



Predicting Restaurant Recessions

- Timothy Park, Howard Elitzak, and Abby Okrent
- Economic Research Service, USDA
- FCSM 2018 Research and Policy Conference

Plan for Presentation

- **Research Issue:**
 - Need for accurate predictions of restaurant recessions
 - Current focus: an array of economic and financial variables
 - Changes in Gross Domestic Product
 - Short and long-term interest rates
- **Econometric approach**
 - Forecasts from a probit model
- **Evaluating predictive performance from competing models**
 - Receiver Operating Curve
 - Statistical measures for this measure
 - Comparing model performance and identifying better models



The USDA Food Expenditures Series

FES: more comprehensive than other data series!

- FES: accounts for sales to ALL U.S. food purchasers—
Households == Government == Business
- FES: more accurate as it excludes non food items sold
by U.S. retailers:
Drugs == Branded supplies == Pet food == Ice
- Alternatives series
 - Personal consumption expenditures (BEA)
 - Consumer Expenditure Series (BLS)
 - These series only cover sales to U.S. *households*.



The USDA Food Expenditures Series

Data Sources

Census:

Annual and Monthly Retail Trade Survey = Quarterly Services Survey
Annual Survey of Manufacturers = Census of Population
Census of Agriculture

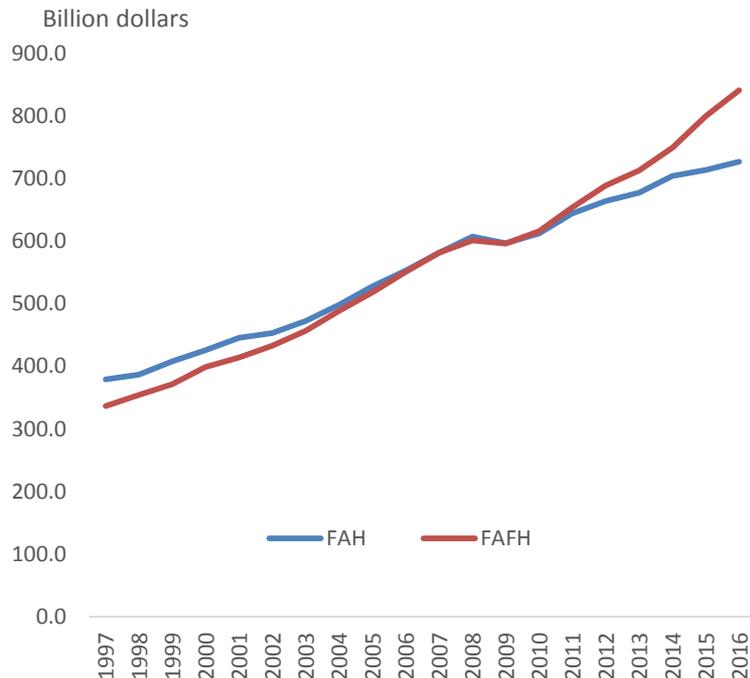
Other sources:

Amtrak Annual Report = SIPP = USDA/FNS = IRI
NCES = SAS = OJJDP = CPI/PPI
CACFP = AHA = Department of Defense

