the plot of the historical data. These regression lines are the ones that the expert system has determined best represent the trends in the historical dataseries, after accounting for data outliers and level-shifts. The identification of the trends is based upon a process called *optimum segmentation*. a process which is described below.

Several other features of the expert system interface make it very easy for the users to operate. The system allows users to display the data not just as plots, but also as tables (by clicking on the *table* icon-button in the button panel on the right of the screen). The user can print any of the graphs or tables being displayed, by clicking on the ***fan-fold paper*** icon-button. Clicking on the ***question mark*** icon-button pops up an extensive help menu. Many of the features incorporated into the interface screens of the expert system were borrowed directly form other graphical computer systems that had been developed previously for use by BEA analysts. The various buttons, sliders, and scrolling menus operate in this system just as they do in other graphical data-review programs that the BEA analysts were already familiar with, so the users of the expert system were able almost immediately to feel comfortable with the system's operation.

Which computer programming language to use

to develop an expert system, or whether instead to use **a commercial expert system-development shell as a** development tool, is a controversial subject among expert system **developers,**/27/ and vocal partisans can be found for each of the many competing positions.

In the current case, the **expert system was built using Turbo** Pascal for DOS and implemented entirely on networked PC-compatible (486) computers. Turbo Pascal was used not necessarily because it was the best possible tool, but rather because BEA economists have been using that language for several years and thus had achieved a high level of competence in system development using Turbo Pascal.

Figure 2.

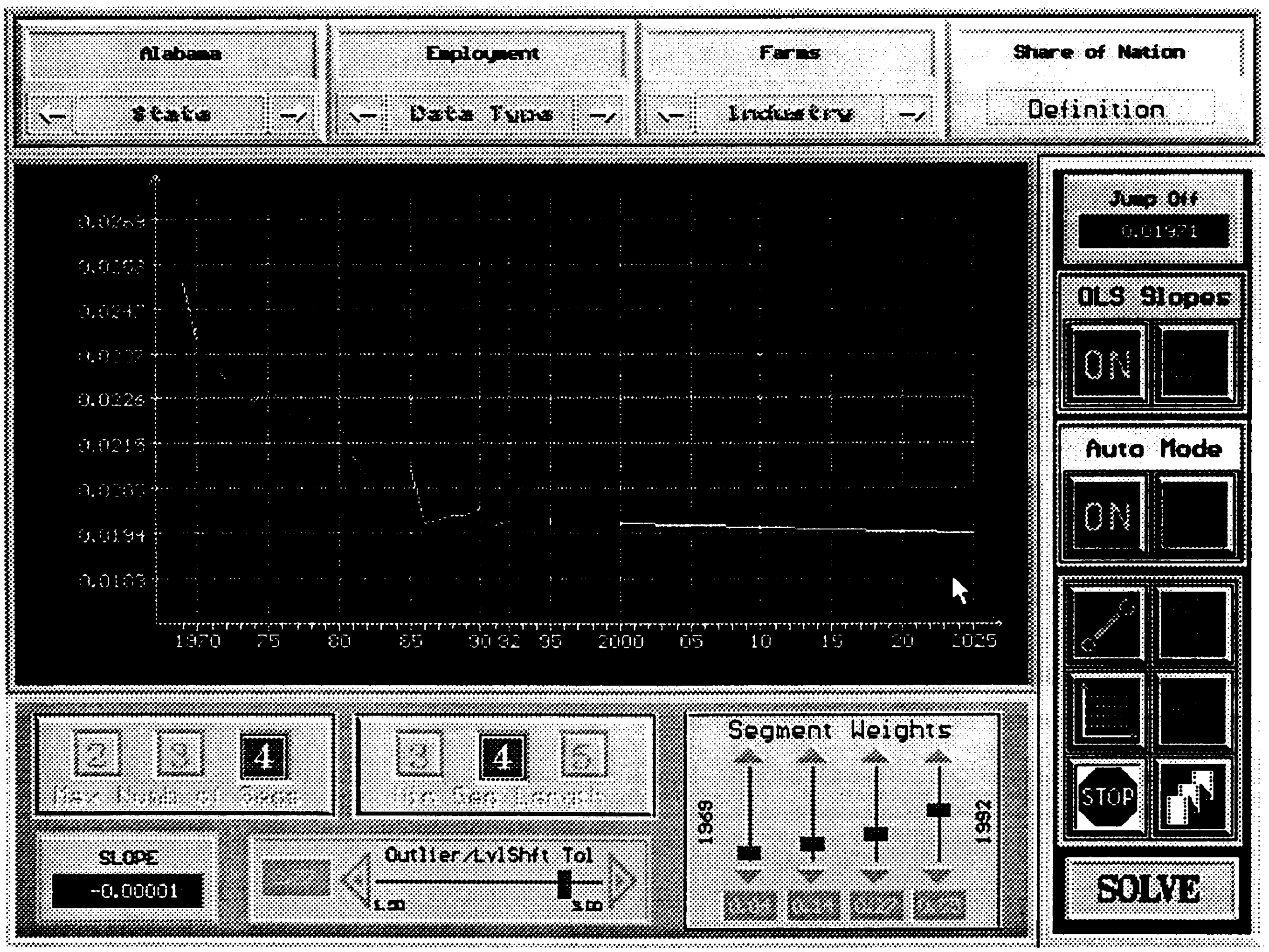
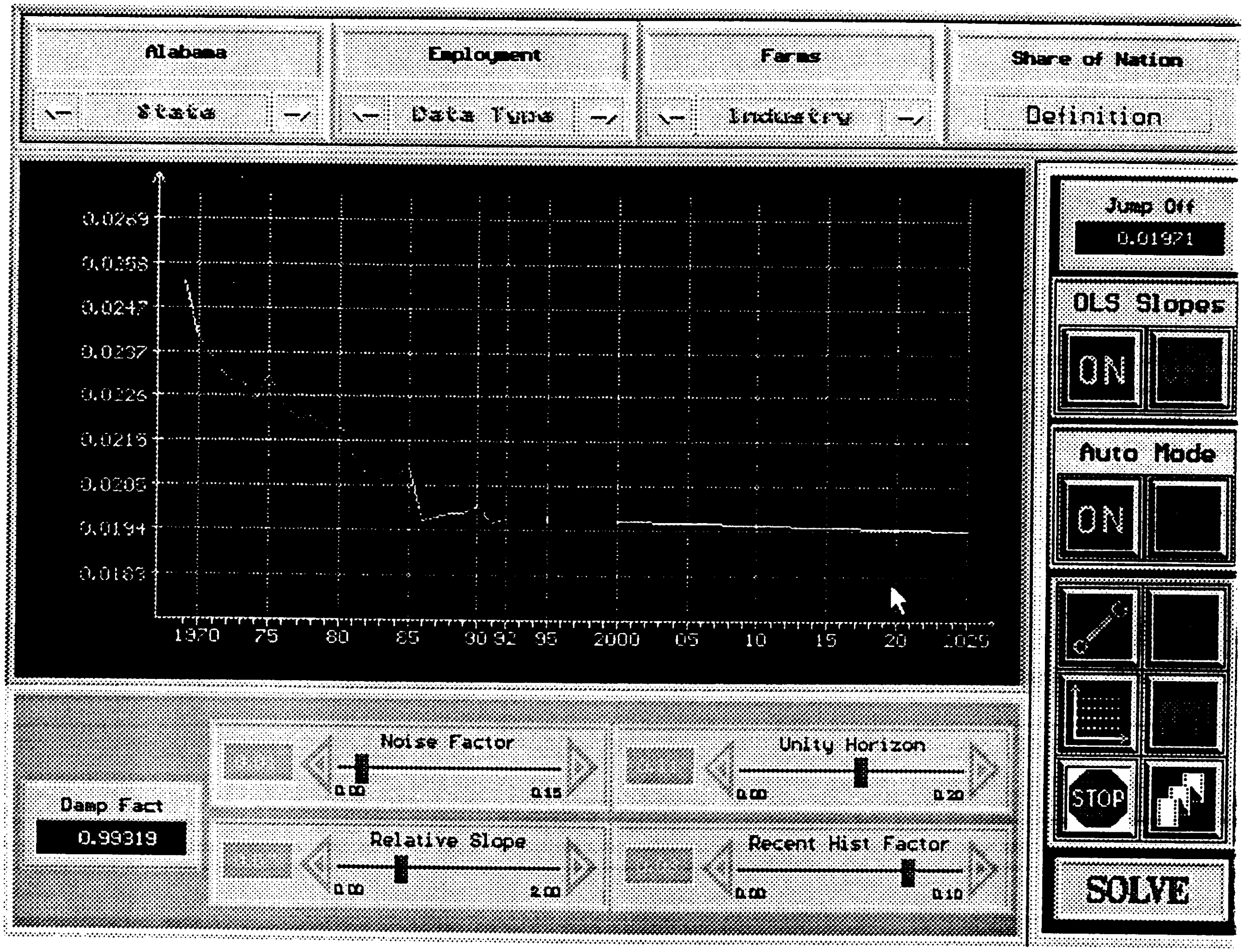


Figure 3.



Alabama
State
Employment
Data Type
Farms
Industry
Share of Nation
Definition
Jump Off
0.01971
OLS Slopes
ON
Auto Mode
ON
STOP
SOLVE
0.0269
0.0258
0.0247
0.0237
0.0226
0.0215
0.0205
0.0194
0.0183
1970
75
80
85
90 92
95
2000
05
10
15
20
2025
Noise Factor
0.00
0.15
Unity Horizon
0.00
0.20
Damp Fact
0.99319
Relative Slope
0.00
2.00
Recent Hist Factor
0.00
0.10

Figure 4.

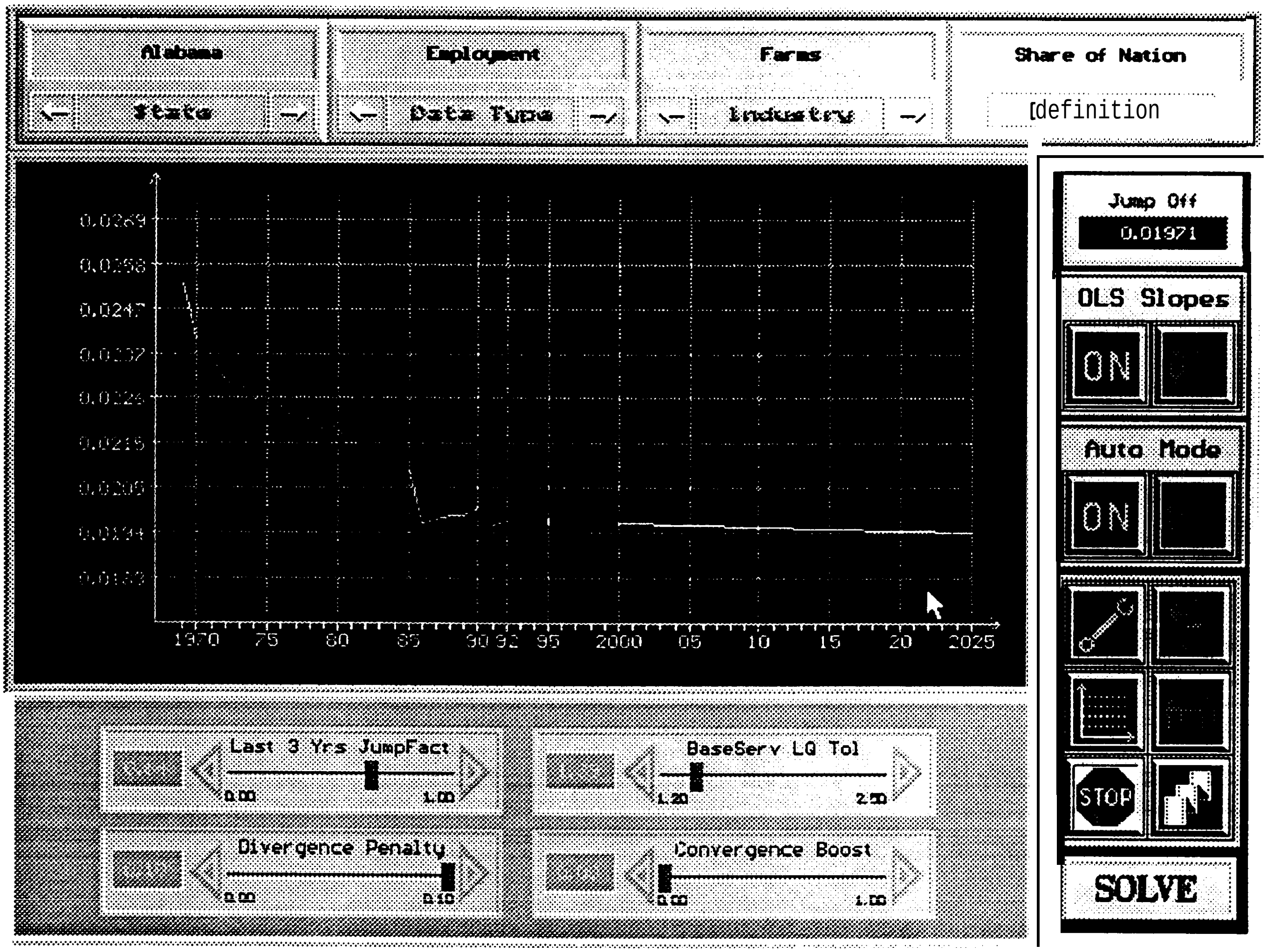
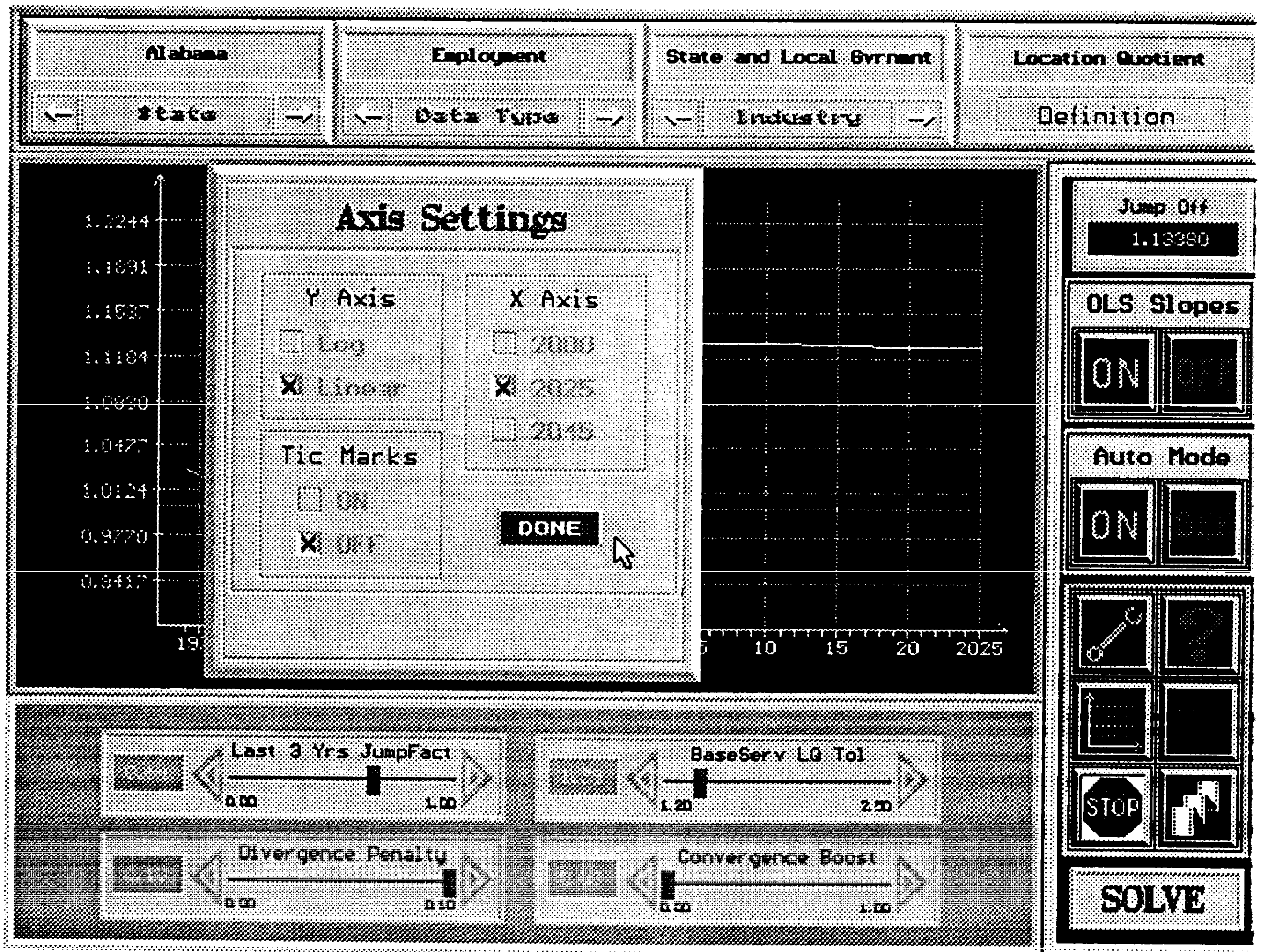

Alabama
State
Employment
Data Type
Farms
Industry
Share of Nation
definition
Jump Off
0.01971
OLS Slopes
ON
Auto Mode
ON
STOP
SOLVE
1970
75
80
85
90 92
95
2000
05
10
15
20
2025
Last 3 Yrs JumpFact
0.00
1.00
BaseServ LQ Tol
1.20
2.50
Divergence Penalty
0.00
0.10
Convergence Boost
0.00
1.00

Figure 5.



Alabama
State
Employment
Data Type
State and Local Gvrnmnt
Industry
Location Quotient
Definition
Axis Settings
Y Axis
Log
Linear
X Axis
2000
2025
2045
Tic Marks
ON
OFF
DONE
Jump Off
1.13380
OLS Slopes
ON
OFF
Auto Mode
ON
10
15
20
2025
Last 3 Yrs JumpFact
0.00
1.00
BaseServ LQ Tol
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2.50
Divergence Penalty
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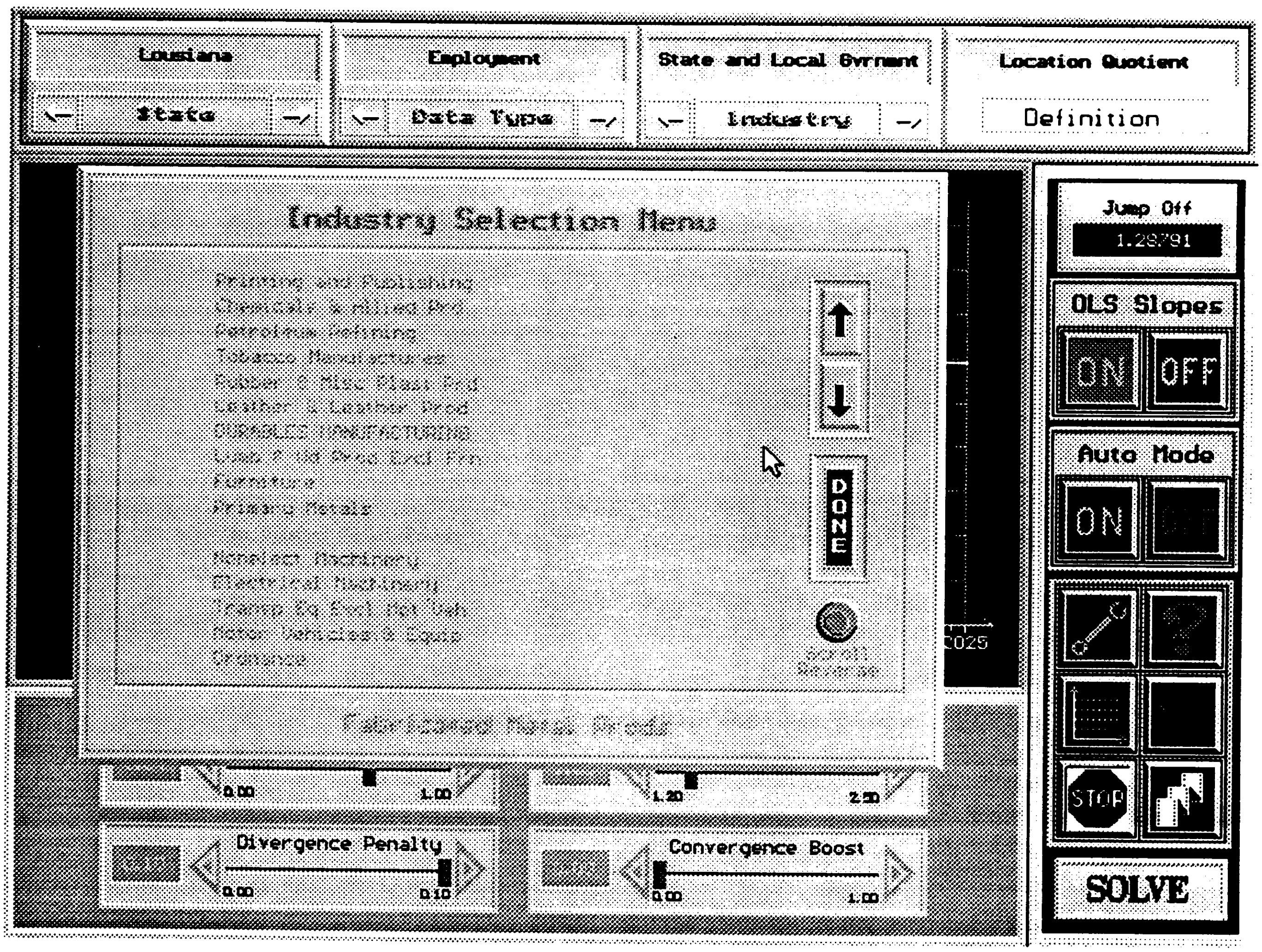
0.10
Convergence Boost
0.00
1.00
STOP
SOLVE

Figure 6.



Lousiana
State
Employment
Data Type
State and Local Gvrnmnt
Industry
Location Quotient
Definition
Industry Selection Menu
DONE
Jump Off
OLS Slopes
ON
OFF
Auto Mode
ON
STOP
SOLVE
Divergence Penalty
Convergence Boost
0.00
1.00
1.20
2.50
0.10

Figure 7.

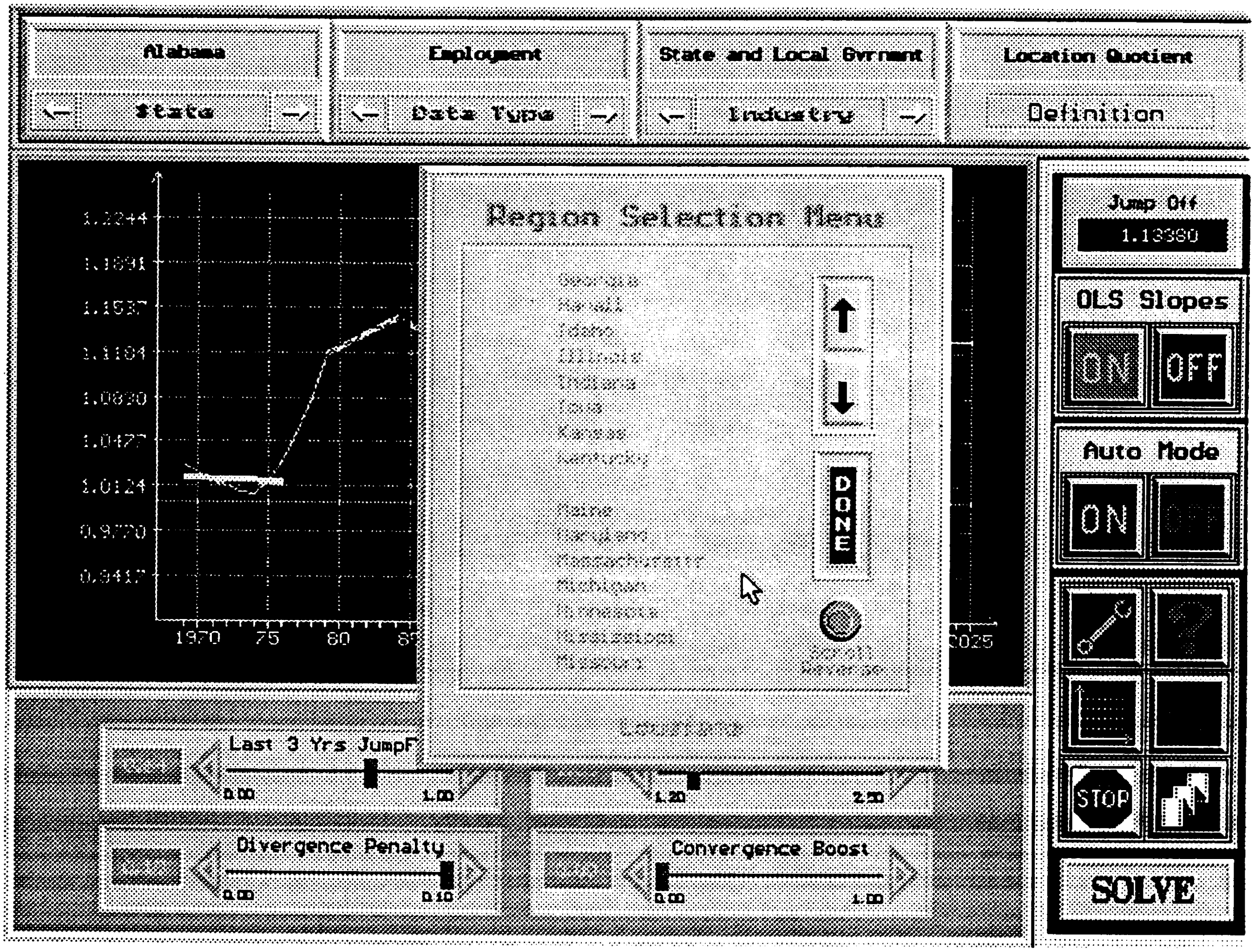

Alabama
State
Employment
Data Type
State and Local Gvrnmnt
Industry
Location Quotient
Definition
Region Selection Menu
DONE
Jump Off
1.13380
OLS Slopes
ON
OFF
Auto Mode
ON
OFF
STOP
SOLVE
Last 3 Yrs JumpF
Divergence Penalty
Convergence Boost
1970
75
80
2025

Figure 8.

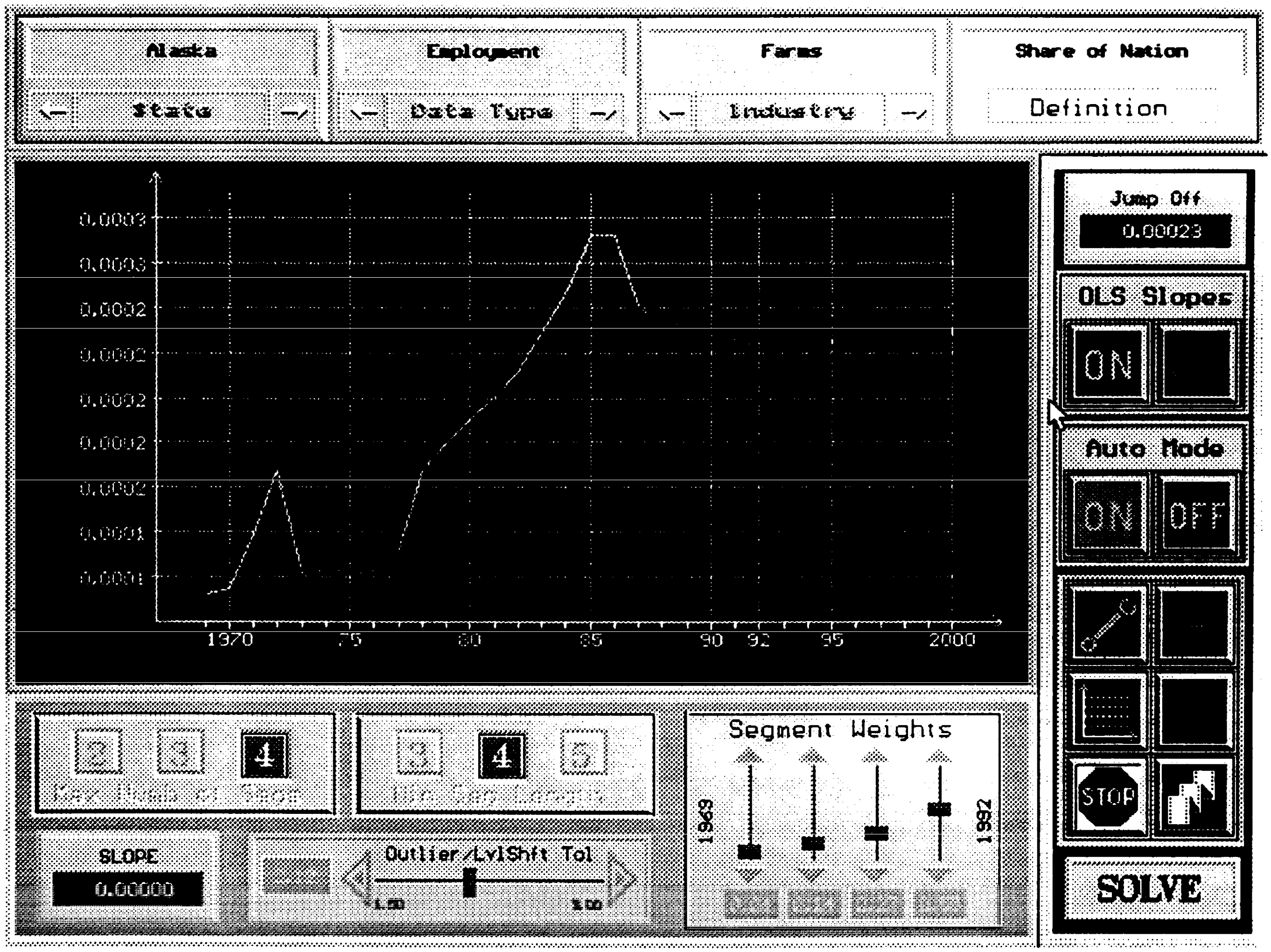
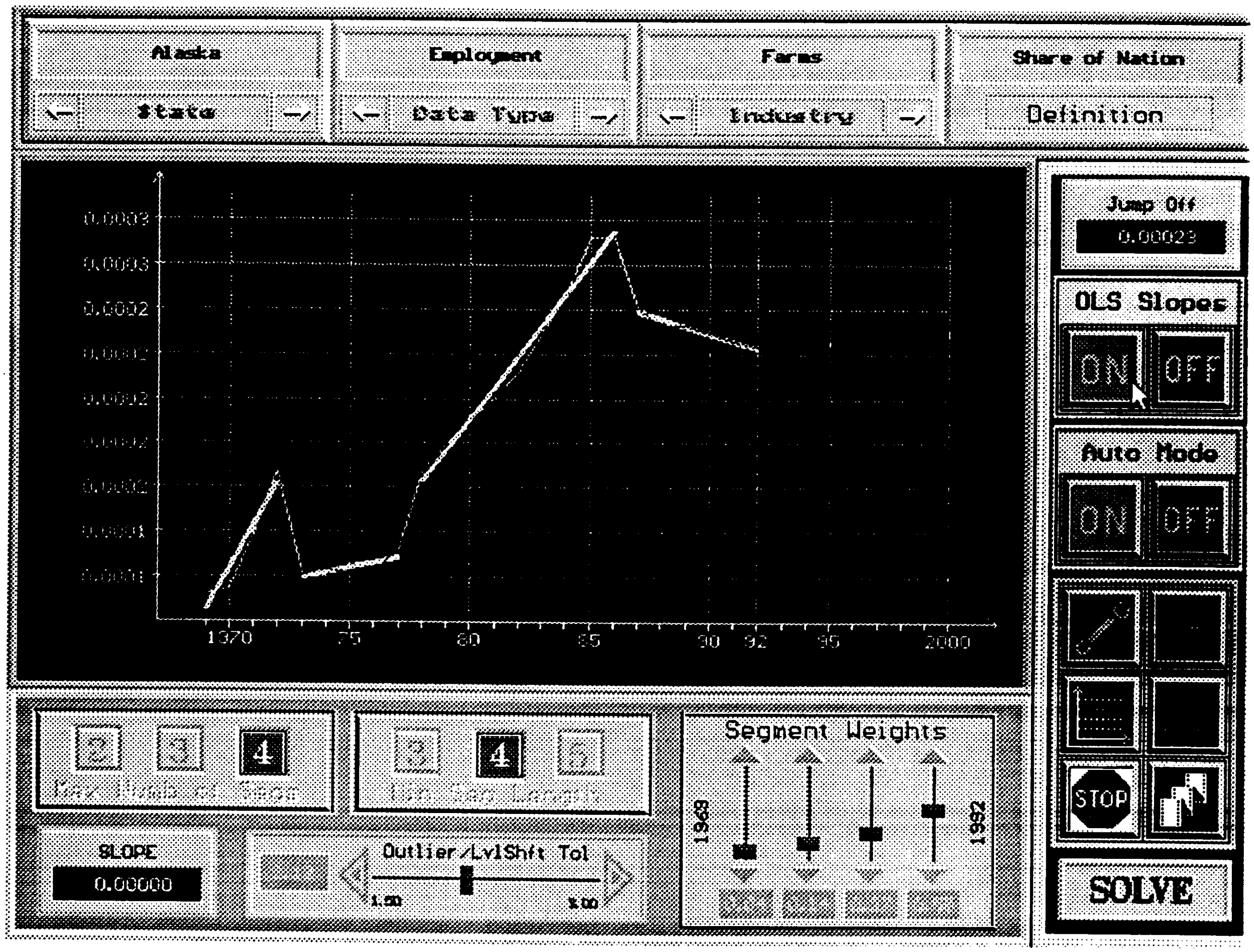

Alaska
State
Employment
Data Type
Farms
Industry
Share of Nation
Definition
Jump Off
0.00023
OLS Slopes
ON
Auto Mode
ON
OFF
1970
75
80
85
90
92
95
2000
Segment Weights
1969
1992
SLOPE
0.00000
Outlier/LvlShft Tol
STOP
SOLVE

Figure 9.



Alaska
State
Employment
Data Type
Farms
Industry
Share of Nation
Definition
1970
75
80
85
90
92
95
2000
Jump Off
0.00023
OLS Slopes
ON
OFF
Auto Mode
ON
OFF
STOP
SOLVE
Segment Weights
1969
1992
SLOPE
0.00000
Outlier/LvlShft Tol
2
3
4
5

V. Optimum Segmentation

The process of optimum segmentation is a crucial element of the current expert system, because it plays a major role in the determination of both the slope (B) and the damping factor (D) in the extrapolation equation (equation 3, on page 7, above). Optimum segmentation is a procedure by which the best (minimum mean squared error) estimate of the trends in a data series can be identified, subject to the following three constraints:

1. A sequence of contiguous data values is a candidate for analysis only if it is long enough, where "long enough" means greater than or equal to a minimum segment length specified by the user, [n the current expert system, the parameter that specifies the minimum segment length is **Min_Seg_Len.** A minimum segment length of four or five seems to work well in practice.

2. For a sequence of data values to be considered a "segment," the data values must be contiguous after the whole **timeseries** has been scanned and **outliers** and level shifts have been identified. No segment can contain a level-shill as anything but an endpoint, and no segment can contain an **outlier.** That is, analyzable data segments exist between these **discontinuities,** so trends can be identified only ***between*** such **discontinuities,** never ***across*** them

3. No more than a specified maximum number of trends is permitted in a single data series. This is also a user-specified parameter. A maximum allowable number of three or four trends works well in practice. In the current expert system, the maximum number of trends that will be identified is determined by the parameter Max_Seg_Num. (The parameter **Max_Seg_Num** specifies only the ***maximum*** number of segments the program will look for, but there is no guarantee that so many segments can be found.)

The first step in the optimum segmentation process is to **identify outliers** and level shifts in **the timeseries** data points. In the current expert system, the identification of **outliers** and level-shifts is controlled by the parameter **Outlier_Factor.** **The** average absolute first difference for the timeseries is computed as:

$$4.\ MAD = Mean\ Abs\ Diff = \frac{\sum_{i=2}^{n} ABS\,(X_i - X_{i-1})}{n-1}$$

The individual (n- 1) first differences are then compared to the computed MAD for the timeseries as **a whole. Outliers and level-shifts are identified at those locations where the observed first difference exceeds the MAD by** more than the amount allowed by the parameter **Outlier_Factor.** An **outlier is** a data **point** whose first differences both to the left and to the right exceed the parametric tolerance level. That is, data point Xi is identified as an **outlier if:**

$$ABS(X_{i-1} - X_i) > Outlier\_Factor * MAD \quad AND$$
$$ABS(X_{i+1} - X_i) > Outlier\_Factor * MAD$$

A data point is identified as a level-shift if:

$$ABS(X_{i-1} - X_i) > Outlier\_Factor * MAD$$
$$XOR$$
$$ABS(X_{i+1} - X_i) > Outlier\_Factor * MAD$$

The endpoints of the **timeseries.** of **course, are special cases that can only ever be identified as level-shifts, since the beginning point has only a right-hand first difference** while the endpoint has only **a left-hand** first difference.

The **outliers** and **level-shifts** constitute dataseries **discontinuities** that divide the **timeseries** into a collection of noncontiguous segments. **Outliers** are excluded **from** the analysis and represent gaps in the dataseries that admissible data segments are not permitted to cross. Level-shifts also represent **discontinuities,** but they are not excluded **from** the analysis. Instead, the discontinuity is one-sided on the side of the data point where the large first difference occurs. If the large first difference is to the **left** (that is, $ABS(X_{i-1} - X_i) > Outlier\_Factor * MAD$). then a **level-**

shift is identified as occurring between point X_{i-1} and X_i, and a discontinuity occurs between them, breaking the dataseries into separate data segments at that juncture.

After identifying the outliers and level-shifts, in the historical dataseries we are left with a collection of data segments:

$$5: \quad \Gamma = \{ G_1 , G_2 , \ldots , G_n \} \qquad (n \geq 1)$$

in which every segment begins or ends with one of the following:

1. the beginning of the historical timeseries,
2. the end of the historical timeseries,
3. a point next to an **outlier,**
4. the data point just before a **level-shift** occurs,
5. the data point just after a level-shift occurs.

As was briefly mentioned above, the current expert system includes a parameter, Min_Seg_Len, that specifies the minimum number of data points that a segment must contain in order for it to be admissible. Because some of these segments contained in equation 4 may be shorter than the minimum required length, we need to construct the subset of **Γ,** by excluding those segments that do not have at least the minimum number of elements to be analyzed. The new set contains data segments such that every segment has length greater than or equal to **Min_Seg_Len:**

$$6: \quad \check{\Gamma} = \{ \check{G}_1 , \check{G}_2 , \ldots , \check{G}_m \} \qquad (m \leq n)$$

$$Len(\check{G}_k) \geq \text{Min-Seg-Len} \qquad (k = 1 \ldots m)$$

If m $\geq$ Max_Seg_Num, then we can proceed no **further:** For if the identification of **outliers** and level shifts has already given us the maximum number of segments we can have (an extremely rare occurrence), we must take the most recent segments until we have selected **Max_Seg_Num** of them. If segments are **left** out of the analysis of the overall slope, then it w ii I be the most ancient segments that will be omitted. not the recent ones. In fact, this almost never happens.

If m < Max_ Seg_Num, however. the problem is somewhat more complicated. In this case we need to **proceed further** and examine the lengths of the individual elements of the set of long segments to determine whether any is long enough to be further subdivided into subsegments that satisfy the constraint on segment length. A segment $\check{G}_k$ is a candidate for further division if:

$$LEN(\check{G}_k) \geq q * \text{Min\_Seg\_Len}$$

where q is a positive integer $\geq$ 2. The largest positive integer for which the above equation is true determines the number of subsegments into which an individual segment can be subdivided without violating the requirement that a segment be no shorter than **Min_Seg_Len** in length. But it does not determine the **number of different ways** such a subdivision can be made. **This** is a problem that belongs to the branch of mathematics called ***combinatorics.*** which is concerned with the number of ways discrete finite subsets can be constructed from a discrete finite set. For example, if $LEN(\check{G}_k)$ = I I and **Min_Seg_Len** = 4, then clearly the segment can be broken into two continuous segments (without violating the requirement that each segment be $\geq$ Min Seg_Len) four different ways: (7,4), (6,5), (5,6), and (4,7). For any set of segments of length $\geq$ **Min_Seg_Len,** there maybe a surprisingly large number of possible ways for them to be subdivided into subsegments, each of which satisfies the requirement that length $\geq$ **Min_Seg_Len.** If $LEN(\check{G}_k)$ = 17, **Min_Seg_Len** = 4, and **Max_Seg_Num** = 3, for example, the series can be subdivided eighteen different ways. .

Optimum segmentation is accomplished by subdividing $\check{\Gamma}$ all possible ways (subject to the constraints imposed on what constitutes an admissible segment), and then determining which among al I these possible segmentations is the "best." The measure used to determine which of the (quite possibly very large number of) possible segmentations is the best is the total mean squared error computed from ordinary **least-**squares regression I ines passed through each of the

subsegments. That is. $\check{\Gamma}$ is segmented (and subsegmented) according to the procedures described above. Then each different (and admissible) way of dividing up the timeseries is evaluated by regressing the individual segment elements against time, and computing the resulting mean squared error for each subsegment. relative to the regression line through its elements. The overall score for a particular segmentation scheme is then the sum of the mean-squared errors for each subsegment, and the optimum segmentation is the one segmentation out of all possible admissible segmentations that achieves the minimum total mean squared error.

Identifying a Slope

The most simplistic means for identifying a slope to use in extrapolating a dataseries is to compute an ordinary least-squares line through the historical observations and use the resulting OLS slope parameter as the extrapolation slope. This may give good results in some cases, but not in most cases. The existence of outliers, level-shifts, and changes in statistical regime will cause the simple OLS slope to yield unacceptable results in a large number of the cases to be extrapolated.

A slightly less simplistic approach would attempt to take account of discontinuities in the historical dataseries. Before computing an OLS line through history, the historical observations could be scanned for the presence of outliers and level-shifts, defined as any absolute first difference (Abs(X' - X'-')) greater than Z times the average absolute first difference for the series as a whole (Z being a user-determined parameter). After identifying outliers and level shills in the historical data, OLS slopes can be computed for the remaining series segments. The overall slope to be extrapolated is then computed as the double-weighted average of the slopes of the individual segments (weighted both by the *length* and by the *age* of the series). This method for identifying historical trends was used to generate the Metropolitan Statistical Area projections/[28]/ and the BEA Economic Area projections/[29]/ that were published in 1990. While this method is a great improvement over the very simplistic approach described above, it sti ll fails to recognize changes in regime not dramatic enough to appear as an outlier or a level-shift.

The current expert system adopts a much more complex approach to identifying the historical slope to be extrapolated. Given the optimum segmentation of a timeseries to be extrapolated, the overall slope to be extrapolated into the projection period is defined as:

7: $$B = 0.5 \bullet \sum_{i=1}^{m} (\varphi_i + \gamma_i) * B_i$$

where:

φ_i = "vintage" weight for segment i,

γ_i = "persistence" weight for segment i,

B_i = the slope coefficient of the OLS line through segment i,

$\Sigma\varphi_i = 1.0$ and $\Sigma\gamma_i = 1.0$.

The overall slope that is used in the extrapolation equation (see equation. 3, above) for this dataseries, then is a double-weighted average of the slopes of the individual series segments that result from the optimum segmentation of the dataseries. The "persistence" weights reflect the number of data points in each individual segment. The longer a segment is, the greater is the persistence weight. The "vintage" weights reflect the fact that more recent information is more valuable that older information. so the vintage weights decline as the age of the segments increases. Both the vintage weights and the persistence weights sum to unity. The persistence weights are a function of the number of data points in a given segment as a share of the total number of data points in the timeseries as a whole (after excluding outliers). The vintage weights were set as part of the process described above in which the team of veteran analysts operated the interactive expert system and came to an agreement on the best values for all of the many parameters in the system.

Determining the Damping Factor

The darnping factor determines the degree to which the overall slope (identified above) persists into

the projection period, and so may be thought of as representing the degree of confidence that we have in the assessment of the overall slope. By substituting limiting values for D into the generalized extrapolation equation above it can be seen that a damping factor of unity is equivalent to a linear extrapolation, with the constant slope equal to B, the extrapolation one would prefer if one were supremely confident that slope B would persist forever into the future. At the other limit, a damping factor of zero amounts to an extrapolation which simply holds the jumpoff value constant throughout the projection period, the extrapolation one would prefer if one had no idea whatsoever the value of the variable might be tomorrow. In the current system, the damping factor is required to lie between unity and 0.800:

$$1.00 \geq D \geq 0.80$$

Precisely *where* the value of the damping factor lies within this range is determined by a function whose independent variables are reflective of the degree of confidence that we have in our assessment of the slope we are extrapolating:

$$D = f(\text{NumSegs, Noise, RelSlope, RecHist})$$

where:

NumSegs is a measure of the number of segments the historical series is broken into as a resu lt of the identification of outliers and level-shifts. The greater the number of pieces the timeseries is broken into, the less confident we feel about the resulting slope. The relationship between D and NumSegs is therefore inverse.

Noise is a measure of the goodness-of-fit of the regression lines drawn through the optimized segments. Noise is computed as the total mean absolute percent error computed from the OLS lines through the optimum segments. The damping factor D varies inversely with Noise.

RelSlope is the absolute value of the ratio of the overall slope to the jumpoff value. The relationship between this variable and D is inverse: the greater the magnitude of the slope relative to the jumpoff value, the less willing we are to let the slope persist into the future. Smaller slopes are permitted to persist to a greater degree than larger ones.

RecHist is a binary variable taking the values 0.0 or 1.0. If the sign of the most recent historical segment is that same as the sign of the slope to be extrapolated (and may therefore be thought of as con firming, or at least not contradicting. the assessment of the overall slope), then RecHist takes the value of 0.0. If the signs of the two slopes are opposite (so that recent history may be seen as contradicting the assessment of the overal l slope), then RecH ist takes the value of 1.0.

The function that determines the value of the damping factor to be applied to the extrapolated slope is unity minus a linear combination of the four variables described above:

8: $$D = 1 - (\varrho_1 * \text{NumSegs} + \varrho_2 * \text{Noise} + \varrho_3 * \text{RelSlope} + \varrho_4 * \text{RecHist})$$

where the weights assigned to the four independent variables are user-determined, and are *not* required to sum to unity. The damping factor is required to be between 1.0 and 0.80. By the nature of the function used to specify the value of the damping factor. the maximum possible value of D is 1.00, with reductions to the value arising almost as penalties assessed for data series noisiness, slope steepness, and so on.

A minimum value of 0.800 for the damping factor may appear to be a rather high minimum value, but in fact it is not. The extrapolation equation requires that the damping factor be applied *annually* throughout the projection period, so a the minimum value of 0.80 leads to a relatively flat extrapolation path.

Additional Constraints on Relatives

Extrapolated relatives (except the product per job relative used to extrapolate GSP) have additional constraints on them to prevent them from diverging too greatly from unity, or to cause them to converge more rapidly toward unity.

Divergence Penalty: a user-settable parameter ***reduces*** the damping factor for relatives that are diverging from unity in the projection period, causing

the extrapolated line to dampen off more rapidly.

Convergence Boost: a user-settable parameter *increases* the damping factor for converging relatives, causing the extrapolated line to darnpen off less rapidly than it would otherwise do.

Unity Horizon: a user-settable range near unity causes extrapolated relatives to diverge much less from unity if they have historically been within this range most of the time.

Unity Fence: a user-settable parameter forces extrapolated values to diverge much less from unity if the jumpoff value lies anomalously on the opposite side of unity from most of the historical values.

VI. Future Directions

While the set of evaluation rules and parameters that was developed for the current expert system generate extrapolations that are indistinguishable from those produced by human experts in most cases, a few historical timeseries still need significant adjustment by human reviewers. It is hoped that by examining these remaining anomalous cases, additional rules may be developed and incorporated into the system at a later time, so that ultimately all (or very nearly all) historical timeseries will be extrapolated satisfactorily by the expert system. There is no expectation, however, that a purely mechanical system can (in our lifetimes, at least) generate longterm projections that will need neither detailed review nor occasional adjustment: the inherent noisiness of regional economic data and the incidence of such nonperiodic events as strikes, natural disasters, plant openings or closings, Christmas bonuses, industry reclassifications, and so on, conspire to make human review of mechanically generated projections a continuing necessity.

A more systematic analysis of the performance of the expert system is needed. While it is reassuring to hear from system users that the output of the expert system is usually indistinguishable from projections prepared by experienced regional economists, a more rigorous analysis of the system's performance is required to confirm and to quantify this subjective assessment. In particular, the overall performance of the system could be measured by comparing its extrapolations against a set of projections prepared by human experts. This comparison is somewhat complicated by the fact that human experts are expected to delve deeply into anomalous cases, by searching newspaper databases, talking to State-level analysts, and consulting with the BEA measurement analysts who prepared the estimates that comprise the historical data from which the projections are derived. While this outside information undoubtedly improves the quality of the resulting projections, it also somewhat muddies the waters, because no expert system can draw upon such resources. In comparing the differences between machine-generated extrapolations and those produced by humans, one would have to exclude those human-generated projections that resulted largely from outside information that the expert system could not draw upon. If large differences then stil l remain in the two sets, then those differences need to be examined to determine whether adjustments to the expert system rules or parameters could bring the two sets of projections into closer alignment.

A detailed analysis of the influence of each of the expert system rules and parameters would be very useful. It is not currently known which of the system's rules and parameters have the greatest influence on the shapes of the projections it produces. The rules and parameters that are the most influential are clearly the ones upon which efforts at improvement should be focused. On the other hand, if some rules or parameters never or seldom affect the system's output. then perhaps they need to be modified or eliminated.

VII. Notes

1. The views expressed in this paper are solely the author's and do not necessarily reflect those of the Bureau of Economic Analysis or the U.S. Department of Commerce.

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4. The means by which the two projection systems, the midterm NRIES II model and the longterm extrapolation system, were linked is described in: U.S. Department of Commerce, Bureau of Economic Analysis, BEA Regional Projections to 2045, Volume 1: States (Washington, DC: U.S. Government Printing Office, 1995).

5. U.S. Department of Commerce, Bureau of Economic Analysis, BEA Regional Projections to 2040, Volume 1: States (Washington, DC: U.S. Government Printing Office, 1990).

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7. For a more complete description of the methodology underlying the longterm projections system, see: U.S. Department of Commerce, Bureau of Economic Analysis, BEA Regional Projections to 2045, Volume 1: States (Washington, DC: U.S. Government Printing Office, 1995).

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19. Jerald L. Feinstein, Jerald L., "Introduction to Expert Systems, " Journal of Policy Analysis and Management, Vol. 8, No. 2 (1989): 182-87.

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21. Aman, Gerard P. 'Historical Trends and Their Longrun Extrapolation in BEA's Regional Economic Projections, " Paper presented at the annual meetings of the Regional Science Association, New Orleans. LA. (December 1991).

22. The classification of industries into basic industries and residentiary industries is described in: U.S. Department of Commerce, Bureau of Economic Analysis, BEA Regional Projections to 2045. Volume 1: States (Washington, DC: U.S. Government Printing Office, 1995), p. M-4.

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25. The design of the graphical user interface for the expert system relied mainly upon two books for inspiration and guidance: Shneiderman, Ben, Designing the User Interface: Strategies for Effective Human-Computer Interaction. Second Edition (Reading, MA: Addison-Wesley Publishing Company. 1992) and Galitz, Wilbert O., User-Interface Screen Desire (Boston: QED Publishing Group, 1993).

26. Figures 2 through 9 do only a fair job of depicting the user interface screens of the expert system. The screens are actually drawn in 16-color VGA (640 X 480) graphics mode. and are much sharper, clearer, and attractive than these figures seem to indicate.

27. Payne and McArthur, Developing Expert Systems, 42-67.

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How accurate were the Census Bureau's State population projections for the early 1990's?

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Int reduction. United States Bureau of the Census' Current Population Report P25-1111 lists population projections for each of the 50 States and the District of Columbia from 1993 to 2020.' In this paper, the Census Bureau's State projections are examined for accuracy during the early 1990's. Comparison of the State population projections against State population estimates for the years 1993 to 1995 provides users of these projections a reliable measure to gauge the State projections' accuracy. This paper also examines the components of population change, such as births, deaths, and net migration, and the State population projection totals published by State agencies. The evaluation of projections against post-census estimates marks one step in an ongoing quality control process in the Census Bureau's projections program.

Evaluations undertaken for this study include:

(1) comparing the Census Bureau 1993, 1994, and 1995 State population projections totals with the comesponding Census Bureau annual State population estimates;

(2) comparing the Census Bureau 1990 to 1995 State projected components of change with the corresponding State estimated components; and

(3) comparing the State agencies' 1995 population projections with the 1995 Census Bureau State population estimates.

This paper first presents the evaluation methodology and a brief description of the Census Bureau State population estimate data. For each of the three evaluations, the paper covers a description of the projection data and the results of the comparison. The final section of the paper summaries the conclusions found by the study.

These evaluations are beneficial to users interested in the accuracy of the Census Bureau's State projections. Results from the evaluations also can identify improvements for future State population projections models developed at the Census Bureau.

Methods. The basic methodology behind the projection evaluations consisted of comparing the State projection totals for selected years with the independent State estimates developed at the Census Bureau for the same dates. To summarize results of these comparisons, the mean absolute percentage error (MAPE)[2] was derived, where:

$$MAPE = (100/n) * \Sigma[|projection - estimate|/estimate]$$

MAPE's were developed for the United States (the States and the District of Columbia), wherenequalled51, and for each census region or division, where n equalled the number of States in each region or division. For evaluating the State agencies projections, n equalled the number of States in each region or division with data published between 1991 and 1993.

The net and percent population difference at the State level provided a method to compare the projections and estimates. The results showed the magnitude and direction of growth in the State populations and their components of change. All data used were based on readily available figures rounded to the nearest 1,000 (unless noted otherwise).

State Estimates 1990 to 1995. State estimates used to evaluate the State population projections were derived from Census Bureau county estimates using a demographic procedure called the "component change" method.[3] The "component change" method annually updates population estimates using administrative data for counties. The baseline county population estimates were derived from the 1990 enumerated census population distributions. State estimates were obtained by summing up the appropriate county estimates.[4]

State Projections for 1993, 1994, and 1995. The Census Bureau's State population projection model is a complex demographic model that projects geographic

'For a detailed description of the State population projection results and the methodology, see Campbell, Paul R., 1994, Population Projections for States, by Age, Sex, Race, and Hispanic Origin: 1993 to 2020, U.S. Bureau of the Census, Current Population Reports, P25-1111, U.S. Government Printing Office, Washington, DC.

'For a detailed discussion of various measures of accuracy for projections, see Armstrong, J. Scott, 1978, Long-Range Forecasting: From Crystal Ball to Computer, John Wiley& Sons, New York.

[3]U.S. Bureau of the Census, 1996, "State Population Estimates and Components of Change 1990- 1995," data file issued by the Population Distribution Branch. A summary description of the data are in U.S. Department of Commerce, 1996, News, "New York Loses Population, Texas, Florida, and California Have Largest Gains, Census Bureau Reports," U.S. Bureau of the Census, Press Release CB96-10 issued 1/26/96.

'For a detailed discussion on the production of State and county estimates, see Byed y, Edwin R., and Kevin Deardorff, 1995, National and State Population Estimates: 1990 to 1994, U.S. Bureau of the Census, Current Population Reports, P25-1 127, Government Printing Office, Washington, D.C.

growth and decline of populations by accounting for annual aging, fertility, mortality, internal and international movement of State population. The model breaks down the population counts by age, sex, race and Hispanic origin. The State population projections prepared for July 1, 1993 to 2020 use the cohort-component method. This method requires separate assumptions for each component of population change - births, deaths, internal migration (also known as domestic or State-to State migration), and international migration - by single year of age, sex, race, and Hispanic origin.

The States' components are derived from various annual administrative record sources and both the 1980 and 1990 census distributions for each race/Hispanic origin group. Starting points for these projections are the 1990 census distributions and the 1992 State estimates.[5] National fertility, mortality, and international migration trends, by age, sex, race and Hispanic origin, were used to project the States to the year 2020.

The dynamic possibilities of change in State-to-State migration makes it the most difficult component to forecast. Migration trends projected in Current Population Report P25-1111 are based on matched Internal Revenue Service (IRS) tax return data sets containing 17 annual observations (from 1975-76 to 1991-92) on each of 2,550 State-to-State migration flows. Due to the projections model inability to predict reversals in migration flows, four sets of alternative State population projections were created. These four projection series provide users with different scenarios based on past domestic migration trends. All four sets of State projections are summed and adjusted by age, sex, race and Hispanic origin to agree with the National population projection middle series.

The four alternative State projection series differ from each other on the internal migration component. A brief description of each series follows:

(1) Series A uses a time series model. The first five years of projections use the time series projections exclusively. The next ten years of projections are interpolated toward the mean of the series, while the final 15 years use the series mean exclusively.

(2) Series 13 is an economic model. This model uses census division groupings of States that are subdivisions of the four census regions, see Table 1 for the groupings. Division-to-division migration is regressed against the changes in employment in the origin, the destination, and the rest of the nation. The regressions are performed separately for each origin with indicator variables for the destination. The projected division-to-division flows are then allocated to the State-to-State flows based on the State-to-State flows' historic share of the division-to-division flow.

(3) Series C is the floating mean model. For the first ten projection years, the n-th projection is the mean of the n most recent observations. After ten years, the projections is the mean of the most recent ten years.

(4) Series D is the null series, which assumes no internal migration.

Series A, the time series model, was accepted as the "preferred series" after a preliminary evaluation of the performance of the State-to-State migration models. Evaluation of the migration models was performed by withholding the recent data and using the models to predict the withheld data (i.e., 1975-76 to 1990-91 data were used to predict 1991-92)6.

Findings -- Table 1 presents a comparison of the MAPEs for the 1993, 1994, and 1995 Census Bureau State population projections. These projections represent lead times of 1 year-out, 2 years-out, and 3 years-out from the base year of 1992. Examining the MAPEs for the United States, its regions, and its divisions suggests that the preferred series' results generally were the most accurate.

In Series A, the maximum MAPEs for lead times of 1 year-out, 2 years-out, and 3 years-out for the divisions projections were 0.5, 1.4, and 2.3 percent, respectively. For the 3 years-out predictions, this maximum suggests that, on the average, U.S. division projections are within 2.3 percent of the actual values. Series C results were the second most accurate. In Series C, the maximum MAPEs for lead times of 1 year-out, 2 years-out, and 3 years-out were 0.6, 1.3, and 2.3 percent, respectively. Results for the 1 year-out and 2 years-out projections are close since Series A and C are both influenced the first year-out by baseline domestic migration trends. For both Series A and C, the MAPEs were all 1.0 percent or less 3 years-out in all divisions except the Mountain and Pacific divisions. The largest errors were in the Mountain and Pacific divisions in all three series.

Table 2 presents a comparison of the net and percent differences between the projected and estimated total populations for the U. S., regions, divisions, and States. At the State level, the percent differences are low for 1 year-out projections. In Series A for 1993 projections (1 year-out), non-western States ranged from -0.5 to 0.6 percent difference between the projections and estimates, while Western States had a wider range of percent differences from -0.7 to 1.1 percent.

'In the absence of State estimates by race and Hispanic origin, the initial base populations for the State projections were the 1990 census distributions, by age, sex, race, and Hispanic origin, prorated to the States estimates for July 1, 1990. This preliminary base population was projected forward to July 1, 1991 and July 1, 1992, and controlled to the corresponding annual State and national estimates.

'For a discussion of the evaluation of previous migration models, see Sink, Larry D., 1990, "Evaluating Migration Projections," Paper Resented at Federal-State Cooperative Programs for Population Projections Conference held in May.

By 1995 (3 years-out), the percent differences show the largest declines in accuracy occurring in the Mountain, Pacific, and New Englartd States. Outliers in Series A showing the greatest percent differences from the estimates were Alaska (5.0 percent), Arizona (-3.5), Nevada (-3.5), Hawaii (2.9), and California (2.6). Allother States' percent differences in 1995 were very accurate in comparison, ranging between plus and minus 1.6 percent.

Series D, the null migration series, shows the impact of projecting the least likely assumption of nil domestic migration. Results 3 years-out in Series D implies that most States in the West, followed by a few States in the South and Northeast, are very dependent on growth and decline through domestic migration. The greatest errors were found in Nevada (9.6 percent too low) and the District of Columbia (9.7 percent too high). Natural increases (births minus deaths) and international migration errors, however, also contribute to the percent differences between the projections and estimates. A more detailed discussion of the accuracy in the components of change follows.

Components of Change 1990 to 1995 The components of change account for the growth or decline in the State population projections. The comparisons of the State projection components of change (in Current Population Report P25-1111) with corresponding State estimates components of change (consistent with Census Bureau press release CB96- 10) are useful to identify accuracies among the births, deaths, net internal migration, and international migration components.

Since the April 1, 1990 census age, sex, and race/Hispanic origin distributions were accepted as the State projections preliminary starting points, projected components of change are available for July 1, 1990 to July 1, 1995. The July 1, 1990 States populations were projected to 1991 and controlled to the States and national estimates, with this process repeated for 1992.7 State projection distributions by age, sex, and race/Hispanic origin for 1990-1995 are consistent with corresponding 1990 to 1992 State and National estimates and 1993 to 1995 National projections. Fertility and mortality State components were not controlled to their corresponding estimated (1990- 1992) or projected (1993- 1995) National components. International migration levels for States were constant at the national level over the projection period.

In the present evaluation, the States estimates' internal migration components includes federal citizens movement[8]. The residual component calculated for State estimates were excluded.[9] The residual component is the net difference between the sum of the States' components of change and the national controls. [10]

One should be cautious in comparing the States estimates and projections components of change, since they are faced with several discontinuities. The State estimates and projections use different data sets and methodologies. State projections use a cohort component model and static assumptions, while State estimates use a county "component change" model and historical truths.

There are four reasons for being cautious in comparing the net and percent differences on the components of population change. First, when the States estimates components are close to zero and varies greatly with State projections components the resulting percent differences can be extremely large (more than 100 percent). The percent difference also cannot be calculated when the State estimate is equal to zero. Second, the State estimates and projections models diverge in their demographic accounting of the movement of the domestic and international migration components. When the components of change are summed (i.e., births - deaths +/- domestic migration +/- international migration), the results equal to the net population change for the States estimates over the period 1990 to 1995. The components of change for the State projections are not controlled back to the national totals; therefore, the sum of the components does not equal to the net population change in the State projections for the period 1990 to 1995. Third, residual changes introduced through State and National controls cart cause problems for this evaluation in the State projections, some net differences (or residual) are introduced when the projections are summed and adjusted to the age and sex distribution of the National population projections. Finally, the error in one component may compound errors in other components. For example, too many migrants increase the population, which raises the number of births and deaths. This analysis enables us to identify which components of change accounts for the most errors in the projections.]]

The components of change for 1990-1995 State estimates identify cumulative period accuracy. Fertility and mortality levels arc expected to be static or slow to change in comparison to changes in migration trends. Consequently, projected birth and death components are

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'In the absence of States estimates with race/Hispanic origin details, the 1990 census distributions were used as the **preliminary** baseline populations. The final baseline was 1992.

"'Federal citizen movement component is the net movement of federally associated civilians and military personnel to each State **from** outside the **country,"** see U.S. Bureau of the Census, 1996, op. cit.

The exclusion of the residual component from the State estimates and projections components imply that thesum of the components shown in table 3 will not equal to the net population change.

[10]"**Residual** is the effect **of national** controls on **subnational** estimates. It is the difference between the implementation of the national estimates model and the **county/state** estimates models. " U.S. Bureau of the Census, 1996, op. cit.

[11]**Use** of readily available estimates and projections rounded to the nearest 1,000 persons conceals some of the diminutive differences between the projections and estimates.

likely to be more accurate than projected internal migration or international migration components.

