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## Revisiting the Ability of Interest Rate Spreads to Predict Recessions: Evidence for a Small European Economy

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**ABSTRACT**

In this paper we examine the power of the interest rate spread and of other financial variables as predictors of economic recessions in Spain. The domestic term spread is found to have little information about future real activity. However, term spreads in big economies to which Spain is related, specifically Germany and the US, are found to have significant predicting power but at different time horizons. Both these findings are in line with the facts that the monetary policy of Spain has not been independent and that it has been conditioned by that of other big economies, most notably Germany.

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# 1 Introduction

Recent economic events, especially the recession that has struck some of the advanced economies in late 2000 and 2001, have revived the interest for the empirical study of economic cycles, especially for the factors that determine whether an economy stays into an expansion or moves into a recession (see Leamer, 2001, for an original analysis of the causes and characteristics of economic expansions), or the variables that can help predict the direction that the economy is taking.

Policymakers, for example, are among the most avid consumers of forecasting or structural econometric models developed in order to predict future rates of growth, or future levels of activity. In particular, and given the attention that a single economist, the Chairman of the Fed, generates, it is fair to say that monetary policy is now in the spotlight of most economic policy analyses. Should the Fed, or any other central bank (CB) for that matter, target real activity or should it just focus on price stability? Could the Fed or the European Central Bank (ECB) have reacted sooner to avoid or smooth the last recession? These and other questions are now being more frequently asked,and are putting increased pressure on monetary policymakers to anticipate economic fluctuations and smooth them accordingly. An important part of the job of the Central Bank is therefore to gather the information about current and, if possible, future economic conditions, so that policy decisions (if at all the CB is targeting real output) can be taken at the right moment or, better, enough in advance so that lags in policy effectiveness can be taken into account and the worse real consequences can be avoided .

The issue of predicting real economic activity is, however, not only of interest for the Central Bank, though, but also for most agents in the economy. In particular, a key issue, related to the above, involves trying to guess the stance of the monetary policy (is it being expansionary or contractionary?), which would yield indications as to where real activity is heading. The inverse could also be true: Agents might want to predict the direction of real activity since that would then give clues about the immediate stance of monetary policy and signal, for example, upcoming movements in interest rates.

However, traditional indicators of monetary policy stance, by which one could gather information about the actions of the Central Bank, were monetary aggregates and exchange rates in addition to the outcomes of structural macroeconomic models built for forecasting purposes. All these indicators have been shown to be problematic and unstable, and so agents have looked for alternative indicators in the hope of finding variables that have predictive content about future developments of economic activity. Most agents could relate to an analysis that helped predict whether the economy is going to suffer a recession in the near future. In particular, could the last recession have been predicted beforehand by using indicator variables that incorporate information about the future?

Probably the most relevant of these indirect indicators is the term spread of interest rates, that is, the difference between a long term rate and a short term rate. A substantial amount of research has been done on the predictive ability of the term spread for future activity, and the results have been quite encouraging, showing that indeed the informational content of the term spread about future output is high. However, most of the research has been carried out for the cases of big economies, mainly the US, Germany and the UK. A key characteristic of these economies is that they have had fairly independent monetary policies in the last few years, especially since the breakup of the managed floating of the European Monetary System.[1] Very little, if at all, research has been done on smaller economies, whose policies are instead constrained by some dependency of a big economy or by the sometimes unofficial links of the central bank to the government. Theoretical arguments posit that the predictive content of spread-type of variables should be substantially diminished if a country does not have an independent monetary policy or if the monetary policy does not target real activity. Thus, the analysis of the predictive content of financial variables for a smaller economy with significant dependencies may shed light on the true character of these variables as predictors of future economic conditions.

In this paper we study the informational content of some financial variables, placing special emphasis on term spreads, about future economic conditions in Spain. Spain is a country that meets the above conditions of being smaller than the major economies and of being suspect of not having an independent monetary policy, both because of the Bank of Spain's former relationship with the government and because of its participation in the European Monetary System (EMS) and the subsequent transition period undergone in order to qualify for the European Monetary Union (EMU). Our findings are striking. The informational content of domestic financial variables in Spain is non-existent regarding future real activity. However, we show how foreign term spreads of countries to which Spain is related (Germany and the US) do have substantial predictive power of real output, and could have helped, for example, predict the recession that, if not officially, hit Spain shortly before the end of 2000.

The paper proceeds as follows. Section 2 reviews the theoretical arguments for the predictive content of financial variables, placing special emphasis on interest rate spreads and their relation to future economic activity. Section 3 develops the empirical analysis used to ascertain the extent to which these financial variables have predictive content in Spain. Section 4 presents the results of the analysis. Section 5 concludes the paper.

## 2 The informational Content of Financial Variables

The literature on why current values of financial variables have information about future activity and future inflation is by now abundant. All dynamic general equilibrium models, and most static ones including some interest parity

[1] In the case of Germany, of course, this was true until January 1999, when it surrendered its national monetary policy to the European Central bank (ECB).

condition or a Fisher-type effect, will yield a forward looking solution for some variable, in which its current value is a function of the discounted expected future path of a set of fundamental variables. Stock prices, for example, are a forward looking variable, a function of future dividends. Thus, the value of a stock today is supposed to have information about expectations about the future. If these expectations are rational, then the evolution of a stock price today should be informative about future profits of the company. This was also the argument in Campbell and Shiller (1988) when they derived a solution for the current dividend yield as a function of expectations of future stock returns, thus positing that current dividends might have information about future returns.

In this paper we are interested in the informational content of some financial variables, mainly the term spread, but also foreign term spreads and stock prices or exchange rates, about future real activity. If any of these variables has power to predict a future growth or decline in real activity, then this variable could reasonably be used for planning and economic policy purposes. We review now some of the theoretical arguments that support the predictive power of our financial variables of interest, some which are based on arguments similar to the one outlined above whereas others are based mainly on the interplay between the Fisher effect and the transmission mechanism of monetary policy.

## 2.1 The Term Spread

The term spread, that is, the difference between a long and a short term interest rate, has been the object of a number of analyses that show its ability to predict not only future output and real activity, but also future inflation rates. Bernanke (1990) and Mishkin (1990) are among the first and most relevant papers that show that term spreads must have information, under certain circumstances, about future inflation and future output. The argument usually rests on the fact that long rates are, under the expectations hypothesis, predicting the future path of real rates and inflation rates. Hamilton and Kim (2002) give a clear and concise account of the theory and give a further interpretation of the ability of the spread to predict future activity by decomposing the spread into two different terms, one which accounts for future expected rates and one which accounts for the term premium.[2]

Imagine that we have a short and a long riskless rate. If there are no liquidity or risk differences between the two, the spread between both rates has to be a consequence of a difference in expected real rates and expected future inflation rates with respect to the current period. This simple realization allows us to infer the reasons why the value of the spread today may be related to future activity.

[2] This decomposition hinges on the existence of a term premium, which may stem from either a risk premium or a liquidity premium. They differentiate both terms by using an IV estimator. This decomposition is necessary if risky interest rates are used, given that, as we develop below, the term premium and the future expected rates term have opposite implications in terms of the predictability of future activity.

The first and most widely used argument, rests on *current* monetary policy, and its countercyclical character. Suppose that the Central Bank adopts a transitory expansionary monetary policy and increases money supply. This will be associated with an immediate decline in short-term rates, both nominal and real. However, longer term rates will move down by a lesser amount, both because a current monetary expansion raises long term inflation expectations and because it will be expected that the Central Bank will revert back to a contractionary policy, neutral or anti-inflationary in the future, with the subsequent increase in short rates. These two combined movements of short and long rates make the spread increase, causing a steepening of the yield curve. Given that the cause of the widening of the spread was an expansionary monetary policy that leads to lower current real rates, an increase in real activity is expected to follow, and thus the bigger spread would be anticipating an increase in real activity.

A similar argument rests, instead, on *expected* future monetary policy. If the market expects a future expansive monetary policy, the real rate of interest will be expected to decrease which in turn would expand output in the future. At the same time, the current nominal long term rate of interest will increase if inflationary expectations are created. For this argument to lead to the positive relationship between current spreads and future activity the expected increase in inflation must be bigger than the expected decrease in the real rate.

A more formal treatment of these monetary policy–related arguments can be found in the model that incorporates a monetary policy reaction function in Estrella (1997). In this model of dynamic rational expectations with a monetary policy reaction function, a positive relationship is obtained between the yield curve slope and future growth in real activity if the Central Bank is targeting real activity. If the only objective of the Central Bank is inflation, then this link disappears.

This latter argument is not a minor point. For the spread to have any predictive power, and this rests mainly on the above arguments all of which are related to real-side implications of monetary policy, or at least to be manifest in the data, we need the Central Bank to have a stance (officially or unofficially) of carrying countercyclical monetary policy. The Fed indeed has this explicit function, whereas the ECB does not have it as an *official* objective.[3] Even so, we believe that in the light of the ECB's actions during the last recession, it can be considered, at least unofficially, to have a secondary objective of influencing the real side of the economy.

Additionally, we need the CB's monetary policy to be effective in affecting real activity, should it decide to do so Regarding the effectiveness of monetary policy, or the ability of the CB to influence economic activity, some issues have to be mentioned. The first of these relates to the independence of the CB as the only institution responsible for making policy decisions. If the CB is not independent from the government and is required to finance government budget

[3] Most national Central Banks of the European countries prior to EMU did not have as a formal objective that of influencing the real side of the economy either, especially during the transition period before 1999.

deficits, then one would not expect the term spread to truly reflect expectations about future rates or inflation, given that monetary policy would be conditioned by the financial needs of the government. Effectiveness of monetary policy consequently depends on the ability of the CB to deploy its instruments without being influenced or constrained by the fiscal side of the economy. Thus, it is now generally accepted that fiscal and monetary policy decisions should be made by independent institutions, and that central banks should be completely detached from the Government structure. Specifically, both the Fed and the ECB are independent institutions, this independence being more evident, if possible, for the ECB. Of course, this has not always been the case: Some of the European nations had to legally overcome a history of formal dependence of the CB before they could take part in the European Monetary System (EMS) and, later, in the euro area. This casts some serious doubts about the extent to which term spreads may have been reflecting future economic conditions in those countries.

A second issue that has arisen in international comparisons of the predictability of real activity from financial or monetary variables, is that this effect will be more intense in countries with *internationally* independent monetary policies, such as Germany and the US (Bernard and Gerlach, 1998). Given that our objective in this paper is to analyze the predictive power of financial variables in European countries, two considerations make this independence difficult to justify for a subset of the countries used in the analysis. First, the EMS arrangement that required European countries to actively manage the exchange rate and keep it within a band, was for all purposes constraining the monetary policy of the member countries, especially of those whose currency was subject to higher pressure and volatility. A second, less subtle dependence was created during the very process that led to the birth of the ECB: The Maastricht Treaty convergence criteria that EU countries had to meet to take part in the euro area forced small European countries to keep some macro variables, most notably inflation and interest rates, within a certain range from those of the best performing countries, of which Germany was the immediate reference. Thus, the monetary policy of these EU countries was effectively constrained by their need to meet the convergence criteria. Some of these countries, mostly the Southern European countries (Italy, Portugal and Spain) had to accept, in fact, painful real effects in their economies in order to maintain the value of some nominal variables within convergence levels.

All the reasons outlined above, which directly impede the ability of the central bank to influence real activity, lead us to expect a lower predicting power of domestic spreads for Spain with regards to future activity, more noticeable given the dissimilarity of the Spanish economy with that of the EU reference country, Germany (so that the necessity to keep financial variables in line with those of Germany has effectively constrained Spanish monetary policy effectiveness).

Some simple dynamic IS-LM models can also be used to show a relationship between current spreads and future activity. In a world of sticky prices in the short run (so constant expected inflation), short term fluctuations lead mostly to output changes, and therefore interest rates must be increasing to maintain equilibrium in the money market. Thus, expecting future output shocks leads to expected increases in the interest rates and the spread today should widen to reflect those expected higher future rates.

Other, more formal, arguments have been developed that point at the existence of a positive relationship between the slope of the yield curve and future activity. Harvey (1988) develops a CCAPM model that yields this relationship based on the smoothing of consumption (easily detectable in the traditional Euler condition). Kydland and Prescott (1988) set up an RBC type of model where again consumption smoothing leads to a similar solution (and to the same first order condition; see Romer, 1998). In their setting, expected productivity shocks which lead to an increase in expected future output also lead to a higher real interest rate as agents substitute current for future consumption with the corresponding steepening of the yield curve. Given that these models are specified in terms of real rates, if we use nominal rates in the analysis, we need to assume that inflation expectations do not play a role (or that inflation expectations are the same regardless of the time horizon or interest maturity).