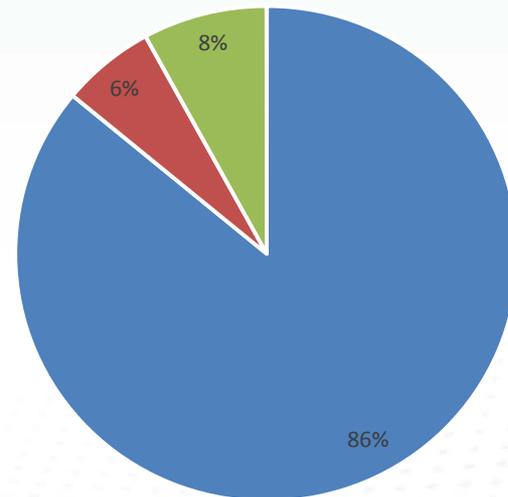


Applications of the Data

FAFH Now Higher than FAH



Share of total food expenditures, by final purchasers



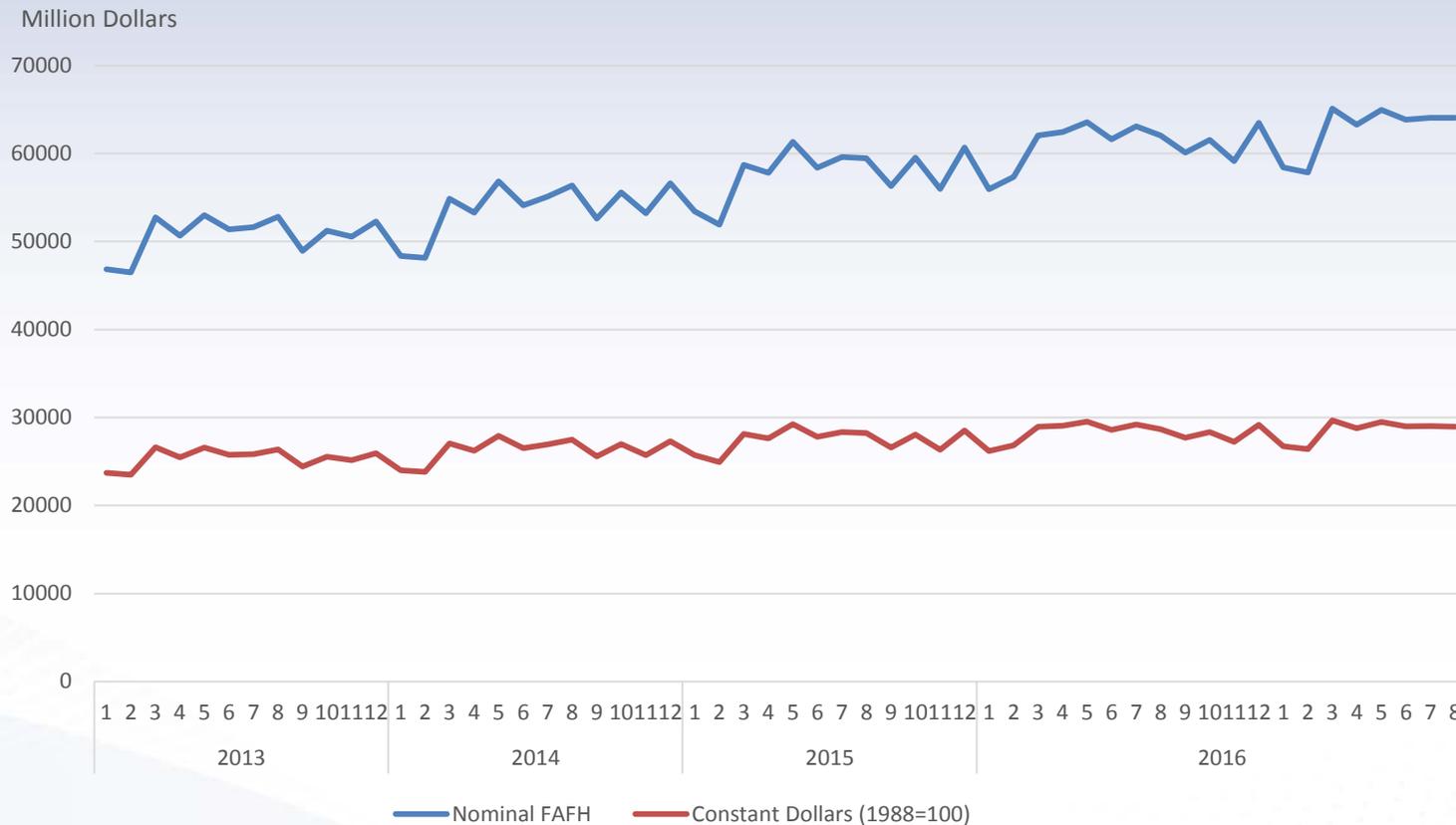
■ Households ■ Government ■ Businesses



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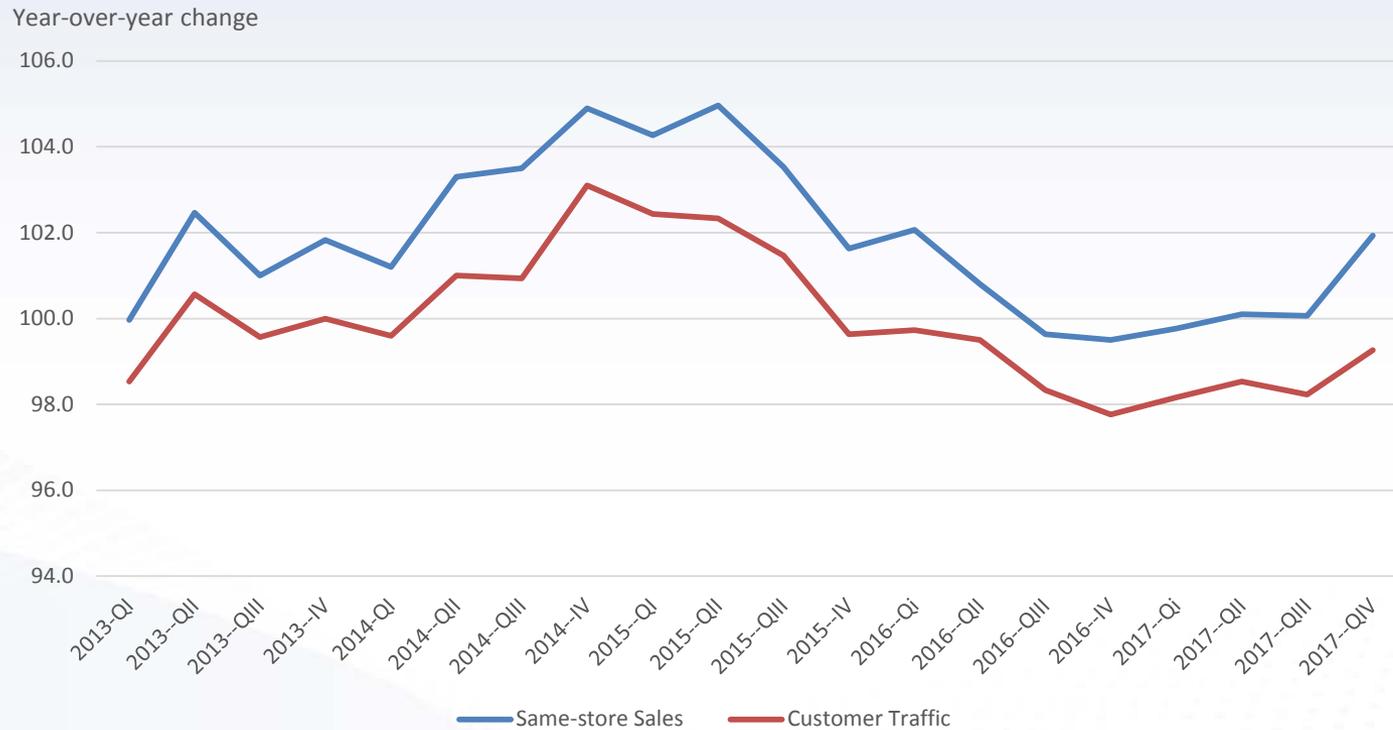
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Monthly FAFH Expenditures



Based on monthly food sales data from the Census Bureau, excluding food revenues at schools and colleges, the value of FAFH furnished to employees or part of a secondary activity, and donations and government assistance.

Restaurant Performance Indexes



Source: National Restaurant Association

Same-store sales compares same-store sales volume in the reference month versus the same month in the previous year.

Customer traffic compares customer traffic in the reference month versus the same month in the previous year.

Predicting recessions with restaurant sales

Validity of using restaurant sales

Mentioned as a leading indicator of business cycles

- **Little empirical research in this area**

Food industry analysts often discuss “food recessions”

- **Binary probit model: assess factors influencing restaurant sales**

Restaurant sales are food away from home = **FAFH**

Grocery sales are food at home = **FAH**

- **Incorporate data from the Food Expenditure Series**

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Restaurant sales and the macroeconomy?

