USDA United States Department of Agriculture, Economic Research Service

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

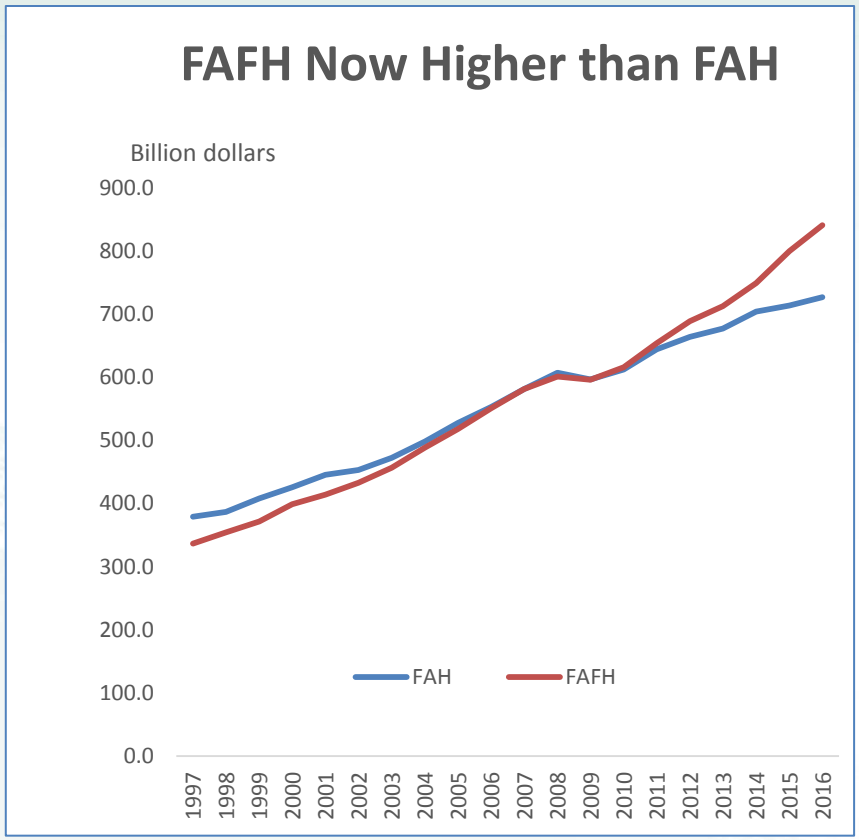
Census:

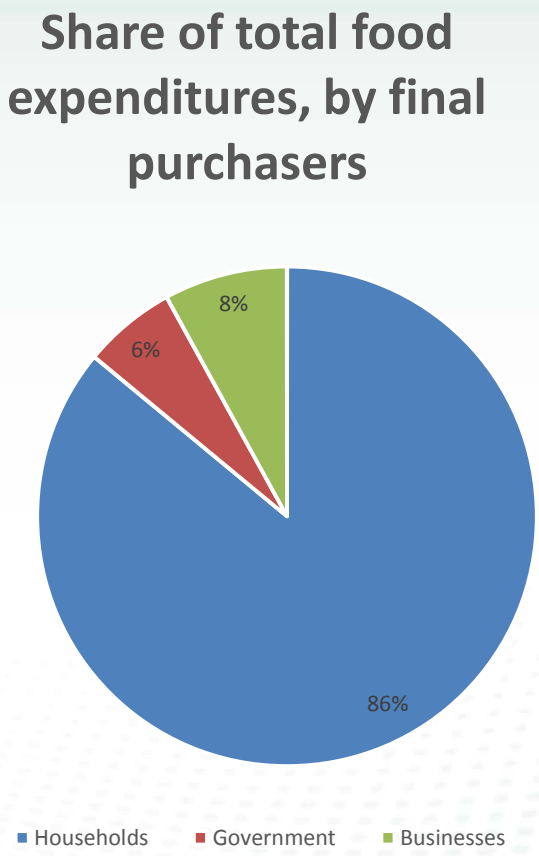
Annual and Monthly Retail Trade Survey = Quarterly Services Survey
Annual Survey of Manufacturers = Census of Population
Census of Agriculture

Other sources:

