



Predicting Recessions: A Regression (Probit) Model Approach

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PREVIEW

Forecasting recessions is fraught with difficulties: we never know if we are in recession until long after one has started. This makes it all the more important to try to predict in advance the likelihood of recession, so that businesses can plan accordingly. Peter takes us inside the economist's crystal ball, identifying key indicators of economic recession and how they can be combined into a predictive model. The model forecasts a difficult 2009.

INTRODUCTION

We economists spend much of our time biting our tongues, especially when asked about the probability of recession. There are so many factors affecting the future path of the economy that we nearly always have to condition our views by what we are assuming today, which, by the way, may be at odds with what we thought yesterday, or even an hour ago. When we hear someone pontificating over the likely state of economic affairs under this policy or that policymaker, we bristle, wishing sometimes that we had the intestinal fortitude of the weatherman.

This past year brought us new heights for oil prices, an asset-backed securities crisis and its associated contagion, a rapid rise in unemployment, and a presidential election, all of which generated renewed interest in “nowcasting” a recession – determining if and when recession began – and forecasting recessions in the future.

Because of data lags, we never know if we are in recession until long after one has started. The official

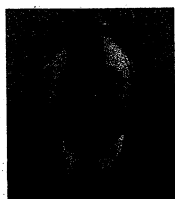
KEY POINTS

- Economic forecasters have identified many variables as potential predictors of recession. I will describe the role of five key predictors: *the interest rate spread, the credit spread, the ISM index, changes in a stock price index, and changes in the price of oil.* However, the impact of these causal factors can change from one recession to the next.

- Through a variation on a traditional regression model called a probit model, I will show how to link the probability of a recession to the behavior of these key predictors.

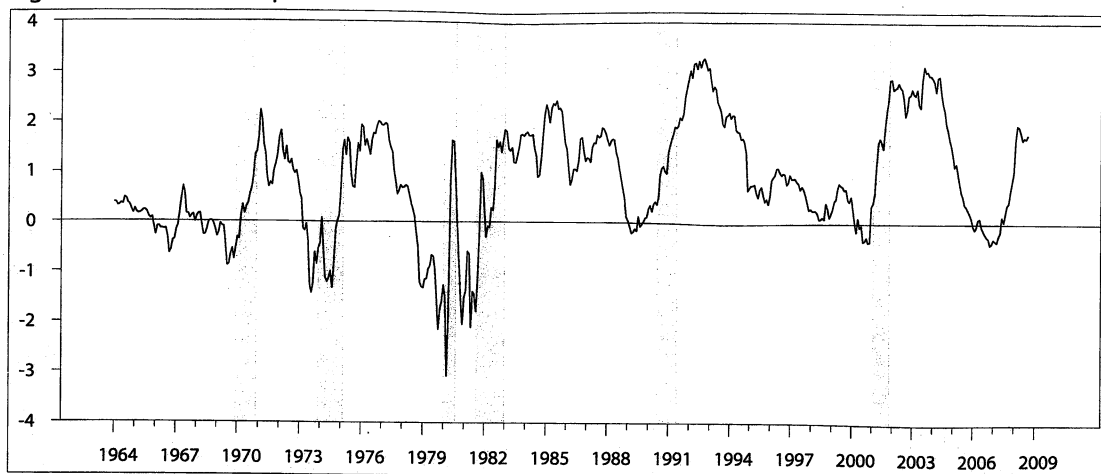
- As of the end of November 2008, the model suggests the United States is currently in a recession and that it will probably last into the third quarter of 2009. More rough times ahead.

recession-dating agency in the United States, the National Bureau of Economic Research, announces recession dates after looking at a wide range of economic indicators. The well-worn definition of a recession as being two successive quarterly declines in real GDP is too restrictive and incapable of capturing all of the features associated with a decline in economic activity; the NBER's approach is to look at a variety of economic indicators when dating the American business cycle (www.nber.org/cycles). While recognizing that we won't know we're in a recession until we've been in it for a while or it has passed, it is all the more important to try to predict in



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Figure 1. Interest Rate Spreads



Note: The spread shown is the 10-year minus the 1-year bond rate.
Source: Series GS10-GS1 from the Federal Reserve Bank of St. Louis FRED database

advance the likelihood of recession, so that businesses can plan accordingly and policymakers can assess how best to respond should a downturn occur.