- **Restaurant analysts assert a close relationship exists**
 - Restaurant sales performance in 2016 was similar to the second half of 2000 and the first half of 2007
 - Periods which immediately preceded the last two recessions
 - In the first half of 2007, month-to-month sales dropped three times
 - In the second half of 2016, month-to-month sales dropped three times
 - Restaurant sales declined in January, 2017

The restaurant recession has arrived

By [Tonya Garcia](#) and [Ciara Linnane](#)

Published: Nov 8, 2016 3:16 p.m. ET



Moody's slashes its profit growth outlook as consumers struggle to pay bills and restaurants grapple with weak traffic



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Data for Predicting Recessions

- Monthly data from January 1997 – August 2017
- Dependent Variable = **FAFH Recession Indicator**
- Independent Variables =

Spread Difference: 10-year and 3-month Treasury yields

Spread_{t-6} Spread lagged 6 months

gdpPCH % Change in GDP

FAH Food at Home expenditures

FAH_{t-6} Food at Home lagged 6 months

- Model 1 gdpPCH, Spread, Spread_{t-6}
- Model 2 gdpPCH, Spread, Spread_{t-6}, **PLUS** FAH
- Probit models



Features of the Sample

- Time period: 1997 to 2017
- Quarterly declines in GDP = 29% of the time
- Quarterly declines in FAFH = 50% of the time
- **FAFH and GDP declines**
 - Probability of FAFH decline | Given drop in GDP 58%
 - Probability of GDP decline | Given drop in FAFH 33%
- **Size of drop in FAFH**
 - Percent decline in FAFH | Given drop in FAFH 4.5%
 - Percent decline in FAFH | Given drop in GDP 0.14%



Out of Sample Predictive Performance

- Estimate each probit model
January 1997 – December 1999
- Predict recession probability
January 2000 – August 2017
- Predictions for 1-month ahead, 6-months ahead
Update sample and re-estimate probit model each period
- Evaluation based on **R**eceiver **O**perating **C**haracteristics Curve

ROC Curve

AUROC

= Area under **ROC**

= Summary measure of performance



Measuring Predictive Accuracy

		OBSERVED	OUTCOMES
		Recession	Expansion
PREDICTED OUTCOME	Recession	TP	FP
	Expansion	FN	TN

True Positive Rate = $TP / [TP + FN]$

False Positive Rate = $FP / [FP + TN]$



Multidimensional Performance Assessment

Receiver operator characteristic (ROC) curve

– Predicting true recession events

- Recession occurred
- Correctly predicted a recession

➔ True Positive Rate

– Predicting false recession events

- Recession did not occur
- Incorrectly predicted a recession

➔ False Positive Rate

– Combine in a summary statistic

Graph combining FPR & TPR (in % terms)

– (FPR, TPR) (FPR, TPR)

– (0, 1.00) (0.76, 0.76)

		OBSERVED OUTCOMES	
		Recession	Expansion
PREDICTED OUTCOMES	Recession	300%	09%
	Expansion	01%	01%



Predicting Recessions with the ROC Methodology

Z_t = true state of economy (1 if FAFH recession, 0, otherwise)
 P_t = probability of FAFH recession from probit model
 C^* = thresholds for defining a recession, [0.05,, 0.95, 1]

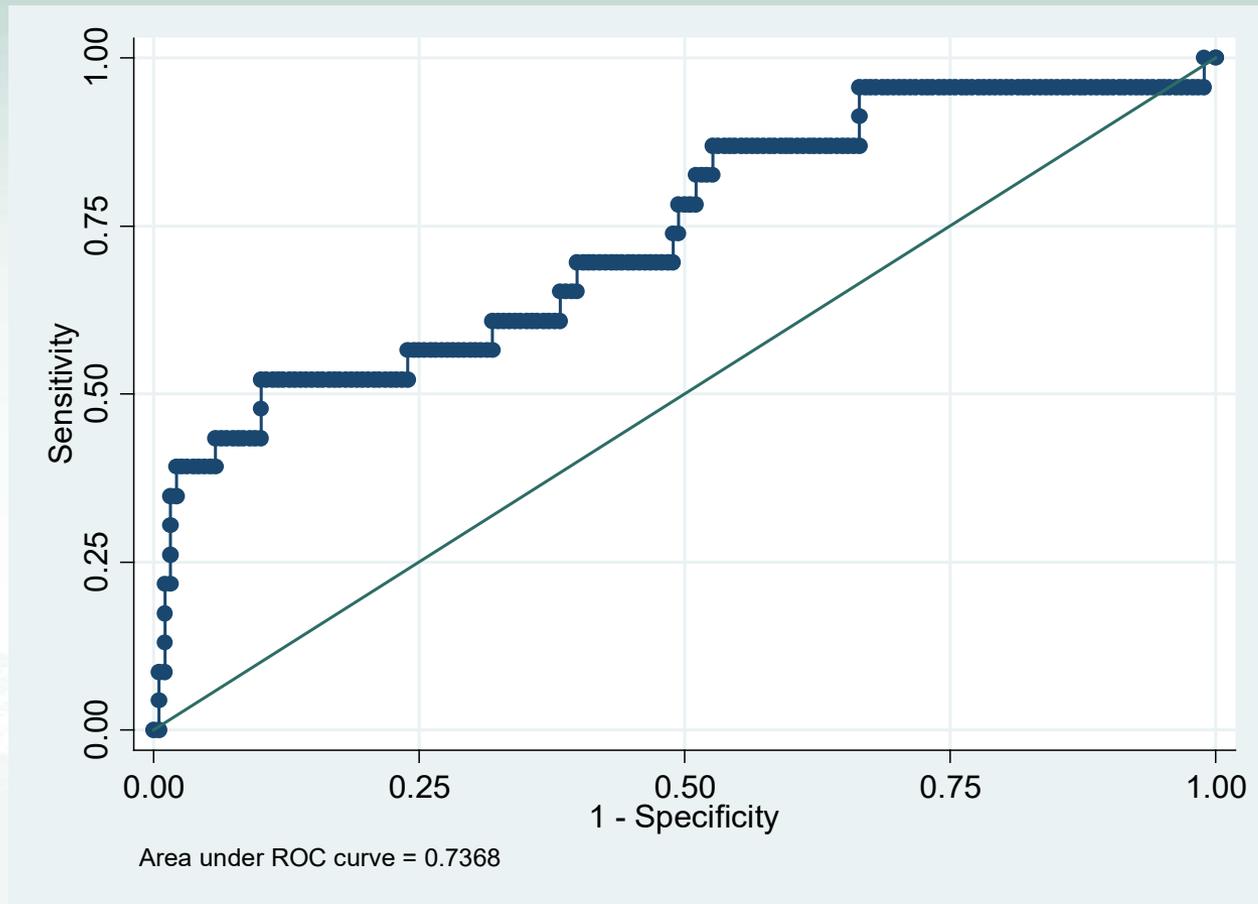
- Given a threshold C^* , we define the predicted outcome

