Predicting Reversals in the Business and Stock Market Cycles in the U.S.

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Predicting Reversals in the Business Cycle in the U.S.

Plan of the presentation

- Introduction
- Description of the Model and Estimation Results
- In-Sample Forecasting Performance
- Out-of-Sample Simulation

Introduction

- Predicting the reversals in the US business cycle has been over time a challenging task and Kauppi and Saikkonen (2005) and Nyberg (2008) are among the two most recent papers on this issue.
- The results from KS (2005) show that dynamic and autoregressive probit models have more substantial predictive power than a static model in forecasting US recessions. The yield curve continues to be an important predictor.
- Nyberg (2008) shows that lagged values of stock market returns and foreign term spread are also significant predictive variables. He also demonstrated the superiority of dynamic probit models over static models in forecasting US recessions.
- I will now go through the research that I did on forecasting the US business cycle. I will describe briefly the model and illustrate its performance in predicting since 1962 the reversals in the business cycle.

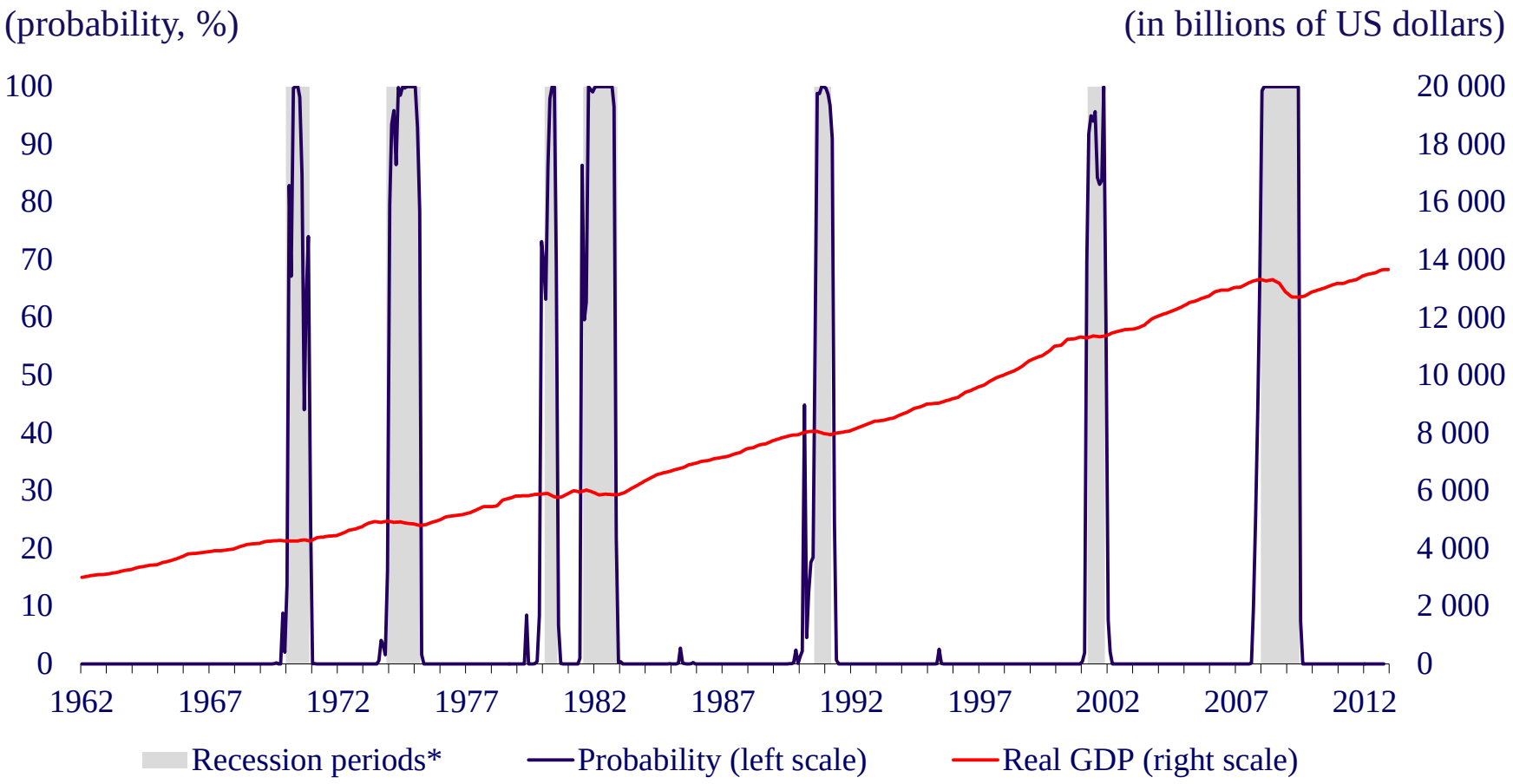
Description of the Model and Estimation Results

Model

- In the model, the business cycle in the U.S. is characterised by two phases: expansion and recession.
- The static probit modeling approach (see, e.g., Estrella and Mishkin (1996)) is used to estimate the probability of a reversal in the U.S. business cycle. No information is used about the past state of the economy in predicting future reversals to recession and expansion phases.
- The model is estimated with monthly data from January 1962 and it includes many U.S. economic times series, such as building permits, initial claims, consumer sentiment, and the yield curve.
- The predicted outcome for the business cycle is determined using the 50% rule:
  - When the economy is an expansion, the model predicts the start of a recession if the probability is equals to or exceeds 50%.[1] Otherwise, the model predicts that the expansion will continue.
  - When the economy is a recession, the model predicts the start of an expansion if the probability is equals to or falls below 50%.[1] Otherwise, the model predicts that the recession will continue.
- Figure 1 (next slide) illustrates the monthly evolution of the probability of the U.S. being in a recession (identified by the blue line), the recession periods (grey shaded area) and real GDP in the U.S. (red line) since January 1962.[2]

1. It is possible that an increase (decline) in the probability to above (below) 50% could be explained by a limited number of the model's predictive variables. When the model signals of a reversal in the business cycle, the source of the change in the probability is investigated in order to reduce the risk of a false alarm.
2. For illustration purpose, the quarterly real GDP data was interpolated into monthly values.

Figure 1: Probability of the U.S. Being in a Recession and Real GDP in the U.S.[1]: 1962-2012



Source: The Forecasting Advisor. Last data point is December 2012.

1. The probability were computed with the on-month ahead probit model.

* The reference dates are from the U.S. National Bureau of Economic Research. The left hand side of the shaded area corresponds to the start of the recession and the right hand side to the end of the recession.

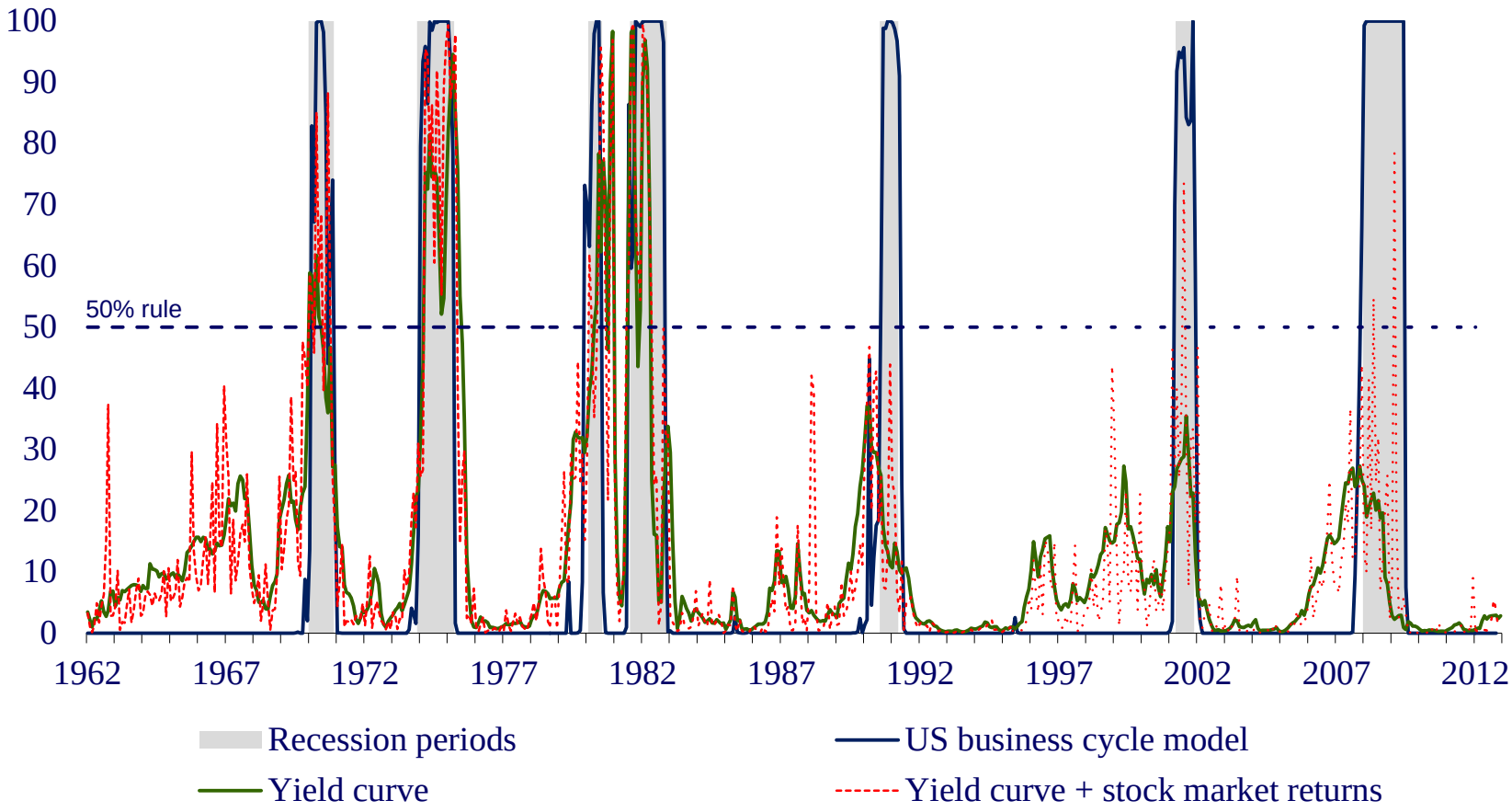
Table 1
Some Key Probit Estimation Output for the U.S. Business Cycle Model [1]

Model	McFadden R-square	
U.S. Business Cycle Model	0.89	
Alternative probit models:		
Yield curve	0.32	
Yield curve + stock market returns	0.40	
Kauppi & Saikkonen (2005)	0.20 to 0.58[2]	
Wright (2006)	0.22 to 0.50	
Nyberg (2008)	0.29 to 0.84[2]	
Kauppi (2008)	0.23 to 0.68[2]	
Prediction Evaluation (Success rate based on the 50% rule)	In-Sample[3]	Out-of-Sample[4]
Predicted / Total Recession Months	78 / 83 (94%)	24 / 24 (100%)
Predicted / Total Expansion Months	529 / 536 (99%)	251 / 259 (97%)

1. The results are from the one-month ahead probability model.
2. The high value are obtained with dynamic/autoregressive probit models.
3. Based on an estimation period of January 1962 to July 2013.
4. Based on an estimation period of January 1962 to December 1989. The out-of-sample starts in January 1990.

Figure 2: Probability of the U.S. Being in a Recession : In-Sample Forecasting Performance of Three Specifications

(probability, %)



Source: The Forecasting Advisor. Last data point is December 2012.