Some alternative analyses of spreads have used risky rates to compute the spreads. Analysis on the Paper-Bill Spread, the difference between a short term risky rate and the riskless rate and on the term spread on risky rates, the difference between a long term risky rate and a short term risky rate, lead in fact to the opposite relationship: A narrowing of those spreads is identified with a lower probability of recession or with higher future real activity.[4] In this paper we do not focus on these spreads, which reflect market's expectations of risk more than monetary policy actions or effectiveness.

Empirical analyses of the predictive power of term spreads can be found in Estrella and Hardouvelis (1991) for the US economy and Davis and Fagan (1997) for a group of developed economies, where also predictability of inflation rates is analyzed; Bonser-Neal and Morley (1997), Estrella and Mishkin (1997) and Bernard and Gerlach (1998) analyze this predictability in a multi-country setting; Estrella, Rodrigues and Schich (2000) study the stability of this predictive relationship, concerned mostly about a Lucas type of critique. For specific countries, Davis and Henry (1994) analyze the case of the UK, Smets and Tsatsaronis (1997) put special emphasis in the evidence for Germany and its comparison with the US and Atta-Mensah and Kacz (2001) study the case

[4] Friedmann and Kuttner (1993, 1998) show how the spread between risky commercial paper and riskless T-bills leads cycles, but the relationship is in this case negative. A current higher spread signals that the perceived risk in the economy is higher, thus predicting less future activity and a higher probability of recession. Hamilton and Kim (2002) use the risky term spread, where a risky long term rate is subtracted of a risky short term. This spread is incorporating both expected increases in real rates and inflation rates and expected increases in the risk of the economy. An increase in expected risk anticipates a higher probability of output reductions (recessions) and therefore an increase on the spread of risky assets could be negatively related to future activity and this effect should be decoupled from the usual positive relationship explained above.

Kwark (2002) builds a more formal general equilibrium model that yields this same conclusion in the context of risky loans and investment decisions. In Kwarks's model, investment is done before shocks hit the economy. Therefore, when a positive shock narrows the spread by lowering the default risk of risky loans, this increases investment in the following period and therefore the narrowing of the spread is leading increases in future activity.

of Canada. Lahiri and Wang (1996) provide a survey of and extensions to the theory and results on the predictive power of the spread. We review in greater detail some of the more relevant evidence for our paper, focused on Europe and Spain, in Subsection 2.3.

## 2.2 Other relevant variables

Other financial variables that have been found to have predictive power about future activity are foreign spreads, stock returns, exchange rates, central banks' discount rates and monetary aggregates.

### 2.2.1 Foreign Spreads

The term "foreign spreads" may be a little misleading, since it can be interpreted as the *term spread in foreign countries* or as the *spread between a national and a foreign interest rate.*

In the case of the spread between a domestic and a foreign interest rate, the argument follows from uncovered interest parity, by which the current spread should be reflecting information about the future evolution of the exchange rate. Therefore, if there is a link between the exchange rate and real activity, the current foreign spread should be predicting expected activity. A bigger spread now (the national interest rate is higher) reflects expectations of future depreciation of the national currency, associated with an expansion in real output. Davis and Henry (1994) and Davis and Fagan (1997) show that there is some mild predictive power in these foreign spreads, but secondary to that of the domestic term spread.

The other possible foreign spread that could be used is the term spread in a foreign country. For instance, using the term spread in Germany or the US to predict future activity in Spain. There are three channels for predictive power of these spreads. First, spreads in foreign countries may be predicting future activity in those countries. If these countries are significant trade partners or big economies that can impact the world interest rate (think of the last US recession and its influence on world interest rates) then future activity in the domestic country will be influenced in the same way. Second, the spread in the foreign country may be reflecting the monetary policy in that foreign country. If the domestic country's monetary policy is tied to or dependent on that of the foreign country (think of the EMS system or of the Maastricht requirements that we mentioned above, which for all purposes constrained some European economies to not have a monetary policy focused on targeting real activity, but on tracking Germany's inflation and interest rates) then foreign spreads may well be more informative about future domestic activity than domestic spreads. Third, there might be a regularity in the timing of business cycles across countries: The US cycle, for example, may be leading the cycle in other Western economies if they are all affected by the same external factors. That is, there may not be a direct transmission of cycles from one economy to another, but there may be common factors that affect the different economies in the same way. However, this effect may not be simultaneous but instead the different economies may take more time to react to those factors. In this regard, there is some evidence that the US cycle leads other developed economies.

Bernard and Gerlach (1998) use the latter type of spreads and show that US and German spreads add significant predictive power to national spreads for a set of developed countries. Fernández Galar (2001) gives evidence for a related effect by showing that real activity (proxied by recession dummies) in Germany leads real activity in Spain.

#### 2.2.2 Exchange Rates

Davis and Fagan (1997) comment how the evolution of the exchange rate was frequently used by small economies as a predictor of future activities. These arguments are all based on the expansionary effects of real depreciations, which tend to be associated with expectations of output growth. Also, some of the arguments for a causal link between the spread and future output rested on the information contained in the spread about the future evolution of the exchange rate. Thus, we would expect exchange rate depreciations to predict an increase in future activity, and therefore a lower probability of a recession.

#### 2.2.3 Changes in Short and Long Rates

Changes in the interest rates at the different ends of the yield curve may also be informative about future output. A widening of the spread may come both from the short rate going down or from the long rate going up. Both movements may have slightly different implications with regards to future activity. If the long term rate increases, it can be caused by expectations of a future higher real rate of interest (in which case this would predict lower future activity) or by expectations of future inflation (which would be associated with higher future activity). Thus, the predictive content could actually go both ways. Our argument in Section 2.1 for expected monetary policy required the real rate to be expected to go down by less than the inflation expectations would go up, which is exactly parallel to our rationale above.

On the other hand, if it is the short term rate that goes down, this will reflect a current expansive monetary policy which is unambiguously associated with positive real growth. Estrella and Hardouvelis (1991) and Estrella and Mishkin (1997) present some evidence for a differing effect of movements at the two ends of the yield curve, but again this effect is secondary to that of the spread. Annaert, de Ceuster and Valckx (2001) present a similar analysis, but based purely on the effect of interest rate volatility.

If risky interest rates are used, then this argument complicates further, given that an increase in long term rates may be associated with expected increases in risk, so there will be now three possible sources of movement of the long rate, with different implications with respect to future activity.

### 2.2.4 Monetary Aggregates

Some of the arguments developed above rely on financial variables reacting faster to monetary policy actions than real activity, which again leads us to think that it is monetary indicators that should be used as predictors. As Davis and Fagan (1997) comment, monetary aggregates have indeed been widely used as indicators of the monetary policy stance and of expected movements in output. However, they also note that monetary aggregates tend to be easily distorted by financial innovations and major financial events In fact, as Blinder (1998) states, most Central Banks have for all purposes abandoned monetary aggregates as intermediate targets, and agents and policymakers are increasingly looking at more stable (and more easily measurable) indicators.

Still, there is evidence (Estrella and Mishkin, 1998) that the evolution of some monetary aggregate has information additional to that of the spread and other financial variables.

### 2.2.5 The Central Bank's Discount Rate

A similar argument to what was said in the case of monetary aggregates applies here. If one could observe the CB's monetary policy stance directly, this would amount to observing the direct cause of future output changes. In other words, observing CB's actions should have information on the direction of future output movements. There is no easy way to gather information on the most frequently used instrument of monetary policy, open market operations. We do have access to another instrument, namely the discount rate. Changes in the discount rate affect directly the availability of funds for commercial banks, and therefore their ability to expand monetary base by giving loans. A lowering of the discount rate should have the same effects as a monetary expansion, and thus should be associated with higher future output and a lower probability of a future recession. However, the evidence in favor of the predictive power of the discount rate is weak. Estrella and Mishkin (1997) used it in their comparative analysis of European economies and found little evidence of significant predicting power.

### 2.2.6 Stock Returns

If stock prices are indeed forward looking variables that depend on the expectations of future dividends and firm profits, returns on a stock index today should be related with increased expected activity and therefore they should have predictive power additional to that of interest rates.

Evidence of the predictive power of stock returns can be found in Estrella and Hardouvelis (1991), Davis and Fagan (1997) and Estrella and Mishkin (1998). Annaert, de Ceuster and Valckx (2001) show the existence of an additional link between stock market volatility and future real activity.

### 2.3 Evidence for Europe and Spain

Evidence on the predictive power of the spread and other financial variables is still scarce for Europe, and much more scarce for most European countries: Published evidence so far has focused on Germany, the UK and France. The first multicountry analysis that includes evidence for European countries that we are aware of was carried out by Estrella and Mishkin (1997). They found that the term spread has a high predictive power for Germany and the US, but this power is significantly lower for France and still lower for Italy. Bernard and Gerlach (1998) found significant predictive power for some countries such as Canada, Germany, the US and France but much lower for Belgium, the UK, the Netherlands and Japan. They also found that German and US spreads can be used to predict future activity in some of the other European countries. McMillan (2002) reports a low informational content about future activity of the spread for the case of the UK. Ahrens (2002) reports also predictive power in the spread for eight OECD countries. He fits a Markov-switching process to the spreads, although he finds that the two-state process does not add much predictive power over the simple use of the spread.

The comments in Section 2.1, especially those related to the independency of monetary policies, make the analysis of a smaller European country, such as Spain, very relevant. Indeed, the evidence cited above for the case of Italy (Estrella and Mishkin, 1997) runs along this lines. The fact that the independency of the Spanish monetary policy can easily be called into question, especially in the last twenty years, makes it likely that the results that held for bigger countries such as the US, Germany or the UK may not hold for Spain. In fact, the only article along these lines that has so far focused on the Spanish case, Alonso et al. (2001), found that there is no predictive power at all in Spanish financial indicators, especially in the spread.

## 3 Methodology

We set now to analyze the evidence for the informational content of the term spread and other financial variables for the case of Spain. The theoretical arguments in Section 2 should be enough to make the analysis of Spain especially relevant. Evidence of predictive power has been found for other big European economies, but mostly for the major countries, which have autonomous monetary policies and are less dependent on neighboring economies. Spain is a mid-size country within the euro zone, which is quite dependent on both other European economies and on the US for trade purposes. Also, due to the willingness to join the EU and, posteriorly, the EMU its economic policies (both fiscal and monetary) have been substantially constrained by those of the other major EMU players, most notably Germany. The analysis of the predictive power of financial variables in Spain can therefore provide further insights on the relevance of the different determinants of that predictive power and clarify some of the conflicting arguments as to the direction of that predictability.

## 3.1 Data

Table 1 contains the main sources of our data, the measures employed for each of the conceptual variables and the available range for the different measures. Most of the variables are available for the period ranging from 1970:1 to 2002:1. Two variables effectively constrain the period of the sample to start in January 1979. The constraining variables are the interest rates on Spanish T-bills and the government bond yields, which are available only starting 3:1978 and 1:1979 respectively.

Insert Table 1

All the variables introduced have been transformed to guarantee stationarity. Interest rate changes are stationary by construction, so no transformation is necessary. The term spread has been subject to unit root tests, which reject the hypothesis of a unit root at the 1% confidence level. In the case of the real exchange rate, stock prices and the monetary aggregate, all of them present evidence of unit roots and are therefore included in the analysis in terms of their logarithmic growth rate.

The only variable that requires additional explanation is the recession indicator, but we defer discussion of that variable until Section 3.3.

## 3.2 Econometric Methodology

Following Estrella and Hardouvelis (1991), Estrella and Mishkin (1997, 1998) and Bernard and Gerlach (1998) we analyze the predictive power of the spread and other financial variables when forecasting the probability of a future recession. Analyses with output growth (Estrella and Hardouvelis, 1991, Davis and Fagan, 1997, Hamilton and Kim, 2002) usually give poorer results. First of all, given that recessions in developing economies are usually mild in terms of output declines, the dependent variable has little variation around its average value, especially during economic downturns. The information in the growth variable can be amplified by using an indicator for recessionary and expansionary months. Second, the spread has been found to predict better when drastic changes in output take place (Estrella and Hardouvelis, 1991). Given that these do seldom take place, the amplification provided by the binary variable can help detect the relevant relationships. Furthermore, the prediction of recessions on their own stance is important, given the (monetary and fiscal) policy interest and the public interest in understanding recessions.