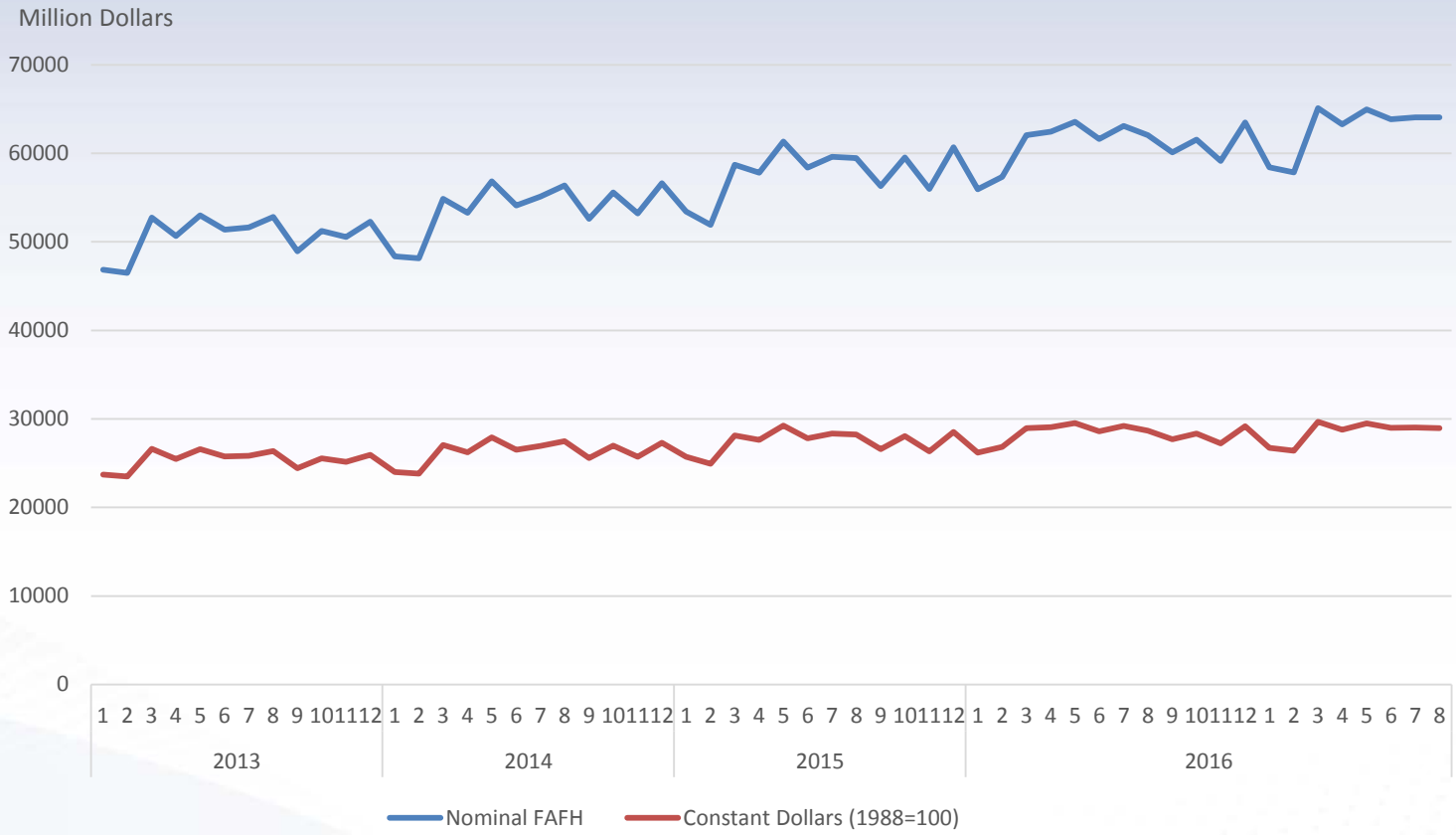
Amtrak Annual Report = SIPP = USDA/FNS = IRI
NCES = SAS = OJJDP = CPI/PPI
CACFP = AHA = Department of Defense

Applications of the Data





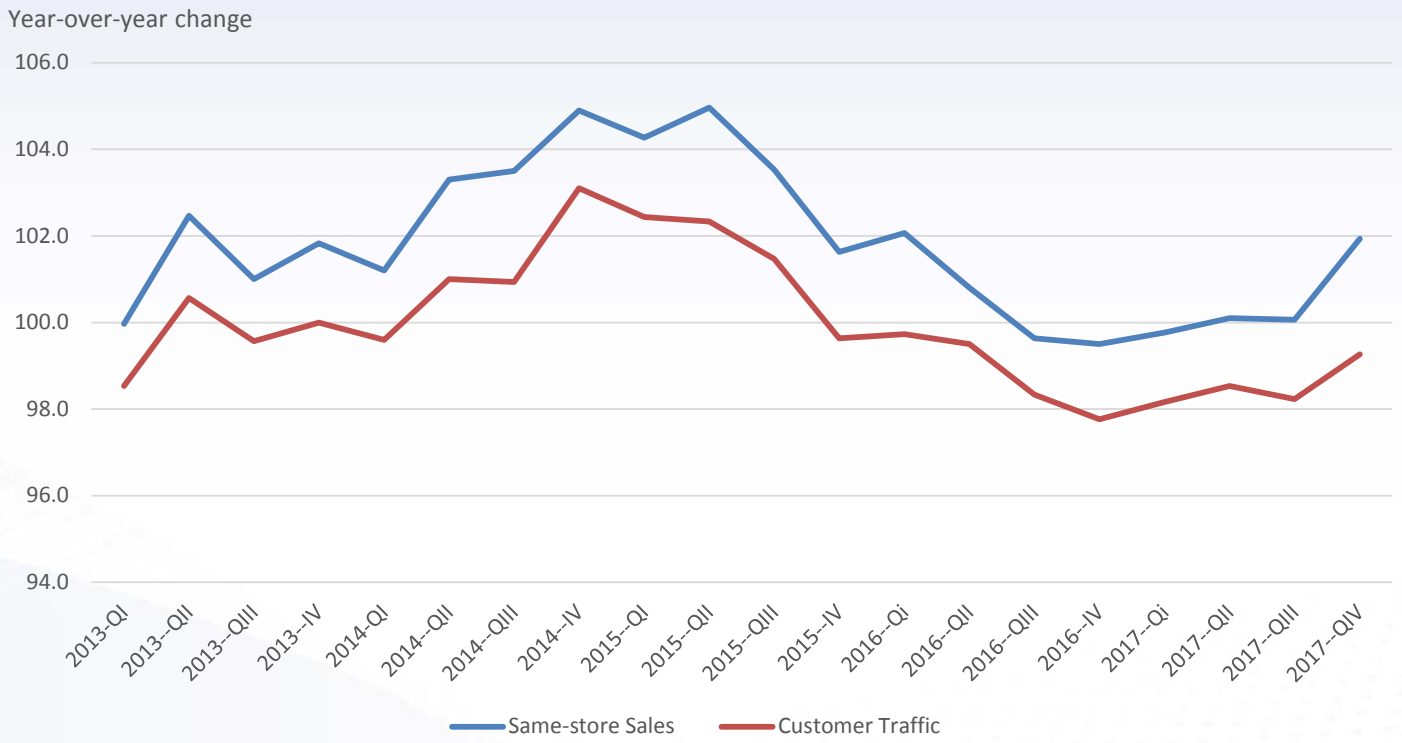
Monthly FAFH Expenditures



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.