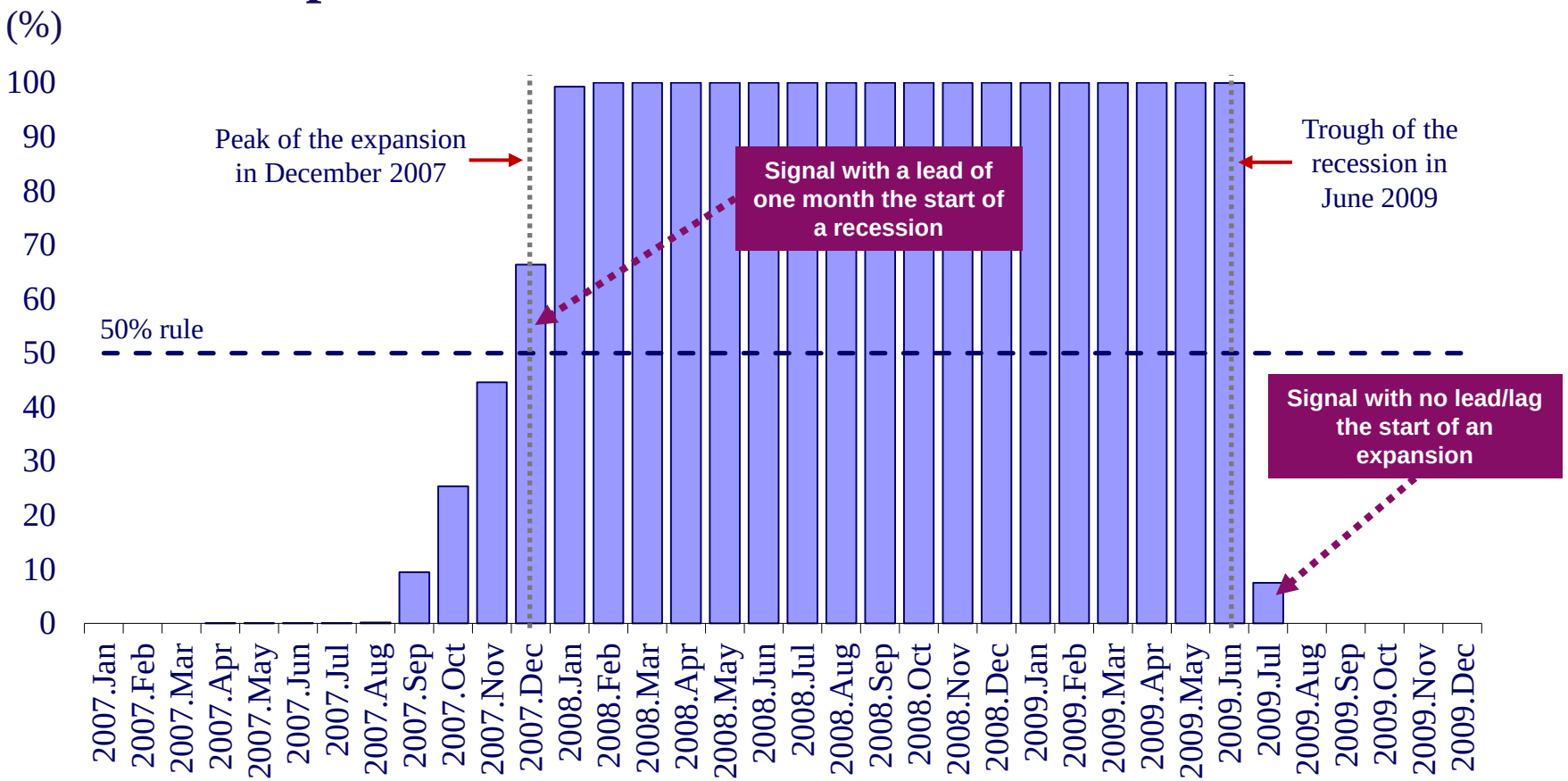
Table 2
Performance of the Model in Predicting the Reversals in the Business Cycle in the U.S. since 1962[1]

Business Cycle Reference Dates[2]		Lead (-) / Lag(+) in Predicting the Start of the Recession (in months)	Lead(-) / Lag(+) in Predicting the Start of the Expansion (in months)
Peak	Trough		
December 1969	November 1970	+1	0
November 1973	March 1975	+1	0
January 1980	July 1980	-2	0
July 1981	November 1982	-1	-1
July 1990	March 1991	0	+1
March 2001	November 2001	-1	+1
December 2007	June 2009	-1	0
Average		-0.43	+0.14

1. The results are based on the one-month ahead probability model.
2. The reference dates are from the U.S. National Bureau of Economic Research.

In-Sample Forecasting Performance

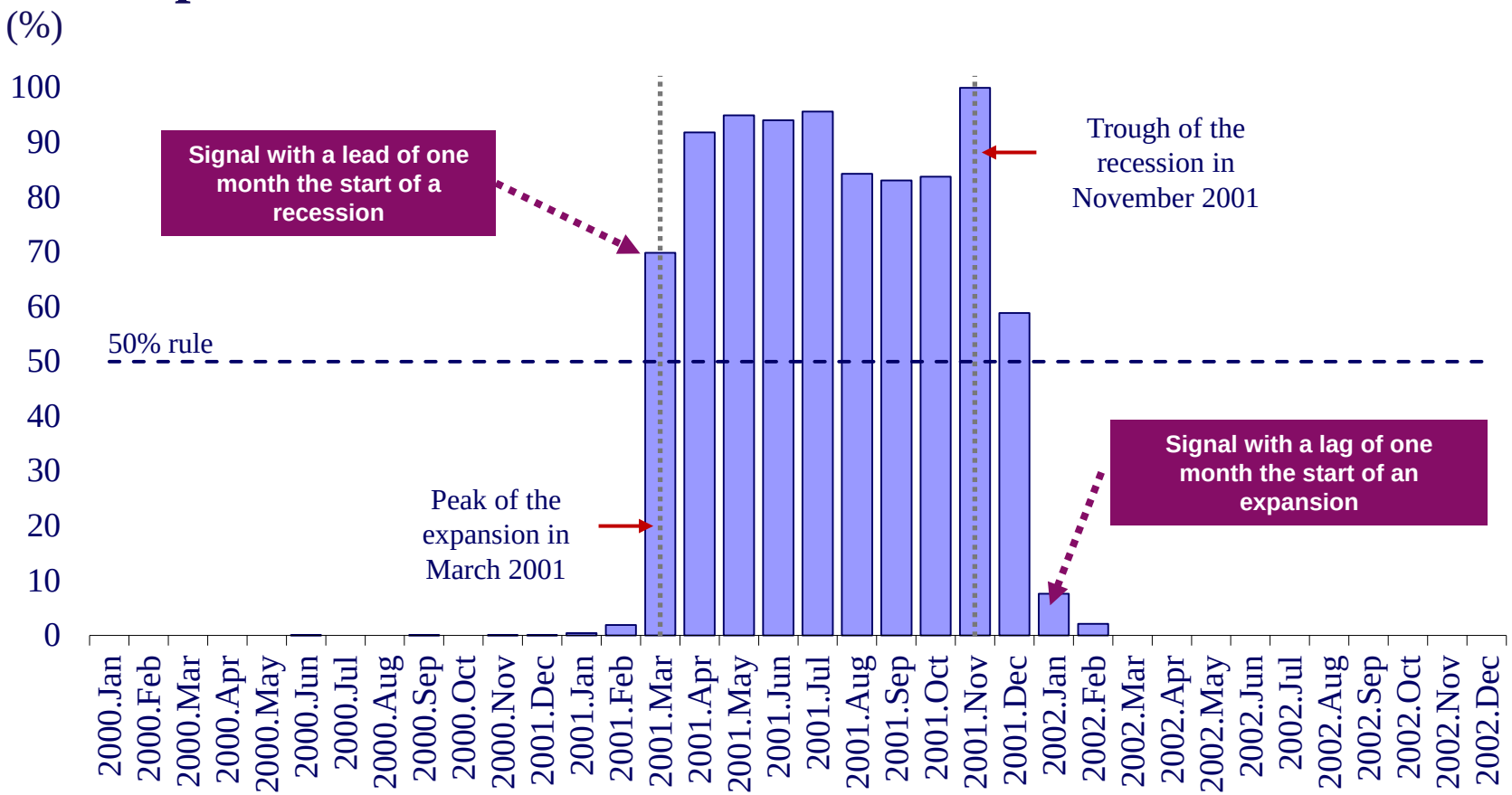
Figure 3: Probability of the U.S. Being in a Recession: 2008-2009 Episode[1]



Source: The Forecasting Advisor.

1. In-sample probabilities from the one-month ahead probit model.

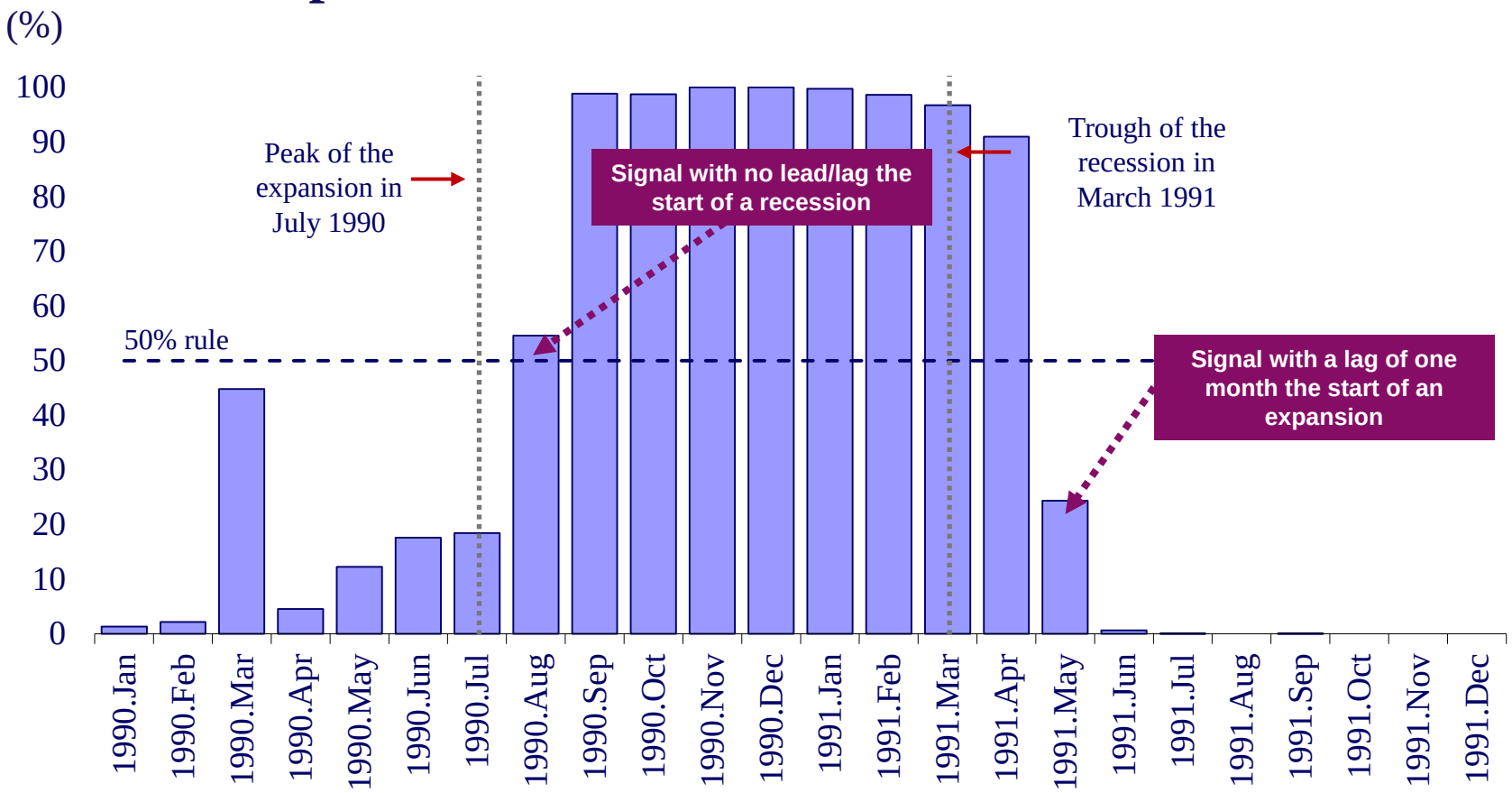
Figure 4: Probability of the U.S. Being in a Recession: 2001 Episode[1]



Source: The Forecasting Advisor.