Our dependent variable is defined as the indicator

$$y_t = \left\{ \begin{array}{c} 0 \text{ if month } t \text{ is an expansionary month} \\ 1 \text{ if month } t \text{ is a recessionary month} \end{array} \right\}$$

The definition of a month as a recessionary month deserves a further explanation, so we devote Section 3.3 to explaining the methodology used for the dating of the recessions.

Once we have the (0,1) recession variable, we use a probit model, where we specify the probability that the economy will be in a recession as a function of a single index that depends on a set of parameters $\boldsymbol{\beta}$, and a set of observable variables $\mathbf{x}_t$. These explanatory variables will usually be lagged values of our variables of interest (i.e. lagged spread, lagged German spread, etc.). Hereafter, we write $\mathbf{x}_{t-k}$ as the set of explanatory variables, to emphasize the fact that they are $k$-period lagged values or, alternatively, that we are trying to predict the probability of a recession $k$ periods ahead by using current information. Thus, the model is specified as

$$P(y_t = 1|\mathbf{x}_{t-k}, \boldsymbol{\beta}_k) = F(\boldsymbol{\beta}_k' \mathbf{x}_{t-k}) = F_t \tag{1}$$

where $F$ is, in this case, the cumulative distribution function of the normal distribution. Of course, given the definition of our dependent variable it follows

$$P(y_t = 0|\mathbf{x}_{t-k}, \boldsymbol{\beta}_k) = 1 - F(\boldsymbol{\beta}_k' \mathbf{x}_{t-k}) = 1 - F_t \tag{2}$$

from where the full (log)likelihood of a sample can be constructed, given values of the observable variables $\mathbf{X}$:

$$L(y_t, ...y_1|\boldsymbol{\beta}_k, \mathbf{X}) = \sum_{y_t=0} \ln(1 - F_t) + \sum_{y_t=1} \ln(F_t) \tag{3}$$

Estimation of these parameters by QMLE is straightforward since the likelihood function is globally concave. The interpretation of the value of the parameters is a little more involved, given the inherent nonlinearity of the model. Thus, the marginal effect of $\mathbf{x}_t$ corresponds now to the increase in the probability that $y_t$ will be equal to one given an increase of one unit in $\mathbf{x}_t$, but the formula for that marginal effect (which is, of course, the derivative of $F_t$ with respect to $\mathbf{x}_{t-k}$) is equivalent to $\frac{\partial P(y_t=1)}{\partial \mathbf{x}_{t-k}} = \boldsymbol{\beta}_k \frac{\partial F_t}{\partial\left(\boldsymbol{\beta}_k' \mathbf{x}_{t-k}\right)} = \boldsymbol{\beta}_k f_t$, where $f_t$ is the density function of the normal variable for the value of the indicator $\boldsymbol{\beta}_k' \mathbf{x}_{t-k}$.[5] Also, $R^2$ as a function of the sum of squares loses its meaning. Alternative measures of the goodness of fit have been proposed, and we use the pseudo-$R^2$ of Estrella (1998) which can be calculated as

$$\mathbf{R}^2 = 1 - \left(\frac{L_u}{L_c}\right)^{-\frac{2}{N} L_c} \tag{4}$$

where $L_u$ is the value of the above (log)likelihood of the estimated (unrestricted) model, and $L_c$ is the (log)likelihood of the model where all slope parameters have been set to zero.

Once the parameters have been estimated, forecasts of the probability of recession can be constructed by collecting data on $\mathbf{x}_{t-k}$. A simple one-period

[5] The interpretation of the sign of the parameters, however, is the same as that in linear models.

ahead prediction of the probability that the economy will go into a recession in the following period could be obtained by estimating the model as

$$\widehat{P}(y_t = 1|\mathbf{x}_{t-1}, \widehat{\boldsymbol{\beta}}_1) = F(\widehat{\boldsymbol{\beta}}_1' \mathbf{x}_{t-1}) \tag{5}$$

and the predictions can, of course, be made for a longer horizon of $k$ months into the future by reestimating the model using

$$\widehat{P}(y_t = 1|\mathbf{x}_{t-k}, \widehat{\boldsymbol{\beta}}_k) = F(\widehat{\boldsymbol{\beta}}_k' \mathbf{x}_{t-k}) \tag{6}$$

In this paper, to keep the parallelism with some of the cited references, we predict recessions one month ahead, and one to eight quarters ahead, so $k$ in our case will be $k = 1, 3, 6, 9, 12, 15, 18, 21, 24$.

There is a problem with the standard errors of this estimate, given that the $k$-period ahead forecast introduces an MA structure in the errors which deems regular QMLE standard errors inconsistent (Hansen and Hodrick, 1980, for the discussion when $y_t$ is a continuous variable; Poirier and Ruud, 1988, and Estrella and Rodrigues, 1998, for the discussion on the 0-1 dependent variable). To complicate matters further, the errors in the original variable (which could be interpreted as a continuous version of the recession indicator) are not observable, and therefore it is not easy to account or correct for possible time structure in those errors.

We follow here the procedure of Estrella and Rodrigues (1998), that build from a GMM interpretation of the first order conditions of the QMLE estimator of the regular probit model.

In the above model, define $f_t = F_t'$, $u_t = y_t - F_t$ and $w_t^2 = 1/F_t(1-F_t)$. Then the FOC of the QMLE estimate of $\boldsymbol{\beta}_k$ that come from setting the derivatives of $L$ with respect to $\boldsymbol{\beta}_k$ equal to zero are:

$$\sum_{t=1}^{T} u_t w_t^2 f_t \mathbf{x}_{t-k} = 0 \tag{7}$$

These equations, which could be used as the moments of a GMM estimator, can be interpreted as a non-linear least squares problem that minimizes a quadratic function of $u_t^2$. Under some assumptions on the distribution of the $\mathbf{x}$, the estimators are consistent regardless of the structure of the errors. We can then construct a GMM estimator of the covariance matrix of these moment conditions, which would yield consistent estimates of the covariance of the estimates. Define $h_t = u_t w_t^2 f_t \mathbf{x}_t$ and $h = \sum_{t=1}^{T} h_t$. Estimation in the GMM framework implies selecting the values of the elements in $\boldsymbol{\beta}_k$ that minimize $h'Wh$ for some weighting matrix $W$. Note that any positive definite $W$ will produce the QML estimators, given that the number of moment conditions (the derivatives of $L$ with respect to $\boldsymbol{\beta}_k$) is the same as the number of parameters.

We need to estimate now the covariance of the parameter estimates, which is a function of the covariance of the moments, $h$, and of the derivatives of the moments with respect to the parameters. For the variance of the moments we use the sample autocovariances of $h$

$$\Omega_j = \frac{1}{T} \sum_{t=j+1}^{T} h_t h'_{t-j} \tag{8}$$

from which we can construct a Newey-West type estimator by weighting the autocovariances

$$S = \Omega_0 + \sum_{j=1}^{m} \lambda_j \left( \Omega_j + \Omega'_j \right) \tag{9}$$

where if $\lambda_j = 1$ we have the regular estimator in Hansen (1982) and if we set $\lambda_j = 1 - \frac{j}{m+1}$ we have the Newey-West (1987) weighting scheme. With a proper selection of $m$ (that grows with $T$ but at a fractional power), this matrix is a consistent estimator of the covariance matrix of the orthogonality conditions (moments).

Given that we have the estimates for the parameters obtained with $W = I$ (there is no asymptotic gain in using other weighting matrices) a consistent covariance matrix for the GMM estimator, is, following the general formula in Hansen (1982),

$$V = \frac{1}{T} \left( H'H \right)^{-1} H'SH \left( H'H \right)^{-1} \tag{10}$$

where $H = \frac{1}{T} \frac{\partial h}{\partial \beta} = \frac{1}{T} \sum_t \frac{\partial h_t}{\partial \beta}$ and $S$ is defined above.

With this correction to the standard errors, the FOC of the QMLE can be used to get consistent point estimates of the parameters and then to get the correct standard errors and t-stats. We follow this procedure and compute, along with the regular QMLE standard errors, Hansen-corrected and Newey-West corrected standard errors, all of them with lag length $m$ equal to the one dictated by Newey-West's rule of $m = 4(N/100)^{\frac{2}{9}}$. Estrella and Rodrigues (1998) do not find any of the two versions of the corrected standard errors to dominate the other, so we have decided to present both sets, along with the regular QMLE errors.

### 3.3 Dating the Recessions

The definition of certain months or quarters as recessionary months is not an easy task. In the case of the US, for example, the NBER defines which quarters are officially considered recessionary, but the procedure has been subject to criticism. The OECD is now elaborating a turning point list for its members, but the list of the countries for which it is elaborated is so far incomplete and the dates are still being subject to scrutiny by both academic and policy-makers. Furthermore, the data series used for dating each country's phases are different, and thus the procedure makes the results across countries less directly comparable.

The issue of how to detect the phases of the cycle is in fact still a subject of heated debate among academics. In particular, there are two main approaches currently being used to locate the expansionary / contractionary phases of a cycle. One, pioneered by Hamilton (1989) advocates a parametric specification of the data generating process of the variable of interest, where two different regimes are allowed, one which corresponds to the expansions and therefore contains some type of upward trend and another which corresponds to the contractions and therefore contains a downward trend. Examples of this approach are Goodwin (1993), Diebold and Rudebusch (1996) and those contained in the book by Kim and Nelson (1999). The second approach takes a nonparametric perspective, and instead of fitting a fully-specified statistical data generating process, looks at the original data series in search for the specific features of the cycle. That is, this procedure looks for periods of generalized upward trend, which will be identified with the expansions, and periods of a generalized downward trend which will be identified with the contractions. The key feature of this analysis is the location of turning points, peaks and troughs, in the series. These turning points, that correspond to the switch from an expansion to a contraction (peak) and viceversa (trough) determine the different phases of the cycle. This approach was first applied by Bry and Boschan (1971) to the location of business cycles, but has since then been used also by Watson (1994), Artis et al. (1997) and Harding and Pagan (2000, 2002a).

We consider that the advantages of the nonparametric approach, and its intuitiveness make it a preferred methodology,[6] and so we use the results in a paper by Gómez Biscarri (2002) that uses the Bry-Boschan nonparametric algorithm to date the expansions and contractions in a set of 14 European countries and the US. This paper incorporates the modifications in the original algorithm introduced by Artis et al. (1997), who use only one series of industrial production to locate the turning points. The results in Artis et al. (1997) have been widely used by researchers doing analyses similar to ours. However, the data in that paper covered a period ranging only up to December, 1993. The paper by Gómez Biscarri (2002) uses the same algorithm to locate the recessionary months but the data continue until January 2002, thus making it ideal for our purposes. The cited paper contains all the details of the dating algorithm and comparisons with the results in AKO.

Figure 1 shows the series of Spanish industrial production used in the cited paper, where the identified recessionary periods (those ranging from a peak to a trough) have been shaded for convenience of inspection. The specific dates of the peaks and troughs obtained, that mark the beginning and end of the recessionary and expansionary phases of the Spanish cycles, are listed in Table 2. For the purposes of our analysis, those months between a peak and a trough are considered recessionary, and have a value of $y_t = 1$. Recessions are assumed to start the month following the peak and end the month identified as the

[6] We do not comment on the advantages / disadvantages of one approach vs. the other. A fascinating discussion can be found in the exchange between Hamilton (2002) and Harding and Pagan (2002b).

trough.

Insert Figure 1

Insert Table 2

# 4 Results

A probit equation of the form in (5) has been estimated using a range of independent variables. Common to all equations is the inclusion of the domestic spread, which is our main variable of interest. In addition to the domestic spread, we add one by one the other possible indicators, namely the German term spread, the US term spread, stock returns, real exchange rate appreciation, changes in short and long rates, changes in the Bank of Spain's discount rate and the rate of growth of a monetary aggregate. In all cases we estimate (5) for $k = 1, 3, 6, 9, 12, 15, 18, 21, 24$, thus analyzing the predictive ability of the spread at horizons of one month, and one to eight quarters. All the tables present the results of the slope coefficients of the relevant variables (the intercept is omitted) for the 9 different forecast horizons, and the three sets of t-statistics. Also, the tables include the pseudo $R^2$, that gives an estimate of the goodness of fit achieved by the variables in the model.