We utilize a variety of approaches to modeling recession probabilities. There is a long history of trying to construct leading indicators that signal shifts in economic activity, and in many cases these indices perform very well at capturing business-cycle turning points – periods when the economy dips into recession and then subsequently out of the trough and into recovery and expansion. Finding the “right” variables to use to construct reliable leading indicators and diffusion indicators takes judgment and experience. It’s a bit like trying to follow a recipe from an old cookbook – as ingredients and the technology we use to bake the cake change, we need to adjust the mix and do some experimenting to get it “just right.” Creating leading indicators is a somewhat similar process, although usually not as tasty.

More generally, when economists try to forecast the likelihood of recession, we use a wide range of techniques and methods. Some involve computationally intensive algorithms linking various economic indicators, while others rely on measurements of anxiety in markets, Delphi groups, surveys, and even flipping coins and tarot cards. My purpose in this article is to take a traditional regression model to see if we can link

the probability of a recession to information we think might play a predictive role. I’m not suggesting this is the best approach to use – it’s just one of the available methods in the economist’s toolbox – so let’s see how well this approach does at forecasting recession.

RECESSION PREDICTORS

The official dates of the last few recessions in the United States are illustrated by the shaded regions in Figure 1:

December 1969 to November 1970

November 1973 to March 1975

January 1980 to July 1980

July 1981 to November 1982

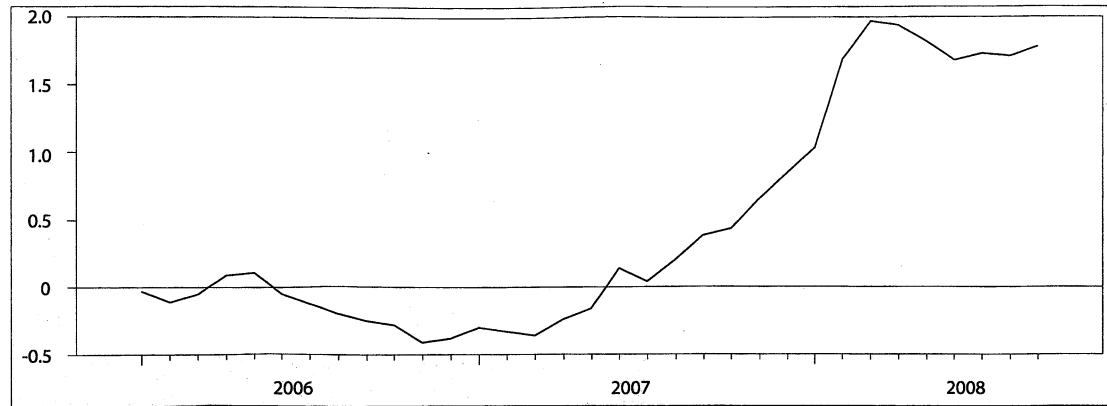
July 1990 to March 1991

March 2001 to November 2001

Interest Rate Spread: Many econometric modelers have found that the interest rate spread – the difference between a long-term interest rate and a short-term rate – does a good job at predicting recession. Normally, long-term rates are higher than short-term rates. But when the interest rate spread turns negative, it is usually a sign that recession is expected soon.

The explanation for the effect of the interest rate spread usually relies on the idea that policy interest rates, which are at the short end of the maturity spectrum, fall when central bankers want to stimulate the

Figure 2. Interest Rate Spreads



economy. If the market expects short-term rates to fall, interest rate arbitrage between short-term and long-term instruments will drive the long-term interest rate below the current short-term rate, leading to a negative spread. And when would the market expect policy interest rates to fall? When it senses that the central bank sees excessive slack in the economy, hence an impending economic downturn or recession. Figure 1 shows that the spread has become negative before each of the last six recessions.

Figure 2 shows that the spread became negative in 2006 and 2007. Market commentary at the time indicated a recession was on its way, but that recession never materialized – until perhaps now. This suggests that a negative spread might not *always* foretell a recession, but if it walks like a duck and it quacks like a duck ... it's probably a duck.