1. In-sample probabilities from the one-month ahead probit model.

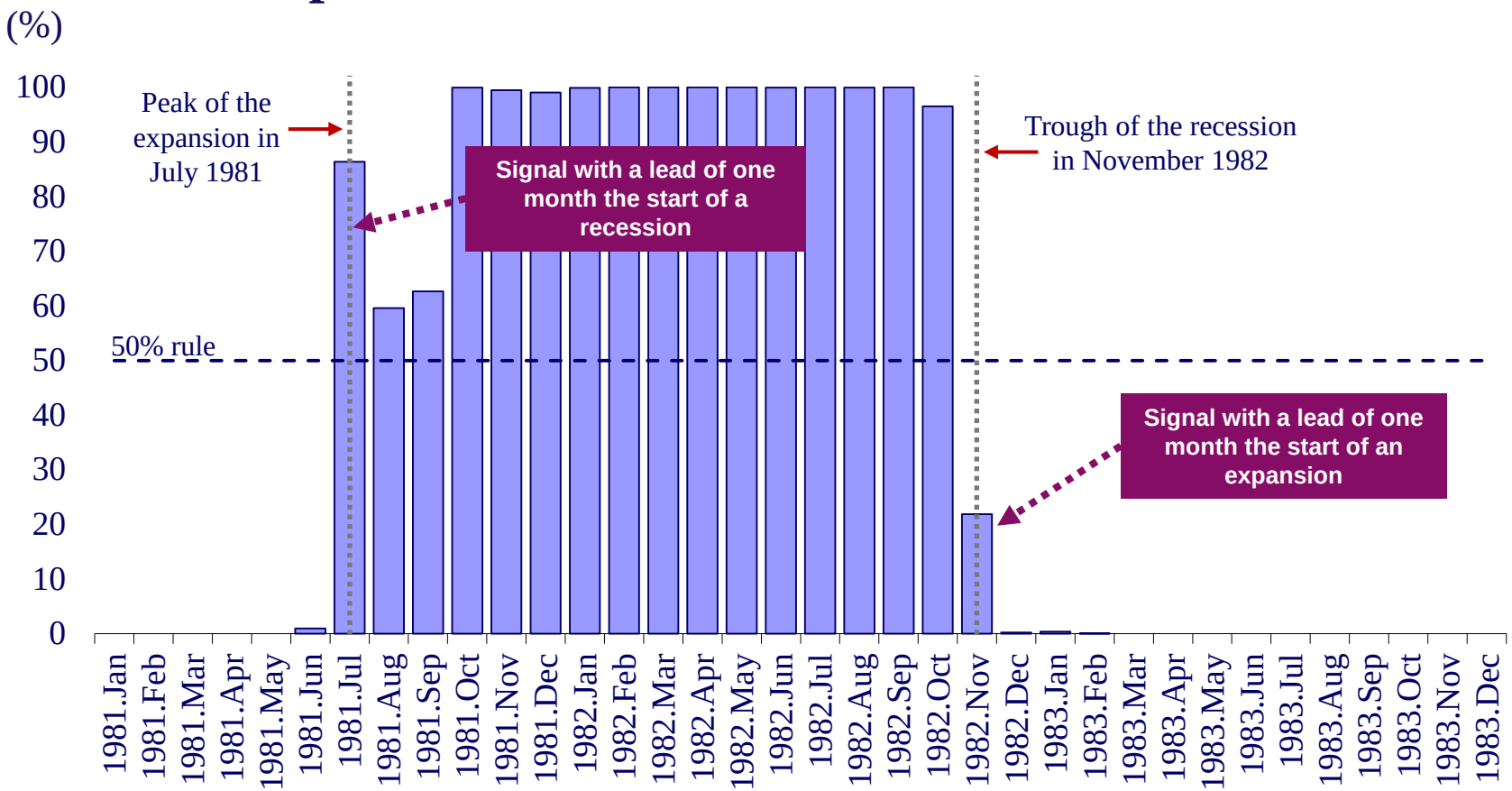
Figure 5: Probability of the U.S. Being in a Recession: 1990-1991 Episode[1]



Source: The Forecasting Advisor.

1. In-sample probabilities from the one-month ahead probit model.

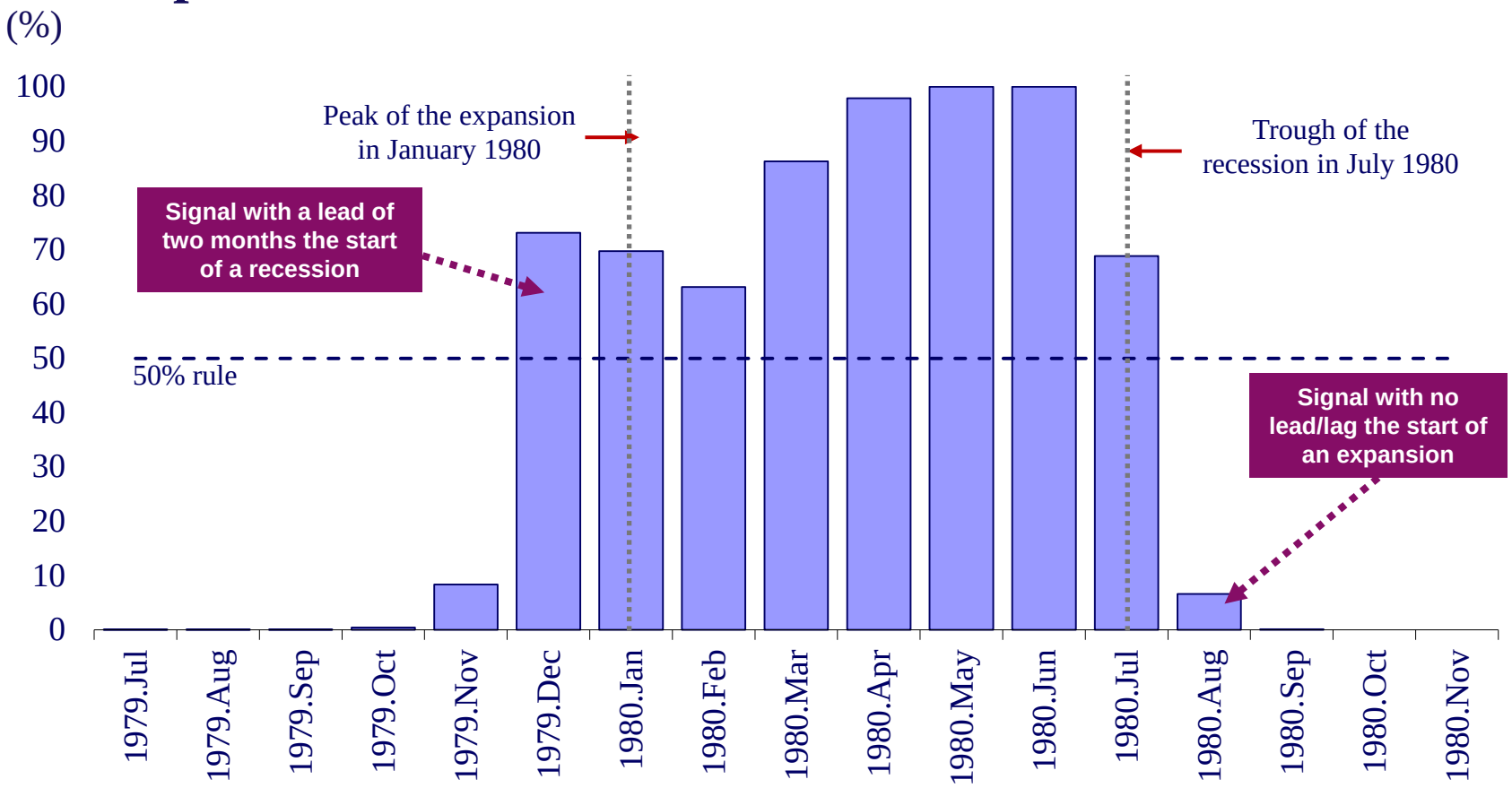
Figure 6: Probability of the U.S. Being in a Recession: 1981-1982 Episode[1]



Source: The Forecasting Advisor.

1. In-sample probabilities from the one-month ahead probit model.

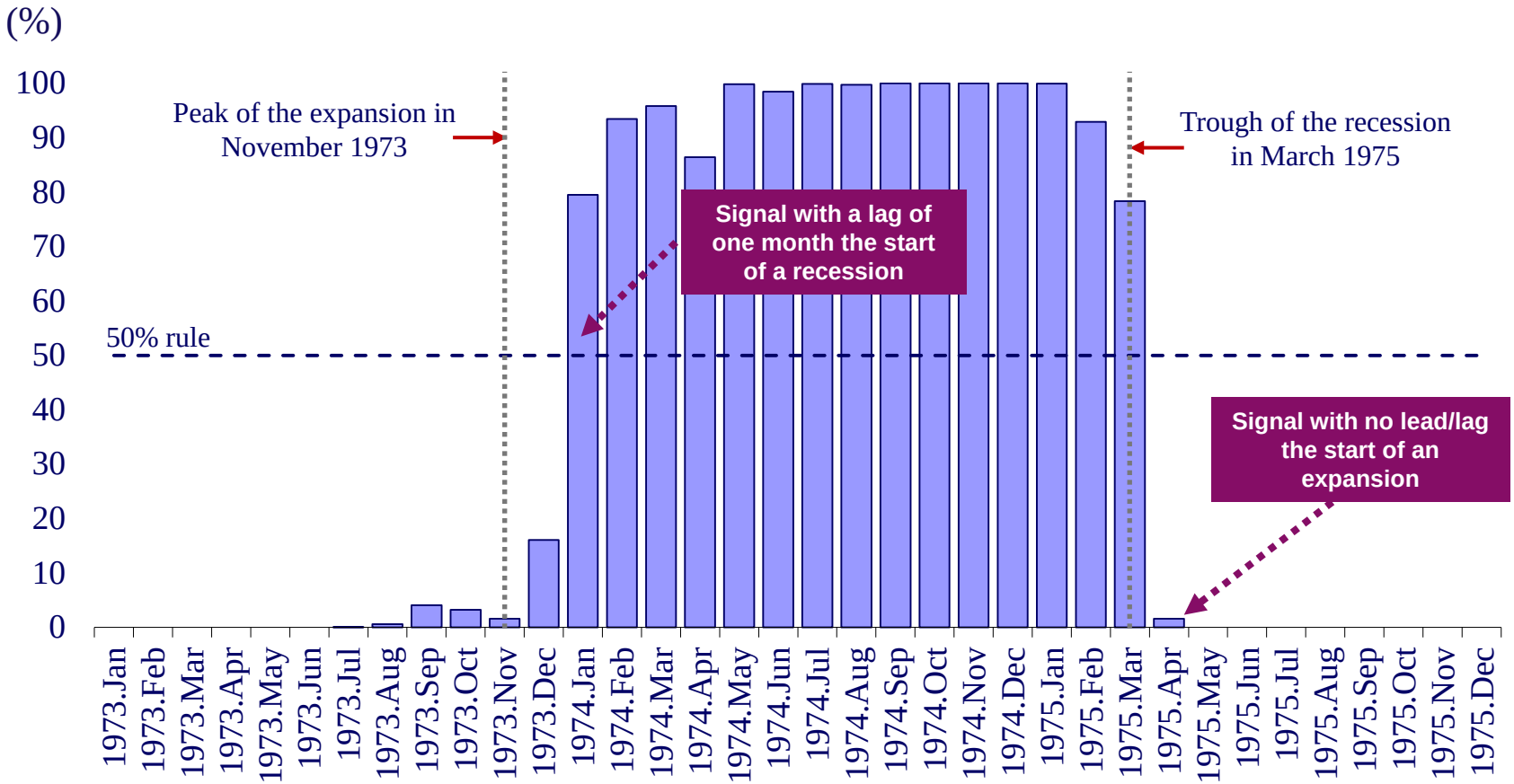
Figure 7: Probability of the U.S. Being in a Recession: 1980 Episode[1]



Source: The Forecasting Advisor.