We do not comment on the differences between the three sets of t-statistics. It can be seen, though, that both sets of consistent standard errors (Hansen weighted and Newey-West weighted) yield very similar values of the t-stats, which are consistently smaller than regular QMLE t-stats. This result, robust across forecast horizons and independent variables, gives strong evidence for the existence of a time structure on the errors of the model, and therefore for the inconsistency of regular QMLE standard errors and t-statistics.[7] This evidence casts serious doubts on the results in other papers that have not used the correct standard errors. In fact, it can be seen that in several cases the correct t-stats are in the area of non-significance whereas the QMLE are in the rejection area. This is most noticeable, and most painful, in the case of the domestic spread (Table 3).

We turn now to an analysis of the different explanatory variables.

## 4.1 The spread and Foreign Spreads

Estimates for the model that uses the domestic spread as the only independent variable appear in Table 3. The coefficients are quite stable across forecast horizons, but also the fact that there does not seem to be any predictive power in the domestic spread is evident. QMLE t-stats are above significance levels, but the corrected t-stats are consistently below, and give no evidence of predictive power at all. The extremely low values of the pseudo $R^2$ confirm this result.

[7] If there were no time structure, then the autocovariances of the moments would all be zero and the three sets of standard errors would be identical.

Also, one can see that the sign of the coefficient changes across forecasting horizons with no clear pattern. There does not seem to be any difference in the predicting power across different horizons. This result is therefore extremely robust for our data and in line with the scarce literature that has analyzed the Spanish economy before (Alonso et al., 2001): The term spread in Spain does not have any power to predict future changes in real activity, and therefore, to give a warning for incoming recessions.

We have already hinted at the reasons why this could be the case. The fact that Spain does not have a clearly independent monetary policy, or at least it has not had it for the last twenty some years given its dependence on the government and its entry into the European Union, most likely accounts for this lack of informational content of financial variables. The Bank of Spain indeed became officially independent from the Government in the early 1990's, but mostly because of EU requirements. Then, the regulations of the EMS before its collapse in 1993 and the Maastricht convergence criteria after 1992 have caused that monetary policy in Spain post-1992 has been mainly determined by the need to meet Maastricht's monetary objectives and by the actions of Germany and, to a lesser extent, France. It is no surprise to see that financial and monetary variables in Spain seem to bear no relation with real activity.

Then of course the question is whether this dependency of Spain with respect to Germany is indeed there and reflected in the data. We show in Table 4 the results of the probit equation that includes now both the domestic term spread and the term spread of Germany. The results in that table are striking. The predictive content of the domestic spread is still nonexistent. However, the German spread presents a significant ability to predict Spanish recessions. This ability is highest at the one quarter horizon, but it remains fairly high up to four quarters into the future. The coefficient attached to the German spread is high and significant. Its predictive power peaks at one quarter, for which the pseudo $R^2$ is an impressive 33%, and then it declines consistently until it loses predictive power at the five quarter horizon. The sign of the coefficients is the predicted for riskless spreads (i.e. a widening of the spread signals an increase in activity and therefore a lower probability of a recession) and the magnitude of the coefficients evolves in a parallel way to the pseudo $R^2$, as is reasonable. One should not be surprised by this result, since it is giving confirmation to our previous story. It may be that the German spread is giving a reasonable picture of the monetary policy stance of the Bundesbank,[8] and, given that other European countries were followers of the Bundesbank policies, this stance also characterizes the stance of other Central Banks. An alternative reading of these results could be that the German spread is predicting recessions in Germany that get afterwards transmitted to Spain given the dependence, in real terms, of the Spanish economy with respect to that of Germany. However, this real dependence is probably not that strong to justify such a powerful influence.

[8] We have to consider that our data only contain three years of the period during which the ECB has been operating. The fact that the results are stable also for the ECB period give additional insights that confirm the fact that the monetary policy within the union may be too highly influenced by German economic conditions.

Table 5 shows the results of using the US term spread instead of the German. Again, the results for the domestic spread do not change at all. The US spread seems to have no predictive power for Spanish recessions in short horizons (one month or one-two quarters). However, at a three quarter horizon the US spread begins to have significant predictive power, and this predictive power keeps increasing until quarter five, where it peaks at a level of the pseudo $R^2$ of 18%, which is quite high for such a long horizon. The predictive power stays for the seven and even eight quarter horizons. Again, the coefficients have all a negative sign, as predicted by most of our theoretical arguments. The reasons for this result are probably coming from the real side more than from the monetary side. Spain is very much dependent in real terms from the US. Thus, the predictive power of the US term spread might come from the fact that it can predict US recessions (this is by now a result that has been confirmed by many studies) that then get transmitted to the Spanish economy. This may be also the reason why the forecasting ability is not present for very short horizons, but only for medium terms. A second reason could just be the effect on the world interest rate of US monetary policy. Given the relevance acquired in the latter years by the actions of the Federal Reserve, it could be argued that the Fed's moves are taken as a reference by the rest of the countries, and then we have another "non-independent Spanish monetary policy" type of argument, but coming this time from the relevance of the US in the world economy and in world financial markets.

Table 6 presents the results of the analysis that includes all three spreads at the same time. The results are perfectly coherent with those in Tables 3-5 that only included one or two of the spreads: The values of the coefficients are very stable. That is, there does not seem to be a problem of collinearity of the spreads (which in the case of a probit equation might lead to more confusing effects than in the linear case). The predictive power of this equation is now high both for short horizons (where the German rate takes most of the power) and for long horizons (where the US spread does the work). At all horizons pseudo $R^2$'s are above 18%, and they reach 36% for one and two quarters. It seems, therefore, that an analysis that looked at these two spreads could do a substantial job forecasting the probability of recessions in Spain even for long horizons. The conclusion follows that these two spreads should be useful monetary indicators for the economic authorities of Spain. Now, of course, the monetary authority has been surrendered to the ECB (which most likely does use these two spreads as secondary indicators), but other government authorities should definitely take into account the information contained in these two financial indicators as a useful predictor of future real activity and of future recessions within the country.

Insert Tables 3-6

These two effects could, alternatively, be understood in the context of the literature that has focused on finding the macroeconomic factors that determine interest rates or stock returns (Dungey, Martin and Pagan, 2000 and references therein). What we have termed the *US effect* could be identified with a *world factor* in the terminology of the above literature, that is, with the influence of some factor related to worldwide economic conditions. In the same manner, the *German effect* would refer to a *European factor*, that measures economic conditions in Europe and that therefore has informational content about the evolution of the Spanish economy, which is directly subject to the influence of European economic conditions. Thus, we may have uncovered a possible decomposition of the evolution of the Spanish economy, that is subject to both world and European factors. The timing of the effect of these factors is still relevant: The world factor seems to affect Spain with a few quarters delay, whereas the European factor has more immediate effects.

## 4.2 Other variables

We comment now on the predictive power of other variables that were mentioned throughout Section 2.

First, we use an indicator of stock returns. Table 7 shows that there is very little evidence of stock returns having predictive power over real activity in the short run (one month or one quarter) or in the long run (six to eight quarters), but there is some mild predicting power over medium horizons (two to four quarters), although the goodness of fit statistic is never above 6%. The sign of the relationship is consistent across horizons, and consistent with the theoretical argument that forward looking stock prices will react (so the return will be positive) anticipating future growth in activity (so a lower probability of a recession). Thus, the use of stock prices as a possible indicator of future real activity by policymakers may be warranted, although its predicting power is not high.

Insert Table 7

Table 8 shows the results of the model that uses real exchange rate appreciations as possible indicators of future activity and of recessions. Results for this variable, along with the domestic spread, could not be more disappointing. No predictive power is apparent, the sign of the coefficients changes almost at random and the value of the coefficients swings wildly. There seems, therefore to be no information at all in real exchange rates, to predict future activity. Reasons for this lack of connection, considering that Spain is a moderately open country, may be that the floating band of the exchange rate (and the requirements to keep inflation and interest rates low during the Maastricht transition) forced Spain to keep a real exchange rate out of line with fundamentals. It could also be due to the fact that, as analyses of import and export elasticities show, neither exports nor imports are very sensitive, at least in a short run, to movements in the exchange rate. Therefore, a J-curve type of phenomenon would eliminate short term real effects from exchange rate depreciations.

Insert Table 8

Changes in interest rates at the different ends of the yield curve have some predictive power. The results in Table 9 show that changes in the long rate predict the probability of a recession, though mildly, at long horizons. The coefficient of the change in the long rate is positive, indicating that a steepening of the yield curve because the long rate increases tends to be associated with a higher probability of recession. Notice that including the changes in both rates in the equation is equivalent to including the change in the spread from the previous period, although allowing for the effect of both ends of the yield curve to be different. The fact that only the change in the long term has some predictive power hints at the fact that increases in the long rate are associated more with increases in expected real rates (if the government bond is considered to have a risk premium, the argument of increased risk would also apply) and not in expected inflation. Thus, an increase in the long rate would be associated with a higher probability of a future decline in activity.

Insert Table 9

Results on using the changes in the central bank's discount rate appear in Table 10. As was already found in Estrella and Mishkin (1997), the inclusion of a central bank rate does not seem to add much predictive power on top of what the spread has, which in this case is little anyway. As we have mentioned, the Bank of Spain has been substantially constrained in its use of the discount rate as a policy instrument aimed at real activity. It is not surprising to find therefore, that the interest rate in its direct control seems not to have any information about the evolution of output.

Insert Table 10

The last variable we analyze is a monetary aggregate, measured by M3. Growth of monetary aggregates has been a traditional intermediate target of monetary policy, especially in big countries. Results of including the growth rate of M3 in the probit equation, shown in Table 11, are so disappointing that they do not merit further comment. There are at least two possible reasons for this lack of predictive power. First, as we have mentioned before, Central Banks have almost unanimously substituted monetary aggregates as immediate targets of monetary policy for more easily manageable variables such as interest rates (Blinder, 1998). Second, it may be argued that it is real money that influences activity. However, it is probably growth in nominal money that gives a better idea of the contractiveness or expansiveness of monetary policy, regardless of the inflationary consequences. Also, throughout the period studied (the 1970's are not included due to data constraints), inflation rates have been more stable in Spain, although declining. This means that latter growth rates in real M3 are higher than those at the beginning of the sample. In any case, the performance of the variable is very poor. There does not seem to be any predictive power of increases in the quantity of money regarding future activity. The additional argument by Davis and Fagan (1997) that monetary aggregates are too subject to financial events and innovations in financial practices to be very useful in practice may apply here.

Insert Table 11

Finally, we estimate a complete model, where we include all the variables that have been found to be relevant in the last analyses. Results for this model, that includes foreign spreads, the changes in the short and long rate and the return of the stock index, are shown in Table 12. It can be seen that the coefficient estimates, their signs and their significance remain stable (thus not hinting at problems of collinearity among our explanatory variables). In fact, the only significant change is that now the change in the short rate seems to show some predictive power at short horizons, with the predictability going in the direction that should be expected: The sign is positive, showing that an increase in the short rate is associated with a higher probability of recession, or with an anticipated decline in real activity, which is what we should expect given that changes in short rates correspond to changes in the real rate or, in other words, to a tightening of current monetary policy. The predictive power of the full model is slightly above that of the model with the foreign spreads, reaching a pseudo $R^2$ of 39% at a two quarter horizon. The improvement provided by the stock return variable and by the changes in the rates is not big, though, so it looks that the model with the three spreads is quite a good predictor of future activity or of recessionary periods.

Insert Table 12

## 4.3 In sample forecasts

We review in this subsection the performance of some of the estimated models in terms of in-sample prediction of the recessionary periods. Thus, we estimate the models using the data for the whole sample, and we then find the fitted values of $y_t$, or the best guesses for the probability of a recession $k$ months ahead, given data up to $\mathbf{x}_{t-k}$. In other words, in the graphs we are going to plot the estimate of the probability of being in a recessionary month at time $t$ given data that was available $k$ months before.

$$\widehat{P}(y_t = 1|\mathbf{x}_{t-k}, \widehat{\boldsymbol{\beta}}_k) = F(\widehat{\boldsymbol{\beta}}_k' \mathbf{x}_{t-k}) \tag{11}$$

The forecasts are in-sample given that we do use all the data available to estimate the parameters of the relationship and make the predictions of the value of $y_t$.