Findings -- The States' estimated components of population change shown in Table 3 identify the gains or declines of the State population through births, deaths, internal migration, and international migration for the period July 1, 1990 to July 1, 1995. Among the four regions, the West and South, followed by the Midwest, had the fastest growth. Although natural increase has played a major role in this growth, domestic migration in the South and international migration in the West accounted for the regional differences. Areas having the greatest population losses through domestic migration were the Middle Atlantic States in the Northeast and the Pacific States in the West.

Table 4 shows the results of calculating components of change MAPEs for the preferred series State projections in Current Population ReportP25-1111 (using the Census Bureau State population estimates for the 1990-95 period). The death component is the most accurate component for all regions and divisions, followed by the birth component. While both migration components are major sources of error in the State projections, domestic migration is consistently the least accurate component across all regions and divisions.

The domestic migration component MAPEs obtained are not representative of the total country since several States are excluded. Results should be viewed with caution since Alaska, Iowa, and Kansas were excluded from the calculation of the domestic migration MAPEs.[12] These three State had extremely high domestic migration component MAPEs. Their exclusion also affected the domestic migration component MAPEs for the Midwest and West regions, as well as the West North Central and Pacific divisions.

Table 5 show the net and percent differences between the projected and estimated components of State population change for 1990-95. The table results show the general accuracy of each component of change. Clearly, the mortality component is the most accurate, followed by the fertility component. The direction of the error varied with most States having too few deaths and too many births. The fertility and mortality methodology in the current projections appear sufficient to produce accurate results. [13]

As expected, the major source of errors in the State projections were the State-to-State migration component, followed by the international migration component. Frequently, both projected migration components are too low. Contrary to these findings, California, with the largest share of the nation's domestic and international movement, was too high on both components.

Between 1990 and 1995, States like Texas, Arizona, Massachusetts, and Georgia were under projected by over 100,000 persons, while California was over projected by nearly a half million domestic migrants. In the international migration component, the projected population of California had 346,000 over-projected immigrants, which was a quarter of the projected 1.4 million immigrants added to the nation over the 5-year period.

State Agencies Projections 1995. Shortly after the 1990 census results were released, many State agencies began developing and publishing 1990 census based State population projections. [14] To evaluate projections prepared by the State agencies, comparisons were made between the recent 1995 total State population estimates from the Census Bureau with the State agencies' population projections.

These comparisons should be viewed with 'extreme caution' since the State agencies' projections suffer several inconsistence, including different baseline years and projection methods. Even though most of the results for the 42 States used in this comparison were published between 1991 and 1993, they may not necessarily be based on 1990 census results or have comparable administrative records data.

More specifically, the State agencies' projections may be based on the demographic cohort-component model, an economic or labor force model, or simple extrapolation of growth rates. Some State agencies' projections are produced at the county or other local levels and then aggregated to obtain State totals. Some are produced by official State agencies or by private firms. The States agencies' projection models usually rely on more local information to make judgments concerning local trends, which are not readily available to demographers producing projections for all States in the Nation.

The State agencies' results may not include the 1991 and 1992 State estimates. [15] State agencies' figures may not even refer to midyear 1995; they maybe projected to dates other than July 1, 1 995. The State agencies' official

'*Domestic migration for Alaska and Kansas, based on the State estimate component were rounded to the nearest 100 persons (rather than 1,000 persons) to avoid zero denominators in the calculation of the percent differences (see Table 5.)

"State projections start with the July 1, 1990 population (by race) controlled to the corresponding National estimates (by race) and State estimates (without race data) for 1990, 1991, and 1992, which mostly affects the State-to-State migration component. Births and deaths for 1990 through 1992 were not controlled back to the National totals. See Current Population Report P25-1111 for details.

[14]State agencies' population projections available for 1995 and other selected years are included in Current Population Report P25-1111, along with publication dates.

*'The Census Bureau's projections were published in March 1994; they were completed during the summer of 1993.

1995 totals for California, Tennessee, and Georgia were not available, since these States produced ten year projections rather than annual projections. Obtaining 1995 projections for these States required exponentially interpolating figures (formula $P_t = PO\ e^{rt}$) using the 1990 estimates and 2000 projections for each State. State agencies with 1990 figures that were not fairly close to either the census results or midyear 1990 estimates were not included in the analysis.[16]

Findings -- Table 6 contains the State agencies' net and percent differences between their projected and estimated population counts for 1995. A close examination suggests that the quality of available State agencies' projections vary greatly. Only a few States (9 out of 42 States with available data) have projections that are very accurate, ranging from plus to minus 1.0 percent. Most of the State agencies' net and percent differences are slightly higher than the preferred series results in Current Population Report P25- 1111.

The Mean Absolute Percentage Errors (MAPEs) were calculated for those divisions and regions containing States with available data. MAPEs with the greatest errors occurred in the West and South. The State agencies' projections, like the Census Bureau's projections, had trouble predicting reversal in domestic migration trends in the West. No attempt is made here to argue which projections are more accurate, given that the results are not necessarily comparable.

Conclusions. ***How accurate are the States projections?*** -- The level of accuracy of the State projections depends on how much error we are willing to accept without rejecting the usefulness of the results. The resulting MAPEs suggest that the projections are very accurate for all regions but the West. The slow increases in error over the time (between 1993 and 1995) were expected. Rapid decline of accuracy in reported Census Bureau State population projections for several States in the West point to the inability of the migration models to predict the reversal in migration streams. Clearly, States like Alaska, Arizona, Nevada, Hawaii, and California are outliers (with the least accurate projections).

Past evaluations -- In essence, the evaluation process began with the examination of the internal migration component long before each set of State projections are produced. The internal migration component, the most difficult component to predict, often suffers the greatest loss of accuracy over the projection horizon. Past evaluations of our internal migration models indicated that the mean predicts more accurately than our time series model for projections ten or more years out, to which the necessary adjustments were made. The recurring problem of failing to produce accurate projections for Western States suggests that perhaps more attention should be directed to the potential for changes in those States with rapid growth than in the past. Furthermore, our economic migration model did not appear to improve the level of accuracy.

Table 7 compares the MAPEs one year out from the baseline year for the past three Census Bureau State population projection publications. As seen in Table 1, a comparison of the MAPEs for Series A to C shows the time series model as most accurate. Based on earlier evaluations of previous State projections, the P25- 1111 State population projections show results that are slightly more accurate than the other publications. The U.S. and regional MAPEs for up to 3 years-out in the preferred series in P25-1111 are lower than the old projections series in P25-1017.[17] Generally, the U.S. and regional MAPEs 1 year-out in P25- 1111 for Series A, B, and C were lower than the 1 year-out results in Series P25- 1053.[18]

The comparisons of projections with the eventual estimated populations at the State level suggest that current and past migration models have been the least accurate for States in the West. The direction of the error (under-projected versus over-projected) varies for States in the West among the three projection reports.

Similar to previous projections those Current Population Report P25-1111 do not adequately predict turning points in the domestic migration flows. It appears that these changes are linked regionally, which may require more complex modeling to predict trends. For example, as California began to have losses through domestic migration, other States in the region began to show rapid growth. International immigration also peaked during 1992-93 then began to decline.

Implications for Future Projections -- This evaluation did not attempt to examine the methodological errors introduced by other differences in the projections and estimates. Several methodological problems that are likely to contribute to projection inaccuracies are as follows: (1) dated domestic and international migration rates based on the retrospective data from the earlier 1980 census; (2) projections based on inadequate or incomplete baseline race and Hispanic origin characteristics; (3) the lack of complete

[16] The 1990 figure for Georgia was the July 1, 1990 estimate prepared by the Census Bureau. The New York 1990 population appears to be much higher than the 1990 census figure and was excluded from this analysis. The data for South Dakota was excluded since the figures cited were incorrect.

[17] Wetrogan, Signe, I, 1988, Projections of the Population of States, by Age, Sex, and Race: 1988to2010, U.S. Bureau of the Census, Current Population Reports, P25-1017, U.S. Government Printing Office, Washington, DC.

[18] Although both reports have Series A, B, and C, a different set of internal migration assumptions are use in each report. See Wetrogan, Signe, I, 1990, Projections of the Population of States, by Age, Sex, and Race: 1989 to 2010, U.S. Bureau of the Census, Current Population Reports, P25-1053, U.S. Government Printing Office, Washington DC.

integration between the State estimates and projections, i.e., race and Hispanic origin details were not available for post census estimates; and (4) problems caused by controlling the projections to the national estimates and projections, and less detailed State estimates.

Future Census Bureau State population projections will contain several improvements. First, more detailed and reliable baseline populations will be used. For example, in Current Population ReportP25-1111, the race and Hispanic details were based on the 1990 census, projected to 1991 and 1992, and then controlled to State estimates to produce starting point populations. Domestic and international migration rates will be updated with retrospective migration data from the 1990 census. The projections in Current Population Report P25-1111 used 1980 census data. Other plans will include exploring the possibility of producing sub-state level projections, such as, metropolitan - nonmetropolitan projections for the most populous areas in an attempt to identify counter sub-state trends that may improve our ability to project State populations accurately. Finally, alternative and economic models will be evaluated in an attempt to forecast migration trends.

Additionally, the current State projections were constrained by pressures from users for more demographic characteristics based on less detailed data and fewer staff resources. The future evaluation and tracking of the Census Bureau's State population projections on more detailed demographic characteristics (age, sex, race, and Hispanic origin) should further identify potential sources of refinement for the State population projection model.

Table 1. Mean Absolute Percentage Error for State Population Projections in Series A, B, and C: 1993 to 1995

Regions and Divisions,	Series A			Series B			Series C		
	1993	1994	1995	1993	1994	1995	1993	1994	1995
United States	0.3	0.6	0.9	0.5	1.1	1.6	0.3	0.6	1.0
Northeast	0.3	0.5	0.7	0.6	1.4	2.1	0.3	0.5	0.8
New England	0.4	0.6	0.9	0.9	1.8	2.6	0.3	0.7	1.0
Middle Atlantic	0.2	0.2	0.3	0.2	0.5	0.9	0.2	0.2	0.4
Midwest	0.2	0.4	0.6	0.2	0.4	0.7	0.2	0.4	0.5
East North Central	0.2	0.3	0.4	0.1	0.2	0.5	0.2	0.4	0.4
West North Central	0.3	0.5	0.7	0.3	0.5	0.8	0.3	0.5	0.6
south	0.2	0.4	0.6	0.3	0.6	1.0	0.2	0.4	0.8
South Atlantic	0.2	0.4	0.7	0.2	0.5	0.9	0.2	0.4	0.9
East South Central	0.1	0.4	0.6	0.4	1.0	1.4	0.1	0.4	0.7
West South Central	0.3	0.4	0.5	0.3	0.5	0.7	0.3	0.4	0.6
West	0.5	1.2	1.8	0.9	2.0	3.0	0.5	1.2	1.9
Mountain	0.4	1.1	1.5	1.0	2.1	3.0	0.4	1.1	1.7
Pacific	0.5	1.4	2.3	0.9	1.8	3.0	0.6	1.3	2.3

Notes: See text for details. Base-year: 1992.
1993: refers to 1 year-out; 1994 refers to 2 years-out; 1995: refers to 3 years-out.
Mean absolute percent error (MAPE) based on State data from reportP25-1111 and CB96-10.

Table 2. Estimates, Net& Percent **Difference** between Projected& Estimated Populations by Year, Series, & Geography

Regions, divisions, and states	**Population** Estimates **(in 1 ,000's)**			Series A: Net **difference** (in 1,000's)			Series A: Percent difference			Series B: Net **difference** (ii 1,000'S)			Series B: Percent **difference**		
	1993	**1994**	1995	**1993**	**1994**	**1995**	1993	1994	1995	1993	1994	1995	1993	1994	1995
United States	257,800	260,350	262,755	**128**	**359**	**682**	0.0	0.1	0.3	126	361	682	0.0	0.1	0.3
Northeast	51,275	51,382	51,466	**-48**	**-47**	**-25**	-0.1	-0.1	-0.0	179	410	657	0.3	0.8	1.3
New **England**	13,232	13,265	13,312	**-31**	**-67**	**-114**	-0.2	-0.5	-0.9	**103**	**204**	**289**	0.8	1.5	2.2
Middle Atlantic	38,044	38,117	38,153	**-18**	**20**	**90**	-0.0	0.1	0.2	**75**	**206**	**369**	0.2	0.5	1.0
Midwest	61,040	61,408	61,804	**109**	**170**	**189**	0.2	0.3	0.3	-68	-180	-335	-0.1	-0.3	-0.5
East North Central	42,960	43,193	43,456	**88**	**141**	**154**	0.2	0.3	0.4	-30	-94	-198	-0.1	-0.2	-0.5
West **North** Central	18,080	18,215	18,348	**21**	**29**	**35**	0.1	0.2	0.2	-38	-86	-137	-0.2	-0.5	-0.7
south	89,426	90,712	91,890	**-64**	**-154**	**-162**	-0.1	-0.2	-0.2	-176	-381	-503	-0.2	-0.4	-0.5
South Atlantic	45,725	46,378	46,995	**-5**	**-2**	**24**	-0.0	-0.0	0.1	-16	-23	-7	-0.0	-0.0	-0.0
East South Central	15,706	15,895	16,066	**-12**	**-36**	**-47**	-0.1	-0.2	-0.3	-69	-153	-222	-0.4	-1.0	-1.4
West South Central	27,995	28,440	28,828	**-47**	**-117**	**-138**	-0.2	-0.4	-0.5	-91	-206	-273	-0.3	-0.7	-0.9
west	56,059	56,848	**57,596**	**131**	**390**	**679**	0.2	0.7	1.2	191	512	862	0.3	0.9	1.5
Mountain	14,785	15,233	**15,645**	**-61**	**-178**	**-261**	-0.4	-1.2	-1.7	-142	-338	-503	-1.0	-2.2	-3.2
Pacific	41,274	41,615	**41,951**	**192**	**568**	**940**	0.5	1.4	2.2	333	850	1365	0.8	2.0	3.3
New England:															
Maine	**1,239**	1 ?239	1,241	**-3**	**-3**	**-5**	4.2	-0.2	-0.4	10	24	35	0.8	1.9	2.8
New Hampshire	1,123	1,135	1,148	**-5**	**-10**	**-16**	-0.4	-0.9	-1.4	12	25	35	1.1	2.2	3.0
Vermont	576	580	**585**	**-3**	**-4**	**-6**	-0.5	-0.7	-1.0	**1**	**5**	**8**	0.2	0.9	1.4
Massachusetts	6,018	6,041	**6,074**	**-26**	**-58**	**-98**	-0.4	-1.0	-1.6	**27**	**48**	**59**	0.4	0.8	1.0
Rhode Island	**999**	**994**	**990**	**5**	**8**	11	0.5	0.8	1.1	15	28	41	1.5	2.8	4.1
Connecticut	**3,278**	**3,275**	**3,275**	**0**	1	-1	0.0	0.0	-0.0	37	75	110	**1.1**	2.3	3.4
Middle Atlantic:															
New York	18,153	18,153	18,136	-13	6	42	**-0.1**	0.0	0.2	34	**100**	183	0.2	0.6	1.0
New Jersey	7,859	7,903	7,945	-23	-18	-14	-0.3	-0.2	-0.2	2	31	60	0.0	0.4	0.8
Pennsylvania	12,031	12,062	12,072	19	31	62	0.2	**0.3**	0.5	40	74	126	0.3	0.6	1.0
East North Central:															
Ohio	11*MI	11,104	11,151	**19**	**39**	**52**	0.2	0.4	0.5	-14	-28	-48	**-0.1**	**-0.3**	-0.4
Indiana	5,707	5,755	5,803	10	**14**	**17**	0.2	0.2	0.3	-9	-22	-37	-0.2	-0.4	-0.6
Illinois	11,690	**11,759**	**11,830**	18	23	23	0.2	0.2	0.2	-lo	-33	-60	-0.1	-0.3	-0.5
Michigan	9,457	**9,492**	**9,549**	28	39	26	0.3	0.4	0.3 7		-2	-37	0.1	-0.0	-0.4
Wisconsin	5,044	**5,083**	5,123	14	26	36	0.3	0.5	0.7	-3	-9	-16	-0.1	-0.2	-0.3
West North **Central:**															
Minnesota	**4,524**	**4,568**	4,610	3	**5**	**9**	0.1	0.1	0.2	-10	-20	-29	-0.2	-0.4	-0.6
Iowa	**2,822**	**2,831**	2,842	6	**14**	**19**	0.2	0.5	0.7	**-3**	**-4**	**-8**	-0.1	-0.1	-0.3
Missouri	**5,235**	**5,279**	**5,324**	-11	-24	-38	-0.2	**-0.5**	**-0.7**	**-27**	**-54**	**-83**	-0.5	-1.0	-1.6
North Dakota	637	639	**641**	-1	-2	-4	-0.2	-0.3	-0.6	**-2**	**-4**	-7	-0.3	-0.6	-1.1
South Dakota	717	723	729	2	4	6	0.3	0.6	0.8	**-3**	**-6**	-9	-0.4	-0.8	-1.2
Nebraska	1,614	1,624	1,637	**5**	**8**	**7**	0.3	0.5	0.4	-2	-5	-11	-0.1	-0.3	-0.7
Kansas	2,532	2,551	**2,565**	**16**	**24**	**36**	0.6	0.9	1.4	8	7	10	0.3	0.3	0.4
South Atlantic:															
Delaware	**699**	**708**	717	**0**	**1**	**1**	0.0	0.1	0.1	**-1**	**-2**	**-2**	-0.1	-0.3	-0.3
Maryland	**4,952**	**5,000**	5,042	**14**	**23**	**36**	0.3	0.5	0.7	**15**	**25**	**39**	0.3	0.5	0.8
District of Columbia	**578**	567	554	-1	0	5	-0.2	0.0	0.9	1	4	10	0.2	0.7	1.8
Virginia	6,475	**6,551**	6,618	**-7**	**7**	**28**	-0.1	0.1	0.4	**-8**	**6**	**27**	-0.1	0.1	0.4
West Virginia	1,818	1,824	1,828	**-2**	**-4**	**-4**	-0.1	-0.2	-0.2	**-6**	**-12**	**-16**	-0.3	-0.7	-0.9
North Carolina	6,953	7,070	7,195	-7	-21	-45	-0.1	-0.3	-0.6	-13	-34	-65	-0.2	-0.5	-0.9
South Carolina	3,627	3,643	3,673	20	47	59	0.6	1.3	1.6	18	43	54	0.5	1.2	**1.5**
Georgia	6,901	7,058	7,201	-30	-71	-99	-0.4	-1.0	-1.4	-24	-58	-81	-0.3	-0.8	-1.1
Florida	13,722	13,958	14,166	8	15	44	0.1	0.1	0.3	2	4	28	0.0	0.0	0.2
East South Central:															
Kentucky	3,793	3,828	3,860	-6	-8	-9	-0.2	-0.2	-0.2	-21	-40	-57	-0.6	-1.0	-1.5
Tennessee	5,093	5,176	**5,256**	0	-15	-28	0.0	-0.3	-0.5	-21	-56	-90	-0.4	-1.1	-1.7
Alabama	4,181	4,220	**4,253**	**1**	**9**	**21**	0.0	0.2	0.5	-14	-22	-25	-0.3	-0.5	-0.6
Mississipp	2,639	2,670	2,697	**-7**	**-21**	**-31**	-0.3	-0.8	-1.1	-13	-34	-50	-0.5	-1.3	-1.9
West South Central:															
Arkansas	2,425	2,453	2,484	**-3**	**-8**	**-16**	-0.1	-0.3	-0.6	-7	-15	-28	-0.3	-0.6	-1.1
Louisiana	4,289	4,316	**4,342**	**23**	**20**	**17**	0.5	0.5	0.4	15	**3**	**-8**	0.3	0.1	-0.2
Oklahoma	3,232	**3,257**	**3,278**	**-1**	**-6**	**-7**	-0.0	-0.2	-0.2	-3	**-10**	**-13**	-0.1	-0.3	-0.4
Texas	18,049	18,413	18,724	**-66**	**-122**	**-132**	-0.4	-0.7	-0.7	-%	-183	-224	-0.5	-1.0	-1.2
Mountain:															
Montana	841	856	870	-5	-7	-8	-0.6	-0.8	-0.9	-9	-14	-19	-1.1	-1.6	-2.2
Idaho	1,101	1,134	1,163	-4	-8	-7	-0.4	-0.7	-0.6	-17	-33	-46	-1.5	-2.9	-4.0
Wyoming	470	476	**480**	**3**	**4**	**7**	0.6	0.8	1.5	**2**	**3**	**4**	0.4	0.6	0.8
Colorado	**3,568**	3,662	**3,747**	**-17**	**-31**	**-37**	-0.5	-0.8	-1.0	**-32**	**-62**	**-84**	-0.9	-1.7	-2.2
New Mexico	1,616	1,655	1,685	-2	-lo	-9	-0.1	-0.6	-0.5	-8	-22	-27	-0.5	-1.3	-1.6
Arizona	3,944	4,079	**4,218**	-29	-85	-146	-0.7	-2.1	-3.5	-45	-117	-194	-1.1	-2.9	**-4.6**
Utah	1,860	1,909	**1,951**	**-1**	**-8**	**-7**	-0.1	-0.4	-0.4	-11	-28	-37	-0.6	-1.5	-1.9
Nevada	**1,385**	1,462	**1,530**	**-6**	**-33**	**-53**	-0.4	-2.3	-3.5	-22	-65	-99	-1.6	-4.4	-6.5
Pacific:															
Washington	5,255	**5,338**	5,431	0	3 8	6 6	0.0	0.7	1.2	-15	9	22	-0.3	0.2	0.4
Oregon	3,035	3,087	3,141	**-5**	**-1**	**0**	-0.2	-0.0	0.0	-17	-26	-36	-0.6	-0.8	-1.1
California	31,220	31,408	**31,589**	**179**	**494**	**809**	0.6	**1.6**	2.6	343	823	1303	1.1	2.6	4.1
Alaska	598	**603**	**604**	5	16	30	0.8	2.7	5.0	8	**21**	38	1.3	**3.5**	6.3
Hawaii	1.166	**1,178**	1,187	13	22	34	1.1	1.9	2.9	14	24	37	1.2	2.0	3.1

See notes at end of table.

Table 2. Estimates, Net& Pereent **Difference** between Projected & Estimated Populations **by** Year. Series, & **Geography** -continued

Regions, divisions, and **States**	Series C: Net **difference** (in 1,000's) 1993	1994	1995	Series C: **Percent** difference 1993	1994	1995	Series D: Net **difference** (in 1,000's) 1993	1994	1995	Series D: **Percent difference** 1993	1994	1995
United **States**	129	361	680	0.1	.0.1	0.3	126	363	680	0.0	0.1..	0.3
Northeast	-49	-44	-1	-0.1	-0.1	-0.0	309	668	1041	0.6	1.3	2.0
New England	-31	-66	-99	-0.2	-0.5	-0.7	77	152	211	0.6	1.1	1.6
Middle Atlantic	-19	22	99	-0.0	0.1	0.3	231	516	831	0.6	1.4	2.2
Midwest	109	170	185	0.2	0.3	0.3	135	222	264	0.2	0.4	0.4
East North Central	85	145	164	0.2	0.3	0.4	136	238	297	0.3	0.6	0.7
West North Central	24	25	21	0.1	0.1	0.1	-1	-16	-33	-0.0	-0.1	-0.2
south	-62	-156	-185	-0.1	-0.2	-0.2	-411	-848	-1206	-0.5	-0.9	-1.3
South Atlantic	-12	7	75	-0.0	0.0	0.2	-258	-508	-738	-0.6	-1.1	-1.6
East South Central	-6	-43	-69	-0.0	-0.3	-0.4	-76	-166	-243	-0.5	-1.0	-1.5
West South Central	-44	-121	-190	-0.2	-0.4	-0.7	-77	-175	-224	-0.3	-0.6	-0.8
West	131	391	680	0.2	0.7..	1.2	93	321	580	0.2	0.6	1.0
Mountain	-54	-185	-322	-0.4	-1.2	-2.1	-226	-501	-743	-1.5	-3.3	-4.7
Pacific	185	576	1002	0.4	1.4	2.4	319	822	1323	0.8	2.0	3.2
New England:												
Maine	-4	-2	1	-0.3	-0.2	0.1	1	6	9	0.1	0.5	0.7
New **Hampshire**	-3	-12	-20	-0.3	-1.1	-1.7	-5	-9	-15	-0.4	-0.8	-1.3
Vermont	-3	-4	-5	-0.5	-0.7	-0.9	-3	-3	-4	-0.5	-0.5	-0.7
Massachusetts	-24	-60	-100	-0.4	-1.0	-1.6	36	66	85	0.6	1.1	1.4
Rhode Island	4	9	14	0.4	0.9	1.4	14	27	39	1.4	2.7	3.9
Connecticut	-2	4	10	-0.1	0.1	0.3	33	66	96	1.0	2.0	2.9
Middle Atlantic:												
New York	-14	8	48	-0.1	0.0	0.3	194	419	659	1.1	2.3	3.6
New Jersey	-21	-21	-19	-0.3	-0.3	-0.2	14	54	95	0.2	0.7	1.2
Pennsylvania	17	34	70	0.1	0.3	0.6	24	42	77	0.2	0.3	0.6
East **North Central:**												
Ohio	19	39	52	0.2	0.4	0.5	21	43	58	0.2	0.4	0.5
Indiana	9	15	18	0.2	0.3	0.3	-7	-18	-32	-0.1	-0.3	-0.6
Illinois	17	24	25	0.1	0.2	0.2	65	115	161	0.6	1.0	1.4
Michigan	27	41	35	0.3	0.4	0.4	64	111	133	0.7	1.2	1.4
Wisconsin	14	26	34	0.3	0.5	0.7	-6	-13	-23	-0.1	-0.3	-0.4
West North Central:												
Minnesota	3	5	8	0.1	0.1	0.2	-6	-13	-19	-0.1	-0.3	-0.4
Iowa	6	13	17	0.2	0.5	0.6	3	7	9	0.1	0.2	0.3
Missouri	-11	-24	-35	-0.2	-0.5	-0.7	-13	-28	-45	-0.2	-0.5	-0.8
North Dakota	0	-3	-7	0.0	-0.5	-1.1	2	4	6	0.3	0.6	0.9
south Dakota	2	4	3	0.3	0.6	0.4	-1	-2	-4	-0.1	-0.3	-0.5
Nebraska	5	8	7	0.3	0.5	0.4	1	1	-2	0.1	0.1	-0.1
Kansas	18	22	28	0.7	0.9	1.1	12	15	22	0.5	0.6	0.9
South Atlantic:												
Delaware	0	1	2	0.0	0.1	0.3	-4	-8	-12	-0.6	-1.1	-1.7
Maryland	12	26	47	0.2	0.5	0.9	15	25	39	0.3	0.5	0.8
District of Columbia	-2	0	5	-0.3	0.0	0.9	17	35	54	2.9	6.2	9.7
Virginia	-5	5	26	-0.1	0.1	0.4	-33	-44	-48	-0.5	-0.7	-0.7
West **Virginia**	-2	-4	-9	-0.1	-0.2	-0.5	-3	-6	-8	-0.2	-0.3	-0.4
North Carolina	-4	-24	-52	-0.1	-0.3	-0.7	-63	-134	-215	-0.9	-1.9	-3.0
South Carolina	17	50	70	0.5	1.4	1.9	6	18	15	0.2	0.5	0.4
Georgia	-29	-72	-104	-0.4	-1.0	-1.4	-79	-169	-247	-1.1	-2.4	-3.4
Florida	1	24	91	0.0	0.2	0.6	-114	-226	-315	-0.8	-1.6	-2.2
East south **Central:**												
Kentucky	-3	-11	-18	-0.1	-0.3	-0.5	-16	-29	-41	-0.4	-0.8	-1.1
Tennessee	1	-17	-35	0.0	-0.3	-0.7	-40	-95	-148	-0.8	-1.8	-2.8
Alabama	2		19	0.0	0.2	0.4	-15	-24	-28	-0.4	-0.6	-0.7
Mississippi	-6	-2$!	-35	-0.2	-0.8	-1.3	-5	-17	-26	-0.2	-0.6	-1.0
West South **Central:**												
Arkansas	-2	-9	-22	-0.1	-0.4	-0.9	-14	-30	-50	-0.6	-1.2	-2..
Louisiana	24	19	4	0.6	0.4	0.1	40	53	65	0.9	1.2	
Oklahoma	0	-7	-16	0.0	-0.2	-0.5	-3	-9	-11	-0.1	-0.3	-0.3
Texas	-66	-123	-156	-0.4	-0.7	-0.8	-100	-188	-228	-0.6	-1.0	-1.2
Mountain:												
Montana	-4	-8	-15	-0.5	-0.9	-1.7	-13	-23	-33	-1.5	-2.7	-3.8
Idaho	-4	-8	-11	-0.4	-0.7	-0.9	-23	-45	-62	-2.1	-4.0	-5.3
Wyoming	3	4	4	0.6	0.8	0.8	0	-2	-3	0.0	-0.4	-0.6
Colorado	-13	-35	-64	-0.4	-1.0	-1.7	-62	-121	-172	-1.7	-3.3	-4.6
New Mexico	-1	-11	-15	-0.1	-0.7	-0.9	-15	-34	-44	-0.9	-2.1	-2.6
Arizona	-26	-89	-167	-0.7	-2.2	4.0	-62	-148	-240	-1.6	-3.6	-5.7
Utah	0	-9	-15	0.0	-0.5	-0.8	-13	-31	-41	-0.7	-1.6	-2.1
Nevada	-9	-29	-38	-0.6	-2.0	-2.5	-38	-97	-147	-2.7	-6.6	-9.6
Pacific:												
Washington	0	39	73	0.0	0.7	1.3	-67	-95	-136	-1.3	-1.8	-2.5
Oregon	-6		6	-0.2	0.0	0.2	-37	-65	-96	-1.2	-2.1	-3.1
California	172	50!	861	0.6	1.6	2.7	411	957	1508	1.3	3.0	4.8
Alaska	6	15	27	1.0	2.5	4.5	-1	5	14	-0.2	0.8	2.3
Hawaii	13	21	34	1.1	1.8	2.9	13	21	32	1.1	1.8	2.7

Notes: Net **difference** obtained as rejected populations minus estimated populations. **Figures** may not sum to **totals** due to rounding. **Percent** difference for each year **equals [(projection** - estimate) /estimate] * 100. See text **for** details.

Table 3. **Estimated Components** of **Population** Change, by **Geography** July 1,1990 to July 1, 1995 (numbers in 1,000's)

Regions, divisions, and states	Population change	Perce change	Births	Deaths	Domestic migrants	International migrants	Federal citizens movement	Residual
United States	13352	5.4	20222	11134	0	3783	480	0
Northeast	607	1.2	3769	2408	-1680	921	28	-22
New England	92	0.7	935	589	-387	130	10	-6
Middle Atlantic	515	1.4	2834	1819	-1293	791	17	-16
Midwest	2036	3.4	4559	2757	-230	415	38	12
East North Central	1377	3.3	3256	1922	-328	344	16	11
West North Central	659	3.7	1303	834	98	70	21	1
South	6159	7.2	6938	3966	2008	876	258	45
South Atlantic	3237	7.4	3404	2072	1250	464	174	17
East South Central	858	5.6	1163	757	387	30	26	9
West South Central	2(%3	7.7	2371	1137	371	381	58	20
West	4550	8.6	4956	2003	-98	1572	157	-34
Mountain	1929	14.1	1233	531	1045	132	34	15
Pacific	2621	6.7	3723	1472	-1144	1439	124	-49
New England:								
Maine	10	5.1	78	57	-16	3	2	0
New Hampshire	36	9.1	78	44	-4	5	0	1
Vermont	20	14.7	38	24	3	3	0	1
Massachusetts	55	5.5	432	273	-181	79	3	-5
Rhode Island	-15	5.6	71	48	-46	7	2	-1
Connecticut	-14	13.4	237	144	-143	35	3	-3
Middle Atlantic:								
New York	134	-0.4	1428	834	-1001	547	10	-15
New Jersey	205	7.2	594	358	-220	185	4	0
Pennsylvania	176	-8.2	813	627	-71	59	3	-1
East North Central:								
Ohio	288	8.8	806	509	-48	34	4	2
Indiana	248	10.7	422	257	65	14	1	4
Illinois	382	6.6	%1	529	-283	222	9	2
Michigan	238	15	716	407	-132	58	2	2
Wisconsin	221	3.3	352	220	70	17	0	2
West North Central:								
Minnesota	222	4.5	328	181	52	23	1	-1
Iowa	62	2.2	191	139	2	8	0	0
Missouri	197	3.4	381	263	56	18	5	0
North Dakota	4	4.5	44	29	-16	2	3	0
South Dakota	32	3	54	34	8	2	2	0
Nebraska	56	0.8	118	75	3	6	3	1
Kansas	85	5.1	189	115	-8	11	8	0
South Atlantic:								
Delaware	48	0.9	54	31	19	4	1	1
Maryland	244	2.6	385	199	-18	61	13	2
District of Columbia	-49	5.1	55	36	-84	15	2	-1
Virginia	405	4.7	483	256	52	67	55	3
West Virginia	36	3.8	110	100	22	2	0	1
North Carolina	538	8.8	515	306	269	22	34	5
South Carolina	174	3.6	2 n	157	29	7	16	3
Georgia	695	25.6	558	274	345	40	22	4
Florida	1146	3.3	969	713	616	245	30	0
East South Central:								
Kentucky	168	2.7	267	181	63	7	9	2
Tennessee	365	10.9	370	242	217	13	6	1
Alabama	205	0.7	311	204	82	7	6	2
Mississipp	120	8.1	214	131	26	3	5	2
weat South Central:								
Arkansas	129	0.6	175	129	78	3	2	1
Louisiana	125	2.7	353	193	-56	12	8	3
Oklahoma	131	4.2	235	157	31	11	9	2
Texas	1678	9.9	1609	658	319	355	39	15
Mountain:								
Montana	70	1.5	57	36	46	2	1	1
Idaho	151	-1.5	86	40	97	7	1	1
Wyoming	27	5	33	17	7	1	1	1
Colorado	443	4.7	270	116	245	28	13	3
New Mexico	165	7.5	139	58	60	17	5	2
Arizona	539	9.8	349	160	292	48	7	4
Utah	222	12.8	186	50	71	11	2	2
Nevada	311	3.6	113	53	227	18	3	3
Pacific:								
Washington	530	6.5	392	195	257	61	18	-3
Oregon	282	10.8	210	133	178	27	1	-1
California	1685	2	2964	1096	-1532	1315	81	-47
Alaska	50	4.5	56	11	-8	5	8	1
Hawaii	74	5.9	100	36	-39	32	17	0

Notes: See text for detaila. Data reported by U.S **Bureau** of Census, **Population** Distribution **Branch.**

Table 4. Mexm Absolute Percentage Error for State Projections Components of Change in Series A: **July** 1, **1990 to** July 1,1995

Regions, divisions, and states	Population change	**Percent** change	**Births**	Deaths	Domestic migrants	**International** migrants
United States	228	22.8	2.7	1.8	49.1 *	29.8
Northeast	46.6	**46.6**	2.3	**1.2**	59.4	46.3
New England	58.7	**58.7**	**3.3**	**0.5**	75.1	67.2
Middle Atlantic	225	225	**0.4**	2.6	27.9	4.5
Midwest	227	227	2.1	**1.6**	52.0 *	27.6
East North Central	10.5	10.5	2.6	**0.7**	37.2	19.9
West North Central	31.4	31.4	1.8	2.3	**66.8** *	33.0
South	**11.5**	**11.5**	**3.1**	**1.5**	520	28.5
South Atlantic	125	125	**2.8**	**1.2**	47.4	28.2
East south central	**12.0**	120	**4.0**	1.9	48.4	15.5
West South Central	**8.7**	8.7	**2.9**	1.8	66.1	422
West	21.1	21.1	2.8	2.6	35.0 *	223
Mountain	13.1	13.1	**3.1**	3.0	30.9	24.3
Pacific	34.0	34.0	**2.2**	1.9	43.2 *	19.1

Notes: See text for **details.** Mean absolute percentage error **(MAPEs)** baaed an State projections from **report** P25-1111 and State estimates.
***Domestic migrants** MAPEa exclude Alaska, Iowa, and Kansas which had extremely high percent **differences.**

Table 7. Mean Absolute Percentage Error for State Projections 1 year-out from Selected Census Bureau publications

Regions	Report P25-111 1 Series A	Report P25-111 1 Series B	Report P25-111 1 Series C	Report P25-1053 Series A	Report P25-1053 Series B	Report P25-1053 Series C	Report P25-1017
United States	0.3	0.5	0.3	0.4	0.7	0.4	0.5
Northeast	0.3	0.6	0.3	0.3	0.5	0.4	0.2
Midwest	0.2	0.2	0.2	0.2	0.3	0.3	0.2
south	0.2	0.3	0.2	0.3	0.7	0.3	0.4
West	0.5	0.9	0.5	0.6	1.1	0.7	1.1

Source: See text for details.

Table 6. State Agencies Net and Percent Difference between Projected and Estimated Population and Mean Absolute Percentage Error (MAPE): 1995 (numbers in 1,000's)

Regions, divisions, and States	State projection	Net difference	Percent difference	MAPE's
United States	223,140	-220	-0.1	1.9
Northeast	38,764	360	0.9	1.6
New England	12,482	159	1.3	1.5
Middle Atlantic	26,282	201	0.8	1.8
Midwest	37,508	-551	-1.4	1.5
East North Central	21,796	-281	-1.3	1.3
West North Central	15$712	-270	-1.7	1.6
south	90,085	-1249	-1.4	1.9
South Atlantic	46,238	-2(Y2	-0.4	1.5
East south central	15,570	-4%	-3.1	2.9
West South Central	28,277	-551	-1.9	1.8
West	56,783	1220	2.2	2.5
Mountain	13,313	-298	-2.2	2.2
Pacific	43,470	1518	3.6	2.8
New England:				
Maine	1,251	10	0.8	
New Hampshire	1,124	-24	-2.1	
Vermont	585	o	0.0	
Massachusetts	6,128	54	0.9	
Rhode Island	NA	NA	NA	
Connecticut	3,394	119	3.6	
Middle Atlantic:				
New York	18,470	334	1.8	
New Jersey	7,812	-133	-1.7	
Pennsylvania	NA	NA	NA	
East North Central:				
Ohio	11,045	-106	-1.0	
Indiana	5,626	-177	-3.1	
Illinois	NA	NA	NA	
Michigan	NA	NA	NA	
Wisconsin	5,125	2	0.0	
West North Central:				
Minnesota	4,528	-82	-1.8	
Iowa	2,823	-19	-0.7	
Missouri	5,206	-118	-2.2	
North Dakota	628	-13	-2.0	
South Dakota	NA	NA	NA	
Nebraska	NA	NA	NA	
Kansas	2,527	-38	-1.5	
South Atlantic:				
Delaware	702	-15	-2.1	
Maryland	5,056	14	0.3	
District of Columbia	NA	NA	NA	
Virginia	6,552	-66	-1.0	
West Virginia	1,790	-38	-2.1	
North Carolina	7,042	-153	-2.1	
South Carolina	3,742	69	1.9	
Georgia	7,079	-122	-1.7	
Florida	14,275	109	0.8	
East south Central:				
Kentucky	3,765	-95	-2.5	
Tennessee	5,034	-222	-4.2	
Alabama	4,114	-139	-3.3	
Mississippi	2,657	-40	-1.5	
West South Central:				
Arkansas	2,404	-80	-3.2	
Louisiana	4,296	-46	-1.1	
Oklahoma	3,299	21	0.6	
Texas	18,278	-446	-2.4	
Mountain:				
Montana	NA	NA	NA	
Idaho	NA	NA	NA	
Wyoming	472	-8	-1.7	
Colorado	3,685	-62	-1.7	
New Mexico	1,644	-41	-2.4	
Arizona	4,132	-86	-2.0	
Utah	1,879	-72	-3.7	
Nevada	1,501	-29	-1.9	
Pacific				
washington	5,431	0	0.0	
Oregon	3,125	-16	-0.5	
California	33,052	1463	4.6	
Alaska	637	33	5.5	
Hawaii	1,225	38	3.2	

Notes: See text for details. NA refers to data not available. Figures exclude States with no data,

Table 7. Mean Absolute **Percentage Error for** State Projections 1 year-out from Selected Census **Bureau** publications

Regions	------- RepmtP25-1111 -------			-------- **Report** P25-1053 --------			**Report P25-1017**
	Series A	Series B	Series C	Series A	Series B	Series C	
United States	0.3	0.5	0.3	0.4	0.7	0.4	0.5
Northeast	0.3	0.6	0.3	0.3	0.5	0.4	0.2
Midwest	0.2	0.2	0.2	0.2	0.3	0.3	0.2
south	0.2	0.3	0.2	0.3	0.7	0.3	0.4
West	0.5	0.9	0.5	0.6	1.1	0.7	1.1

Source: See text for details.

California's Growing and Changing Population: Comparison of Experimental State Population Projections

Larry Sink
U.S. Bureau of the Census
Prepared for 1996 Federal Forecasters Conference

The purpose of this paper is to present and compare the results for California from two sets of experimental state projections which are preliminary versions of the Census Bureau's next round of state projections, which will be released as Population Projections for States by Age, Sex. Race, and Hispanic Origin: 1995 to 2025 (PPL-47). The methods used to produce the two sets of projections compared here are the same except for the models used to project state-to-state migration. One of the models employed here is the same as the Preferred Series of the most recent Census Bureau projections, the other is an economic model based on Bureau of Economic Analysis (BEA) employment projections. These models produce very different results for California, and offer an idea of the range of possibilities for California's rapidly changing population. Those wishing to obtain another perspective on California's demographic future may want to consult the projections prepared by the California state government (ref. 4).

California is not only America's largest state, it is also the fastest growing state in absolute terms, having added over one and a half million to its population between 1990 and 1994. Even more remarkable than the pace of its growth is the rapidity with which its population composition is changing. Both sets of projections indicate that White non-Hispanics will cease to be a majority of California's population by the end of this decade, and will be out-numbered by Hispanics within 20 years. Both series also show a rapid increase in California's Asian population.

The Census Bureau produces its projections using the cohort-component method (see ref. 1 & 2 for more detailed description of population projection methodology). In this method, population change is separated into its components, births, deaths, and migration, which are expressed as rates and projected independently. In the case of births and deaths, this is fairly straightforward. Fertility and mortality rates, when controlled for age, race, ethnicity, and (in the case of mortality) sex, tend to be fairly stable over time, even though there have been a few notable exceptions to this rule in the case of fertility. At the national level, past trends in fertility and mortality rates are studied and experts are consulted to determine the amount of change to be expected in these rates over the projection period, which are assumed to apply uniformly over all states. The state-level projections begin with the most recently observed rates, to which the national rates of change are applied over the projection period. Because it is more complex, migration is first divided into domestic, which is movement within the United States, and foreign, which is movement between the U.S. and foreign countries. Foreign migration poses the greatest problem for projection, depending as it does on future political decisions and circumstances in other parts of the world that are difficult if not impossible to predict. At the Census Bureau the decision has been made that the best way to deal with these difficulties is to set a reasonable level (with demographic detail) for net foreign migration based on the study of past levels and to hold this level constant over the projection period. The Census Bureau's national-level projections utilize three different levels of net foreign migration, a high and a low level to represent the limits of what is considered to be reasonable and a middle level to represent what is thought to be most likely, and produce different series of projections for each level. The Census Bureau's state projections use only the middle assumption and distribute this migration based on the proportions of foreign migration that the states have received in the past. Regarding domestic migration, we have data on state-to-state migration extending back to 1975. We analyze the trends in these flows and project each individual state-to-state flow. The net domestic migration for each state is calculated by summing that state's in- and out-flows and taking the difference, which is done for each year of the projection.

The same methods are used in the projections presented here. Birth and death data from the National Center for Health Statistics (NCHS) are used to compute state-level fertility and mortality rates (with demographic detail), which are projected by applying the annual rates of change used in the Middle Series of the Census Bureau's most recent national projections (see ref. 2). The middle level net foreign migration from the most recent national projections is used and allocated to the states based on the proportion of foreign migration that the states have received in the

past (see ref. 1), Most of this migration goes to just a few states, and California receives nearly **40%,** which is a major factor in the changes these projections produce for California's population.

The projections of domestic migration are based on state-to-state migration rates developed at the Census Bureau from administrative records data obtained from the Internal Revenue Service (IRS), whose trends are analyzed and projected using alternative mathematical models. These models are used to project the crude migration rates for each state-to-state flow, which are converted into **age-race-sex-ethnicity-specific** rates with the use of migration information from the 1990 census, by the same method used in the Census Bureau's most recent state projections (see ref. 1). Of the two domestic migration models used here, one is the same as the Preferred Series from the Census Bureau's most recent state projections. This approach uses a time-series model to project the first five years, then over the subsequent ten years interpolates from the time-series projection to the mean of the observed data for that flow, and **allows** the rates to remain at their observed means for the remainder of the projection period. The other migration projection model used here is an economic model which utilizes BEA employment projections (see ref. 4 for a description of these projections) and essentially treats the rate of change of state-to-state migration rates as a function of the rates of change in the employment rates in the origin and destination states. For ease of reference, the projection series that utilizes the time-series model is referred to as Series A and the series that utilizes the economic model is referred to as Series B. These projections are performed for **all** states and the District of Columbia, and carried out to 2025. The following analysis discusses the results of these projections for California.

Figure 1 displays the components of change for California observed from 1991 to 1994. Natural increase refers to the difference between births and deaths. Thus, the quantities plotted show the amount added to (or subtracted from) California's population by the excess of births over deaths, net domestic migration, and net foreign migration. As **can** easily be seen, natural increase and foreign migration both make consistently **large** contributions to California's population, while domestic migration consistently siphons off large numbers. Figures 2 and 3 display the projections of these components. Basically the same trends can be seen here, except that natural increase adds a progressively larger amount over the projection period and domestic migration subtracts a progressively smaller amount. Comparison of the domestic migration components in Figures 2 and 3 shows clearly the difference between the two migration projection models. In Figure 2 it can be seen that the time-series model keeps domestic migration near its last observed value for the first five years of the projection, then increases it sharply over the next ten years to the value that results from having all the migration rates set to their mean values. It should be noted that California's domestic migration depends not only on its population and migration rates to other states, but also on the migration rates **from** each of the other states to California and the populations of those states, thus the level of domestic migration can change even when the migration rates are held constant because of changes in the population distribution. As can be seen in Figure 3, the economic model projects domestic migration at a level similar to that of the time-series model out to 2000, but continues a slow pace of increase throughout the projection period which causes California to sustain very large losses to domestic migration for the entire projection period.

To understand the effect these trends have on the population composition of **California,** it is necessary to look at the composition of each of the projected components of change. Figures 4-9 present these components for both projection series broken down into race/ethnic categories. The domestic migration projections are presented in Figures 4 and 5. In both series, California's huge domestic out-migration seems to principally affect non-Hispanic Whites, with smaller but still substantial losses of Hispanics and relatively little effect on the other **race/ethnic** groups except for non-Hispanic Asians, who experience modest in-migration under the time-series model. The time-series model projects huge initial out-migration of non-Hispanic Whites which tapers rapidly to zero by 2009 and increases slowly thereafter, while the projected out-migration of Hispanics remains between 50,000 and 100,000 for the entire projection period so that the total out-migration of Hispanics over the projection period is similar in size to that of non-Hispanic Whites. In the economic **model,** on the other hand, California loses large numbers of non-Hispanic Whites to domestic migration throughout the projection period, and the out-migration of Hispanics, though consistently larger than in the time-series model, is substantially smaller than that of non-Hispanic Whites for most of the projection period. Figures 6 and 7 display the composition of foreign migration in the two series, which are the same except for small differences due to the differences in population composition between the two series. In both series, foreign migration adds about 160,000 Hispanics, between 80,000 and 100,000 non-Hispanic Asians, and about 50,000 non-Hispanic Whites to California's population in every year of the projection period. The number of non-Hispanic Black and American Indian foreign migrants is negligible. The projections of California's natural

increase from the two series are presented in Figures 8 and 9. In both series, the only groups to receive notable gains from natural increase are Hispanics and non-Hispanic Asians. Both groups gain somewhat more in Series A than in Series B because both have a somewhat larger population base in Series A as a result of smaller losses to domestic migration under the time-series model as compared to the economic. The remarkable aspect of these natural increase projections, however, is the tremendous increases they make to California's Hispanic population, which begin around 250,000 per year and increase steadily to over 400,000 per year by the end of the projection period!

The net effect of these components on California's projected population is shown in Figures 10 and 11, which plot the composition of California's projected population over time. Both series show the non-Hispanic Black and American Indian populations staying relatively constant and the' non-Hispanic Asian and Hispanic populations growing steadily over the entire projection period. In Series A the non-Hispanic White population declines in the earlier part of the projection period and then returns to its initial level, while in Series B it declines throughout the projection period. The non-Hispanic Asian and Hispanic populations both grow somewhat more rapidly in Series A. Despite these differences, however, both series present essentially the same picture of California's demographic future. Both show California transforming from a non-Hispanic White majority state with a substantial Hispanic minority and relatively small numbers of the other race/ethnic groups to a state which is predominantly Hispanic with a large non-Hispanic Asian population. Given the observed differences among California's various race/ethnic groups with regard to fertility and migration, the general changes forecast by these projections seem nearly inevitable. Different assumptions regarding the projection of these observed trends, as between the time-series and economic models presented here, only affect the timing of these changes.

The principal weakness of these projections is the set of assumptions regarding foreign migration that serve to allocate to California a relatively unchanging block of foreign migrants in each year of the projection period. If the numbers of California's Hispanic and Asian immigrants were to decline during the projection period, the composition of California's population would change more slowly. However, the assumptions which underlie our projections of California's natural increase have a much stronger theoretical foundation, and it is clear that natural increase alone would produce the changes discussed above, albeit more slowly, even though lower levels of immigration would somewhat reduce the natural increase of Hispanics and Asians. The recent severe recession in California's economy has undoubtedly played a large role in the huge losses California has sustained as a result of domestic migration. Because this out-migration has disproportionately affected non-Hispanic Whites, the speed with which California's domestic migration is projected to return to its historical levels will also affect the timing of the changes discussed above. It is even possible, though unlikely, that sufficiently high growth in California's domestic migration could offset the changes to its population composition caused by foreign migration and natural increase.

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2. Day, Jennifer Cheeseman, ***Population Projections of the United States by Age, Sex, Race, and Hispanic Origin:*** U. S.Bureau of the Census, Current Population Reports, P25-1 130, U.S. Government Printing Office, Washington, DC, 1996.

3. State of California, ***Projected Total Population of California Counties: 1990 to 2040, Report 93 P-3.*** Sacramento, CA, 1993.

4. U.S. Department of Commerce. Bureau of Economic Analysis. ***BEA Regional Projections to 2045: Volume 1, States.*** U.S. Government Printing Office, Washington, DC, 1995.

Figure 1. Estimated components of change for California, 1991-1994

d=net domestic migration **f=net** foreign migration **n=natural** increase

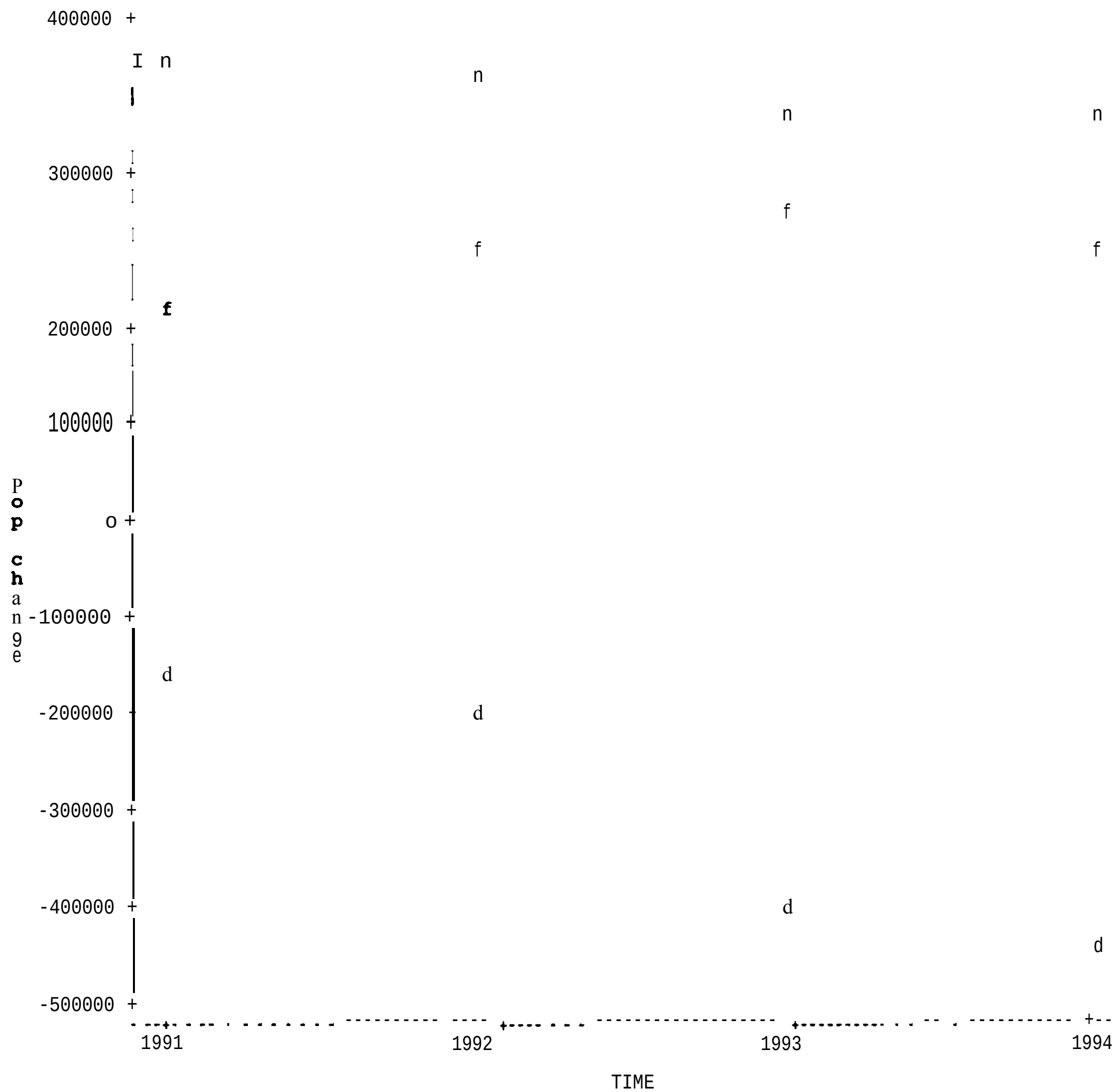

Figure 2. Experimental projections of components of change for California, 1995-2025

d=net domestic migration **f=net** foreign migration **n=natural** increase

Series A

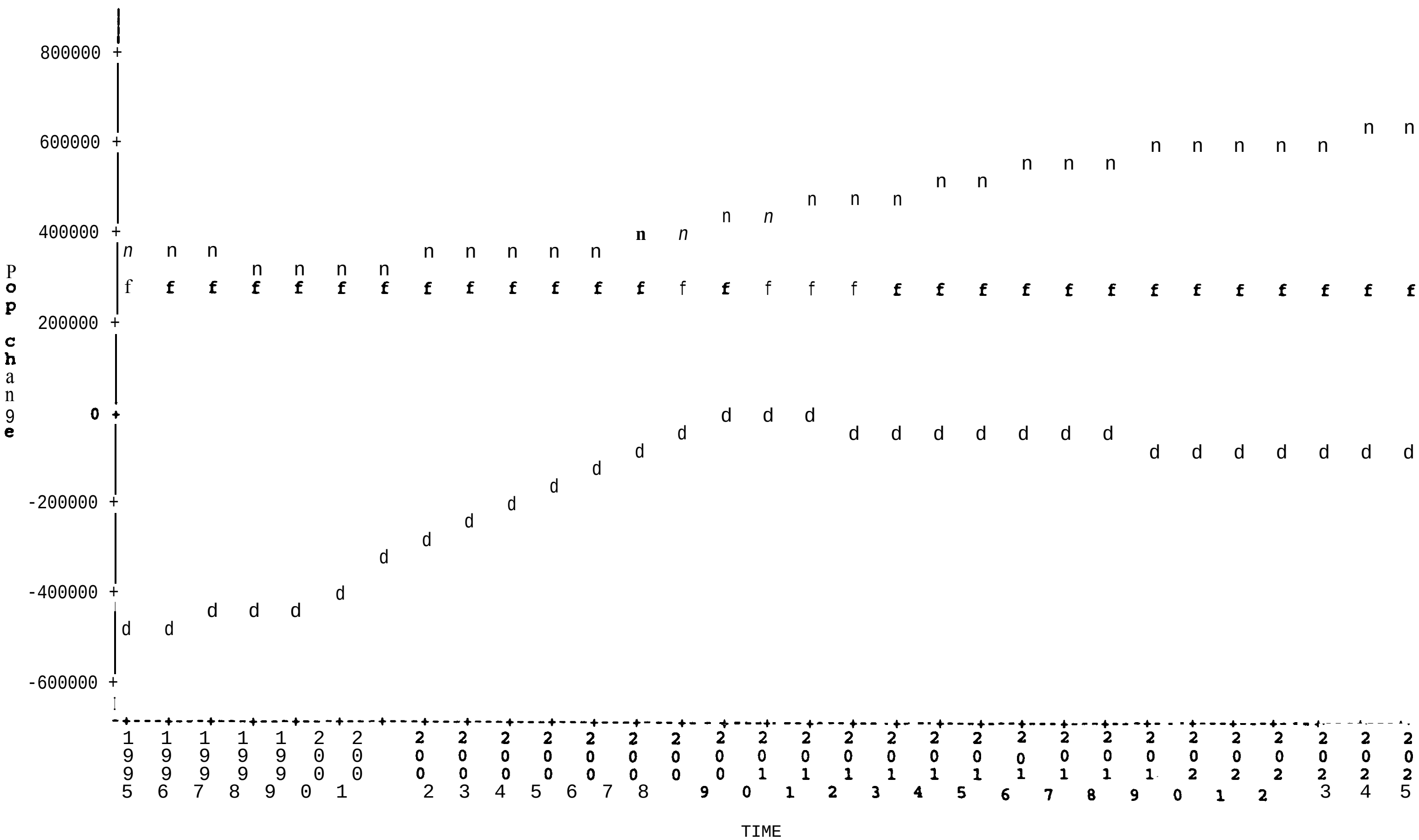

Figure 3. Experimental projections of components of change for California, 1995-2025

d=net domestic migration f=net foreign migration **n=natural** increase

Series B

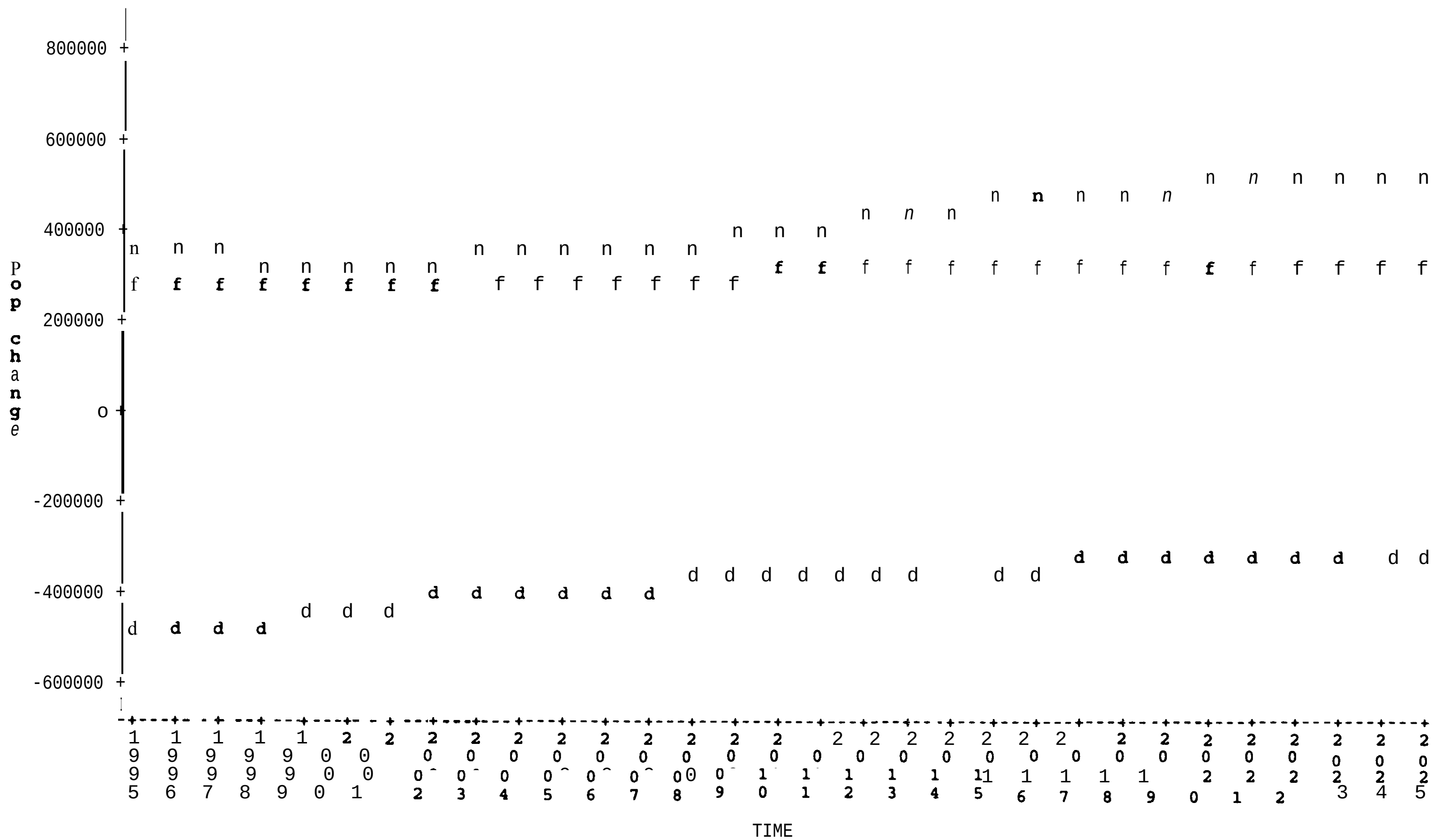

Figure 4. Experimental projections of components **of** change for California, by **race/ethnicity**

1=White non-Hispanic **2=Black** non-Hispanic 3=American Indian non-Hispanic 4=Asian non-Hispanic 5=Hispanic