United States Department of Agriculture
Economic Research Service

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.

United States Department of Agriculture
Economic Research Service

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**

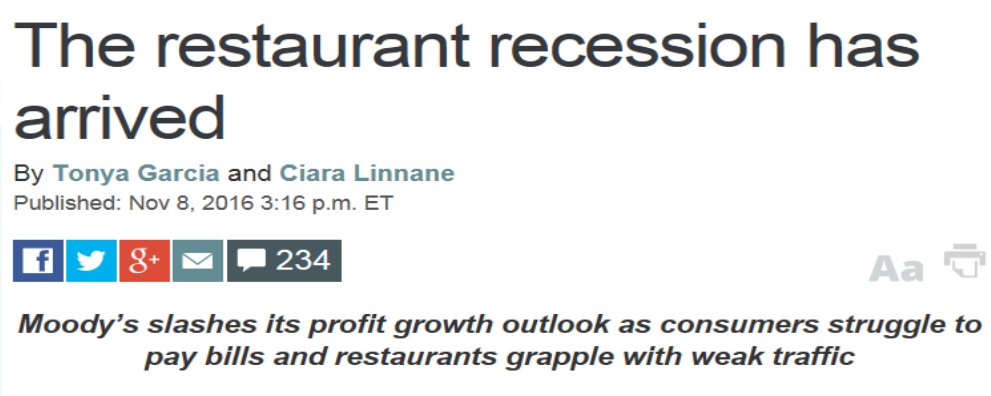
  Grocery sales are food at home = **FAH**

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

  Economic Research Service, USDA

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

234 Aa

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

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 GPD **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** → **True Positive Rate**
  - **Recession occurred**
  - **Correctly predicted a recession**
- **Predicting false recession events** → **False Positive Rate**
  - **Recession did not occur**
  - **Incorrectly predicted a recession**
- **Combine in a summary statistic**

		OBSERVED OUTCOMES	
		Recession	Expansion
PREDICTED OUTCOMES	Recession	100%	0%
	Expansion	0%	100%

Graph combining FPR & TPR (in % terms)

- **(FPR, TPR)** **(FPR, TPR)**
- **(0, 1.00)** **(0.76, 0.76)**

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, [0.0.05, ..., 0.95, 1]

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

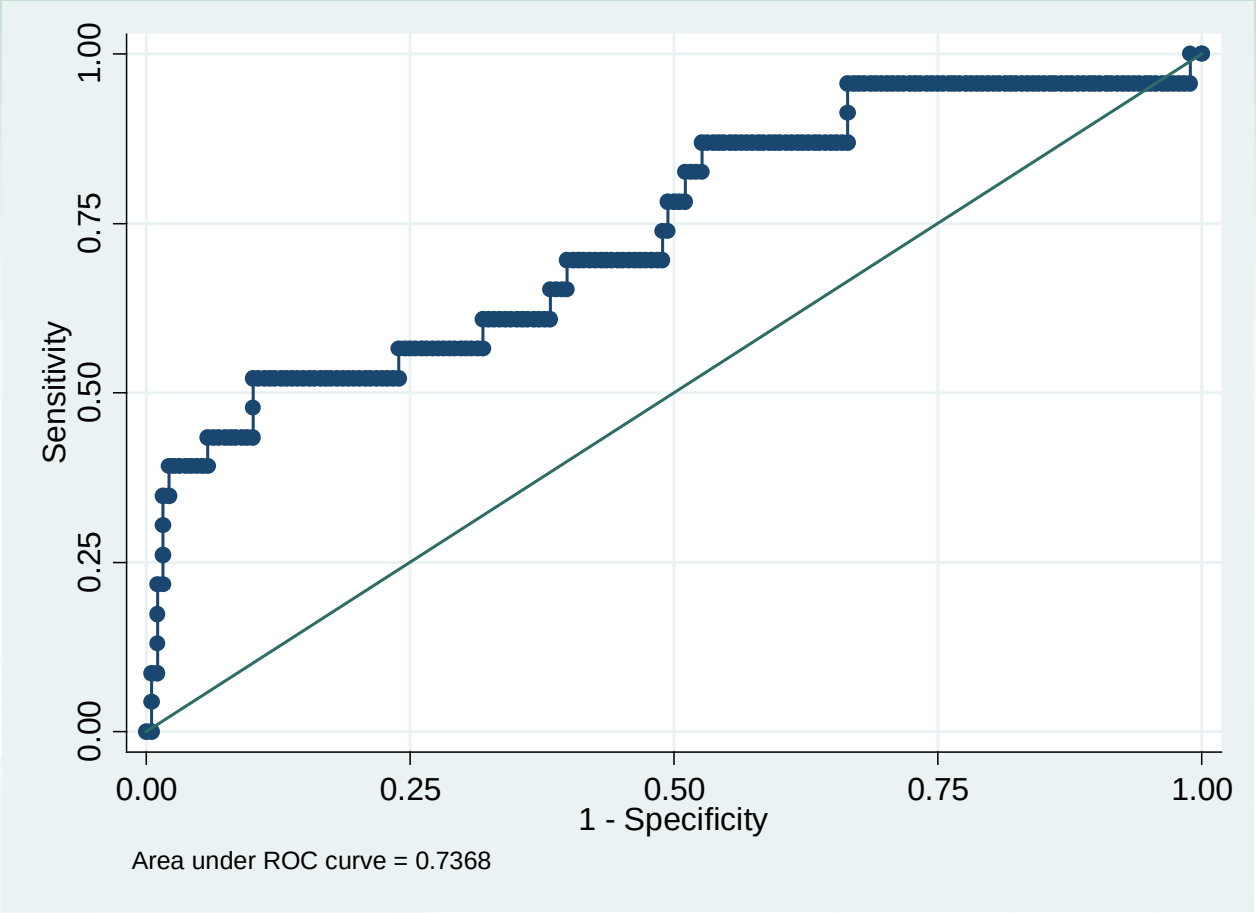
$\hat{Z}_t$ = **1,** if $P_t \geq C^*$

= **0,** if $P_t < C^*$

- 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

ROC: Measure of Predictive Performance

- Two models A and B

  $\mathbf{ROC_A}$ (r) $\mathbf{>}$ $\mathbf{ROC_B}$(r) $\mathbf{==>}$

  Model A stochastically dominates Model B

- $\mathbf{AUROC_A} > \mathbf{AUROC_B}$ $\not\Rightarrow$ $\mathbf{ROC_A}$ (r) $\mathbf{>}$ $\mathbf{ROC_B}$(r)