Figures 2 and 3 plot the forecasted probability of a recession at time $t$ given data up to time $t-k$ (values for $k$ are $1, 3, 6, 9, 12, 15, 18, 21, 24$), for the model that uses only the domestic term spread as explanatory variable. The graphs include a line that marks the recessionary periods (i.e. those for which the predicted probability should be one). It is clear from both figures that the performance of the domestic spread is quite poor, and not much can be gained in terms of predicting recessions from looking at that variable.

Insert Figures 2 and 3

Figures 4 and 5 plot the same series of in-sample forecasts of the probability of a recession coming from the model that includes the German and the US spread. We can see that now the first two recessions and the last one in 2001 can be quite accurately predicted, and this predictive power is best at a 1-2 quarter horizon. It can be seen ,though, that the model misses one of the recessionary periods, and gives a false signal for another period in the mid 1990's. Surprisingly enough, these two mispredictions improve somewhat when the forecasting horizon lengthens.

Insert Figures 4 and 5

Figures 6 and 7 show the final results of in-sample forecasts for the full model that incorporates also the changes in short and long rates and the stock returns. The results do not change much for this model, and even though the predictive power is slightly improved, the additional variables do not seem to add much in terms of improving the forecasts.

Insert Figures 6 and 7

Figure 8 shows the evolution of the pseudo $R^2$'s for the different models that we have commented on, which are, along with the in-sample forecasts, a measure of how good a fit the models are providing to the probability of recession. It is interesting to see the differing effect of the US and the German spread (in Figure 8a), and how the rest of the variables, even those that yielded significant coefficients, provide close to no improvement over the domestic spread (Figures 8b and 8c), although in the full model they add a little predictive power at all horizons (Figure 8d).

Insert Figure 8

### 4.4 Out of sample forecasts: A Recession in 2001?

Even though in-sample forecasts usually yield fairly good predictions, most models are found to perform quite poorly when asked to predict out of sample (Estrella and Mishkin, 1998). Thus, we conduct a simple, and at the same time interesting on its own right, exercise of out of sample forecasting. We reestimate our full model, using initially only data from 1979:1 to 1999:12. Then, using the estimated parameters and the next observation of the explanatory variables we predict the value of $y_t$ for the next period. That is, we calculate a one step ahead forecast of the probability of recession, given only past data. For example, in the one month forecasting horizon we would estimate the model using data on $y_t$ from 1979:2 to 1999:12 and data on the explanatory variables from 1979:1 to 1999:11. Then, given the estimated parameters, we predict the value of $y_t$ in 2000:1 using the value of the explanatory variables in 1999:12. Thus, we are emulating the process that a policymaker would follow when estimating future probabilities of recession, by reestimating the model every time a new datapoint is available. We keep doing the process until the last observation, in 2002:1. Thus, the last 25 predictions in the graphs in Figures 9 and 10 are done in a recursive way, whereas the first 250 are just simple in-sample predictions done with the data from 1979:1 to 1999:12. It can be seen in the Figures that one could have done a great job at predicting the recession (or, even though it may not qualify "officially" as a recession, there definitely was a deceleration of economic activity and industrial production) in late 2000 and early 2001, which mildly hit some of the Western economies. Notice that the predictions, especially those at longer horizons, are done *without using any data on the incoming recession*, that is, the fact that the estimated probabilities jump and accurately predict the recession is based exclusively on the past performance of the explanatory variables to predict recessions.

Insert Figures 9 and 10

The conclusion from this out-of-sample exercise is quite striking, then. A Spanish policymaker doing a similar analysis, and updating the estimates as information became available would have been able to give quite an accurate prediction of the incoming recession three and even four quarters ahead. This is good news, for it does confirm the predictive power, even out of sample (which is the interesting feature of the analysis for policymakers), of a simple model that includes only three financial variables and, maybe, some information on stock prices.

# 5 Conclusions

We have conducted an analysis on the informational content of some financial variables, such as domestic and foreign term spreads, stock prices and real exchange rates, about future real economic activity (proxied by an indicator of the recessionary months). We have focused on analyzing the case of Spain, a midsize European economy with severe constraints on the independence of its monetary policy.

Our results show that the domestic spread has absolutely no informational content about future real activity, whereas the German spread has substantial predictive power in the short term (1-3 quarters) and a US term spread has predictive power in the longer term (5-7 quarters). This of course constitutes evidence in favor of the informational content of spreads in general, but only when the monetary policy of the country in particular is independent. In the case of Spain, where there are reasons to suspect that its monetary policy was highly dependent on that of Germany, and of course highly affected by that in the US, the domestic spread loses all informational content. On the other hand, the spreads of those two countries contain significant information about the future. We identify the German and US spreads as a "European" and a "world" or "American" factor respectively: These variables are informative about the general economic conditions in both Europe and the rest of the world and therefore should have informational content about economic conditions in Spain. We show that the relationship between these two factors and the Spanish economy are robust and stable over time, to the extent that the deceleration that took place in industrial production in Spain in late 2000 could have been accurately predicted as far as four quarters in advance.

Other variables such as the changes in different interest rates, stock prices, exchange rates and monetary aggregates have very little, if at all, informational content about future activity. The cases of the real exchange rate, the discount rate and the monetary aggregate are especially surprising: There is no evidence of any predictive content in these variables, one of which is usually regarded as a forward looking variable, and the other two which are directly controlled by monetary policy and used as direct instrument and intermediate target, respectively. Further investigation of the reasons for failure of these two variables is therefore a priority both for researchers and for policymakers, especially given our objective of trying to understand the channels through which policy instruments, or variables that can be influenced by policy, affect the real side of the economy.

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**Table 1**

Sources of Data and Measurement

| | Measure | Source | Range |
|---|---|---|---|
| Recession Indicator | 0,1 Indicator for contractionary months | Gómez Biscarri (2002), from IIP index | 1:1970-1:2002 |
| IIP Index | SA Index of Industrial Production | OECD Main Economic Indicators | 1:1970-1:2002 |
| Short-Term Rate | Interest Rate on T-Bills | IFS of the IMF | 1:1979-1:2002 |
| Long-Term Rate | Long Term Government Bond Yield | IFS of the IMF | 3:1978-1:2002 |
| German Spread | Long Term Government Bond Yield minus Interest Rate on T-Bills | IFS of the IMF | |
| US Spread | 10 Yr. Government Bond Yield minus Interest Rate on 3 month T-Bills | Federal Reserve Bank at St. Louis | 1:1970-1:2002 |
| Stock Market Index | General Index of the Madrid Stock Exchange | Madrid Stock Exchange Research Dept. | 1:1970-1:2002 |
| Real Exchange Rate | Real Effective Exchange Rate | OECD Main Economic Indicators | 1:1970-1:2002 |
| Quantity of Money | M3 | IFS of the IMF | 1:1970-1:2002 |

**Table 2**

Identified Peaks and Troughs for Spain (Based on IIP Index)

| | Date |
|---|---|
| Trough | |
| Peak | 01/74 |
| Trough | 01/75 |
| Peak | 03/80 |
| Trough | 08/82 |
| Peak | 06/90 |
| Trough | 04/93 |
| Peak | 05/95 |
| Trough | 04/96 |
| Peak | 11/00 |

**Table 3**
Parameters and pseudo-R2 of the model with Domestic Spread
QMLE, Hansen and Newey-West corrected t-stats in brackets

| | FORECASTING HORIZON | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1Month** | **1 Q** | **2 Q** | **3 Q** | **4 Q** | **5 Q** | **6 Q** | **7 Q** | **8 Q** |
| **Spread** | **-0.172** | **-0.164** | **-0.144** | **-0.144** | **-0.151** | **-0.160** | **-0.166** | **-0.184** | **-0.219** |
| QMLE | -3.341 | -3.207 | -2.856 | -2.786 | -2.860 | -3.006 | -3.130 | -3.450 | -3.979 |
| Hansen | -1.225 | -1.269 | -1.172 | -1.168 | -1.179 | -1.174 | -1.232 | -1.364 | -1.562 |
| Newey-West | -1.563 | -1.619 | -1.477 | -1.460 | -1.486 | -1.501 | -1.569 | -1.737 | -1.993 |
| **Pseudo R2** | **0.034** | **0.031** | **0.025** | **0.025** | **0.029** | **0.032** | **0.035** | **0.042** | **0.059** |

**Table 4**
Parameters and pseudo-R2 of the model with Domestic and German spread
QMLE, Hansen and Newey-West corrected t-stats in brackets

| | FORECASTING HORIZON | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1Month** | **1 Q** | **2 Q** | **3 Q** | **4 Q** | **5 Q** | **6 Q** | **7 Q** | **8 Q** |
| **Spread** | **-0.034** | **-0.009** | **0.002** | **-0.041** | **-0.089** | **-0.121** | **-0.137** | **-0.157** | **-0.197** |
| QMLE | -0.847 | -0.211 | 0.036 | -0.697 | -1.534 | -2.143 | -2.471 | -2.842 | -3.530 |
| Hansen | -0.346 | -0.099 | 0.020 | -0.321 | -0.629 | -0.830 | -0.966 | -1.118 | -1.382 |
| Newey-West | -0.429 | -0.120 | 0.023 | -0.390 | -0.791 | -1.064 | -1.233 | -1.427 | -1.765 |
| **German Spread** | **-0.939** | **-0.961** | **-0.855** | **-0.679** | **-0.471** | **-0.320** | **-0.258** | **-0.261** | **-0.246** |
| QMLE | -8.498 | -8.845 | -8.226 | -6.885 | -5.051 | -3.574 | -2.971 | -3.003 | -2.743 |
| Hansen | -3.304 | -3.528 | -3.440 | -2.886 | -2.066 | -1.393 | -1.137 | -1.144 | -1.092 |
| Newey-West | -4.181 | -4.499 | -4.348 | -3.627 | -2.612 | -1.785 | -1.467 | -1.471 | -1.399 |
| **Pseudo R2** | **0.327** | **0.333** | **0.285** | **0.212** | **0.129** | **0.081** | **0.067** | **0.075** | **0.088** |

**Table 5**
Parameters and pseudo-R2 of the model with Domestic and US spread
QMLE, Hansen and Newey-West corrected t-stats in brackets

| | FORECASTING HORIZON | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1Month** | **1 Q** | **2 Q** | **3 Q** | **4 Q** | **5 Q** | **6 Q** | **7 Q** | **8 Q** |
| **Spread** | **-0.167** | **-0.148** | **-0.114** | **-0.101** | **-0.098** | **-0.106** | **-0.117** | **-0.146** | **-0.188** |
| QMLE | -3.161 | -2.827 | -2.185 | -1.877 | -1.814 | -2.080 | -2.336 | -2.946 | -3.693 |
| Hansen | -1.154 | -1.108 | -0.877 | -0.785 | -0.773 | -0.822 | -0.950 | -1.203 | -1.466 |
| Newey-West | -1.476 | -1.418 | -1.114 | -0.982 | -0.967 | -1.047 | -1.195 | -1.516 | -1.864 |
| **US Spread** | **-0.043** | **-0.128** | **-0.236** | **-0.339** | **-0.406** | **-0.409** | **-0.389** | **-0.337** | **-0.341** |
| QMLE | -0.693 | -2.076 | -3.810 | -5.299 | -6.318 | -6.310 | -5.754 | -4.766 | -4.805 |
| Hansen | -0.264 | -0.835 | -1.506 | -2.101 | -2.572 | -2.666 | -2.394 | -2.060 | -1.974 |
| Newey-West | -0.334 | -1.054 | -1.916 | -2.664 | -3.251 | -3.320 | -2.981 | -2.583 | -2.499 |
| **Pseudo R2** | **0.036** | **0.048** | **0.081** | **0.136** | **0.177** | **0.179** | **0.169** | **0.148** | **0.166** |