Series **A**

Plot of domestic migration vs. time

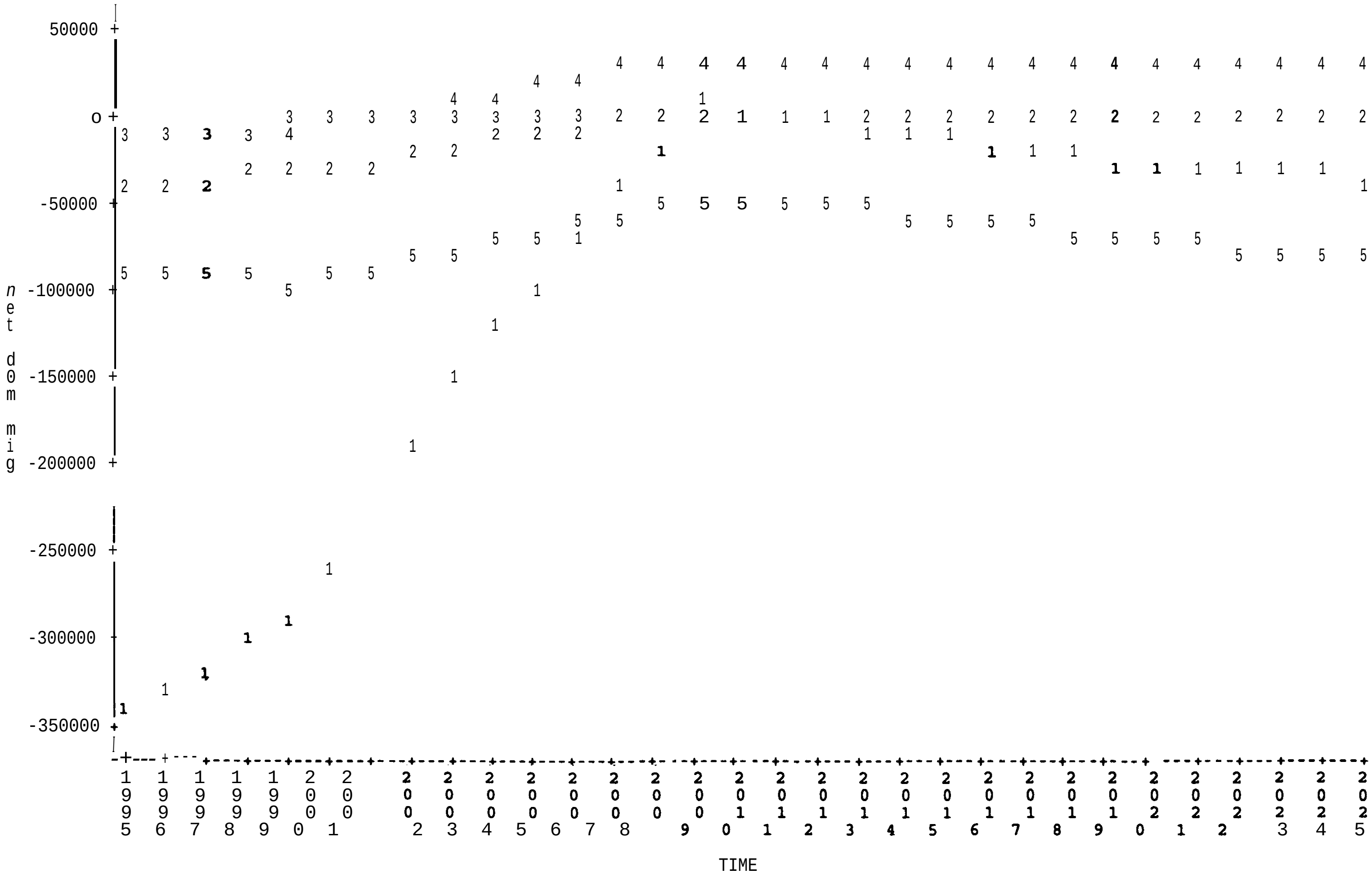

Figure 5. Experimental projections of components of change for California, by **race/ethnicity**

1= White non-Hispanic **2=Black** non-Hispanic **3=American** Indian non-Hispanic **4=Asian** non-Hispanic **5=Hispanic**

Series B

Plot **of** domestic migration vs. time

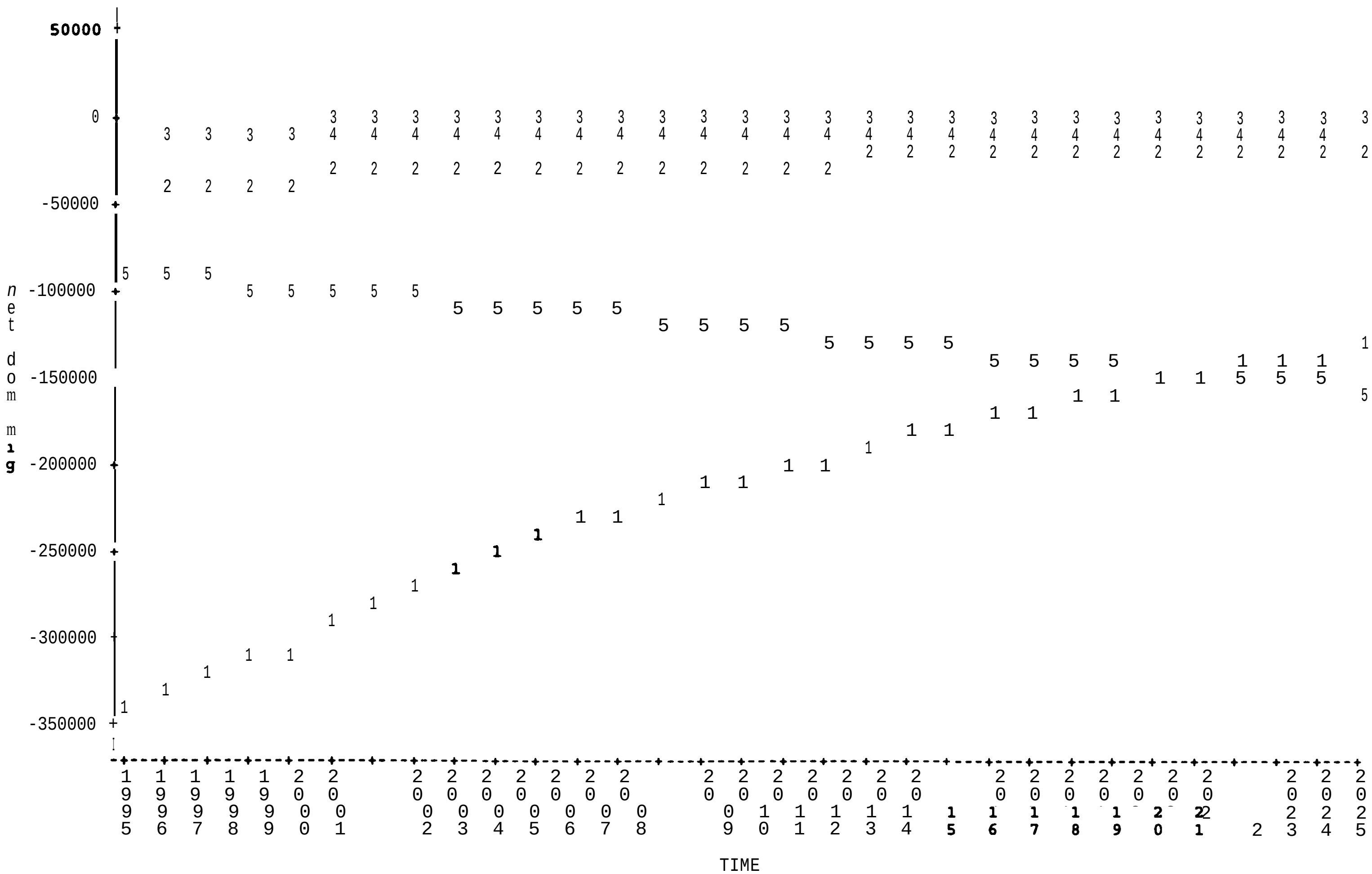

Figure b. Experimental projections **of** components of change for California, by **race/ethnicity**

1=White non-Hispanic **2=Black** non-Hispanic 3=American Indian non-Hispanic 4=Asian non-Hispanic **5=Hispanic**

Series A

Plot **of** foreign migration vs. time

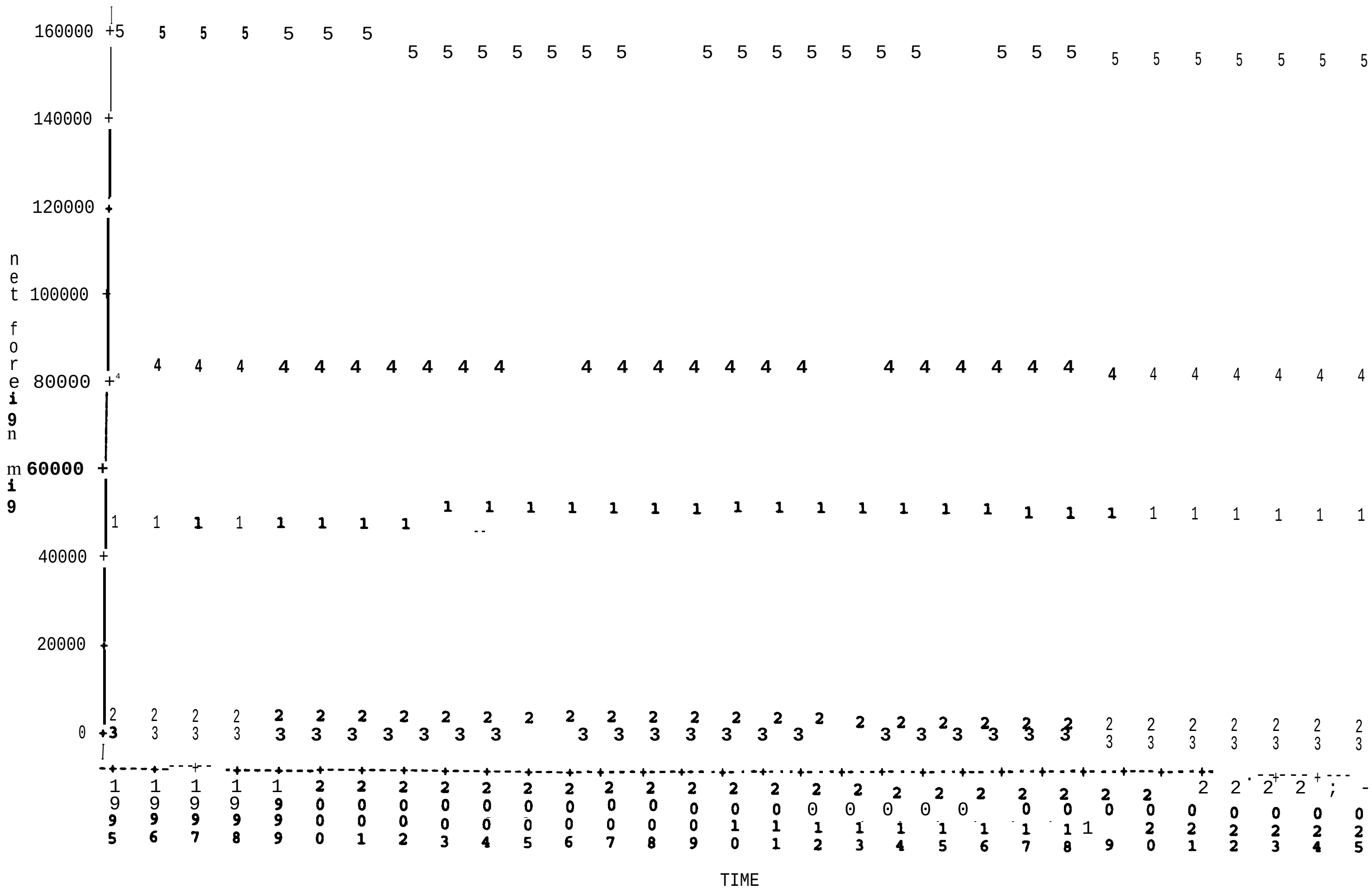

Figure 7. Experimental projections of components of change for California, by **race/ethnicity**

1=White non-Hispanic **2=Black** non-Hispanic **3=American** Indian non-Hispanic **4=Asian** non-Hispanic **5=Hispanic**

Series B

Plot of foreign migration vs. time

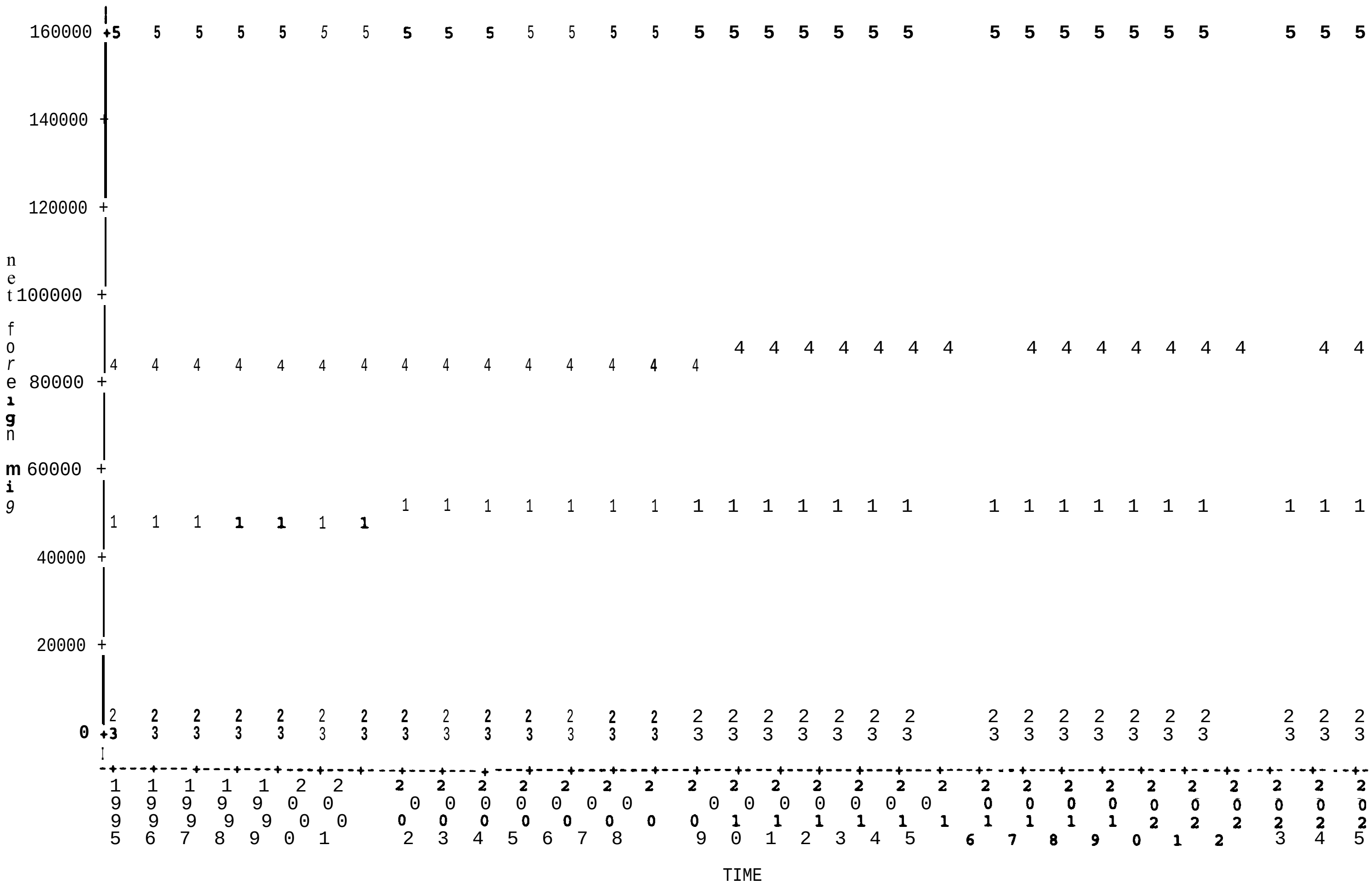

Figure *8.* Experimental projections of components of change for California, by **race/ethnicity**

1=White non-Hispanic **2=Black non-Hispanic** 3=American Indian non-Hispanic 4=Asian non-Hispanic **5=Hispanic**

Series A

Plot of natural increase vs. time

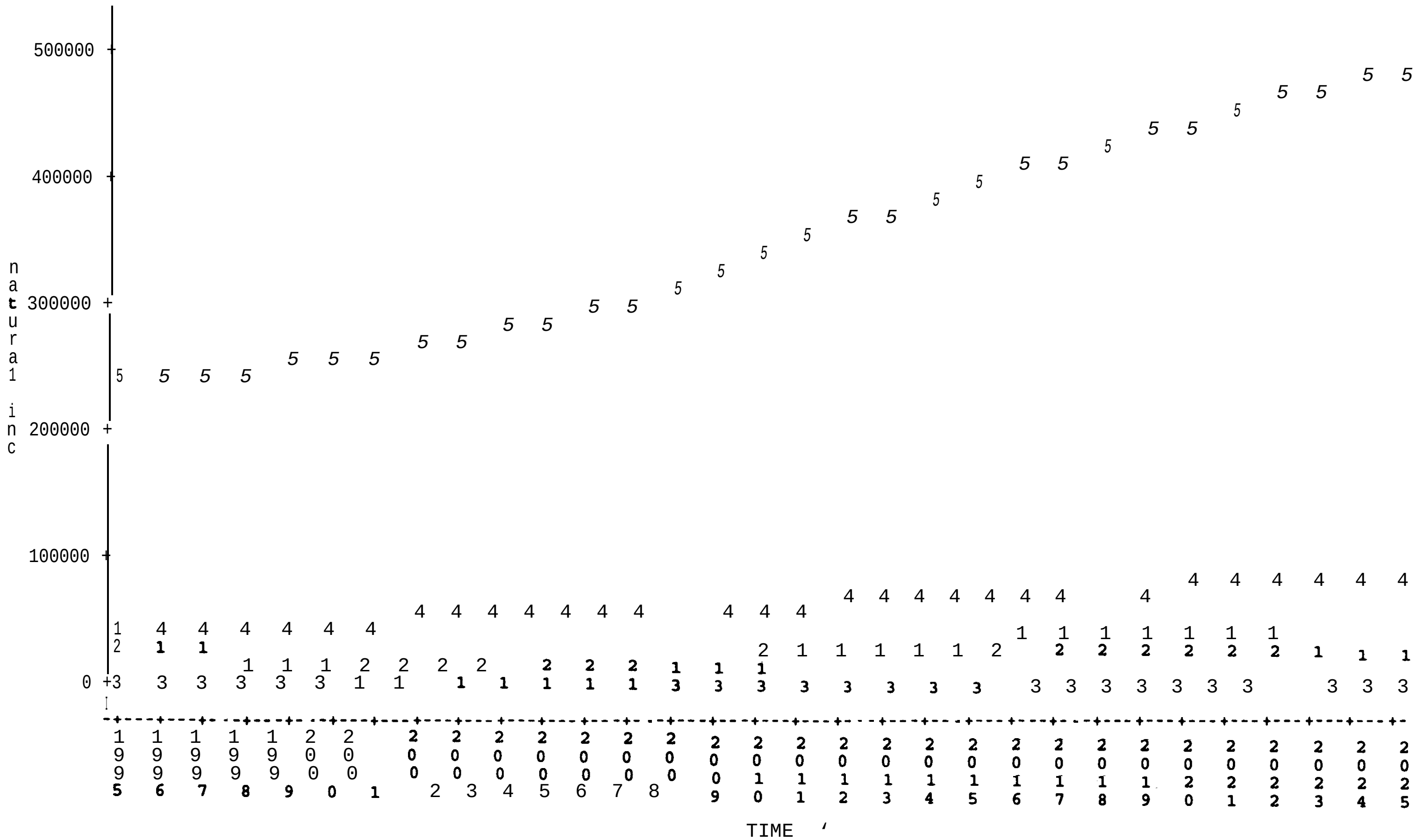

Figure 9. Experimental projections of components of change **for** California, by **race/ethnicity**

1=White non-Hispanic **2=Black** non-Hispanic 3=American Indian non-Hispanic **4=Asian** non-Hispanic **5=Hispanic**

Series B

Plot of natural increase vs. time

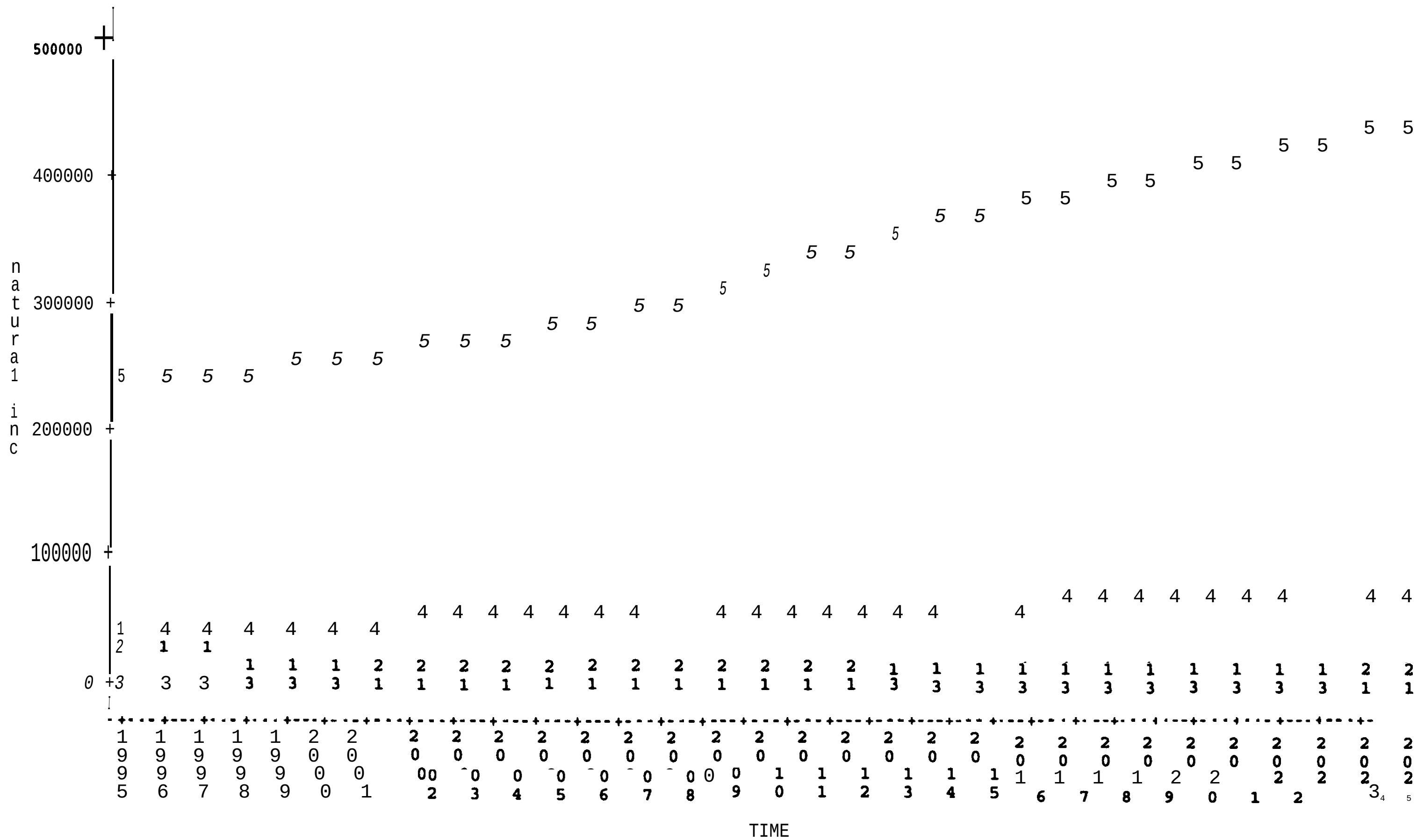

Figure 10. Experimental population projections for California by **race/ethnicity**

1=White non-Hispanic **2=Black** non-Hispanic **3=American** Indian non-Hispanic 4=Asian non-Hispanic **5=Hispanic**

Series A

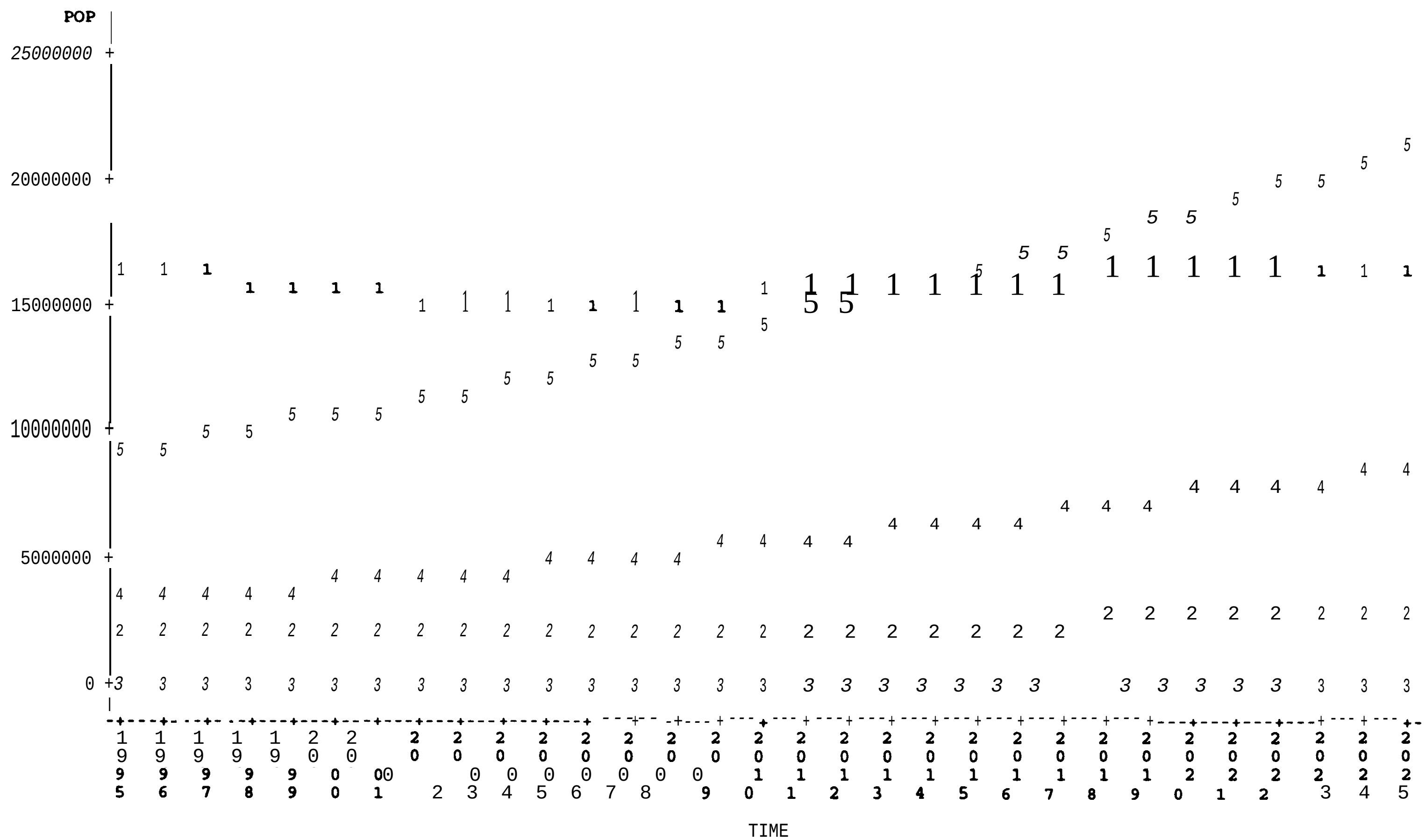

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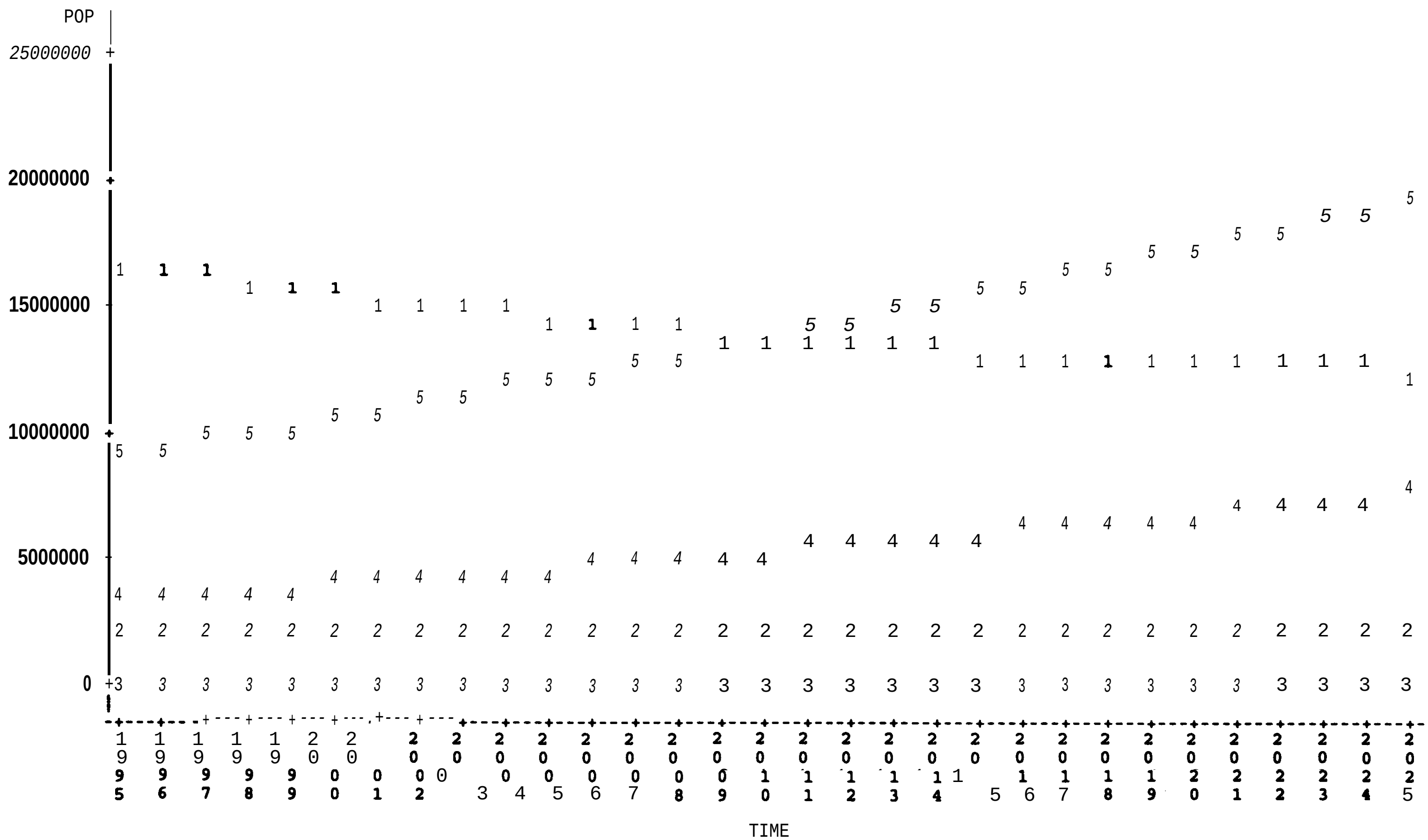
Figure 11. Experimental population projections for California by race/ethnicity

1=White non-Hispanic **2=Black** non-Hispanic **3=American** Indian non-Hispanic **4=Asian** non-Hispanic **5=Hispanic**

Series B



FORECASTING THE LONG RUN

Chair: Karen S. Hamrick
Economic Research Service, U.S. Department of Agriculture

How Federal Forecasters Can Use the Millennium Project,
Jerome C. Glenn, American Council forthe United Nations University

Beyond Ten Years: The Need to Look Further,
R. M. Monaco, INFORUM, University of Maryland
John H. Phelps, Health Care Financing Administration

How Federal Forecasters Can Use the Millennium Project

Jerome C. Glenn
American Council for the United Nations University

The Millennium Project of the American Council for the United Nations University is as a global capacity for early warning and analysis of long-range issues and strategies in cooperation with the Smithsonian Institution and The Futures Group with additional funding from Ford Motor company and Monsanto Corporation. It originated from a recently completed time-year feasibility study funded by the US EPA, UNU, UNDP, and UNESCO.

200 futurists and scholars from 50 countries participated in the feasibility study and concluded that the purpose of the Project should be to assist in organizing futures research, up-date and improve global thinking about the future, and make that thinking available through a variety of media for consideration in public policy making, advanced training, public education, and feedback to create cumulative wisdom about potential futures.

It is to accomplish these ends by connecting individuals and institutions around the world to collaborate on research to address important global issues. The project is not intended to be a one-time study of the future, but to provide an on-going capacity as a geographically and institutionally dispersed think.

The Project works with U.N. Organizations, governments, corporations, non-govemmental organizations and individuals to produce observations about global issues and opportunities and state-of-the-art methodology reports in a variety of media. To connect research to implementation, policy makers will be encouraged to participate in the Project's research, advanced training, and other forms of symposia. The project utilizes advanced telecommunications and software, as well as more traditional means.

During the first year of the operations, the Millennium Project will:

1. Conduct a 1996 Global Look-Out panel of Millennium Project participants who will be asked to provide observations and judgments about developments that suggest future world issues and opportunities. The first responses of a four round sequence are enclosed in this article. The 200 people from 50 countries listed in the feasibility study (available on the Millennium Project's homepage listed later) was the initial basis for this panel. Additional participants were added from literature searches and self-selected by finding the Project through various means including the Project's homepage on Internet.
2. Identify and construct "mini-scenarios" or "vignettes" as a means of describing changes as a part of the questionnaires we will use in the lookout panels. These are included in this article and compose a grid with the developments collected in the first round of the Global Look-Out Study.

3. Identify and organize major global scenarios. The Project welcomes your suggestions about recently published global scenarios that you think should be considered for inclusion in the Project's data base of important global scenarios.

4. Scan Internet, academic literature, and other sources for emergent trends, questions, issues, and potentially significant potential events. AC/UNU/Millennium Project Interns have begun identifying and entering items. Experiments to include public input to the scanning process will also be explored.

5. Integrate the results from these activities into a "State of the Future Report," in print, on-line, and possibly on CD-ROM, and other media.

Simultaneously, explorations will continue the development of Millennium Project "Nodes." Nodes are groups of organizations and individuals who take on responsibility for some demerit of the Project. The current nodes include Moscow (focusing on frontiers of futures research methodology), Cairo (focusing on advanced training in futures research and possibly implications of future developments for education), and Buenos Aires (for regional futures in South America). Some interest has also be expressed in creating nodes in Beijing, Paris, and Tokyo.

A portion of the Project's methodology work is supported by the Ministry of Science and Technology, Russian Federation and computer support from the Maui High Performance Computer Center, Hawaii.

Millennium Project Planning Committee was selected to reflect a range of views and geography. It includes:

1. Olugbenga Adesida, African Futures, UNDP, Abidjan
2. Mohsen Bahrami, Nat. Research Council of Iran, Tehran
3. Peter Bishop, University of Houston, Clearlake, Texas
4. George Cowan, Santa Fe Inst., Santa Fe, New Mexico
5. Francisco Dallmeier, Smithsonian Inst., Wash., D.C.
6. James Dater, University of Hawaii, Hawaii
7. Noriaki Funada, Dentsu Inst. of Human Studies, Tokyo
8. Nadezhda Gaponenko, Min. Sci&Tech Policy, Moscow
9. Jerome Glenn, American Council/UNU, Wash., D.C.
10. Michel Godet, Conservatoire d'Arts et Metiers, Paris
11. Horatio Godoy, Pres., INFODEC, Beunos Aires
12. Theodore J. Gordon, The Futures Group, Glaston., CT.
13. Hazel Henderson, Consultant, St. Augustine, Florida
14. Neil Kotler, Smithsonian Institution, Washington, D.C.
15. Qin Linsheng,Chinese Society of Future Studies, Beijing
16. Bruce Lloyd, South Bank Polytechnic, London
17. Pentti Malaska, World Fut. Studies Fed., Turku, Finland
18. Eleonora Masini, Pontifical Gregorian University, Rome
19. Shari Pu, Academy of Social Sciences, Beijing
20. David Rejeski, OSTP, House, Washington, D.C.
21. Siddig Salih, UN Econ. Corn. For Africa, Addis Ababa
21. Mihaly Simai, World Institute of Economics, Budapest
22. Robert Smith, The Futures Group, Washington, D.C.
23. Allen Tough, University of Toronto, Toronto
24. H. Wageih Hassan, Al Azhar U. &Al Arham, Cairo
25. Rusong Wang, Chinese Acad. of Sciences, Beijing
26. Norio Yarnarnoto, Mitsubishi Research Institute, Tokyo

Ex Officio

Kate Fish, Director, Public Policy, Monsanto
Michael Kaericher, Director of Strategic Issues, Ford Motor Company

1996 **GLOBAL LOOK-OUT STUDY**

The first round asked participants to identify current developments that may result in future world issues or opportunities and are not yet generally known or are seriously misunderstood.

The criteria for identifying the most important developments included: magnitude or severity of impact, number of people who may ultimately be affected, possibility that policy or human actions can make a difference, imminence of impacts, permanence or irreversibility of effects, and current lack of a responsible decision maker or leadership to address the development.

Participants were asked to describe the development, its potential consequences, goals and strategies to address it, and references. Three examples were given, Here is one:

Development: ***Increasing appearance of estrogen mimicking compounds in the environment resulting from the breakdown of plastics, insecticides, and other manufactured materials.***

Potential Consequences: ***Potentially diminished fertility and reproductive capacity of males of all species, including human males, disappearance of some species, backlash against chemical and industrial industries, rise in organic agriculture, pressure for cloning research, sperm banks more popular.***

Potential goal: ***Coordinated research and funding by producers of these compounds to produce substitution compounds that do not affect reproduction, and production of a simple self-administered diagnostic test to determine current status of these compounds' existence in the body, current effect on the subject's body, treatment options.***

References: ***"Our Stolen Future: How We are Threatening Our Fertility, Intelligence & Survival - A scientific Detective Story" by T. Colbourn, D. Dumanoski, and J.P. Myers, 1996.***

142 developments were collected. One-line distillations are included in the chart below.

SCENARIOS

The Millennium Project staff created three scenario axises harmonization vs fictionalization; strong vs weak economy, and individual vs communal orientation yielding a scenario space of:

1. Increasing Harmonization, Strong Economy, Individualism
2. Increasing Harmonization, Strong Economy, Communalism
3. Increasing Harmonization, Weak Economy, Individualism
4. Increasing Harmonization, Weak Economy, Communalism
5. Decreasing Harmonization, Strong Economy, Individualism
6. Decreasing Harmonization, Strong Economy, Communalism
7. Decreasing Harmonization, Weak Economy, Individualism
8. Decreasing Harmonization Weak Economy Communalism

Four of these were chosen for further development because the provided a sufficient range of possible futures in which to see how developments from the Look-Out panel might evolve and issues that should be considered.

They were:
Case 1. Cybertopia - successful completion of InfoAge
Case 3. The Aftermath - collapse of cybertopic
Case 6. New World Boards/Regionalism
Case 8. A Mean World of local groups against others

Descriptions of these scenarios and other elements of the Millennium Project can be found on the Millennium Project's home page at: http://nko.mhpcc.edu/millennium/Millennium_Project.html. Readers can self-subscribe to the Project Public Listserv at millen-l@american.edu; or write to AC/UNU/Millennium Project, 4421 Garrison Street, NW, Washington, DC 20016-4055 USA.

THE MILLENNIUM PROJECT

Developments from Look-Out Round 1 in Four Alternative Scenarios

Developments organized by Millennium Project Domains: Demographics and Human Resources Environmental Change and Biodiversity Technological Capacity Governance and Conflict International Economics and Wealth Integration and Whole Futures	**Cybertopia** Increasing Harmonization Strong Economy Individualistic Orientation	**The Aftermath** Increasing Harmonization Weak Economy Individualistic Orientation	**New World Boarders** Increasing Fractionization Strong Economy Communal Orientation	**A Mean World** Increasing Fractionization Weak Economy Communal Orientation
Domain 1: Demographics and Human Resources				
Population				
24. High population growth among poor nations and people.				
25. The growth of use and effectiveness of social marketing.				
31,59. Development of a means of extending life span by at least 25% through genetics or bio-drugs.				
38. Population growth seen as necessary to achieve economic growth and human vitality.				
79. Proposed pensions schemes and incentives to invite parents to have fewer or no children.				
92. Discovery that the maintenance of the tips of DNA is common to "immortal cells" (sperm, eggs, and cancer cells), and hence. we may learn how to genetically engineer the age of different parts of the body.				
114, 132. Increasing life span and changing age composition of the population.				
122. Development and widespread availability of a chemical which permits the selection of a male or female child before conception.				
138. Drastic reduction in the quality of human population in the Third World in the next 15-20 years as a result of hunger, growth of infections and chronic diseases.				
Migration				
34. Ecological migration from countries affected by desertification, floods, and deforestation.				
52. Migration of large numbers of people from the developing world to the developed world and from rural to urban settings.				

	Cybertopia	The Aftermath	Regionalism	A Mean World
Medicine and Health				
18. Gene therapy becoming a conventional therapeutic approach in medicine; initiative in the genetic approach to human health (GAHH).				
19. Completion of the Human Genome Mapping Project, leading to the capacity for predictive diagnosis and anticipation of behavioral propensities.				
32. The spread of sexually transmitted diseases (STDs) to women and young girls.				
48. Increased frequency of reemerging and new diseases.				
58. Some governments abdicating their responsibilities in public health as a result of budget contractions.				
108. Presence of HIV in 25% of the adult population of essentially all cities in sub-Sahara Africa.				
113. Increasing resistance to antibiotics.				
Food and Water				
39. Increased food scarcity owing to population growth and a general inability to increase production to keep up with that growth.				
40. Increased scarcity of fresh water, possibly exacerbated by global warming.				
61. Increasing need to improve water resources, for larger populations, and to alleviate demand and pollution pressures on existing waterways.				
102. Novel protein foods significantly replacing meat.				
119. China's buying of food on the world market impedes the ability of poorer countries to provide themselves with food.				
140. Deterioration of public and personal hygiene (public sanitation of water and waste streams).				
Education and Leisure				
22,84. Proliferation of information technology displacing many low-skilled, well-paid workers in the developed world; simultaneously, shortage of people with adequate skills.				
66. Distance learning increasingly practical, through the Internet and World Wide Web multimedia capabilities.				
71. "Learning Organization" concepts increasingly recognized as the most innovative and useful new management technique of the past decade.				
73. Through satellite TV/computer links, instant access to essentially everyone, and to all the information that is available in the world.				

	Cybertopia	The Aftermath	Regionalism	A Mean World
93. Integration of human consciousness and technology Increasingly technology is being put into and on the human body, and intelligent technology is being put in the environment.				
125. As a result of entry of many countries into the post-industrial era, growth of unemployment and free time, and the division of the population into "able" and "unable."				
139. Non-technological development of natural capabilities for increasing the effectiveness of the human brain (now 6 to 8%) by three to four times.				
Domain 2: Environmental Change and Biodiversity				
Pollution				
4. Development of affordable cars that produce ⅓ the amount of C02, are otherwise pollution free and do not require petroleum.				
27. Doubling of the demand for energy in less than 30 years as a result of population and economic growth.				
30., 135. Industrialization of China, India, etc., increasing the load on the environment by a factor of five to ten.				
83. Gridlock: Excessive urban motor vehicle traffic congestion, resulting pollution, and political backlash.				
109. Increasing appearance of estrogen mimicking compounds in the environment resulting from the breakdown of plastics, insecticides, and other manufactured materials.				
112, 116. Environmental issues on the horizon include: chlorine, electromagnetic fields, life cycle assessment, ultraviolet exposure, environmental hormones, and biological contamination standards for drinking water.				
Biodiversity				
8. Increasing number of micro-organisms that are immune to pharmaceuticals or pesticides.				
49. Essentially full control of the genetic and biochemical processes of living organisms				
50. Adoption of an effects-oriented approach to the monitoring of ecological systems, rather than measuring contaminants or physico-chemical properties.				
60. Initiating a search for and cataloging the vast variety of bacteria of the planet.				
127. Destruction of the environment, especially loss of biodiversity.				
Sustainability				
14. A false sense of security about the extent of natural resources				

	Cybertopia	The Aftermath	Regionalism	A Mean World
20,21. Increased understanding and education about interactions between human activities and the environment, e.g. Environment and Climate Program (CEC) and Consortia for International Earth Science Information Network (CEISIN).				
41. Corporate support for sustainable concepts.				
86,87. Sustainable communities, e.g. China's Comprehensive Experimental Communities for Sustainable Development, and Sustainable Technology Demonstration Project.				
142. Increasing pressure under the seabed associated with the plates' movement, accumulating energy to cause earthquakes, especially around Tokyo area.				
Policy				
89. Key opinion shapers making light of the risk of global climate change, the existence of uncertainty is being widely interpreted as meaning that there will be little or no effect.				
105. Environmental security becoming an important concern in foreign policy.				
Domain 3: Technological Capacity				
Information and Communications				
15. Extremely smart and flexible computers; real artificial intelligence.				
111. Availability of continuous speech, user-independent, computer voice input systems making possible a new sort of human to machine interface that requires no training.				
136. The spread of the Internet.				
Biomedicine and Psychiatry				
6. Development of brain-like intelligent systems using neural networks, to help achieve a more fictional understanding of human intelligence.				
47. Personal health history records in the form of intelligent credit cards				
62. Symbiosis with the computer-even via the keyboard.				
104. New understanding of the functioning of the brain, leading, perhaps to understanding of self consciousness.				
123. Ability to change basic human characteristics, through genetic engineering or chemical interventions.				
Search for Extra Terrestrial Intelligence				

	Cybertopia	The Aftermath	Regionalism	A Mean World
16,45. Successful scientific search for extraterrestrial intelligence.				
Search for Knowledge				
7. Recognition that there is far more to learn in physics and other disciplines, that the frontiers of knowledge are unbounded.				
26,43. SO-called "cold fusion" (which is probably neither} tapping new energy sources by several different routes.				
46. Development of faster than light travel.				
51. Decreasing human skills development in concept formation and communication in an increasingly complex world.				
56. Need for scientific and philosophical thinking to explore the ethical foundation of advanced sciences and the scientific foundation of contemporary ethic.				
141. New kinds of knowledge production and certification, new earners of knowledge (think of environmental groups as one example).				
Machines				
5. Airplanes that can reach orbit at much lower costs than current methods.				
42. Development of viable hybrid automotive technology.				
100. Power Relay Satellites in geosynchronous orbit, Solar Power Satellites in Earth orbits, and Lunar Power Satellites on the lunar surface.				
101. Satellite systems providing virtually instant, ubiquitous communications connectivity between both fixed and mobile users, including telephony, video, data, and multi-media.				
110. Nanotechnology (or molecular engineering)--construction atom by atom on the scale of a nanometer (one billionth of a meter).				
133. Aging of existing nuclear power plants.				
Domain 4: Governance and Conflict				
War and Political Instability				
11. The threat of weapons in outer space.				
23,33. Religious, racial, ethnic, ideological wars such as in Rwanda and Liberia.				
36. Mexico's recurrent economic and political crises provoke national disintegration posing see and immediate challenges to the U.S. and the North American Region, including low intensity conflict.				
77. Emergence of nationalism in Asia, e.g. Japan (including the possibility of a Japanese military buildup), in response to the continued pressure from the U. S., China and Korea.				

	Cybertopia	The Aftermath	Regionalism	A Mean World
90. Information warfare; the deliberate insertion of false data or manipulation or falsification of information by electronic means to achieve political ends.				
106. The "patriot" movement gains strength in the US and causes legal, police, and military responses to assure public tranquility in the nation.				
115. Deepening of ethnic sentiments in populations (homonization of economies and knowledge, but heterogeneity in terms of ethnic affiliation and stronger determination of ethnic boundaries).				
118. China turns militant, possible wars with India and Russia or against an alliance between these two, possible war with Formosa.				
120. US retreats from the position of "world policemen."				
129. Threat of regional nuclear conflict when more and more countries and potentially terrorist groups will have access to nuclear weapons.				
Terrorism and Crime				
3, 134. Nuclear terrorism and proliferation posing far more of a threat to the survival of the human species than is generally appreciated.				
37. High-tech terrorism.				
70. Organized crime groups becoming sophisticated global enterprises with the know-how to yield enormous illegal profits (information fraud, organ traffic, arms traffic, etc.).				
107. The public becoming fed up with crime, recidivism, and liberal courts; reinstitution of the death penalty, harsher penalties, pushing the limits of "cruel and unusual" penalties.				
131. A generation of children whose behavior has included extreme criminality at an early age, resulting in an increasing siege mentality among law-abiding citizens.				
Violence				
54. Violence as a global problem. Sources, instruments, promotion and exploitation of violence abound (movies, TV, drugs, fundamentalism, racism, terrorism).				
103. Introduction into military, police and terrorist arsenals of non-lethal weapons, including, for example, aerosols that induce sleep, and sticky foams.				
128. Violence in the mass media and aggressive advertising support the increasing expectations of a consumer society that cannot be fulfilled in real life.				
Therapies for Conflict				
55. Globalization: increasingly clear demand for global thinking, responsibility, ethics, approach, effort, action and results.				
63. Space as insurance against the destruction of humanity				

	Cybertopia	The Aftermath	Regionalism	A Mean World
(&iveman-				
2. The global Islamic community beginning to adopt futures thinking in establishing its plans and **goals.**				
12. Increasing complexity of issues that lead to conflict, outstripping ability of institutions to **anticipate** and deal with the issues.				
13. Failure of educationsystem to develop leadership skills.				
57. Increasing failure of governments in 1st world countries due to inability to manage complex **systems** in a global village-widening gap between rate of technological change and **societal/institutional** change.				
58. Information/communication technologies increasing the ability to simultaneously **decentralize/localize/fragment** and to **centralize/globalize/integrate.**				
72. A preoccupation with power at **all** levels of society (and in our education system).				
124. Ineffectiveness of political andeconomic institutions, above all at a supranational level.				
Economic Systems				
55. Capitalism stands essentially unchallenged as the dominant economic system throughout the world.				
121-. Europe turns into a major world player, rejuvenates and creates a new identity of the occident.				
126. The uneven and unfair distribution of wealth among nations (North/South divide) and also within nations.				
130. The increasing deterioration of the international monetary system, based mainly on US dollars.				
Domain 5: International Economics and Wealth				
Rich-Poor, and other Gaps				
9. Increasingly apparent conflicts between economic and societal **aims;** economic measurement and incentives **subvert** social growth.				
O. Growth in the number of aging seniors place burden on younger generation.				
53. The inability of developing countries to use developed technologies the power of technology is limited by the ignorance of users.				
57. Improving economic status of many "developing" countries, thus increasing global demand for **food,** energy and **manufactured** products.				
74. The widening economic gap between the "haves" and "have nets" within and between countries.				

	Cybertopia	The Aftermath	Regionalism	A Mean World
85. High population growth and high educational achievement of many developing nations producing more highly educated citizens than their economies can productively employ.				
Work				
29. Interactive information technology systems become widely used in work, education and other social functions.				
35. Increase in the impact of new technologies, especially in the service sector.				
137. Changing composition of the workforce; shift in labor from industrial to service sector.				
Organizations				
28. Decentralization of institution big corporations are breaking up into small, self-supporting units, big government welfare state policies are being dismantled.				
69. The human tendency to discount distant space and time (i.e., focus on the "here and now") is increasingly dangerous.				
International Economics				
75. Natural resources being bought by international cartels, with unprecedented speed and scale; in a decade, 70% of natural resources will be controlled by private financial powers.				
76. Family business increasing its presence, power and influence over many aspects of politics, economics and culture, without proper market competition or public scrutiny.				
88. Environmentally-adverse forms of energy perpetuated in part because of economic distortions and incomplete accounting for costs.				
91. Tele-national citizens (Third World people who live and work in First World but help develop their countries via tele-commuting).				
Domain 6: Integration and Whole Futures				
Planning and Futures Research				
1. The failure of linear thinking about the future				
81. Increasing ability of individuals and decision-makers to assess a broader range of issues.				
94. Growing distance between dreams and expectations, deriving from fear of dystopic futures.				
97. The economic value of information is becoming more important than information sought for other purposes.				
98. The growth and change of the meaning of expertise; the tendency to lean on experts and leave it to them to tell the rest of us what to do.				
The Pursuit of Meaning				

	Cybertopia	The Aftermath	Regionalism	A Mean World
17. The eager pursuit of greater meaning and purpose from work and from life (among many groups of people, not just those with plenty of fbod and possessions).				
99. The growing feeling of **guilt;** we know more and more about human-made problems, environmental and other, and feel less and less comfortable with our everyday life and practices.				
Social Change				
64. Memes (postulated as the smallest unit of social evolution) becoming a new method for planning and directing the evolution of technology and society.				
82. Participatory round tables that include the ability to weigh interest and quality of contributions in given time frames and creating a new form of structuring meetings and conferences.				
95. The blurring of the borderline between truth and fiction; the certainty of reality is disappearing from our conception of the world.				
96. The blurring of the borderline between private and public.				
117. Changing role of women in society.				
New Age				
44. Wild Card: return of the Messiah, Sri **Satha** Sai Baba				
78. Reconsidering consciousness, wholeness, and synthesis				
80. Use of space and visual access as a new way to approach synthetic realm, making use of Virtual Reality and **Cyberspace** in design.				

FEDERAL FORECASTERS CAN USE THE MILLENNIUM PROJECT IN A NUMBER OF WAYS BY BECOMING A SPONSOR

1. Multi-disciplinary, multi-cultural, and **multi-**institutional **feedback** on your questions. The questions can be stated as a development in the Global Look-Out studies, posed in the group messaging processes, and or sent directly to relevant Millennium Project participants.

2. Connect quantitative and judgmental forecasting. Variables within quantitative models used by federal forecasters can be defined by judgmental inputs from participants.

3. Access to individuals and institutions around the world.

4. Gives you an extra eye on international environmental scanning for emerging issues that might otherwise have "blind-sided" you.

5. International assessment and up-dates on methodology via ***Frontiers of Futures Studies: Handbook of Tools and Methods (1996),*** General issues of methodology in the ***State of the Future Report*** (1 **997),** and Specific contracted global studies. Several are currently under design such as rules-based models of development, and applications of non-linear dynamics societies in transition using Russia as a case study.

6. Organization of scenarios and assumptions about the **future** to check for completeness of our own. The ones included in this study are backdrop scenarios, but an annotated scenario system.

7. Draw on output as it is developed to see impact on your specific concerns and **feedforward** to help shape the project bean international utility to you.

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BEYOND TEN YEARS: THE NEED TO LOOK FURTHER

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Introduction

Projecting anything ten years into the future is, in many people's opinion, a futile exercise. However, sometimes projecting only ten years into the future is not sufficient. In public policy, actuarial projections of the status of the Social Security trust fund and the Hospital Insurance (HI) trust fund look more than 50 years into the future. For public policy areas where the age distribution of population is important, projections that stop before the baby boom generation begins to retire will tell only a part of the story. There are predictable consequences of current and past public policy decisions that arise out of that changing age distribution. Designing a policy that works well only until that generation begins to retire seems -- to stretch a phrase -- somewhat short-sighted.

Actuarial projections are not generally done with a consistent economic model. In this paper, we try to show how and when a consistent economic framework is needed to make more useful projections for public policy analysis.

Background to Recent Work

Since 1993, the Office of the Actuary (HCFA) and INFORUM have developed and refined a tool that defines and quantifies the economic links between the health care sector and the rest of the economy. We anticipated using this tool for at least two purposes. First, we anticipated using it for general research and policy analysis. The LIFT framework has already been used several times this way. For example, in Monaco and Phelps (1994), we used LIFT 2010 to conclude that comprehensive health care reform would benefit the economy as a whole after an initial phase-in period. In Monaco and Phelps (1995), we used the LIFT framework to highlight the role that health care prices play in causing federal budget deficits, and pointed out that lower health care prices, given the current federal role in financing health care, would lead to a lower federal deficit through both direct and indirect thanks. This work also implied that comprehensive health care reform, to the extent that it resulted in lower health price inflation with little or no reduction in the quantity or quality of services, would have important benefits for the rest of the economy. [2]

The LIFT framework could also serve a second major purpose, namely, it could contribute some insights into the Office of the Actuary's projections work. The Office develops projections of health care spending, along with projections of the actuarial status of the Federal Hospital Insurance Trust Fund. In this paper, we examine what insights LIFT 2050 can bring to the Office's projections.

Variables in the Current Projections Work

The current projections work is largely actuarial.[3] Exogenous assumptions about population and economy-wide inflation are combined with demographic and service-specific factors to develop spending projections by 18 types of goods and services. These spending projections are compared with projections of "funds available to pay for that service" and iteratively adjusted to settle on the path of spending for each good and service. (Burner and Waldo, p. 223.)

In recent published work, the economy-wide inflation rate is the only "identified" exogenous macroeconomic variable. Previous work suggests there are other economy-wide variables are implicit in the service-specific factors. For example, the number of physician visits per person (per-capita use), depends on real consumer income and how generously the federal government subsidizes medical care purchases. Similarly, how much is typically spent on each physician visit (intensity effects), will also vary along with real consumer income and the generosity of government subsidies (Freeland and Schendler, p. 8.).

Paths for macroeconomic and demographic variables relevant to the health-care projections work are taken from various sources. For example in Burner and Waldo (1995), projections of macroeconomic variables are taken from the President's budget for fiscal year 1996. Population

projections are taken from the 1994 Old Age, Survivors, and Disability Insurance (Social Security) report. The horizon for this set of projections is 11 years (1994-2005). Longer term projections -- through 2030 -- were published in Waldo et. al (1991) and Burner et. al. (1992). Macroeconomic variables and demographic projections for these very long-term projections were taken from the Social Security trust fund reports of the respective publication year.

The authors of these studies are quick to point out that the actuarial approach does not incorporate feedback from the health sector to the rest of the economy. At the same time, the projections are put forth asa . . . " 'basecase' against which the advantages and disadvantages of proposed reforms can be measured" (Sonnefeld et. al., p. 1.). In the rest of this paper, we discuss the feedback problem and ask whether strict actuarial projections can be improved by incorporating general economic feedback into the "base case" projections.

The Feedback Problem

The actuarial approach to economic projections and the "economic" approach are very different . The strict actuarial approach largely relies on "disembodied" trends. In other words, values of health-sector variables change over time, but their evolution is not related directly to other factors. In practice, the matter is more complicated. One recent characterization of the approach is found in Burner and Waldo (1995):

> The model is actuarial in nature because it relies primarily on trend analysis to project the factors accounting for the growth in spending. However, in using this model, we have not simply extrapolated from past trends. Instead, we have used the model as a framework to incorporate certain actuarial, statistical, economic, and judgmental factors (p. 222).

From this passage it is clear that this approach is much more sophisticated than the strict actuarial approach. However, there does not appear to be a formal set of equations that link the trend analysis with the "actuarial, statistical, economic, and judgmental factors" that complete the analysis. In other words, there appear to be no formal equations linking changes in the health sector variables to nonhealth care sector variables. Without such equations, two issues arise. First, are the exogenous macroeconomic and demographic assumptions consistent with the projections in the health care sector that they help to develop? Second, if there is an inconsistency, does it seriously compromise the validity of the health care spending projections?

We can turn to the Social Security trust fund projections to highlight the consistency issue. The most recent Social Security trust fired report predicts the trust fund will be insolvent in 2030 under base assumptions. After 2030, the fund is assumed to borrow in credit markets. The base macro assumptions behind the insolvency projections are arrived at independently of the status of the Social Security fund. After 2019, values for real growth, productivity, real interest rates, etc. are held constant at their "ultimate" values -- averages over a previous long-term history. No consideration is taken that real GDP growth in the history was generated during a period when social insurance funds had small and growing surpluses. Real interest rates are not allowed to vary as the fund moves from surplus to deficit. By assumption, the overall economy is unaffected by the switch from small, growing surplus to large, growing deficits.

Is this a reasonable assumption? Are constant real GDP growth rates and constant real interest rates consistent with the inexorable movement of Social Security from surplus to deficit, and then, an ever-widening deficit? Most, if not all, policymakers (and forecasters) would answer no. That is, most appear to believe that the status of the Social Security trust fund at least partially determines the health of the economy. Moreover, attempts to preserve the solvency of the trust fund -- via taxation or reduction of benefits -- will also influence real economic growth.[5]

Actuarial reports often include ranges in an attempt to encompass a variety of macroeconomic futures. That can be useful, especially if such alternatives are themselves macroeconomically consistent. However, the use of ranges does not, by itself, address the feedback issue. For example, if a deteriorating balance tends to raise real interest rates, which may then make the balance deteriorate faster, this is not incorporated into the macroeconomic variable ranges.[6]

In addition to macroeconomic feedback, there also may be feedback to demographic variables. More generous Social Security or Medicare payments may induce earlier retirement or lead to longer life

expectancies, with corresponding second-round effects on Medicare and Social Security trust fund solvency. There are feedbacks from the macroeconomic outcomes to the demographic outcomes. For example, a faster-growing economy with low inflation and low interest rates is likely to attract more immigrants (and assimilate them) than a less favorable macroeconomic environment.

Projections of a Growing Health Care Sector

A common theme of recent health spending projections is that the health sector will account for ever-larger shares of current dollar output. In Burner and Waldo (1995), the share of national health expenditures in GDP is projected to rise 4 percentage points -- to 17.9 percent -- between 1994 and 2005. In projections done to 2030, the share is projected to 30 percent of GNP. Because this ratio is used in public policy discussions and is a much quoted output of the projections work, it merits some discussion here.

Burner and Waldo show that it is possible to raise the health spending share by 4 percentage points without reducing 'real nonhealth GDP per capita. But, this calculation assumes that real GDP growth is unrelated to its composition. This poses an interesting dilemma. To the extent that we assume overall GDP grows at some "natural" rate, independent of what is produced, then the health share -- or any other industry share -- is irrelevant. What matters is the unmeasurable "social welfare" that derives from a particular composition of GDP. For small variations in the sizes of some sectors, the independence of what is produced from how fast the economy grows is of little importance. However, few would argue that the level of GDP in the future is truly independent of the structure of production across larger variations.

Suppose that, rather than making overall GDP growth exogenous, we allow the nonhealth part of GDP to be exogenous. We can then ask what happens to real GDP as the health sector evolves. In this case, real GDP growth is a combination of the two sectors' growths. If full employment is always assumed, then increasing real health spending as a share of GDP can only arise by increasing health sector productivity or by taking resources from the nonhealth sector. Moving workers from one sector to another must affect the path of GDP, except when labor productivity in the health and nonhealth sectors are the same.

When health sector productivity is lower than the average, moving workers to the health sector must reduce real GDP (assuming full employment). There is again a single exception: nonhealth sector productivity could rise to offset the loss of workers. The only way this can occur is if there is a strong positive relationship between the share of the health sector in the economy and nonhealth productivity growth. However, we ruled that possibility out by assuming nonhealth GDP to be exogenous.'

From the above discussion, it appears that allowing GDP growth to be unchanged as the health-sector share of activity changes can cause problems. However, the above discussion has focused only on the changes in quantity of services produced. A similar set of issues arises when rising medical prices are the reason the health share of GDP increases. These issues are discussed more fully in Monaco and Phelps (1994).[8]

Measuring Feedback

Simply identifying that feedback is an issue does not tell us that it is important. If it is not very important, then acknowledging feedback is interesting, but will do little in the way of improving the projections. To measure the strength of feedback, we tried two experiments with LIFT 2050. First, we examined the sensitivity of the economy to changes in the prices of health care goods. To do this, we forced the average hourly labor compensation rate in the medical sector to grow faster than the growth of hourly labor compensation in the entire economy. We forced wage growth in the medical sector up enough to cause the price of health care to grow one percentage point above baseline values. We call this the "Prices-Up" scenario.

In our second experiment, we raised real consumer spending on medical-care goods by enough to approximately match the rise in nominal consumer health spending in the Prices-Up scenario. We call this the "Real Services-Up" scenario. The two alternative scenarios make use of two other important assumptions:

o Medicare and Medicaid are assumed to maintain their share of nominal health spending.

o No government tax changes to offset rising deficits in the Social Security and Medicare trust funds.

These simulations attempt to measure the extent to which changes in the assumed "health inflation premium" and " intensit y" factors can influence the rest of the economy across a large span of years.

Prices Up Scenario

Table 1 shows the effects of increased health-price inflation on several variables of an increase in health price inflation. From the outset, it useful to point out that we are examining effects in the neighborhood of figures currently used in policy documents. That is, we are not working at some **arbitrary** point where sensitivities are large. For example, Burner and Waldo arrive at nominal NHE growing 2.5 percentage points faster than nominal GNP through 2005. The Prices Up scenario moves the growth differential from 2 percentage points to 2.5 percentage points. Thus, the Prices Up price increase merely brings the Base health care spending up to the differential projected in Burner and Waldo.