$$\hat{Z}_t = \begin{cases} 1, & \text{if } P_t \geq C^* \\ 0, & \text{if } P_t < C^* \end{cases}$$

- Compare true Z_t with predicted \hat{Z}_t
Calculate true positive rate
Calculate the false positive rate
- For each C^* , plot (FPR_i , TPR_i)
Plot the coordinates for each threshold
FPR_i on X axis
TPR_i on Y-axis
Connect the coordinates == the **ROC** curve



GDP Model == 1-month ahead Forecasts



GDP Model = Spread, Spread_{t-6}, gdpPCH

AUROC = 0.737



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ROC: Measure of Predictive Performance

- Two models A and B

$$\text{ROC}_A(r) > \text{ROC}_B(r) \implies$$

Model A stochastically dominates Model B

- $\text{AUROC}_A > \text{AUROC}_B \not\equiv \text{ROC}_A(r) > \text{ROC}_B(r)$

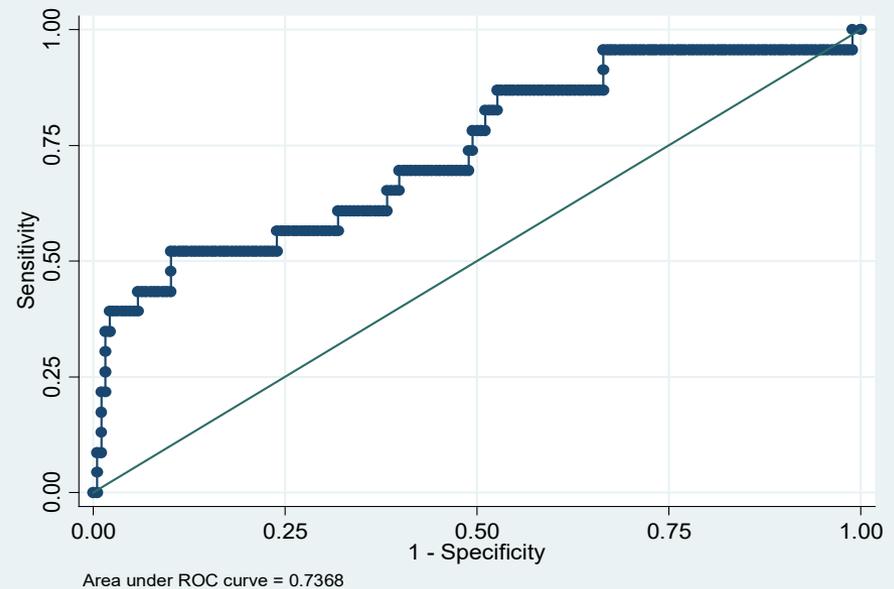
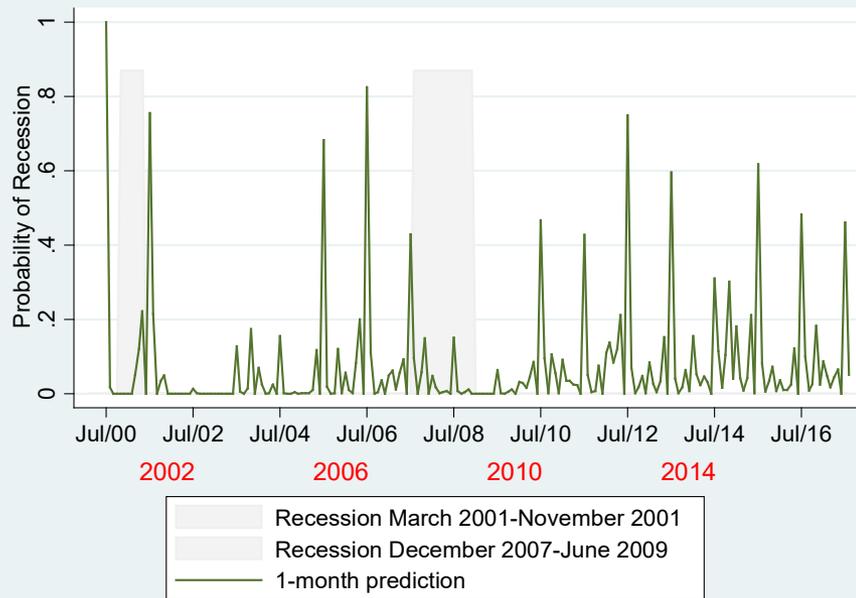
- $\text{AUROC} \in [0.5, 1.0]$ is bounded between 0.5 ... 1.0

- Other Notes:

- Simple non-parametric estimates of AUROC are available
- AUROC is asymptotically normal