**Table 6**

Parameters and pseudo-R2 of the model with Domestic, German and US spread

QMLE, Hansen and Newey-West corrected t-stats in brackets

| | FORECASTING HORIZON | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1Month** | **1 Q** | **2 Q** | **3 Q** | **4 Q** | **5 Q** | **6 Q** | **7 Q** | **8 Q** |
| **Spread** | **-0.022** | **0.027** | **0.075** | **0.047** | **-0.008** | **-0.053** | **-0.080** | **-0.112** | **-0.162** |
| QMLE | -0.506 | 0.521 | 1.219 | 0.730 | -0.142 | -1.027 | -1.578 | -2.253 | -3.265 |
| Hansen | -0.205 | 0.238 | 0.701 | 0.371 | -0.062 | -0.404 | -0.637 | -0.916 | -1.297 |
| Newey-West | -0.255 | 0.290 | 0.814 | 0.439 | -0.076 | -0.516 | -0.805 | -1.158 | -1.649 |
| **German Spread** | **-0.951** | **-1.013** | **-0.968** | **-0.793** | **-0.548** | **-0.351** | **-0.280** | **-0.286** | **-0.266** |
| QMLE | -8.495 | -8.640 | -8.108 | -7.145 | -5.363 | -3.667 | -3.063 | -3.192 | -2.784 |
| Hansen | -3.348 | -3.551 | -3.452 | -3.132 | -2.330 | -1.495 | -1.213 | -1.256 | -1.158 |
| Newey-West | -4.223 | -4.512 | -4.339 | -3.881 | -2.906 | -1.883 | -1.544 | -1.597 | -1.468 |
| **US Spread** | **-0.072** | **-0.190** | **-0.325** | **-0.410** | **-0.440** | **-0.410** | **-0.386** | **-0.336** | **-0.339** |
| QMLE | -1.157 | -3.034 | -5.277 | -6.290 | -6.866 | -6.076 | -5.475 | -4.607 | -4.661 |
| Hansen | -0.529 | -1.449 | -2.227 | -2.592 | -2.810 | -2.619 | -2.283 | -1.957 | -1.901 |
| Newey-West | -0.635 | -1.747 | -2.802 | -3.244 | -3.556 | -3.231 | -2.838 | -2.465 | -2.411 |
| **Pseudo R2** | **0.331** | **0.359** | **0.359** | **0.336** | **0.283** | **0.226** | **0.200** | **0.181** | **0.195** |

**Table 7**

Parameters and pseudo-R2 of the model with Domestic spread and (log) Stock Returns

QMLE, Hansen and Newey-West corrected t-stats in brackets

| | FORECASTING HORIZON | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1Month** | **1 Q** | **2 Q** | **3 Q** | **4 Q** | **5 Q** | **6 Q** | **7 Q** | **8 Q** |
| **Spread** | **-0.168** | **-0.160** | **-0.138** | **-0.137** | **-0.146** | **-0.155** | **-0.163** | **-0.180** | **-0.217** |
| QMLE | -3.244 | -3.117 | -2.725 | -2.660 | -2.775 | -2.914 | -3.053 | -3.364 | -3.927 |
| Hansen | -1.193 | -1.238 | -1.123 | -1.130 | -1.144 | -1.147 | -1.209 | -1.338 | -1.547 |
| Newey-West | -1.521 | -1.577 | -1.414 | -1.407 | -1.441 | -1.465 | -1.538 | -1.702 | -1.973 |
| **Stock Returns** | **-1.958** | **-2.050** | **-3.083** | **-3.773** | **-3.232** | **-2.722** | **-2.242** | **-2.354** | **-1.893** |
| QMLE | -1.525 | -1.590 | -2.247 | -2.595 | -2.272 | -1.970 | -1.644 | -1.698 | -1.389 |
| Hansen | -1.974 | -1.632 | -2.577 | -2.854 | -2.382 | -2.194 | -1.897 | -1.979 | -1.556 |
| Newey-West | -1.590 | -1.556 | -2.330 | -2.658 | -2.253 | -2.017 | -1.688 | -1.765 | -1.427 |
| **Pseudo R2** | **0.042** | **0.040** | **0.045** | **0.056** | **0.051** | **0.048** | **0.046** | **0.054** | **0.066** |

**Table 8**

Parameters and pseudo-R2 of the model with Domestic Spread

and the Change in the Real Exchange Rate

QMLE, Hansen and Newey-West corrected t-stats in brackets

| | FORECASTING HORIZON | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1Month** | **1 Q** | **2 Q** | **3 Q** | **4 Q** | **5 Q** | **6 Q** | **7 Q** | **8 Q** |
| **Spread** | **-0.171** | **-0.164** | **-0.144** | **-0.144** | **-0.154** | **-0.162** | **-0.169** | **-0.190** | **-0.223** |
| QMLE | -3.323 | -3.214 | -2.841 | -2.790 | -2.931 | -3.071 | -3.216 | -3.607 | -4.108 |
| Hansen | -1.225 | -1.282 | -1.173 | -1.183 | -1.231 | -1.215 | -1.281 | -1.448 | -1.634 |
| Newey-West | -1.562 | -1.633 | -1.476 | -1.473 | -1.544 | -1.549 | -1.628 | -1.840 | -2.080 |
| **Change in RER** | **-1.242** | **1.480** | **-1.023** | **1.346** | **7.892** | **5.758** | **6.330** | **11.072** | **7.906** |
| QMLE | -0.192 | 0.225 | -0.157 | 0.215 | 1.250 | 0.926 | 1.007 | 1.693 | 1.191 |
| Hansen | -0.149 | 0.191 | -0.129 | 0.163 | 1.038 | 0.727 | 0.833 | 1.279 | 1.006 |
| Newey-West | -0.162 | 0.192 | -0.134 | 0.174 | 1.084 | 0.778 | 0.866 | 1.371 | 1.052 |
| **Pseudo R2** | **0.034** | **0.031** | **0.025** | **0.025** | **0.034** | **0.035** | **0.038** | **0.052** | **0.064** |

**Table 9**

Parameters and pseudo-R2 of the model with Domestic Spread
and the change in the Short Rate and in the Long Rate
QMLE, Hansen and Newey-West corrected t-stats included

| | FORECASTING HORIZON | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1Month** | **1 Q** | **2 Q** | **3 Q** | **4 Q** | **5 Q** | **6 Q** | **7 Q** | **8 Q** |
| **Spread** | **-0.186** | **-0.170** | **-0.141** | **-0.142** | **-0.150** | **-0.163** | **-0.172** | **-0.195** | **-0.230** |
| QMLE | -3.531 | -3.260 | -2.698 | -2.640 | -2.731 | -2.895 | -3.029 | -3.356 | -3.944 |
| Hansen | -1.303 | -1.291 | -1.093 | -1.089 | -1.122 | -1.121 | -1.183 | -1.313 | -1.525 |
| Newey-West | -1.660 | -1.647 | -1.379 | -1.362 | -1.410 | -1.430 | -1.505 | -1.670 | -1.945 |
| **Change in Short** | **-0.102** | **-0.039** | **0.010** | **0.000** | **-0.004** | **-0.036** | **-0.056** | **-0.103** | **-0.126** |
| QMLE | -1.010 | -0.378 | 0.088 | 0.003 | -0.031 | -0.304 | -0.482 | -0.908 | -1.115 |
| Hansen | -0.899 | -0.370 | 0.083 | 0.003 | -0.028 | -0.270 | -0.436 | -0.774 | -0.941 |
| Newey-West | -0.958 | -0.366 | 0.085 | 0.003 | -0.029 | -0.279 | -0.442 | -0.809 | -0.994 |
| **Change in Long** | **-0.228** | **-0.174** | **0.209** | **0.308** | **0.323** | **0.623** | **0.700** | **0.799** | **0.528** |
| QMLE | -1.095 | -0.834 | 1.005 | 1.479 | 1.548 | 2.877 | 3.161 | 3.518 | 2.417 |
| Hansen | -0.906 | -0.705 | 0.770 | 1.148 | 1.134 | 1.995 | 2.241 | 2.478 | 1.697 |
| Newey-West | -0.920 | -0.723 | 0.829 | 1.234 | 1.263 | 2.264 | 2.476 | 2.720 | 1.909 |
| **Pseudo R2** | **0.042** | **0.034** | **0.029** | **0.033** | **0.038** | **0.064** | **0.074** | **0.091** | **0.080** |

**Table 10**

Parameters and pseudo-R2 of the model with Domestic Spread and Change in the Discount Rate
QMLE, Hansen and Newey-West corrected t-stats included

| | FORECASTING HORIZON | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1Month** | **1 Q** | **2 Q** | **3 Q** | **4 Q** | **5 Q** | **6 Q** | **7 Q** | **8 Q** |
| **Spread** | **-0.167** | **-0.157** | **-0.138** | **-0.138** | **-0.147** | **-0.154** | **-0.161** | **-0.179** | **-0.214** |
| QMLE | -3.245 | -3.058 | -2.711 | -2.659 | -2.790 | -2.869 | -2.998 | -3.338 | -3.857 |
| Hansen | -1.266 | -1.213 | -1.116 | -1.119 | -1.136 | -1.121 | -1.181 | -1.320 | -1.515 |
| Newey-West | -1.621 | -1.546 | -1.405 | -1.396 | -1.436 | -1.433 | -1.503 | -1.680 | -1.932 |
| **Change in Disc.** | **-0.012** | **0.014** | **0.009** | **-0.001** | **-0.022** | **0.006** | **0.005** | **-0.002** | **0.006** |
| QMLE | -0.323 | 0.398 | 0.252 | -0.021 | -0.667 | 0.201 | 0.154 | -0.058 | 0.190 |
| Hansen | -0.737 | 0.873 | 0.000 | 0.000 | -0.672 | 0.524 | 0.784 | -0.173 | 0.539 |
| Newey-West | -0.522 | 0.560 | 0.415 | -0.033 | -0.666 | 0.307 | 0.230 | -0.086 | 0.275 |
| **Pseudo R2** | **0.032** | **0.029** | **0.023** | **0.023** | **0.028** | **0.030** | **0.033** | **0.040** | **0.056** |

**Table 11**

Parameters and pseudo-R2 of the model with Domestic Spread and Rate of Change of M3
QMLE, Hansen and Newey-West corrected t-stats included

| | FORECASTING HORIZON | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1Month** | **1 Q** | **2 Q** | **3 Q** | **4 Q** | **5 Q** | **6 Q** | **7 Q** | **8 Q** |
| **Spread** | **-0.170** | **-0.165** | **-0.146** | **-0.144** | **-0.151** | **-0.157** | **-0.165** | **-0.179** | **-0.215** |
| QMLE | -3.308 | -3.213 | -2.874 | -2.788 | -2.848 | -2.969 | -3.099 | -3.382 | -3.925 |
| Hansen | -1.215 | -1.277 | -1.182 | -1.171 | -1.176 | -1.164 | -1.224 | -1.342 | -1.545 |
| Newey-West | -1.551 | -1.627 | -1.491 | -1.463 | -1.483 | -1.488 | -1.559 | -1.708 | -1.971 |
| **Change in M3** | **2.177** | **-1.351** | **-2.263** | **-0.857** | **0.634** | **3.157** | **2.654** | **6.751** | **6.449** |
| QMLE | 0.366 | -0.229 | -0.367 | -0.140 | 0.103 | 0.499 | 0.418 | 1.059 | 0.984 |
| Hansen | 0.480 | -0.367 | -0.425 | -0.174 | 0.168 | 1.015 | 0.703 | 1.649 | 1.957 |
| Newey-West | 0.485 | -0.294 | -0.420 | -0.178 | 0.142 | 0.737 | 0.593 | 1.510 | 1.468 |
| **Pseudo R2** | **0.034** | **0.031** | **0.025** | **0.025** | **0.029** | **0.033** | **0.036** | **0.047** | **0.063** |