In general, the results in Table 1 suggest that a 1 percentage point increase in rate of health inflation brings the following results over 10 years (through 2005):

o Raises the personal health spending share of GNP by 0.8 percentage points in the tenth year.

o Raises the average inflation rate for the economy by 0.2 percentage points.

o Reduces the number of jobs in the tenth year by 500,000 (with a 500,000 loss in the medical services sector.

0 Reduces real GDP growth by 0.1 percentage point 1995-2005.

0 Raises the federal deficit as a share of GNP by 0.3 percentage points in the tenth year.

These summary figures suggest how the macroeconomic projections might be altered if the HCFA projections raise the "premium" by which health prices grow relative to the overall inflation rate. They also point out that how consumers change their medical services consumption in response to higher medical care prices can dominate the overall real GDP and employment story.

The effects on the economy of long periods of health price growth are remarkable, as **Table** 1 shows. For example, by 2050, the consumer health spending share of GNP has risen by 6 percentage points, while the inflation rate continues to be 0.3 to 0.4 percentage points higher than the base. While the overall economy has lost 2 million jobs, the health sector itself has lost 6.2 million. The reduction in medical services employment is due to lower consumer demand for medical services in the face of an ever-increasing relative price of medical care.

A major effect of faster health price inflation is a spectacular rise in the federal deficit, which by 2050 is up by 4 percentage points relative to GNP (see Table 2 for details). The Prices Up scenario raises the deficit enough to raise short term interest rates by 50 basis points and long-term rates by 110 basis points. The interest rate increases initially keep pace with increased inflation, tending to keep real interest rates unchanged. Between 2015 and 2030, real interest rates are higher with higher health-price inflation, and after 2030 they are substantially higher. The increase in real interest rates reflects the effects of a large and growing federal deficit on the demand for credit. A major portion of the growing federal deficit is due to the deficit in LIFT's combined social insurance **fund.**[9]

The bottom panel of Table 2 shows the extent to which higher health care inflation affects the federal budget. Deflating all the accounts by the GDP deflator -- which in the case of health care transfers measures the opportunity cost of spending -- real federal spending per-capita is about 20 percent higher with higher health care inflation. Of the increase ($2076 per person) due to higher health care inflation, $907 is due to the direct effects of higher health care spending and $1191 is the increase in interest payments on the federal debt. Thus, about 60 percent of the effect of higher health care spending on the federal budget is indirect, coming about through a higher federal debt and higher interest rates.

Table 3 shows further interesting indirect effects of higher health care price inflation. In LIFT, higher prices in a sector are directly linked to the returns to that sector. In fact, it is convenient in LIFT to raise factor payments -- in this case labor compensation -- to raise prices. However, the effect of prolonged periods of health sector inflation in excess of the overall rate is huge increase in the relative wage of the medical services industry. For example, by 2005, real labor income per hour (wages, salaries, and

proprietor income divided by labor hours in the sector) is $4.10 (95 $) higher when health care inflation is continuously higher by 1 percentage point. This is about a 13 percent increase relative to the base.

By 2050, average real labor income per hour in the medical services sector has reached $96. 80,compared to $25.80 as the economywide average. It is hard to imagine that these changes in the relative medical labor income would not have an impact on the supply of labor. This may raise another potential feedback issue. Are the projections of manpower needs made by the Bureau of Health Professions consistent with the labor income implications of sustained differences in health care inflation? That is, with a sustained health services inflation differential, would we expect to have more medical practitioners attracted into the health care sector?

Real Services Up Scenario

Tables 4 through 6 summarize the effects of raising real health spending to approximate the increase in consumer health spending from the Prices Up scenario. We did this to try to make the two alternative scenarios roughly comparable. This proved to be hard because changing real spending set off a different chain of effects than did increasing prices. By 2050, our in real spending increases raised consumer health spending in nominal terms by about 95 percent of the increase from our Prices Up scenario. The percentage differences vary by year, however. In 2005, the Real Services Up scenario increased consumer health spending about 35 percent more than the Prices Up scenario. Nominal health spending in the two scenarios is roughly the same in 2015.

The following schedule shows the increases in real spending relative to the base:

	Percent increase relative to base
1995	0.0
2005	10.5
2015	13.3
2030	19.5
2050	28.5

Raising real health spending sets off considerable feedback effects in the economy through 2005. In particular, higher real spending:

0 Raises nominal GDP growth by 0.1 percentage points annually during 1995-2005.

0 Raises aggregate inflation by 0.3 percentage points annually during 1995-2005.

0 Increases the number of jobs in the economy by 600,000 in 2005, with a 1.3 million job increase in the medical services sector.

o Lowers the unemployment rate by 0.4 percentage points in 2005.

0 Raises interest rates by 0.3 percentage points; real rates by 0.2 percentage points.

o Raises the federal deficit as a share of GNP by 0.4 percentage points.

Higher real health spending through 2050, like higher prices, has enormous influences in the very long term. For example, as health spending comes to dominate consumer spending and overall economic activity, the overall inflation rate begins to approximate inflation in the health spending deflator. Since health prices rise faster than the general price level in the Base, overall inflation is increased when real spending rises. The effect gets larger as the simulation horizon lengthens. Between 2030 and 2050 the overall inflation rate is 0.6 percentage points higher in the Real Services Up scenario relative to the Base (higher than the inflation increase between 2030 and 2050 in the Prices Up scenario).

Higher real health spending increases overall employment by 3.6 million in 2050, with a 8.2-million increase in the number of medical services jobs. The number of nonmedical jobs is actually lower by 4.6 million in 2050 as a result of higher real medical services spending and real GDP (not shown on the tables) is down by about one percent. Higher employment with lower real GDP is a result of moving workers from higher productivity sectors to lower productivity sectors. Lowering average worker productivity reduces potential GDP by 2.4percentage points relative to the Base in 2050.

The combination of lower productivity growth, higher inflation, and more resources" devoted to health care spending has an even more devastating impact on the federal budget deficit than does raising health care prices alone. By 2050, the federal deficit as a share of GNP is 5 percentage points higher than

in the Base, compared with 4 percentage points in the Prices Up scenario.

Table 6 shows that, unlike the Prices Up scenario, real labor income per hour is lower in all sectors. This is the result of a higher general price level brought on by the shift in activity to higher-priced medical services, which raises the general price level. The expansion in the demand for medical **services** is met through increased employment (productivity is largely unaffected by the increase in demand).

Conclusion

In this paper, we addressed whether HCFA projections about the size of the health care sector in the economy are consistent with the exogenous assumptions that were used to develop the projections initially. We showed that it is difficult for such consistency to hold without a formal model that links the health care sector to the **nonhealth** sector. Because the sectors are linked, assigning factors for price growth in the health sector above the general inflation rate without then incorporating these into the projection of the general inflation rate yields inconsistent results. A similar statement holds true "intensity of use" assumptions, or more generally, assumptions about the real demand for medical services.

Some of these feedback effects are general macro effects. That is, some operate through macro channels, like interest rates. Other **effects** work themselves out by altering the industrial composition of price growth, or employment growth, or other industrial variables.

There is nothing new about the consistency problem. While it is logically true, for policy the issue is whether the feedback problems are severe enough to compromise the usefulness of the projections in the first place. A key part of the answer to that empirical question is the length of the projection period. For example, over the reasonably short 10-year horizon, raising the "health inflation premium" by a percentage point raises the overall inflation rate by 0.3 percentage points. Not accounting for the increase in the general inflation rate will lead to overstating the health share of GNP and the **ex-post** "health inflation premium." To the extent that general inflation is higher, real economic growth will be lower in the long run, as a result of a series of well-documented channels. However, the macro effect is probably small for a ten-year horizon.

There are also distributional impacts, which can compromise the projection's validity even in this horizon. For example, raising the "health inflation premium" significantly raises the relative attractiveness of work in the health sector. Relatively high wages would attract workers into the field (even allowing for a lag for the education of new workers), eventually causing relative wages in the sector to move toward the economywide average. However, because the "health inflation premium" is exogenous, this adjustment is precluded. As a result, relative returns to labor in the sector begin to reach remarkable levels, even at ten-to-fifteen years.

As a practical matter, over a ten-year horizon, changing health price inflation premiums or intensity of use assumptions have noticeable effects on the macroeconomic variables that would be inputs to the HCFA projections. Reasonable analysts could differ about whether the usefulness of the projections is compromised when assumptions change by amounts close to those shown here. However, as the projection horizon lengthens, the consistency problems multiply. For example, under the assumptions that Medicare and Medicaid fund a relatively fixed share of personal medical spending, growth in these programs explodes in the future. In the simulations reported here, we did not change any tax or spending programs to reduce the deficit to more reasonable levels. Higher tax rates or **lower** spending on other programs to keep the deficit a reasonable levels would have large "feedback" effects on other sectors of the economy and on the economy in general.

The general problem of holding fixed the rest of the economy while changing significant features of health care spending is empirically important over horizons in excess of 10-to-15 years. This suggests that **longer-term** projections that do not incorporate feedback can paint an **un-necessarily** rosy or depressing view of the future, depending on the nature and scope of the feedback. Our work suggests that serious **sectoral** imbalances -- in government accounts, in the industrial structure of compensation, etc. -- arise that would, in a model that incorporated economic relationships, result in significant differences in the general economic environment. If the **interaction** of the health care sector and the rest of the economy is strong enough to- change the outlook for the general economy, these interactions need to be incorporated in work that evaluates policy proposals. The implication of our work is that, especially for longer term projections, incorporating

feedback effects would substantially improve the usefulness of **HCFA's** projection work.

ENDNOTES

1. Work on LIFT and LIFT 2050 was funded by the Health Care Financing Administration, HCFA Contract 500-93-0007. We gratefully acknowledge HCFA'S financial support, and the help and guidance provided by Dan Waldo in the Office of the Actuary. The LIFT framework, which had been traditionally used to run simulations with about a 15-year horizon, was extended to run through, 2050. To differentiate the models, we refer to them as LIFT 2010 and LIFT 2050. Opinions expressed here are the author's opinions, and do not represent opinions of HCFA or the University of Maryland. A recent description of LIFT appears in McCarthy (1991).

2. How prices could be lowered without affecting the quality or quantity of services rendered is really the issue. Many analysts have pointed to administrative inefficiencies in the financing and delivery of health care services as a reason for rapid price growth. To the extent they are correct, reforms that eliminate these inefficiencies raise productivity (definitionally), and allow the economy to operate on a higher production possibility frontier.

3. **Recent descriptions of the approach appear in Burner and Waldo (1995) and Sonnefeld et. al.** (1991).

4. Warshawsky (1992) examines the actuarial and economic approaches to making health care sector projections. The distinction in his mind appears to be that the economic approach embeds the health sector inside a larger, consistent framework that incorporates the interactions of the health sector and all other sectors, either for several sectors, as in LIFT, or as an aggregate, as in a one-sector macro model. The major difficulty with the economic approach is that the embodied feedback equations are always subject to controversy (which macro approach is best?) and **re-specification.** Because there is always disagreement about the macro model, the macro assumptions, and the linkages equations, it is pragmatic to hold those constant while the already complicated task of making health-sector projections is completed. However, the pragmatic solution for making health care projections may not lead to the most useful set of projections.

5. *The* projections are done on a current law basis, so that tax or program changes are not considered. We adopt this convention below, but note that large tax increases or benefit reductions must occur to keep the system(s) in actuarial balance.

6. It is worth emphasizing that the lack of a consistent model behind the exogenous macroeconomic variables that incorporates feedbacks from the sector under study makes it problematic to use the projections as a base case for policy analysis. This is because policy analysis is interested in the overall impact of a change, not the ceteris **paribus** impact of a policy change. In that sense, it is difficult to figure out what it means to, say, hold real GDP constant and ask what tax rate will keep the Social Security trust fund solvent. This is of course because a policymaker could not hold real GDP constant and then adjust the tax rate. She must account for the interactions of the two. While the issue is paramount for policy analysis, the focus of the current paper is the effect on the projections work of the lack of feedback. We will address the policy analysis issues in a companion paper.

7. In a later section, we show that this does not happen in LIFT.

8. We believe that **NHE/Medicare** trust fund projections and the macroeconomic projections are done independently. Currently, there is no formal feedback mechanism between the medical sector projections and the **macro** projections. There may be "unquantified" contact between the groups that allow the macro assumptions to reflect the effects of a rising health care share. It is hard to know how to evaluate these "unquantified" links.

9. LIFT keeps track of the combined social insurance fund, which includes **OASDI,** HI, and several other smaller funds like the federal retirement fund. Naturally, considering the source of the shock in the Prices Up scenario, most of **the** change in social insurance fund solvency is due to changes in the solvency of the HI fund.

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TABLE l: SUMMARY OF BASE AND PRICES UP SCENAR1O

'alues for Prices Up Scenario are shown as deviations from Base values.									
						Annualized Growth Rates			
	1995	2005	2015	2030	2050	95-05	05-15	15-30	30-5(
Macroeconomic Indicators									
GDP, $ billion	7039	11348	18121	34438	79313	4.8	4.7	4.3	4.2
	8	266	959	3497	16383	0.2	0.3	0.3	0.5
Consumer health spending, $ billion	810	1598	3017	6789	20563	6.8	6.4	5.4	5.5
	4	126	483	2006	9991	0.7	0.7	0.7	0.7
:onsumer Health spending/GDP, %	1.5	14.1	16.7	19.7	25.9				
	0	0.8	1.7	3.5	6.0				
Price Measures. 1994 = 100									
GiNP deflator	103.3	139.5	185.3	283.5	497.1	3.0	2.8	2.6	2.4
	0.1	3.7	10.6	29.5	101.5	0.1	0.3	0.3	0.4
Consumer spending deflator	103.1	143.7	195.3	300.6	534.8	3.3	3.0	2.7	2.6
	0.2	4.6	13.3	37.3	125.3	0.3	0.4	0.4	0.5
:onsumer health spending deflator	103.6	160.1	240.7	392.3	685.3	4.4	4.0	3.2	2.7
	0.8	17.5	54.1	166.6	513.5	1.0	1.0	1.0	1.0
Employment Measures									
otal jobs, millions	130.6	148.8	166.4	184,3	212,7	1.3	1.1	0.7	0.7
	0	-0.5	-0.8	-1.3	-2.0	0	0	0	0
Health sector jobs, millions	10.3	13.0	15.5	19.2	30.1	2.3	1.8	1.4	2.3
	0	-0.5	-1.2	-2.6	-6.2	-0.3	-0.4	-0.5	4).5
as a percent of total jobs	9.5	10.5	11.1	12.5	17.0				
	0	-0.4	-0.8	-1.6	-3.5				
Unemployment rate, %	5.8	6.3	5.2	5.1	4.1				
	0	0.3	0.5	0.7	0.9				
Other Indicators									
Three month bill rate, %	5.8	5.3	5.2	5.0	5.4				
	0	0.3	0.4	0.5	0.5				
)-year Treasury note rate, %	7.1	6.6	6.2	6.1	6.8				
	0	0.3	0.4	0.7	1.1				
Federal surplus, $ billions	-179	-244	-314	-901	-3568				
	0	-48	-166	-714	-4464				
relative to GNP, %	-2.5	-2.1	-1.7	-2.6	-4.5				
	0	-0.3	-0.7	-1.7	4.0				
Combined Sot. Ins. Trust Fund, $ bil	876	1610	1708	4901	-61141				
	0	-50	-485	4344	46811				
Solvency Ratio	158.7	177.7	111,3	-149.3	-781.5				
	-0.1	-12.6	-38.4	-91.0	-262.0				

TABLE 2: FEDERAL GOVERNMENT SPENDING AND RECEIPTS. BASE AND PRICES UP SCENARIO

Alternatives are shown in deviations from base values.

	1995	2005	2015	2030	2050	95-05	05-15	15-30	30-5(
Total Spending	1601	2457	3770	7314	17972	4.3	4.3	4.4	4.5
	2	103	357	1467	7984	0.4	0.5	0.6	0.9
Purchases	448	582	767	1186	20%	2.6	2.7	2.9	2.8
	0	9	24	61	193	0.1	0.1	0.1	0.2
Defense	2%	387	510	785	1375	2.7	2.8	2.9	2.8
	0	6	16	38	120	0.1	0.1	0.1	0.2
Transfers to persons & states	902	1520	2557	5335	13166	5.2	5.2	4.9	4.5
	1	69	259	1036	4808	0.4	0.5	0.5	0.7
Hospital & medical	251	520	987	2238	6869	7.3	6.4	5.5	5.6
	0	36	147	633	3282	0.7	0.7	0.7	0.7
Net Interest	221	311	389	709	2571	3.4	2.2	4.0	6.4
	0	25	73	364	2960	0.8	0.9	1.6	1.8
Other	30	43	57	85	138	3.7	2.8	2.6	2.4
	0	0	1	5	23	0	0.1	0.3	0.4
Total Receipts	1422	2212	3457	6413	14404	4.4	4.5	4.1	4.(J
	2	58	206	753	3519	0.2	0.3	0.4	0.5
surplus	-179	-244	-314	-901	-3568				
	0	-48	-166	-814	-5868				
Addenda									
Debt of Federal Government	3568	5124	6901	12633	40744	3.6	3.0	4.0	5.9
	0	149	763	4572	35266	0.3	0.8	1.4	1.6
Social Insurance Fund Receipts	568	874	1368	2558	5789	4.3	4.5	4.2	4.1
	1	23	80	290	1328	0.2	0.3	0.3	0.5
Personal Contributions	268	419	663	1253	2881	4.4	4.6	4.2	4.2
	0	12	44	164	766	0.3	0.3	0.4	0.6
Interest	92	128	136	-142	-3017	3.5	1.2	0	16.5
	0	2	-14	-234	-3336	0.2	-1.2	0	-1.3
Social Insurance Fund Outlays	569	934	1582	3382	8094	4.9	5.3	5.2	4.6
	1	40	147	582	2588	0.4	0.5	0.4	0.6
Outlays to Public	552	906	1535	3282	7858	4.9	5.4	5.2	4.6
	1	39	143	565	2513	0.4	0.5	0.4	0.6
Balance	91	68	-78	-966	-5322				
	0	-14	-82	-527	-4596				
Trust Fund Accumulation	876	1610	1708	-4901	-61412				
	0	-50	-485	4344	-46812				
Solvency Ratio	159	178	111	-149	-782				
	0	-13	-38	-91	-262				
Real Federal Spending Per Capita, 1995$									
Total Spending	6076	6306	6770	7966	10695	0.4	0.7	1.1	1.5
	-2	96	240	666	2076	0.2	0.2	0.3	0.5
Purchases	1699	1495	1377	1291	1247	-1.3	-0.8	-0.4	-0.2
	-1	-16	-34	-66	-121	-0.1	-0.1	-0.2	-0.3
Defense	1125	994	916	855	818	-1.2	-0.8	-0.5	-0.2
	-1	-11	-23	-45	-82	-0.1	-0.1	-0.2	-0.3
Transfers to persons & states	3425	3901	4592	5810	7835	1.3	1.6	1.6	1.5
	0	73	192	453	1009	0.2	0.2	0.2	0.2
Medicare & Medicaid	952	1334	1772	2438	4088	3.4	2.8	2.1	2.6
	-1	55	155	385	907	0.4	0.4	0.4	0.3
Net Interest	839	799	699	772	1530	4).5	-1.3	0.7	3.4
	-1	43	86	283	1191	0.5	0.6	1.3	1.3
Other	114	111	103	93	82	-0.2	-0.8	-0.7	-0.6
	0	-3	-4	-4	-3	-0.3	-0.1	0	0
Total Receipts	5398	5679	6207	6984	8572	0.5	0.9	0.8	1.0
	0	0	14	60	247	0	0	0	0.1

TABLE 3: REAL LABOR INCOME PER **HOUR,** 95$, BASE AND PRICES UP SCENARIO

Alternatives are shown in deviations from base values.

	1995	2005	2015	2030	205(
ALL PRIVATE INDUSTRIES	16.7	17.1	18.4	21.3	25.8
	0	0.1	0.1	0.4	1.0
Farm & agricultural services	12.1	11.5	11.6	12.6	14.3
	0	-0.2	-0.5	-1.0	-2.0
Mining	25.7	25.3	25.9	28.4	32.2
	0	-0.4	-1.0	-2.2	4.4
Contract construction	17.4	17.0	17.5	19.7	22.5
	0	-0.3	-0.6	-1.5	-3.0
Nondurable manufacturing	19.7	19.9	20.9	23.4	27.1
	0	-0.3	4).8	-1.7	-3.6
Durables manufacturing	21.4	21.2	22.1	24.7	28.6
	0	-0.3	-0.9	-1.9	-3.9
Transportation	19.0	18.3	18.7	20.5	23.2
	0	-0.3	-0.7	-1.6	-3.2
Utilities	26.6	26.3	27.3	30.4	35.1
	0	-0.4	-1.1	-2.3	-4.8
Wholesale and retail trade	15.0	14.6	15.1	16.5	18.5
	0	-0.3	-0.6	-1.3	-2.6
Finance, insurance, real estate	22.7	22.3	23.0	25.6	29.4
	0	-0.4	-0.9	-1.9	-3.9
Non-medical services	18.8	18.7	19.3	21.2	24.4
	0	-0.3	-0.8	-1.7	-3.5
Medical services	25.6	31.6	39.2	48.8	56.2
	0.3	4.1	9.7	22.3	40.7

TABLE 4: SUMMARY OF BASE AND REAL SPENDING UP SCENARIO

Values for Prices Up Scenario are shown as deviations from Base values.									
						Annualized Growth Rates			
	1995	2005	2015	2030	2050	95-05	05-15	15-30	30-5(
Macroeconomic Indicators									
GiDP, $ billion	7039	11348	18121	34438	79313	4.8	4.7	4.3	4.2
	0	164	655	3054	18276	0.1	0.2	0.3	0.6
Consumer health spending, $ billion	810	1598	3017	6789	20563	6.8	6.4	5.4	5.5
	0	165	459	1812	10092	1.0	0.4	0.6	0.8
Consumer Health spending/GDP, %	11.5	14.1	16.7	19.7	25.9				
	0	1.2	1.9	3.2	5.5				
Price Measures, 1994 = 100									
GNP deflator	103.3	139.5	185.3	283.5	497.1	3.0	2.8	2.6	2.4
	0.0	3.7	10.6	29.5	101.5	0.1	0.2	0.3	0.6
Consumer spending deflator	103.1	143.7	195.3	300.6	534.8	3.3	3.0	2.7	2.6
	0.2	4.6	13.3	37.3	125.3	0.3	0.4	0.4	0.5
Consumer health spending deflator	103.6	160.1	240.7	392.3	685.3	4.4	4.0	3.2	2.7
	0.8	17.5	54.1	166.6	513.5	0.0	0.0	0.0	0.0
Employment Measures									
Total jobs, millions	130,6	148.8	166.4	184.3	212.7	1.3	1.1	0.7	0.7
	0	0.6	0.8	1.8	3.6	0	0	0	0
Health sector jobs, millions	10.3	13.0	15.5	19.2	30.1	2.3	1.8	1.4	2.3
	0	1.3	2.0	3.7	8.2	1.0	0.2	0.4	0.3
as a percent of total jobs	9.5	10.5	11.1	12.5	17.0				
	0	1.0	1.4	2.3	4.3				
UUnemployment rate, %	5.8	6.3	5.2	5.1	4.1				
	0	-0.4	-0.5	-0.9	-1.6				
Other Indicators									
Three month bill rate, %	5.8	5.3	5.2	5.0	5.4				
	0	0.3	0.6	1.1	2.4				
O-year Treasury note rate, %	7.1	6.6	6.2	6.1	6.8				
	0	0.3	0.5	1.0	2.6				
Federal surplus, $ billions	-179	-244	-314	-901	-3568				
	0	-52	-159	-701	-5506				
relative to GNP, %	-2.5	-2.1	-1.7	-2.6	4.5				
	0	-0.4	-0.8	-1.7	-4.9				
Combined Sot. Ins. Trust Fund, $ bil	876	1610	1708	4901	-61141				
	0	-124	-655	-4442	-51443				
Solvency Ratio	158.7	177.7	111.3	-149.3	-781.5				
	-0.1	-19.5	-47.2	-99.6	-305.0				

TABLE 5: FEDERAL SPENDING AND RECEIPTS, BASE AND REAL SPENDING UP SCENARIO

Alternatives are shown in deviations from base values.

	1995	2005	2015	2030	2050	95-05	05-15	15-30	30-50
Total Spending	1601	2457	3770	7314	17972	4.3	4.3	4.4	4.5
	0	88	300	1334	9302	0.4	0.4	0.6	1.1
Purchases	448	582	767	1186	2096	2.6	2.7	2.9	2.s
	o	4	17	73	358	0.1	0.2	0.2	0.5
Defense	2%	387	510	785	1375	2.7	2.8	2.9	2.8
	0	3	12	49	236	0.1	0.2	0.2	0.5
Transfers to persons & states	902	1520	2557	5335	13166	5.2	5.2	4.9	4.5
	0	59	193	823	45%	0.4	0.3	0.5	0.8
Hospital & medical	251	520	987	2238	6869	7.3	6.4	5.5	5.6
	0	49	141	568	3235	0.9	0.4	0.6	0.8
Net Interest	221	311	389	709	2571	3.4	2.2	4.0	6.4
	0	25	89	432	4320	0.8	1.3	1.8	2.6
Other	30	43	57	85	138	3.7	2.8	2.6	2.4
	0	0	1	5	28	0	0.1	0.3	0.6
Total Receipts	1422	2212	3457	6413	14404	4.4	4.5	4.1	4.(I
	o	37	140	632	37%	0.2	0.2	0.4	0.7
Surplus	-179	-244	-314	-901	-3568				
	0	-52	-159	-701	-5506				
Addenda									
Debt of Federal Government	3568	5124	6901	12633	40744	3.6	3.0	4.0	5.9
	0	172	852	4630	37949	0.3	0.8	1.3	1.7
Social Insurance Fund Receipts	568	874	1368	2558	5789	4.3	4.5	4.2	4.1
	0	11	48	228	1329	0.1	0.2	0.3	0.6
Personal Contributions	268	419	663	1253	2881	4.4	4.6	4.2	4.2
	0	6	26	124	730	0.2	0.2	0.4	0.7
Interest	92	128	136	-142	-3017				
	0	-2	-22	-257	-4552				
Social Insurance Fund Outlays	569	934	1582	3382	8094	5.0	5.3	5.1	4.6
	0	34	113	485	2603	0.4	0.3	0.4	0.7
Outlays to Public	552	906	1535	3282	7858	4.9	5.4	5.2	4.6
	0	33	110	471	2527	0.4	0.3	0.4	0.7
Balance	91	68	-78	-966	-5322				
	0	-25	-88	-514	-5826				
Trust Fund Accumulation	876	1610	1708	-4901	-61412				
	0	-125	-655	-4442	-51433				
Solvency Ratio	159	178	111	-149	-782				
	0	-20	-47	-1oo	-305				
Real Federal Spending Per Capita, 1995$									
Total Spending	6076	6306	6770	7966	10695	0.4	0.7	1.1	1.5
	0	148	293	698	2438	0.2	0.2	0.3	0.6
Purchases	1699	1495	1377	1291	1247	-1.3	-0.8	-0.4	-0.2
	0	-8	-16	-30	-65	-0.1	-0.1	-0.1	-0.2
Defense	1125	994	916	855	818	-1.2	-0.8	-0.5	4).2
	o	-5	-lo	-20	-42	-0.1	-0.1	-0.1	-0.1
Transfers to persons & states	3425	3901	4592	5810	7835	1.3	1.6	1.6	1.5
	0	104	181	359	718	0.3	0.1	0.1	0.1
Medicare & Medicaid	952	1334	1772	2438	4088	3.4	2.8	2.1	2.6
	0	109	185	374	778	0.8	0.2	0.3	0.2
Net Interest	839	799	699	772	1530	4).5	-1.3	0.7	3.4
	0	54	130	371	1788	0.5	0.6	1.5	1.9
Other	114	111	103	93	82	-0.2	-0.8	-0.7	4).6
	o	-1	-2	-2	-2	-0.3	-0.1	0	0
Total Receipts	5398	5679	6207	6984	8572	0.5	0.9	0.8	1.0
	0	25	36	74	192	0	0	0	0.1

TABLE 6: REAL LABOR INCOME PER HOUR. 95$, BASE AND REAL WENDING UP SCENARIO

Alternatives are shown in deviations from base values.

	1995	2005	2015	2030	2050
ALL PRIVATE INDUSTRIES	16.7	17.1	18.4	21.3	25.8
	0	0.0	-0.1	-0.1	-0.4
Farm & agricultural services	12.1	11.5	11.6	12.6	14.3
	0	-0.1	-0.2	-0.4	-0.9
Mining	25.7	25.3	25.9	28.4	32.2
	0	-0.2	-0.4	4.9	-1.8
Contract construction	17.4	17.0	17.5	19.7	22.5
	0	-0.2	-0.4	-0.9	-2.7
Nondurable manufacturing	19.7	19.9	20.9	23.4	27.1
	0	-0.1	-0.3	-0.5	-1.1
Durables manufacturing	21.4	21.2	22.1	24.7	28.6
	0	-0.2	4.4	-0.7	-1.6
Transportation	19.0	18.3	18.7	20.5	23.2
	0	-0.2	-0.3	4).6	-1.4
Utilities	26.6	26.3	27.3	30.4	35.1
	0	-0.2	-0.5	-0.9	-2.0
Wholesale and retail trade	15.0	14.6	15.1	16.5	18.5
	0	-0.1	-0.2	-0.4	-0.4
Finance, insurance, real estate	22.7	22.3	23.0	25.6	29.4
	0	-0.2	-0.4	-0.9	-1.9
Non-medical services	18.8	18.7	19.3	21.2	24.4
	0	-0.1	4).3	-0.6	-1.4
Medical services	25.6	31.6	39.2	48.8	56.2
	0.0	-0.4	-0.8	-1.6	-3.3

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FORECASTING AND THE INTERNET

Potential for Increased Collaboration among Energy and Economic Forecasters,
David Kline, National Renewable Energy Laboratory

Potential for Increased Collaboration among Energy and Economic Forecasters

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Introduction

Despite its origins in government-sponsored research, effective control of the Internet does not reside within the government. In fact, the question of who does control the Internet may not even be well-posed. As one observer put it, "The thing that makes the Internet work is the absolute discipline with which they maintain the anarchy[2]."

If there is any truth at all in this characterization, it poses a conundrum for government agencies in the business of supplying information. It might appear at first glance that the response of these organizations to the emergence of the Information Highway should simply be to learn how to do what they have traditionally done, using the new tools provided by the Internet.

However, I will argue in what follows that the forecasting community currently has an opportunity to do better than this in two important ways. First, we can recognize that the Internet has developed its own mores, which are different from those we are used to in our roles as government forecasters. Recognizing these unique conventions -- which have been characterized as a "gill economy[3]," may lead to a better fit with current Internet practice, and better acceptance among potential customers. Some federal agencies, in fact, appear to have caught onto the essentials of this approach'.

The main thrust of this paper, however, explores the increased ii.met.ionality of our work as forecasters that can be achieved by exploiting the capabilities of the Internet. After a brief introduction to establish a context, the remainder of this paper will argue that exploiting technologies already available could provide improved forecasting capability, enhanced access to forecasts and assumptions both by forecast developers and by their customers, and better opportunities for communication and feedback among forecasters and their clients[5].

Perhaps partly because of the conundrum posed above, forecasters as a group do not have a visible or cohesive presence on today's net. What follows will provide some thoughts as to the advantages of increasing this presence, as well as on how it might be established.

An Interpretation of Emerging Developments

It is obvious that forecasters will have to respond to the Information Highway. Even without the high-visibility commitment to this concept in the administration, the mere traffic statistics for the Internet should serve as handwriting on the wall. The fact that *Newsweek* devotes a page in each issue to Internet developments suggests that average citizens will increasingly expect to access the emerging network. This expectation creates both responsibilities and opportunities for public agencies.

My interpretation of current trends suggests that they will create a set of increased expectations, some of which have important implications for forecasters. First, it appears that more and more people will expect easy, online access to a wide variety of information, including forecasts. A second, more subtle expectation maybe that because increased coordination, for example in macroeconomic assumptions, will become possible, it will also be expected.

The enhanced functionality implied by these expectations can be supported by a small number of added software functions, which will have some valuable side effects for the forecasting community as a whole. As discussed in the next section, the network hardware and software tools to carry out these functions are currently available. What is lacking is a scheme for identifying and indexing the collection of forecasts and supporting data, and some conventions for storage formats. Once these schemes are developed, they can easily be implemented using existing

software. These existing tools can also provide powerful searching capabilities, automatic data delivery, and novel forums for discussion of modeling, data, and interpretation issues.

Key Attributes of Networked Access to Energy-Economic Forecasts

The following discussion will focus first on providing increased accessibility to forecasts and assumptions to outside users. Next, the discussion addresses the side benefits to be gained by the forecasting community itself.

Note that the following sketch represents just one possibility for how such improved access could be designed and implemented. It is intended primarily to demonstrate that one version of a system that accomplishes some of the objectives implicit in the above discussion can be constructed on today's existing network. Hopefully, such a demonstration will help motivate action to build such a system.

Improved Customer Access

Forecasting organizations currently provide access to many of their forecasts and assumptions in some electronic form. Many are in the process of setting up Internet access to these data. Potential users of these systems will benefit from the following capabilities:

- Ease of locating, classifying, and comparing data and forecasts from widely distributed sources;
- Ease of access to these forecasts and supporting data; and
- Means to provide feedback to the providers of these data, ranging from bug reports to indepth comments on methods, data, and results.

In thinking about the design of online services, federal forecasters should keep two special constituencies in mind: students and researchers. Researchers will be among the most intensive users of federal forecasts and data, and the best positioned to make useful comments and suggestions. Special attention should also be given to outreach to students at all levels as part of the government's continuing commitment to education.

Beneficial Side Effects of Improved Access

Access systems that provide outside users with the increased ease of use and opportunities to provide feedback outlined above would also have several important benefits to the forecasting community itself. Forecasters would be better able to locate and compare data and resumptions developed in different organizations It is not difficult to foresee that increasing attention to consistency among assumptions will be required of forecasters in the future. Improved accessibility of forecasts across agencies will also allow forecasters to more readily place their own forecasts in the context of other current projections.

Such a prospect may raise the specter of a single "official" future scenario imposed on all federal forecasters. However, an enhanced ability to access alternative assumptions and assess their implications is a two-edged sword. It can also be used to quickly and dramatically illustrate the irresolvable uncertainty inherent in all forecasts. The existence of these uncertainties is a point that cannot be overemphasized.

In addition, the ability to compare forecasts across organizations is a first step in understanding their differences. A variety of insights into the common features, as well as the differences, among forecasts can emerge from such compari sons[6].

Conferencing

Online conferencing facilities should be considered an integral part of enhanced communication and coordination among forecasters. Perhaps even more than an enhanced ability to access each others' data, conferencing offers possibilities for enriching the collaboration among forecasters in different organizat ions.

Conferencing systems are beginning to become a familiar feature of online systems for many people, with the best-known examples being large commercial systems such as CompuServe and America Online. Conferencing systems provide a way to structure a discussion into a number of separate topics, or threads, and a means of storing the history of the discussions. Surprisingly, these seemingly minor features appear to create an environment significant y different other forums that we are used to'. My own experience suggest that conferencing capabilities could offer forecasters the opportunity to create whole new channels of discussion and collaboration which could benefit the quality and effectiveness of much of their work.

In the context of what is envisioned in this paper, conferencing could provide the following added fictions:

- A centralized repository for bug reports,
- A forum for discussion of desirable design changes and enhancements to the system,
- Discussion of the methods and results of the forecasts themselves
- Feedback on work in progress, and
- Outreach and educational functions.

One Vision of Online Access to Forecasts

The following discussion outlines one scheme that could be used to provide online access to energy and economic forecasts that would provide the benefits described above. It should be emphasized that this sketch is only one of a number of possible ways that increased accessibility discussed above could be achieved. This sketch is intended primarily to demonstrate that a great deal can be achieved using *existing* networks and software tools.

Distributed Storage and "Live Links"

Several years ago, a client-server software system called World Wide Web made its appearance on networks around the world. Since that time, World Wide Web (WWW, Web) traffic has grown even more rapidly than traffic on the Internet as a whole. It appears from these phenomenal growth statistics that this basic form of delivery will become increasingly prevalent over time. The following discussion, based on the Web model, will illustrate that it could seine the purposes envisioned here quite well. (A brief description of WWW clients and how they operate appears in the notes[8].)

Currently available WWW software can could be used to construct a kind of online catalog of energy-economic forecasts, organized as follows: At the top level there would be a "home page" describing the scope of forecasts and data covered by the catalog, and the top level of the catalog itself.

Searching for Specific Types of Data

One way to locate datasets in this structure would be to search by type of information. At the top level of this kind of search, simply be a two-way choice between "Energy" and 'Economic" forecasts. Under each of these major headings is a list of generic types of variables for which forecasts exist. Macroeconomic variables would include activity levels, prices index levels, interest rates, and trade figures. Energy variables would include demand projections, supply projections, and price projections. In each of these categories, there would be a list of specific variables, e.g. natural gas prices, oil production, electricity demand.

Two more attributes are necessary to go from a specific variable to an actual forecast dataset: time and space. Many variable may be available at different frequencies: annually versus monthly, for example. The identification of a specific variable for which forecasts are sought would bring up a list of the frequencies for which forecasts are available. Similarly, many variables are available on both national and regional geographical bases. The branches in the index that describe geographic attributes could follow the time frequency. After all the attributes have been specified, a list of the available datasets appears.

Using a standard web browser, the user could at this point select the dataset to be delivered directly to his workstation. In addit ion, at the "terminal" node of such a search, the user will see immediately if more than one forecast is available having the specified attributes, and the vintage and source of each such forecast.

The level of effort that would be required to implement this kind of indexing and searching capability would make it practically impossible using the media currently available for accessing forecast results. Some organizations have developed systems for creating pieces of this kind of scheme for specific purposes, such as comparing recent forecasts of specific types. But it seems safe to assume that no one would try to build anything like a complete index from the ground up based on, say, paper-published forecasts.

However, such an index could be built relatively easily, if the forecast datasets to be indexed were available on WWW servers. Many of the organizations that produce these forecasts, such as the Energy Information Administration and the Commerce Department, already have Web servers running.

A simple way to build such an index would be to use a sequence of hand-built pages that would embody the index scheme described above. This would be a straightforward task, if somewhat tedious. The problem would be that it would be somewhat intricate to maintain. Happily. one response to the nearly overwhelming

proliferation of information available on the WWW (not to mention the Internet as a whole) has been the emergence of searching and indexing tools[9]. These tools could make both searching and maintenance of the index itself much more efficient. Using these tools, an indexing scheme could be written that would require very little maintenance, absent major changes in its design.

Searching by Forecast Source

This same indexing scheme could also provide for searching by forecast ***source,*** i.e. forecasting organization. This would provide a mode of access more like what is currently available, for example by perusing the publication catalogs of each forecasting organization. However, the WWW version would embody two important advantages. First, it would provide catalogs for a variety of organizations in something like a common format on the users' desktop. (Each forecasting organization could maintain its own catalog. The master index would consist of a list of links to these catalogs.) Mom importantly, once a particular forecast was located, it could in most cases he downloaded immediately.

Conferencing

As described above, the WWW system already in place provides the basic framework on which forecast cataloging, searching and retrieval services could be constructed. The Web also supports interactive, two-way communication that would allow for conferencing possibilities[10]. Alternatively, conferencing systems hosted on Unix servers can be accessed during a WWW session, since browsers can spawn telnet sessions to arbitrary sites. In either case, a conferencing system could be set up in virtual close proximity to the forecast access and retrieval system.

Advantages over what Currently Exists

Most federal organizations providing forecasts and data make them available in electronic form by some means. Commerce department data is available on the Economic Bulletin Board, which is Internet accessible. Energy Information Administration data is available on a BBS system, and its Internet accessibility is slated to be enhanced in the near future.

In a sense, this paper simply argues for a more unified approach across organizations to providing access to forecasts and data via the Internet than might occur if we do not pay specific attention to it. The writing on the wall is fairly clear: Forecasters will be putting their work online. From this perspective, providing the unifying framework envisioned here does not require a great deal of additional work, especially relative to the benefits to be gained.

Implementation

Tasks to be Performed

The primary elements of what needs to be done to implement the ideas described here are organizational, rather than software engineering tasks. The main requirements are:

- Identifying the universe of data and forecasts to be included in the access system;
- Defining standards for forecast and data storage. These standards do not need to be excessively rigid or detailed. but a minimal amount of standardization would be quite helpful;
- Designing the search and retrieval functions to be provided and developing an indexing scheme to support them. The discussion above presents a strawman for the general features of this functionality;
- Constructing, and maintaining the common parts of the system, which support the cataloging and searching functions. (Maintaining the data would most naturally be the responsibility of each forecasting organization.)

Creating a Team

Players from a number of different organizations have an obvious stake in any effort to provide the kinds of unifying services discussed hew. Ideally, an *ad hoc* working group could be formed , including representatives from forecasting organizations, as well as consumers of forecasts from business and academic organizations. The group will also need some expertise with WWW and associated tools.

To succeed, this project would require participation from a wide variety of organizations. Hopefully this organizational challenge will not prove insurmountable. This paper was written to take advantage of the

opportunity to plant the seeds of this idea with people in a number of different forecasting groups at once.

Conclusions

This paper sketches briefly the advantages of a coordinated scheme for locating and retrieving energy and economic forecasts and data. Providing such a scheme would have a number of advantages for forecast developers in their work, as well as for forecast consumers, as discussed above. Such a service would also have other implications for forecasters generally.

First, they might improve the integrity of forecasts. An improved ability to compare and contrast forecasts which cover the same ground will contribute to their overall consistency and quality.

Second, an improved ability to juxtapose alternative forecasts will provide striking illustration of the irresolvable uncertainties inherent in all forecasts. This should help us maintain a respectful recognition of Niels Bohr's remark that it is always difficult to make predictions, especially about the future.

Third, the existence of such a network could increase the access of forecasters to *each other as* colleagues, effectively increasing the size of our professional community. This may turn out to be one of the more significant benefits of this effort from the forecasters' point of view.

Notes

I. The contents of this paper represent the viewpoint of the author alone, and any errors are his sole responsibility.

2. From an online posting by Alan Stapleton-Ross. The identity of its actual originator has been lost.

3. In a gift economy, people create things because they think other people will get benefit from them, and then proceed to give them away. I see evidence that the Internet works in essentially this way on a daily basis.

4. The work of the National Center for Supercomputer Applications in developing and distributing the Mosaic software and other tools represents an example of the kind of "gift economy" practice I have in mind here. Examples of information services which fit this emerging paradigm exist in a number of partnerships with the K- 12 educational community. (See for example, the NASA Ames K- 12 server at the world wide web location URL http: //quest. arc.nasa.gov. For more on world wide web and URLs, see note 6.) The availability of extensive weather-related information, provided through the collaborative efforts of a number of governmental and academic organizations, is abetter-known example.

5. A number of the anecdotes recounted in Howard Rheingold's *The Virtual Community, (1993)* suggest that the changes in communication possibilities offered by networked systems can create surprisingly radical changes in the way business is conducted.

6. See, for example, the work of the Energy Modeling Forum at Stanford, as summarized in Huntington, H. G., J.P. Weyant, and J.L. Sweeney, (1982) "Modeling for insights, Not Numbers: The Experiences of the Energy Modeling Forum," ***Omega: The International Journal of Management Science,*** Vol. 10., No. 5.

7. Again, see Rheingold (1993).

8. The user's interface to the World Wide Web is a client, or "browser." Browsers are available for all popular personal computer platforms, and the fact that the browser runs on the user's workstation is important. The basic unit of information from the browser's point of view is called a "page" or "home page. " For our purposes, the important elements of a page are its text, and the accompanying *links.* (WWW pages can also contain still images, sound, and movies, but these bells and whistles are not particularly important to this discussion.) The links are what allow the Web to function as a truly distributed database. This distributed database works because a link simply instructs the browser to fetch another document, which could be located on any WWW server anywhere in the world. The fetched document might contain text, tables, multimedia material, or binary files. When items like binary files are fetched, the user has the option to store them directly to a local disk file. A Universal Resource Locator, or URL is the address of a WWW page, given in a standard form comprehensible to browsers.

9. One good example of searching and indexing tools written to optimize use of both server and workstation resources is found at the Harvest Information Discovery and Access System. An complete description of this system can be found online beginning at the URL http://rd.cs.colorado. edu/harvest/.

10. A newly-opened service that exploits many of the interactive features of the Web system is *Wired* magazine's Hotwired service, which can be accessed at URL http: //www.hotwired. corn.

FORECAST EVALUATION

Session I

Moderator: Doug Hale, Energy Information Administration, U.S. Department of Energy

An Evaluation of Forecasting Models,
Ching C. Yu, Sandra T. Absalom, and Patrician. Plunkert,
U.S. Bureau of Mines

Time-Series Models to Forecast Nuclear Net Generation of Electricity,
Inderjit Kundra, Energy Information Administration

Session II

Moderator: Howard Fullerton, Bureau of Labor Statistics, U.S. Department of Labor

Forecasting State Motor Gasoline demand with Shrinkage Estimators,
Frederick Joutz and Robert P. Troust, Energy Information Administration
and the George Washington University

Predicting the National Unemployment rate that the “Old” CPS Would Have Produced,
Richard Tiller and Michael Welch, Bureau of Labor Statistics,
U.S. Department of Labor

AN EVALUATION STUDY OF FORECASTING MODELS

Ching C. Yu, Sandra T. Absalom, & Patricia A. Plunkert, U.S. Bureau of Mines
Ching Yu, 810 Seventh St., N.W. Washington, D.C. 20241-0002

OVERVIEW

The purpose of this paper is to evaluate the accuracy of several forecasting models in projecting monthly U.S. primary aluminum production. The forecasting models under consideration are five exponential smoothing models, the Box-Jenkins model, and the dynamic regression model.

The exponential smoothing techniques are among the most widely used. They extrapolate smoothed estimates of level trend, and/or seasonality of a time series. The Box-Jenkins technique was introduced by Box and Jenkins (1976). The main principle for the technique is to build the most parsimonious model possible, in terms of number of parameters, that reproduces adequately the autocorrelation function of the data. The dynamic regression technique combines a time-series-oriented dynamic feature with the effects of the explanatory variable(s) of the regression to produce forecasts.

Historical monthly U.S. primary aluminum production data, published by the U.S. Bureau of Mines, was used to evaluate the models and subsequently to conduct the forecasting. The historical simulation from the models was compared with the historical data to determine the degree of simulation error. In addition, "ex-post" forecasting was conducted to test the accuracy of prediction of each model.

DATA SOURCES

The *historical* monthly U.S. primary aluminum production and the Standard and Poor's Aluminum Stock Price Index, from January 1948 to August 1994, were used in this study. The data series of the monthly U.S. primary aluminum production for the period between January 1948 and August 1993 was used to determine the simulation errors. Subsequently, the "ex-post" forecasting for the period between September 1993 and August 1994 was conducted and compared with actual production numbers. The Standard and Poor's Aluminum Stock Price Index was used as the explanatory variable for the dynamic regression model.

FORECASTING MODELS

Forecast Pro software (1987) was used to develop and test each model. The following table defines the notations.

Y_t (m) : forecast for time t + m from origin t

m. forecast lead time

S_t : smoothed level at end oft

a: smoothing parameter for level of series

Y,: observed value at time t

T,: smoothed trend at end oft

γ: smoothing parameter of trend

I_t: smoothed seasonal index at end of time t

σ: smoothing parameter for seasonal index

ϕ: trend dampening factor

p: autoregression order

k(B): autoregressive polynomial of order p

p,: seasonal autoregressive order

K(B^s): seasonal autoregressive polynomial of order p,

d: differencing operator

q: moving average order

6(B): moving average polynomial of order q

q_s: seasonal moving average order

O (B^s): seasonal moving average polynomial of order q_s

e_t: one step forecast error $Y_t - Y_{t-1}$

X_t: observed value of the variable at time t

n: corresponding coefficient of x_t

ε: random shock at time t

R(B): stationary autoregressive polynomial of order p

Exponential Smoothing Models

Five types of exponential smoothing models were investigated. They are simple exponential smoothing (SES), Holt two parameter exponential smoothing (H2E) (Holt, 1957), dampened two parameter smoothing (D2P), winters three parameter smoothing (W3P) (winters, 1960) and dampened three parameter smoothing (D3P).

(1) SES

Simple exponential smoothing assumes that the only forecastable feature in the data is the current level. The forecasting equation is

$$Y_t(m) = S_t \qquad (1)$$

and the recursive smoothing equation is

$$S_t = \alpha Y_t + (1-\alpha) S_{t-1} \qquad (2)$$

The forecasts from this model consist of a horizontal line at the current level. In this case, the smoothing parameter for the level is 0.599512. It is apparent that this model is not appropriate for trended and/or seasonal data.

(2) H2E

The Holt two parameter exponential smoothing model assumes that *the data* contain both a current level and a current trend. The forecasting equation is

$$Y_t(m) = S_t + mT_t \qquad (3)$$

and the smoothing equations are

$$S_t = \alpha Y_t + (1-\alpha)(S_{t-1} + T_{t-1}) \qquad (4)$$

$$T_t = Y(S_t - S_{t-1}) + (1-\alpha)T_{t-1} \qquad (5)$$

In this *case*, the parameters for the current level and trend are 0.481803 and 0.2S0776.

(3) W3P

Winters three parameter smoothing assumes the data contain a current level, a current trend, and use a multiplicative seasonal factor to model seasonality. The forecasting equation is

$$Y_t(m) = (S_t + m T_t) I_t(m) \qquad (6)$$

and the smoothing equations are

$$S_t = \alpha (Y_t / I_{t-p}) + (1-\alpha)(S_{t-1} + T_{t-1}) \qquad (7)$$

$$T_t = \gamma (S_t - S_{t-1}) + (1-\alpha) T_{t-1} \qquad (8)$$

$$I_t = \sigma (Y_t / S_t) + (1-\sigma) I_{t-p} \qquad (9)$$

The fitted parameter for current level, trend, and seasonal factors are 0.793572, 0.349354 and 0.147566, respectively.

(4) D2P and D3P

For the two dampened tread models, forecasts are extended as a damped exponential trend rather than a linear trend. The forecasting equation for dampened two parameter smoothing is

$$Y_t(m) = S_t + (\phi + \phi^2 + .. + \phi^m) T_t \qquad (10)$$

The smoothing equations are

$$S_t = \alpha Y_t + (1-\alpha)(S_{t-1} + \phi T_{t-1}) \qquad (11)$$

$$T_t = \gamma (S_t - S_{t-1}) + (1-\gamma) \phi T_{t-1}. \qquad (12)$$

The parameters for the current level, trend, and dampened factor are 0.511206, 0.216569, and 0.910504, respectively. The forecasting equation for the dampened three parameter smoothing is

$$Y_t(m) = (S_t + (\phi + \phi^2 + .. + \phi^m) T_t) I_t(m) \qquad (13)$$

The smoothing equations are

$$S_t = a (Y_t / I_{t-p}) + (1-\alpha)/(S_{t-1} + \phi T_{t-1}) \qquad (14)$$

$$T_t = 7 (S_t - S_{t-1}) + (1-\gamma) \phi T_{t-1} \qquad (15)$$

$$I_t = \sigma (Y_t / S_t) + (1-\sigma) I_{t-p} \qquad (16)$$

The smoothing parameters for the current level, trod, seasonal factor, and dampened factor are 0.863865, 0.071646, 0.284698, and 0.94218, respectively.

BJ

The non-seasonal Box-Jenkins model is a combination of autoregression (AR), integration (I), and moving average (MA) operations in the general autoregressive integrated moving average model (ARIMA). This family of models can present the correlation structure of univariate time series with a minimum number of parameters to be fitted. The objective is to decide which ARIMA (p,d,q) model fits the data best. The ARIMA model can be presented in a polynomial form as

$$k(B)(1-B)^d Y_t = \theta(B)e_t \tag{17}$$

The multiplicative seasonal model uses two ARIMA models in tandem. The symbol for a particular model for this family is

ARIMA (p,d,q)(P,D,Q)$_s$

where s represents the seasonal period, P represents the number of seasonal autoregressive terms in the model, D represents the number of times the data were seasonally differenced, and Q represents the number of seasonal moving average terms. The polynomial form for the multiplicative seasonal mode is

$$k(B)\ K(B^s)\,(1-B)^d(1-B^s)^D Y_t = \theta(B)\,O(B^s)\ e_t\ . \tag{18}$$

The standard diagnosis procedure for this model, such as the autocorrelation fiction, partial autocorrelation function and Bayes Information *Criterion* (Schwarz, 1978), were used to select the beat fit model from the family of ARIMA models. In this case, the multiplicative seasonal model is ARIMA(0,1,0)(1,1,1).

DR

The dynamic regression model conducts the forecasting via the combination of time- series-oriented dynamic modeling and the effect of explanatory variable(s). The phasea of modeling development include development of a dynamic model, development of an explanatory model, and examination and adjustment. The ordinary least square dynamic regression model has the form

$$k(B)Y_t = \Pi X_t + e_t\ . \tag{19}$$

The Cochrane-Orcutt model is used when the error from the ordinary least square model is correlated. Equation 19 is replaced by the pair of equations:

$$\phi(B)\ Y_t = \Pi X_t + w_t \tag{20}$$

$$R(B)w_t = \epsilon_t \tag{21}$$

Equations 20 and 21 can also be written as a single equation

$$R(B)(k(B)\ Y_t - \Pi X_t) = \epsilon_t \tag{22}$$

The final equation for this model is

Pro = 21732 + 29.66 Spa -1.01 Pro(-l) -0.094 Pro(-11) + Auto(-12) + Auto(-24),

where "Spa" is the Standard and Poor's Aluminum stock Price Index, "Pro" is the monthly Us. Primary aluminum production, "Auto" is the autoregression portion of the Box-Jenkins model.

EVALUATION METHODS

After the data were fitted to different forecasting models, the historical simulation and the 'ex-post' forecasting of the time Series wee conducted. Testing of the historical simulation examines how closely each simulated variable tracks its corresponding data series. The quantitative measure used most often for this purpose is called root-mean-square (RMS) simulation error. The RMS simulation error is defined as a measure of the deviation of the simulated variable from the time path; therefore, a model chosen for forecasting purposes should have the smallest RMS simulation error possible. The RMS simulation error for variable Y, is defined as

$$\text{RMS simulation error} = \sqrt{1/T \sum_{t=1}^{T} (Y_t^s - Y_t^a)^2}$$

where Y^s_t: simulated value of Y,

Y^a_t: actual value

T : number of months in the simulation

Another means to evaluate the forecasting models is to conduct "ex-post" forecasting. The model is simulated forward starting at the end of historical simulation (August 1993) and continuing as long as the historical data are available (in this case, August 1994). The extent of accuracy for "ex-post" forecasting can also be determined by RMS simulation error and MRE as described above.

RESULTS AND CONCLUSIONS

Table A summarizes the historical (January 1948- August 1993) simulation error for RMS and MRE for the models.

Table A

Model	RMS error (metric tons)
SES	12,281
H2E	12,312
W3P	7,383
D2P	12,322
D3P	7,231
BJ	7,6s3
OR	0.179

The range of RMS historical simulation error is between 7,231 and 12,322 metric tons. The dampened three parameter smoothing model has the smallest RMS historical simulation error, followed by the Winters three parameter smoothing Box-Jenkins, dynamic regression, simple exponential smoothing, and Holt tWO parameter smoothing models. The dampened two parameter smoothing model has the largest RMS historical simulation error.

Table B is the forecasting error for RMS and MRE for the 'ex-peat" forecasting (September 1993-August 1994) for the models.

Table B

Model	RMS error (metric tons)
SES	9,517
H2E	881
W3P	7,394
D2P	3,248
D3P	3,345
BJ	7,962
DR	11,236

The range of RMS forecasting error is between 881 and 11,236 metric tons. The Holt two parameter smoothing models produces the smallest RMS forecasting error, followed by the dampened three parameter smoothing, Winter three parameter smoothing, Box-Jenkins and simple exponential smoothing. The dynamic regression model has the largest RMS forecasting error.

Criteria for selecting a forecasting model should be based more on predictive accuracy, and leas on the goodness of fit to the historical data. Often highly complex models fit the historical data quite well but forecast poorly. Even though the Holt 2 parameter smoothing model does not fit as well as other models in historical simulation, it provides the most accurate "ex-post" forecasting. In conclusion, the Holt two parameter smoothing model is recommended for predicting the U.S. primary aluminum production. However, it is necessary to continue monitoring the predictive accuracy of the model due to the fact that "ex-post" forecasting is based only upon a 12 month period. In addition, future work should also be emphasized on conducting research for other explanatory variable(s) for the dynamic regression model.

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TIME-SERIES MODELS TO FORECAST NUCLEAR NET GENERATION OF ELECTRICITY

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Key Words: Nuclear, Auto-Regressive, STIFFS, Combination, weights

The Energy Information Administration (EIA) publishes quarterly forecasts of nuclear net generation of electricity in the ***Short-Term Energy Outlook*** using the Short-Term Nuclear Annual Power Production Simulation Model (SNAPPS). The Office of Statistical Standards (OSS) recently developed alternative models using both time series and a combination of time series and SNAPPS methods. This paper presents a description of the alternative models and the results of their comparison with historical values and the published forecasts.

OSS undertook this project to meet one of the recommendations from the Independent Expert Review (IER)[1] of the SNAPPS model. This recommendation states that:

> "A time-series model of monthly or quarterly aggregate nuclear power generation should be estimated to provide a benchmark against which to compare the forecasting accuracy of SNAPPS. This would serve as a complement to, rather than a substitute for SNAPPS, since it would not provide all the capabilities that SNAPPS possesses. It might, however, prove to be a useful weapon in Nuclear Alternate Fuels Division's (NAFD) forecasting arsenal."

Consequently, OSS has developed six models: three time-series forecasting models (two monthly and one quarterly using X-11-ARIMA/88[2]); and three Combination models. The Combination models use weights to combine time-series and SNAPPS model forecasts. These weights are estimated from a linear regression with historical values as an independent variable, and the forecasts of the time-series models and the SNAPPS model as the dependent variables. When the out of estimation period projections from these models for the years 1985-92 were compared with the SNAPPS forecasts, all the alternative models did better or equally well. However, the Combination models, in most of the cases, outperformed the SNAPPS model, significantly, especially for 2 to 7 quarters ahead forecasts.

DATA

The historical monthly power generation data for the years 1970 through 1992 were used to develop these models. These data were culled from the files identified as CN6944.PRJ.F759 **.MASTERxx** (xx ranges from 1970 through 1992). These files are maintained by the Office of Coal, Nuclear, Electric and Alternate Fuels **(CNEAF).**

SNAPPS MODEL

SNAPPS is a straightforward accounting model. One to two quarters ahead forecasts are made using Nuclear Regulatory Commission (NRC) data concerning reactor capacity, reactor capacity factor, reactor operating hours in a month, and nonrefueling outages. Three to eight quarters ahead forecasts are made using the relationship between the monthly capacity factors and the percent of capacity on line. This relationship is modeled by a Box-Jenkins Transfer Function.

ALTERNATIVE MODEL

This mode 1 predicts future generation as a function of the past generation adjusted for trend and **seasonality.** The historical data series for nuclear power generation were found to have a strong trend and **seasonality.** The removal of the trend (by taking the first differences), and the **seasonality** (by taking the twelfth differences) resulted in a series which were almost stationary. Similar trend and **seasonality** patterns were observed for the quarterly data.

The above analysis suggested the use of a seasonal AutoRegressive Integrated Moving-Average **(ARIMA)** type of mode 1. These models are best described by Box-Jenkins (1976) and are essentially sophisticated extrapolative devices that are of greatest use when it is expected that the underlying factors causing demand for products will behave in the future in the same way as in the past. A significant advantage of **ARIMA** models is that forecasts can be developed in a very short time. More time is spent in obtaining and validating the data than in building the models.

To build the mode 1, **X-11-ARIMA/88** was used. This program has built in models which are evaluated and analyzed against the data. The program selects the model which is best suited to the data according to built in statistical controls such as mean absolute percentage error of the forecasts for the last three year, the **chi-square** statistics for the randomness of the residual, under differencing, overdifferencing, stability, **invertibility,** correlation between parameters, and the presence of **smal** 1 parameter values. If the program does not find a model meeting the stated requirements, the user can specify his own model. The **X-**11-ARIMA provides forecasts for up to three years at the user's

request, with default being one 1 year..

This program evaluates multiplicative ARIMA models of the type (P d q) (P D Q)$_s$ where p and P denote the number of ordinary and seasonal autoregressive parameters respectively; q and Q denote the number of ordinary and seasonal moving averages respectively; d and D denote the degree of the ordinary and seasonal differences, respectively; and s denotes the period of seasonality (12 for monthly series and 4 for quarterly series).

A. TIME-SERIES MODELS

Three models were developed, two monthly and one quarterly. The monthly ARIMA models were of the form (O 1 2) (0 1 1)$_{12}$, one additive and the other multiplicative (Log Additive). These models were of form:

I. Ml = Additive Model

$$(1-B)*(1-B^{12})Y_t=(1-a_1B-a_2B^2)*(1-a_{12}B^{12})e_t$$

11. M2 = Multiplicative (Log Additive) Model

$$(1-B)*(1-B^{12})LOG(Y_t)=(1-a_1B-a_2B^2)*(1-a_{12}B^{12})e_t$$

Where: B is the backshift operator and is defined as

$$BY_t = Y_{t-1},$$

and the backshift operator of order k is defined by

$$B^kY_t = Y_{t-k},$$

a_1 and a_2 are the parameters for the ordinary moving averages and a_{12} is the parameter for the seasonal moving average, and e_t is an independent identically distributed error term.

III. M 3 = The quarterly forecasting model was of the form (O 1 1)*(O 1 1)$_4$ which is equivalent to:

$$(1-B)*(1-B^4)Y_t=(1-a_1B)*(1-a_4B^4)e_t$$

Symbols are defined as above with a, replacing a_{12}.

The forecast models were tested using the entire data set for the period 1970-92. First the models were fitted for the period of 1970 to September 1984 and monthly/quarterly forecasts were made for 1 to 8 quarters ahead, beginning October 1984. The model parameters were updated every three months beginning with December 1984 and ending with September 1992. The updated parameters were used to make monthly/quarterly forecasts every three months.

CNEAF'S forecasts were copied from the Quarterly ***Short-Term Energy Outlooks*** for the years 1985-92. These forecasts were made using SNAPPS model and will be referred to as "CN" in this paper.

To be competitive and consistent with the CN forecasts, 2-8 quarters ahead forecasts obtained from the time-series models were treated as 1-7 quarters ahead

forecasts. In other words, the first quarter time-series forecasts were ignored. This was done because the program office claims that the historical data lags by a quarter. This implies that one quarter ahead forecasts made for the 1st quarter of 1985 were made using historical data upto the third quarter of 1984. Seven quarters ahead forecasts made for the 4th quarter of 1992 were made using historical data upto the 4th quarter of 1990.

The X-11-ARIMA program also tests and accounts for the Trading Day and Easter variations. The models developed by 0SS were not found tobe significantly affected by these variations.

B. COMBINATION MODEL

The Combination model uses weights to combine the Time-Series (M) and CN forecasts. Two different methods were used to determine the weights for developing this model. One method uses Ordinary Least Squares Regression, and the other method minimizes the variance of the resulting forecasts. The second method was suggested by Granger (1969) and Newbold and Granger (1974).

- METHOD I

(a) Ordinary Least Square Regression **without Constant**

$$Y_i = A*CN_i + B*M_i + e_i$$

(b) Ordinary Least Square Regression with constant term

$$Y_i = C + A*CN_i + B*M_i + e_i$$

Where:

Y = historical values of nuclear net generation of electricity,

M = time-series model forecasts,

CN = SNAPPS model forecasts

A & B = regression coefficients to be used as weights for combining the CN and M model forecasts, respectively. .