GDP Model == 1-month ahead forecasts



$$\text{GDP Model} = \text{Spread}, \text{Spread}_{t-6}, \text{gdpPCH}$$

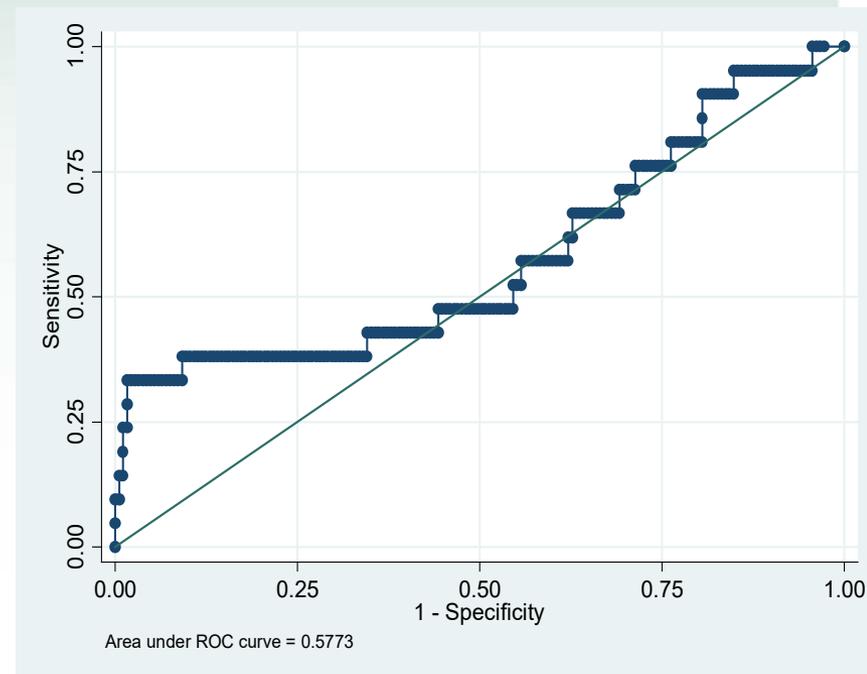
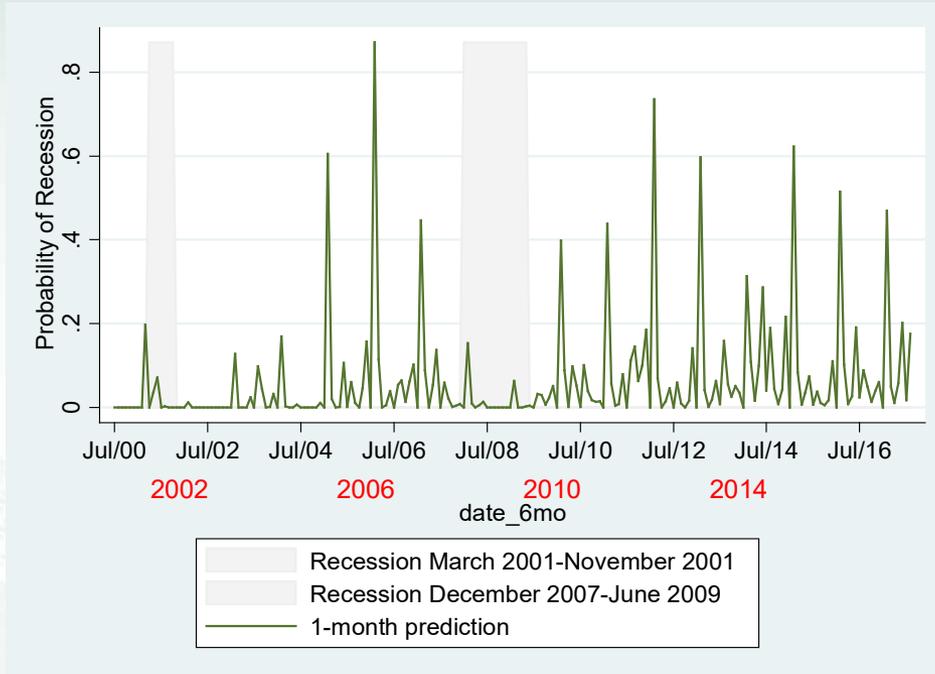
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GDP Model == 6-month ahead Forecasts