**Table 12**
Parameters and pseudo-R2 of the Full model
QMLE, Hansen and Newey-West corrected t-stats included

| | FORECASTING HORIZON | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1Month** | **1 Q** | **2 Q** | **3 Q** | **4 Q** | **5 Q** | **6 Q** | **7 Q** | **8 Q** |
| **Spread** | **-0.005** | **0.072** | **0.122** | **0.079** | **0.009** | **-0.052** | **-0.084** | **-0.122** | **-0.170** |
| QMLE | -0.108 | 1.151 | 1.707 | 1.094 | 0.150 | -0.939 | -1.572 | -2.293 | -3.255 |
| Hansen | -0.044 | 0.519 | 1.037 | 0.561 | 0.066 | -0.372 | -0.638 | -0.926 | -1.277 |
| Newey-West | -0.054 | 0.632 | 1.180 | 0.662 | 0.081 | -0.473 | -0.802 | -1.171 | -1.624 |
| **German Spread** | **-0.966** | **-1.064** | **-1.032** | **-0.835** | **-0.562** | **-0.375** | **-0.306** | **-0.315** | **-0.276** |
| QMLE | -8.392 | -8.492 | -7.893 | -7.154 | -5.334 | -3.725 | -3.162 | -3.284 | -2.855 |
| Hansen | -3.348 | -3.432 | -3.494 | -3.363 | -2.437 | -1.572 | -1.287 | -1.318 | -1.195 |
| Newey-West | -4.220 | -4.387 | -4.347 | -4.080 | -2.992 | -1.960 | -1.636 | -1.680 | -1.516 |
| **US Spread** | **-0.097** | **-0.221** | **-0.335** | **-0.422** | **-0.446** | **-0.417** | **-0.386** | **-0.338** | **-0.336** |
| QMLE | -1.562 | -3.584 | -5.500 | -6.532 | -6.957 | -6.235 | -5.414 | -4.621 | -4.682 |
| Hansen | -0.718 | -1.655 | -2.359 | -2.746 | -2.914 | -2.697 | -2.319 | -1.963 | -1.900 |
| Newey-West | -0.864 | -2.010 | -2.953 | -3.422 | -3.659 | -3.329 | -2.884 | -2.485 | -2.417 |
| **Stock Returns** | **-2.531** | **-2.814** | **-3.413** | **-4.214** | **-3.380** | **-2.422** | **-1.618** | **-1.601** | **-1.603** |
| QMLE | -1.758 | -1.850 | -2.225 | -2.712 | -2.248 | -1.704 | -1.154 | -1.121 | -1.123 |
| Hansen | -2.584 | -1.796 | -2.647 | -2.947 | -2.675 | -2.147 | -1.336 | -1.333 | -1.337 |
| Newey-West | -1.964 | -1.790 | -2.379 | -2.827 | -2.391 | -1.869 | -1.224 | -1.233 | -1.236 |
| **Change in Short** | **0.010** | **0.261** | **0.391** | **0.302** | **0.189** | **0.057** | **0.006** | **-0.061** | **-0.098** |
| QMLE | 0.065 | 1.655 | 2.873 | 2.361 | 1.596 | 0.525 | 0.055 | -0.589 | -0.911 |
| Hansen | 0.045 | 1.056 | 2.075 | 1.699 | 1.207 | 0.405 | 0.044 | -0.439 | -0.663 |
| Newey-West | 0.050 | 1.231 | 2.287 | 1.874 | 1.317 | 0.428 | 0.045 | -0.476 | -0.739 |
| **Change in Long** | **-0.537** | **-0.613** | **-0.063** | **0.052** | **0.106** | **0.548** | **0.663** | **0.785** | **0.437** |
| QMLE | -2.237 | -2.138 | -0.225 | 0.192 | 0.408 | 2.153 | 2.644 | 3.077 | 1.826 |
| Hansen | -1.725 | -1.764 | -0.190 | 0.182 | 0.339 | 1.653 | 1.959 | 2.314 | 1.470 |
| Newey-West | -1.841 | -1.933 | -0.207 | 0.186 | 0.363 | 1.788 | 2.158 | 2.504 | 1.598 |
| **Pseudo R2** | **0.347** | **0.378** | **0.386** | **0.373** | **0.310** | **0.265** | **0.239** | **0.230** | **0.215** |

Figure 1
SPAIN
Evolution of IIP and Estimated Recessions (Shaded)

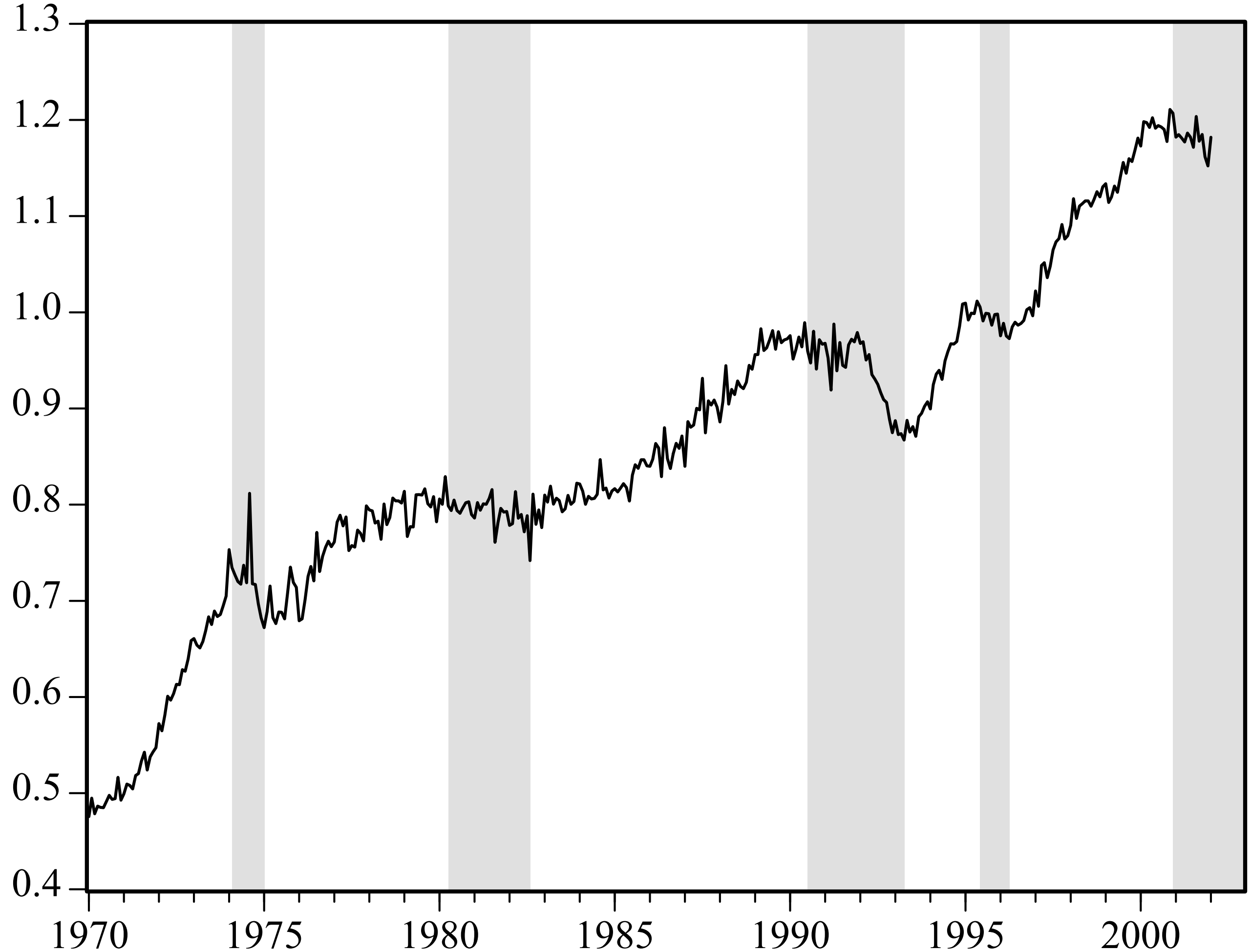


Figure 2:
Domestic Spread only
Fitted value of probability of recession: 1 month ahead

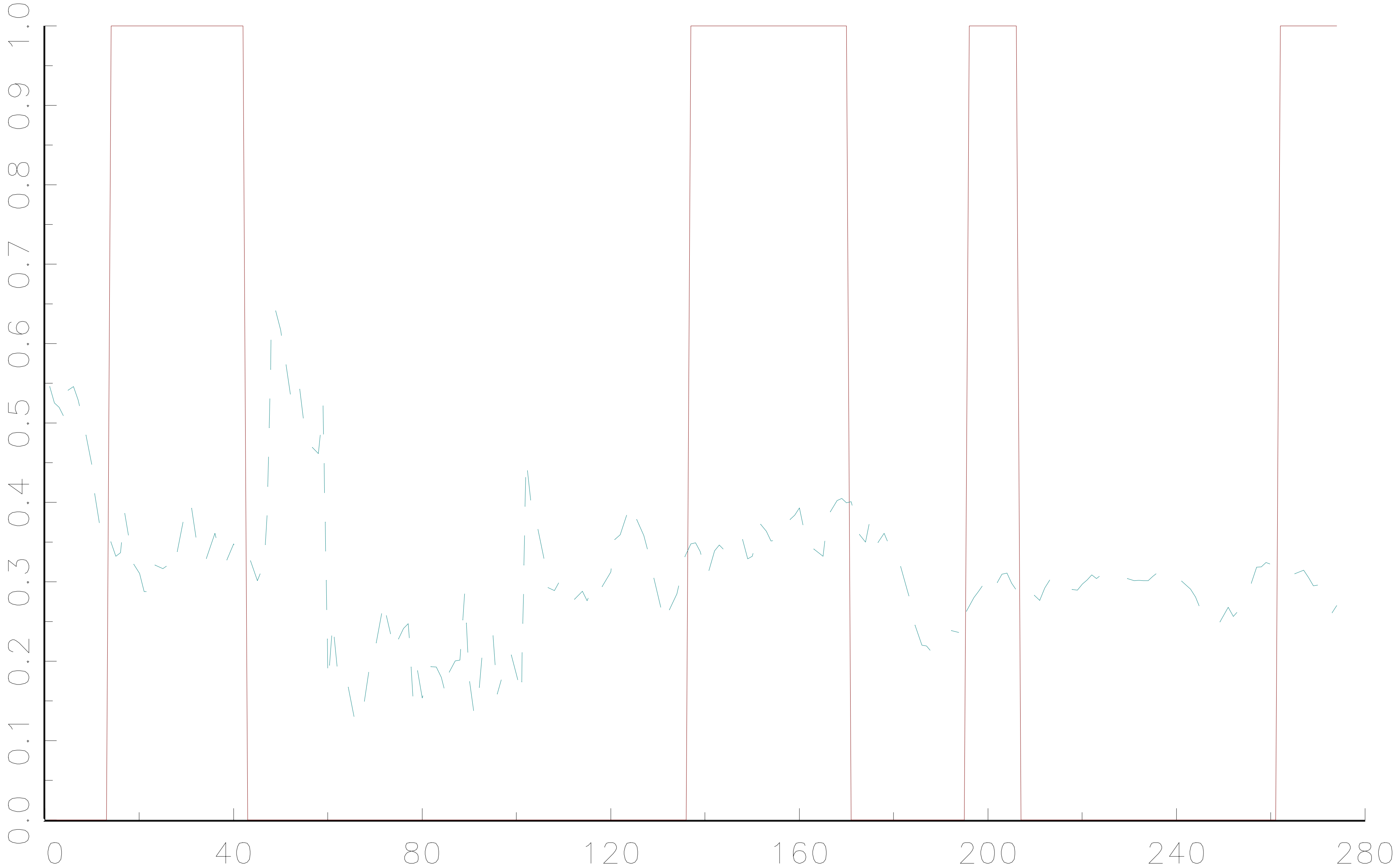


Figure 3a:
Domestic Spread only
Fitted value of probability of recession: 1 quarter ahead

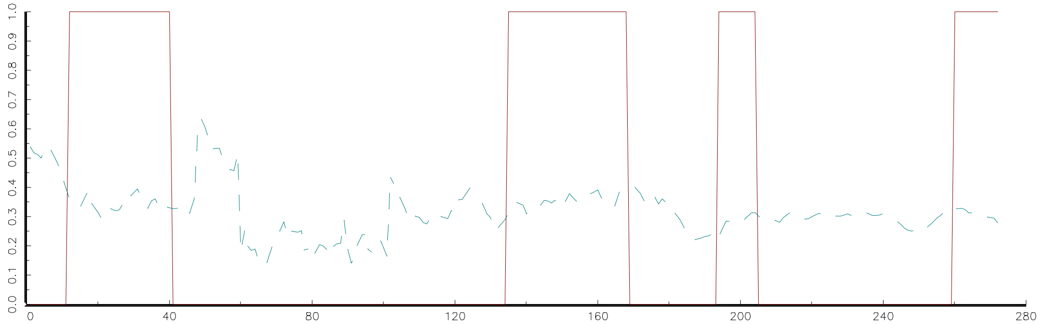



Figure 3b:
Domestic Spread only
Fitted value of probability of recession: 2 quarters ahead