C = Constant

i = ith observation

e_i = independently identically distributed error terms with mean O and variance σ^2.

- METHOD II

If W_a and W_b denotes the weights, the combined forecast (F) is given as:

$$F = W_a * CN + W_b * M$$

The variance of F is given by

$$Var(e_F) = W_a^2*Var(e_{CN})+W_b^2*Var(e_M)+2*W_a*W_b*Covar(e_{CN},e_M)$$

Where e_F, e_{CN}, and e_M are respectively the forecasting errors of F, CN, and M.

Under the restriction that $W_a + W_b = 1$, when $Var(e_F)$ is minimized with respect to W_a, we obtain

$$W_a = \frac{Var(e_M) - Covar(e_{CN}, e_M)}{Var(e_{CN}) + Var(e_M) - 2 * Covar(e_{CN}, e_M)}$$

$$W_b = 1 - W_a$$

Another set of weights were determined by ignoring the covariance term. The resulting weights were obtained as:

$$W_a' = \frac{Var(e_M)}{Var(e_{CN}) + Var(e_M)}$$

Four sets of quarterly weights for each of the 7 quarters were estimated using M and CN forecasts for the periods of 1985-88, 1985-89, 1985-90, and 1985-91. These weights were used to combine CN and time-series forecasts starting with the first quarter following the estimation period and ending with the 4th quarter of 1992.

Table 1 lists the number of quarters used to determine the weights, and the number of quarters for which forecasts were made. The number of missing observations per quarter are 0 for quarters 1-4, 1 for quarter 5, 8 for quarter 6, and 19 for quarter 7. This is because CN'S 1-7 quarters ahead published forecasts are always available for quarters 1-4, mostly for quarter 5, occasionally for quarter 6, and rarely for quarter 7.

EVALUATION TECHNIQUES:

Models Ml and M2 make monthly forecasts. Quarterly forecasts from these models are obtained by adding across the months falling in a specified quarter. To evaluate the quality of these models, the forecasts were compared with the CN forecasts and historical numbers over a period of 8 years (1985-92).

The CN and time-series model forecast errors were tested for significant differences. Root Mean Square errors (RMSE) and Percent Mean Absolute Errors (%MAE) were used to compare the forecasting performance of all the models. These measures were computed as follows:

Define:

e_{cni} = CN %forecasting error, i quarters ahead forecasts,

e_{mi} = Time-Series model %forecasting error, i quarters ahead forecasts,

$P_t = e_{cni} - e_{mi}$

$Q_t = e_{cni} + e_{mi}$

E_{ij} denotes the Forecasting error for the quarter j, i <u>quarters ahead</u>,

F_{ij} denotes the Forecasted value for the quarter j, i <u>quarters ahead</u>,

A_{ij} denotes the Historical value for the quarter j, i

quarters ahead, and

n_i denotes the total number of **quarters**, for quarter i ahead forecasts.

1. TESTING THE SIGNIFICANCE OF FORECASTING ERROR DIFFERENCES

One to seven quarters ahead percent forecasting error was computed from the following equation:

$$E_{ij} = \left(\frac{F_{ij} - A_{ij}}{A_{ij}}\right) .100$$

For testing the differences in errors, regress P_t on Q_t. If he coefficient on Q_t "is significantly different **from** zero it implies that one forecast is better than the other.

2. ROOT MEAN SQUARE ERRORS (RMSE)

One to seven quarters ahead **RMSE** were computed from the following equation:

$$RMSE = \sqrt{\frac{\sum_{j=1}^{n_i} (F_{ij} - A_{ij})^2}{n_i}}$$

3. PERCENT MEAN ABSOLUTE ERROR (%MAE)

One to seven quarters ahead **%MAEs** were computed from the following equation:

$$MAE = \frac{\sum_{J=1}^{n_i} |((F_{ij} - A_{ij})/A_{ij}) .100)|}{n_i}$$

4. SELECTION OF MODEL

Tables 2 and 3 **display** one to seven quarters ahead Root Mean Square Errors (RMSE) and Percent Mean Absolute Errors (**%MAEs**), respectively. It is obvious from these tables that the **RMSEs** and **%MAEs** observed from the three different **time-series** models do not appear to be significantly different from each other. However, model Ml appears to have an edge over the other two. Consequently, we will concentrate on one combination model **CN+M1** and one time-series model Ml to evaluate the performance of the various models.

5. WEIGHTING SCHEME

Tables **4** and 5 'present **RMSEs** and **%MAEs,** respectively, associated with the combined model **CN+M1**. They were developed by using weights determined by **applying** 1) Ordinary Least Squares

Regression Method **with** and **without** Constant term and 2) Minimizing the Variance of the resultant **forecasts method with** and **without Covariance** term. Like tables 1 and 2, these tables do not reveal any significant differences among the displayed **RMSEs** and **%MAEs.** However, regression with constant term and the variance only method appear to have an edge - over the others. As a result, the three models CN, Ml, and **CN+M1** (based on regression **with** constant term and variance only) will be evaluated and compared. An important consequence of these two tables is that:

> as we move from 1988 to 1991, an increase in the number of available observations for estimating the weights is followed by an almost equal decline in the number of observations for which the forecasts are made. This has resulted in an increased precision for the combined model forecasts, especially, for the one developed by using minimum variance estimation method.

RESULTS:

Before discussing the results, it is pertinent to point out that by the time **CN** forecasts are published, one quarter ahead forecasts are updated using more recent (one to two months of) historical data. This makes the one quarter ahead forecast comparison between **CN** and the alternative models somewhat inappropriate. **Despite this,** we **will find** that the time-series and the combination **models** did equally well or better than the CN model. The results follow:

- The forecasting errors as calculated from the CN and the alternative time-series model Ml were not found to be significantly different from each other, except for 2 quarters ahead forecasts.
- TABLE 2:- This table lists **RMSEs** for each of the forecasting quarter as obtained using all the forecasting quarters between 1985 to 1992. It is obvious from this table that CN forecasts for 1 to 3 quarters ahead have an edge over Ml. Whereas for 4 to 7 quarters ahead, time-series model forecasting accuracy appears to have exceeded CN .
- Table 3: This table presents percent **%MAEs** for each of the forecasting quarter as obtained using all the forecasting quarters between 1985 to 1992. As expected, conclusions from the **%MAEs** table are similar to the one drawn from the **RMSEs** table namely; as we go further in the future, the time-series models have an edge over CN.
- Table 6 displays one to seven quarters ahead Root Mean Square Errors obtained

from the models CN, Ml, and the combined model CN+M1. The combined model has two entries, the first corresponding to the regression method with constant term and the second to the method of minimizing the variance without covariance term.

Compared with CN, the combination model forecasts have reduced the RMSEs for almost all the quarters. Of the two methods used to develop the combination model, minimum variance method accuracy exceeds CN even for the one quarter ahead forecasts. Barring one quarter ahead forecasts, even Ml forecasting accuracy appears to have exceeded CN for all the other quarters.

The reduction in RMSEs varies from 1% in the one quarter ahead forecasts to about 59% in the 6 quarters ahead forecasts. In other words, the further we go into the future, the more accurate is the combination model when compared to CN.

Table 7:- As expected, the conclusions from this table which presents %MAES are similar to the ones drawn from the RMSEs (Table 6). These conclusion are that as we go further in the future, compared with CN the combination model provide superior forecasts. The reduction observed in the %MAEs varies from about 1% in the one quarter ahead forecasts to 60% in the six quarter ahead forecasts.

Conclusion

From the above analysis, it is safe to conclude that compared with CN, all of the alternative models are capable of performing better or equally well in making forecasts for the nuclear net power generation of electricity. For one quarter ahead forecasts, CN may have an edge over the alternative models. But as we go into the future, the combination model outperforms CN model substantially and significantly.

TABLE 1: NUMBER OF QUARTERS USED FOR THE ESTIMATION OF WEITHTS AND FORECASTING

QUARTERS AHEAD	TYPE OF ACTIVITY	NUMBER OF QUARTERS BY PERIOD OF ESTIMATION			
		1985-88	1985-89	1985-90	1985-91
1	ESTIMATION OF WEIGHTS	16	20	24	28
	FORECASTING	16	12	8	4
2	ESTIMATION OF WEIGHTS	15	19	23	27
	FORECASTING	16	12	8	4
3"	ESTIMATION OF WEIGHTS	14	18	22	26
	FORECASTING	16	12	8	4
4	ESTIMATION OF WEIGHTS	13	17	21	25
	FORECASTING	16	12	8	4
5	ESTIMATION OF WEIGHTS	12	16	20	24
	FORECASTING	15	11	7	3
6	ESTIMATION OF WEIGHTS	6	9	12	16
	FORECASTING	12	9	6	2
7	ESTIMATION OF WEIGHTS				5
	FORECASTING				1

TABLE 2: ONE TO SEVEN QUARTERS AHEAD ROOT MEAN SQUARE ERRORS (RMSE) ESTIMATED FROM THE INDIVIDUAL MODELS

QUARTERS AHEAD	TYPE OF' MODELS				NUMBER OF QUARTERS
	CN	Ml	M2	M3	
1 "	7.42	8.75	9.11	9.00	32
2	8.30	9.82	10.74	9.99	31
3	9.05	9.48	10.51	8.84	30
4	10.75	8*68	9.21	8.91	29
5	9.99	8.71	10.10	8.72	27
6	11.64	11.05	10.29	6.10	28
7	16.14	7.79	13.24	6.00	6

CN = SNAPPS MODEL
Ml = ADDITIVE MONTHLY TIME-SERIES MODEL
M2 = MULTIPLICATIVE (NATURAL LOG) MONTHLY-TIMES-SERIES MODEL
M3 = ADDITIVE QUARTERLY TIME-SERIES MODEL

TABLE 3: ONE TO SEVEN QUARTERS AHEAD PERCENT MEAN ABSOLUTE (%MAE) ESTIMATED FROM THE INDIVIDUAL MODELS

QUARTERS AHEAD	TYPE OF MODELS				
	CN	Ml	M2	"M3	NUMBER OF QUARTERS
1	4.83	5.71	5.86	5*93	32
2 '	4.60.	6.05	6.74	5.92	31
3	5.03	5.64	6.31	5.27	30
4	5.92	5*39	5.26	5.71	29
5	5.71	5.81	6.15	5.78	27
6	6.16	6.05	7.15	6.14	28
7	9.40	4.21	6.65	3.65	6

CN = SNAPPS MODEL
Ml = ADDITIVE MONTHLY TIME-SERIES MODEL
M2 = MULTIPLICATIVE (NATURAL LOG) MONTHLY-TIMES-SERIES MODEL
M3 = ADDITIVE QUARTERLY TIME-SERIES MODEL

TABLE 4: ONE TO SEVEN QUARTERS AHEAD ROOT” MEAN SQUARE ERRORS (RMSE) FOR THE COMBINED MODEL CN & Ml USING DIFFERENT WEIGHTING PROCEDURES AND AVAILABLE DATA UP TO THE FOURTH QUARTER OF THE YEAR:

QUARTERS AHEAD	METHOD	1988	1989	1990	1991
1	R(CONST)	8.52	8.02	5.92	5.06
	R(NO-CONST)	8.85	5.71	5.47	5.11
	VAR+COV	8.21	5*77	5.79	4.46
	VAR(ONLY)	7.91	5.61	5.47	4.68
		(16)	12)	8)	4)
2	R(CONST)	8.57	7.46	5.68	5.38
	R(NO-CONST)	8.30	11.06	9.74	5.89
	VAR+COV	9.65	13.10	10.45	5.17
	VAR(ONLY)	9.28	8.89	8.06	5.68
		16)	(12)	8)	(4)
3	R(CONST)	8.92	7.75	5.52	5.73
	R(NO-CONST)	8.55	9.35	6.67	9.24 "
	VAR+COV	8.70	10.92	8.41	4.72
	VAR(ONLY)	8.53	8.68	7.58	4.86
		(16)	12)	(8)	(4)
4	R(CONST)	9.32	6.73	5.42	6.07
	R(NO-CONST)	12.71	8.45	5.97	6.77
	VAR+COV	8.64	9.77	6.18	5.20
	VAR(ONLY)	8.24.	9.47	6.35	4.58
		16)	12)	8)	(4)
5	R(CONST)	12.64	6.00	5.04	5.33
	R(NO-CONST)	10.90	5.81	4.89	4.22
	VAR+COV	6.77	7.31	7.16	1.04
	VAR(ONLY)	6.48	7.21	6.85	1.06
		15)	(11)	7)	(3)
6	R(CONST)	7.39	6.19	8.72	5.51
	R(NO-CONST)	8.43	7.12	7.48	2.01
	VAR+COV	1.75	9.60	13.39	5.97
	VAR(ONLY)	10.51	9.36	12.03	5.81
		12)	9	6)	2)
7	R(CONST)			NA	0.07
	R(NO-CONST)			8.93	2.18
	VAR+COV			12.39	10.38
	VAR(ONLY)			12.36	9.18
				3)	(1)

NOTE :- FIGURES IN PARENTHESIS DENOTE THE NUMBER OF OBSERVED QUARTERS

R DENOTES REGRESSION METHOD

VAR+COV METHOD USES BOTH VARIANCE & COVARIANCE TERMS

VAR(ONLY) METHOD IGNORES COVARIANCE TERM

TABLE 5: ONE TO SEVEN QUARTERS AHEAD PERCENT MEAN ABSOLUTE ERRORS (%MAE) FOR THE COMBINED MODEL **CN** & Ml USING DIFFERENT WEIGHTING PROCEDURES AND AVAILABLE DATA UP TO THE FOURTH QUARTER OF THE YEAR:

QUARTERS AHEAD	METHOD	1988	1989	1.990	1991
1	**R(CONST)**	4.08	3.88	2.74	3.22
	R(NO-CONST)	5.22	2.72	2.64	3.25
	VAR+COV	4.48	2.75	2.78	2.49
	VAR(ONLY)	4.40	2.74	2.66	2.80
		(16)	**(12)**	**(8)**	**(4)**
2	**R(CONST)**	5.00	3.55	2.72	3.42
	R(NO-CONST)	4.85	5.85	4.71	3.72
	VAR+COV	5.47	7.45	5.37	2.28
	VAR(ONLY)	5.38	4.37	4.27	3.26
		(16)	**(12)**	**(8)**	**(4)**
3	**R(CONST)**	5.30	3.40	3.04	**3.61**
	R(NO-CONST)	4091	5.34	3.46	4.80
	VAR+COV	**5.24**	6.46	4.42	2.93
	VAR(ONLY)	5.07	4.84	4.11	3.01
		(16)	**(12)**	**(8)**	**(4)**
4	**R(CONST)**	5.61	3.18	2.68	3.77
	R(NO-CONST)	7.71	3.63	2.55	3.52
	VAR+COV	4.79	4.43	2.60	2.29
	VAR(ONLY)	4.08	4.27	2.88	2.37
		(16)	**(12)**	**(8)**	**(4)**
5	**R(CONST)**	8.27	3.34	2.28	3.07
	R(NO-CONST)	7.02	2.85	2011	2.63
	VAR+COV	3.90	3.48	3.56	0.56
	VAR(ONLY)	3.33	3.41	3.33	0.57
		15	**11**	**7**	**3**
6	**R(CONST)**	4.04	3.39	4.51	2.41
	R(NO-CONST)	4.83	3.84	5.32	1.25
	VAR+COV	6.96	2.43	7.89	2.37
	VAR(ONLY)	6.29	5.52	6.97	3.46
		12	**9**	**6**	**2**
7	**R(CONST)**			NA	0.07
	R(NO-CONST)			4.42	1.38
	VAR+COV			6.13	6.59
	VAR(ONLY)			6.10	5.82
				(3)	**(1)**

NOTE :- FIGURES IN PARENTHESIS DENOTE THE NUMBER OF **OBSERVED** QUARTERS
R DENOTES REGRESSION METHOD
VAR+COV METHOD USES BOTH VARIANCE **& COVARIANCE** TERMS
VAR(ONLY) METHOD IGNORES **COVARIANCE** TERM

TABLE 6: ONE TO SEVEN QUARTERS AHEAD OUT OF ESTIMATION PERIOD ROOT MEAN SQUARE ERRORS (RMSE) FOR CN, Ml, AND THE COMBINED MODEL (CN + Ml) USING DATA UP TO THE FOURTH QUARTER OF THE YEAR:

QUARTERS AHEAD	MODEL	1988	1989	1990	1991
1	CN	7.99	6.75	7.07	3.46
	Ml	10.35	7.17	6.67	6.91
	CN+M1(REGRESSION)	8.52	8.02	5.92	5.06
	CN+M1(VARIANCE)	7.91	5.61	5.47	4.68
		(16)	(12)	(8)	(4)
2	CN	9.96	10.50	10.10	5.45
	Ml	11.36	8.94	8.13	10.56
	CN+M1(REGRESSION)	8.57	7.46	5.68	5.38
	CN+M1(VARIANCE)	9.28	8.89	8.06	5.68
		(16)	(12)	(8)	(4)
3	CN	11.15	11.64	11.49	7.26
	Ml	10.60	9.56	8.53	11.16
	CN+M1(REGRESSION)	8.92	7.75	5.42	5.73
	CN+M1(VARIANCE)	8.53	8*68	7.58	4.86
		(16)	(12)	(8)	(4)
4	CN	13.29	14.28	13.29	9.30
	Ml	9.38	8.78	8.80	10.91
	CN+M1(REGRESSION)	9.32	6.73	5.42	6.07
	CN+M1(VARIANCE)	8.24	8.47	6.35	4.58
		(16)	(12)	(8)	(4)
5	CN	12.12	13.01	14.66	11.89
	Ml	8.30	8.67	6.85	9.17
	CN+M1(REGRESSION)	12.64	6.00	5.04	5.33
	CN+M1(VARIANCE)	6.48	7.21	6.85	1.06
		(15)	(11)	(7)	(3)
6	CN	13.98	14.60	17.08	14.02
	Ml	9.94	9*94	7.48	5.00
	CN+M1(REGRESSION)	7.39	6.19	8.72	5051
	CN+M1(VARIANCE)	10.51	9.36	12.03	5.81
		(12)	(9)	(6)	(2)
7	CN			19.82	17.00
	Ml			9.22	0.50
	CN+M1(REGRESSION)			-	0.07
	CN+M1(VARIANCE)			12.36	9.18
				3	1

NOTE :- FIGURES IN PARENTHESIS DENOTE THE NUMBER OF OUT OF SAMPLE QUARTERS FOR WHICH FORCASTS WERE MADE
CN = SNAPPS MODEL
Ml = TIME-SERIES ADDITIVE-MODEL

TABLE 7: ONE TO SEVEN QUARTERS AHEAD OUT OF ESTIMATION PERIOD MEAN ABSOLUTE PERCENT ERRORS FOR CN, M1, AND THE COMBINED MODEL (CN + Ml) USING DATA UP TO THE FOURTH QUARTER OF THE YEAR:

QUARTERS AHEAD	MODEL	1988	1989	1990	1991
1	CN	4.32	3.14	3.06	1.66
	M1	6.27	4.33	4.02	" 4.33
	CN+M1(REGRESSION)	5.22	2.72	2.64	3.25
	CN+M1(VARIANCE)	4.40	2s74	2.66	2.80
		(16)	(12)	(8)	(4)
2	CN	5.72	5.41	5.02	2.28
	M1	6.82	4.99	4.64	6.78
	CN+M1(REGRESSION)	4.85	5.85	4.71	3.72
	CN+M1(VARIANCE)	5.38	4.37	4.27	3.26
		(16)	(12)	(8)	(4)
3	CN	6.96	7.04	6.52	4.22
	M1	5.82	5.01	4.37	5.96"
	CN+M1(REGRESSION)	4.91	5.34	3.46	' 4.88
	CN+M1(VARIANCE)	5.07	4.84	4.11	3.01
		(16)	(12)	(8)	(4)
4	CN	7.39	7.58	7.69	5.56
	M1	5*44	4.79	4.89	5.98
	CN+M1(REGRESSION)	7.71	3.63	2.55	3.52
	CN+M1(VARIANCE)	4.08	4.27	2.88	2.37
		16	12	8	4
5	CN	7.02	7.35	8.47	7.06
	Ml	5.09	4.99	3.99	5.72
	CN+M1(REGRESSION)	7.02	2.85	2.11	2.63
	CN+M1(VARIANCE)	3.33	3*41	3.33	0.57
		15	11	7	3
6	CN	8.03	8.14	10.27	8.63
	M1	5.75	5.48	3.99	2.88
	CN+M1(REGRESSION)	4.83	3.84	5.32	1.25
	CN+M1(VARIANCE)	6.29	5.52	6.97	3.46
		(12)	(9)	(6)	(2)
7	CN			11.78	10.79
	Ml			4.53	0.32
	CN+M1(REGRESSION)			4.42	1.38
	CN+M1(VARIANCE)			6.10	5.92
				3	1

NOTE :- FIGURES IN* PARENTHESIS DENOTE THE NUMBER OF OUT OF SAMPLE QUARTERS FOR WHICH FORCASTS WERE MADE
CN = SNAPPS MODEL
Ml = TIME-SERIES ADDITIVE MODEL

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FORECASTING STATE MOTOR GASOLINE DEMAND WITH SHRINKAGE ESTIMATORS*

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INTRODUCTION

This paper discusses the general problem of forecasting individual cross-sections with pooled cross-section and time series data. The traditional approach to forecasting with pooled cross-section and time-series data is a dichotomy of either pooling the data and forecasting each cross-section with a single equation or not pooling the data and forecasting each cross-section with separate equations. Both these approaches are based on extreme assumptions. If the data are pooled all cross sections are assumed to be exactly alike. If separate forecasting equations are used for each cross-section all cross-section are assumed to be totally different. The truth probably lies somewhere in-between. There is some similarity between each cross-section but they are not exactly alike.

Several shrinkage estimators have been suggested in the literature that take account of the similarity between different cross-sections without assuming each cross-section is exactly alike. Maddala (1991) notes that shrinkage estimators are better than either pooled estimator or individual ordinary least squares estimators. Vogel and Trost (1979) also report better predictions from shrunken estimators.

Generally speaking the objective of researchers using pooled cross-section and time series data fall under the heading of either forecasting or estimating important policy parameters such as price and income elasticities. Quite often both these objectives will not be met with the same shrinkage estimator even though a shrinkage estimator may dominate both the pooled and unpooled estimators for one of the objectives. For example, there may be cases where the pooled regression gives results that are inconsistent with economic theory while the shrinkage estimates are consistent with economic theory. In some other cases, the shrinkage estimators may stabilize the resulting estimates from the individual equations. In instances such as these the shrinkage estimator dominates the pooled and unpooled estimators if estimating policy parameters is the objective. This was the case in Maddala, Trost, Joutz and Li (1994). However, some shrinkage estimators may give poor or inconsistent estimates of theoretically important economic parameters such as price and income elasticities and yet perform well in forecasting. Others that give attractive coefficients from a theoretical point of view may not forecast well.

In this paper a State motor gasoline demand model is estimated with several shrinkage estimators and with more traditional estimators such as pooled and individual cross section estimators. The purpose of this paper is to compare the forecast accuracy of these alternative estimation techniques. The issue of estimating important policy parameters such as long run and short run income and price elasticities will not be addressed in this paper.

SHRINKAGE ESTIMATORS

Consider the general formulation for annual pooled cross section and time series data given by

$$y_{it} = \alpha + \beta_1 x_{1,it} + \beta_2 x_{2,it} + \dots + \beta_k x_{k,it} + \epsilon_{it} \tag{1}$$

i = 1,2 ......,N Cross Sections;
t = 1,2 ......,T Time Periods.

In equation (1) y_{it} is the annual observation of the dependent variable for cross-section i in year t and the $x_{k,it}$ are the respective explanatory variables that could include lagged dependent variables and ϵ_i is a Tx 1 vector distributed N(O, σ_i^2).

The implicit assumption in both the fixed effects and random effects models for pooling data is that the slope coefficients are the same for all the cross section units. This may not be a tenable assumption. In practice the constancy of slope parameters across the different cross section units is often rejected. This implies that the equations should be estimated separately for each cross section rather than obtaining an overall pooled estimate.

The problem with the two usual estimation methods of either pooling the data or obtaining separate estimates for each cross-section is that both are based

on extreme assumptions. If the data are pooled it assumes the parameters are all the same. If separate estimates are obtained for each cross-section it assumes the parameters are all different for each cross-section. The truth probably falls somewhere in-between. The parameters are not exactly the same but there is some similarity between them.

One way of allowing for similarity is to assume that the parameters all come from a joint distribution with a common mean and a non-zero covariance matrix. This suggests that the resulting parameter estimates should be a weighted average of the overall pooled estimate and the separate time series estimates based on each cross section. Thus, each cross section estimate is "shrunk" towards the overall pooled estimate.

The idea of shrinkage occurs frequently in the literature on prediction. See, for example, Rubin (1980), Copas (1983) and Rao (1987). Rubin (1980) provides evidence of better predictions with shrinkage estimators in a study that predicts first year law school grades based on the LSAT score and college grade point average. The traditional approach is to use a separate admitting equation for each law school by the method of least squares using data on students who attended the school in recent years. These least squares estimates can fluctuate widely from year to year. The study by Rubin argues that estimation of the admitting equation by the Empirical Bayes shrinkage methods provides more stable and better prediction.

A shrinkage estimator sometimes suggested is the so called Stein rule estimator defined by

$$\tilde{\beta}_i = (1-\frac{c}{F})\hat{\beta}_i + \frac{c}{F}\hat{\beta}_p \tag{2}$$

where $\hat{\beta}_i$ is the OLS estimator and $\hat{\beta}_p$ is the estimator from the pooled regression. F is the test statistic to test the null hypothesis

$$\beta_1 = \beta_2 = ... = \beta_N = \beta. \tag{3}$$

Under the null hypothesis where k is the dimension of β, F has an F-distribution with degrees of freedom (N-1)K and N(T-k) if equation (1) does not have separate dummy variables and $E(\epsilon_i\epsilon_i') \cdot \sigma^2 I$. The optimal value of the constant c suggested by Judge and Brock (1978, p. 190-195) is

$$c = \frac{(N-1)k - 2}{NT- NK + 2} \tag{4}$$

The Stein-rule estimator given by equation (2) shrinks the individual $\hat{\beta}_i$ towards the pooled estimator $\hat{\beta}_p$. The factor c given by equation (4) is roughly k/(T-k) for large N. Thus, the higher the number of explanatory variables k relative to the number of observations T, the larger will be the shrinkage factor $\frac{c}{F}$ for a given F. Zeimer and Wetzstein (1983) apply the Stein-rule estimator to a wilderness demand model and argue that the Stein-rule gives better forecasts than the pooled or the individual cross-section estimators.

Note that the Stein-rule shrinks the individual cross-sections estimators $\hat{\beta}_i$ towards the pooled estimator $\hat{\beta}_p$. Rao (1973) advocates shrinking towards a simple average of the individual cross-sections rather than the pooled estimator. The Bayesian approach results in an iterative procedure and shrinking towards a weighted average of the individual cross-section estimates. Under certain conditions the classical random coefficients estimator of Swamy (1970) is the same as the Bayesian estimator. We will discuss the Bayesian approach and classical random coefficient model next.

BAYESIAN APPROACH AND CLASSICAL RANDOM COEFFICIENT MODEL

The traditional approach to estimating regression coefficients with either pooled cross-section and time series data or with panel data is a dichotomy of either estimating β_i from the data on the i[th] cross-section or from the pooled sample. The general solution that emerges from the Bayesian approach is to shrink each individual β_i towards a common estimate $\beta\bullet$. The question is: What is $\beta\bullet$ and how is the shrinkage factor determined?

Assuming the disturbance term has a Normal distribution with zero mean and variance σ_i^2 equation (1) can be written compactly as

$$y_i \sim N(X_i\beta_i, \sigma_i^2 I)$$

$$(i = 1,2, \ldots, N). \tag{5}$$

There are N cross-section units with T observations each. The dimension of I is TxT, the dimension of X_i is Txk and the dimension of β_i is kx1. In addition

assume the β_i's vary across the N cross-sections and are generated from the random process

$$\beta_i \sim N(\mu,\Sigma) \tag{6}$$

Taken together equations (5) and (6) form a stochastic model. This model has different interpretations in the classical and Bayesian methods. In the classical context it specifies a random coefficient model. In the Bayesian context it specifies a stochastic model with a prior distribution for β_i. Before discussing the Bayesian model we will first present the classical random coefficient model.

The Classical Random Coefficient Model

In the classical random coefficient model, equations (5) and (6) imply

$$y_i = X_i\mu + w_i \tag{7}$$

where $w_i \sim IN(0,\Omega_i)$ and

$$\Omega_i = X_i\Sigma X_i' + \sigma_i^2 I. \tag{8}$$

Hence, it is a Generalized Least Squares (GLS) model and the GLS estimate of μ is given by

$$\hat{\mu}_{GLS} = [\sum_{i=1}^{N} X_i'\Omega_i^{-1}X_i]^{-1}[\sum_{i=1}^{N} X_i'\Omega_i^{-1}y_i]. \tag{9}$$

Using results from Rao (1973), Swamy shows that $\hat{\mu}_{GLS}$ is a weighted average of the Ordinary Least Squares estimator (OLS) of β_i and can be written as

$$\hat{\mu}_{GLS} = \sum_{i=1}^{N} W_i\hat{\beta}_i \tag{10}$$

where

$$\hat{\beta}_i=[X_i'X_i]^{-1}X_i'y_i \tag{11}$$

$$W_i = [\sum_{i=1}^{N} P_i^{-1}]^{-1}P_i^{-1} \tag{12}$$

and

$$P_i = (X_i'\Omega_i^{-1}X_i)^{-1} + \Sigma. \tag{13}$$

Two obstacles in applying the GLS procedure are the unknown parameters Σ *and* σ_i^2 in Ω. Swamy (1970) proposes a two-step procedure which uses the least squares estimators $\hat{\beta}_i$ *of* β_i and their residuals to obtain an unbiased estimator of Σ *and* σ_i^2. This estimator is also used by Rao (1975) in the empirical Bayes procedure. The Swamy (1970) method for estimating Σ *and* σ_i^2 *is*

$$\hat{\Sigma}=\frac{1}{N-1}\sum_{i=1}^{N}[\hat{\beta}_i - \frac{1}{N}\sum_{i=1}^{N}\hat{\beta}_i][\hat{\beta}_i - \frac{1}{N}\sum_{i=1}^{N}\hat{\beta}_i]' - \frac{1}{N}\sum_{i=1}^{N} \tag{14}$$

where

$$\hat{\sigma}_i^2 = \frac{1}{T-k}[y_i-X_i\hat{\beta}_i]'[y_i-X_i\hat{\beta}_i] \tag{15}$$

and $\hat{\beta}_i$ is given by equation (11).

One potential problem with the estimator for Σ is that it may not be positive definite. Swamy suggests using only the first part of equation (14) to estimate Σ. Hsiao (1986) adopts the same strategy. This suggested estimator is

$$\hat{\Sigma}=\frac{1}{N-1}\sum_{i=1}^{N}[\hat{\beta}_i - \frac{1}{N}\sum_{i=1}^{N}\hat{\beta}_i][\hat{\beta}_i - \frac{1}{N}\sum_{i=1}^{N}\hat{\beta}_i]' \tag{16}$$

In the random coefficient model interest centers on the mean parameters μ *and* σ_i^2 and the measure of heterogeneity Σ. The paper by Pesaran and Smith (1993) is concerned with the estimation of μ. The paper by Mairesse (1990) is concerned with the estimation of Σ as well. The traditional pooled estimator of equation (7) is OLS adding fixed or random effects but ignores the structure Ω_i. When the explanatory variables are exogenous there is only the heteroskedasticity problem and thus one gets consistent estimates of μ. If there are lagged endogenous variables in equation (7) the matrix Ω_i involves serial correlation as well and hence the OLS estimator for μ is not consistent.

In the classical model it is inappropriate to discuss obtaining estimators for the individual parameters β_i because they are treated as random variables. Hence,

inference is based entirely on μ, Σ *and* σ_i^2. One can, however, talk of predictors for the random parameters β_i. Lee and Griffiths (1978) derive the best linear unbiased predictors for β_i based on the prior likelihood approach advocated by Edwards (1969). This amounts to estimating β_i, σ_i^2, μ, *and* Σ by maximizing the likelihood

$$L(\beta_i,\sigma_i^2,\mu,\Sigma \mid y,X)=constant-\frac{T}{2}\sum_{i=1}^{N}\ln\sigma_i^2-\frac{1}{2}\sum_{i=1}^{N}\frac{1}{\sigma_i^2}(y_i \ldots$$
$$-\frac{N}{2}\ln|\Sigma|-\frac{1}{2}\sum_{i=1}^{N}(\beta_i-\mu)'\Sigma^{-1}(\beta_i-\mu) \qquad (17)$$

The resulting estimates for β_i, μ, σ_i^2, *and* Σ are given ss

$$\beta_i^*=[\frac{1}{\sigma_i^2}X_i'X_i+\Sigma^{-1}]^{-1}\,[\frac{1}{\sigma_i^2}X_i'X_i\hat\beta_i+\Sigma^{-1}\mu^*] \qquad (18)$$

$$\mu^* = \frac{1}{N}\sum_{i=1}^{N}\beta_i^* \qquad (19)$$

$$\hat\sigma_i^2 = \frac{1}{T}[y_i-X_i\beta_i^*]'[y_i-X_i\beta_i^*] \qquad (20)$$

$$\Sigma^*=\frac{1}{N}\sum_{i=1}^{N}[\beta_i^*-\mu^*][\beta_i^*-\mu^*]' \qquad (21)$$

where $\hat\beta_i$ is the OLS estimate of β_i given by $\hat\beta_i=[X_i'X_i]^{-1}X_i'y_i$.

As will be shown next, these maximum likelihood estimators (MLE) are closely related to the Bayesian estimators.

A Bayesian Approach

In a Bayesian framework equation (6) specifies the prior distribution of β_i. Since this prior distribution involves the parameters μ *and* Σ, if they are not known priors must be specified for these hyperparameters. One can then derive the posterior distribution for the parameters β_i.

If μ, σ_i^2 *and* Σ *are* known, the posterior distribution of β_i is normal with mean β_i^* and is given by

$$\beta_i^*=[\frac{1}{\sigma_i^2}X_i'X_i+\Sigma^{-1}]^{-1}\,[\frac{1}{\sigma_i^2}X_i'X_i\hat\beta_i+\Sigma^{-1}\mu] \qquad (22)$$

where $\hat\beta_i$ is the Ordinary Least Squares estimate of β_i.

Assuming a non-informative prior for μ, the mean of the posterior distribution of μ is $\mu_* = \frac{1}{N}\sum_{i=1}^{N}\beta_i^*$. Since in general σ_i^2 *and* Σ will not be known, one needs to specify priors for the hyperparameters. Smith (1973) takes the conjugate Wishart distribution for Σ^{-1} and the independent inverse χ^2 distributions for the σ_i^2. This gives the estimators

$$\hat\sigma_i^2 = \frac{1}{T+\nu_i+2}[\nu_i\lambda_i + y_i-X_i\beta_i^*]'[y_i-X_i\beta_i^*] \qquad (23)$$

$$\Sigma^*=\frac{1}{N-k-2+\delta}\sum_{i=1}^{N}[R + \beta_i^*-\mu^*][\beta_i^*-\mu^*]' \qquad (24)$$

As discussed in Smith (1973), VP λ_i, R *and* δ are parameters arising from the specification of the prior distributions and k is the dimension of β_i. Approximations to vague priors are obtained by setting ν_i=O, δ =1, and R to be a diagonal matrix with small positive entries (eg, 0.001).

The estimators are then

$$\hat\sigma_i^2 = \frac{1}{T+2}[y_i-X_i\beta_i^*]'[y_i-X_i\beta_i^*] \qquad (25)$$

$$\Sigma^*=\frac{1}{N-k-1}\sum_{i=1}^{N}[\beta_i^*-\mu^*][\beta_i^*-\mu^*]' \qquad (26)$$

Equations (2S) and (26) have to be solved iteratively along with the equations for β_i^* *and* μ^* given by

$$\beta_i^* = [\frac{1}{\hat{\sigma}_i^2} X_i'X_i + \Sigma^{*-1}]^{-1} [\frac{1}{\hat{\sigma}_i^2} X_i'X_i\hat{\beta}_i + \Sigma^{*-1}\mu^*] \tag{27}$$

$$\mu^* = \frac{1}{N}\sum_{i=1}^{N} \beta_i^*. \tag{28}$$

Note that in equations (25) to (28), the prior mean μ^* is an average of β_i^*, the estimate of the prior variance Σ is obtained from the deviations of β_i^* form their average μ^*, and the estimate of σ_i^2 is obtained from the residual sum of squares using β_i^*. Equation (2S) to (28) have to be solved iteratively, with the initial iteration using the OLS estimator $\hat{\beta}_i$ to compute μ^*, $\hat{\sigma}_i^2$ *and* Σ ● . Also, to improve convergence with the iterative procedure Σ• is computed as

$$\Sigma^* = \frac{1}{N-k-1}[R + \sum_{i=1}^{N} (\beta_i^* - \mu^*)(\beta_i^* - \mu^*)'] \tag{26a}$$

where is a diagonal matrix with small positive entries (eg. 0.001).

Hence, as noted in Maddala (1991) many shrinkage estimators only differ on the basis of the overall estimators towards which the individual estimators are shrunk and the estimates of variances and covariance matrices. For example, Smith (1973) shows with some matrix manipulations that the GLS estimator $\hat{\mu}_{GLS}$ in equation (10) is related to the Bayesian estimator β_i^* by the equation

$$\hat{\mu}_{GLS} = \frac{1}{N}\sum_{i=1}^{N} \beta_i^*, \tag{29}$$

which is the same as the Bayesian and MLE estimators for μ. Also, the MLE estimators given by Lee and Griffiths (1978) only differ from the GLS and Bayesian estimators in the divisors for $\hat{\sigma}_i^2$, *and* Σ^*.

Forecasting From Pooled Models

in the methods discussed above estimation of important parameters is the primary concern and forecasting is only secondary. Several papers where forecasting is the primary concern are Garcia-Ferrer, et, al. (1987), Zellner and Hong (1989) and Min and Zellner (1993). These papers consider the problem of forecasting international growth rates from unpooled and pooled models with various methods of pooling. The forecasting was done on output growth rates for up to eighteen countries year by year for the thirteen year period 1974 to 1987 using data for the twenty-three year period 1951-1973 to start the forecast.

Min and Zellner (1993) discuss several issues concerning the forecasting exercise:

1. Fixed versus time-varying parameter models.
2. Whether or not to combine forecasts from different models.
3. How should the combination of forecasts be done?
4. How do the different procedures perform in practice?

The basic model considered in these studies is

$$y_{it} = \beta_{it}'x_{it} + u_{it}$$
$$u_{it} \sim N(0,\sigma_i^2) \tag{30}$$

$i = 1, \ldots\ldots N$ and $t = 1,2, \ldots\ldots T$.

In this model y_{it} is the growth rate of the ith country in year t, and x_{it} includes three lagged values of y_{it}, two lagged values of real stock market returns, lagged value of the growth rate of real money supply and the world rate of return, defined as the median of the N country real stock returns.

Min and Zellner discuss several different models of the coefficients β_{it}. These are:

1. Unpooled fixed coefficient model where β_i is estimated separately for each country.
2* Unpooled time varying coefficient model given by

$$y_{it} = \beta_{it}'x_{it} + u_{it}$$
$$\beta_{it} = \beta_{i,t-1}' + v_{it}$$
$$v_{it} - IN(O, \phi_i\sigma_i^2 I)$$

This model is estimated with a Bayesian recursive state-space algorithm with ϕ_i

ranging from O to 0.5. This type of model is often termed the Kalman filtering method.

3. Pooled time varying coefficient model with hyperparameters. This model is given by

$y_t = X_t\beta_t + u_t$

where y_t is an N x 1 vector, X_t is an N x k matrix, β_t is an k x 1 vector and u_t is an N x 1 vector. $E(u_t u_t') = \sigma^2 I$.

$$\beta_t = B\theta_t + \epsilon_t, \qquad \epsilon_t \sim N(0,\sigma^2\Sigma),$$
$$\theta_t = \theta_{t-1} + \eta_t, \qquad \eta_t \sim N(0,\phi\sigma^2 I_k),$$

where

ϵ_t, η_t *and* u_t *are* independent.

4. The standard random coefficient model across the N cross-sections but constant over time given by $\beta_t = B\theta + \epsilon_t$

Note that this is simply the pooled time varying coefficient model with ϕ = O.

Min and Zellner (1993) found that the pooling methods led to substantially better forecasts in terms of MSE'S than the unpooled methods.

A FORECASTING MODEL OF MOTOR GASOLINE DEMAND

There have been numerous studies of motor gasoline demand. Greene (1992) and Jones (1993) model gasoline demand indirectly by first modeling vehicle miles traveled and then obtain gasoline demand from the identity that vehicle miles travelled divided by realized miles per gallon vehicle efficiency equals gallons of gasoline demand. Others have take a more direct approach of obtaining motor gasoline demand. For example, Gately (1993) models gasoline demand per driver as a log-linear equation with real Gross National Product per driver, real gasoline price, dummy variables for 1974 and 1979 and lagged gasoline demand per driver as independent variables. McRae (1994) models gasoline demand per vehicle as a polynomial function of real per capita income, the real price of gasoline and the number of vehicles per capita.

Greene (1992) takes an indirect approach because he is interested in measuring the rebound effect with respect to the fuel efficiency of vehicles. Gately takes a more direct approach because he is interested in testing for "hysteresis" of oil demand. Our paper is concerned with forecasting per capita motor gasoline demand for each of the fifty U. S. States. Therefore, we will take a direct approach where motor gasoline demand per capita is modelled as a dynamic linear regression (DLR) with State income and real State gasoline price as independent variables.

Consider the following DLR(1, 1) model

$$y_{it} = \alpha_i + \sum_{k=1}^{5} \beta_{i,k}\, x_{it,k} + e_{it} \tag{31}$$

i= 1,2,3 , ...,50 (States) and
t=2 ,3,4, ...20(Years)

where:

- i = U. S. state subscript
- t = Year subscript
- k = Explanatory variable subscript
- Y = Natural logarithm of per capita motor gasoline demand
- x_1 = Lagged logarithm of per capita motor gasoline demand
- x_2 = Natural logarithm of per capita personal income
- x_3 = Lagged logarithm of per capita personal income
- x_4 = Natural logarithm of motor gasoline price
- x_5 = Lagged logarithm of motor gasoline price

The annual State motor gasoline price data used in this study were obtained from The State Energy Price and Expenditure System of the Energy Information Administration (1993). The annual State motor gasoline quantity data and State population data used in this study were obtained from State Energy Data System of the Energy Information Administration (1993). Annual State income data were drawn from the Bureau of Economic Affairs and the annual Consumer Price Index for the U. S. was from CITIBASE. Data were available over the time period 1970 to 1991.

We only examine the forecasting performance of random cross-section parameter models where the parameters are fixed over time. Time varying parameter models estimated with a state-apace algorithm will be studied in a later paper.

A COMPARISON OF FORECAST ACCURACY

The forecast performance of four modeling approaches are presented in Tables 1-3. The four models are:

1. A pooled model with separate state dummy variables for the intercept terms (PFD),

2. A pooled model without state intercept dummy variables (FIX),
3. An unpooled model where each State is estimated separately with ordinary least squares (OLS),
4. The random coefficient shrinkage model with estimation given by equations (25) to (28) (SHRINK).

In Table 1 we present the results from one year ahead forecasts for 1990 based on estimating the models over the 1971 through 1989 period. The second column gives the per capita motor gasoline consumption for 1990 by state. Percentage forecast errors are calculated as the actual minus the predicted value.

The forecasts comparisons of these four models are presented in columns 3-6 respectively. The mean error, root mean square error, maximum error, minimum error are presented at the bottom of the table. The SHRINK has the lowest mean error and the FIX has the lowest root mean square error. OLS by state has the largest root mean square error, 4.87, versus about 3.3 for the other three techniques. None of the forecasting techniques appears to be biased as measured by the ratio of mean error to the root mean square error. All of the models appear to have poor predictive ability for Alaska and Wyoming under predicting in the former and over predicting in the latter.

Table 2 is constructed similar to Table 1 except that the one year ahead forecasts are based on estimating the models over the 1971-1990 period. The PFD model has the lowest mean error and the FIX model has the lowest root mean square error. The SHRINK produces the second lowest value for both of these statistics. Again, none of the forecasting models appear to be biased. Alaska and Illinois have relatively large over predictions for all the models with percent errors in the 10-20% range.

Table 3 presents the two year ahead forecast error comparisons based on the models estimated from 1971 through 1989. The SHRINK model produces the lowest mean error and second lowest root mean square error. The highest mean error is from the FIX model at nearly 3 % while the OLS model has the highest root mean square error at 5.76%. All the models continue to be unbiased on average. Alaska and Wyoming remain difficult to predict with relatively higher forecast errors. They are joined by California, Louisiana, and Illinois.

There is a tendency for the forecast errors to be of the same sign particularly when the predictions are for greater consumption per capita than actual. All four models over predict at the same time in 24, 22, and 23 of the 50 states and the District of Columbia in Tables 1, 2, and 3 respectively. They simultaneously under predict in 6, 10, and 3 cases for the same tables respectively.

CONCLUSION

In this paper we forecast annual State per capita motor gasoline consumption with pooled cross-section and time series data. Since the coefficient estimates based on the pooled data are quite different from the estimates based on the average of the individual State regressions, we apply a Bayesian estimation procedure that shrinks the individual state coefficient estimates towards a common mean.

We then compare the forecast performance of four alternative models: 1. a pooled regression with separate State dummy variables for the intercept term, 2. a pooled regression without State dummy variables for the intercept term, 3. an unpooled OLS regression estimated separately for each State, and 4. a random coefficient shrinkage estimation model based on a Bayesian shrinkage procedure. On balance, all four models performed equally well in one step ahead and two step ahead forecasts.

Although the random coefficient shrinkage estimator gave superior results for parameter estimation in an energy elasticity study by Maddala, Trost, Joutz and Li (1994), they did not out perform more traditional approaches in forecasting State motor gasoline demand. Hence, the main conclusion from this paper is that shrinkage estimators that vary over the cross-sections but are fixed over time do not significantly out perform the traditional OLS pooled and unpooled forecasting procedures. The application Min and Zellner (1993) time varying parameter models to the State motor gasoline forecasting problem is left for future research.

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Table 1

Motor Gasoline Consumption per Capita

Forecast Error Comparison, 1990

One Year Ahead Percentage Errors

late	Actual Gallons	Poded Regression With Dummies	Poded Regression Without Dummies	OLS Regression by State	Shrinkage Estimation
K	434.0	10.80	13.70	7.92	10.95
L	500.2	-0.65	-1.90	-0.23	-1.43
R	504.3	-1.56	-2.60	2.79	0.07
Z	437.7	-5.21	-5.62	-3.51	-3.69
:A	420.2	-4.29	-3.92	-3.31	-3.68
‘0	441.1	0.11	0,12	-1.04	0.16
:T	389.4	0.99	-0.18	-2.34	-1.27
׀C	266.4	1.48	-1.23	1.08	3.28
׀E	494.9	-1.33	-1.61	-3.93	-0.53
FL	448.6	-1.36	-2.19	-3.33	-0.79
GA	522.0	-1.30	-2.02	-0.43	-0.75
HI	318.1	-2.93	-3.75	-0.96	2.41
\	457.7	-3.01	-2.89	1.80	-2.27
)	451.9	1.82	0.79	3.43	2.13
	435.1	5.88	5.09	6.23	6.16
✓	456.6	0.05	-0.44	-6.33	-1.01
.S	466.2	-5.26	-5.19	-6.51	-4.47
.Y	472.3	-1.48	-2.53	-0.65	-0.09
A	428.8	-8.49	-6.87	-7.24	-4.38
VIA	385.4	1.33	-0.72	-7.01	-2.23
VID	408.1	-2.78	-3.59	-4.29	-2.88
IE	472.6	1.65	0.01	-7.s4	-0.84
VII	440.3	-1.37	-1.70	-2.81	-1.57
VIN	429.2	4.81	-5.28	4.23	-4.30
V10	513.9	0.49	0.13	0.35	0.93
VIs	459.4	0.34	-1.38	-0.10	0.90
IT	502.7	-0.26	0.35	-3.77	1.35
IC	476.6	-0.97	-2.18	-3.22	-1.24
ID	477.4	4.87	4.26	-8.68	-3.94
IE	458.1	-0.01	-0.30	4.96	1.12
IH	437.4	0.79	-1.03	4.52	-3.16
IJ	416.1	-1.32	-2.46	-1.86	-2.20
IM	499.7	-3.13	-2.91	-5.90	-2.56
Iv	503.2	-4.46	-3.11	-0.43	-2.05
IY	317.4	5.17	2.45	-0.15	5.51
)H	416.9	-3.97	4.65	-5.s5	-4.99
)K	506.7	0.50	1.05	7.00	3.81
)R	453.4	-2.68	-2.99	-4.32	-2.46
'A	370.7	0.43	-1.53	0.40	1.08
II	361.1	0.60	-1.56	-7.79	-0.83
;C	*504.7*	-0.11	-1.53	18.77	2.03
;D	504.4	-1.83	-1.98	1.75	-1.13
"N	486.3	-3.42	4.05	-5.06	-4.49
X	486.9	-0.72	-0.27	-0.67	1.03
IT	396.8	-5.70	-6.76	-9.21	-4.72
'A	464.8	-0.47	-1.38	-5.52	-2.93
'T	486.7	3.88	2.63	3.77	3.56
VA	447.6	-2.39	-2.86	-2.03	-3.39
VI	406.2	-1.41	-2.22	0.88	0.16
W	444.0	1.89	0.27	1.33	2.55
W	609.6	-7.83	-5.74	-10.62	-10.16
Aean Error		-1.0041	-1.6236	-1.6395	-0.7270
Floot Mean Sq. Error		3.2244	3.1727	4.8740	3.3745
Aaximum		10.8004	13.6952	16.7744	10.9499
Ainimum		-7.8266	-6.8716	-10.6165	-10.1644

Table 2

Motor Gasoline Consumption per Capita

Forecast Error Comparison, 1991

One Year Ahead Percentage Errora

tate	Actual Gallons	Poded Regression with Dummies	Poded Regression without Dummies	OLS Regression by State	Shrinkage Estimation
K	362.1	-23.24	-20.49	-5.95	-21.15
L	502.6	0 s 5	-0.72	-1.98	-0.38
R	504.0	-0.44	-1.46	0.25	-0.05
	446.7	0.97	0.69	-3.52	0.82
A	405.7	-4.05	-3.48	-6.56	4.08
o	434.0	-1.95	-2.04	-0.87	-1.45
T	395.3	5.37	4.77	0.84	2.80
c	277.8	3.78	0.73	3.77	4.91
E	475.5	-4.02	-4.24	-9.26	-4.07
L	441.2	-1.18	-1.88	-1.41	-0.46
	520.8	-0.08	-0.72	-1.11	-0.20
I	324.5	1.27	-0.03	-5.84	1.72
A	460.3	0.17	0.30	-0.32	0.11
D	437.9	-2.73	-4.03	-0.17	-2.22
L	373.9	-14.66	-15.62	-10.62	-15.22
N	451.1	-1.38	-1.91	0.22	-0.82
s	457.8	-2.60	-2.59	-6.41	-3.25
Y	481.3	1.42	0.28	1.31	1.77
	419.4	-3.77	-4.25	-7.97	-3.35
A	378.0	1.81	0.32	-2.92	-0.85
MD	414.8	3.68	3.19	-2.31	1.42
ME	474.6	2.20	0.75	-0.09	1.82
MI	446.4	1.00	0.77	0.10	1.0C
MN	449.9	4.83	4.60	0.19	3.9
Mo	513.2	-0.25	-0.63	0.58	-0.84
MS	470.5	1.77	-0.10	2.97	2.5
MT	504.0	-2.33	-1.98	-3.10	-3.76
NC	471.6	-0.24	-1.50	-1.04	-0.57
ND	492.7	2.81	3.22	-0.25	2.6(
NE	442.6	-3.23	-3.69	-1.20	-3.0
NH	455.9	6.26	4.94	0.81	3.2(
NJ	424.5	4.86	4.23	-3.65	1.1
NM	506.8	0.15	0.27	0.87	1.1
NV	492.1	-2.78	-1.25	2.87	0.0$
NY	307.5	0.48	-2.51	-3.84	-2.7C
OH	414.6	-0.49	-1.03	-5.28	-1.51
OK	499.5	-2.67	-2.33	2.44	-0.0
OR	452.5	-0.76	-1.06	-2.24	-0.4:
PA	369.9	0.96	-1.08	0.77	0.8
RI	360.4	2.14	0.13	-1.74	1.1
SC	492.5	-1.69	-3.22	-1.84	-3.6
SD	513.3	0.94	0.55	3.96	0.51
TN	467.9	-4.07	-4,65	-4.96	-3.01
TX	465.9	-5.31	-5.02	-1.56	-3.9
JT	401.5	-1.19	-2.38	-2.48	-0.6
VA	464.2	0.93	0.18	-3.37	-1.2
VT	492.1	2.64	1.54	5.94	3.1
WA	445.8	-0.31	-0.71	-4.20	-1.47
WI	412.9	1.52	0.66	0.97	1.5
WV	439.3	-0.86	-2.73	-0.66	-0.6
WY	607.2	-2.94	-1.10	-14.75	-5.9(
Mean Error		-0.7202	-1.3394	-1.8939	-1 .033(
Root Mean Sq. Error		4.5840	4.1526	3.8371	4.204
Maximum		6.2591	4.9417	5.9435	4.910
Minimum		-23.2425	-20.4900	-14,7452	-21.148

Motor Gasoline Consumption per Capita

Forecast Error Comparison, 1991

Two Year Ahead Percentage Errors

State	Actual Gallons	Pooled Regression with Dummies	Pooled Regression without Dummies	O LS Regression by State	Shrinkage Estimation
AK	362.1	-11.24	-5.09	-5.80	-10.86
AL	502.6	-0.11	-2.66	-1.31	-1.87
AR	5040	-1,94	-4.06	3.33	0.95
AZ	446.7	-3.83	-4.69	-2.35	-1.76
CA	405.7	-8.24	-7.59	-728	-6.83
CO	434.0	-2.02	-2.1 t	-2.47	-106
CT	395.3	6,06	4.33	0.30	1.85
x	277.8	4.80	-0.60	5.05	8.87
DE	475.5	-5,34	-6.01	-9.25	-3.83
FL	441.2	-2.59	-4.21	-3.62	-1.42
GA	520.8	-1.37	-2.84	-0.10	-0.49
Hi	324.5	-1.41	-3.62	-2.45	5.06
A	460.3	-2.65	-2.58	3.89	-1.50
ID	437.9	-1.16	-3,40	0.98	-0.58
L	373.9	-8.42	-10.22	-8.71	-8.51
IN	451.1	-1 44	-2.50	-7.92	.3,22
KS	457.0	-7.66	-781	-8.28	-6.99
KY	481 3	0.02	-2.20	1.40	2.20
LA	419.4	-9.98	-11 04	1001	-6.38
MA	378.0	2.88	-0.61	-929	-3.25
MD	4148	1 03	-0.39	-2.23	-003
ME	474.6	3.62	0.61	-7.48	-1.28
MI	446.4	-0.33	-1,01	-1.04	-0.69
MN	449.9	0.49	-0.35	1.62	1 27
	513.2	0.14	-0,70	-0.50	-0.10
	470.5	1.99	-147	2.26	3.30
	504.0	-2.67	-1.76	-7.74	-2.84
c	471.6	-1.23	.3,74	-4.21	-2.32
D	492.7	-1.54	-0.82	-2.24	-0.79
E	442.6	-3.38	-4.15	3.95	-1 38
H	455.9	680	3.79	-0.84	0.20
J	424.5	3.52	1.65	-0.56	077
M	506.8	-2.82	-2.58	-435	-1.98
V	492.1	-7.16	-451	2.79	-1.85
Y	307.5	5.16	-036	-9.16	067
H	414.6	-4.24	-5.64	-737	-6.34
K	4995	-2.31	-1.46	7.01	409
R	452.5	-3.35	-4.08	-468	-2.82
A	369.9	1.20	-2.72	1.58	2.31
	360.4	2.56	-1.50	-8.66	-0.71
c	492.5	-t .84	-487	18.02	327
D	513.3	-0.81	-1.45	5.17	-0.42
	467.9	-7.44	-8.81	-9.36	-9.06
x	465.9	-6.17	-5.46	-4.95	-3.54
T	401,5	-6.55	-8.83	-8.94	-5.46
A	464.2	0.39	-1.33	-7.32	-471
	492.1	6.09	3.86	5.92	5.24
A	445.8	-2.60	-3.64	-5.09	-5.12
I	412.9	0.14	-156	3.54	2.83
	439.3	0.88	-255	-0.02	1.94
	607.2	-10.33	-678	-13.34	-13.97
Mean Error		-1.69	-2.98	-2.41	-1,57
Root Mean Sq. Error		429	3.23	5.76	4.18
Maximum		6.80	4.33	18.02	8.87
Minimum		-11 24	-1104	-13.34	-13,97

Predicting the National Unemployment Rate that the "Old" CPS Would Have Produced

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KEY WORDS: Time series forecasting, Structural Models, CPS

Abstract: In January 1994. the introduction of the redesigned Current Population Survey (CPS) questionnaire and automat ion of collection procedures was expected to affect most labor force estimates. To help evaluate the change in the unemployment rate attributed to these revisions. time series models were used to extrapolate the pre-1994 series to predict the unemployment rate estimates for 1994.

L Introduction

Beginning with January 1994 data, the Current Population Survey (CPS) introduced new data collection procedures and population controls based on the 1990 census. adjusted for census undercount. These new procedures may result in substantial changes in many labor force series, including the national unemployment rate. In order to address the issue of comparability between the "old" and "new" series for various groups of data users. time series models were developed by the Bureau of Labor Statistics to predict what the national unemployment rate would be during the early months of 1994 under the "old" CPS data collection procedures and population controls based on the 1980 census.

The model uses the historical relationships between CPS data and unemployment insurance claims for the CPS reference week and employment from the Current Employment Statistics Survey (the BLS payroll survey of business establishments). The model was fitted to data from January 1976 through December 1993, the last month for which official estimates were made using the "old" data collection procedures. As soon as data are validated from the new parallel survey, which will use the "old" CPS methods, these data will be incorporated into a model to estimate what the monthly unemployment rate would have been had the "old" survey been continued. The new model and sample-based estimates then may replace the projections described in this paper.

This report discusses background of the CPS; gives a brief description of the data used in the models; presents the model and examines test statistics relevant to assessing its performance: predicts the unemployment rate, not seasonally adjusted, that would have been produced had the "old" survey been continued in 1994: describes the methods used (o seasonally adjust the model-based prediction; and offers caveats concerning the predictions. Additional technical detail is provided in the complete paper.

II. Background

The CPS is a monthly probability sample survey of about 60,000 households, conducted by the Bureau of the Census for the Bureau of Labor Statistics (BLS). Beginning with the January 1994 interview, the CPS is conducted using a new questionnaire in a completely computer-assisted environment. The Bureau of the Census and the BLS tested the new procedures for 18 months (July 1992 - December 1993) on a separate, national-based probability sample of 12.000 households. The results of this parallel survey indicate that the CPS annual average unemployment rate would have been 0.5 percentage point higher in 1993 if the new approach had been used. Additionally. the introduction of 1990-based population controls raises the unemployment rate 0.1 percentage point more than that obtained from 1980-based population controls. Additional effects due to design differences are discussed in Kostanich and Cahoon[1].

To better understand the differences between the "old" and "new" methodology, we are switching the old CPS procedures to the parallel survey sample of 12.000 households (here in after "new parallel survey"). In other words, in January 1994, the CPS sample of 60,000 households began using the "new" methods. and the parallel survey sample of 12,000 households began using the "old" methods. Due to operational constraints, it was not possible to avoid this switch-over with its possible attendant effects on respondents and interviewers.

Although data are being collected using both the old and new collection methods. the official labor force estimates are based on the CPS using the new methods. We cannot provide the public with an immediate source of comparison between the "new"

and "old" labor force estimates because the reliability of data from the new parallel survey may be low during the initial months, due to nonsampling errors associated with the start-up period that are beyond our control. As an interim measure. we developed a structural time series model to predict what the monthly national unemployment rate would have been had the "old" CPS been continued. This paper outlines the research conducted jointly by the BLS, the Bureau of the Census, and consultants from Iowa State University to develop this prediction.

III. Description of data

The data used for modeling the unemployment rate cover the period January 1976 through December 1993. These data consist of estimates of the civilian noninstitutional population and the unemployment rate from the CPS, estimates of employment from the Current Employment Statistics (CES) survey, and unemployment insurance continued claims counts provided by the Employment and Training Administration. The CPS and CES data are official BLS estimates obtained from the Bureau's LAB STAT database. Data are not seasonally adjusted, and levels are rounded to the nearest thousand.

The CPS data are composite and based on 1980 population controls. The CES data are final benchmarked up to March 1992, first benchmarked for the period April 1992 through April 1993, third closing for the period May 1993 through November 1993, and second closing for December 1993. Although the most recent CES data are subject to further revision, for the sake of consistency. we will not use data reflecting future revisions to reestimated our model. The unemployment insurance claims counts are the total number of regular state unemployment insurance claims filed during the week that includes the CPS reference week. These do not include claims paid under the Emergency Unemployment Compensation Act or earlier extended benefits provisions.

IV. The prediction model

A number of different time series models were fit to CPS unemployment rate data for the period January 1976 through December 1993 for a total of 216 observations. The alternatives considered were structural time series models with explanatory variables multiple regression with autocorrelated disturbances and univariate ARIMA models[4]. (See the appendix for more details.) A structural time series model was selected as the preferred model because of its goodness of fit to the historical data, forecasting performance. and ease of explanation.

The structural model is essentially a multiple regression that includes a trend and seasonal component and two explanatory variables as regressors. This model differs from the usual regression model in that the trend and seasonal components do not have a fixed functional form over the entire sample period but rather are allowed to vary smoothly over time. The model is given by

$$Y_t = \mu_t + \beta_1 CLR_t + \beta_2 CESEP_t + S_t + \varepsilon_t \quad .$$

where

Y_t = CPS unemployment rate for month t,

μ_t = time varying trend term,

$CLR_t = 100(UI_t/CESEM_t)$,

$CESEP_t = 100(CESEM_t/POP_t)$,

UI_t = unemployment insurance claims,

$CESEM_t$ = employment level from the CES.

POP_t = civilian noninstitutional population,

β_1, β_2 = fixed regression coefficients,

S_t = the seasonal component, and

Et = a random disturbance (noise) term.

The two explanatory variables used in the model are the ratio of worker claims for unemployment insurance benefits to CES employment (CLR) and the ratio of CES employment to the estimated civilian noninstitutional population (CESEP).

The CLR and CESEP variables are included in the model because they are strongly correlated with the CPS unemployment rate, and are readily available on a timely basis. However. the variables do not explain a significant amount of variation in the CPS rate. A complete explanation would require a complex model with many variables. As an alternative to such a complex model. we add stochastic trend and seasonal

components to capture both long-run movements and seasonal variation in the CPS unemployment rate that are not accounted for by the two regressors (CLR and CESEP). Note that in this model the seasonal component reflects the seasonal pattern in the unemployment rate not accounted for by the explanatory variables and thus it is not suitable for seasonally adjusting the unemployment rate.

The trend component, μ_t, or time varying intercept, is represented as a nonstationary autoregressive process (random walk). That is. its current value is equal to its previous period value plus a random disturbance. Thus, the trend will change very smoothly over time. shifting up or down, with no persistent directional change. The magnitude of the change is determined by the variance of the disturbance term. Similarly, the seasonal component is specified as a nonstationary process consisting of the sum of six trigonometric terms with seasonal periodicities. Each of these components contains a random disturbance with a common variance. This allows the amplitude and phase of the seasonal pattern to change slowly over time, where the degree of change depends upon the size of the disturbance variance.