Other variables that are considered to have predictive power include:

- **The credit spread:** the difference between returns on low-grade and high-grade securities. A higher credit spread may reflect increasing concerns over future economic activity.
- **The ISM (Institute for Supply Management) production index** (formerly known as the Purchasing Managers' Index). An index value below 50 signals an expected contraction in production.

- **Changes in the inflation-adjusted value of stock prices.** Lower real-stock valuations can portend distress in markets.

- **The effective federal funds rate**, which measures the stance of monetary policy. Lowering of rates indicates an effort by the Fed to stimulate the economy.

- **Price of oil.** Given its recent behavior, one might consider that changes in the price of oil may also provide insight into the likelihood of recession, so it too will be considered as a potential predictor of the probability of recession.

All these data are freely available for download from the St. Louis Federal Reserve Bank's FRED database (<http://research.stlouisfed.org/fred2>) and the Institute for Supply Management's website (www.ism.ws/ISMReport). The series identifiers in FRED include FEDFUNDS, (GS10-GS1), (BAA-AAA), OILPRICE, SP500 and PCEPI, and the ISM index (PMI).

In Figure 3, it is clear that these potential recession predictors are correlated with past U.S. recessions. Real stock prices appear to fall just before a recession, and the effective federal funds rate seems to decline before each recession, perhaps capturing the anticipatory policy response. The ISM index starts falling long before the recession begins and appears to rise above 50% shortly after the recession is over. Oil prices, though, seem to have a varying pattern before and

after recessions. In the 1970s and in the early 1990s, prices rose before and during the recession. In the early 1980s and the recession of 2001, oil prices rose before the recession; then, once the economy slipped into decline, oil prices fell.

THE PROBLEM OF SHIFTING CAUSAL FACTORS

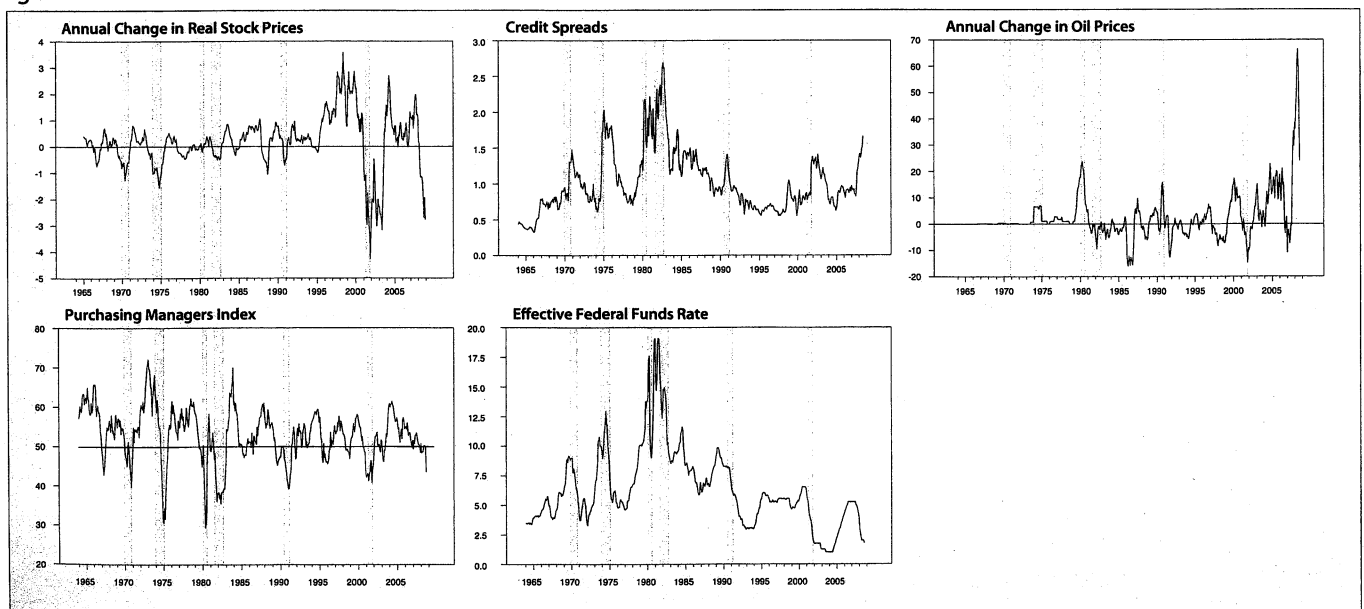
The question of the “right” combinations of variables to provide an effective recession forecasting model has puzzled economists for years. One problem is that different causal factors appear to have been at play from one recession to the next. In the early 1970s, widespread drought caused significant shocks to world food output while economies were stressed by oil price spikes and stagflation. The recession of the early 1990s was primarily the result of restrictive monetary policies aimed at restraining inflation, while that of 2001 was generally thought to be the result of aftereffects from the tech meltdown as well as a reduction in U.S. net exports (Walsh [1993], Kliesen [2003]).