1. In-sample probabilities from the one-month ahead probit model. .

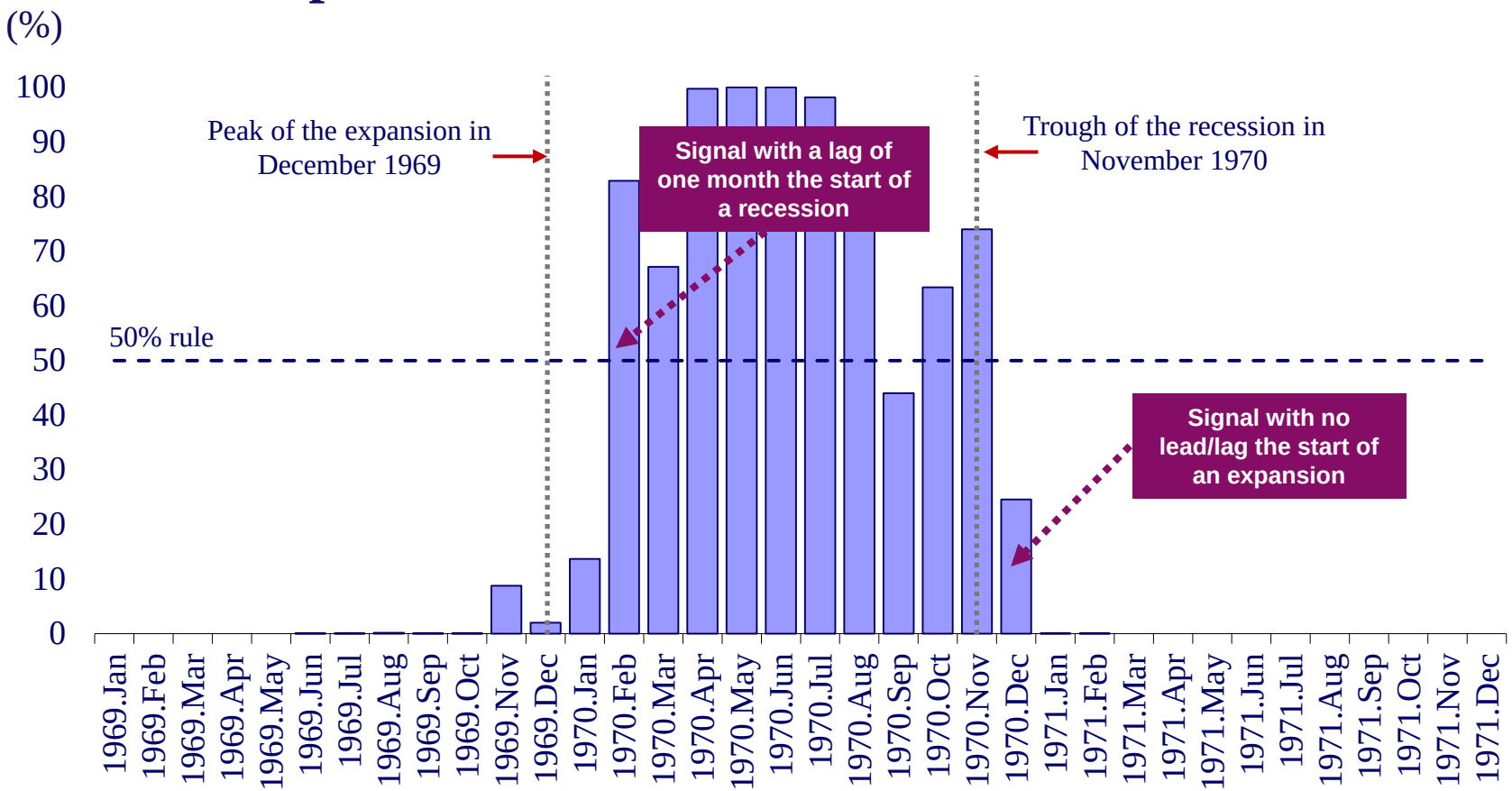
Figure 8: Probability of the U.S. Being in a Recession: 1973-1975 Episode[1]



Source: The Forecasting Advisor.

1. In-sample probabilities from the one-month ahead probit model.

Figure 9: Probability of the U.S. Being in a Recession: 1969-1970 Episode[1]

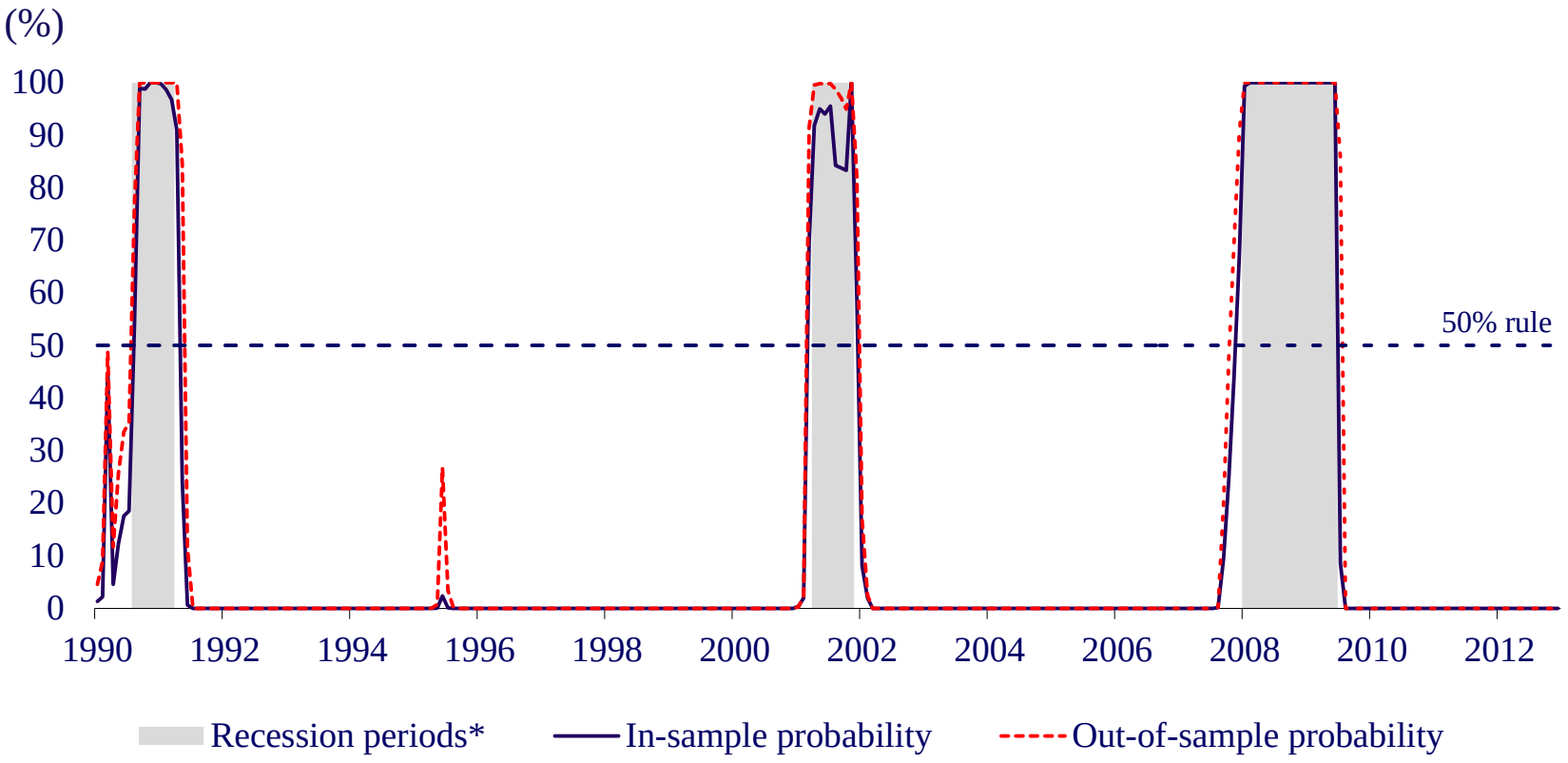


Source: The Forecasting Advisor.

1. In-sample probabilities from the one-month ahead probit model.

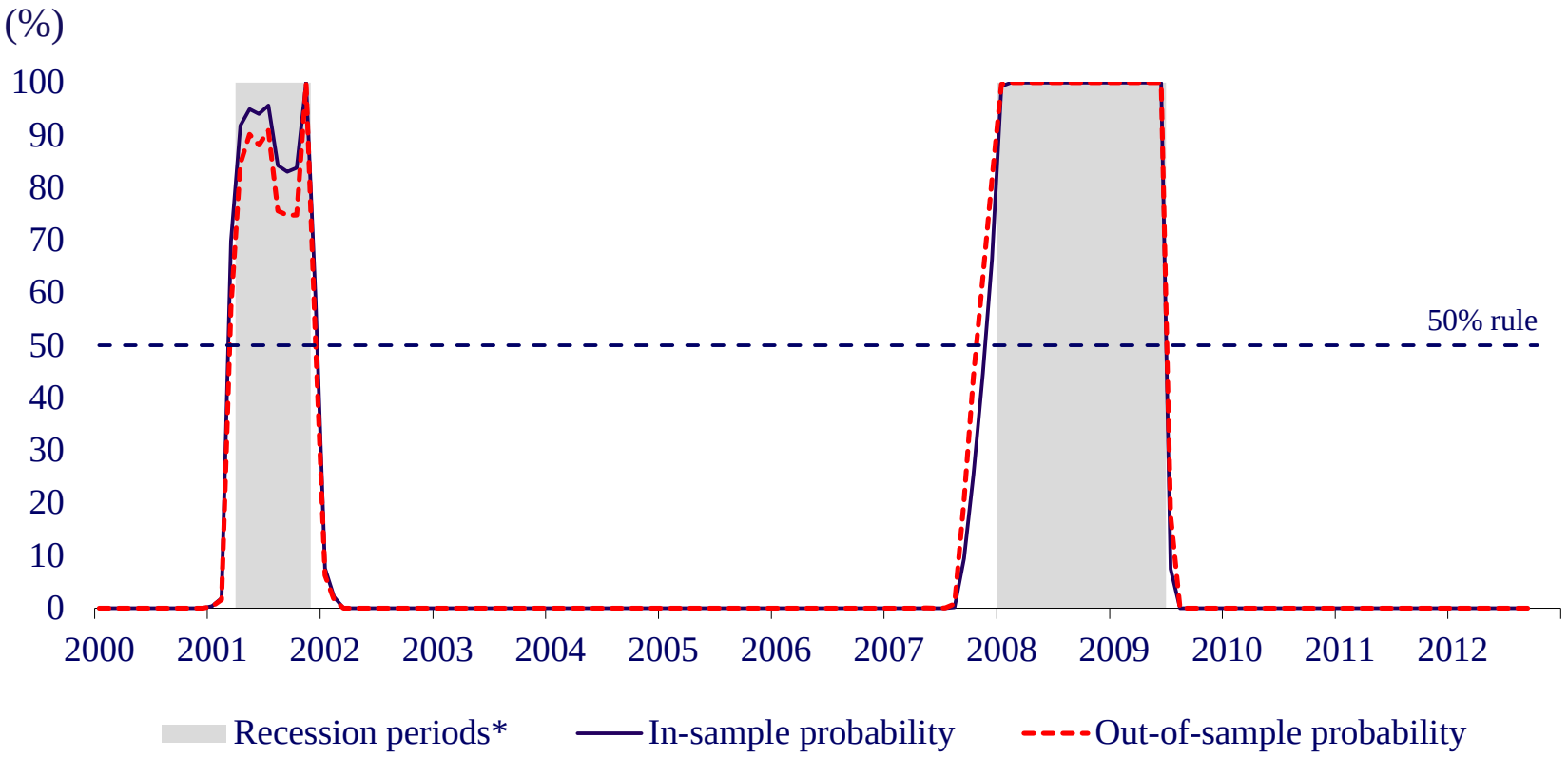
Out-of-Sample Forecasting Performance

Figure 10: Probability of the U.S. Being in a Recession: In- and Out-of-Sample Probabilities from January 1990 to December 2012[1]



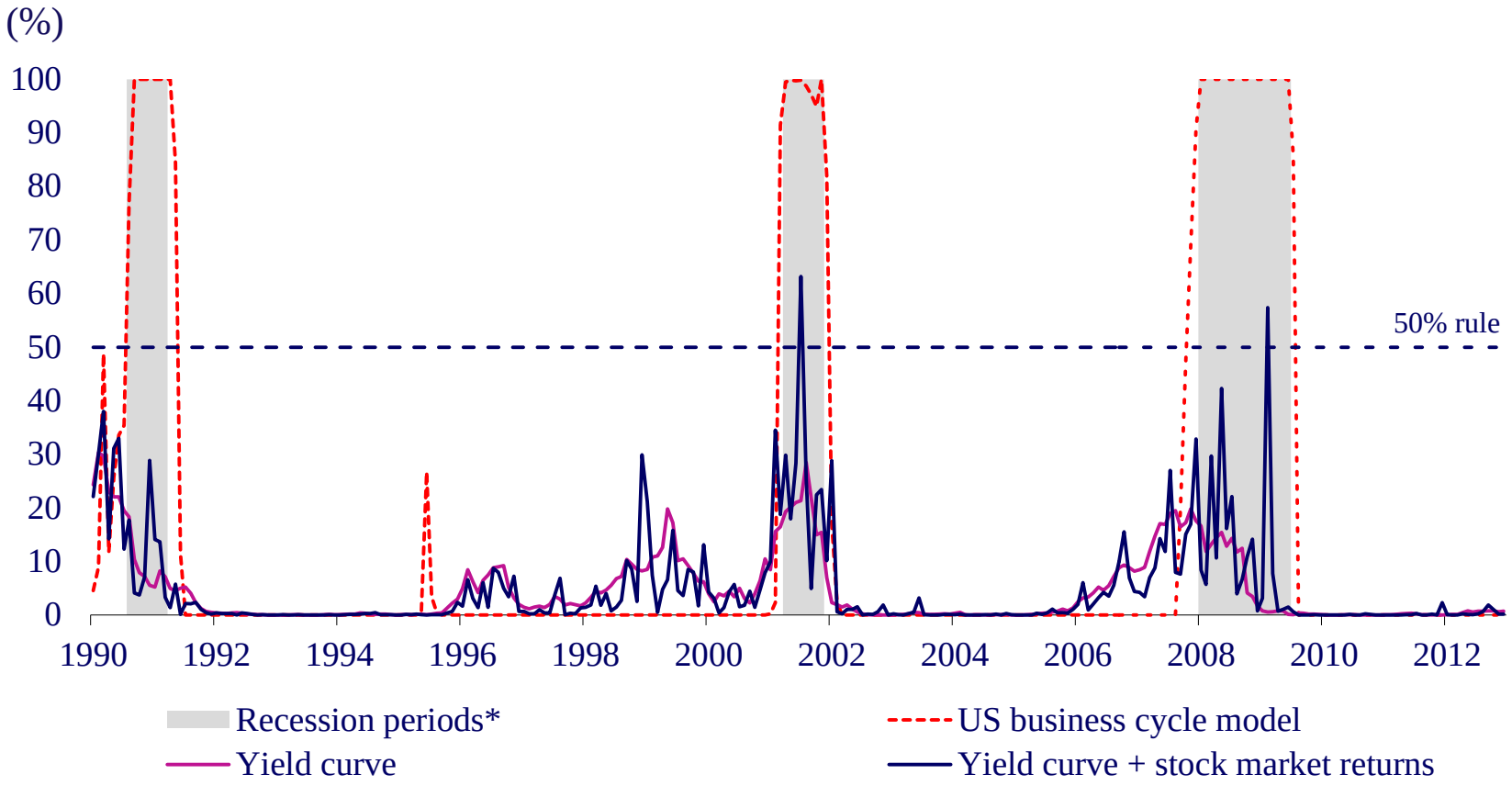
Source: The Forecasting Advisor. 1. The out-of-sample probabilities are computed with coefficients of the model estimated from January1962 to December 1989. In-sample probabilities are computed with the coefficients of the model estimated from January 1962 to December 2012. * The shaded area corresponds to the reference dates for the recession periods as defined by the U.S. National Bureau of Economic Research.