The effect of specifying the trend and seasonal components in the fashion just described is to discount past observations in the computation of these components. Thus. data from the 1990's are assumed to be more relevant for predicting the trend and seasonal components in 1994 than are data from the 1970's. The degree of discounting depends upon the size of the variances of the trend and seasonal components. These variances are determined empirically.

Table 1 presents the values of the estimated coefficients and t-ratios for the two explanatory variables, and monthly estimates of the trend and seasonal components for 1993. The trend has a large positive value, but is offset by multiplying the CESEP variable by its negative coefficient.

In the initial model estimation, the seasonal pattern was estimated to vary smoothly over time. A closer examination, as suggested by Wayne Fuller of Iowa State University, revealed that most of the change in the seasonal component was occurring in May and June, months when teenagers have a strong influence on labor force movements. There has been a secular decline in the relative size of this teenager group, which might explain the observed changes in the seasonal pattern. To test this possibility, a seasonal change variable for May and June expressed as a function of the percent of 16 to 19-year-olds to total population was introduced. When this variable was added to the model. the variance in the residual seasonal component was reduced to zero. While this had little effect on the final predictions, it did reduce the standard deviation of the prediction error by 15 percent.

The lower part of Table 1 presents evaluative statistics. The standardized one-step ahead prediction errors generated from the model were tested for autocorrelation, non-normality, and increasing variance over the 1993 sample period. The Q statistic is the portmanteau test for autocorrelations in the prediction errors up to 24 lags. This statistic has an asymptotic chi-squared distribution with 24 degrees of freedom. A value of about 40 or more would indicate significant autocorrelations. The normality test can be compared to a chi-square distribution with two degrees of freedom. A value higher than about six would indicate lack of normality. The variance test checks for larger prediction errors in the last third of the sample relative to the first third. This test statistic has an F distribution. The root mean square error (RMSE) is the standard deviation of the one-step-ahead prediction errors computed over the last year of the sample period. This statistic measures how well model predictions compare to actual observations. None of the diagnostics in table 1 suggests that the model is inappropriate.

Three alternative coefficients of determination (R^2, R_D^2, and R_s^2) are shown as measures of goodness of fit. The conventional R^2 is 1 minus the sum of squared prediction errors to the sum of squared deviations of the unemployment rate observations about the mean. It shows how much of the variation in the series is explained by the full set of model variables. including the time-varying intercept and the seasonal factors. The R_D^2 measure indicates how much of the variation in the first difference of the series can be explained by the model. The R_S^2 measure is even more stringent; it represents the share of the residual variation explained by the model after taking first differences and then subtracting seasonal means. This measure is considerably lower than the value for R^2. Nevertheless. the model makes a relatively large contribution to explaining the variation in the unemployment rate that remains even after trend

and seasonal movements have been factored out of the series.

Table 1. Model Estimates and Evaluative Statistics

	Coefficients/components (T-ratios in absolute value)	
	CESEP [1]	CLR [2]
	-0.47 (6.9)	0.56 (7.3)
	Trend (1993)	Seasonal (1993)
Jan	32.58 (8.1)	-0.09 (1.5)
Feb	32.61 (8.1)	-0.09 (1.6)
Mar	32.53 (8.1)	-0.20 (4.6)
Apr	32.48 (8.0)	-0.35 (10.9)
May	32.40 (8.0)	0.08 (1.3)
Jun	32.40 (8.0)	0.46 (14.7)
Jul	32.31 (8.0)	0.07 (2.1)
Aug	32.20 (8.0)	-0.10 (2.5)
Sep	32.12 (7.9)	0.13 (2.8)
Oct	32.09 (7.9)	0.08 (1.9)
Nov	31.98 (7.9)	0.14 (3.4)
Dec	31.94 (7.9)	-0.12 (2.9)
	Evaluative statistics	
Q	12.83	
Normality	1.04	
Variance Test	1.20	
Rinse	0.17	
R^2	0.98	
R_D^2	0.85	
R_s^2	0.31	

Predictions

Table 2 presents the official unemployment rate estimates for 1993 with associated standard errors and 90 percent confidence intervals together with the predicted values for January through October 1994, their standard errors, and 90-percent confidence prediction intervals. The standard errors are computed from the model. The prediction intervals will become longer as the prediction period is extended.

The predicted rate is seasonally adjusted by using the implicit seasonal factors derived from the official rate estimates (discussed in detail later in this report). Approximate confidence intervals for the seasonally adjusted estimates are computed using the standard errors for the unadjusted data.

V. Seasonal adjustment procedure

The seasonally adjusted national unemployment rate from the CPS is produced by aggregating 12 independently adjusted series. The component series are: agricultural employment, nonagricultural employment. and unemployment, each for four sex-age groups (men 20 years and older; women 20 years and older; men 16 to 19 years: and women 16 to 19 years). Eight of these series are seasonally adjusted using multiplicative adjustment factors; the remaining four -- nonagricultural men and women aged 16 to 19 years. and unemployed men and women aged 16 to 19 years use additive adjustment factors.

The seasonal adjustment factors are generated using X-11 ARIMA software, and the factors for 1994 are given in the January 1994 issue of *Employment and Earnings.* Each of the 12 series is separately adjusted for seasonal variation. The series then are added to derive seasonally adjusted aggregate figures. The seasonally adjusted unemployment estimate is a sum of four seasonally adjusted unemployment components. The seasonally adjusted figure for the civilian labor force is a sum of eight seasonally adjusted civilian employment components and four seasonally adjusted unemployment components. The overall unemployment rate is derived by dividing the estimate of unemployment by the estimate of the civilian labor force.

The modeling described here yields an estimate of the unemployment rate, not seasonally adjusted. A seasonally adjusted rate was calculated by multiplying the unadjusted rate estimate by the ratio of the official January 1994 adjusted rate to the official January 1994 unadjusted rate. This approach seemed reasonable because analysis indicated that monthly differences between CPS and initial parallel survey unemployment rates were not affected by seasonal adjustment.

The official CPS unemployment rate, seasonally adjusted. for January 1994 is 6.7 percent, and the not seasonally adjusted unemployment rate is 7.3 percent. The ratio of the seasonally adjusted rate to the not seasonally adjusted one is, therefore, 0.9178. To obtain the seasonally adjusted prediction of the January 1994 unemployment rate that would have been produced by the "old" CPS methods, we multiply the not seasonally adjusted prediction of 6.9 percent by 0.9178. This gives us a seasonally adjusted prediction of 6.3 percent for January 1994.

VI. Caveats

It is important to note that the predicted estimates are based on historical relationships that may or may not carry over into the future. Specifically, it should be noted that no concurrent CPS data are used in the model to reflect the old CPS questionnaire and data collection methodology. This means that disturbances to the economy in early 1994 will not be reflected in the predictions, except as captured by the explanatory variables. In view of this, the predictions should be interpreted with caution, especially when the period is extended beyond January. As soon as data from the new parallel survey that replicates the "old" CPS methods have been validated, they will be incorporated into a model to estimate what the monthly unemployment rate would have been had the "old" survey been continued. These model and sample based estimates will then replace the projections described in the present report. Production of these estimates will continue, as we seek to help users better understand the relationship between the new, official series and the data derived from the "old" CPS.

APPENDIX: Description of the Modeling Methods

Three different approaches to time series models were used to estimate alternative forecasts of the CPS unemployment rate in 1994. These methods are based on the structural modeling approach [1]; autoregressive-integrated-moving-average (ARIMA) models[2]; and multiple regression models. The structural model provided the best alternative to satisfying the objective of multi-period forecasting with explanatory variables. This appendix provides further technical detail on the structural modeling method and then briefly addresses the regression model and ARIMA approaches considered.

Structural modeling with explanatory variables. This approach. as exemplified in the work of A.C. Harvey[3], explicitly models components known to exist in a time series, such as trends, seasonals, and irregulars. In univariate form, these models are closely related to ARIMA models, but do not include as wide a class of models as the G.E.P. Box-G.M. Jenkins approach [4]. When explanatory variables are added to this model, it is similar to a regression model. The general form of the model used in our application is described below.

Let

$$Y_t = \mu_t + \beta_t X_t + S_t + \varepsilon_t ,$$

where Y_t is the observed unemployment rate at time t; μ_t is a time varying intercept or trend term: β_t is a (1xk) row vector of time-varying coefficients; X_t is a column vector of explanatory (regressor) variables at time t; St is a seasonal component: and ε_t is an error term.

The time-varying trend is represented by a locally smooth linear trend with a random level, μ_t, and slope, γ_t. This is expressed as

$$\mu_t = \mu_{t-1} + \gamma_{t-1} + \upsilon_t$$

$$\gamma_t = \gamma_{t-1} + \upsilon_t^*,$$

where υ_t and υ_t^* are independent white noise terms with zero expectations and variances σ_υ^2 and $\sigma_{\upsilon^*}^2$. Similarly, the regression coefficient vector is described by

$$\beta_t = \beta_{t-1} + \xi_t ,$$

where ξ_t is a white noise vector with zero expectation and covariance matrix $\mathrm{Diag}(\sigma_{\xi_1}^2, .., \sigma_{\xi_k}^2)$.

The seasonal component is modeled by

$$S_t = \sum_{j=1}^{6} S_{jt} ,$$

where

$$S_{jt} = \cos(\omega_j) S_{j,t-1} + \sin(\omega_j) S_{j,t-1}^* + \zeta_{s_j} ,$$

$$S_{jt}^* = -\sin(\omega_j) S_{j,t-1} + \cos(\omega_j) S_{j,t-1}^* + \zeta_{s_j}^* ,$$

$$\omega_j = 2\pi p_j^{-1}, p = \{12>6>4,3>2.4>2\}>$$

and the ζ_{s_j} and $\zeta_{s_j}^*$ are **independent white noise disturbances with zero means and constant variance.**

This model provides, as a special case, the standard time series regression model in which the intercept and regression coefficients are fixed and the seasonal component is represented by monthly dummy

variables. The role of the time varying intercept is to capture long run variation in the unemployment rate that is not reflected in the explanatory variables. Similarly, the purpose of the seasonal component is to account for seasonal movements in the rate that can not be fully explained by the regressor variables. Seasonal movements are allowed to slowly change in magnitude over the sample period. The error term, ε_t, accounts for survey measurement error and can be modeled by a stationary process. For national data. the relative variance of the CPS survey errors are small enough so that the autocorrelation structure can be ignored; thus we let ε_t be a zero mean, white noise process with variance σ_ε^2. Additionally, we assume that all disturbance terms in the model are normally distributed.

In our application, we used two explanatory variables in the model. These are $CESEM_t$, employment estimated by the Current Employment Statistics survey; UI_t, worker claims for unemployment insurance benefits; and POP_t, representing the civilian noninstitutional population, 16 years and over. These variables are defined below.

$$CESEP_t = 100(CESEM_t/POP_t)$$

$$CLR_t = 100(UI_t/CESEM_t)$$

Two models were fitted. One model includes both variables, and the other includes only the CLR variable. For parameter estimation and signal extraction, the models were expressed in state space form. The parameters were estimated based on a maximum likelihood procedure, using the Kalman filter to estimate the likelihood function. Given the parameters of the system, the Kalman filter was used to optimally decompose a sample observation into its signal and noise components

Regression models with autoregressive disturbances. In this approach, multiple regression models with autocorrelated errors are formulated as follows[6].

$$Y_t = \beta X_t + \varepsilon_t$$

$$\varepsilon_t = \sum_{i=1}^{p} \theta_i \varepsilon_{t-i} + \upsilon_t$$

These models were estimated in both level and difference form. Variables used in the model are as follows:

$$RMPY7 = (POP_t)^{-1} Y7 - 3559(POP_t)^{-1}$$
$$RMPY6 = (POP_t)^{-1} Y6 - 50416(POP_t)^{-1}$$

Y7 = Unemployment insurance claims
Y6 = CES employment
POP = Civilian population 16+
CPSUER = CPS unemployment rate
DR = First difference of CPS unemployment rate
RMDIF = Lag(RMPY7 - .5RMPY6)
MMDINT = $[RMPY7 - 0.46RMPY6 + 0.43RMDIF][\overline{POP}]^{-1}[POP - \overline{POP}]$
$\overline{POP}$ = mean of POP

$$TREND = \left[1 + e^{\{0.375(t-122)\}}\right]^{-1}$$

The level model contained RMPY7, RMPY6, RMDIF, MDINT, TREND, 11 seasonal dummies, and 11 cross-product terms of TREND with the seasonal dummies. The difference model contained DRMPY7, DRMPY6, DRMDIF, 11 seasonal dummies, and the 11 season-by-TREND cross product terms. The notable features of these regression models were the inclusion of the TREND variable, estimated from fitting a logistic function to the unadjusted unemployment rate and the detrending of several variables. An additional variable, the proportion of teenagers 16 and older in the civilian noninstitutional population was included in the difference model to account for changing seasonality in May and June. Other auxiliary variables were tried in the regression model, but did not improve the model fit; these variables included the help-wanted index and number of hours worked in the manufacturing sector.

ARIMA models

ARIMA modeling is one of the most frequently used approaches to short term forecasting These models allow for a wide variety of potential forecast functions for extrapolating a time series from its own past. However, because forecasts are required for up to the first 5 months of 1994. the ARIMA univariate model has limited application, as the forecasts standard errors for this type of model increase considerably as the forecast period is extended.

With multi-period forecasting, models that use related series (when the values of those series are available during the forecast period) are preferred because their forecast errors are likely to be smaller. However, ARIMA models are useful benchmarks for comparison, because they often produce high quality forecasts over the first few periods of the forecast range. ARIMA models that were useful for one-step-

ahead forecasts were the (3.1,0)(0,1,1)12 and the (0,2,2)(0,1 .1)12.

Endnotes

1. D. L. **Kostanich**, and L. S. **Cahoon**, "Effect of Design Differences Between the Parallel Survey and New CPS ," *CPS Bridge Team Technical Report 3*, (Bureau of Labor Statistics, **1994).**

2. A. C. *Harvey* , ***Forecasting***, *Structural Time Series Models and the **Kalman** Filter* (Cambridge, Cambridge University Press, 1989).

3. *W. A.,* **Fuller**, *Introduction to Statistical Time Series* **(New York. Wiley, 1976).**

4. G. E. P. Box, and G. M. Jenkins, ***Time Series*** *Analysis: Forecasting and Control (San* Francisco, Holden-Day, 1976).

Table 2. Official and Predicted Unemployment Rates Based on the old CPS Design January 1993- October 1994

Month	Not seasonally adjusted	Standard error*	Seasonally adjusted Unemployment rate	90% Confidence interval lower	upper
Official					
January 93	7.9	0.12	7.1	6.9	7.3
February	7.7	0.12	7.0	6.8	7.2
March	7.3	0.12	7.0	6.8	7.2
April	6.8	0.11	7.0	6.8	7.2
May	6.7	0.11	6.9	6.8	7.1
June	7.1	0.11	6.9	6.8	7.1
July	6.9	0.11	6.8	6.6	7.0
August	6.5	0.11	6.7	6.6	6.9
September	6.4	0.11	6.7	6.5	6.9
October	6.3	0.11	6.7	6.5	6.9
November	6.1	0.10	6.5	6.3	6.6
December	6.0	0.10	6.4	6.2	6.6
Predicted					
January 94	6.9	0.17	6.3	6.0	6.6
February	7.0	0.20	6.4	6.1	6.7
March	6.6	0.22	6.3	5.9	6.7
April	5.9	0.24	6.1	5.7	6.5
May	6.0	0.26	6.1	5.7	6.5
June	6.1	0.28	5.9	5.4	6.3
July	6.1	0.29	6.0	5.5	6.4
August	5.8	0.31	6.0	5.5	6.5
September	5.6	0.32	5.9	5.4	6.5
October	5.5	0.34	5.9	5.3	6.4

*Standard errors are based on rates that are not seasonally adjusted and are used to construct the confidence intervals.

POLICY ANALYSIS

Macroeconomic Implications of Health Care Cost Containment,
John H. Phelps, Health Care Financing Administration
R. M. Monaco, INFORUM

MACROECONOMIC IMPLICATIONS OF HEALTH CARE COST CONTAINMENT

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ABSTRACT

Simulations with a long-term interindustry model show that there are potentially large benefits to the overall economy in implementing health care cost containment as part of health reform. Successful coat containment enhances economic growth and substantially improves the federal fiscal position.

INTRODUCTION

Reducing health spending growth is one of the major goals of the Administration's recent health proposal (the Health Security Act of 1S93) as well as many other health reform proposals. This paper summarizes simulations that explore how significant economic benefits may arise when high and rapidly growing health care spending is reduced. We have found benefits that appear to be larger than the costs identified with health care reform. In other papers, we addressed the economic effects of cost containment and implementing a specific health care reform package (Monaco and Phelps 1994). Here we explore the various benefits, under different assumptions, of a large reduction in health spending, without overlaying the complexities of implementing any specific comprehensive reform proposal.

Our major substantive conclusion is that if society does not control health care spending growth, economic growth will be lower, unemployment will be higher, and reducing the federal deficit and guaranteeing the OASDI trust funds will be very difficult without raising income and social insurance tax rates. States will face ever-increasing pressure to increase taxes or reduce nonhealth spending.

We have also reached an important conclusion about *how health care* reform should be analyzed. We found that the major economic impacts from reducing health spending take at least ten years to fully develop. As in many other cases, smaller changes made earlier in the policy cycle cumulate into larger results over time. Thus, we have concluded that longer-run analysis is essential to the health care reform debate. As a corollary, because the analysis horizon is crucial, we believe that shorter-run, largely macroeconometric approaches to analyzing reform arc incomplete.

The results reported in this paper can help to define the elements necessary for a useful health care proposal, and emphasize how the benefits of reducing health care spending accrue. Because the benefits of controlling health care spending - particularly medical price inflation - are so large, any credible plan needs to be explicit about the mechanisms that reduce spending. whether any plan can legitimately claim it will contain medical care cost increases should become a major criterion for it's inclusion in serious health *care* reform debate.

ANALYTICAL FRAMEWORK

Our approach to investigating the channels through which changes in the health care sector affect the general economy has been developed by the Office of the Actuary, Health Care Financing Administration (HCFA), in conjunction with INFORUM, a nonprofit research group at the University of Maryland. The simulations were performed with INFORUM's long term interindustry macroeconomic model (LIFT, summarized in McCarthy 1991). Over the past three years, HCFA has cooperated in enhancing the model to become a more useful health policy analysis tool. We expanded LIFT from 78 to 85 sectors, increasing the number of health care industries to seven. Labor compensation by industry has been disaggregate to allow analysis of the effects of altering employer contributions for health insurance on the rest of the economy. Although largely relying on econometrically estimated equations, unlike short -term macroeconomic modets, LIFT is designed to capture longer-run developments. Its current simulation horizon is 2010, although continued development of the model is aimed at extending the horizon to 2050.

Two Basic Simulations

To investigate cost containment effects, we compare a low health spending growth scenario (LS) with a high health spending growth scenario (HS). Real consumer spending (PCE) on health grows about 2 percent annually in the LS scenario, and overall consumer health inflation averages 3.1 percent annually. This is less than half the annual historical rate of 6.7 percent between 1980 and 1993. The HS scenario doubles consumer medical price inflation to 5.8 percent. This figure is comparable to the rate of health care inflation in recent HCFA and CBO projections, and is still below the 1980-93 annual average growth

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(See CBO 1993 and Waldo, ct. al. 1991).

Projections of health price inflation differ slightly across health industries, with growth rates of 5.8 percent in five health care sectors, a 63 percent increase for Physicians and a 7.1 percent increase for Other medical services. Health prices are semi-exogenous in alternative simulation(s). In the high spending alternatives, prices are set to grow 29 percentage points faster than the GDP inflation rate. Government health care spending is assumed to be constant in real terms across all scenarios; only medical price inflation is changing.

While our two scenarios involve different assumptions about growth rates of medical inflation, our assumptions about money supply growth are critical to our long-term inflation results. We have assumed that the money supply is unchanged between the LS and HS scenarios. Thus, we are assuming that the Federal Reserve does not accommodate higher nominal spending growth. Implicitly, this is akin to a tighter monetary policy regime; in HS, by 2010 the ratio of M2 to nominal GNP is 7 percent below the LS ratio.

Where other assumptions had to be made, we tried to make assumptions that minimized the economic differences between the LS and HS scenarios. For example, we know that higher inflation will have some negative impacts on international trade because exchange rates do not fully decline to offset the rising Us. price level. However, because there is considerable disagreement on the extent of the adjustment, we assumed that the exchange rate fully adjusts to inflation, and note that any other assumption would magnify the deleterious effects of high medical spending. Likewise, we know that some of the increases in employer health costs in the HS scenario will be passed through to higher labor compensation and prices. But there is no agreement on which industries will tend to do this or on how much will be passed through. Following others, notably CBO (1994), we have assumed that increases in health costs come at the expense of wages and salaries, leaving total labor compensation unchanged. Finally, oil prices are assumed to rise at the rate of GDP inflation. The impacts from altering some of these assumptions are discussed in a final section.

BASIC SIMULATION COMPARISONS

In this section, we compare the results of our HS scenario with the LS scenario. Higher medical care inflation raises the federal deficit substantially. Thus, in looking at the economic cost of not controlling high medical inflation, we must decide whether to allow the deficit to rise to unrealistically high levels, or to force the economy to absorb higher federal spending with higher taxes or lower spending on other goods. Since increasing tax rates requires an explicit government decision, we start by assuming no changes tax rates. In a final section we report the effects of raising taxes to fund high medical price inflation.

Inflation and Interest Rates

The higher growth rate in medical inflation (6.3 vs. 3.0 percent) shown in Table 1, results in a 70 percent increase in medical prices by 2010, illustrating the cumulative longrun effects of changing growth paths. This 3.3-percentage-point change in the growth rate of medical inflation is larger than the 2.9-percentage-point higher assumption due to second round effects of the increase in the GDP deflator. The 70-percent increase in medical prices raises the overall price level considerably by 2010. The GDP deflator is 8 percent higher in 2010, consistent with a half percentage point increase in 1994-2010 inflation. The consumer price deflator is up 14 percent by 2010, consistent with a 0.8-percent annual increase over the base consumer inflation rate. Because medical inflation primarily affects consumer goods, price increases differ across major GDP components. For example, compared with the base in 2010, deflators for residential and non residential structures and federal defense are up only 3 percent. Similarly, the producers' durable equipment deflator is up 4 percent while the export deflator is up 7 percent. Price changes for each of the 85 producing sectors show considerable variation.

Interest rates are higher under HS than LS. The movements in interest rates reflect two Countervailing forces. First, higher inflation raises both short- and long-term interest rates. This occurs through two channels. In the long run, nominal interest rates reflect the inflation rate on a point-for-point basis. Further, the higher price level reduces the real value of the monetary base - whose nominal value was unchanged between the LS and HS scenarios - which further raises interest rates in the model.

At the same time that interest rates rise with inflation, the model associates the higher unemployment that accompanies HS with lower interest rates. In our HS alternative, the effects of inflation overwhelms the unemployment effect. Even with the increased unemployment, short and long term rates are up 1.2 and 1.4 percentage points respectively by 2010. Because annual inflation is up less than interest rates, higher health care inflation has led to higher real interest rates for the economy as a whole. In turn, higher real interest rates raise the exchange value of the dollar, reducing exports even when exchange rates have fully incorporated inflation changes.

The Federal Budget

High health spending has a devastating effect on the federal deficit, the size of the federal debt and the solvency of federal social insurance trust funds as shown in Table 1. Although nominal federal receipts are 12 percent above the base in 2010, federal expenditures are up 27 percent. The disparity between federal receipts and outlays highlights that increasing medical inflation will increase the federal deficit, trust fund outlays, and other federal outlays under current institutional arrangements. Thus higher medical inflation will put pressure on policymakers to raise taxes or reduce nonhealth spending.

Several factors combine to produce large federal deficits and reduced trust funds. First, faster growth in medical prices directly lead to higher federal outlays for Medicare and Medicaid. Secondly, when employers are assumed not to pass increased spending on health benefits through to higher prices, rising

employer spending on health benefits reduces the share of labor compensation devoted to taxable wages and salaries, reducing federal receipts for fixed tax rates. Finally, higher deficits tend to put additional upward pressure on interest rates, further raising the cost of servicing all of the federal debt. The result is that in the HS scenario with no tax increases, federal spending increases While the tax base decreases.

The gap between federal receipts and spending growth is larger for social insurance programs than for general federal funds. This reflects the lower share of taxable labor compensation and fixed Social Security tax rates in the model. In contrast, federal income tax receipts rise slightly in LIFT because federal personal income tax receipts are based on total personal income, not just the taxable portions. Thus, relative to taxable income, LIFT' assumes rising effective tax rates.

Federal Expenditures

Three components of federal spending increase the most under HS. Medicare, included in trust fund outlays, increases by $245 billion with higher health care inflation. Medicaid -- included in general federal funds outlays as grants-in-aid to states - increases by $137 billion in 2010. Finally, interest payments almost double by 2010, an increase of S215 billion. This large increase reflects the responses of federal interest payments to higher interest rates and to changes in the level of the publicly held federal debt.

The increases in federal government net interest play a dual role in the economy. While they increase the size of the federal deficit and, through cumulation, the federal debt, they also raise personal income, helping to prop up demand in the economy. Higher net interest payments financed by increased deficit spending become, in effect, an automatic stabilizer associated with higher medical care inflation. A larger share of consumer income derived from interest payments may have serious distributional consequences for the real economy, however, for the most part, the distributional consequences are largely absent in LIFT.

With high health care spending, the federal deficit not related to social insurance increases by S213 billion by 2010. Further, the social insurance surplus declines by S244 billion. The total increase in the federal deficit of S457 billion in 2010 reflects both of these changes and stimulates the economy at the cost of increasing the federal debt.

In 1980 the federal debt was 26 percent of GDP. By 1994, the debt is likely to rise to nearly 50 percent of GDP. Under the LS scenario annual deficits decline until the federal budget is virtually balanced by 2010. As a result, the debt as a share of GDP declines to 36 percent. In the HS scenario, the debt share rises to 47 percent in 2010. Rapid growth in the federal debt under HS is the result of outlays exceeding receipts and the self-reinforcing interaction between the deficit, interest payments, and interest rates, which rise with federal credit demand.

Solvency of Social Insurance Trust Funds

Under the LS scenario, the solvency ratio of the LIFT social insurance trust funds is 331.3 in 2010. This means that the accumulated trust funds are more than three times larger than the annual outflow for 2010. In 2010, the annual social insurance fund surplus is more than $294 billion. Overall, the LS solvency ratio is around the level that many believe is needed in 2010 to meet the social insurance demands of the baby boom generation. **Solvency is maintained with a constant 7.65 percent social security contribution rate.**

In the HS scenario the annual surplus in 2010 has dropped to $50 billion, the solvency ratio has declined by more than 50 percent and trust funds have been reduced by $1.5 trillion. The decline in the social insurance trust funds is driven by the excess of increased outlays over increased receipts (S300 vs $% billion in 2010). Receipts lag because the tax base of wages and salaries is largely flat, compared with the LS scenario. By 2010, wages and salaries are unchanged in the higher-health-spending scenario while other labor income has doubled and personal income has increased by 15 percent. Personal income increases because the expanding government outlays and indexed OASDI payments are not paid for by tax increases. ***Very simply, the inescapable conclusion is that high medical inflation is*** incompatible ***with solvent social insurance trust funds.***

Personal Income And Economic Growth

Rising medical care prices raise three major components of federal spending and business outlays for health insurance. Medicaid and Medicare outlays increase much faster than GDP. Federal interest payments also increase faster than GDP. These increases translate directly into increases in personal income in LIFT. Although business spending *on* health insurance also increases, personal income is unaffected since overall labor compensation is not directly affected by the split among compensation categories.

The 15-percent increase in personal income is almost double the increase in nominal GDP because the government borrows to finance transfers and interest payments Personal transfer income is up almost 30 percent and interest income is up 22 percent. This stimulates consumer demand, essentially by borrowing from the future. The direct stimulus to personal income of higher medical transfer payment levels and a higher level of net interest payments accounts for more than half of the personal income increase by 2010, the other half comes from inflation. The federal government is not the only source of transfer and interest income. Medicaid is a state and local transfer program, and consumers hold state and local bonds and other' interest bearing assets.

Real Output and Employment

Higher health care spending leads to a slightly more than 1 percent reduction in real GDP by 2010. Of the major GDP components, the major reductions occur in investment, exports, and consumer spending. Real fixed investment - including residential structures -. is down 2 percent by 2000 and 5 percent by 2010. Real exports decline 1.5 percent by 2010 relative to the

base. That effect is due to largely to higher real interest rates, which has raised the real value of the dollar. Although much less on a percentage basis than investment or exports, the $11 billion decline in real consumer spending about matches the decline in exports. In LIFT, higher interest rates tend to raise savings, reducing overall consumption directly. The 1.1 million jobs lost reflects the reductions in output which vary by industry, reflecting changes in domestic and foreign demand. Agriculture, mining, construction, and durables manufacturing show small reductions (less than half a percent). Nondurable employment is down 4.8 percent.

Alternatives: Tax Rates. Exchange Rates. Employer Costs

In one alternative, we raised tax rates to restore solvency in the social insurance trust fund. To do this, wc raised FICA rates by 22 percentage points. Raising tax rates restored the solvency ratio and the federal deficit to that of the LS scenario. Without the deficit financing of the HS scenario, the stimulation to personal income and personal consumer expenditures declines. The result is that instead of declining byS11 billion in 2010, PCE declines by more than three percent (S87 billion) relative to LS. The number of lost jobs doubles to 2.2 million in 2010.

Our HS scenario assumed that employers did not pass the higher cost of health benefits on to higher prices. In alternative scenarios, when we allowed business to fully pass through rising costs, inflation increased, causing higher federal deficits and interest rates and lower GDP. The negative effects were further exacerbated in when, in separate alternatives, we did not allow exchange rates to adjust to fully offset domestic inflation. In the extreme case of fixed exchange rates which do not respond to inflation, GDP declines by almost than 3 percent of GDP (S 114 billion) in 2010. This is of course the upper limit. The most likely effects are considerably less. As a result the economic costs reported in the basic simulations understate the full costs.

CONCLUSIONS

Several points stand out in our basic comparison of high and low health spending. First, the overall inflation rate is changed substantially, even when the monetary authority does not accommodate higher spending. 'Ibis leads to changes in real income and in interest rates, which have important second round effects on the economy. Secondly, the basic comparison highlights the exposure of federal and state and local budgets to high health care spending. Higher health care spending increases government outlays by far more than the concomitant increase in incomes raise revenue. The result is ballooning federal deficits. One extremely important aspect of the deficit problem appears in the social insurance accounts. Because Medicare is part of the social insurance system, social insurance outlays rise dramatically when spending on health care is increased. The decline in the solvency of the social insurance system poses a special problem for policymakers who need to guarantee the solvency of the system. When FICA rates are increased to restore the solvency of the trust funds, the stimulation from increased deficits is eliminated and negative impacts on economic output and employment are much larger. In either case, the costs of a continued high growth in health spending are quite large and must be addressed by health care reform.

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TABLE 1

Line 1 is the Low Health Spending Scenario (LS)
Line 2 is the High Health Spending Scenario (HS) as a deviation from LS

	1980	1994	2003	2010	1980-94	1995"2010
HEALTH SPENDING						
Consumer Health Spending, S bill	194	767	1200	1740	9.81	5.04
		1	368	1072		3.0s
Consumer Health Spending\GDP, %	7.2	11.4	11.6	121	3.25	0.34
		0	3.2	6.2		2.59
Medicare & Medicaid, $ bill	60	289	474	671	11.21	5.16
		2	1s6	43s		3.13
Share of consumer health spending, %	31.0	37.7	39.5	38.s	1.4	0.12
		0	0	o		0.08
Employer Health Ins. Spending, $ bill	61	245	,369	521	9.9s	4.64
		0	' 112	318		3.02
Share of labor compensation, %	3.7	6.2	6.3	6.4	3.65	0.24
		0	l a	3.5		273
INFLATION AND INTEREST RATES						
Gross Domestic Product, bill S	2686	6722	10330	14338	6.S5	4.7
		-4	286	1014		0.46
GNP deflator, .77= 100	127.5	227.6	297.7	364.2	4.14	2.91
		0	10.8	30.4		0.53
PCE deflator, 77-100	181.7	322.2	426.4	524.9	4.09	3.03
		0.4	28.5	74.1		0.85
Consumer health deflator, 77=100	131.6	330	433.3	539.9	6.57	3.03
		3.7	147.8	371.3		3.27
Producers' durable equipment, 77=100	122.2	166.3	1%.4	220.4	2.2	1.73
		0.1	2.9	8		0.23
Exports, merchandise, 77=100	131.2	170.6	210.3	244	1.88	221
		0	6.6	16.2		0.42
Three month bill rate, %	11.5	4.2	5	4.9	-7.11	-0.87
		0	0.6	1.2		1.36
lo-year note rate, %	11.5	6.7	6.3	5.8	-3.83	-1.06
		0	0.8	1.4		1.32
Real rate of interest, %	2.6	4A	3.3	3	3.9	-1.82
		o	0.3	0.6		1.2
Ratio of M2 to nominal GNP, %	57.6	58.7	56.5	55.8	0.14	-0.26
		0	-1.6	-3.7		-0.46
PERSONAL INCOME COMPONENTS, billions of $						
Personal income	2265	5649	8615	11880	6.S3	4.s9
		1	514	1618		0.84
Labor compensation	1644	3974	5895	8099	6.3	4.4
		-8	88	346		0.29
Wages and salaries	1379	3257	4780	6501	6.14	4.27
		-7	-44	-42		4.01
Supplements	266	716	1116	1598	7.09	4.%
		0	132	387		1.4
Employer health ins. cent	61	245	369	521	9.95	4.64
		0	112	318		3.02
Interest income	274	710	1128	1s73	6.8	4.87
		0	114	377		1.42
Government transfers	321	943	1443	1978	7.69	4.56
		4	222	616		L72

Table 1, cont'd	1980	1994	2003	2010	1980-94	1995-2010
REAL OUTPUT (bill of 77 $) and EMPLOYMENT						
GDP	2105	2951	3467	3934	2.41	1.79
		-2	-29	-46		4.07
Personal assumption	13S2	1993	2292	2563	278	1.57
		-2	; -14	-11		-0.02
Health goods & services	148	233	277	322	3.24	201
		-2	-7	-14		-0.22
Nonhealth goods& services	1202	1779	2037	2265	28	1.52
		1	-7	4		0.02
Fixed investment	360	471	598	713	1.92	259
		-1	-14	-29		-0.24
Merchandise exports	148	275	399	522	4.42	3.93
		0	-3	-7		-0.1
Merchandise imports	166	406	521	637	639	2.85
		-1	-3	-4		-0.02
Unemployment rate, %	7.1	63	6.1	53	-0.86	-1.2
		0.1	0.6	0.7		0.71
Total jobs, mil	104	127	143	157	1.46	1.3
		0	-1	-1		4.04
FEDERAL BUDGET, billions of $						
Receipts	553	1340	2022	2788	6.32	4.55
		0	92	300		0.67
Personal Tax and non Tax Receipts	256	546	794	1042	5.41	3.94
		0	47	142		0.83
Expenditures	613	1508	2174	2804	6.43	3.76
		5	264	757		1.53
Purchases of Goods andServices	209	438	565	692	5.28	284
		0	7	16		0.14
Transfer Payments	252	675	1018	1399	7.04	4.49
		4	140	389		1.54
:Hospital & medical	36	155	247	356	10.51	5.07
		2	86	245		3.24
Grants-in-Ad to S&L Govt (Medicaid)	89	184	286	386	5.23	4.57
		0	50	137		1.95
Net Interest Paid	53	183	264	277	8.89	1.95
		0	67	215		3.77
Surplus or Deficit (-), NIPA	-60	-169	-152	-16	738	-16.38
		-5	-172	-457		2213
Social Insurance Funds	-6	89	171	294	0	7.5
		-3	-87	-244		-11.24
Other Funds	-54	-258	-323	-310	11.16	0.63
		-2	-85	-213		336
Debt of Federal Government	715	3353	4604	5098	11.04	2.49
		4	576	2234		239
Debt as a % of GDP, %	26.3	49.9	44.6	35.6	4.57	-221
		0.1	4.2	12.2		1.94
SOCIAL INSURANCE TRUST FUNDS, billions of S						
Federal Receipts	197.9	634.9	981.4	1403.1	833	4.92
		-0.4	22	57		0.26
Interest receipts	11.1	83.6	128.7	193.1	14.42	5.22
		0	-6.4	-39.9		-1.56
Federal Outlays	204	546.2	810.7	1108.8	7.03	437
		3	109.1	300.9		1.51
Old age benefits	118.6	305.7	442.3	603.2	6.76	4.21
		0.4	29.6	85.4		0.85
Hospital & medical	35.6	155.1	247	355.7	10.51	5.07
		2.4	86.1	245.2		3.24
Balance	4.1	88.7	170.7	294.2	0	7.5
		-3.4	-87.1	-244		-11.24
Trust Fund Accumulation	132.6	792.6	1888.2	3564.4	12.77	9.26
		-3.7	-386	-1558.2		-3.75
Solvency Ratio	66.7	149.7	240.1	331.3	5.77	4.89
		-1.5	-71.8	-184.6		-5.26

ECONOMICS AND EMPLOYMENT

Infrastructure Alternatives for 2005: Employment and Occupations,
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Foreign Trade Alternatives for Employment and Occupations, 2005,
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Health Care Alternatives: Employment and Occupations in 2005,
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Infrastructure alternatives for 2005: employment and occupations

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The Bureau of Labor Statistics recently published its biennial projections of the U.S. economy. [1] In a variation of the BLS moderate-case scenario that focuses on infrastructure spending for 2005, this article projects that an additional $41 billion in infrastructure investment would generate 833,000 new jobs. Most of these jobs would be seen in construction and related industries, as demand shifted into occupations with a close connection to working on the Nation's infrastructure.

As in the past, the BLS projections contain three alternatives covering the most plausible range of gross domestic product and its demand components, along with the expected change in employment by industry and occupation. Within this range of gross domestic product and employment are other paths the economy might follow if different events affect the distribution of demand. By varying the moderate scenario for 2005 to reflect other possible outcomes for selected demand categories, special assumptions can be derived and studied. In what follows, we analyze two such modifications of the moderate scenario, each focused on infrastructure spending. [2]

As will be shown, even under optimistic assumptions about future growth, the impact of infrastructure spending on employment is not great in total. However, this spending does affect certain industries, such as construction, very heavily. Note that the article focuses on infrastructure spending per se and does not examinine the productivity increases this type of investment might have on other parts of the economy.

Two alternative spending paths are laid out around the moderate-growth projections: a low-investment version, reflecting a fixed infrastructure share of gross domestic product over the projection period,[3] and a high-investment scenario, reflecting an increasing share of gross domestic product allocated to infrastructure replacement and improvement. Each of these alternatives provides some answers to questions regarding the potential impact of that alternative on employment and presents a range of both direct and indirect employment related to infrastructure spending. Certain assumptions were made to establish bounds between which infrastructure expenditures might fall. This study does not attempt to choose which is the best or correct level of infrastructure spending, but quantifies some of the alternative levels that have been suggested by researchers knowledgeable in the area.[4]

The study concentrates on five categories of infrastructure spending: highway construction, local transit construction, railroad and airport construction, water and sewage construction, and the operation of existing water and sanitation facilities.[5]

Modifications from the moderate projections are developed to measure the impact of infrastructure investment on the level and distribution of employment by industry and by occupation. Two methodological approaches were taken. One assumes that any increase or decrease in infrastructure spending is offset by other categories of gross domestic product, resulting in no change in the total projected gross domestic product for 2005. The second approach allows total gross domestic product to vary with the changes in infrastructure spending. This approach serves to highlight the industries and occupations that are sensitive to infrastructure spending. Assuming a constant gross domestic product, on the other hand, reflects the idea that the projected level of gross domestic product is the most likely to be attained, and, as a consequence, should a higher or lower level of one demand category take place, compared with its level in the moderate scenario, alternative offsets in other demand categories are more than likely to take place.

Background

Much discussion has occurred over the past few years about the state of the infrastructure in the United States, the lack of infrastructure investment during the 1980's, and the need to examine carefully the links between infrastructure spending and productivity. Deteriorating bridges, highways, and sewer systems, environmental regulations, shifts in population, and budget constraints frame the issues surrounding the U.S. infrastructure. Exacerbating these trends, over the past three decades

infrastructure spending as a percent of gross domestic product has alternated between steadily declining and remaining constant. The National Council on Public Works Improvement has stated that "The quality of America's infrastructure is barely adequate to fulfill current requirements and is insufficient to meet demands of future economic development."6

The current state of the U.S. infrastructure stock, coupled with projections of future demand, has been explored by other analysts. For example, a study conducted by the Office of Technology Assessment recommends a broad increase of 20 percent in total national infrastructure spending,[7] and another carried out by the National Council on Public Works Improvement goes even further, urging an increase of 100 percent.[8] In a similar vein, the American Association of State Highway and Transportation Officials estimates that total spending on highways should be 70 percent higher to keep pace with future travel growth.[9] The U.S. Department of Commerce estimates that infrastructure use by industries alone will increase at least 30 percent over the next 10 years.[10] And, according to the Environmental Protection Agency (EPA), local governments, which currently spend approximately 87 percent of all government outlays on water supply and resources and water and solid waste facilities, are expected to require a 65-percent increase in funding by the year 2000 to comply with the Clean Water Act and other EPA regulations.[11]

In the BLS models, employment is distributed both to industries that make direct expenditures on the infrastructure, thus comprising direct employment, and to industries that supply inputs that are consumed by infrastructure industries, making up indirect employment. The construction industry carries out most of the direct infrastructure spending, and in turn, the largest portion of infrastructure employment requirements fall into this industry. Manufacturing and service industries, which provide the materials and support necessary to construct the bridges, highways, and airports of the Nation, account for the majority of indirect infrastructure employment.

Assumptions

Using 1990 as a starting point, we developed a plausible range of assumptions regarding the portion of gross domestic product allocated to infrastructure spending, to produce high and low alternatives for the year 2005. The distribution of infrastructure spending among the various designated categories was obtained by reviewing government and private studies on recommended infrastructure spending priorities. For the high-investment case, it was assumed that infrastructure's share of gross domestic product would increase by 50 percent over the 1990 level; for the low-investment case, it was assumed that the share would remain at the 1990 level. (See table 1.)

Highway construction is an area that has received much interest because of the low growth in spending that has been prevalent since the interstate highway system was completed. Demand for truck transportation has been affected by today's "just in time" inventory policy, which depends on an efficient road system, as do the smaller, but specialized, high-technology firms that are important for employment growth. The category "new nonbuilding facilities, n.e.c. " includes railroad and airport construction. Spending on railroad construction may increase if high-speed train usage replaces a portion of the growth in automobile usage in intercity passenger travel. Furthermore, the same two factors of "just in time" inventory management and high technology that influence truck transportation may be reflected in some changes in railroad demand. More airport construction can be expected as the economy resumes a projected growth path closer to full employment and as population and income grow. Construction of new local transit facilities is expected to increase as government incentives to conserve energy and lower pollution continue to be offered. Finally, environmental pressures will necessitate more spending on the construction and operation of waste treatment facilities and clean water projects.

Table 2 presents the direct and indirect employment related to spending on infrastructure in 1990. From 1977 to 1990, the portion of gross domestic product spent on the selected infrastructure sectors declined, a trend BLS expects will be reversed in its 1992-2005 projections. However, investment spending as a share of real gross domestic product, is still expected to be lower than in 1977. (See table 3.)

In the moderate-growth projections to 2005, most of the categories of infrastructure investment maintain a real share of gross domestic product that is very close to the share they accounted for in 1990. The one exception is water and sanitation services, for which a significant increase in investment spending has been anticipated over the coming decade and a half. The category is projected to jump from a 0.36-percent share of gross domestic product (a 23.3-percent share of all infrastructure

investment) in 1990 to a 0.45-percent share of gross domestic product (a 27.5-percent share of all infrastructure investment) in 2005. In both the low- and the high-investment scenarios, this growth in water and sanitation services is projected to slow and be partially replaced by higher expenditure shares for new water supply and sewer facilities.

After establishing infrastructure category totals, we used BLS data to distribute each category to the direct inputs necessary for production. We used BLS input-output tables to determine the industry outputs required to satisfy the direct and indirect demand. For example, construction depends heavily on the paint, paving and asphalt, stone and clay, iron and steel, and engineering, architectural and surveying industries as primary inputs. In addition, water and sanitation services rely on the maintenance and repair construction, scientific and controlling instruments, and petroleum industries. After we determined output by industry for each scenario, we derived the employment by industry.

Results

The level of spending on infrastructure outlined above results in 178 thousand fewer employees in the low-infrastructure scenario and 833 thousand more employees in the high-infrastructure alternative, compared with the level of employees in the moderate-growth scenario for 2005. (See table 4.) In the high infrastructure scenario, for example, construction employment is up 382 thousand, followed by services, up 175 thousand, and manufacturing higher by 75 thousand. Changes at the industry level affect mostly small industries, such as asphalt, cement, concrete, and gypsum production.

Table 4 also shows each industry's occupational requirements in the three scenarios. As expected, occupational categories required by the construction industry, such as precision production, craft, and repair and operators, fabricators, and laborers, highlight the list. Within these two major categories are occupations such as carpenters, electricians, plumbers, painters, truck drivers, and helpers. Broadly represented in all industries, administrative support occupations also respond to the changes assumed in the investment alternatives. The executive, administrative, and managerial category, as well as the technicians and related support category, encompasses construction managers, drafters, architects, surveyors, civil engineers, and landscapers, all of whom are employed for construction purposes.

GDP offsets

A different perspective is attained by offsetting the alternative infrastructure spending in 2005 with other areas of demand gross domestic product. Because spending is not carried out in a vacuum. it is plausible to assume that an increase in one type of spending will be offset by a decrease in another type. Projections of gross domestic product developed for 2005 have been adjusted to reflect the low- and high-infrastructure scenarios by keeping total gross domestic product for that year unchanged. This has been accomplished by assuming that changes in infrastructure spending are matched by offsets in producers' durable equipment spending and in State and local government purchases. The outcome is a picture of employment reflecting a heavier emphasis on infrastructure spending. (See table 5.)

Such an analysis shows almost no variation in the level of employment between the alternatives at the total stage, but does in the sector distributions. For example, because education represents a large part of State and local government spending, it shows the largest offset. Also, manufacturing in total, and especially the large industries of investment spending--in particular, computers and metalworking machinery--show the impact of the offset. In the occupational analysis, the expected results: occupations demanded by the education and manufacturing industries are those most affected by the offset in infrastructure spending changes.

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[1] See Monthly Labor Review, November 1993.

[2] Although bls depends on a model to project economic variables for 2005, the analysis we present does not use that model to drive the various infrastructure spending levels. This is because the areas targeted for more outlays are fairly detailed--well beyond the detail in the macroeconomic model used by bls.

[3] While the projection articles in the November 1993 issue of the Monthly Labor Review cover the period from 1992 to 2005, the analysis we present examines the period 1990-2005 because actual data for 1991 and 1992, which would have allowed us to use either of those years as the initial year for our projections, were unavailable to us.

[4] See, for example, David Alan Aschauer, "Infrastructure: America's Third Deficit," Challenge, March-April 1991, pp. 39-45; Andrew C. Lemer, "We Cannot Afford Not to Have a National

Infrastructure Policy," APA Journal, Summer 1992, pp. 362-67; Kevin McDermott, "Reinvesting the Infrastructure," D & B Reports, September-October 1992, pp. 20-23; William M. Miller, "The American Infrastructure," Industry Week, May21, 1990, pp. 80-90; John Prendergast, "Rehabbing the U.S.," Civil Engineering, September 1991, pp. 66-69; Suneel Ratan, "Repairing Our Infrastructure," Fortune, October 19, 1992, pp. 91-93; and Joan Szabo, "Our Crumbling Infrastructure," Nation's Business, August 1989, pp. 16-24.

[5] In acknowledging the limitations of the study, it is important to note that long run changes in employment are generated by supply-side forces. To generate an alternative, changes in demand were made at the industry level. Employment would then change only as spending effects were felt in industries with differing productivities. Because total employment would remain virtually unchanged, the study is consistent with the fact that supply shocks drive long-run employment, whereas demand shocks affect only the distribution of employment.

[6] Fragile Foundations: A Report on America's Public Works (National Council on Public Works Improvement, February 1988), p. 1.

[7] Delivering the Goods: Public Works Technology, Management, and Financing eta-set-477 (U.S. Congress, Office of Technology Assessment, April 1991).

[8] Fragile Foundations, p. 2.

[9] Cited in Szabo, "Our Crumbling Infrastructure," p. 22.

[10] Ibid.

[11] Delivering the Goods, p. 170-71.

Table 1. Infrastructure spending, 1990 and projected to 2005

[millions of 1987 dollars]

Category	1990	2005 Low Infra-structure	2005 Moderate Growth	2005 High Infra-structure-	Difference LQw	Difference High
Total	$75,141	$99,077	$107,944	$148,882	-8,867	40,938
New water supply and sewer facilities	17,468	23,805	24,608	35,708	-803	11,100
New roads	28,767	39,166	39,307	58,782	-141	19,475
New local transit facilities	1,731	2,327	3,292	3,524	-965	232
New nonbuilding facilities, nec	9,694	9,974	11,033	14,961	-1,059	3,928
Water and sanitation, incl. combined serv.	17,481	23,805	29,704	35,907	-5,899	6,203
			Percent distribution			
Total	100.0	100.0	100.0	100.0	100.0	100.0
New water supply and sewer facilities	23.2	24.0	22.8	23.9	9.1	27.1
New roads	38.3	39.5	36.4	39.5	1.6	47.5
New local transit facilities	2.3	2.3	3.0	2.4	10.9	0.6
New nonbuilding facilities, nec	12.9	10.0	10.2	10.0	11.9	9.6
Water and sanitation, incl. combined serv.	23.3	24.0	27.5	24.1	66.5	15.2

SOURCE: Historical data, Bureau of Economic Analysis, U.S. Department of Commerce; projected data, Bureau of Labor Statistics.

Table 2. Employment related to spending on infrastructure, 1990*
[In thousands]

	Total	Direct	Indirect
All industries	1.709.8	735.4	974.4
Agriculture, forestry, fisheries	9.8	0.0	9.8
Mining	23.1	0.0	23.1
Construction	680.1	635.9	44.2
Manufacturing	217.7	0.0	217.7
Transportation	101.2	0.0	101.2
Communications	9.2	0.0	9.2
Public Utilities	111.0	99.5	11.5
Trade	119.7	0.0	119.7
Finance, insurance, &real estate	32.2	0.0	32.2
Services	299.2	0.0	299.2
Government	106.5	0.0	106.5

* The employment figures include wage and salary workers, the self-employed, and unpaid family workers.

Table 3. Infrastructure Shares of Gross Domestic Product, 1960, 1970, 1977, 1987, 1990, and projection to 2005

[Percent of GDP in 1987 dollars]

	1960	1970	1977	1987	1990	2005*
Total	2.45	1.98	1.67	1.56	1.54	1.62
New water supply and sewer facilities	0.41	0.37	0.35	0.37	0.36	0.37
New roads	1.16	0.96	0.56	0.59	0.59	0.59
New local transit facilites	0.02	0.05	0.04	0.03	0.04	0.05
New nonbuilding facilities, nec	0.59	0.37	0.38	0.21	0.20	0.17
Water and sanitaion, incl. combined serv.	0.26	0.24	0.35	0.37	0.36	0.45

* Moderate alternative of BLS projections, ***Monthly Labor Review***, November 1993

SOURCE: Historical data, Bureau of Economic Analysis, U.S. Department of Commerce; projected data, Bureau of Labor Statistics.

Table 4. Employment related to infrastructure spending, 1990 and projected to 2005
Gross Domestic Product Level in 2005 Varies with Infrastructure

thousands of iobs

Industry	1990	2005 Low Infrastructure	2005 Moderate Growth	2005 High Infrastructure	Differences from moderate Low	Differences from moderate High
Total employment	1,709	2,012	2,190	3,024	-178	833
Agriculture, forestry, fisheries	10	10	11	15	-1	4
Mining	23	22	23	33	-1	10
Construction	680	845	886	1,268	-41	382
New roads	317	414	415	621	-1	206
New water supply and sewer facilities	193	252	260	377	-8	117
New nonbuilding facilities, nec	107	105	117	158	-12	42
Maintenance & repair construction	44	49	59	75	-1o	15
Manufacturing	218	176	190	265	-14	75
Cement, concrete, gypsum, &plaster prd.	34	26	28	40	-1	12
Transportation services	101	117	135	176	-18	41
Trucking and warehousing	85	101	117	151	-16	34
Communications	9	7	8	10	-1	2
Public utilities	111	141	175	213	-34	38
Water & sanitation, incl. comb. serv.	100	132	164	199	-32	35
Wholesale and retail trade	120	140	153	210	-13	57
Finance, insurance, real estate	32	36	39	54	-3	15
Services	299	398	422	598	-24	175
Engineering and architectural services	157	193	200	290	-7	90
Government	107	120	148	182	-28	34
State & local government enter. ,nec	96	111	138	168	-27	30
Occupation						
Total , all occupations	1,709	2,012	2,190	3,024	-178	833
Executive, administrative,& managerial	199	250	271	376	-21	105
General managers and top executives	49	51	55	76	-4	21
All other managers & administrators	25	38	41	57	-3	16
Construction managers	19	27	29	41	-2	12
Professional specialty	147	197	214	296	-17	82
Technicians and related support	63	78	85	118	-6	33
Drafters	26	28	30	43	-1	13
Marketing and sales	108	132	142	198	-11	56
All other sales and related workers	40	45	49	68	-4	19
Marketing & sales worker supervisors	24	29	31	44	-2	13
Administrative support occ. ,incl clerical	247	261	290	393	-29	102
Secretaries, except legal and medical	43	41	45	62	-4	17
General office clerks	38	45	50	68	-5	18
Bookkeep'g, account 'g, & audit 'g clerks	36	36	39	54	-3	15
Service occupations	105	139	156	209	-17	54
Agri. ,forestry,fishing,& related occ	43	44	47	66	-3	19
Precision production, craft, and repair	456	541	583	813	-42	230
Carpenters 62	74	78	112	-4	34	
Blue collar worker supervisors	51	59	65	89	-6	24
Electricians36	45	47	67	-2	20	
Plumbers, pipefitters, and steamfitters	27	29	31	43	-2	13
Painters & paperhangers, const. & maint.	21	27	29	41	-2	12
Operators, fabricators, and laborers	341	369	403	554	-33	152
Truck drivers light and heavy	77	93	104	140	-11	36
Helpers, construction trades	51	58	61	87	-3	26
All oth help, labor,&mat ,movers,hand	4 7	55	60	83	-5	23

SOURCE: Historical and projected data, Bureau of Labor Statistics.

Table 5. Employment related to infrastructure spending, 1990 and projected to 2005
Gross Domestic Product Level Remains Constant AS Infrastructure Spending Varies

thousands of iobs

Industry	1990	2005 Low Infrastructure	2005 Moderate Growth	2005 High Infrastructure	Differences from moderate Low	Differences from moderate High
Total employment	122,028	147,492	147,482	147,449	10	-33
Agriculture, forestry, fisheries	3,276	3,326	3,325	3,323	1	-2
Mining	734	574	575	581	-1	6
Nonmetallic minerals, except fuels	111	108	108	113	0	5
Construction	6,617	7,450	7,483	7,826	-33	343
New roads	317	414	415	621	-1	206
New water supply and sewer facilities	193	252	260	377	-8	117
New nonbuilding facilities, nec	107	105	117	158	-12	42
New educational buildings	179	314	312	304	2	-8
Manufacturing	19,525	18,024	17,999	17.896	25	-103
Cement, concrete, gypsum, &plaster prd.	227	176	177	“189	-1	12
Fabricated structural metal products	440	347	347	353	0	6
Metalworking machinery	337	341	339	330	2	-9
Computer equipment	395	239	237	230	2	-7
Miscellaneous electric components	345	303	302	297	1	-5
Transportation services	3,816	4,654	4,667	4,685	-13	18
Trucking and warehousing	1,815	2,242	2,256	2,278	-14	22
Communications	1,319	1,135	1,135	1,133	0	-2
Public utilities	%5	1,051	1,084	1,117	-33	33
Water & sanitation, incl. comb. serv.	187	270	303	337	-33	34
wholesale and retail trade	27,730	32,533	32,523	32,478	10	-45
Retail trade, exe. eat. & drink. places	14,426	15,947	15,945	15,934	2	-11
Wholesale trade	6,519	7,617	7,610	7,577	7	-33
Finance, insurance, real estate	7,361	8,782	8,781	8,778	1	-3
Services	32,381	47,887	47,890	47,963	-3	73
Engineering and architectural services	874	1,104	1,109	1,194	-5	85
Personnel Supply Services	1,575	2,646	2,644	2,634	2	-10
Government	18,304	22,076	22,021	21.669	55	-352
State & local government enter., net.	625	769	795	’823	-26	28
State & local government hospitals -	1,072	1,259	1,250	1,209	9	-41
State government education	1,730	2,318	2,301	2,226	17	-75
Local government education	6.042	8.069	8.012	7,750	57	-262
Occupation						
Total , all occupations	122,028	147,492	147,482	147,449	10	-33
Executive, admin.,& managerial	12,252	15,191	15,195	15,221	-4	26
Construction managers	202	264	265	276	-1	11
Education administrators	340	434	432	423	2	-9
Professional specialty	16,284	22,838	22,801	22,634	37	-167
Other teachers and instructors	791	1,085	1,082	1,069	3	-14
All other teachers and instructors	513	734	731	717	3	-14
Teachers, special education	347	628	625	608	3	-17
College and university faculty	788	1,032	1,026	998	6	-28
Teachers, elementary	1,414	1,776	1,767	1,722	10	-45
Teachers, secondary school	1,226	1,735	1,724	1,678	11	-46
Technicians and related support	4,203	5,664	5,664	5,667	0	3
Drafters	329	349	350	360	-1	10
Marketing and sales	13,257	15,665	15,665	15,669	0	4
Administrative support,incl clerical	22,454	25,410	25,406	25,357	4	-49
Service occupations	18,859	25,821	25,820	25,792	1	-28
Janitors and cleaners	2,846	3,413	3,410	3,395	3	-15
Agri.,forestry, fishing,& related occ	3,531	3,649	3,650	3,658	-1	8
Precision production, craft, and repair	14,273	15,358	15,380	15,521	-22	141
Carpenters 1,050	1,173	1,176	1,205	-3	29	
Blue collar worker supervisors	1,835	1,971	1,974	1,986	-3	12
Electricians564	617	618	635	-1	17	
Plumbers, pipefitters, and steamfitters	383	377	378	389	-1	11
Painters & paperh'gers, const. & maint.	463	568	569	578	-1	9
Operators, fabricators, and laborers	16,914	17,896	17,902	17,930	-6	28
Helpers, construction trades	514	528	530	554	-2	24
Truck drivers light and heavy	2,448	3,031	3,039	3,060	-8	21
All other help, labor, &mat, movers,hand	1,669	2,042	2,044	2,055	-2	11
Bus drivers. school	380	506	504	493	2	-11

SOURCE: Historical and projected data, Bureau of Labor Statistics.

Foreign trade alternatives for employment and occupations, 2005

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As the world turns increasingly into a global marketplace, the issue of foreign trade becomes more complex. U.S. trade with China has grown rapid] y in recent years. New markets in Eastern Europe and in the former Republics of the Soviet Union are emerging. Perhaps the most important element on the trade horizon is the recently negotiated GATT (General Agreement on Tariffs and Trade) and the lately ratified NAFTA (North American Free Trade Agreement) among the United States, Canada and Mexico.[1] Globalization of trade is an ongoing process that may be hastened or slowed, but chances are that it will not be stopped. The coming decade will likely see some major changes in the way products are produced and delivered to the consuming sector of the world economy.

The BLS projections of the U.S. economy to 2005, described in the November 1993 issue of the ***Monthly Labor Review,***[2] offer three alternative views of potential growth to provide a range of future paths for final demand and employment. However, because those alternatives address only a few of the unknowns of the coming 13 years, special scenarios have been prepared which explore other areas of uncertainty in our economy.[3] This article focuses on the area of foreign trade, presenting an evaluation of the potential employment impacts of different levels of demand in this area.[4]

To assess the impact of a U.S. economy which may be more or less competitive in world markets, the analysis of foreign trade presented here focuses primarily on the impacts on employment due to changes in exports and imports. The trade alternatives presented here do not attempt to portray the effects of any particular policy or trade agreement such as NAFTA. Rather, they are prepared to evaluate the sensitivity y of the economy to changes in foreign trade. Exports and imports are both important components of our economy and are projected to become even more important between now and 2005. Because exports and imports tend to balance in the long run, their employment impacts at the aggregate level generally balance out except in terms of relative differences in the productivity of the industries affected. However, some industries are sensitive to trade growth. This analysis demonstrates that the shifting structure of the global economy brings prospective employment changes in many industries, some closely associated with foreign trade and others not normally so associated.

Historical perspective

Trend in exports and imports. U.S. exports and imports of goods and services are the two components of gross domestic product (GDP) that have gained the most in importance over the past 25 years. Exports (in 1987 dollars) grew at an average annual rate of 7.1 percent between 1970 and 1980, and increased their share of GDP from 5.6 percent to 8.5 percent over the same period. Imports also grew strongly, at 4.0 percent per year over the 1970-80 period, increasing from 6.8 to 7.7 percent of GDP. (See table 1.)

Exchange rate fluctuations of the U.S. dollar relative to other currencies in the first half of the 1980's, combined with much stronger competition in export markets, led to declines in U.S. real exports of 0.7 percent per year between 1980 and 1985. Imports, on the other hand, continued to do well over this period, as the appreciated exchange rate favored foreign producers and many U.S. industries appeared to have difficulties competing with European and Japanese manufacturers. Imports continued to grow strongly, accelerating to 9.4-percent annual growth between 1980 and 1985.

After 1985, the exchange rate of the U.S. dollar relative to other currencies fell quite rapidly. The depreciated exchange rate made exports relatively cheaper than imports, leading to lower prices abroad for U.S. produced goods. At the same time, there seemed to be increasing demand for U.S. products, notably machinery, and exports grew more rapidly. Between 1986 and 1992, exports rose by 9.8 percent annually, while imports slowed to a 3.9-percent rate of growth. By 1992, exports accounted for an 11.6-percent share of GDP, while the import share had risen to 12.3 percent.

In recent years, the United States has enjoyed a large surplus in the trade of services while running a still large but improving deficit in the trade of goods. Goods accounted for about three-fourths of total U.S. exports and imports during the 1970s. Exports of services, however, have become increasingly important during the past two decades: from 22 percent of total exports in 1970, or 1.2 percent of GDP, they

rose to *26* percent of total exports, or 3.0 percent of GDP in 1992. The trend in imports of services was in the opposite direction. Services declined sharply as a share of total imports between 1970 and 1992, from 28 percent to 16 percent, while their import share of GDP remained about 2 percent over the same period. The substantial increase in exports of services led to a trade surplus in services of $54 billion in 1992, compared with a deficit of $18 billion in 1970. On the other hand, the merchandise trade deficit rose to $86 billion from $17 billion over the 1970-92 period.

Industry-level exports. Other important trends in U.S. foreign trade relationships become apparent only at the industry level of detail. Twenty industries accounted for 47 percent of total exports in 1977. (See table 2.) Of these, 13 were in the goods-producing sector of our economy. Others included wholesale trade, air transportation, water transportation, and trucking and warehousing--those service sectors that facilitate the transfer of goods between producers and purchasers. Only 3 of the top 20 industries were true service-producing industries--depository institutions, real estate, and security and commodity brokers. The aerospace, motor vehicles, agricultural products, and chemical industries accounted for a significant proportion of total exports in 1977, a proportion that increased noticeably between that year and 1990.[5]

By 1990, the top 20 exporting industries accounted for over 50 percent of total exports. Although the United States exports goods and services across a broad range of industries, a significant proportion of those exports are becoming increasingly concentrated in a relatively small handful of industries.