So how do economists decide which variables to include in their forecasting models? As with most questions in economics, the answer is, “It depends.” Are we trying to build a model that will forecast the

2001 recession (and the post-recession expansion)? If so, it makes sense to fit the relationships from the mid-1980s until 2000 and then ask how well the model forecast into 2001 and 2002, the period after onset of recession but before recovery began. If we’re trying to build a model to forecast whether there will be recession in 2009, then using data from the mid-1980s through 2008 makes sense. One important caveat is that there’s no reason to assume the structure of economic relationships remains fixed over time, so the variables giving the best model on data until mid-2008 might be much different from those giving the best model to use to explain the 2001 recession.

Another wrinkle in the modeling process is that economic data are frequently revised. That’s one reason why economists put financial variables such as interest rates and asset prices into their recession forecasting models, because these variables are rarely revised. As an example, consider the preliminary estimates of real GDP growth released by the Bureau of Economic Analysis for the second quarter of 2008. The initial estimate of 3.3 percent was revised down to 2.8 percent in late September 2008 as more data became available. While only half of one percent, media reports immediately cited the increased risk of

Figure 3. Predictive Variables



recession (Englund & MacDonald, 2008). Financial data are not usually subject to these data revisions, and to the extent that markets are efficient, asset prices and returns data should reflect all available information.

Because these key variables frequently change, it is necessary that we economists test our forecasting models to see if they are structurally stable – that is, are the effects of the causal variables consistent over time? For the most part, simple forecasting models are not structurally stable, so that models that do well today will not do well tomorrow. The economist then must continually update the models as new data come in.

A PROBIT MODEL

Probit models are a common approach to predicting recession. A probit model allows us to determine the probability of an event (recession) that either will or won't occur. Statisticians call such an event a "dichotomous dependent variable" and use the values "one" or "zero" to indicate whether we are or are not in recession. Equation (1) is an illustrative probit model for predicting the probability of recession:

In equation (1) below, the left-hand term is the probability of recession twelve months from now, while the right-hand terms are the causal factors.

ISpread denotes the interest rate spread between one-year and ten-year constant maturity government bonds at time *t*.

CSpread denotes the spread between Moody's long-term (30-year) Baa and Aaa seasoned corporate bond yields at time *t*.

Oil denotes the year-over-year change in West Texas Intermediate Crude oil at time *t*.

RSP500 denotes the year-over-year change in the S&P500 index, deflated by the price of consumer expenditures, at time *t*.

FF_t denotes the effective federal funds rate at time *t*.

ISM_t denotes the ISM index (as previously noted, formerly the Purchasing Managers' Index) at time *t*.

The probit model assumes the errors in the equation follow the standard normal distribution, your typical statistical assumption.

Using monthly data spanning from January 1986 until September 2008, the probit model appears to capture the probability of recession fairly well on a historical basis. The estimated model is equation (2), below.

Each coefficient is statistically, significantly different from zero, at or about the ten percent level of significance.

For any time period, once values are entered for the six explanatory variables, the equation yields a probability of recession. For example, plugging in the values for June 2007 data on the right-hand side of the equation leads to a predicted probability of recession in June 2008 of nearly 29%. In Figure 4, we plot the probabilities over the 1986-2008 period. Notice the horizontal line drawn at 0.5. Values above this line indicate that the model is saying that recession has more than a 50-50 chance of occurring.