Figure 11: Probability of the U.S. Being in a Recession: In- and Out-of-Sample Probabilities from January 2000 to December 2012[1]



Source: The Forecasting Advisor. 1. The out-of-sample probabilities are computed with coefficients of the model estimated from January1962 to December 1999. In-sample probabilities are computed with the coefficients of the model estimated from January 1962 to December 2012. * The shaded area corresponds to the reference dates for the recession periods as defined by the U.S. National Bureau of Economic Research.

Figure 12: Probability of the U.S. Being in a Recession: Out-of-Sample Probabilities from Three Models[1]



Source: The Forecasting Advisor. 1. The out-of-sample probabilities are computed with coefficients of the model estimated from January1962 to December 1989. In-sample probabilities are computed with the coefficients of the model estimated from January 1962 to December 2012. * The shaded area corresponds to the reference dates for the recession periods as defined by the U.S. National Bureau of Economic Research.

Predicting Reversals in the Stock Market Cycle in the U.S.

Plan of the presentation

- Introduction
- Description of the Model and Estimation Results
- In-Sample Forecasting Performance
- Out-of-Sample Simulation

Introduction

- In contrast to forecasting the business cycle, there is only two studies to our knowledge that have looked at the issue of predicting the state of the stock market cycle in the U.S.
- The first study is from Chen (2009). With a static probit model, he showed that the yield curve and the inflation rate are the best predictors of the state of the U.S. stock market cycle. Other good predictors are the unemployment rate, short-term interest rates, and industrial production.
- The second study is from Nyberg (2012). His results showed that the state of the U.S. stock market cycle is predictable in- and out-of-sample, the addition of the lagged state of the stock market cycle adds substantial predictive power, and a dynamic probit model outperforms a static probit model in forecasting bear and bull markets.
- I will now move on to the second part of the presentation, which is about the research that I did on forecasting the US stock market cycle. I will describe briefly the model and illustrate its performance in predicting since 1966 the reversals in the stock market between bear and bull markets.

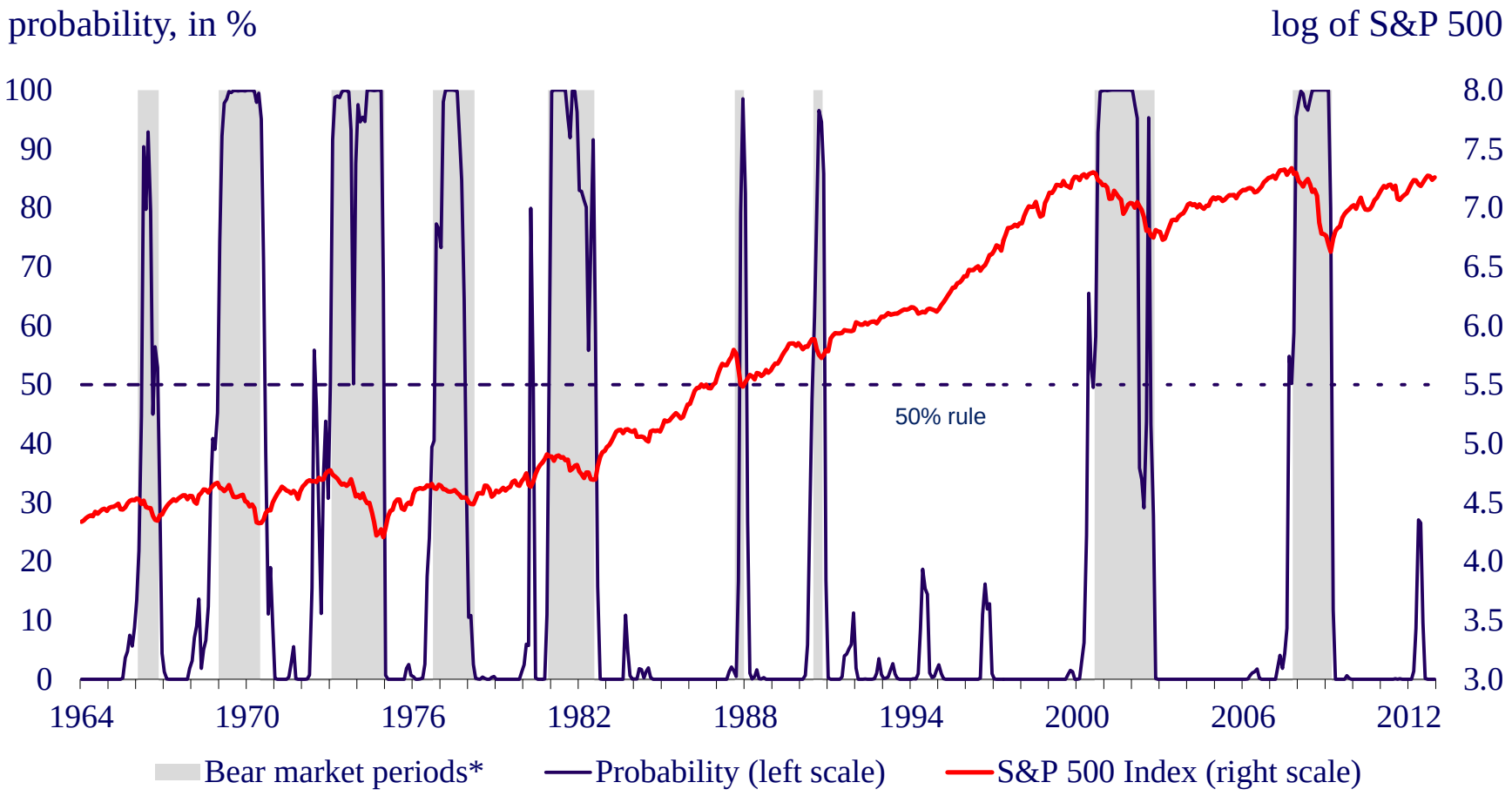
Description of the Model and Estimation Results

The model

- The U.S. stock market is benchmarked with the S&P 500 index.
- The stock market is characterised by two phases: a bull or a bear market. The traditional probit modeling approach (see, e.g. Estrella and Mishkin (1998)) is used to estimate the probability of a reversal in the S&P 500 index between a bear and a bull market. No information is used about the past state of the stock market in predicting future reversals to bear and bull markets.
- The model, which is estimated with monthly data from January 1964, includes a number of U.S. economic indicators, such as production, the unemployment rate and the inflation rate.
- The predicted outcome for the U.S. stock market is determined using the following 50% rule:
  - When a bull market exists, the model predicts a shift to a bear market if the probability is equal to or exceeds 50%.[1] Otherwise, the model predicts that the bull market will continue.
  - When a bear market exists, the model predicts a shift to a bull market if the probability is equal to or falls below 50%.[1] Otherwise, the model predicts that the bear market will continue.
- Figure 1 (next slide) illustrates the monthly evolution of the probability of the S&P 500 index being in a bear market (identified by the blue line), the bear market periods (grey shaded area) area) and the level of the S&P 500 (red line) since January 1964.

1. It is possible that an increase (decline) in the probability to above (below) 50% could be explained by a limited number of the model's explanatory variables. In the future, when the model signals a reversal in the state of the stock market cycle, the source of the change in the probability will be investigated in order to reduce the risk of a false alarm.

Figure 1: Probability of the S&P 500 Index Being in a Bear Market[1]: 1964-2012



Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability). December 2012 is the last data point for both series. 1. In-sample probabilities from the one-month ahead regression probit model.

* See Table 1 for reference dates for the stock market cycle. The left hand side of the shaded area corresponds to the start of the bear market and the right hand side to the end of the bear market.

Table 1
Some Key Probit Estimation Output for the U.S. Stock Market Cycle Model [1]

Model	McFadden R-square	
U.S. Stock Market Cycle Model	0.79	
Alternative probit models: Chen (2009) Nyberg (2012)	 0.006 to 0.103[2] 0.041, 0.135, 0.412[3], 0.807[3]	
Prediction Evaluation **(Success rate based on the 50% rule)**	**In-Sample[4]**	**Out-of-Sample[5]**
Predicted / Total Bear Market Months	126 / 139 (91%)	35 / 43 (81%)
Predicted / Total Bull Market Months	446 / 456 (98%)	82 / 89 (92%)

1. The results are from the one-month ahead probability model.
2. Based on the static probit model approach.
3. The last two values comes from an autoregressive and a dynamic/autoregressive probit model.
4. Based on an estimation period of January 1962 to July 2013.
5. Based on an estimation period of January 1962 to December 1999. Out-of-sample from January 2000 to December 2010.

Table 2
Performance of the Model in Forecasting the Reversals to Bear and Bull Markets in the S&P 500 Index since 1966