A slightly different approach to understanding exports at the industry level is to examine them from the point of view of the export share of output.[6] This approach allows us to identify those industries most affected by exports, and to analyze how their export share of output compares with the overall average for the economy. Exports accounted for 3.8 percent of output (in 1987 dollars) in 1977, a share that rose to almost 6 percent by 1990.

Table 3 presents the 20 industries with the largest share of output going to exports. Clearly, although exports as a whole accounted for only 4 to 6 percent of production over the 1977-90 period, exports of these industries accounted for significant shares of their output historically. With the exception of water transportation, all of these industries are in the manufacturing sector and are generally classified as "high-tech," producing highly complex products with very capital-intensive production methodologies and generally having higher rates of growth in labor productivity. For these 20 industries as a group, about one-fifth of output was accounted for by exports in 1977, rising to almost 30 percent by 1990.

Industry-level imports. Turning to imports, it is not surprising to see a somewhat different story. In 1977, 20 industries accounted for 56 percent of imports. (See table 4.) Of these, three--motor vehicles, crude petroleum, and petroleum refining--accounted for one-third of total imports. While motor vehicles rose slightly in share terms between 1977 and 1990, the two petroleum industries--particularly crude petroleum--dropped in share, from 23 percent to 11 percent, over the same period. Unlike exports, which are becoming more concentrated in a handful of industries, imports are becoming broader-based, affecting a wider range of industries.

In 1977, total imports of goods and services accounted for about 4 percent of total supply (domestic output plus imports), rising to 6 percent by 1990. (See table 5.) In 1977, import penetration was highest in household audio and video equipment; fishing, hunting, and trapping; footwear; and crude petroleum--industries with traditionally high shares of demand satisfied by foreign manufacturers. By 1990, these traditional import industries had been joined by another group of sectors with only very low 1977 import penetration ratios--industries such as telephone and telegraph apparatus, computers, electric lighting and wiring, and x-ray and other electromedical apparatus. In short, foreign producers became competitive over the 1980's in many industries not formerly considered to be import-sensitive. This shift has been eased by more rapid international technology transfer.

The moderate-growth projection

Foreign trade determination is interrelated and highly complex. As exports grow more or less rapidly, effects are seen in other categories of domestic spending as domestic incomes increase at varying rates of growth. To the extent that healthy or ailing export growth affects the Federal deficit and inflation in this country (and thus abroad), the exchange rate of the dollar likely will shift. In combination with domestic income changes, this shift in turn affects imports.

The export and import components used in the moderate-growth alternative developed for the regular set of BLS projections published in the November

1993 issue of the *Review* are based on the assumption that the recent pattern of improvement in the U.S. trade position will continue. Overall, exports of goods and services are projected to increase at an average annual rate of 5.0 percent over the 1992-2005 period, while imports grow by 4.1 percent. Both exports and imports are projected to increase their share of GDP by significant amounts in the next decade. By 2005, the net trade balance on goods and services is expected to attain a net positive level of$51 billion, although there is still a deficit in merchandise trade.[7]

At the industry level, export growth in these projections continues to be concentrated in a relatively small group of industries. Industries in which exports are expected to account for the largest shares of output are also those industries higher capital-labor ratios and with higher projected rates of growth in labor productivity. (See tables 2 and 3.) Import demand will also continue recent trends to become broader-based over time, as imports become more prominent in many domestic markets. (See tables 4 and 5.)

Special foreign trade alternatives

In this study, the moderate-growth alternative is used as a baseline, and two alternative projections of foreign trade are developed to examine a high and a low volume of trade. The high-trade alternative illustrates a world with stronger trade growth and higher domestic demand; a low-trade alternative illustrates poorer economic performance abroad and a weaker domestic economy with respect to trade.

Aggregate assumptions. Under the high-trade scenario, real exports of goods and services are assumed to be 10 to 15 percent higher in total than in the moderate-growth projection in 2005. This is combined with the assumption that imports are likely to grow in tandem with exports over the long term. Only export and import levels are changed; all other GDP categories are assumed to remain constant, so that GDP is unchanged from the level for the moderate-growth alternative. This approach allows us to isolate the direct and indirect impacts on employment of foreign trade changes from the total induced changes in employment. (See text box on next page.)

In like manner, a low-trade alternative assumes that real exports of goods and services decrease by about 8 to 10 percent from the moderate-growth level of exports, and that imports are lower by an amount equal to the decrease in exports, tending toward trade balance in goods and services over the long run, although there is still a deficit in merchandise trade. Again, no changes in other final demand categories are assumed, and GDP equals that of the moderate-growth projection in 2005:

	2005		
	Low- trade	**Moderate-** growth	**High-** trade
GDP (billions of 1987 dollars)	$6,629.1	$6,629.1	$6,629.1
Exports of goods and services	964.4	1,088.4	1,239.9
Imports of goods and services	913.4	1,037.4	1,188.9
Net exports of goods and services	51.0	51.0	51.0

Industry assumptions. Exports and imports of goods and services are widely distributed across many industries. However, alternative foreign trade growth paths will likely have a greater impact on some industries than on others. For instance, the advance of market economies in Third World countries and in former Republics of the Soviet Union and Eastern Bloc countries may significantly increase their demand for capital goods such as computers and communications equipment. In this analysis, export- and import-sensitive industries for the high-trade scenario are defined as those accounting for a larger than proportional share of the assumed changes in trade balances.[8]

Industries for which exports are projected to reach or exceed 35 percent of output in 2005 are deemed export sensitive.[9] (See table 3.) Export-sensitive industries include those generally considered to be "high-tech" in nature, such as those manufacturing computers, electronic components, and aircraft, and those assisting in the development of foreign capital equipment, such as communications equipment. Technological advancement has become a worldwide priority, and the U.S. technological lead in many industries is acknowledged. However, other industries not usually thought of as high-tech, such as tobacco products and farm and garden machinery, also are considered export sensitive. Industries producing services for business, such as advertising and legal services, are assumed to be sensitive to trade

conditions, because they "are needed for the emerging global market system.

By the same token, the import-sensitive industries are here defined as those projected to reach an import penetration rate of 30 percent or more by 2005. (See table 5.) Among these industries, some are highly labor-intensive with lower rates of growth in productivity, such as footwear, apparel, and luggage and handbags. Others, such as semiconductors and related devices, often are not considered to be traditional import industries themselves, but are in fact import sensitive because they supply inputs to many export-sensitive industries, such as computers, broadcasting and communications equipment, and telephone and telegraph apparatus. The tourist-related industries are also included, due mainly to the increases in international business and tourism.

In the low-trade scenario, there are no industry-specific assumptions made beyond the aggregate results for both exports and imports. In other words, the low-trade alternative does not explore any particular sensitivity of the individual industries to the low volume trade conditions. All industries are assumed to be affected proportionally by weaker foreign markets and the weaker domestic purchasing power in the low-trade projection.

Results. To evaluate. the impacts of the special alternatives on employment, the alternative demand distribution is translated into direct and indirect employment requirements at the industry and occupational levels, by use of an input-output table expressed in terms of employment requirements and an industry-occupation matrix. [10]

It is clear that a rise in exports will increase employment in the economy as growing demand abroad translates into greater domestic production levels. A rise in imports, on the other hand, implies a decrease in employment (all other things equal) as less is produced domestically and more of a given level of demand is satisfied with foreign-produced products. More than other categories of demand spending examined in the Bureau's analytical system, however, neither imports nor exports are determined in a vacuum. As factors affecting exports change, other factors that come into play which have an impact on imports, and vice versa. Over the long run, the tendency will be for exports and imports to equilibrate, which accounts for the absence of changes assumed in the alternative net trade figures used here.

Total changes in employment. Because the trade balance level is assumed to be the same for all three alternatives over the long run, employment effects at the aggregate level are expected to balance out except in the case of relative differences in the productivity of the respective industries that are affected by shifting trade. As indicated in table 6, the changes in employment from the 2005 moderate-growth projection are very small--30,000 fewer jobs in the low-trade scenario, and an increase of 16,000 in the high-trade alternative.

Measuring employment effects of foreign trade

BLS examines various employment alternatives for three particularly uncertain areas of the U.S. economy. The health care spending and infrastructure investment alternatives were presented in the April 1994 issue of the *Monthly Labor Review.* These two papers were also presented on November 15, 1994 at the Federal Forecasters Conference. This analysis focuses on the foreign trade area.

In the health care and infrastructure analyses, a straightforward approach was used to assess effects of the alternatives as "employment related to health care spending" or "employment related to infrastructure investment." However, in the foreign trade alternatives, the impacts on employment are not examined from the point of view of "employment related to exports" and "employment related to imports." Subtle interweavings among economies in an increasingly global marketplace make it more difficult to disengage a study of exports from a study of imports. Also, it is especially difficult, if not impossible, in the context of the methodology used by BLS to present a clean estimate of the employment impacts of imports. Rather, the effects of changes in trade-determining factors are assessed in terms of overall GDP and total employment.

One way of looking at the impacts is to consider the overall changes in GDP and in all the components of GDP induced by the assumed changes in the factors affecting foreign trade. This includes not only changes in trade-related employment (direct and indirect), but also changes in employment related to all other categories of demand--consumption, investment, and government. A different way of looking at trade-related employment impacts is to allow only the export and import levels to change and keep all other GDP categories fixed in 2005 at the level from the moderate-growth projection. Although this is a rather artificial approach, it does serve to isolate the direct and indirect impacts of foreign trade changes from the total induced changes discussed above.

Within major industry sectors, the greatest job impact is felt in manufacturing. Accompanying the expansion of exports and related job opportunities in industries with high productivity growth, however, is an even faster growth of imports in industries that support relatively slower growth in labor productivity. By 2005, the manufacturing sector as a whole is projected to decrease by 382,000 more jobs in the high-trade scenario than in the moderate-growth projection. Employment in the low-trade alternative is expected to be 303,000 less in the manufacturing sector by 2005, compared with that in the moderate-growth projection.

In the wholesale and retail trade sector--those industries that facilitate the process of "getting to market"--increases or decreases in foreign trade activity generate greater or lesser indirect demand. This is the case also in the services sector, where job shifts are due only in small part to direct increases or decreases in foreign trade in services. As production levels change in the primary export and import industries, demand begins to change for those industries that supply the primary sector, thus leading to secondary, or indirect, effects on both production and the employment related to that production.

At the detailed industry level, the net impacts on employment vary by industry, and it is here that imports and exports can have their most significant effects on our economy. Table 7 presents the industries with the largest changes in employment from the moderate-growth projection under the low- and high-trade scenarios. The industries most affected by foreign trade are led by wholesale trade and apparel. In the low-trade scenario, wholesale trade exhibits considerably slower job growth--employment is lower by 110,000 jobs than in the moderate-growth alternative--while in the high-trade scenario, wholesale trade is projected to be higher by 127,000 jobs. An increase or a decrease in trade activity means more or less commerce, thus providing greater or lesser indirect demand for wholesalers. Conversely, the apparel industry is expected to decrease by 84,000 *fewer* jobs in the low-trade alternative, and decrease by 111,000 *more* jobs in the high-trade alternative, compared with the moderate-growth scenario. This industry has fewer jobs under the high-trade scenario because import competition rises as demand increases for foreign-produced products. A number of services industries such as colleges and universities and legal services are included among the industries affected by foreign trade.

In general, the high-trade alternative has a more favorable employment impact on industries that depend greatly on the volume of overall trade activity, such as air transportation, water transportation, and wholesale and retail trade. As discussed earlier, this is primarily due to the indirect effects of increasing demand in the foreign trade area. Also, the "high-tech" industries, such as aircraft and aircraft and missile parts and equipment appear to affect employment positively in the high-trade projection because of the U.S. competitive advantage. Conversel y, a group of traditional import-related industries, such as apparel, footwear, and luggage, are affected most because of the increases in import competition.

As can be seen from table 7, the industries with the largest employment impacts in the high-trade alternative are also those most affected in the low-trade alternative. However, the effects are in the opposite direction. Over half of the industries show either no effects or very small employment differences in the special trade alternatives. Not surprisingly, these include many industries not normally associated with foreign trade. It is more important to note that industries with both high exports and high imports also are included in the list of industries with little change. When exports and imports move in tandem, employment effects of export growth often are offset by effects of import growth. Table 8 illustrates this point for a select list of industries.

Occupational impacts. Every major occupational group is projected to be affected by trade changes, but only modestly. The differences in projected occupational employment changes among the alternatives are caused only by differences in projected levels of industry employment. In the low-trade projection, most occupational groups end up with lower employment levels than in the moderate-growth scenario, while the high-trade alternative leads to higher employment levels.

Among detailed occupations, the largest effects are expected among those occupations with very large number of workers, such as general managers and top executives, salespersons, truck-drivers, sewing-machine operators, and blue-collar worker supervisors. However, the majority of occupations show marginal differences among the three alternative projections.

Summary

The analyses of the effects of foreign trade on employment are complicated by the interrelationships of export and import determination. Results of the two alternative trade models described above differ by

only **46,000 jobs in long-term employment growth projected for the economy. The implication seems to be that exports and imports moving in tandem are not important with regard to their effects on aggregate employment. However, the impacts on employment changes vary by industry.**

Footnotes

[1] Many studies have examining the potential impact on the U.S. economy of the North American Free Trade Agreement. For the most recent prior work, see "Agriculture in a North American Free Trade Agreement," Foreign Agricultural Economic Report no. 246 (U.S. Department of Agriculture, September 1992); "North American Free Trade Agreement: America's Competitive Future," ***Business America*** (U.S. Department of Commerce, October 19, 1992); "U.S.-Mexico Trade: Pulling Together or Pulling Apart?" (U.S. Congress, Office of Technology Assessment, October 1992); "The Employment Effects of the North American Free Trade Agreement: Recommendations and Background Studies, special report no. 33 (National Commission for Employment Policy, October 1992); "Potential Impact on the U.S. Economy and Selected Industries of the North American Free-Trade Agreement," USITC publication no. 2596 (U.S. International Trade Commission, January 1993); the following publications of the U.S. Congress, Congressional Budget Office: "Estimating the Effects of NAFTA: An Assessment of the Economic Models and Other Empirical Studies" (June 1993), and "A Budgetary and Economic Analysis of the North American Free Trade Agreement" (July 1993); and William R. White, "The Implications of the FTA and NAFTA for Canada and Mexico," Technical Report no. 7 (Bank of Canada, August 1994.)

[2] A series of five articles, entitled "The American work force, 1992-2005," appeared in the ***Monthly Labor Review*** in November 1993 (U.S. Department of Labor, Bureau of Labor Statistics).

[3] See Janet Pfleeger and Brenda Wallace, "Health care alternatives: employment and occupations in 2005," ***Monthly Labor Review,*** April 1994, pp. 29-37; and Arthur J. Andreassen and Jay M. Berman, "Infrastructure alternatives for 2005: employment and occupations," on pages 22-28 of the same issue. Also see the ***FFC '94 Papers and Proceedings,*** November 15, 1994.

[4] This foreign trade article, "Foreign trade alternatives for employment and projections, 2005," also appeared in the ***Monthly Labor Review,*** November 1994, pp. 37-45.

[5] In this section, the analysis covers the period from 1990 to 2005, rather than from 1992 to 2005. because the industry-level trade analyses presented here have been derived primarily from much more detailed industry data that are not yet available for years after 1990.

[6] Output is defined as gross domestic output or duplicated output. It is a gross or duplicated measure in that it includes not only gross domestic product (GDP), or all final demand purchases of new goods and services, but also all new goods and services produced as intermediate goods for use in further production. For further discussion of the industry output, see James C. Franklin, "Industry output and employ merit," ***Monthly Labor Review,*** November 1993, pp. 41-57.

[7] For a fully detailed discussion of the Bureau's moderate-growth projections, see Norman C. Saunders, "The U.S. economy: framework for BLS projections," ***Monthly Labor Review,*** November 1993, pp. 11-30.

[8] In the high-trade alternative, all of the identified export- and import-sensitive industries are assumed to absorb 5 percent more than proportional share of the assumed changes.

[9] For the most recent studies regarding the trade-sensitive industries, see Robert W. Bednarzik, "An analysis of U.S. industries sensitive to foreign trade, 1982-87," ***Monthly Labor Review,*** February 1993, pp. 15-3 1; and Robert C. Shelburne and Robert W. Bednarzik, "Geographic concentration of trade-sensitive employ merit," ***Monthly Labor Review,*** June 1993, pp. 3-13.

[10] Once a commodity distribution of GDP has been estimated, this "bill-of-goods" is then translated into industry-level employment by multiplying the demand vector by an employment requirements table. The employment requirements table derived from the projected industry total requirements table and industry employment-output ratios from the basic projections estimates, translate a demand bill-of-goods into the employment in all industries necessary to produce a given level and mix of GDP. Finally, a set of industry employments is translated into the set of occupational demands within each of these industries by the use of an occupational staffing pattern matrix, also estimated for 2005 in the

basic projections estimation process. This analysis estimates only production-related changes in employment and occupations and does not address the impacts of income multiplier effects on employment. The data underlying the employment requirements table represent annual averages and should be used for marginal analyses--that is, assessing the effect of an additional increase or decrease in the expenditure category--with caution.

Table 1. Exports and imports of goods and services, selected years

[Billions of 1987 dollars]

Item	1970	1975	1980	1985	1990	1992
GDP	2,868.0	3,221.7	3,776.4	4,279.8	4,897.3	4,979.3
Total exports	161.3	232.9	320.5	309.2	510.5	578.8
Goods	125.2	178.5	248.2	224.8	368.9	426.5
Services	36.1	54.4	72.3	84.4	141.6	152.3
Total imports	196.4	209.8	289.9	454.6	565.1	611.2
Goods	42.1	163.3	235.7	366.5	461.4	512.8
Services	54.3	46.5	54.2	88.1	103.7	98.4
Net exports	-35.2	23.1	30.7	-145.3	-54.7	-32.4
Goods	-16.9	15.2	12.6	-141.7	-92.5	-86.3
Services	-18.3	7.9	18.1	-3.6	37.9	53.9
			Percent distribution			
Total exports	100.0	100.0	100.0	100.0	100.0	100.0
Goods	77.6	76.7	77.4	72.7	72.3	73.7
Services	22.4	23.3	22.6	27.3	27.7	26.3
Total imports	100.0	100.0	100.0	100.0	100.0	100.0
Goods	72.3	77.9	81.3	80.6	81.6	83.9
Services	27.7	22.1	18.7	19.4	18.4	16.1
			Pe n GDP			
Total exports	5.6	7.2	8.5	7.2	10.4	11.6
Goods	4.4	5.5	6.6	5.3	7.5	8.6
Services	1.2	1.7	1.9	1.9	2.9	3.0
Total imports	6.8	6.5	7.7	10.6	11.5	12.3
Goods	4.9	5.1	6.2	8.6	9.4	10.3
Services	1.9	1.4	1.5	2.0	2.1	2.0
Net exports	-1.2	0.7	0.8	-3.4	-1.1	-0.6
Goods	-0.5	0.4	0.4	-3.3	-1.9	-1.7
Services	-0.7	0.3	0.4	-0.1	0.8	1.1

SOURCE: Bureau of Economic Analysis, U.S. Department of Commerce.

Table 2. Real exports of goods and services, top 20 industries, 1977,1990, and projected to 2005

Industry	Percent distribution 1977	1990*	2005 Moderate-growth
Total exports	100.0	100.0	100.0
Computer equipment	0.3	6.1	12.7
wholesale trade	8.0	7.0	6.7
Air transportation	2.2	4.0	4.0
Aircraft	2.9	3.4	2.6
Real estate	3.1	23	2.4
Semiconductors and related devices	0.5	21	22
Other agricultural products	4.9	3.1	22
Motor vehicles and car bodes	5.1	28	21
Motor vehicle parts and accessories	3.9	24	2.0
Aircraft and missile parts and equipment	1.3	1.8	1,9
Depository institutions	1.8	1.6	1.7
Water transportation	2.5	2.3	1.6
Industrial chemicals	3.1	26	1.6
Miscellaneous electronic components	0.7	1.3	1.4
Measuring and controlling devices; watches	1.5	1.4	1.4
Petroleum refining	1.4	1.8	1.4
Aircraft and missile engines	0.9	1.4	1.3
Plastics materials and synthetics	1.2	1.6	1.3
Security and commodity brokers	0.1	1.0	1.1
Trucking and warehousing	1.2	0.9	1.1
All other industries	53.4	49.1	47.3

• The detailed industry data are not yet available for years after 1990. (See footnote 5.)

SOURCE: Historical data, Bureau of Economic Analysis, U.S. Department of Commerce; projected data, Bureau of Labor Statistics.

Table 3. Real exports of goods and services as a share of output, top 20 industries, 1977, 1990, and projected to 2005

Industry	Percent of output 1977	1990	2005 Moderate-growth
Total exports	3.8	5.6	9.2
Aircraft	31.8	39.7	62.6
Computer equipment	29.1	41.6	59.8
Mining and oil field machinery	25.2	41.2	58.7
Ammunition and ordnance, except small arms	28.8	23.6	56.8
Aircraft and missile parts and equipment	31.8	32.4	55.7
Aircraft and missile engines	20.0	27.4	45.6
Construction machinery	27.3	24.7	42.8
Engines and turbines	18.7	21.0	42.S
X-ray and other electromedical apparatus	12.9	24.5	41.3
Water transportation	20.9	320	40.0
Office and accounting machines	11.0	21.8	40.0
Household audio and video equipment	9.6	220	39.6
Special industry machinery	27.6	226	38.1
Electrical equipment and supplies, n.e.c.	13.4	27.2	37.9
Miscellaneous transportation equipment	16.0	16.4	37.3
Electric lighting and wiring equipment	5.6	17.8	36.4
Semiconductors and related &vices	29.3	39.5	36.0
Tobacco manufactures	11.5	15.7	35.9
Farm and garden machinery	11.2	19.6	35.7
Measuring and controlling devices; watches	18.4	22.9	34.3

[1] Domestic output in real terms. (See footnote 6.)

n.e.c. = not elsewhere classified.

SOURCE: Historical data. Bureau of Economic Analysis, U.S. Department of Commerce; projected data. Bureau of Labor Statistics.

Table 4. Real imports of goods and services, top 20 industries, 1977, 1990, and projected to 2005

Industry	Percent distribution		
	1977	1990	2005 Moderate-growth
Total imports	100.0	100.0	100.0
Computer equipment	0.0	4.9	13.9
Motor vehicles and car bodies	10.8	11.7	7.9
Apparel	3.0	5.1	5.9
Crude petroleum, natural gas, and gas liquids	16.7	7.2	5.6
Household audio and video equipment	1.6	3.1	4.6
Semiconductors and related devices	0.5	2.3	3.1
Petroleum refining	6.1	4.1	2.9
Motor vehicle parts and accessories	3.0	29	22
Air transportation	1.9	1.6	21
Miscellaneous electronic components	0.4	1.5	1.7
Industrial chemicals	2.0	1.7	1.3
Pulp, paper, and paperboard mills	21	1.7	1.3
Footwear. except rubber and plastic	1.1	1.5	1.3
Measuring and controlling devices; watches	1.0	1.2	1.2
Photographic equipment and supplies	0.6	1.1	1.2
Toys and sporting goods	0.6	1.4	1.2
Blast furnaces and basic steel products	3.8	1.8	1.1
General industrial machinery	0.7	1.0	1.1
Telephone and telegraph apparatus	0.1	0.9	1.0
Electric lighting and wiring equipment	0.2	0.8	1.0
All other industries	43.8	42.5	38.4

SOURCE: Historical data, Bureau of Economic Analysis, U.S. Department of Commerce; projected data, Bureau of Labor Statistics.

Table 5. Real imports of goods and services as a share of output, top 20 industries, 1977, 1990, and projected to 2005

Industry	Percent of total supply [1]		
	1977	1990	2005 Moderate-growth
Total imports	4.1	5.9	8.1
Footwear, except rubber and plastic	34.3	68.0	86.4
Household audio and video equipment	43.8	63.0	77.9
Luggage, handbags, and leather products, nec	18.2	42.9	59.5
Fishing, hunting, and trapping	42.5	54.9	57.7
Apparel	14.9	36.2	55.4
Jewelry, silverware, and plated ware	26.5	42.4	49.6
Crude petroleum, natural gas. and gas liquids	32.6	34.6	48.4
Office and accounting machines	25.5	31.2	47.5
Toys and sporting goods	18.5	43.9	45.2
Ophthalmic goods	21.2	36.8	4s.1
Telephone and telegraphic apparatus	1.9	24.3	39.8
Computer equipment	4.9	27.1	38.3
Electric lighting and wiring equipment	2.6	19.5	35.4
Photographic equipment and supplies	10.5	23.2	32.8
Semiconductors and related devices	24.4	33.0	32.3
X-ray and other electromedical apparatus	9.8	23.2	30.6
Motor vehicles and car bodies	20.0	32.5	30.6
Manufactured products, nec	10.6	20.4	29.9
Electric distribution equipment	10.0	13.6	29.3
Special industry machinery	12.9	23.0	29.1

[1] Total supply is defined as domestic output plus imports.
n.e.c. = not elsewhere classified.
SOURCE: Historical data. Bureau of Economic Analysis. U.S. Department of Commerce; projected data. Bureau of Labor Statistics.

Table 6. Employment by major industry sector, 1977, 1992 and projected to 2005

[Thousands of jobs]

Major industry sector	1977	1992	2005 Low-trade	2005 Moderate-growth	2005 High-trade
Total employment	91,955	121,092	147,452	147,482	147,498
Agriculture, forestry, fisheries	3,333	3,295	3,330	3,325	3,325
Mining	834	654	594	575	550
Construction	4,846	5,969	7,480	7,483	7,486
Manufacturing	20,100	18,438	18,302	17,999	17,617
Durable manufacturing	11,873	10,485	10,066	9,963	9,828
Nondurable manufacturing	8,227	7,953	8,236	8,036	7,789
Transportation services	2,841	3,812	4,598	4,667	4,737
Communications	1,187	1,279	1,131	1,135	1,142
Public utilities	751	963	1,088	1,084	1,079
Wholesale and retail trade	20,548	27,255	32,383	32,523	32,688
Finance, insurance, real estate	4,832	7,217	8,735	8,781	8,840
Services	17,556	33,557	47,794	47,890	48,009
Government	15,126	18,652	22,017	22,021	22,025

SOURCE: Historical and projected data, Bureau of Labor Statistics.

Table 8. Industries showing little employment change among alternative trade growth scenarios

[Thousands of jobs]

Industry	7005 Low-trade	7005 Moderate-growth	7005 High-trade	Differences from moderate-growth Low	Differences from moderate-growth High
Electrical equipment and supplies, n.e.c.	**49**	**49**	**49**	0	0
Miscellaneous transportation equipment	**58**	**57**	**57**	1	0
X-ray and other electromedical apparatus	58	58	57	0	-1
Office and accounting machines	27	27	25	0	-2
Metal mining	68	65	62	3	-3
Drugs	296	297	298	1	1

n.e.c. = not elsewhere classified.

SOURCE: Bureau of Labor Statistics.

Table 7. Employment by selected industry, 1977, 1992 and projected to 2005 with level changes

[Thousands of jobs]

Industry	1977	1992	2005 Low-trade	2005 Moderate-growth	2005 High-trade	Differences from moderate-growth Low	Differences from moderate-growth High
Wholesale trade	5,004	6,404	7,500	7,610	7,737	-110	127
Aircraft and missile parts and equipment	89	170	242	259	284	-17	25*
Aircraft	270	332	284	302	326	-18	24
Retail trade ex. eating& drinking places	11,293	13,978	15,928	15,945	15,967	-17	22
Depository institutions	1,699	2,106	2,184	2,204	2,226	-20	22
College and universities	705	1,027	1,217	1,236	1,257	-19	21
Trucking and warehousing	1,399	1,839	2,239	2,256	2,274	-17	18
Real estate	1,065	1,670	2,075	2,086	2,102	-11	16
Eating and drinking places	4,251	6,873	8,955	8,969	8,984	-14	15
Water transportation	199	176	158	171	186	-13	15
Other agricultural products	1,497	1,088	840	846	860	-6	14
Air transportation	390	735	955	973	986	-18	13
Management and public relations	o	793	1,366	1,375	1,388	-9	13
Aircraft and missile engines	130	149	137	146	159	-9	13
Computer and data processing services	192	903	1,768	1,777	1,789	-9	12
Legal services	579	1,142	1,501	1,509	1,520	-8	11
Passenger transportation arrangement	o	198	309	320	331	-11	11
Computer equipment	240	355	232	237	246	-5	9
Engineering and architectural services	472	827	1,105	1,109	1,118	-4	9
Hotels and other lodging places	1,268	1,626	2,584	2,589	2,596	-5	7
Miscellaneous transportation services	o	176	225	231	238	-6	7
Communications, except broadcasting	1,005	918	728	732	739	-4	7
Motion pictures	287	426	580	586	593	-6	7
Security and commodity brokers	209	507	651	656	662	-5	6
Insurance carriers	1,141	1,480	1,656	1,660	1,666	-4	6
Apparel	1,149	823	653	569	458	84	-111
Footwear, except rubber and plastic	168	69	67	39	(1)	28	(2)
Household audio and video equipment	123	82	89	64	30	25	-34
Weaving, finishing, yarn and thread mills	548	363	311	292	268	19	-24
Motor vehicle parts and accessories	429	421	438	419	397	19	-22
Knitting mills	238	203	189	175	156	14	-19
Luggage, handbags, & leather products	93	52	45	34	16	11	-18
Fishing, hunting, and trapping	54	69	95	83	66	12	-17
Crude petroleum, natural gas, & gas liquids	177	198	186	173	156	13	-17
Motor vehicles and car bodies	443	314	253	241	227	12	-14
Miscellaneous plastics products, n.e.c.	425	622	856	845	833	11	-12
Toys and sporting goods	130	119	113	105	93	8	-12
Miscellaneous electronic components	247	309	311	302	292	9	-1o
Metalworking machinery	359	307	345	339	329	6	-1o
Blast furnaces and basic steel products	554	250	234	226	217	8	-9
Semiconductors and related devices	148	219	230	226	217	4	-9
Miscellaneous fabricated textile products	185	210	229	221	212	8	-9
Jewelry, silverware, and plated ware	65	58	63	57	49	6	-8
Manufactured products, n.e.c.	278	237	240	232	224	8	-8
Rubber products & plastic hose& footwear	199	171	166	159	152	7	-7
Telephone and telegraph apparatus	149	108	84	81	74	3	-7
Miscellaneous fabricated metal products	249	224	210	205	199	5	-6
Electric lighting and wiring equipment	208	175	160	156	150	4	-6
Sawmills and planing mills	242	191	179	175	169	4	-6
General industrial machinery	78	244	250	248	43		-5

Less than 10,000 jobs.
2 Not computable.
n.e.c. = not elsewhere classified.
SOURCE: Historical and projected data, Bureau of Labor Statistics.

Health care alternatives: employment and occupations in 2005

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The problems of climbing health care costs and a lack of health insurance for an estimated 37 million individuals in the US have focused attention on the current debate over health care reform. Health care expenditures have grown faster than the overall economy for the past three decades, from 7.4 percent of nominal Gross Domestic Product (GDP) in 1970 to over 14 percent by 1992. If current trends prevail, health care expenditures could reach an unprecedented 19 percent of nominal GDP in the year 2000.[1]

In light of the uncertainty concerning future health care expenditures and employment, BLS has conducted an analysis of two possible paths for the health care industry and employment in the economy and in the health-related industries and occupations. The health care alternatives presented in this article examine a high and a low range of health care spending built around the Bureau's 1992-2005 moderate-growth projections described in the November 1993 issue of the *Monthly Labor Review*.[2] *These* alternatives do not attempt to quantify the Administration's proposals for health care reform. Rather, they present a range of employment impacts that might result should health care spending in 2005 fall between the two projected levels.[3]

Regardless of the actual health-related employment levels that are attained in 2005, the ten health-related industries discussed in this article will likely provide a significant number of jobs in the economy. Direct employment in these ten industries accounted for 8.2 percent of total employment in 1990, and is projected to account for 10.1 percent of total employment in 2005 under the moderate-growth scenario. When direct and indirect employment is considered, health care spending accounted for 11.4 percent of total employment in 1990, and is projected to account for 14.5 percent in 2005 under the moderate-growth scenario. In short, health care is such a significant part of our economy that the impact of the ten health care industries on overall employment will be substantial no matter how the health care system changes.[4]

Methodology

This analysis is conducted using two analytical procedures. The first case holds GDP constant in 2005 as the distribution of spending among all industries changes. That is, assumed changes in projected spending in health-care industries are offset with spending changes in non-health industries. The second case shows GDP changing in 2005, reflecting both changes in total health care expenditures as well as in the industry distribution of health care expenditures. Here, no changes in other industries are made to offset the changes assumed for the health-related industries--they remain as projected in the 2005 moderate case.

This study has certain limitations. It does not take into account the potential job losses that may result from business' cost increases as a result of reform because the model used by BLS does not specifically incorporate the detailed cost structure of industries. That is, this study would not account for a business that may reduce employment as a result of higher costs arising from increases in the health care costs of their employees. It also does not incorporate redirected spending that could arise due to cost savings if health care spending savings are realized. Because the detailed industry data used to calculate the health alternatives are not yet available for 1992, this analysis covers the period from 1990 to 2005, rather than from 1992 to 2005 as in the other projections articles in the November 1993 issue of the *Monthly Labor Review.*

***GDP Constant Analysis*.** Total GDP in 2005 in the low- and high-health alternatives using this approach is the same as in the moderate-growth scenario. Changes in demand caused by changes in spending in the health-related industries are offset with demand changes in industries outside of health care such that the overall level of GDP in 2005 is unchanged. These changes are made in proportion to the size of each demand component in GDP. As a result, total employment in the low, moderate, and high cases is very similar, with variations arising only from productivity differences among industries.

GDP Not Constant Analysis. Demand changes using this alternative approach are made in the health-related industries for the low- and high-health alternatives, without offsetting changes in nonhealth-related industries. Since demand and GDP differ greatly for the low, moderate, and high cases, employment also varies substantially. While such an analysis is inconsistent with the fact that long run employment changes are generated by supply side forces, the case of changing GDP is valuable as a partial analysis for assessing the relative impact of alternative health-related spending levels on employment and the distribution of employment by industry and occupation.

For both analyses, the low- and high-health alternatives are estimated using an alternative demand distribution. Each alternative distribution is translated into industry-level employment by using an employment requirements table derived from the projected industry total requirements table and the industry employment-output ratios from the basic projections estimates. A set of industry employments is translated into the set of occupational demands within each of these industries by the use of an occupational staffing pattern matrix, also estimated for 2005 in the basic projections. [5]

As a result of this process, employment directly and indirectly related to health-care spending is estimated. Expenditures in the ten health-related industries identified below require direct employment in those industries. For example, spending on pharmaceuticals translates directly to employment in the pharmaceuticals industry. In addition, however, the ten health-related industries use inputs from other non-health industries, thereby generating indirect employment in non-health industries. For example, workers employed by gardening services who maintain the grounds at a hospital are an indirect employment effect of health care spending. The following tabulation presents the direct and indirect employment related to health care spending in 1990:

Employment (thousands of jobs)			
	Total	**Direct**	**Indirect**
Total *	13,918.5	9859.2	4,059.3
Agriculture, forestry, fisheries	320.6	0.0	320.6
Mining	35.8	0.0	35.8
Construction	255.4	159.1	96.3
Manufacturing	1,134.6	312.8	821.7
Transportation	157.2	0.0	157.2
Communications	65.8	0.0	65.8
Public Utilities	50.2	0.O	50.2
Trade, wholesale and retail	656.0	0.0	656.0
Finance, insurance, and real estate	754.3	295.0	459.3
Services	9,314.2	8,020.0	1,294.2
Government	1,174.3	1,072.3	102.0

includes wage and salary, self employed, and unpaid family workers.

Assumptions

In this study, the definition of health-related industries includes the following':

- New hospitals and institutions (construction)
- Medical instruments and supplies (manufacturing)
- X-ray and other electromedical apparatus (manufacturing)
- Drugs (manufacturing)
- Insurance carriers (services)
- Offices of health practitioners (services)
- Nursing and personal care facilities (services)
- Private hospitals (services)
- Health services, not elsewhere classified (services)
- State and local government hospitals (services)

The term "health services industries" comprises the last five industries listed above--four private health services industries plus one public health service industry (state and local government hospitals).

This study assumes projected 1990-2005 average annual growth rates of 2.0 percent and 4.6 percent in real terms for demand expenditures for the ten health-related industries under the low- and high-health alternatives, respectively, compared to a 3.2 percent rate for the moderate-growth scenario. The moderate-growth scenario incorporates assumptions

that yield a slowing rate of growth in expenditures and employment in health-related industries relative to the 3.6 percent yearly growth rate of the 1979-90 period. Total expenditures for the low- and high-health scenarios were distributed among the ten health-related industries by adjusting the historical distributions upon which the moderate-growth scenario is based. The assumptions outlined below determine the alternative distributions. To derive the alternative spending levels by industry, the assumed projected industry distributions (shown in table 1) were applied to the aggregate spending levels for each alternative. Note that the terms "low," "moderate, " and "high" refer to aggregate spending levels, not spending at the industry level.

Low-health. ***The*** low-health alternative could arise from a variety of circumstances, such as increased use of health maintenance organizations (HMO's) or greater efficiency in the health care system through improved coordination among health care providers. Equally, it could come about because of resistance by payer individuals, businesses, and governments to increases in health care costs. The growth rate assumed for this alternative accounts for an initial increase in spending between 1993 and 1995 consistent with expanding health coverage. The increase in expenditures is moderated over the next two years. From 1997 to 2000, expenditures are assumed to be constant. After the year 2000, expenditures for the ten health-related industries are assumed to grow at approximately twice the annual growth rate of the population.

The following assumptions were made in changing the moderate-growth scenario's 2005 distribution of spending among the 10 health-related industries to reflect the low-health alternative. The share of expenditures for the health services, n.e.c. industry (which includes home health care and outpatient alcohol and drug treatment centers) will increase because of efforts to reach the currently uninsured and because of an emphasis on less expensive health care alternatives. Similarly, relative expenditures for health insurance are expected to increase due to expanded insurance coverage. It is assumed also that relative expenditures for goods and services provided by nursing and personal care facilities, private hospitals, new hospital construction, X-ray and other electromedical apparatus, and state and local hospitals will decrease with a relative shift toward greater reliance on home health care, more outpatient treatment, greater use of clinics, improved preventative care, more efficient use of existing hospital capacity, less overlap of equipment purchases, and some rationing of procedures. Finally, relative expenditures for goods and services provided by offices of health practitioners, medical instruments and supplies, and pharmaceuticals were assumed not to change due to effects such as from expanded insurance coverage and cost containment measures.

High-health. ***The*** high-health alternative could also arise from a variety of circumstances, including expansion of insurance coverage to the currently uninsured without concurrent health care cost reductions, continued development of new technologies that lead to more expensive medical procedures, and/or continued increases in consumer demand for costly medical services. The growth rate for this alternative was derived from assumptions of continued increases in general spending with limited savings from cost containment.

The following assumptions were made in changing the moderate growth scenario's 2005 distribution of spending among the 10 health-related industries to reflect the high-health alternative. Relative expenditures in offices of health practitioners, nursing and personal care facilities, and both private and state and local hospitals are not expected to change because the increase in expenditures on these services caused by expansion of insurance coverage and consumer demand for state-of-the-art medicine will be offset emphasis on less expensive care. Relative spending on health insurance is not expected to change even though insurance coverage may expand. The share of expenditures for health services, net, medical instruments and supplies, X-ray and other electromedical apparatus, and pharmaceuticals is expected to increase because of the assumption of expanded insurance coverage and growing demand without success in controlling costs in this scenario. Relative expenditures for new hospital construction are expected to decrease as a result of greater utilization of the current oversupply of hospital beds.

Results

Table 1 shows that relative to the moderate scenario, the low-health alternative is $123 billion lower and the high-health alternative is $181 billion higher in 2005 (in 1987 dollars). Because of the relative size of the private health services industries, most of the changes in spending and employment from the moderate-growth scenario occur in these four industries.

Table 1 also shows how total health-related spending is distributed among the ten health-related industries. There are three particularly noteworthy points shown by the data. The percent distribution of health services, net, is higher in the low-health scenario than in the moderate because of this alternative's assumption that the demand for these services will increase under reform. This distribution results in a higher level of spending and employment in health services, n.e. c. in the low alternative than in the moderate. Similarly, the health insurance industry shows a higher share in the low-health alternative than in the moderate due to assumed expansion of insurance coverage to the uninsured. However, expenditures and employment remain lower in the low-health case for this industry because the difference in the distributions is not large enough to cause higher expenditures and employment. The same is true for new hospital construction in the high-health alternative. The percent distribution is lower than that in the moderate case because of expected improvements in the utilization of the current oversupply of hospital beds. However, the difference is not great enough to cause a lower level of spending and employment in the high-health alternative.

GDP Constant Analysis. Industry employment in 1990 and for the moderate-growth and the two health alternatives in 2005 when GDP is constant is shown in table 2. The table shows the overall impact when employment in the health-related industries increases or decreases under the low- and high-health alternatives, as well as which industries are gainers or losers in jobs relative to the moderate scenario.

Low-health. Under the low-health alternative, total spending in the health-related industries is assumed to decline relative to the moderate scenario, which causes lower projected total employment in these industries. To keep GDP in 2005 constant, the decrease in health-related spending is assumed to be offset with spending increases in the nonhealth-related industries. This causes total employment in these industries to increase. The net effect of these offsetting spending changes is a projected decrease in employment of 680 thousand in 2005 relative to the moderate-growth scenario. This employment change arises from the redistribution of output among high and low productivity industries and the secondary effects among the supporting industries that supply the inputs necessary to produce the output of goods or services.

While the net employment change under the low-health alternative is relatively modest, the distribution of expenditures and employment among industries does change significantly. It is important to note that while total health-related industry employment is lower and nonhealth-related industry employment is higher than the moderate scenario, employment at the individual industry level does not necessarily behave similarly. For example, the data show that because of the spending assumptions outlined in the previous section, employment is not lower in all of the health-related industries. The exception is health services, n.e.c., an industry whose services are expected to be in greater demand under these assumptions. Similarly, employment in the nonhealth-related industries is not always greater. Specifically, employment in personnel supply services and business services, n.e.c. is lower, because these industries provide services--either directly or indirectly--to health care facilities, so when employment in health care facilities is lower, employment in these two industries also is lower.

High-health. In this scenario, total spending in the health-related industries is assumed to increase relative to the moderate scenario, which causes greater projected total employment in these industries. To keep GDP constant, this increase in health related spending is offset with spending decreases in the nonhealth-related industries, which causes total employment in these industries to decrease. The net effect of these offsetting spending changes is an increase in employment relative to the moderate scenario of over one million in 2005. As with the low-health alternative, this employment change arises from the redistribution of output among high and low productivity industries and the secondary effects among the supporting industries that supply the inputs necessary to produce goods and services. This shows that on average, the level of productivity in the health-related industries is lower than the average for all other sectors.

As in the low-health alternative, the distribution of expenditures and employment among industries changes significantly under the high-health alternative, both in total and among industries. While employment in all of the health-related industries increases consistent with the assumptions used, employment in the nonhealth-related industries is not necessarily lower, despite the lower assumed spending levels for 2005. Specifically, employment in agricultural services, personnel supply services, and business services increases relative to the

moderate-growth scenario. As in the low-health alternative, this is because these industries provide direct and indirect services to health care facilities. Thus, when demand for employment in health care facilities increases, employment in these three industries also increases.

Occupational employment in 1990 and for the moderate-growth and two health alternatives in 2005 when GDP is constant is also shown in table 2. This information addresses the question of whether employment varies in nonhealth-related occupations when employment in the health-related industries changes under the low- and high-health alternatives. Under the low-health alternative, traditional health-related occupations tend to grow more slowly between 1990 and 2005 relative to the moderate-growth scenario, while nonhealth-related occupations tend to grow faster. The notable exceptions include home health aides, which increases relative to the moderate scenario due to the assumption that demand for these workers will increase as expenditure patterns emphasize home care, and general office clerks, receptionists and information clerks, and all other managers and administrators, all of which decrease because of their presence in health care settings despite the fact that they are not traditional "health care workers." Under the high-health alternatives, employment changes as expected, with the traditional health-related occupations growing more rapidly and the nonhealth-related occupations growing slower than under the moderate-growth scenario.

GDP **Not Constant Analysis. Industry employment in 1990 and for the moderate-growth and the two health alternatives in 2005 when GDP changes is shown in table 3. Relative to the moderate-growth scenario, projected 2005 employment associated with proposed health care expenditures is about 3.3 million lower in the low-health alternative and almost 5 million higher in the high-health alternative. The services sector shows the greatest difference in projected employment under both scenarios because of its relative size and the spending changes made under the assumptions used in this analysis.**

The occupations with the largest changes in employment from the moderate-growth scenario under the low- and high-health alternatives are also found in table 3. The services and professional specialty occupations show the greatest differences in projected employment. These occupational categories include health-related occupations such as home health aides, registered nurses, physicians, and nursing aides, orderlies, and attendants. Significant employment changes also occur in occupations that do not immediately appear to be health related. However, these employees, such as general office clerks, secretaries, and janitors, perform work in health care settings, such as in HMO's and clinics, that is not specific to health care.

In the low-health scenario, all occupations are projected to be lower in 2005 than in the moderate alternative, with the exception of home health aides, which increases due to the assumption that increasing emphasis will be placed on home health care. Under the high-health scenario, all occupations are higher in 2005 relative to the moderate-growth scenario, as greater expenditures in health services require more doctors, nurses, lab technicians, and aides.

The following tabulation displays the proportion of total employment and employment in selected industrial sectors generated by health care spending. As the data show, a significant portion of jobs in the services, manufacturing, and government sectors are generated by health care spending.

Employment related to health care spending as a percent of total employment

	1990	2005
Total Employment*	11.4	14.5
Services	28.8	31.5
Manufacturing	5.8	8.3
Government	6.4	6.3

* Includes wage and salary, self employed, and unpaid family workers.

By comparing tables 2 and 3, the industries and occupations most affected by the offsets used in the constant GDP analysis become apparent. Because table 3 shows employment generated by health-related spending only, industries and occupations on table 2 that do not appear on table 3 are those related to the spending offsets. Those industries and occupations in table 2 that show positive differences in the low case and negative differences in the high case are generally those that offset health care spending reductions and increases, respectively. The industry exceptions--agricultural, personnel supply, and business services--

were described above, as was the occupational exception--home health aides.

The largest changes in employment that arise from offsetting health-related spending changes occur in industries within the wholesale and retail trade, services, and government sectors. This is due to the relative size of these industries and the concentration of spending in selected components of final demand, such as education in state and local governments. For occupations, the largest employment differences arising from changes in health-related employment occur among general managers and top executives, teachers, retail salespersons, cashiers, waiters and waitresses, and teacher aides. Again, relative size of the occupations and concentration of a specific final demand category dictate where most of the changes occur.

A comparison of tables 2 and 3 also shows how the results differ under the constant versus changing GDP analyses. For example, manufacturing requires 105 thousand additional jobs when offsetting reduced health care spending keeps GDP constant. When it is only affected by reduced health care expenditures, that is, when GDP is decreasing, 248 thousand fewer jobs are projected. The same is true for many occupations as well. When offsetting expenditures changes are made, general office clerks are projected to show 37 thousand fewer jobs in 2005 than in the moderate case. On the other hand, when only affected by reduced health care spending, 94 thousand fewer jobs are projected.

Summary

This study shows that when GDP is assumed constant, increases in health care spending, which generate increases in health-related employment, come at the expense of spending and employment outside health-related industries. Similarly, decreases in health care spending--the goal of health care reform--translate to decreases in health-related employment with concurrent increases in spending and employment outside of health care. When GDP is assumed to change, the analysis reveals the aggregate impact of the three health-related spending levels, as well as the secondary effects of health care spending in industries outside of health care.

Regardless of the actual levels of health care spending and employment that arise in 2005 under reform, health care will continue to constitute a significant part of our economy's output and employment.

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1 Congress of the United States, Congressional Budget Office, "Managed Competition and Its Potential to Reduce Health Spending," May 1993.

2 For a fully detailed discussion of the Bureau's moderate-growth projections, see Norman C. Saunders, "The U.S. economy: framework for BLS projections,", *Monthly Labor Review,* November 1993, pp. 11-30.

3 Sources that provided supporting research for this paper include: Jeffrey Lemieux, Christopher Williams, and Verdon Stain, The Congressional Budget Office, October 1992 and May 1993 studies; ***Health Care Delivery in the United States*** by Dr. Anthony R. Kovner, 1990, Springer Publishing Company, Inc.; "A Plan For Responsible National Health Insurance" by Pauly, Danzon, Feldstein, and Hoff, *Health Affairs,* Spring 1991; "Play-or-Pay Employer Mandates: Potential Effects" by Zedlewski, Acs, and Winterbottom, *Health Affairs,* Spring 1992; "The Price of Success: Health Care in an Aging Society" by Cassel Rudberg and Olshansky, *Health Affairs,* Summer 1992; Victor Cohn, "New Deal on Health Care," November 3,1992, The Washington Post; Dana Priest, "Mixed Signals on Health Care," November 23,1992, The Washington Post; Dana Priest, "Clinton's Health Care Options," December 16,1992, The Washington Post; Dana Priest, "The Road to Health Care Reform," January 26, 1993; "Health Plan's Likely Features," Dana Priest, "Clinton Plan Envisions Health Security Card," April 10,1993, The Washington Post; April 16,1993, The Washington Post; Fortune Magazine: May 3 and 31, 1993; Business Week Magazine: April 26 and May 3, 1993; Eleanor Clift, "The Next Bite: Paying for Health Care," March 1,1993, Newsweek Magazine; Jolie Solomon, "Drugs: Is the Price Right?" March 8,1993, Newsweek Magazine; Eleanor Clift, "Health Care: Covert Operation," March 15,1993, Newsweek Magazine; Eleanor Clift, "Hillary's Hard Sell," March 29,1993, Newsweek Magazine; Mike McNamee and Susan Garland, "From Brainstorms to Headaches," May 3,1993, Business Week Magazine; .

[4] For more background information on health care, see the ***Monthly Labor Review,*** November 1992, "Health services: the real jobs machine," by David R. H. Hiles.

[5] The data underlying the employment requirements table represent annual averages and should be used for marginal analyses–that is, the effect of an additional increase or decrease in the expenditure category-with caution.

[6] The industries used in the Bureau's projection program are related to the Standard Industrial Classification (SIC) for 1987. The actual SIC content of all of the industries discussed in this article is presented as Table B-1 in The American Work Force: 1992-2005, BLS Bulletin 2452, forthcoming.

[7] About 17 percent of health-related employment is found in Federal, State, and local government health departments, retail pharmacies, educational services, and other industries. This includes those working in Federal government hospitals such as VA hospitals and DOD institutions. However, the health component of these industries cannot be separated from the rest of the industry in the BLS model, so no separate projection is available for them and they are not included in this study.

TOPICS IN FORECASTING

BUILDING A BETTER FORECAST MODEL OF THE RURAL UNEMPLOYMENT RATE

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KEY WORDS: **Forecasting, Unemployment,** Nonmetropolitan, **Cointegration.**

The **nonmetropolitan**[1] unemployment rate is of interest both in absolute terms and relative to the overall U.S. civilian rate. The nonmetro labor force is currently about 27 million workers, or 21 percent of the U.S. labor force. The unemployment rate is one of the few indicators of rural economic well-being available in a timely manner, and as such, has become important both to those doing research on rural areas and to those implementing development policies.

in the mid- 1970's, when nonmetro areas experienced economic prosperity and population growth, the nonmetro unemployment rate was lower than the U.S. civilian rate. (See figure 1.) In 1980, the relationship reversed, and through the 1980's the nonmetro rate was greater than the U.S. rate. Not only was the nonmetro rate higher than the U.S. rate, but it stayed stubbornly high in the expansion of 1983-89 while the U.S. rate decreased. Attention focused on what appeared to be an ever-widening gap between the two rates. By 1990 the gap had decreased markedly, and by the end of 1991 the two rates converged, although this occurred because the nonmetro unemployment rate did not rise as much as the metropolitan rate, and consequently, the U.S. rate, in the 1990-91 recession.

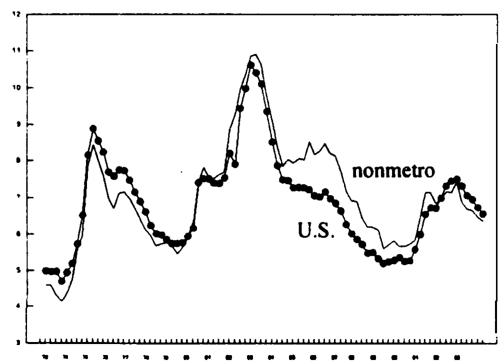

Figure 1 Nonmetro and U.S. unemployment rate (percent), 1973-1993

Previous Research

The previous research that I have done has focused not on definitively modeling the nonmetro unemployment rate, but on capturing the differential effects of national economy trends on the rural economy. The rural economy is not a separate economy but instead a region with the U.S. macroeconomy. Analysis of the nonmetro unemployment rate--such as, is it **high?--is** relative to either the U.S. unemployment rate or the metro rate. In addition, there is a practical data problem in that many variables for the rural economy do not exist, in particular, there is no "rural value product" measure.

My research has found that the nonmetro unemployment rate is more sensitive to international conditions than the metro rate or the U.S. rate. An increase in the value of the U.S. **dollar** makes U. S.-produced goods more expensive in foreign countries and also makes imports from those countries cheaper in the United States. Production and employment in export and import-competing industries tend to decline. This effect is particularly strong in the rural economy because export industries are especially important to rural economies. Goods exports--including agricultural, manufacturing and mining products--account for about three-quarters of U.S. **exports,**[2] and those goods-producing industries currently account for almost twice the percentage of jobs in rural areas **as** in urban **areas.**[3]

There are also differential effects with respect to the real prime rate, but how the nonmetro rate is affected depends on the time period. Analysts generally think that rising real interest rates tend to eventually raise the overall unemployment rate by reducing general economic activity. Before 1985, rural unemployment was more sensitive to **an** increase in real interest rate than the U.S. unemployment rate: an increase in real interest rates increased the rural unemployment rate more than the overall U.S. rate.

In 1985, the definition of nonmetropolitan changed as a result of the 1980 Census: about 30 percent of the nonmetro labor force was reclassified as metro.

The counties that remained nonmetro were the most "rural" of the original group. This new definition changed the way the measured unemployment rate responded to changing real interest rates. After this reclassification, the nonmetro unemployment rate appears to be less sensitive than the metro rate to real interest rate movements. The greater sensitivity to real interest rates seen before 1985 may have been due to interest-sensitive residential and commercial development in growing rural counties that were later classified as urban.

In addition to analyzing the behavior of the nonmetro unemployment rate, I have produced a quarterly forecast monthly of the nonmetro rate for three years. In doing forecasts, 1 have focused on developing a model that forecasts well, and concentrated less on a model that tells a story about the behavior of the nonmetro unemployment rate over the last 20 years. The resulting model:

(1) nonmetro unemployment rate = β_0
+ β_1 *(U.S. civilian unemployment rate)
+ β_2*(the ratio of goods and services exports to GDP)

The estimation was done starting with 1985.3, the first quarter after the nonmetro reclassification. A first-order autoregressive process was used to correct for serial correlation in estimating this equation.

Since the goal here is to forecast the nonmetro unemployment rate, the most likely benchmark of nonmetro movements is the U.S. civilian unemployment rate. All the things that affect the national economy also affect the rural economy, so the U.S. rate is used as a way to capture general economic conditions. Although including the U.S. rate produces simultaneity, since the nonmetro rate is part of the U.S. rate, the effect is slight because nonmetro is about 20 percent of the total over 1985-1993.

Ideally the metro unemployment rate would be used as an independent variable, for it represents a separate labor market whose movements would affect the nonmetro labor market. However, forecasts of the metro unemployment rate are not available, so including it in a forecast equation would not be fruitful. The metropolitan component drives the U.S. rate, and indeed, results are similar whether the U.S. rate or the metro rate is used. The U.S. rate can then be thought of as a proxy for the metro rate. The U.S. rate has the advantages of being well-known and available in a timely manner, both as actual data and as forecast estimates. Having readily available forecasts of the U.S. unemployment rate is crucial to forecasting the nonmetro rate if equation (1) is used. For this analysis, results from using both the U.S. rate and the metro rate as a right-hand-side variable will be presented since the forecasts are all ex post. For ex ante forecasts, which are not included in this paper, only the U.S. rate can be used.

The model in equation (1) has generally done well, however, I am open to improving the model in order to generate more accurate forecasts. The main criticism that I have encountered is that no unit root test was done on the data, therefore the regression coefficients may be spurious. Unit root and cointegration tests are now standard in the battery of econometric tests one performs on a series or a model. There is particular concern with the above model in that there is simultaneity making it especially important to ensure that the residuals are white noise.

In this paper, I present the results of unit root and cointegration tests, develop a model accordingly, forecast from the resulting model, and compare those forecast with forecasts from the simple model, equation (1).

Description of Data

Unemployment data are from the Current Population Survey (CPS), which is conducted by the Bureau of the Census for the U.S. Department of Labor (DOL). These CPS data are quarterly, covering the period 1973.1 to 1993.4. The data include series on the employed and the unemployed. The measure of unemployment used here corresponds to the DOL Bureau of Labor Statistics (BLS) rate U5B, the U.S. civilian unemployment rate: the total unemployed as a percent of the civilian labor force.

BLS does not seasonally adjust the CPS employment/unemployment data. The U.S. Department of Agriculture seasonally adjusts the data using the multiplicative X-11 ARIMA method.[4] The nonmetro series appear to be more seasonal than the metro or the total U.S. series, partly due to the agriculture industry, but also because of recreational areas in nonmetro counties.

In 1983, the classification of counties as nonmetropolitan was changed by the U.S. Office of Management and Budget as a result of the 1980

census. Prior to 1983, the classification was based on the 1970 census. The reclassification was incorporated into the data starting in the third quarter of 1985. The reclassification reduced the nonmetro labor force by about 30 percent. Since county-level data are not available, constructing a series using a consistent nonmetro definition is not possible.

Other data series used in this analysis are the exports of goods and services and gross domestic product (GDP). The series are from the Bureau of Economic Analysis, U.S. Department of Commerce. The nominal values of each are used to created a ratio of goods and services exports to GDP series.

Unit Root Testing

The need for a unit root test comes from the assumption of stationarity in a series. The t-statistics generated by a regression are only valid if the series is stable, i.e., if the mean, variance, and covariance are constant over time.

A series with a unit root is nonstationary in its level form. However if its first difference--y_t-y_{t-1} --is stationary, it is said to be integrated of order one, i.e., I(1). Standard statistical tests done with the stationary first difference series will have accurate diagnostic results.

The unit root literature is mixed in its implications for the nonmetro unemployment rate. The literature suggest detrending the series if possible,[5] and indeed the nonmetro unemployment rate series is seasonally adjusted to detrend for the seasonal trend that is known to exist. Recent research, however, raises the possibility that the unit root found in a seasonally adjusted series may be due to the seasonal adjustment filter X-1 1 ARIMA.[6]

The literature warns that the unit root test will not be able to reject the null hypothesis, HO: there is a unit root, if there is a structural break in the series. Therefore, "... a series which is 1(0), but with a structural break, may be mistaken for an 1(1) series.'" The reclassification of nonmetropolitan in 1985 is indeed a structural break.

Finally, an argument exists that the unemployment rate does not have a unit root, and therefore is a stat ionary series. Economic theory suggests that there is a natural rate of unemployment and that the unemployment rate is a well-behaved series. Cochrane (1991) argues that the unemployment rate, along with the interest rate, should be expressed in rate form (which in this case is the level form of the series) and not as a difference since one expects over the long run that they are stationary.

Despite the above warnings, 1 decided to do the unit root tests, test for cointegration if indicated, and develop a model according to the results of those tests. The first step along this path is to look at the data series.

Correlograms of the Autocorrelations. The correlogram plots the series autocovariances. More specifically, the estimated kth-order autocorrelation coefficient, ρ_k as a function of k, is plotted, where ρ_k is the covariance between y_t and y_{t-k}, normalized by dividing it by the variance of y. What is relevant here is whether or not the ρ_k's die off, and if so, how quickly they do.

The ρ_k's of the nonmetro unemployment rate die off fairly slowly--6 to 8 quarters. (See figure 2.) This pattern suggests that the series is nonstationary and in particular, that it has a "long memory." A shock in any one quarter will affect the unemployment rates for the next 6 to 8 quarters, so therefore the values of y, are time dependent. The correlograms of the U.S. and metro unemployment rates were very similar to that of the nonmetro rate.

The idea that the unemployment rate series has a long memory is consistent with economic theory that characterizes unemployment as having a frictional component and a structural component. Frictional unemployment exists because "... labor markets are inherently dynamic, because information flows are imperfect, and because it takes time for unemployed workers and employers with job vacancies to find each other."[8] One would expect that the frictional component of the unemployment rate series would not be time dependent and so would be stationary.

Structural unemployment occurs when there are regional or occupational imbalances in the labor market. One can easily see that it would take a worker one to two years to learn a new skill or to make the decision to move and then relocate to a new area to look for work. If a shock occurred, such as a large plant closing or a major industrial restructuring in an area, the effects on the unemployment rate would linger for a couple years. Therefore, the structural component of the unemployment rate series would be time-dependent.

Range: 1973.1 - 1993.4
Number of observations: 84

```
==============================================================================
 Autocorrelations          Partial Autocorrelations          ac       pac
==============================================================================
|          . |************ |          . |************ | 1  0.938  0.938
|            |***********  |      *****|  .           | 2  0.834 -0.384
|            | *********   |         . **|  .         | 3  0.704 -0.172
|            |*******      |          . *|  .         | 4  0.566 -0.062
|            |******       |          .  |* .         | 5  0.442  0.086
|            |****         |          .  |  .         | 6  0.337  0.024
I       :    |***          |          . *|  .         | 7  0.244 -0,088
|         .  |**.          |             |  .         | 8  0.164 -0.035
|            |**.          |     :       |***         | 9  0.118  0.225
|         .  |* .          |          . *|  .         | 10 0.084 -0.108
|         .  |* .          |          . **|  .        | 11 0.050 -0.150
|         .  |  .          |          .  |  .         | 12 0.018 -0.028
|         .  |  .          |          .  |  .         | 13 -0.017 0.025
|         . *|  .          |          .  |  .         | 14 -0.055 -0.021
|         . *|  .          |          .  |* .         | 15-0.076  0.087
|         . *|  .          |          . *|  .         | 16 -0.092 -0.084
|         . * I .          |          :  |* :         | 17 -0.098 0.097
|         . * l .          |             |            | 18 -0.094 -0.009
|         . *I  .          |.*I:                      | 19 -0.089 -0.086
|         . *|  .          I          .*I.            | 20 -0.087 -0.050
==============================================================================
Box-Pierce Q-Stat 240.41    Prob   0.0000      SE of Correlations 0.109
Ljung-Box  Q-Stat 255.41    Prob   0.0000
==============================================================================
```

Figure2 Correlogram of the **nonmetro** unemployment rate

Table 1 Unit Root Tests, HO: Unit Root

Variable		Implication for HO: unit root with **Mackinnon** critical values $\tau_{5\%} = -2.90$, $\tau_{1\%} = -3.51$
Nonmetro unemployment rate		
Level value	-2.68	cannotrejectat 50A, **10/0**
First difference	-4.42	reject at 5°/0, 10/0
U.S. unemployment rate		
Level value	-2.84	cannot reject at **5%, 10/0**
First difference	-3.82	reject at 5°/0, 10/0
Metro unemployment rate		
Level value	-3.22	cannot reject at 1°/0, **reject at** 50/0
First difference	-4.11	reject at 5°/0, **1%**
Exports-to-GDP ratio		
Level value	-1.90	cannot reject at 5°/0, 10/0
First difference	-5.88	reject at 5°/0, 10/0

NOTES: **Augmented Dickey-Fuller test done over 1 973.1-1993.4.**
The option of a constant term, no trend was chosen.