Figure 4 indicates that the recession-probability estimates from this model captured the recession in the early 1990s quite well. It also predicted the 2001 recession with a bit of a lag, since the actual start

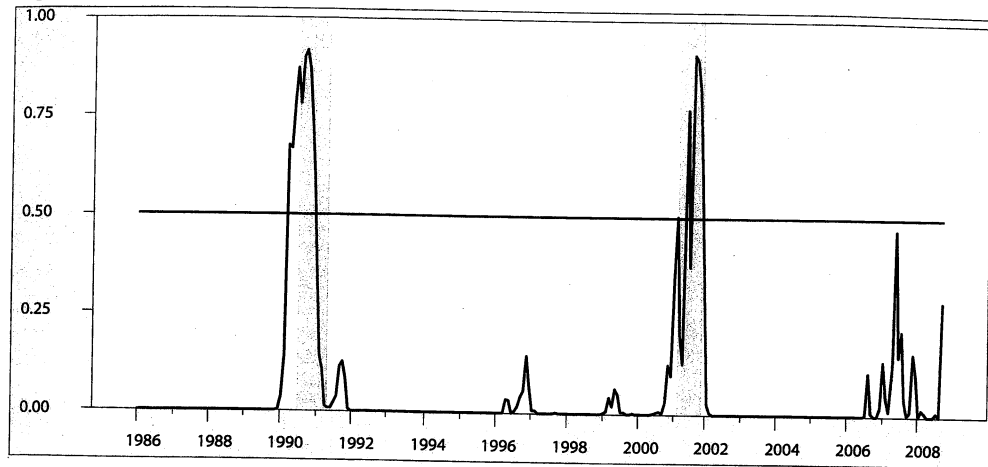
Equation 1:

$$\Pr(\text{Recession}_{t+12}) = \Phi\{\alpha_1 + \alpha_2 \text{ISpread}_t + \alpha_3 \text{CSpread}_t + \alpha_4 \text{Oil}_t + \alpha_5 \text{RSP500}_t + \alpha_6 \text{FF}_t + \alpha_7 \text{ISM}_t\} \quad (1)$$

Equation 2:

$$\Pr(\text{Recession}_{t+12}) = \Phi\{6.03 - 2.22 \text{ISpread}_t - 2.04 \text{CSpread}_t + 0.16 \text{Oil}_t + 0.63 \text{RSP500}_t + 0.54 \text{FF}_t - 0.20 \text{ISM}_t\} \quad (2)$$

Figure 4. Recession Probabilities



date of the recession appears to predate the time at which the recession-probability forecast passes the 50% threshold. At that time, using the available data, some forecasters were able to predict the recession with greater precision. For example, in September 2000 the Economic Cycle Research Institute (www.businesscycle.com) reported that the U.S. Leading Diffusion Index was falling and most likely signalling that a recession would soon follow.

THE CURRENT RECESSION

The probit model's signal of recession for 2008 using data up to September 2007 did not reach 50% (the horizontal line). Remember, we are predicting the probability of recession in the next twelve months, so the predicted recession probability for September 2008 uses data up to September 2007. Recession probabilities peaked in May 2007 at 47%, with any confidence interval around that point prediction including values above 50%, so one might conclude the model is allowing for the possibility of recession. As of November 2008, the NBER had not yet dated additional business-cycle turning points, so we will have to wait and see.

As I have noted, the causal factors underlying recessions have most certainly changed over time. A more realistic probability forecast

might come from a model that continually updates the probability of recession based on both new data and new estimates of the parameters in the probit model. In this way, we explicitly account for structural change in our equation, and we allow the most recent data to color our views of the probability of recession.

Toward this end, I estimated the probit model from January 1986 until January 1998, constructed the probability of recession estimate for January 1999, then updated the dataset to February 1998 and reestimated the model to calculate the probability of recession in February 1999, and so on, up to the most recent data of September 2008. This approach predicts the probability of recession through September 2009. Figure 5 presents these estimated "rolling" recession probabilities. The model appears to have captured the 2001 recession with a bit of a lag and predicted recession in 2007 – a result which the NBER could still confirm after having analyzed the historical record. There appear to be two "false signals" in the late 1990s, although these may be related to the volatility we saw in markets during the run up to, and eventual bursting of, the tech bubble.