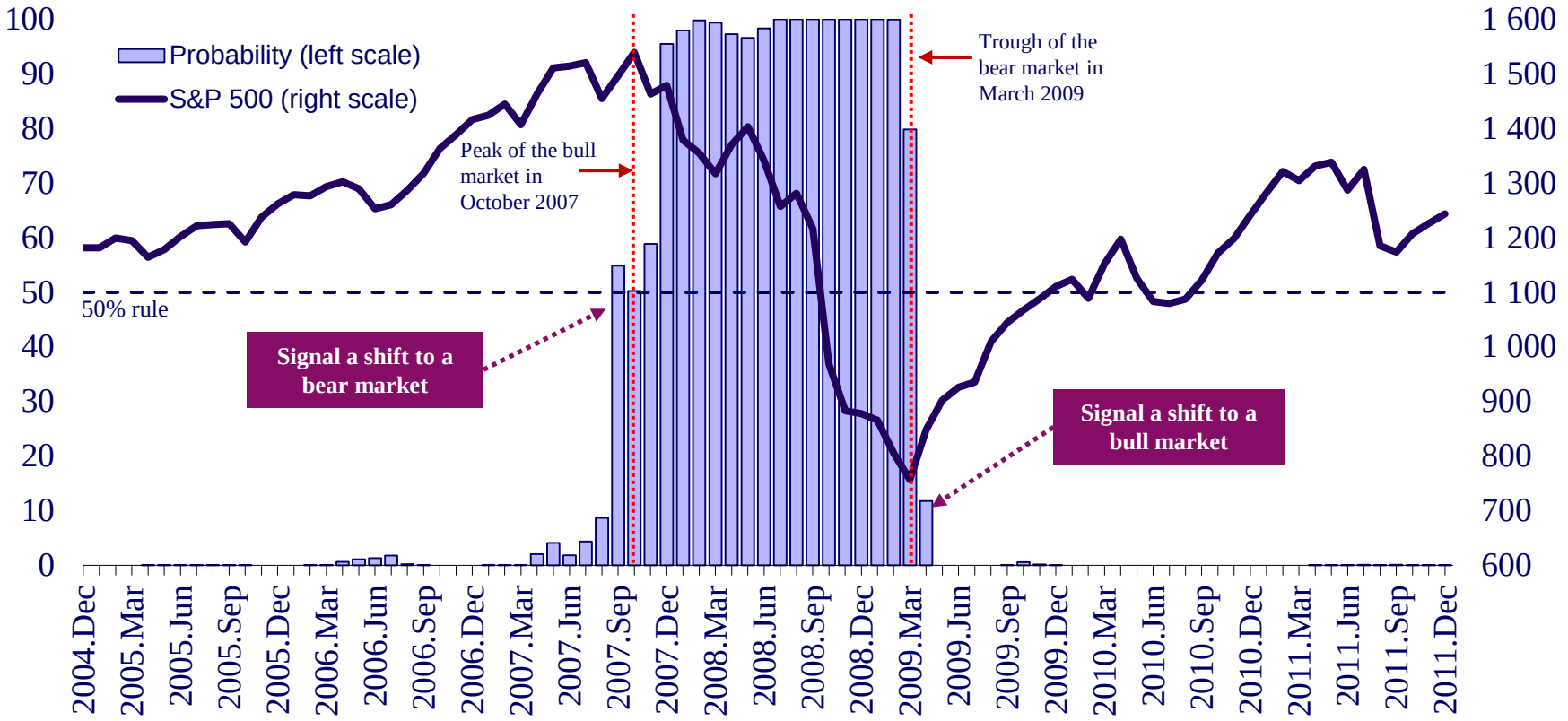
Actual start of the bear market[1]	Signal of a shift to a bear market[2]	# of months before (-) or after (+) the actual start of a bear market	Actual start of the bull market[1]	Signal of a shift to a bull market[2]	# of months before (-) or after (+) the actual start of a bull market
Feb. 1966	Apr. 1966	+2	Nov. 1966	Nov. 1966	0
Jan. 1969	Dec. 1968	-1	Jul. 1970	Sep. 1970	+2
Feb. 1973	Oct. 1972	-4	Jan. 1975	Jan. 1975	0
Oct. 1976	Sep. 1976	-1	Apr. 1978	Dec. 1977	-4
Dec. 1980	Dec. 1980	0	Aug. 1982	May 1982	-3
Sep. 1987	Nov. 1987	+2	Jan. 1988	Feb. 1988	+1
Jul. 1990	Jul. 1990	0	Nov. 1990	Dec. 1990	+1
Sep. 2000	Jul. 2000	-2	Nov. 2002	Jun. 2002	-5
Nov. 2007	Sep. 2007	-2	Apr. 2009	Apr. 2009	0
Average		-0.7	Average		-0.9

1. There are no official reference dates for the start and the end of bear markets for the S&P 500 price index. A bear market is generally defined as a decline of about 20% or more spread in a broad market index over a period of at least two months (see Tables 2 and 3 at the end of the document for the duration and percentage change in all the bear and bull markets since 1966). The dates reported in Table 1 correspond to those available in the economic literature.
2. The signals were determined using the 50% rule.

In-Sample Forecasting Performance

Figure 2: Probability of the S&P 500 Index Being in a Bear Market,[1] 2007-2009

(probability, %) (index)

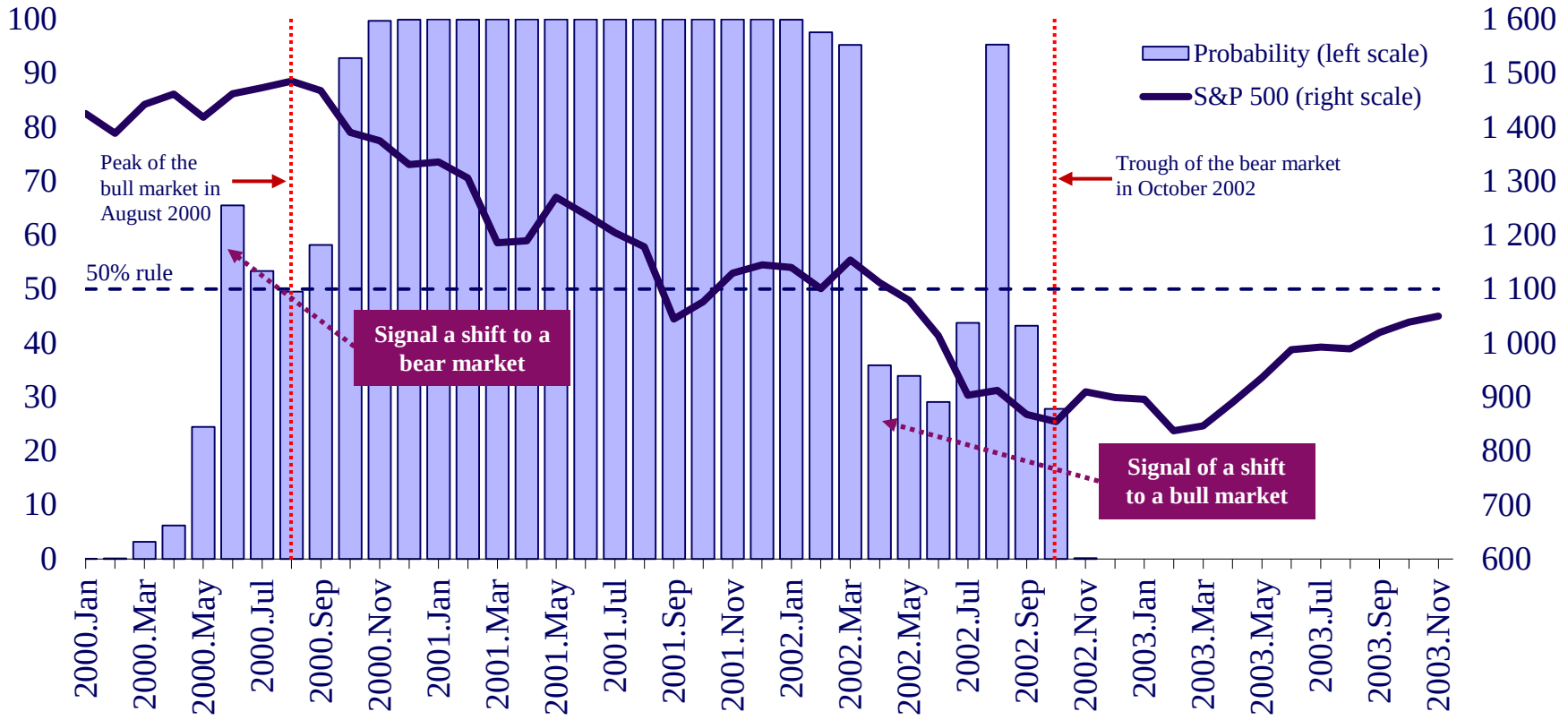


Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability).

1. In-sample probabilities from the one-month ahead regression probit model.

Figure 3: Probability of the S&P 500 Index Being in a Bear Market,[1] 2000-2002

(probability, %) (index)

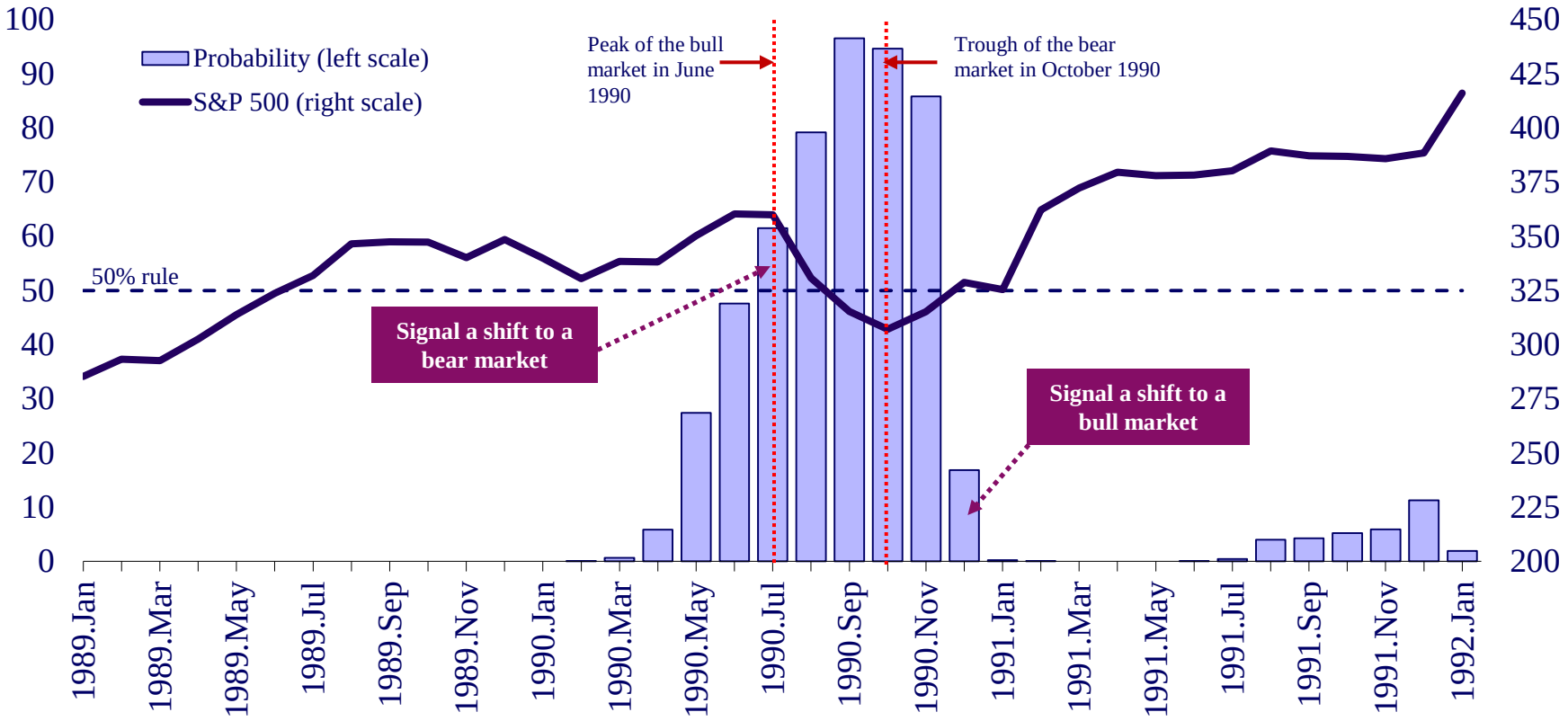


Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability).

1. In-sample probabilities from the one-month ahead regression probit model.

Figure 4: Probability of the S&P 500 Index Being in a Bear Market,[1] 1990

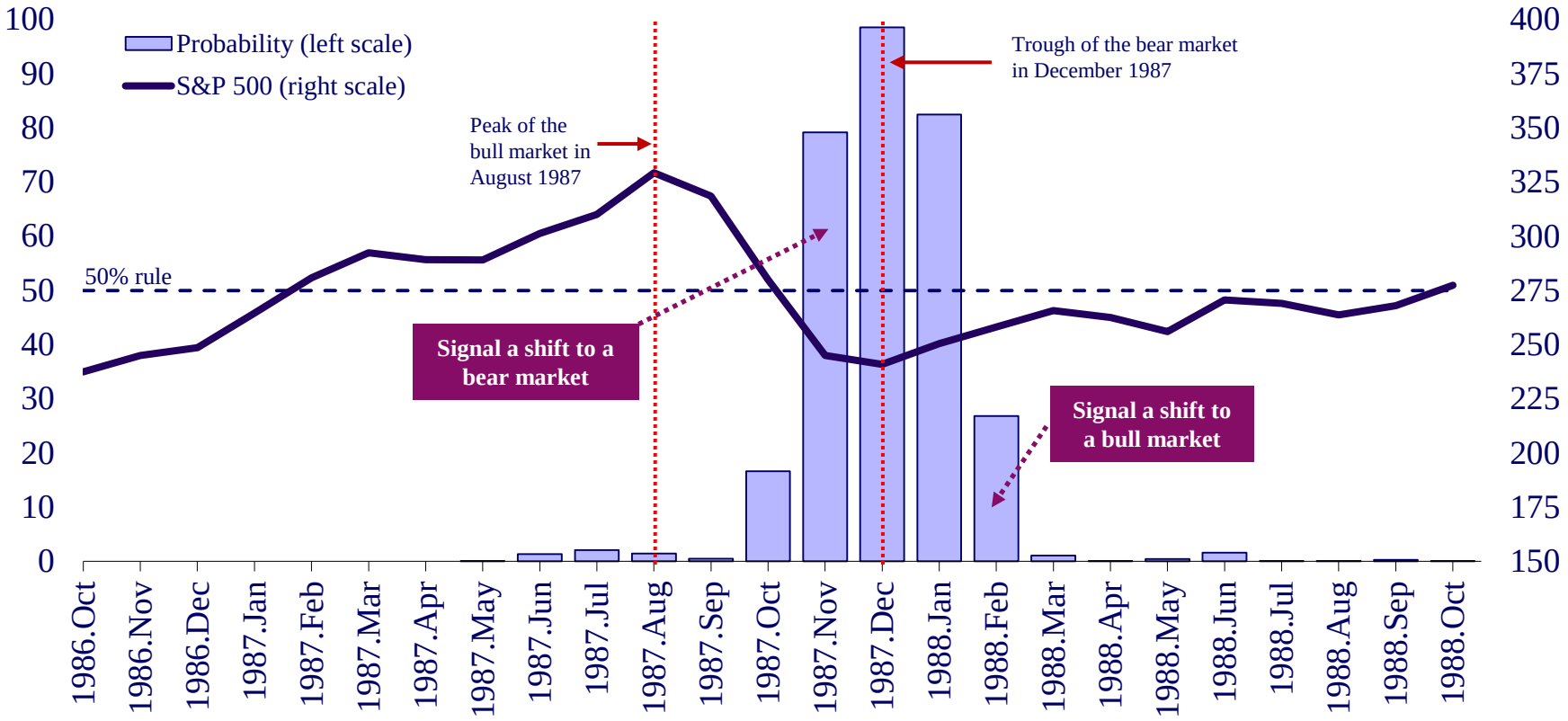
(probability, %) (index)



Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability).
1 In-sample probabilities from the one-month ahead regression probit model.