Unit Root Test. The augmented Dickey-Fuller (ADF) test was run on the nonmetro unemployment rate, the U.S. rate, the metro rate, and the ratio of exports to GDP. (See table 1.) The ADF indicated that the null hypothesis, HO: unit root, could not be rejected at the 1 percent level for the three unemployment rate series and the export ratio, and could not be rejected for all but the metro rate series at the 5 percent level. In addition, the ADF test on the first difference, that is (y_t-y_{t-1}) of each series indicated reject the null hypothesis of a unit root, which in turn confirms that the series is integrated of order one, i.e., the level values series has a unit root.

Cointegration Testing

If data series in a model have unit roots, then the standard statistical tests are invalid. The prescription called for is to detrend unti 1 the series are stationary, The common method of solving the problem is to run the model in first differences, y_t-y_{t-1}. Although the difference series may be stationary, long-run information in the data will be lost. If indeed the variables involved are cointegrated, that is, they have a stationary linear combination, then they are related to each other in the long run and so the first difference model will be misspecified.[9]

The possibility that the series are cointegrated provides a way to use the original series thereby fully utilizing the data's long-run information. If the pair or group of data series in question are each 1(1), but there exist a linear combination of them that is I(0), then the level values of the data can be used.

When considering only two series, the test for cointegration is straightforward. The Engle-Granger Cointegration test (the two-step estimator) is used to determine if a unique linear relationship exists that is I(0) between the variables. For more than two series, however, the Johansen maximum-likelihood estimator is recommended to test for one or more cointegrating relationships. Because the model includes three variables (in this case), at most two equilibrium relationships are possible. The Engle-Granger test requires a unique cointegrat ing vector to be accurate. If the Engle-Granger test is used on three variables, it might pick up only one of the linear relationships, which may lead to an incorrect conclusion. The Johansen method searches for all stationary linear relationships among the variables.

The Johansen method was done on the two groups of series: (1) nonmetro unemployment rate, U.S. unemployment rate, and export-to-GDP ratio, and (2) nonmetro unemployment rate, metro unemployment rate, and export-to-GDP ratio. The appropriate opt ion used was a constant term but no deterministic trend. Previous testing indicated that a deterministic trend was not present. In addition, economic theory would suggest that any trend in the unemployment rate was stochastic. First, the unemployment rate does not grow without bound since it is constrained to values between zero and one. Second, GDP growth displays a stochastic, not deterministic trend,[10] so perhaps GDP movements create a stochastic trend in the unemployment rate.

The results for group (1) are presented in table 2. Three eigenvalues were generated since this is a group of three variables. A likelihood-ratio statistic for the maximum number of distinct equilibrium vectors was calculated for each. For all three eigenvalues, the likelihood ratio was less than the 5-percent critical value, leading to accept the null hypothesis of at most two cointegrating equations. The likelihood ratio for the second eigenvalue is also less than the critical value, so the null of at most one cointegrating equation is accepted. The likelihood ratio for the first eigenvalue is greater than the critical value, so the null of no cointegrating equations is rejected. Therefore, in this case there exists one unique cointegrating equation, represented by the normalized cointegrating coefficients.

The results for group (2) are also presented in table 2. Here, as above, we find one unique cointegrating equation. The existence of a cointegrating equation means that there exists an equilibrium relationship between the nonmetro unemployment rate and the metro rate.[11] Theory would certainly suggest that these two labor markets would attain an equilibrium between them. Although some short-run barriers to movement exist, in the long run labor is free to move between the markets. This cointegrating equation captures what migration data has already born out, that is, workers move to where the jobs are. The cointegrating relationship can be thought of as one where the trends in one series cancel out the trends in the other, producing stationarity. When the nonmetro unemployment rate experiences a shock that creates structural unemployment, some workers may choose to outmigrate, that is, to move to a metro area. At the same time, metro areas will experience a stochastic trend of immigration of workers to the labor force, which will in turn affect the unemployment rate.

Table 2 Johansen Cointegration Test Results

Group 1: Nonmetro Unemployment rate, U.S. unemployment rate, and Exports-to-GDP ratio

Eigenvalue	Likelihood ratio	5% Critical value	1'% Critical value	Hypothesized number of cointegrating equations
0.788100	144.2934	34.91	41.07	None
0.164991	17.0589	19.96	24.60	At most 1
0.027342	2.2733	9.24	12.97	At most 2

Normalized Cointegrating Coefficients: 1 Cointegrating Equation			
Nonmetro unemployment rate	U.S. unemployment rate	Exports-to-GDP ratio	Constant term
1.0000	-1.2385	0.2324	-1.0835
	(0.044 1)	(0.0430)	(0.1958)

Group 2: Nonmetro unemployment rate, Metro unemployment rate, and Export-to-GDP ratio

Eigenvalue	Likelihood ratio	5% Critical value	1 % Critical value	Hypothesized number of cointegrating equations
0.787302	143.3693	34.91	41.07	None
0.166526	16.44299	19.96	24.60	At most 1
0.018204	1.506445	9.24	12.97	At most 2

Normalized Cointegrating Coefficients: 1 Cointegrating Equation			
Nonmetro unemployment rate	Metro unemployment rate	Exports-to-GDP ratio	Constant term
1.0000	-1.3473	0.3383	-1.5338
	(0.0706)	(0.0687)	(0.3052)

NOTES: Tests done over 1973.1-1993.4. Test assumption of no deterministic trend in the data was chosen. Cointegrating equation shown with all terms on the left-hand-side of the equation. Standard errors in parenthesis.

Cointegrating equation. **The Engle-Grander two-step method was used to estimate the cointegrating equation. The Engle-Granger method can be used because the Johansen cointegration test indicated one unique cointegrating vector. In this situation, OLS generates parameters close to the Johansen test parameters,[12] so an OLS equation was estimated on the level values of the variables:

(2) nonmetro unemployment rate= 2.059
+ 0.997 *(U.S. unemployment rate)
- 0. 174*(exports-to-GDP ratio)
+ O. 172*(reclassification dummy)

estimation period: 1973 .1-1991.4
Adjusted R^2=0.966

This is the cointegrating equation that captures the long-run properties of the data. The estimation was done starting in 1973 to utilize this long-run information. Consequently, a dummy variable was included because my previous research found that the reclassification of nonmetropolitan counties created a structural change at 1985.3. The estimation period stops at 1991, because forecasts will be done for 1992 and 1993. The residuals from this OLS equation were saved for use in the next step.

Second, an error-correction model was developed by using the Hendry and Mizon general-to-specific search method, which starts with an overfitted model equation and ends with a parsimonious one.’3 The error correction model captures the short-run dynamic of the labor market process. This estimated equation is as follows:

(3) A(nonmetro unemployment rate)= 0.046
(1 .40)
+ 0.901 *Δ(U.S. unemployment rate)
(13.53)
+ O. 162*A(U.S. unemployment rate(- 1))
(2.53)
+ O. 172* A(exports-to-GDP-ratio(- 1))
(1.99)
- 0.077 *(reclassification dummy)
(-1.45)
- 0.289 *(error correction term(- 1))
(-3.05)

where A = first difference, $y_t - y_{t-1}$
t-statistics are in parenthesis
estimation period: 1973 .3-1991.4
Adjusted R^2=0.801

The error-correction term is the series of residuals generated in the first step. This then is the forecast model. One notices that the coefficients of equations (2) and (3) are similar. The one lagged error correction term means that most of the labor market adjustment takes place in one quarter. This is consistent with the concept of a frictional component of unemployment.

The corresponding estimated equations for group (2) are:

(4) nonmetro unemployment rate= 3.094
+ 0.968 *(metro unemployment rate)
- 0.247 *(exports-to-GDP ratio)
+ O.123*(reclassification dummy)

estimation period: 1973 .1-1991.4
Adjusted R^2=0.953

(5) A(nonmetro unemployment rate) = 0.056
(1.65)
+ 1.021 *Δ(metro unemployment rate)
(15.06)
+ O. 176* Δ(exports-to-GDP-ratio(- 1))
(1.98)
-0. 104*(reclassification dummy)
(-1 .84)
- 0.233 *(error correction term(-1))
(-2.77)

where A = first difference, $y_t - y_{,.}$
estimation period: 1973 .2-1991.4
t-statistics are in parenthesis
Adjusted R^2=0.762

The advantage of developing a cointegrating equation is that long-run information is preserved. At first it does not appear that this information is saved, since the variables in equations (3) and (5) are represented as first differences. However, the long-run information from the level form of the series is contained in the error correction term, and thus, is included in the error correction model.

Forecasting and Evaluation

The ex post forecasts over 1992.1 to 1993.4 from three models were compared. The first, the original model, equation (1), has the following estimated form:

(6) nonmetro unemployment rate = 1.951
(3.01)
+ 0.966 *(U.S. unemployment rate)
(17.28)
-0.152*(exports-to-GDP ratio)
(-3.72)
+ 0.310*(reclassification dummy)
(1.75)

estimation period: 1973 .2-1991.4
AR(1) correction used, p=O.750
Adjusted R^2=0.982
D-W statistic = 2.027

The estimated equation for the original model using the metro unemployment rate as a dependant variable:

(7) nonmetro unemployment rate = 1.084
(0.96)
+ 0.962 *(metro unemployment rate)
(14.58)
- 0.075 *(exports-to-GDP ratio)
(-0.80)
+ 0.559 *(reclassification dummy)
(2.46)

estimation period: 1973 .2-1991.4
AR(1) correction used. p=O.914
Adjusted R^2=0.978
D-W statistics = 2.246

The second model evaluated is the error correction model developed from the cointegrating equation, equations (3) and (5). Because the error correction term is needed for forecasting, a series had to be generated for 1992 and 1993. The first-step OLS equation (equation (2) and equation (4)) was forecast for 1992.1-1993.4. The error correction model was forecast one period out, using the previous period's residual. The residual was defined as the error correction model's forecast minus the OLS model's forecast, i.e., equation (3)'s forecast minus equation (2)'s forecast. Here the first-step OLS model--the cointegrating equation--is representing the trend, so the residual in this case is the "actual" (the error correction model's forecast capturing the business cycles) minus the "fitted" (the first-step OLS model's trend forecast). If the forecast period was over a long period of time, say 10 years, then the cointegrating equation would be used for forecasting. What is of interest over a 10-year period is the unemployment rate trend, not the quarterly fluctuations.

For comparison, a simple first-difference model was also estimated:

(8) A(nonmetro unemployment rate)= 0.018
(0.50)
+ 0.912*A(U.S. unemployment rate)
(15.14)
- 0.062 *A(exports-to-GDP-ratio)
(-0.65)
- 0.045 *(reclassification dummy)
(-0.76)

where A = first difference, $y_t - y_{t-1}$
t-statistics are in parenthesis
estimation period: 1973 .2-1991.4
Adjusted R^2=0.768
D-W statistic = 2.351

(9) A(nonmetro unemployment rate) = 0.036
(0.97)
+ 0.955 *A(metro unemployment rate)
(14.02)
+ 0.008 *A(exports-to-GDP-ratio)
(0.08)
-0.081 *(reclassification dummy)
(-1.30)

where A = first difference, $y_t - y_{t-1}$
t-statistics are in parenthesis
estimation period: 1973 .2-1991.4
Adjusted R^2=0.729
D-W statistic = 2.519

Ex post forecasts were done for eight quarters, 1992.1-1993.4. The actual values of the independent variables were used for the forecast period, except for the error correction term in the error correction model. The construction of a series of error correction terms was done as discussed above. The analysis was done both for the set of models with the U.S. unemployment rate as an independent variable and for the set using the metro unemployment rate.

The forecasts of the three models and the cointegrating equation are presented in tables 3 and 4, and figures 3 and 4. The models were evaluated using the root mean square error (RMSE) statistic. The concerns about the reliability of the RMSE do not apply here since the comparison is across different forecasting methods on a single time series. (See Armstong and Collopy.)

Forecasts from the cointegrating equation are included in tables 3 and 4 to see how its forecasts would do in the short run. The forecasts are not

Table 3 Eight-quarter nonmetro unemployment rate forecasts, using U.S. unemployment rate as an independent variable

	1992.1	1992.2	1992.3	**1992.4**	1993.1	1993.2	**1993.3**	**1993.4**	RMSE
Original model Equation (6)	**7.4**	7.7	7.8	7.7	7.5	**7.4**	7.3	7.1	0.671
Error correction model Equation (3)	7.5	7.7	7.8	7.7	7.4	7.3	7.1	6.9	0.611
First difference model Equation (8)	7.2	7.3	7.3	7.1	6.9	6.8	6.5	6.3	0.150
Cointegrating equation Equation (2)	7.8	8.0	8.0	7.8	7.6	7.5	7.3	**7.1**	0.823
Actual nonmetro	7.1	7.1	7.4	6.9	6.7	6.6	6.4	6.4	--

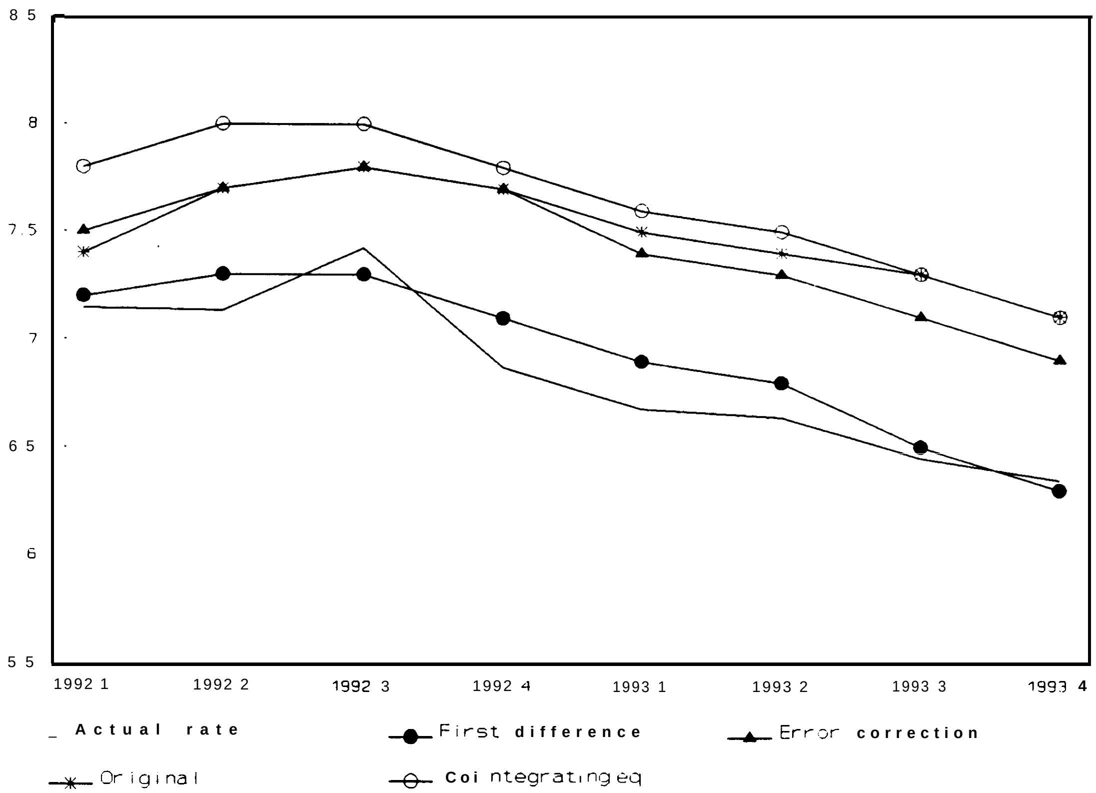

Figure 3 Eight-quarter forecast of the nonmetro unemployment rate, using U.S. unemployment rate as an independent variable. Actual nonmetro unemployment rate also shown. (Percent)

Table 4 Eight-quarter nonmetro unemployment rate forecasts, using metro unemployment rate as an independent variable

	1992.1	1992.2	1992.3	1992.4	1993.1	1993.2	1993.3	1993.4	RMSE
Original model Equation (7)	7.3	7.6	7.6	7.6	7.3	7.2	7.1	6.9	0.537
Error correction model Equation (5)	7.4	7.7	7.8	7.7	7.4	7.3	7.2	6.9	0.607
First difference model Equation (9)	7.2	7,3	7.3	7.2	6.8	6.7	6.4	6.2	0.150
Cointegrating equation Equation (4)	7.9	8.1	8.2	8.1	7.8	7.7	7.5	7.2	0.983
Actual nonmetro	7.1	7.1	7.4	6.9	6.7	6.6	6.4	6.4	--

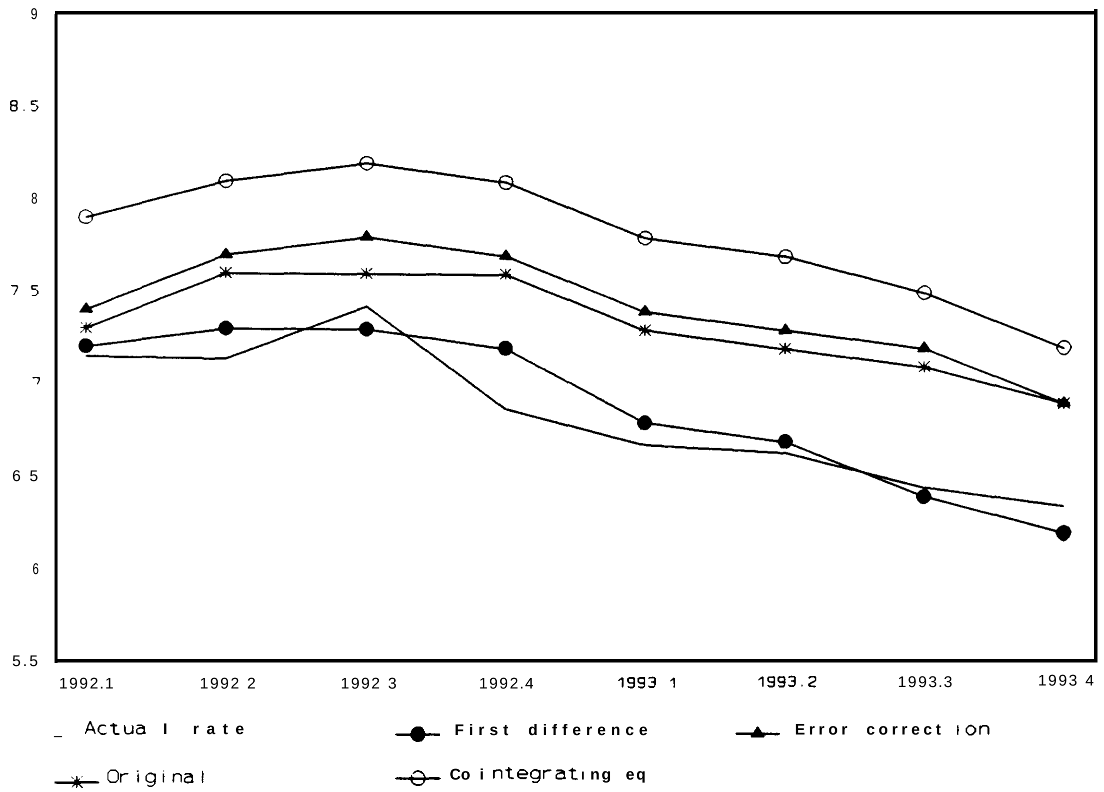

Figure 4 Eight-quarter forecasts of the **nonmetro unemployment rate, using the metro** Unemployment rate **as** an independent variable. **Actual** nonmetro unemployment rate **also** shown. (Percent)

especially accurate, and have the largest RMSES. This is not surprising, as the cointegrating equation captures the long-run trends of the data, and not the short-run fluctuations, and so would not be expected to forecast well over just eight quarters.

The error correction model and the original model forecasts were similar, and consequently the RMSES were about the same. The surprise here is that the first-difference model did considerably better than either of the other models. Both the first-difference model using the U.S. unemployment rate as an independent variable and the one using the metro rate produced low RMSES. The first difference model is especially attractive in that the difference between the actual and the forecast does not increase over the forecast period, as it does with the other two models.

Looking over all the forecasts one notices that there was I ittle difference between the forecasts from the models from using the U.S. rate as an independent variable and those using the metro rate. This result is expected since the metro labor force is 70-80 percent of the U.S. labor force, and consequently dominates the U.S. unemployment rate.

A second observation is that all of the models chronically overshoot in their forecasts. Perhaps this is because the nonmetro unemployment rate was greater than the metro and U.S. rates for almost all of the 1973-1991 period. Although recently the nonmetro rate has dipped below the U.S. and metro rates, the models do not have that information incorporated in them. Future models estimated with additional data points should better be able to forecast a nonmetro rate below the U.S. rate.

Conclusions

Which model to use? Unexpectedly, the error correction model developed from the cointegrating equation did not forecast as well as the first-difference model and about as well as the original model. This is surprising since tests indicate that the series have unit roots and are cointegrated. If indeed this is true, then the error correction model should produce better forecasts. Perhaps the structural break in 1985 from the reclassification of nonmetropolitan is causing problems in the unit root and cointegration testing. Perhaps the series do not actually have a unit root, but are testing as if they do because of the structural break. Or, perhaps they have a unit root but are not actually cointegrated, again because the tests are picking up the structural break.

The error correction model has an additional drawback. In order to produce ex ante forecasts, forecasts assumptions must be made on the error correction term, that is, on the residuals. An alternate explanation for why the error correction model did not perform as well as expected may lie with these forecast residuals. Perhaps the series do have unit roots, are indeed cointegrated in a unique linear relationship, but the additional error introduced into the forecasting process by forecasting the residuals makes the nonmetro unemployment rate less accurate. In any event, while forecasting residuals ex post is a reasonable exercise, doing ex ante forecasts of residuals is not, making this model less attractive for practical reasons.

What independent variable to use? Including the metro unemployment rate is appealing both in terms of economic theory and of statistical concerns. However, forecasts of the metro unemployment rate are not currently readily available, whereas forecasts of the U.S. rate are. The models using the U.S. rate performed very similarly to their metro rate counterparts, making them acceptable substitutes.

The first difference model produces more accurate forecasts than either the original or the error correction model. In addition, this forecast accuracy comes with little additional statistical burden. In addition, the version with the U.S. unemployment rate as an independent variable can be easily forecast. Clearly this is the best choice for forecasting the nonmetro unemployment rate.

ENDNOTES

1. In the text, "nonmetropolitan" and "metropolitan" are used interchangeably with "nonmetro" and "metro." Also used are "rural" and "urban" for "nonmetro" and "metro."

   Metro areas, or Metropolitan Statistical Areas MSA'S), are defined by the Office of Management and Budget. MSA'S include core counties containing a city of 50,000 or more people or an urbanized population of at least 50,000 with a total area population of at least 100,000. Additional contiguous counties are included in the MSA if they are economically and socially integrated with the core county. Metro areas are divided into central cities and areas outside central cities (suburbs), Nonmetro areas are counties outside metro area boundaries. See appendix A for a map of nonmetro counties

(1983 definition of metropolitan-nonmetropolitan).

2. U.S. exports that are goods (merchandise) have been about three-quarters of all exports each year for 1960-1993 (in constant dollars). National Income and Product Accounts (NIPA) data, Bureau of Economic Analysis (BEA), U.S. Department of Commerce.

3. Goods-producing industries accounted for about 27 percent of all nonmetro jobs in 1992, substantially more than for metro areas, 19 percent. Calculated from BEA data by Economic Research Service. See U.S. Department of Agriculture, Economic Research Service, ***Rural Conditions and Trends,*** Fall **1994, Vol. 5, No. 2, pp. 12-13.**

4. The X-1 1 ARIMA is the technique used by the Bureau of Labor Statistics in seasonally adjusting the published U.S. civilian unemployment rate. For more information on the technique, see Estela Bee Dagum, ***The X-1 1-ARIMA Seasonal Adjustment Method,*** Statistics Canada, January 1983.

5. Perrnan, p. 11.

6. Lee and Siklos, 1991.

7. Perman, p. 22.

8. Ehrenberg and Smith, p. 566.

9. Engle and Granger, pp. **9-10.**

10. Stock and Watson (199 1).

11. "At the least sophisticated level of economic theory lies the belief that certain pairs of economic variables should not diverge from each other by too great an extent, at least in the long-run. Thus, such variables may drift apart in the short-run or according to seasonal factors, but if they continue to be too far apart in the long-run then economic forces, such as a market mechanism or government intervention, will bring them together again." Granger (1991), p. 65.

 The cointegrating relationship found with the series nonmetro unemployment, metro unemployment, and exports-to-GDP ratio is no doubt capturing the market mechanism between the nonmetro labor market and the metro labor market. One would expect that these two series would move together in the long run.

12. Campbell and Perron, p. 188. Also, Stock (1987).

13. See Hendry (1989) pp. 281-288, and Granger (1989) chapter 5 for a presentation of the General-to-Specific model search method.

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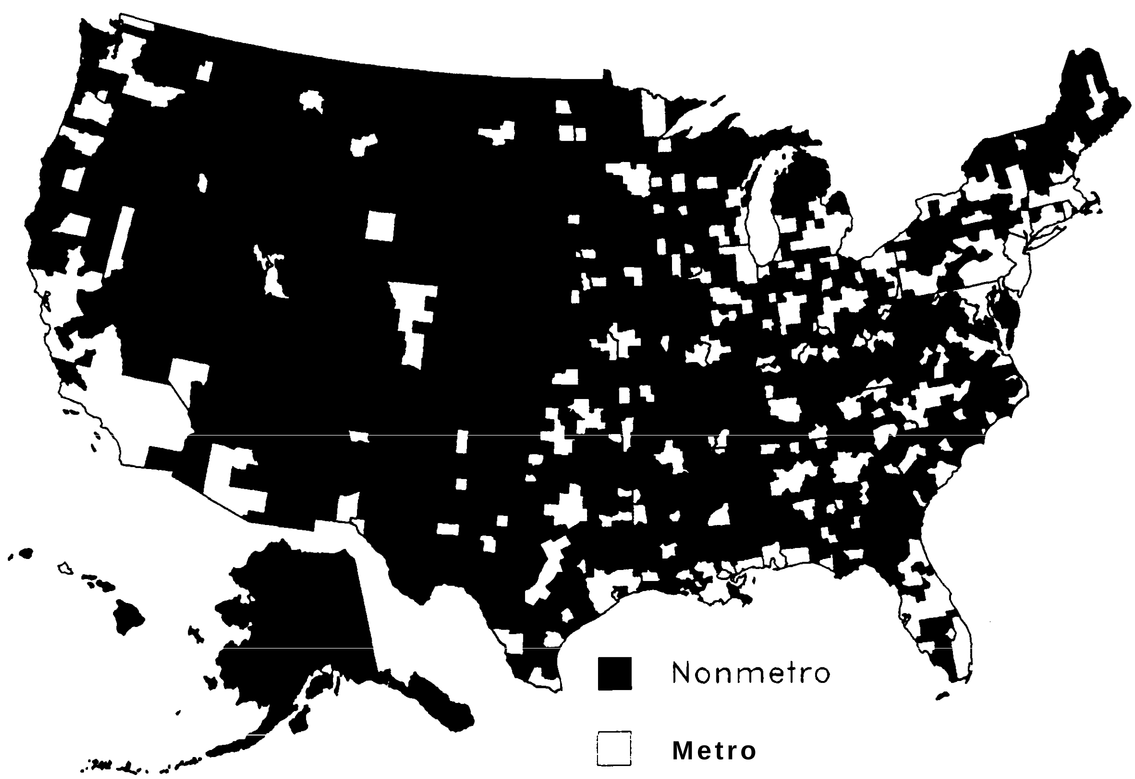
Appendix A: Nonmetropolitan counties (1983 definition)



ARE FORECASTING SKILLS TRANSFERABLE FROM ONE DISCIPLINE TO ANOTHER?*

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KEY WORDS: Forecasting, Normality testing, **Naive models, Transferability of skills**

An important issue involving the forecasting community has been raised recently. [1] This is whether forecasting is a separate discipline or whether it is a specialized activity of more traditional professions, for example, an economist engaged primarily in predicting economic activity. If the former view is correct, forecasting skills should be transferable from the task of predicting one type of variable to forecasting entirely different variables, or, put another way, from one discipline to another. We have some data that enable us to test this hypothesis. The next section describes these data. This is followed by an explanation of the procedures used in this study and the results.

I. THE DATA

For the past several years, forecasters employed by the United States Federal government have held annual one day meetings. As a precursor to the 1992 and 1993 meetings, the participants were given the opportunity to enter a forecasting contest. In each of these years, the individuals were asked to predict five items. The items for the 1992 contest were:

92-1. U.S. civilian unemployment rate for August 1992, as reported by the Bureau of Labor Statistics on September 4, 1992.

92-2. Prime rate for August 31, 1992 as reported by the Wall Street Journal.

92-3. Cash price for No. 2 yellow corn, Central Illinois, per bushel, for August 31, 1992, as reported in the Wall Street Journal.

92-4. High temperature at Washington National Airport for August 31, 1992, as reported by the Washington Post.

92-5. Baltimore Orioles' (baseball team) winning percentage for all games this season through August 31, 1992.

Similarly, the 1993 contest asked:

93-1. August U.S. civilian unemployment rate to be reported by the Bureau of Labor Statistics, September 3, 1993.

93-2. Prime rate for August 31, 1993, as reported by the Wall Street Journal.

93-3. Cash price for a troy ounce of gold (London PM price), for August 31, 1993.

93-4. High temperature at Washington National Airport for August 31, 1993, as reported in the Washington Post.

93-5. Most number of home runs hit by an American League (baseball) player for the 1993 season as of August 31, 1993.

The closing dates for entering these contests were August 7, 1992, and August 13, 1993, respectively. There were 62 and 54 entries in these contests. We shall use these responses and, in particular, their distributions to examine whether forecasting skills are transferable from one discipline to another.

Whereas an individual may be knowledgeable in the subject matter of one or two of the questions in each contest, it is highly unlikely that one would be knowledgeable in all five areas. In this analysis, we will ask whether these individuals can apply the forecasting techniques with which they are familiar to a new set of problems. In this case we shall determine whether the forecasters can on average generate the optimal forecasts for the aforementioned ten items.

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II. METHODOLOGY

A. Optimal Forecasts

In order to test the hypothesis that forecasting skills are transferable, we will determine whether these forecasters made optimal predictions given the information that was available to them.

We define an optimal forecast as one made using minimal readily available knowledge in conjunction with generally available forecasting techniques. Thus knowledge of forecasting procedures is presumed, whereas specific knowledge of the subject matter is not. If minimal knowledge of the subject were not readily available or generally known, then this optimal prediction might be a naive forecast. Here we use ***naive forecast*** broad] y, including several extrapolation techniques, one of which is a no-change forecast.

Our optimal forecast is then a minimal-knowledge, minimal-effort forecast estimate. In some cases it is easy to determine what the optimal forecast should be; in other instances, it is not as clear.

1. Weather Forecasts

There were few if any meteorologists who participated in the contests. They would have been the only individuals who might have had specialized knowledge about weather patterns 2 to 3 weeks into the future. Consequently, we argue that the optimal prediction of 92-4 and 93-4 should have been the average historical high temperature recorded for August 31. This number is readily available in the local newspapers and weather almanacs.

2. Baseball Predictions

Similarly, for the baseball questions, 92-5 and 93-5, we believe that it is possible to determine what the optimal forecast should have been. While some individuals might have more sports knowledge than others, it is unlikely that a participant can predict which team will have a long winning (losing) streak or which batter will go on a home run rampage between the date the contest entry is submitted and August 31 of the relevant year. Consequently, we argue that extrapolating available data would be an appropriate procedure. Thus, if the baseball team had won x% of the n games played by the day that the entry was submitted, the law of large numbers indicates that the team will probably have won x% of all (n+m) games completed by August 31. This then is the optimal prediction. Similarly, assume that the leading slugger had hit one home run every j games. It would then be appropriate to use this rate (homers per game) and multiply it by the number of games that would be completed by August 31 to obtain an estimate of the highest number of home runs hit on that date.

3. Commodity Estimates

The optimal forecasts of the cash price of com (92-3) and of gold (93-3) can also be obtained if one had institutional knowledge and realized that these commodities are traded in financial markets. The finance literature views these markets as efficient with the current price fully reflecting all available information about that commodity. Consequently, future price movements follow a random walk, and the best prediction of a subsequent price is the current spot price.[2] Without institutional knowledge, a forecaster would be forced to make a naive prediction. If that individual chose to use the naive no-change forecast, it would, in fact, be identical to the optimal prediction based on institutional or specialized knowledge. Alternative naive predictions would involve extrapolating a previously observed trend into the future. Since there are many such possible extrapolations, we had no way of determining which to use. Consequently, we used the no-change model as the optimal predictor.

4. Interest Rate Forecasts

The prime rate (92-2 and 93-2) is an administered price which is changed infrequently. As such, it is difficult to predict when a bank will change this interest rate. Since forecasters without inside information are unlikely to be able to predict when such a change will occur, a naive no-change forecast might, in this case, be the optimal one.

5. Unemployment Predictions

There is a process by which an optimal unemployment rate forecast (92- 1, 93-1) can be generated, i.e., by using an econometric model which contains the unemployment rate as an endogenous variable. Then by inserting all known macroeconomic information and by making assumptions about the other unknowns, it would be possible to generate an unemployment forecast. While some participants in the contest would have had access to such econometric models, the vast majority would not have been able to use this procedure.

Most contest participants would have had to realize

that monthly changes in the unemployment rate are relatively small, with 0.1 to 0.3 percentage point changes being the norm. We assume that without specialized knowledge many forecasters might make naive predictions such as (1) no change from last month or (2) the same change that was observed in July will again occur in August. In the analysis presented here we assume that the optimal was(1), no change from last month.

6. How Well Would the Optimals Have Forecast?

Although this paper is not focused on the forecast accuracy of the optimal forecasts, it is nevertheless interesting to see how well the optimals would have done if they had been entered in the contests. The optimal forecasts:

92-1. U.S. civilian unemployment rate:	7.8%
92-2. Prime rate:	6.0%
92-3. Cash price, No. 2 yellow corn:	$2.115
92-4. High temperature:	84°
92-5. Orioles' winning percentage:	0.574
93-1. U.S. civilian unemployment rate:	6.8%
93-2. Prime rate:	6.0?40
93-3. Cash price, troy ounce of gold:	$376.30
93-4. High temperature:	84°
93-5. Most number of home runs:	39

Had the 1992 optimals been entered in the contest, they would have been the fourth most accurate of 63 entries (62 entries plus the optimal). The 1993 optimals would not have fared as well, coming in nineteenth of 55 entries. Although this showing would not have earned the 1993 optimal forecasts an honorable mention, its ranking is well within the top half.

Next we describe a procedure for using these optimal forecasts to test the hypothesis that forecasting skills are transferable. In general terms, we used a variety of statistical techniques to see if the contest forecasts were grouped around the optimal, and specifically, if they were symmetrically distributed around the optimal. If indeed the forecast estimates were found to be distributed symmetrically around the optimal, then we concluded that forecasters were utilizing their skills from one discipline in making forecasts in another.

B. Distribution of Forecasts and Statistical Tests

1. Optimal Forecasts that are Constant Over Time

In order to describe the statistical procedures for testing the hypothesis, it is first necessary to determine what the distribution of these forecasts might look like if all contest participants made optimal predictions. If these predictions were independent of the day on which the entry was submitted, they would all be identical and would be described by the degenerate distribution, and are thus constant optimal forecasts over time. For example, the optimal forecast of the high temperature on August 3 1--the average historical high temperature--is the same whether the forecast is made in May or in August.

Even if all of the contest participants generated these optimal estimates, there might be variations in their submissions. Moreover, some persons might have tried to "game" the system. Knowing that others also knew what the optimal prediction was, they might have wanted to be different and would not have wanted to precisely submit the mean or "best" estimate.[3] Therefore, we would expect that the entries would be distributed symmetrically about this optimal value.

The distribution of the contest participants' forecasts around these optimal predictions will be used to test the hypothesis that forecasting skills are transferable. For this hypothesis to hold, the contest entries should be distributed so that the mean is close to the optimal prediction. Moreover, these submissions should be distributed symmetrically around the mean. The normal distribution and other distributions that are more peaked but still symmetric meet this criterion. Consequently, we will argue that if the distribution of the entries is relatively peaked (at the optimal value) and if the distribution is symmetrical around this value, that our hypothesis cannot be rejected.

Thus, we first test whether the distributions of the forecast entries are normal. If they are, t-tests may be used to determine whether the means of the distributions differ significantly from the hypothesized optimal values. If there are no significant differences, the hypothesis cannot be rejected, and we conclude that forecasters are indeed transferring their skills.

In those cases where normality is rejected, we undertake more tests before rejecting the hypothesis. We first examine the distributions for skewness, which, if it is present, would cause us to reject the

hypothesis. If the distributions are not significantly skewed, we will determine whether they are more peaked than the normal and, using the Wilcoxin Test, whether the mean differs significant 1 y from the expected value. The hypothesis would not be rejected if, for these peaked distributions, there were no significant difference between the mean and the expected value.

2. Optimal Forecasts that Vary with Time

If the optimal predictions vary from day to day and, if all of the entries are not submitted on the same date, the degenerate distribution will not describe these forecasts. For example, the optimal naive forecast for the price of corn--the current spot price--depends on what day the forecast was made.

For these cases (five in number) a different procedure is used. The distribution of these predictions was generated by multiplying the optimal forecast for each day by the number of entries that were submitted on that date. The distribution of the actual entries was then compared with the constructed distribution of optimal forecasts. A chi-square test was used to determine whether there was a significant difference between the two distributions. If there were a significant difference, we would conclude that the contest participants had not been able to transfer their forecasting skills from one discipline to another.

C. Outlier Observations

Implicit in our analysis is the assumption that these contest entries are feasible predictions. In some cases, however, the participants submitted infeasible or highly unlikely forecast estimates. For example, on the home run question (93-5), two participants said that the leading slugger would have hit more than 90 home runs in less than a full season. Since the major league record is 61 for a full season, this is a highly unlikely forecast. Similarly, other entries predicted that the leader would have fewer home runs on August 31 than he had already hit on the date that the entry was submitted. These estimates would be impossible since the home run statistic is cumulative for the season. These observations were outliers which were excluded from the analysis.[4]

The other baseball question (92-5) also yielded outliers. This question asked for the win-loss record of the baseball team on Aug. 31. Given the win-loss record on the date that the entries were submitted and the number of games still to be played between then and August 31, it was mathematically impossible for the team to have a cumulative winning percentage as low as 33% or as high as 80%. These outliers were also removed from the data set.

Although the forecast ranges on some of the other questions were very wide, we could find no rational basis for excluding other observations. Rather we adopted another procedure for anal yzing what we considered to be feasible forecasts and for excluding the others.

D. Alternative Distribution Sets

In examining our data, we noted an interesting phenomenon. The data could be grouped into two sets depending on the dates when the entries were submitted. They were submitted either very early or close to the contest's closing date, with the bulk in the latter category. For example, 44 of the 62 entries for 1992 were submitted in the eight working days prior to the contest's final closing date. Similarly, 38 of the 54 entries for the 1993 contest were submitted within this time frame.

We assume that these later entries reflect more complete and up-to-date information and analysis. We, therefore, will also examine this sub-set of predictions to test the hypothesis that was presented above.

111. RESULTS

We looked at the forecast estimates for each question two ways: the entire set of entries and the later entries only. Therefore, results are presented for 20 groups (two contests times five questions times all entries or later entries only). Of these 20 groups, for 12 groups the optimal forecast was considered constant, that is, not time dependent. Six groups had optimal forecasts that varied with time. The remaining two groups were not tested.

A. Optimal Forecasts that are Constant Over Time

We first examine the entries where the optimal forecast was independent of the date on which it was submitted. There were five questions (generating ten sets of data) where this prediction did not vary from day to day: 1992 contest: unemployment rate, prime rate, and high temperature; 1993 contest: prime rate and high temperature. As discussed above, conceptual] y the high temperature optimal forecast is independent of time. We included the prime rate in this group due to the exceptionally long time, over a

year, that the rate was 6 percent. Due to the timing of the 1992 entries and the movement of the unemployment rate, it can also be included here.

The optimal values of the later entries for two questions in the 1993 contest--unemployment rate and home runs--were single numbers as well. Although conceptually the optimal forecast for these two questions would be time dependent, the short period of time the later entries were made allows us to include these two groups here. In the first, unemployment rate, 32 of the submissions should have predicted 6.8% (the unemployment rate in June) and the remaining six should have forecast a 7.0°/0 rate (the unemployment rate in July). In the second, home runs, 36 of the 38 entries should have indicated that 39 would be hit (the optimal forecast through August 4), while 40 was the optimal value for the other two entries (the optimal forecast as of August 5).

Therefore, questions 92-1,92-2,92-4,93-2, and 93-4 were considered to have constant optimal forecasts when all entries were considered. Questions 93-1 (unemployment rate) and 93-5 (home runs) were included for later entries only. The groups 93-1 and 93-5 for all entries were considered to have optimals that vary with time because of the long time period over which entries were submitted.

The results are mixed. Table 1 presents the significance levels of the Shapiro-Wilk W statistic for each of the 12 groups. The statistic is presented separately for the complete set and for the later entries only. The normality hypothesis was not rejected in only four instances, with three of these occurring in the 1992 contest. These were: (1) the complete set of 1992 forecast entries of the unemployment rate, (2) and (3) both the complete set and the later entry predictions of the 1992 temperature, and (4) the complete set of the 1993 estimates of the high temperature.

For these four cases, t-tests were used to determine whether the means of these distributions differed significantly from the optimal predictions. In all four cases, the means of the entries were not significantly different from the optimal predictions. However, an anomaly should be noted. The 1992 high temperature entries were normally distributed with a mean of 87 degrees, but 51 of the 62 entries (82 percent) in one case and 35 of 44 (80 percent) in the other made predictions in excess of 84 degrees, which was the average historical high. Similarly for 1993, 39 of the 54 individuals (72 percent) submitted entries with forecasts in excess of 84 degrees. It is therefore not obvious that in these three cases where there were normal distributions that the contest participants were making optimal predictions.

We next examined the eight distributions where normality was rejected. Seven of these distributions were found to be significantly skewed when the b, statistic was used. (Only the later set of 1993 entries predicting the unemployment rate was not found to be skewed.) According to the procedures which were set forth above, this should have caused an immediate rejection of the hypothesis that the participants were making optimal forecasts for the other seven items. However, the data also indicated that, in some cases, there were a small number of extreme outliers which tended to exacerbate the skewness. Moreover, the results also indicated that the kurtosis measure, $\sqrt{b_2}$, of these distributions was high and significant. This indicated that the tails of these distributions were heavier than those of a normal distribution. These distributions can be described as being leptokurtic, or more peaked than the normal. More recently the literature describes these distributions as having longer tails. We had previously indicated that distributions that are more peaked than the normal would not cause us to reject the hypothesis that the entrants had generated optimal forecasts. However, symmetry was required and these distributions were found to be significantly skewed. We had a choice: peremptorily reject the hypothesis or do a qualitative analysis of the forecasts. We chose the second approach, knowing quite clearly that we were biasing our analysis in favor of the hypothesis.

Our qualitative analysis was based on the number of contest participants who made the optimal prediction (as we have defined it) or whose entry was "close" to that number. In the case of the four prime rate groups we arbitrarily selected 25 basis points on either side of the optimal forecast as being close. Table 2 indicates that, for this 1992 question, 43 of the 62 entrants of the entire cross-section and that 38 of the 44 later entries were "close." A similar calculation for the 1993 question yielded 51 of 54 and 35 of 38 in this category. This suggests that many of the contest participants made optimal predictions. It should, however, be remembered that this interest rate had been constant for a long period of time and thus was relatively easy to predict.

Table 1: Levels of Significance of W, the Shapiro-Wilk Statistic

1992 Contest-Constant Optimal Forecasts					
Level of Significance of W					
Unemployment Rate (92-1)		Prime Rate (92-2)		High Temperature (92-4)	
All entries	Later entries	All entries	Later entries	All entries	Later entries
0.238*	0.017	0.0001	0.0001	0.187*	0.490*

1993 Contest-Constant Optimal Forecasts							
Level of Significance of W							
Unemployment Rate (93-1)		Prime Rate (93-2)		High Temperature (93-4)		Home Runs (93-5)	
All entries	Later entries	All entries	Later entries	All entries	Later entries	All entries	Later entries
NA	0.0005	0.0001	0.0001	0.079*	0.017	NA	0.031

* indicates normality hypothesis not rejected
NA = Not analyzed

Table 2: Results for 12setsof entries, types of distribution, "closeness to optimal forecast"

Year	Question	Entry	All entries or later?	Normality rejected?	Distribution	Close Observations
1992	92-1	Unemployment	All	No		
1992	92-1	Unemployment	Later	Yes	Sk, L	29 of 44 (65.9%)
1992	92-2	Prime rate	All	Yes	Sk, L	43 of 62 (69.4%)
1992	92-2	Prime rate	Later	Yes	Sk, L	38 of 44 (86.4%)
1992	92-4	High temperature	All	No		
1992	92-4	High temperature	Later	No		
1993	93-1	Unemployment rate	Later	Yes	L	
1993	93-2	Prime rate	All	Yes	Sk, L	51 of 54 (94.4?40)
1993	93-2	Prime rate	Later	Yes	Sk, L	35 of38 (92.1%)
1993	93-4	High temperature	All	No		
1993	93-4	High temperature	Later	Yes	Sk, L	10 of 38 (26.3%)
1993	93-5	Home runs	Later	Yes	Sk	Not leptolurtic

Sk = Skewed
L = Leptokurtic

Table 2 also presents the number of entries that were "close" to the optimal values for the other questions where the distributions were both skewed and leptokurtic. In the unemployment question, about two-thirds of the participants submitted entries which were close to what we considered to be the optimal values. The high temperature question was again an exception. Only ten of the 38 entries were within two degrees of the historical average high temperature for the day in question. These qualitative findings reinforce the mixed nature of our results.

B. Optimal Forecasts that Vary with Time

We had noted above that in some cases the optimal forecasts varied from day to day depending on the date when the entry was submitted. Since we only determined the optimal forecasts for these items for the later entries, there were only three distributions that we could analyze. These were: the com price (92-3), the Orioles winning percentage (92-5), and the gold price (93-3).

Our procedure involved the construction of contingency tables which compared the set of optimal forecasts, based on the day that the entry was submitted, with the distribution of the actual predictions. If, for example, ten entries were submitted on a particular date, and the optimal forecast for that day was 100, the column which contained that figure would be credited with ten observations. The actual predictions were then tabulated and the chi-square distribution was used to determine whether the two sets of forecasts were independent.

There is no way to test the hypothesis that the contest entries are identical to the optimal forecasts. We can, however, test the hypothesis that the forecast estimates are significantly different from the optimal forecasts. To reject this null hypothesis would mean that the contest participants were forecasting optimally. Unfortunately, in no case were we able to reject the null hypothesis that the entries were significantly different from the optimals. (The results are not presented here.) **As a sensitivity test, we also varied the number and widths of the forecast** categories, but the results were identical. The reason for this finding is that a large number of the forecast entries were outside the range of the observations that had occurred just prior to the closing date of the contest. The implication of this finding is that the entries were extrapolations of a recent past trend, which in fact did not continue into the future, instead of being optimally chosen forecasts.

IV. CONCLUSIONS

We have attempted to test the view that forecasting skills are transferable from one discipline to another. Our analysis was based on the entries submitted by forecasters in two contests sponsored by the Federal Forecasters Conference. Our results are quite mixed. In many cases we must reject the view that the entries submitted in those contests were 'optimal' forecasts, but there is some evidence that in some cases the forecasts were close.

One might argue that these contests are not a reasonable test of a forecasters' ability. Most of the questions are asking for point forecasts on a particular day. With the amount of randomness involved in making a day's forecast of the weather or the commodity markets a month ahead, it is unlikely that many forecasters, even those with knowledge in these fields, would predict with no error. Perhaps a better measure of ability to utilize forecasting skills is to evaluate forecast estimates of monthly items, such as the unemployment rate. The fact that these forecasters gave estimates close to the optimal for the unemployment rate and the prime rate is a strong indicator that indeed forecasting skills are being transferred.

In addition, one may argue that the contest, set up as once a year without incorporating the forecasters' accuracy in the previous contests, is not the kind of evaluation most forecasters face. Most forecasters do repeated forecasts over time, and perhaps aim for accuracy, on average, over many forecasts. Realistically, most forecasters are in forecasting marathons, while these contests are forecasting sprints. In any event, this subject--the transferability of forecasting skills--is worthy of further analysis.

ENDNOTES

1. See Bretschneider and Gorr (1989 and 1991), Brown (1992), Fildes (1992), and Levenbach (1993).

2. If the commodity were trading on a futures market and if the price predictions were for a date on which the futures contract expired, then today's futures price might be considered an alternative optimal forecast. However, these conditions did not prevail during either contest period.

3. The contest rules tried to discourage this kind of behavior by adopting a scoring system that awarded extra credit for forecasting the correct answer precisely, i.e., no prediction error. However, an alternate view is that this scoring system **encouraged** gaming the system.

4. On the other hand, it can be argued that if forecasting skills require some institutional knowledge, the exclusion of these observations would bias the results in favor of not rejecting the hypothesis. However, the judges of the contest have observed that these outliers are usually the result of the individual misreading the question.

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A Bibliographic Database As A Health Care Forecasting Tool

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Abstract

The Department of Veterans Affairs Office of Inspector General's Office of Health Care Inspections oversees, monitors, and evaluates quality of care issues in the VA health care system. Numerous individual cases and VA health care programs have been reviewed by this Office. Beyond the basic need of reviewing single cases and single VA health care programs, a need was perceived for a more powerful tool for understanding and monitoring health care provided by VA. A bibliographic database using a commercial bibliographic database package was established. Appropriate health care and VA related database fields, key words, report summary forms, and other tools necessary to establish and maintain this database were developed. This database permits the Office of Healthcare Inspections to identify health care trends within the VA health care system. As the number of Office of Healthcare Inspections findings tracked in the database increases, it is postulated that bibliographic data will reach a sufficient mass to permit forecasting of health care needs, and permit the prospective proposal of interventions within the Department's health care system.

Introduction

The Department of Veterans Affairs (VA's) Office of Inspector General's (OIG's) Office of Healthcare Inspections (OHI), produces a wide variety of reports, dealing with health care issues related to VA and, more broadly, national health policy. When the OHI was established in 1991, there was not a high priority need for a systematic procedure to summarize and record the basic information of the reports. However, as the number of reports grew, the spectrum of topics expanded, and national health reform moved to the forefront of public policy. A need was perceived for a database to manage basic bibliographic information about OHI data. A desire also developed to compile the basic report information in such a way as to permit the identification of trends, and expand upon emerging issues. A mechanism was needed to perform this task. This paper describes the development of that database for OHI, and its possible forecasting implications.

OHI has clinical oversight of VA's health care as one of its inspection responsibilities. Under the initial design of this office, clinical oversight was performed primarily on a case-by-case method, in a reactive fashion. As problems developed or surfaced in individual Veterans Affairs Medical Centers (VAMCs), inspections were conducted and reports written regarding the findings of these specific instances. However, after two years of existence, it became apparent to the OHI that a mechanism was needed that would permit a broader overall review of the final reports to permit a search for health care trends, and to help address system-wide issues and policies within VA. Such trends and system-wide issues were often not observable from single reports on individual cases. What was needed was a system that permitted the OHI to compile cases and health care data in such away that would reveal patterns and trends. Having information from several sources in one place for easy browsing leads to the generation of new ideas and facilitates pattern recognition. After careful study, a decision was made to set up a bibliographic database of the final projects of OHI that would elicit repetitive issues or problems.

Results

The first stage of the process undertaken in OHI was the determination of who else with clinical or health care oversight responsibilities in the Federal Government might already have created such a database. A comparable system to what was envisioned for OHI was utilized by the Government Accounting Office (GAO), which had a bibliographic database of their reports reminiscent of the National Library of

Medicine's MEDLINE® system. From GAO's system, along with a detailed analysis of OHI needs, a determination of many aspects of what was needed for OHI's system could be made.

In consideration of the fact that OHI's primary responsibilities lay in the performance of inspections, and given limited Medical Information Service resources, it was elected to ascertain if a suitable software package on the market existed that would handle the needs perceived and identified in OHI. In addition to standard bibliographic information with an emphasis on medical, clinical and health policy data, i.e., basic library functions, OHI's database would be expected to contain and make available for analysis information regarding the types of OHI products, types of medical issues reviewed, and the actual VA medical centers under review. An outline of what was desired for each entry to include and what types of searches OHI wanted to perform was drafted.

The initial step of specifying information to be included in a governmental health care bibliographic database was far more complex than originally expected. The specification of "fields" took numerous iterations, working in conjunction with OHI's staff. Information was needed to be detailed enough to perform searches to establish trends and facilitate oversight of VA health care, yet brief enough to be manageable for typing. An entry was not to be a repetition of the full report, i.e., only enough information would be entered that would permit cataloging, and direct research and further analysis.

Another issue that needed to be resolved was the degree of comprehensiveness of the proposed database. Many of OHI reports were related to non-OHI VA OIG reports from other OIG Offices, such as Audit or Investigations; from other non-OIG VA sources; from other non-VA governmental sources such as GAO; and from non-governmental sources altogether, such as technical journals and news media reports. If all these reports were also to be included, OHI perceived that the system, at least in its start-up phase, would be overwhelmed. Yet, flexibility was needed to provide entry of select reports from these other potential sources that proved to be particularly valuable in trend establishment. We concluded that our data forms would need to be flexible enough to handle various types of different reports, but consistent to permit searches across all types of reports. Data entry forms would have to be relatively concise so that our system would not be unwieldy.

In searching the literature for a bibliographic database suitable for medical data, a package called Pro-Cite® (Pro-Cite®, Version 2.0, Personal Bibliographic Software, Inc., Am Arbor, Michigan) was revealed. Pro-Cite® is a random information processor that is specialized for the creation, maintenance and use of bibliographic databases. Although primarily designed to aid in the creation of bibliographies, the system allows for the establishment of a database that permits the user to request functional searches based upon the contents of reports. Once information has been entered, the database can be searched to find items about a particular subject, written by a particular author, or published in a particular type of report or during a particular period of time. Because Pro-Cite® is designed for bibliographic entries, the user can employ the program immediately and can avoid the set-up often required by other database programs. Pro-Cite's® editor works like a word processor, so the user may readily insert and delete text, add character styles, and copy text between text and records. Pro-Cite® is a unified program that combines data entry, editing, searching, sorting and printing operations. The program presents an empty record, which is a "work-form" -- a template of fields that tells what information should be entered. Since OHI anticipated utilizing the database for a unique function, templates were modified to allow for information, not usually presented in a bibliography, to be included in the work-forms. The work-form structure was flexible enough to be modified to fit OHI's style of data, but "friendly" enough to need little programming to make the forms fit. In order to accommodate the types of reports published by OHI, we created a unique work-form (see Appendix). This work-form collects characteristics of the documents, such as the title, and authors, dates, type and length of document, as well as issues within the document, e.g., VAMC'S examined, types of cases, etc. In addition, text containing an abstract can be stored.

The additional bibliographic capabilities of Pro-Cite® also proved important. The searching and printing capabilities suited OHI requirements, so, again, little programming was required. The "Authority List"

structure employed in **Pro-Cite®** permitted easy searching, particularly when paired with the Boolean operators. Since the software was designed to handle **MEDLINE®** type **data,** OHI needs were met.

Discussion

Since its inception in May 1993, **synopses** of over 200 reports have been entered. At this threshold of approximately 200 unique data entries, trending may be conducted with this database. This will be discussed at length in a **future** paper.

However, several preliminary trends have noticeably begun to emerge. Certain VA hospitals maybe identified as hospitals with recurring problems- thus flagging them for further review. What we qualitatively suspected is often proving quantitatively correct. In fact, certain issues in health care have been noted to be recurring. For instance, supervision of physicians in training; issues of patient teaching, communication and bedside manner; and issues of patient satisfaction such as waiting time to see the doctor, and waiting time for an appointment to see a specialist have been identified as recurring health care issues.

And what might be forecasted? The proactive, in other words, anticipatory identification of problems, in advance may signal a need for an oversight organization such as OHI to more **carefully** review a facility before it is called into inspector investigate a complaint. Recurring themes in patient satisfaction, i.e., perceptions of care, may **identify** a problem and allow for logical predictions of solutions, again before OHI is called in on a reactive basis. The forecasting of problem facilities, broad areas of patient concern, and system-wide needs is becoming available. The operating phenomenon appears to be that when a critical mass of bibliographic data has been **reached,** it is sufficient to permit the identification of trends and pattern identification. When **further** quantities of bibliographic data are added, a second critical mass may be **reached,** making forecasting a possibility.

Summary

This is a report of a work in progress. The manner in which the simple process of data management has opened up a window of other applications is exciting. In establishing certain databases, forecasting possibilities appear to arise, essentially as an epiphenomon, or derivative phenomenon, of managing these databases.

BIBLIOGRAPHIC DATA FORM

OHI PROJECT #____________ HOTLINE CASE #____________

VAMC ____________________ STATION #_“___

TITLE: ____

____

____

PATIENT'S **NAME:** ______________________ **SSN:** ___________

AUTHOR(S) [CHECK AUTHORS: NOTE PROJECT LEADER/PRIMARY AUTHOR WITH A 'I']

(54) ___
(54A) ___
(54A1) ___
(548) ___
(5481) **NAME, AUTHORS** ___
(5401) ___
(5481) ___
(54C) ___
(54C) ___
(54C) ___
(54C) ___
(54C) ___
(54C) ___
(54C) ___

LEAD OFFICE FOR PROJECT [CHECK ONE]:

•

54 ___ **54A** ___ 548 ___ 54C ___

DATE OF PUBLICATION [MM/DD/YY]: ________

 # OF PAGES [INCLUDING APPENDICES]: _

PACKAGING METHOD [CHECK ONEI

PAGES **(paper)** ___ **DISKETTES** ___ TRANSPARENCIES ___

OTHER **(please** specify)_‘____________________

DESCRIPTORS **(USE ATTACHED LIST)**

TYPE OF DOCUMENT: **[CHECK ONE]**

BLUE COVER
LETTER ___ _
MEMORANDUM
POLICY PAPER _
FACT SHEET _
WORKING **PAPER**
OPINION PAPER _
WHITE PAPER _
ABSTRACT _
JOURNAL **ARTICLE**
PRESENTATION _
CONGRESS/MEDIA BRIEFING ___
PRESS RELEASE ___
COMPUTER **SOFTWARE**
OTHER **(please specify)** _______________

INITIATED OR REFERRED BY: [CHECK ONEI

OHI (54) ___
AUDIT (52) ___
INVESTIGATIONS (51)
HOTLINE ___(53E) _
CONGRESS
GAO ___ _
MEDICAL INSPECTOR (19) ___
PROACTIVE ___
"TELL IT TO THE SECRETARY" "
INSPECTOR GENERAL (50) ___ _
OTHER (please specify) _______________

VAMCS VISITED: _______________

VAMCs CONTACTED: _______________

ABSTRACT [MAY USE **BIWEEKLY ABSTRACT]:** _______________

DESCRIPTORS (Revised Ust)
December 1993

Administrative issues
- Transfers
- Medical Record
- Access to care
- Data Verification
- Directives
- Disability ratings
- Eligibility/entitlement
- Fee-basis treatment
- Resources
- Medical information systems
- Other ________

Administrative Region
- I
- ii
- Ill
- Iv

Affiliations

Agent **Orange**

Chaplain **Service**
- **(Religious Services)**

Clinical Car9/Critical **Care**
- Cardiology
- Pulmonary
- Respiratory
- Nephrology
- Infectious Disease
- Formulary
- Rheumatology
- General Internal Medicine
- Endocrinology
- Immunology
- Hematology
- Oncology
- Gastroenterology
- Neurology
- Dermatology
- General Surgery
- Radiology
- Nuclear Medicine
- Cardiothoracic surgery
- Urology
- Orthopedics
- Neurosurgery
- Anesthesiology
- Medicine/Physiatry
- Rehabilitation
- Psychiatry
  - PTSD
  - Treatment
  - Substance Abuse
  - Treatment
- Obstetrics
- Gynecology
- Pediatrics
- Spinal cord injury
- Traumatic brain injury
- Gerontology/Geriatrics
- Prosthetics
- Radiation oncology
- Other ________

Complications
- Surgical
- Medication error

Delays
- Being seen by provider
- Delay in diagnosis
- Delay in treatment

Dentistry

Dietetics/Nutrition

Drug
- Allergic reaction
- Toxicity
- Overdose
- Monitoring

Economics
- Health care Costs
- Academic Costs

Education
- Medical students
  - Interns
  - Residents
  - Fellows
  - Nursing
  - Pharmacists
  - AHP
  - PA
  - Dentists
  - other ________

Facilities .
- Space
- Cleanliness
- Parking
- Equipment inventory
- Signage

Federal Agencies
- NIH
- FDA
- CDC
- HCFA
- FBI
- DOD
- Other ________

Follow-up

Former Prisoners of War

Gender issues
- Male
- Female
- u.

Health Policy
- Projections
- Demographics
- Rationing
- Continuity of care
- Managed competition
- Single payor
- Alternate systems
- International systems
- State systems

Health Policy **(Cont.)**
VA **plans ●** nd **policies**

Homelessness

Homicide

Hospital **Care**

infectious or **communicable** disease(s)
- **TB**
- HIV
- Infection **control/ practices &** policies
- Hepatitis
- Other ____________

Joint Commission of Accreditation of **Healthcare** Organizations **(JCAHO)**

Labor/Employer relations

Laboratory Service

Legal issues
- Tort claim
- Abandonment
- Therapeutic misadventure
- Sexual harassment
- Other ____________

Multiple Chemical **Sensitivities** Syndrome

Nursing

Occupational/Vocational Therapy

Patient Abuse

Patient Injuries

Patient **Rights**

Patient **Satisfaction** issues
- Privacy

Personnel/staffing
- Attending **physicians**
- **Social** work
- Nursing "
- **Patient** representative
- consulting **physicians**
- Women veterans **coordinator**
- **Pharmacy**
- **Dentists**
- PA
- Other ____________

Pharmacy

Physical **therapy**

Podiatry

Proscription practice

Preventive **Medicine/Screening**

Psychology

Quality Assurance
- **Outcomes**
- Mortality
- **Suicide**
- **Indicators**
- Peer **review**

Research
- **Statistical** data
- **Statistical** methods
- **Protocol**
- **Basic Science**
- **Clinical**
- Drug **trial**
- **Health Services**

Scheduling

Social Work

Supervision

Triage

Types of Care
- , **Primary** Care
- **Secondary** Care
- Tertiary Care
- Intermediate Care
- Nursing **Home** Care
- Long-term **Care**
- **Hospice** Care
- Home Cam
- Domiciliary
- Ambulatory(OPC) Cam

University Hospitals
- **Medical students**

VA **Central** Office **(VACO)**

Veteran **Service** Organizations
- **VFW**
- OVA
- PVA
- AL
- WA

Veterans' Benefits

Vietnam Veterans

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AUTH	AUTHOR(S)
OFFC	LEAD OFFICE FOR PROJECT
TITL	TITLE
VmcV	VAMCS VISITED
LTTR	INITIATED OR REFERRED BY
PaNm	PATIENT'S NAMES [AND SSN'S] REVIEWED
DATE	DATE OF PUBLICATION
RpID	UNIQUE IDENTIFIER

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Abst	ABSTRACT
Call	OHI PROJECT NUMBER
Desc	DESCRIPTORS