- **AUROC** ϵ [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

Summary of Results

- **FAH Model** **Spread, $Spread_{t-6}$** **gdpPCH** **FAH**
- **GDP** **Spread, $Spread_{t-6}$,** **gdpPCH**

1-month ahead forecasts

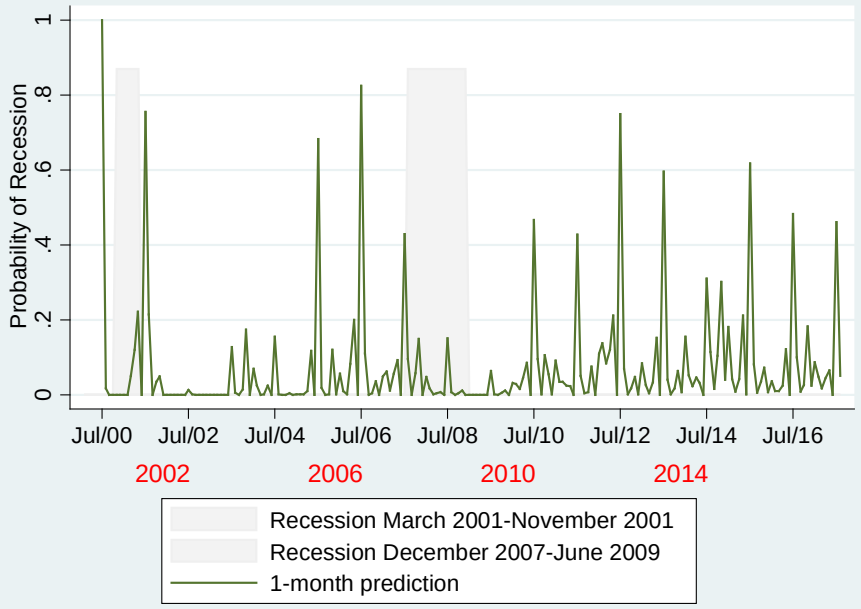
- GDP Model AUROC = 0.737
- FAH Model AUROC = **0.778**