$$\text{GDP Model} = \text{Spread}, \text{Spread}_{t-6}, \text{gdpPCH}$$

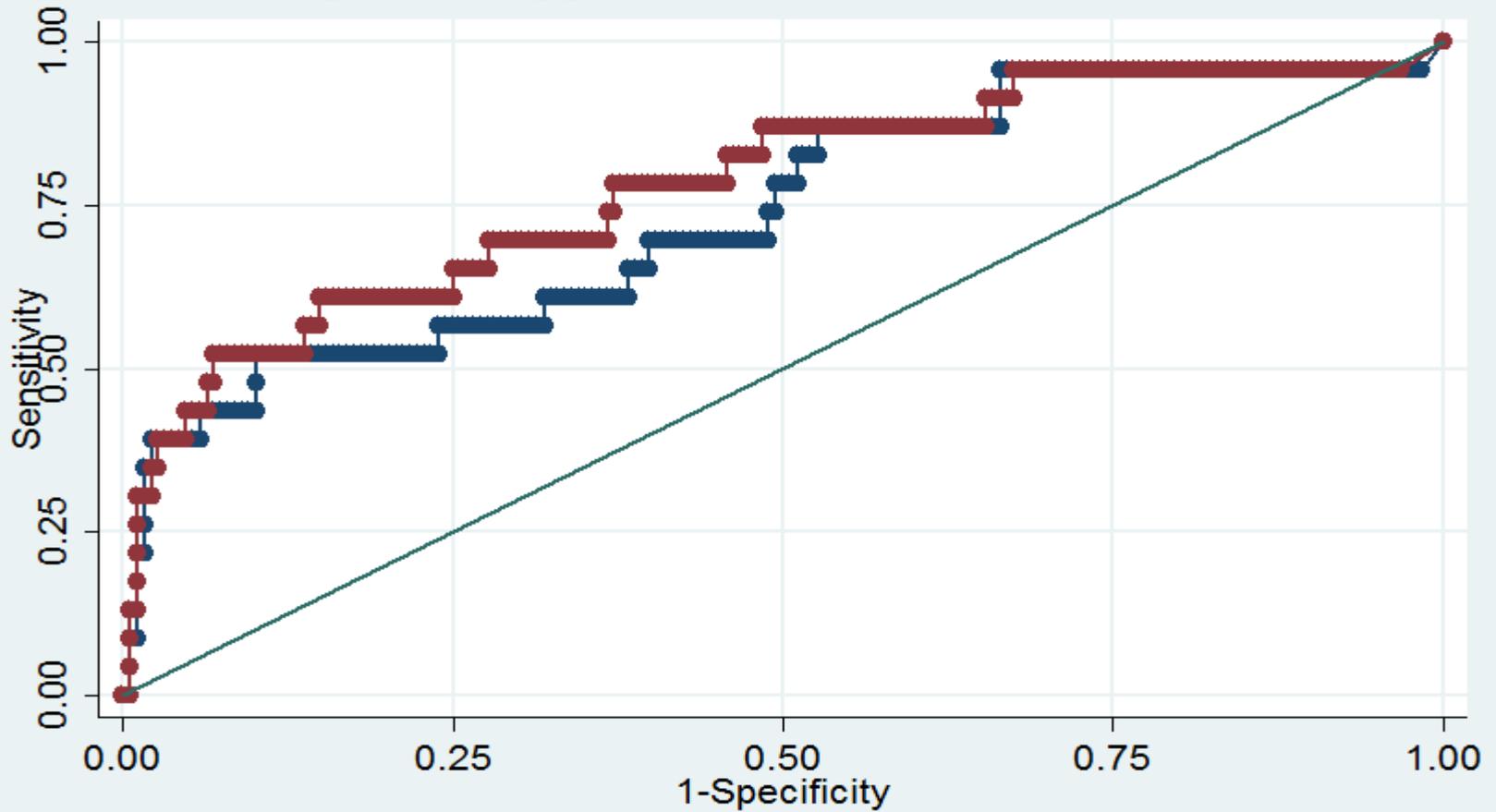
AUROC = 0.577



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Comparing Models: 1-month forecasts



AUROC
GDP Model = 0.737

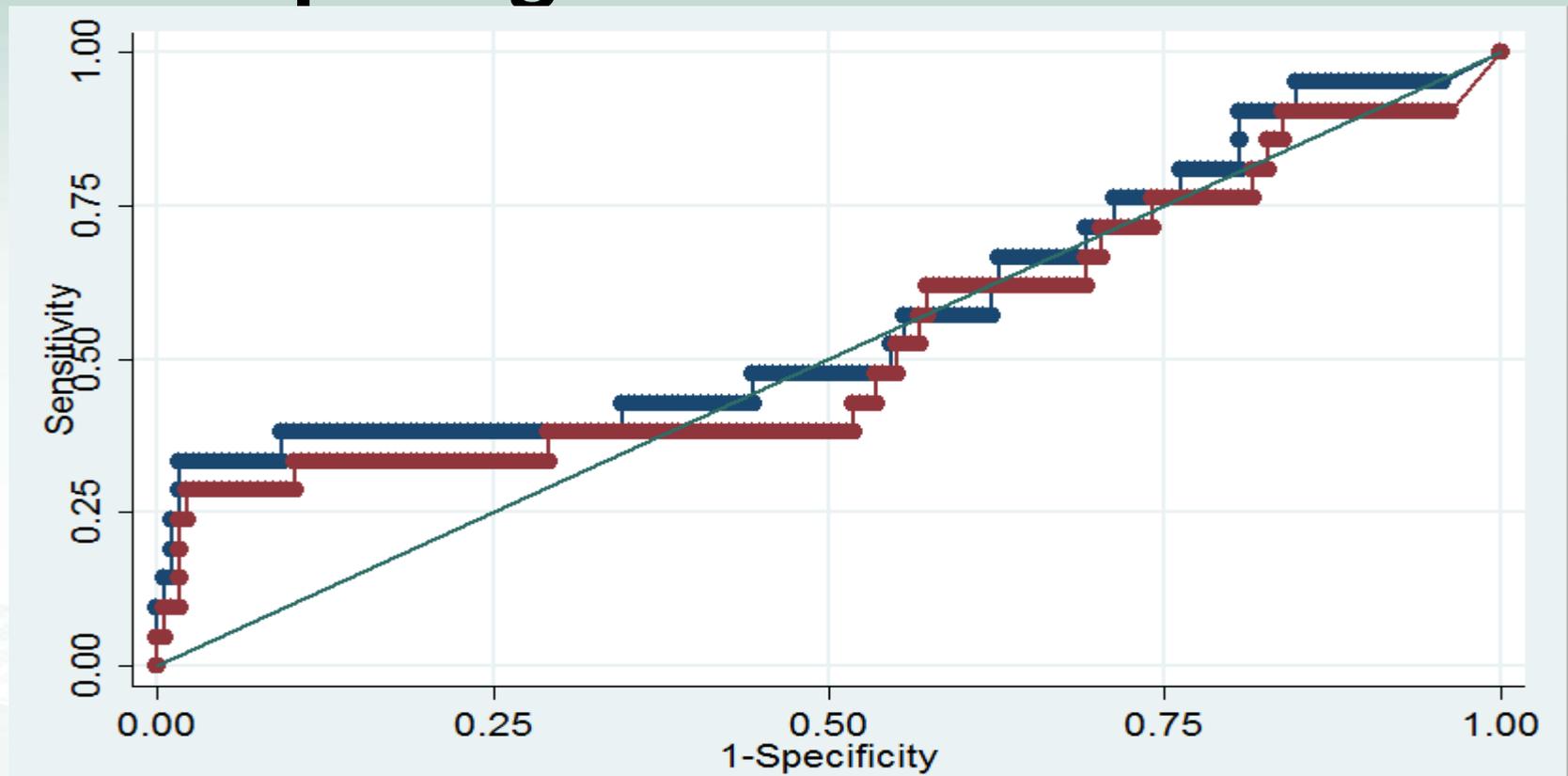
AUROC
FAH Model = 0.778



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Comparing Models: 6-month forecasts