Figure 5: Probability of the S&P 500 Index Being in a Bear Market,[1] 1987

(probability, %) (index)

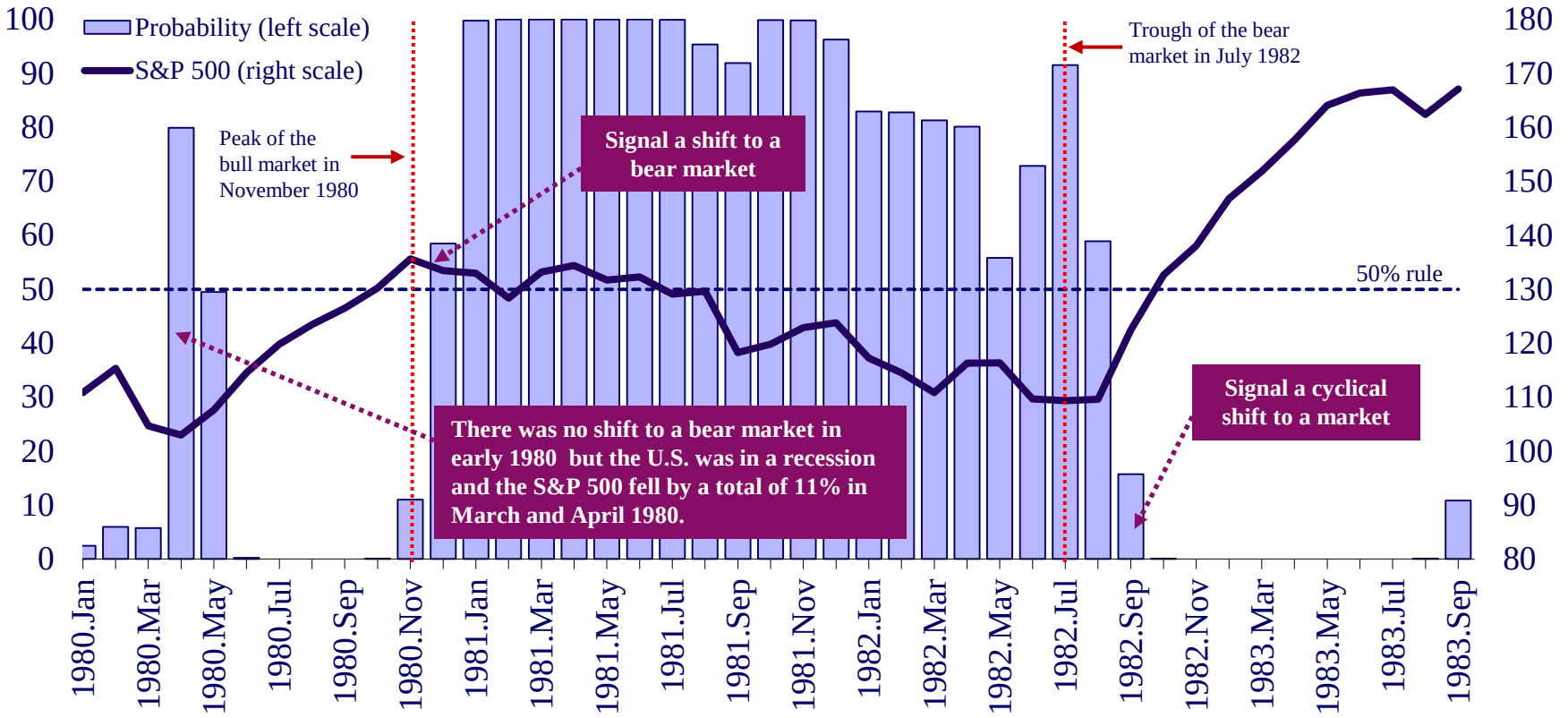


Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability).

1. In-sample probabilities from the one-month ahead regression probit model.

Figure 6: Probability of the S&P 500 Index Being in a Bear Market,[1] 1980-1982

(probability, %) (index)

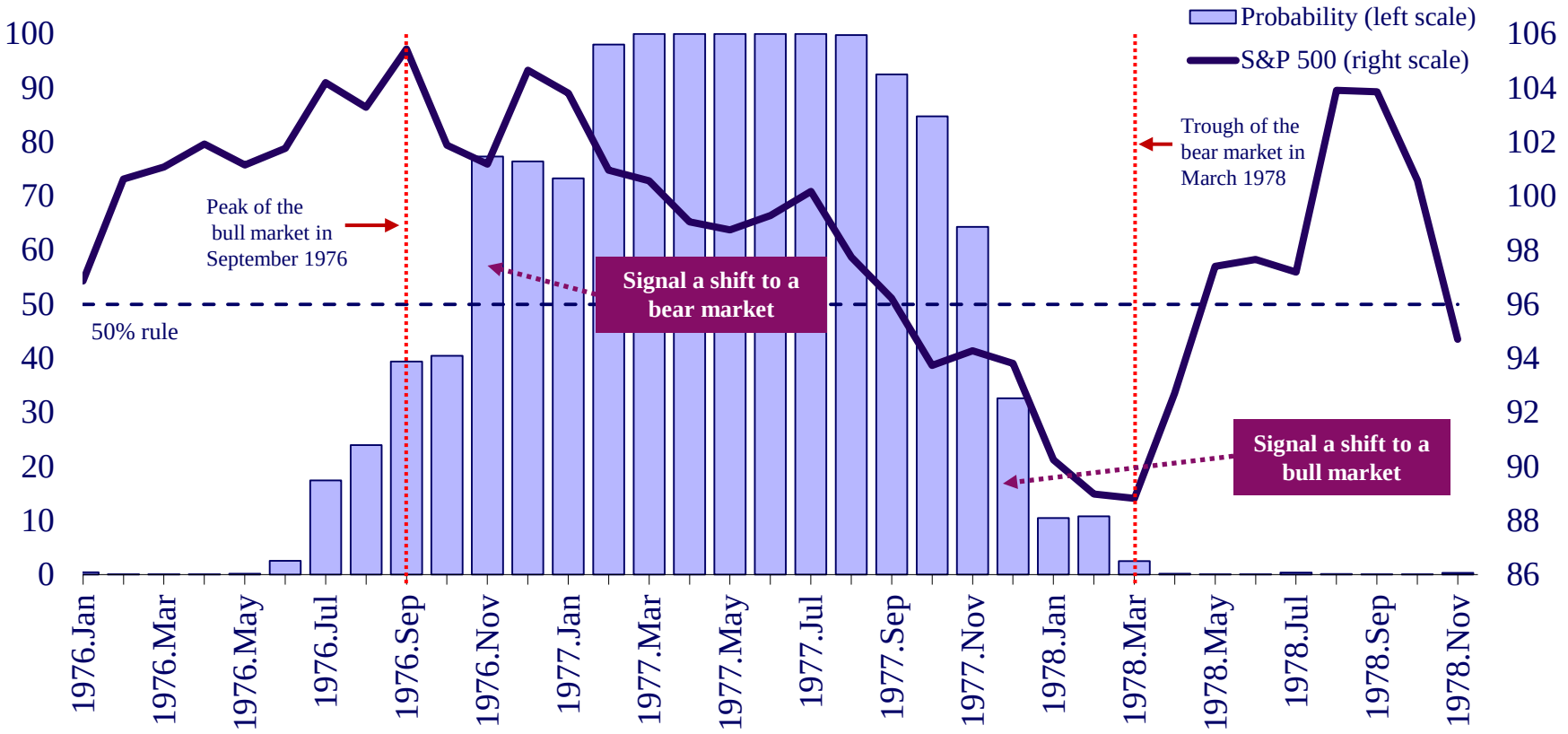


Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability).

1. In-sample probabilities from the one-month ahead regression probit model.

Figure 7: Probability of the S&P 500 Index Being in a Bear Market,[1] 1976-1978

(probability, %) (index)

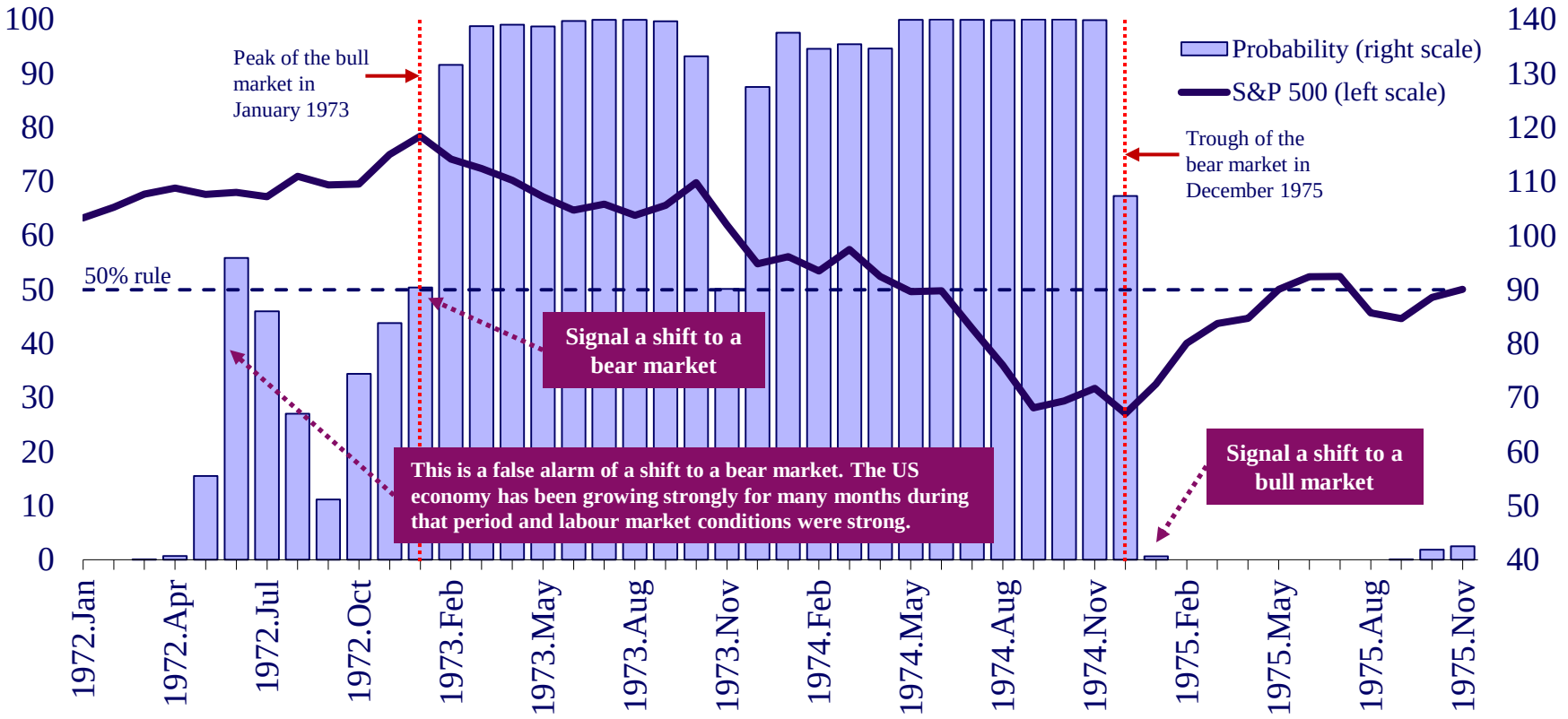


Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability).