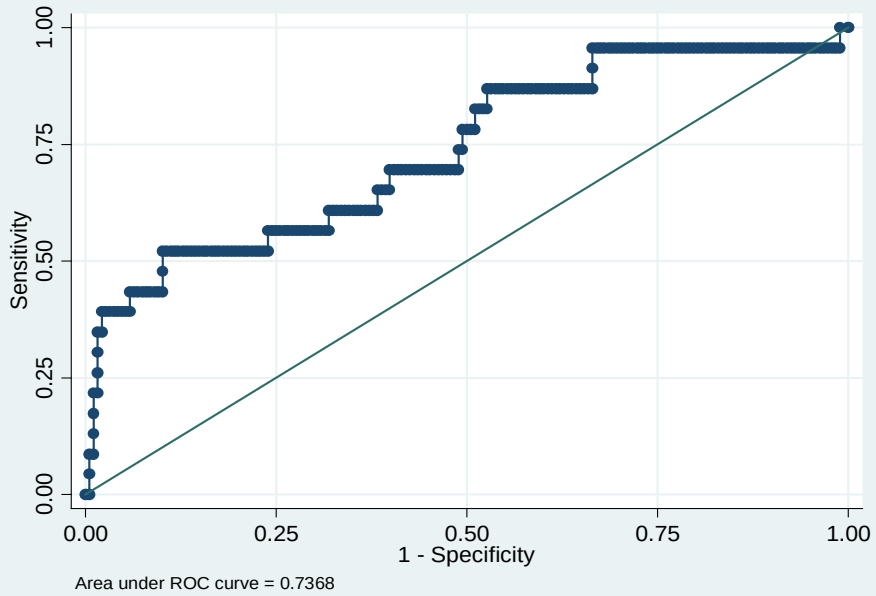
6-month ahead forecasts

- GDP Model AUROC = **0.577**
- FAH Model AUROC = 0.535

- Predictive ability **DECLINES** as forecast horizon **INCREASES**

GDP Model == 1-month ahead forecasts

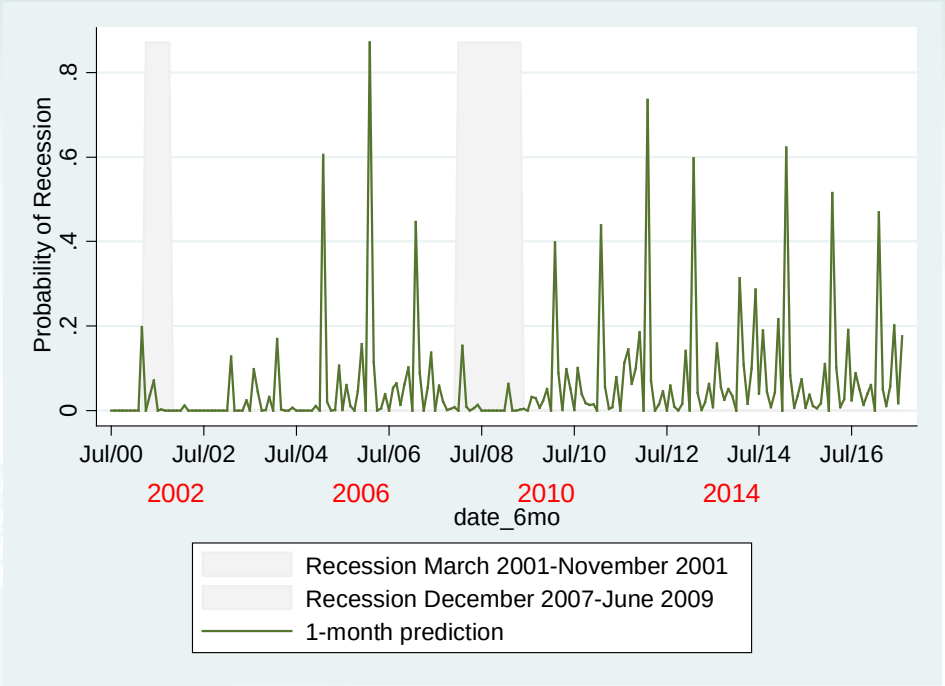


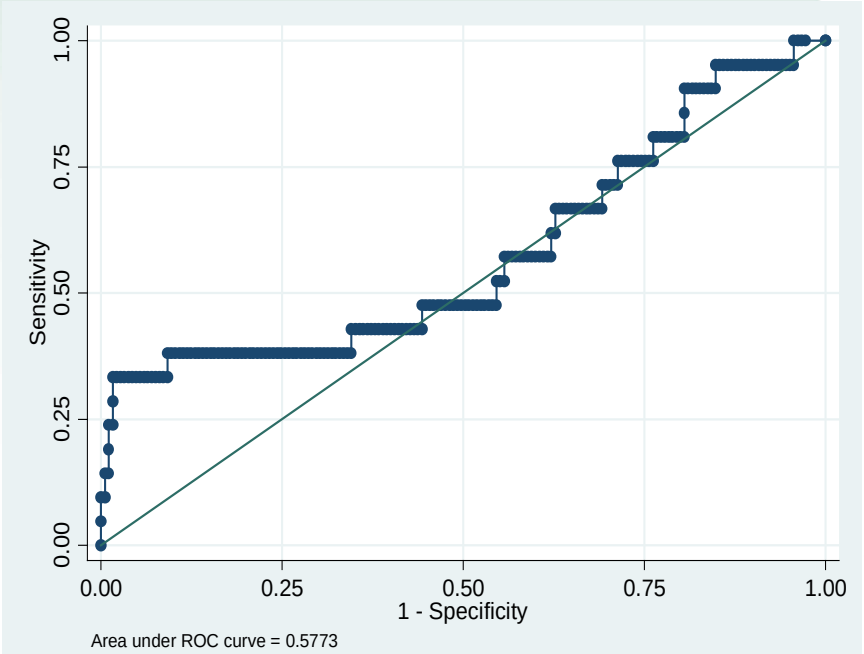


GDP Model = Spread, Spread$_{t-6}$, gdpPCH

AUROC = 0.737

GDP Model == 6-month ahead Forecasts

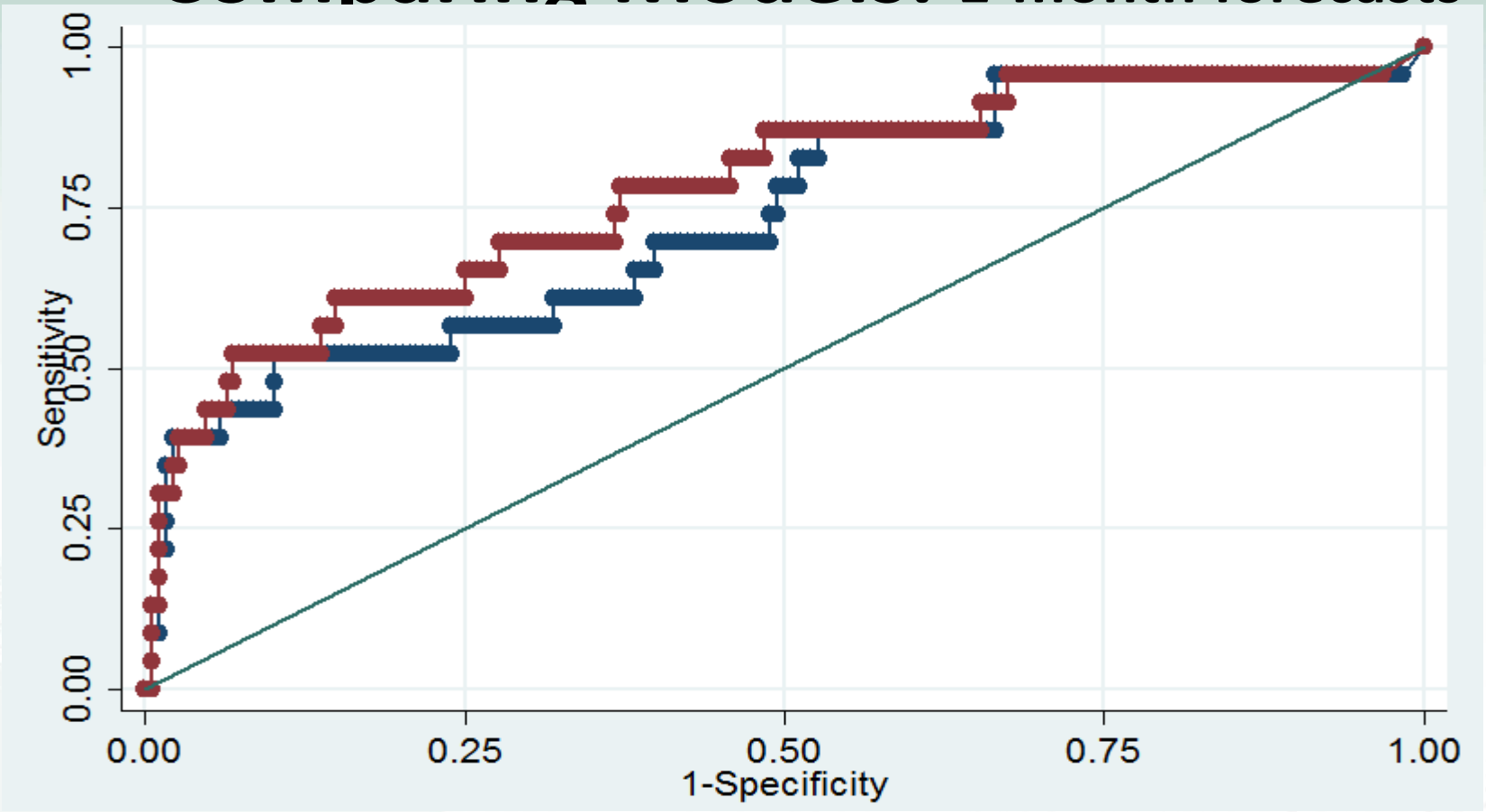




GDP Model = Spread, Spread$_{t-6}$, gdpPCH

AUROC = 0.577

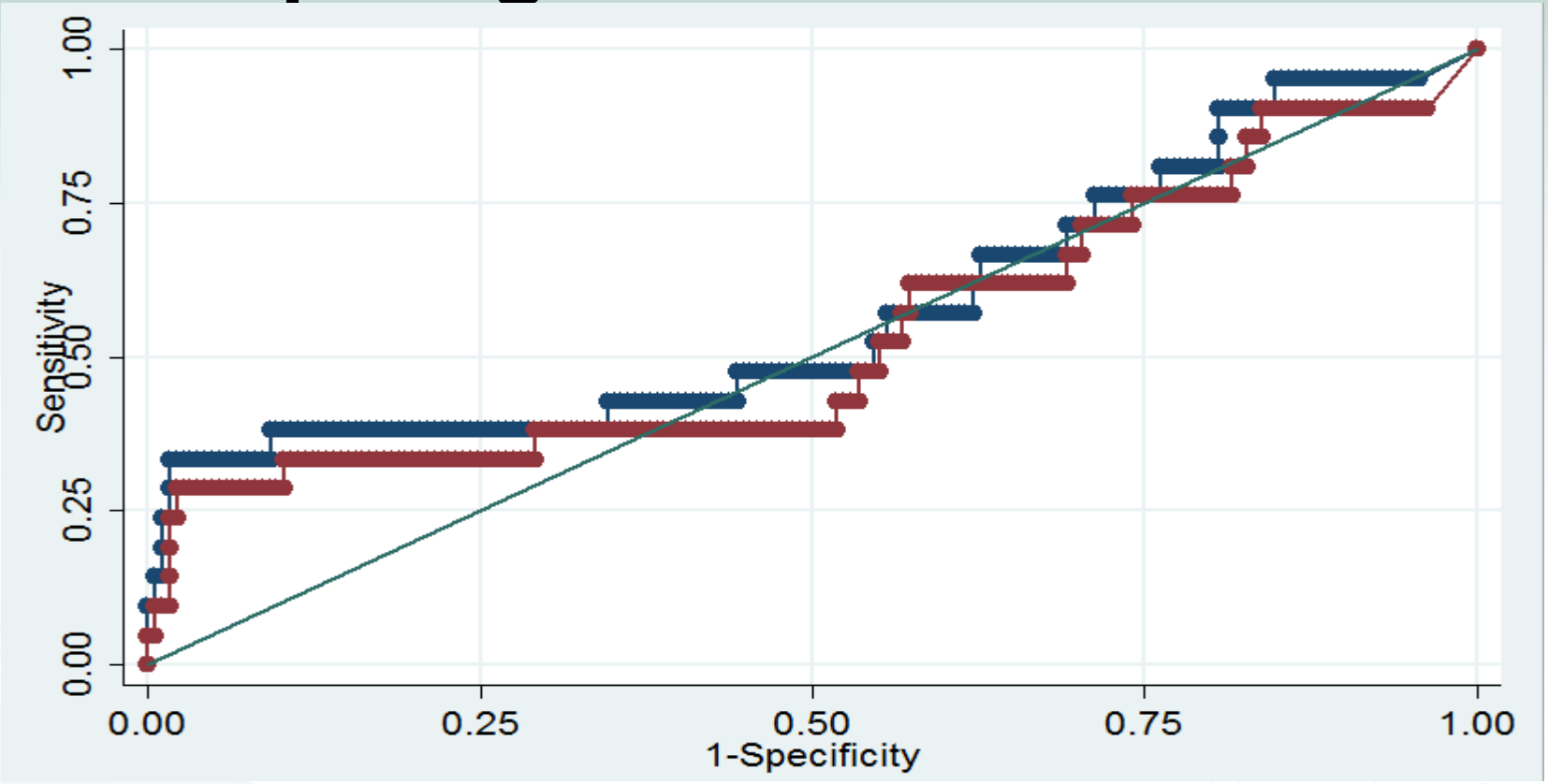