FAH Model

= Spread, Spread_{t-6}, gdpPCH, FAH

AUROC
GDP Model = 0.577

AUROC
FAH Model = 0.53



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Assessment of Results

- **Does the FAH model outperform the GDP Model?**

AUROC for FAH is **HIGHER** than AUROC for GDP Model

Differences in areas are statistically significant

Distributed as a χ^2 statistic with 1 degree of freedom

True for both the 1-month and 6-month forecasts

- **Assessing improvement in forecasting – is the information useful?**

- Adding FAH variables

- AUROC increases by 15%

- Add macro variables to the GDP Model

- AUROC increases by 6% when including Unemployment Insurance UI variable

- Findings by Liu and Moench

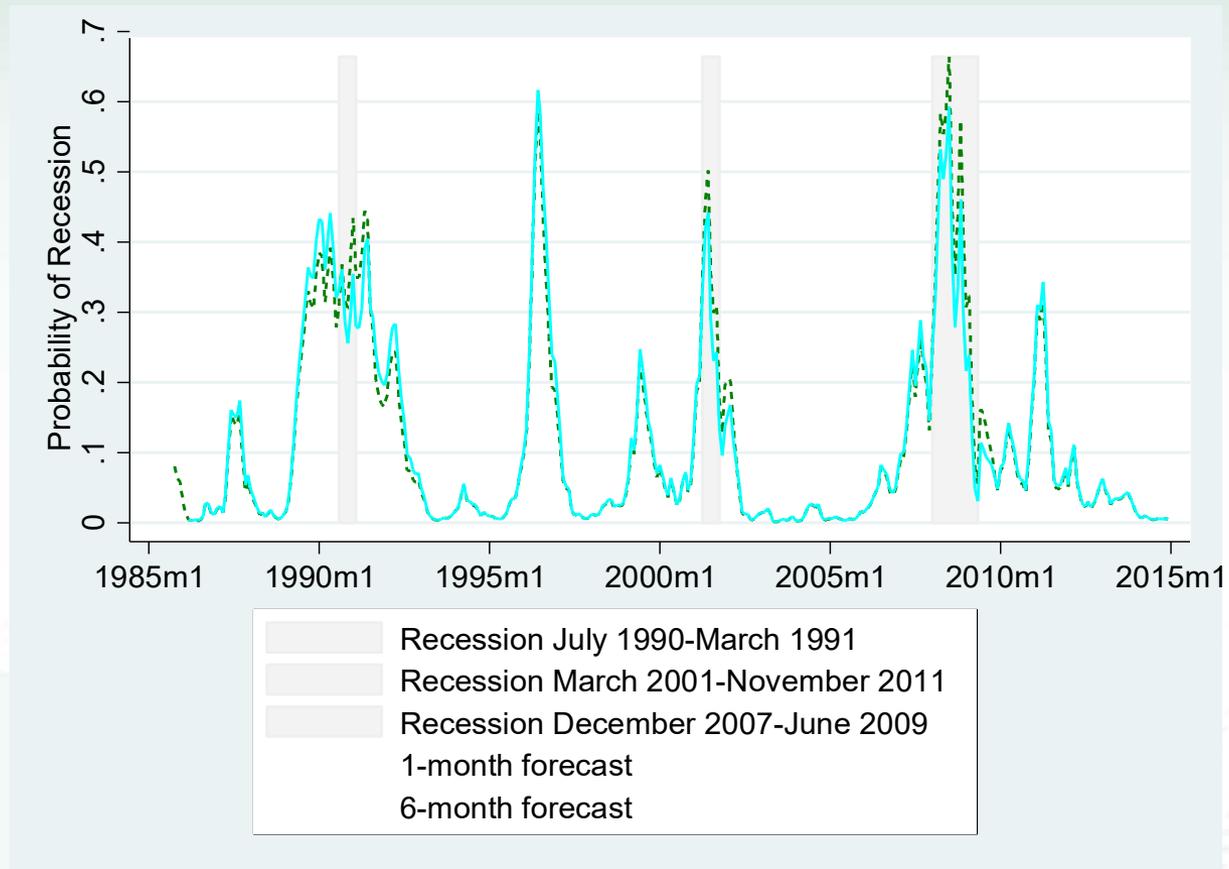
- **Economic implications**



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Comparing Forecasts : 1-month, 6-month forecasts



FAH Model

= Spread, Spread_{t-6}, gdpPCH, FAH



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Conclusions and Future Work

- ROC curve for multidimensional performance
 - **Allows comparison across estimated models**
 - Models with different explanatory variables
 - Models estimated over different populations or time periods
 - **Move beyond a binary indicator [recession, expansion]**
- Other criteria in evaluating model performance
 - **Predicting recessions**
 - and MINIMIZE predictions of false recessions
 - Stekler and Ye propose a precision – recall curve (PR)
- Missing: economic model of predictive performance



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- **References to papers available**