1. In-sample probabilities from the one-month ahead regression probit model.

Figure 8: Probability of the S&P 500 Index Being in a Bear Market,[1] 1973-1975

(probability, %) (index)

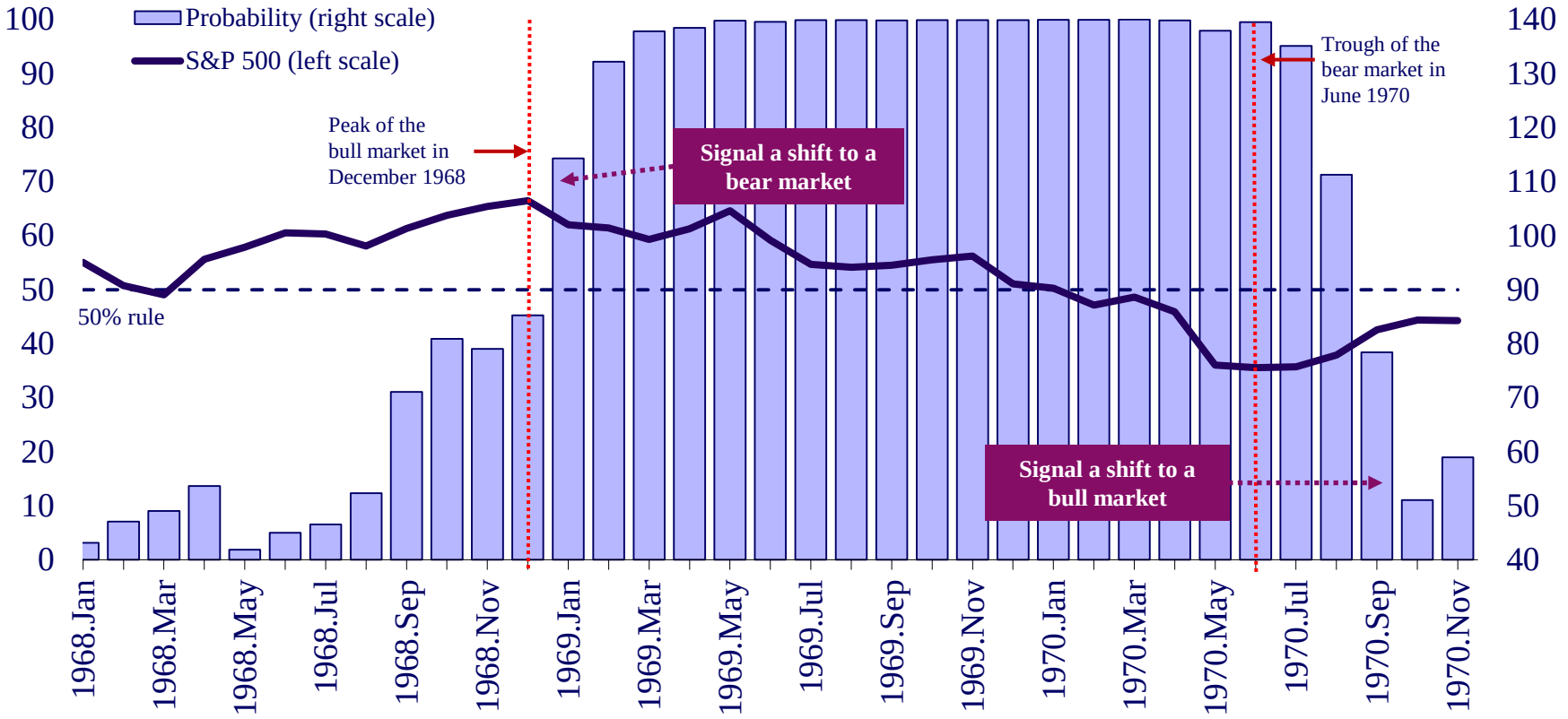


Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability).

1. In-sample probabilities from the one-month ahead regression probit model.

Figure 9: Probability of the S&P 500 Index Being in a Bear Market,[1] 1969-1970

(probability, %) (index)

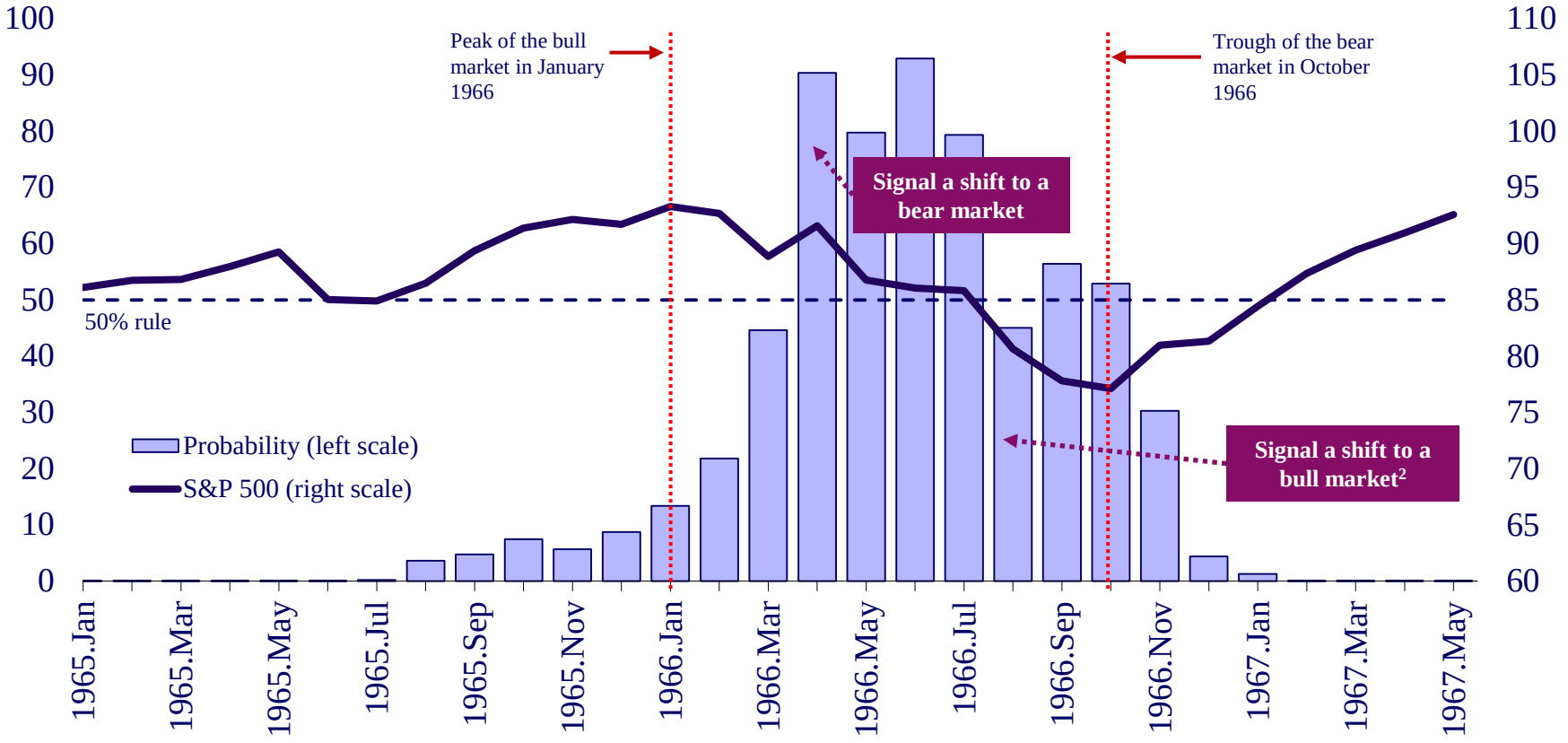


Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability).

1. In-sample probabilities from the one-month ahead regression probit model.

Figure 10: Probability of the S&P 500 Index Being in a Bear Market,[1] 1966

(probability, %) (index)

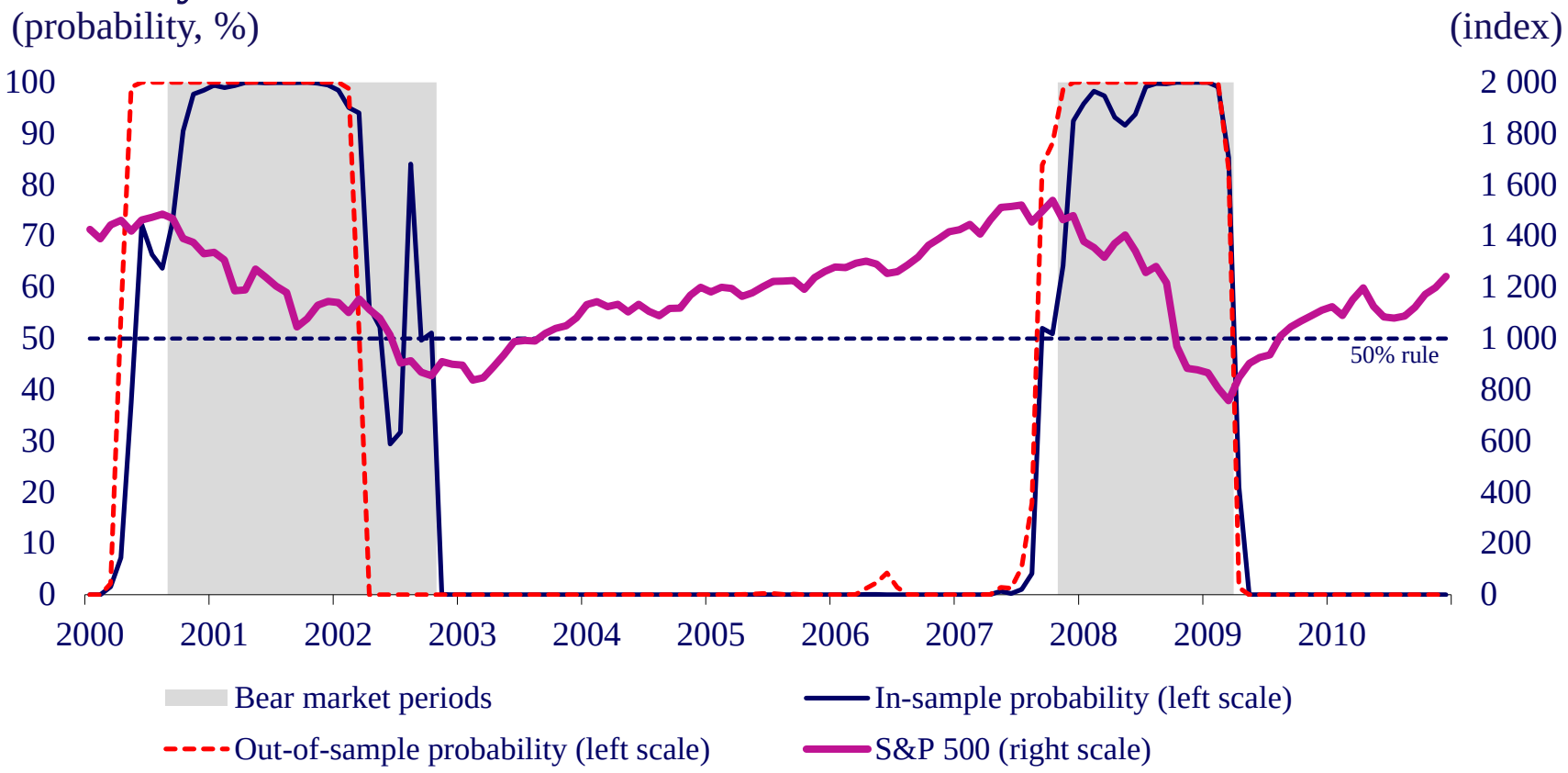


Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability).

1. In-sample probabilities from the one-month ahead regression probit model.

Out-of-Sample Forecasting Performance

Figure 11: Probability of the S&P 500 Index Being in a Bear Market[1]: In- and Out-of-Sample Probabilities from January 2000 to December 2010[2]



Sources: Federal Reserve Bank of St-Louis Fred Database (S&P 500 index) and The Forecasting Advisor (probability). 1. One-month ahead probability. 2. The out-of-sample probabilities were computed with coefficients estimated from January 1964 to December 1999 and the in-sample probabilities with coefficients estimated from January 1964 to December 2012.

Thanks!