Comparing Models: 1-month forecasts



AUROC
GDP Model = 0.737

AUROC
FAH Model = 0.778

Comparing Models: 6-month forecasts



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

AUROC
GDP Model = 0.577

AUROC
FAH Model = 0.53

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

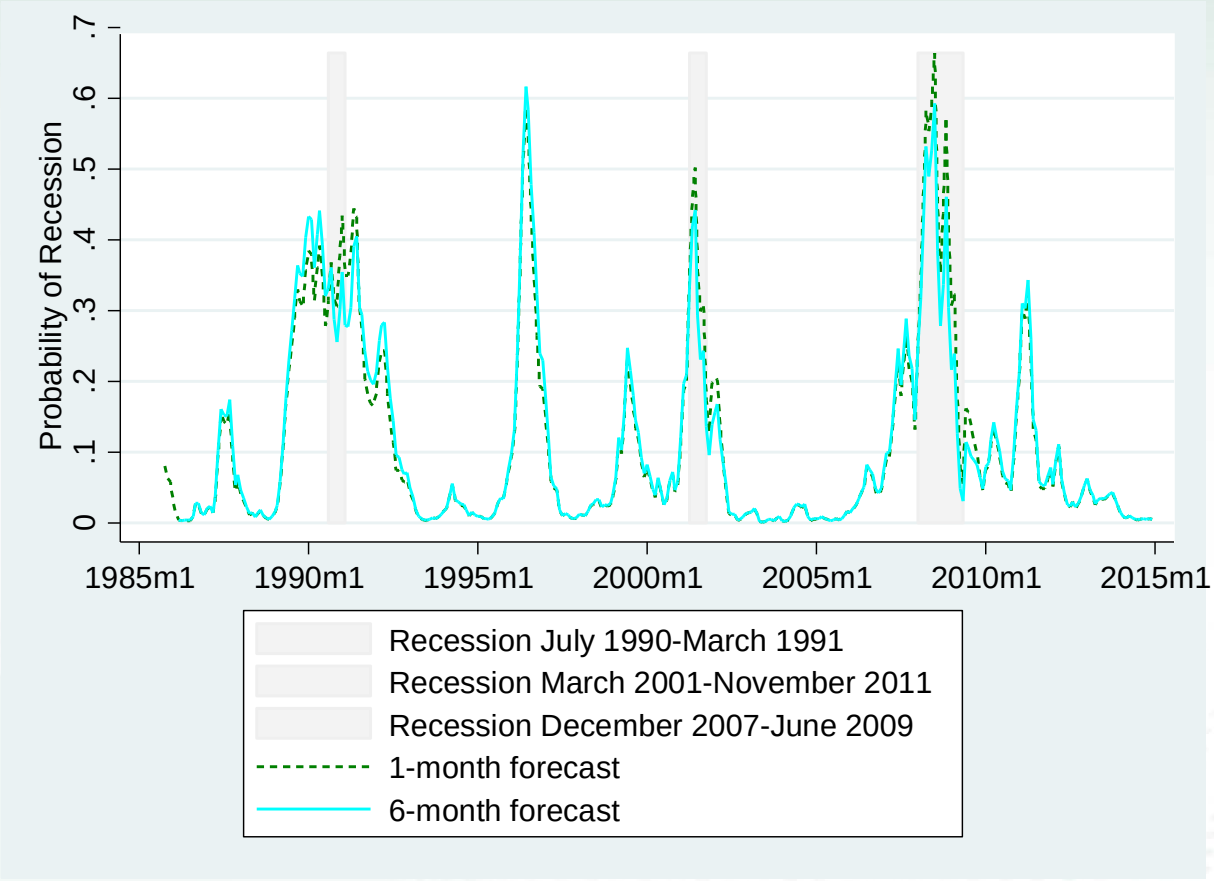
  Distributed as a χ^2 statistic with 1 degree of freedom

  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**

Comparing Forecasts : 1-month, 6-month forecasts



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