Figure 5. Updated Recession Probabilities

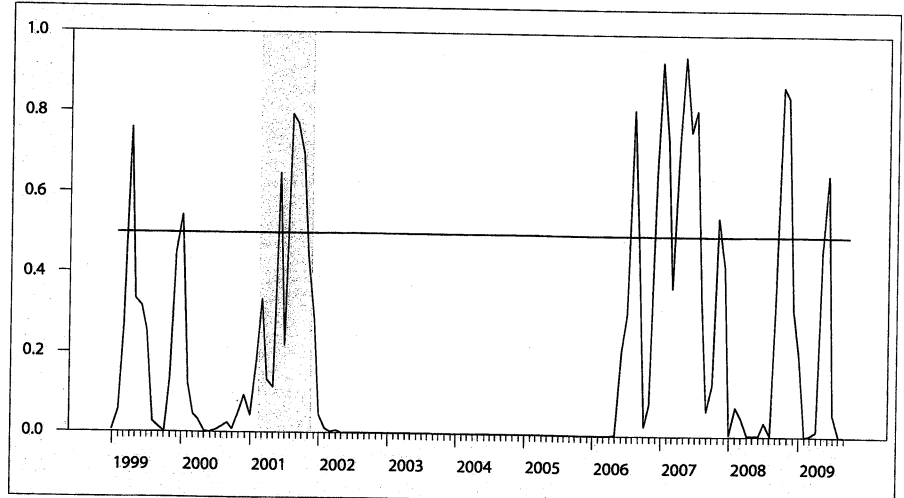


Figure 6. Updated Recession Probabilities 2008-2009

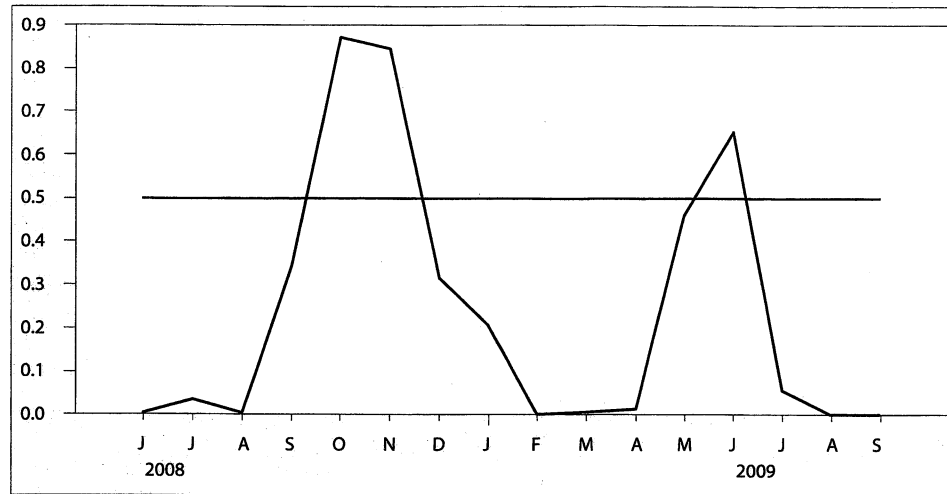


Figure 6 highlights the probability forecasts for 2008-2009. The estimates suggest the United States is currently in a recession and that it will probably last into the third quarter of 2009. (Ed. Note: In early December 2008, the NBER declared that the U.S. economy has been in recession since December 2007.)

A similar prediction comes from Nyberg (2008). Using somewhat more sophisticated versions of the simple probit model examined here, Nyberg predicted a high likelihood of recession in the United States in early 2008. On the other hand, similar models applied by Muhl (2008) predicted (as of February 2008) a very low likelihood of recession in Switzerland into 2008. Unfortunately, as we all know too well, global economic conditions can quickly change with little warning.

These findings suggest that the search for reliable predictors of recession should be viewed as a never-ending story and that economists should mete out our forecasts with humility.

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