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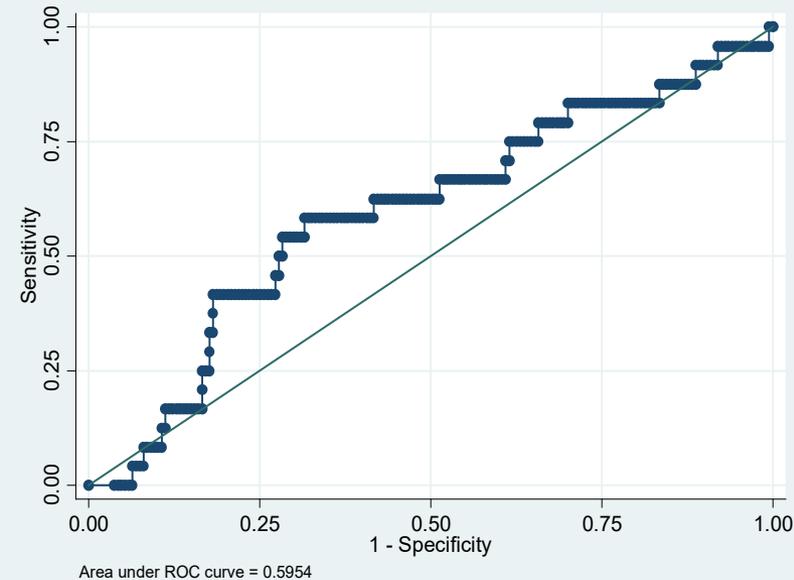
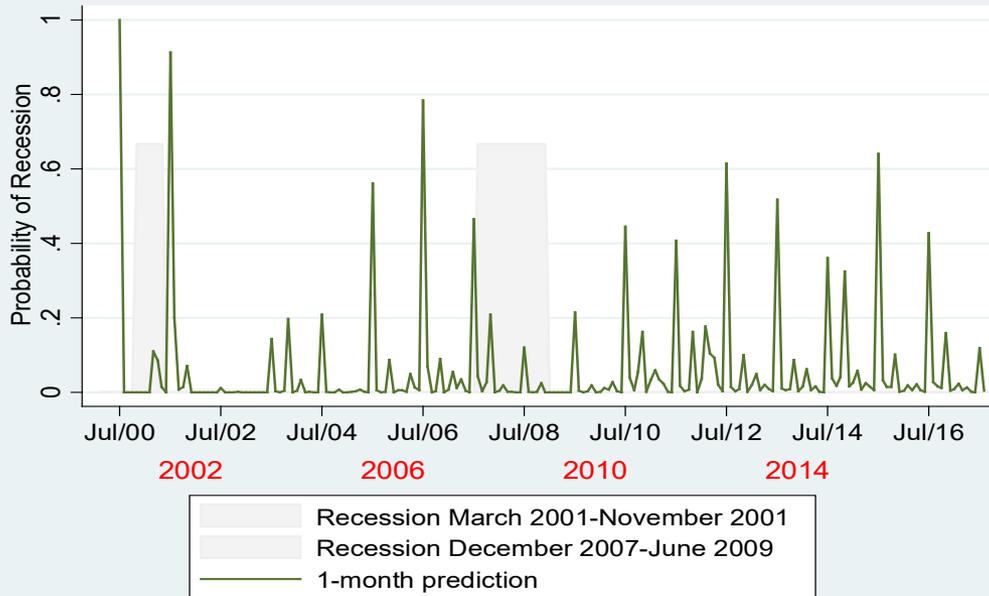
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FAH Model = $\text{Spread}, \text{Spread}_{t-6},$

gdpPCH FAH

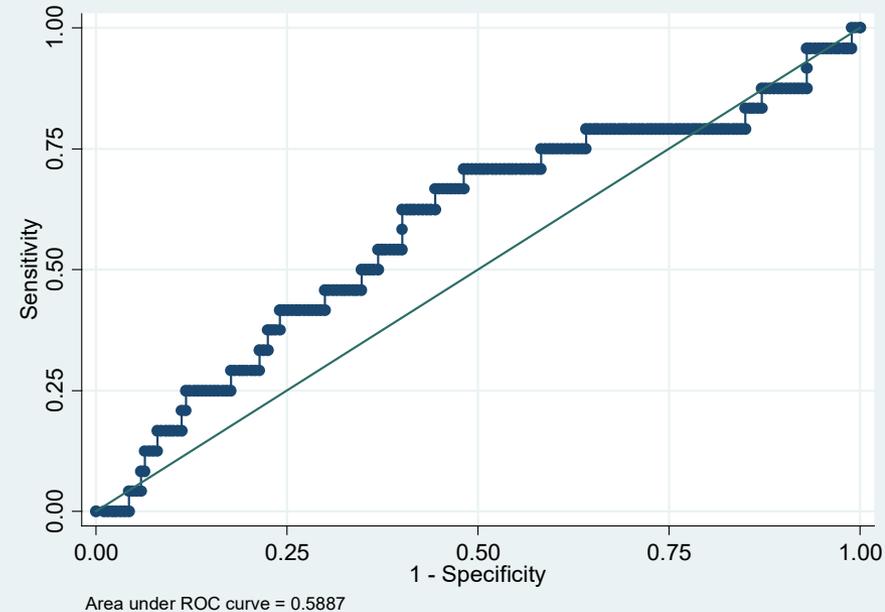
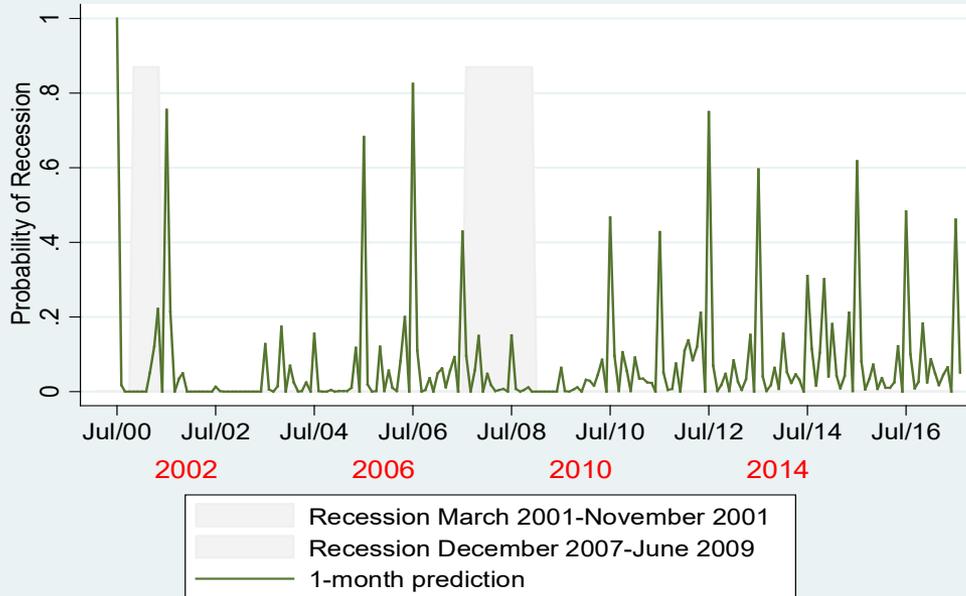
AUROC = 0.594



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FAH Model == 6-month ahead forecasts



FAH Model = Spread, Spread_{t-6},

gdpPCH,

FAH

AUROC = 0.629



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