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

Contact Details

- **Authors:**
  - Howard Elitzak (HElitzak@ers.usda.gov)
  - Abby Okrent (AOkrent@ers.usda.gov)
  - Timothy Park (TAPark@ers.usda.gov)

- **Disclaimer:**
  - The views expressed in this paper and presentation are those of the authors and may not be attributed to USDA or the Economic Research Service.

- **References to papers available**

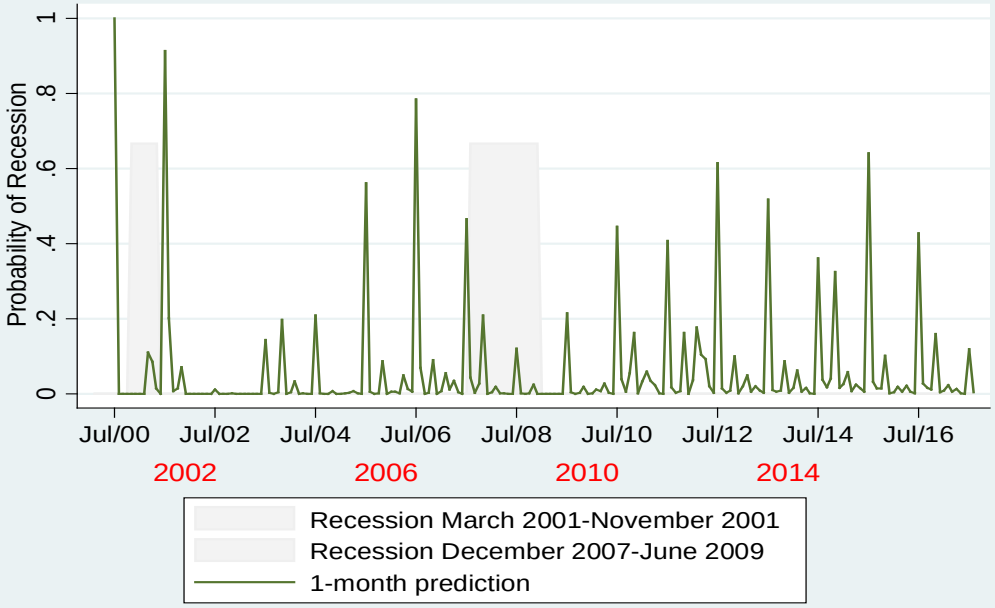
USDA United States Department of Agriculture, Economic Research Service

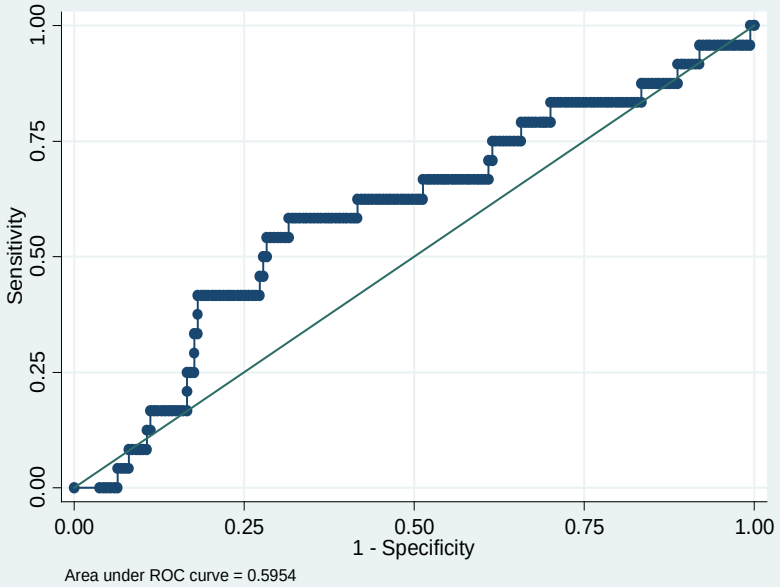
Predicting Restaurant Recessions

- Timothy Park, Howard Elitzak, and Abby Okrent
- Economic Research Service, USDA

- FCSM 2018 Research and Policy Conference

FAH Model == 1-month ahead forecasts

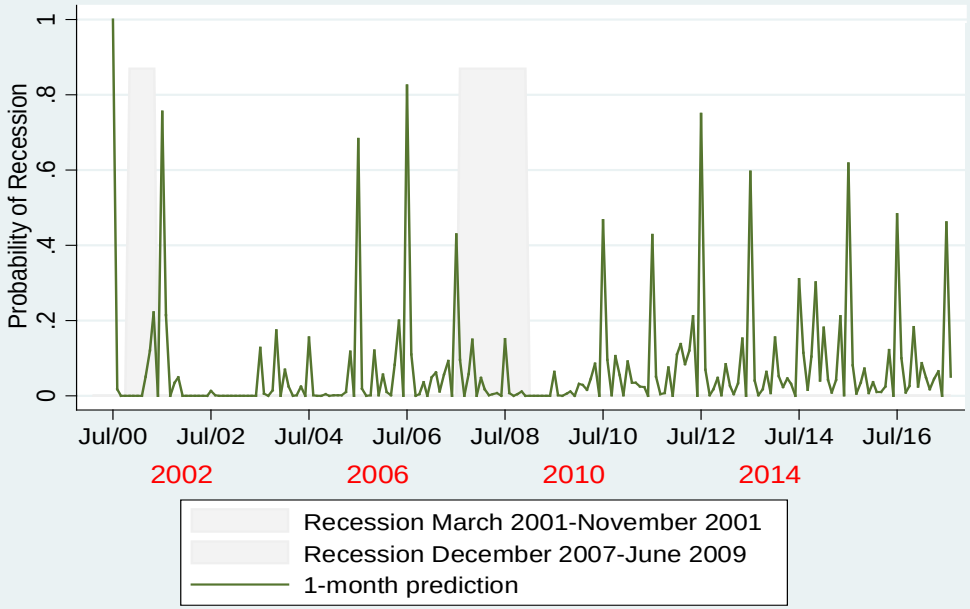


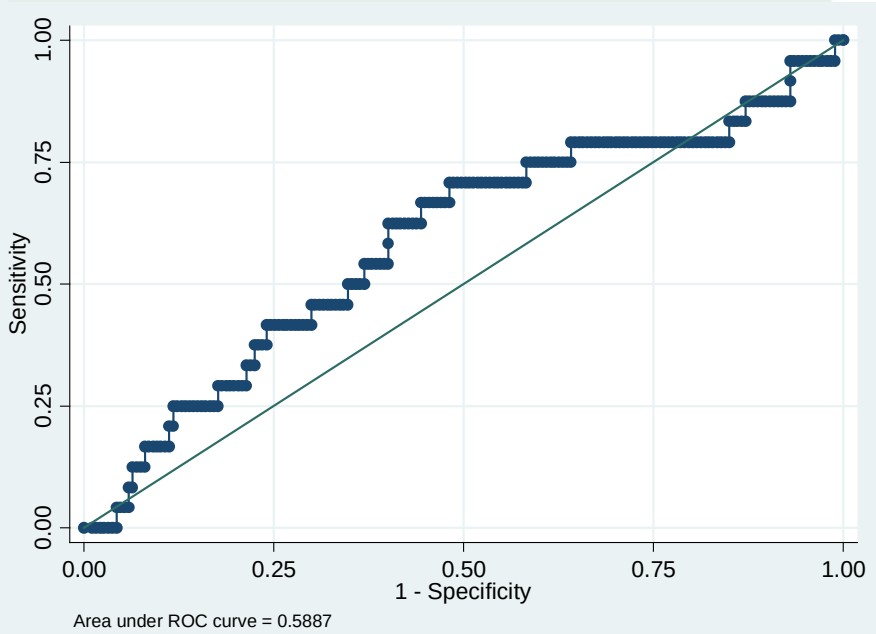


FAH Model = Spread, Spread$_{t-6}$, gdpPCH FAH

AUROC = 0.594

FAH Model == 6-month ahead forecasts





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

AUROC = 0.629