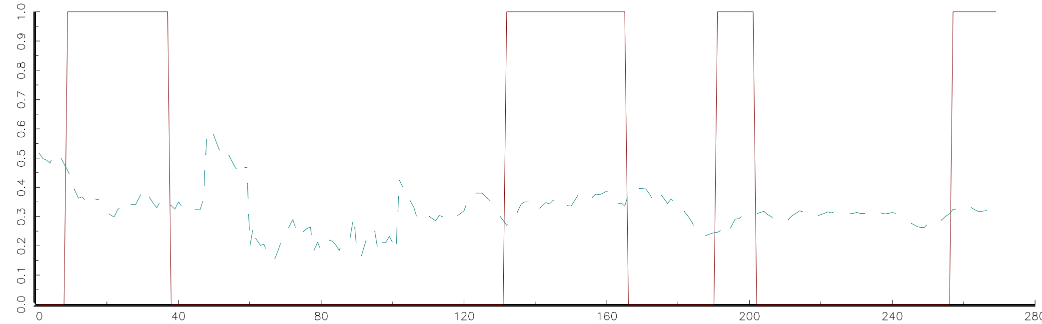



Figure 3c:
Domestic Spread only
Fitted value of probability of recession: 3 quarters ahead

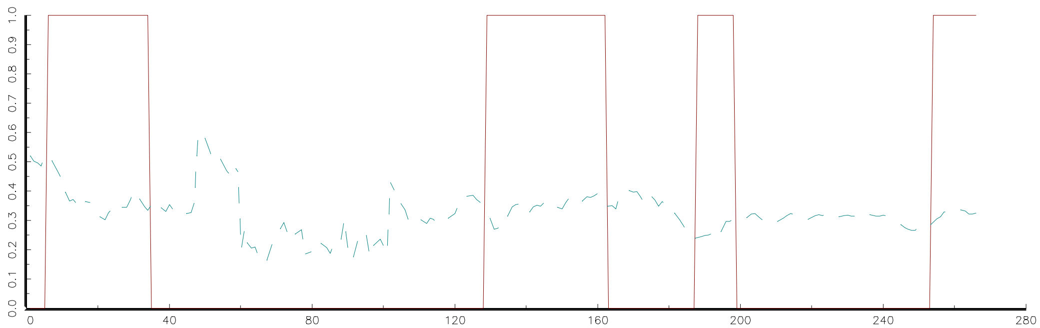



Figure 3d:
Domestic Spread only
Fitted value of probability of recession: 4 quarters ahead

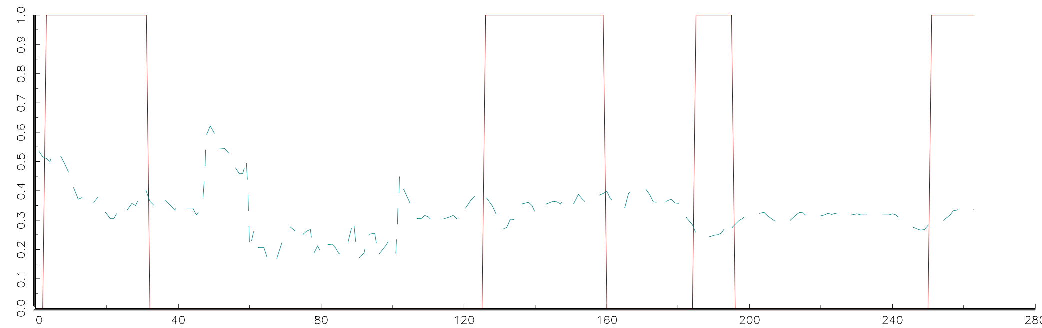



Figure 3e:
Domestic Spread only
Fitted value of probability of recession: 5 quarters ahead

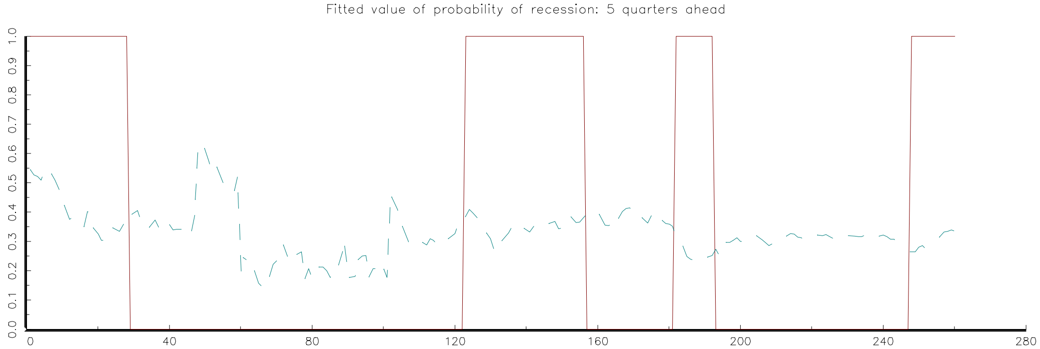



Figure 3f:
Domestic Spread only
Fitted value of probability of recession: 6 quarters ahead

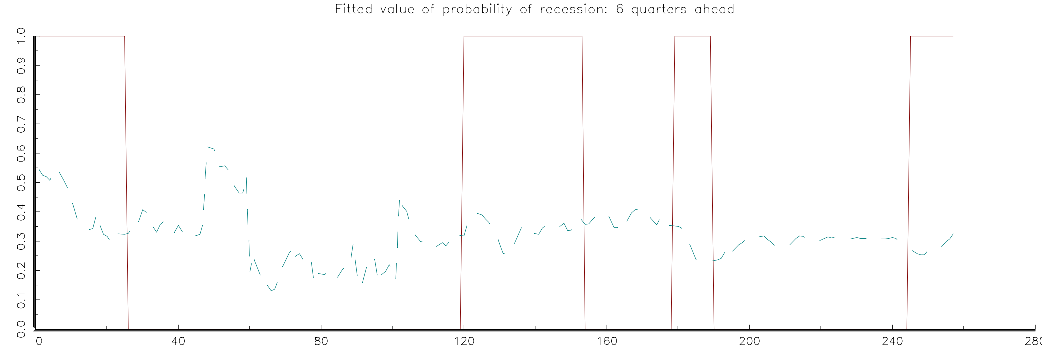



Figure 3g:
Domestic Spread only
Fitted value of probability of recession: 7 quarters ahead

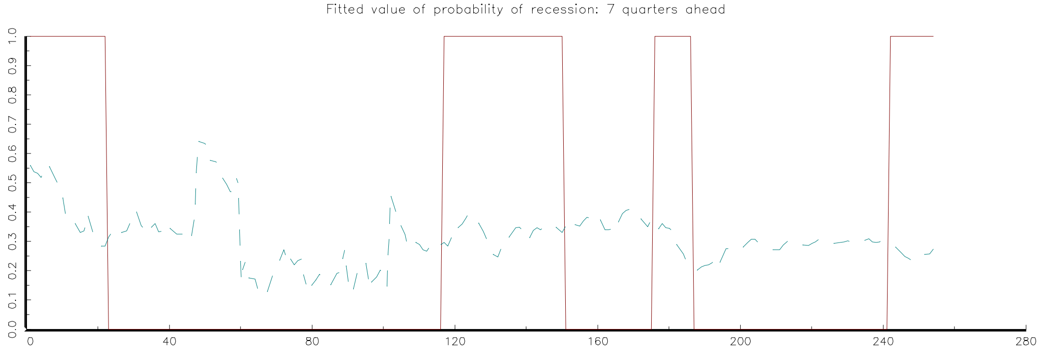



Figure 3h:
Domestic Spread only
Fitted value of probability of recession: 8 quarters ahead

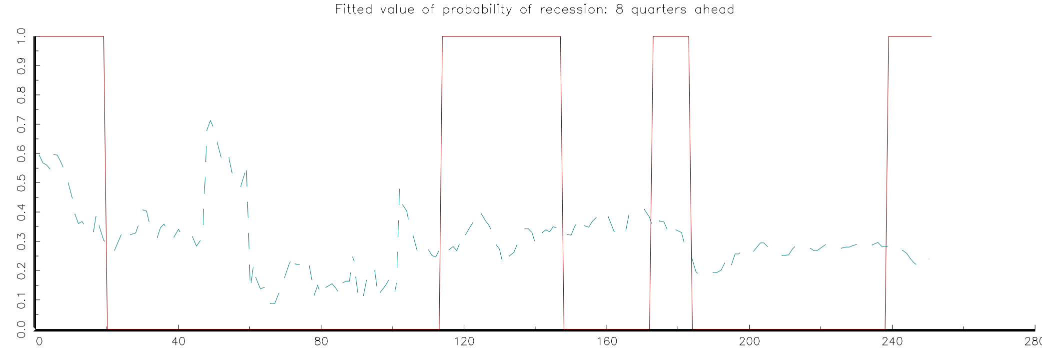


Figure 4:
Domestic, German and US Spreads
Fitted value of probability of recession: 1 month ahead

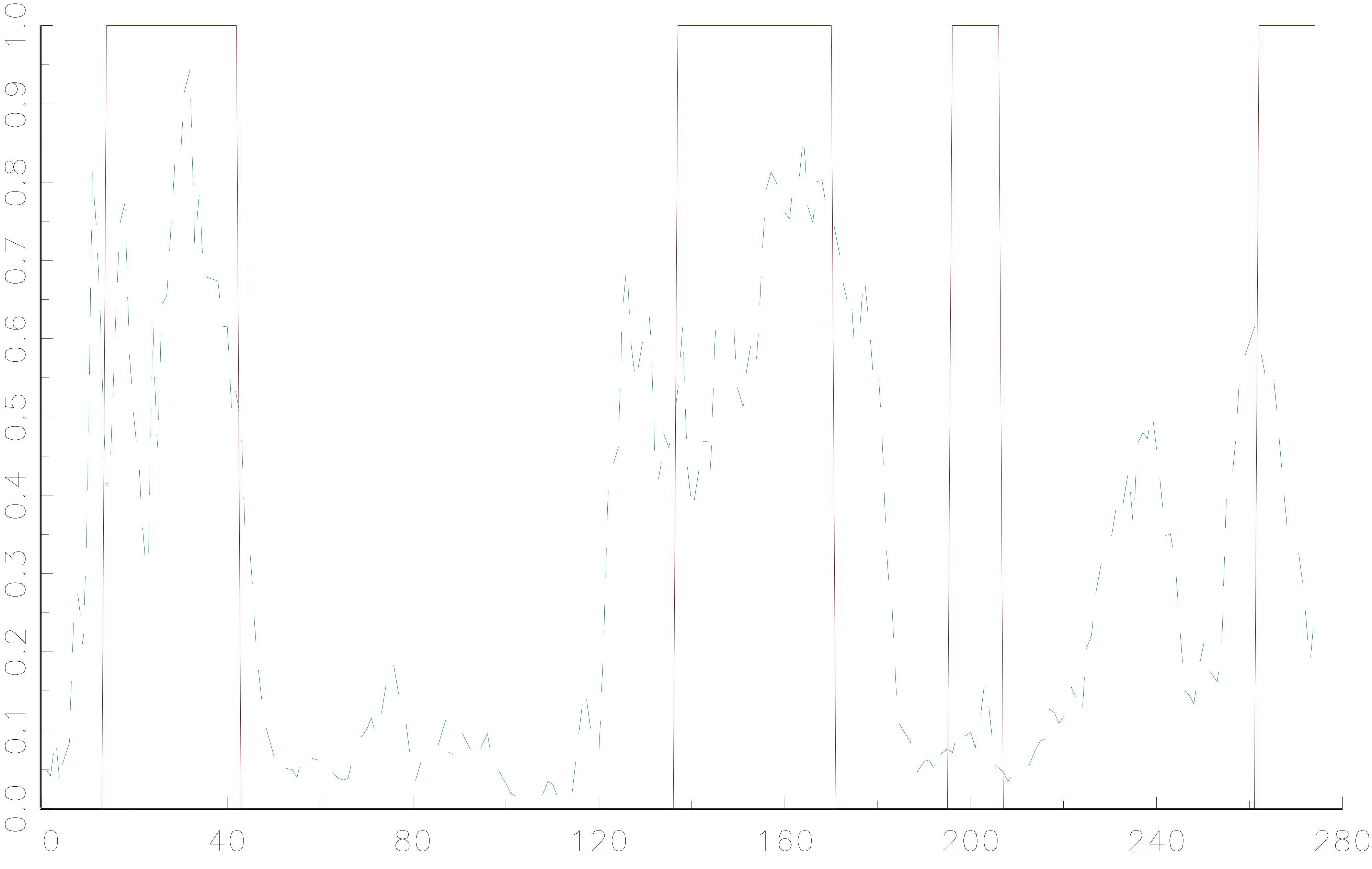


Figure 5a:
Domestic, German and US Spreads
Fitted value of probability of recession: 1 quarter ahead

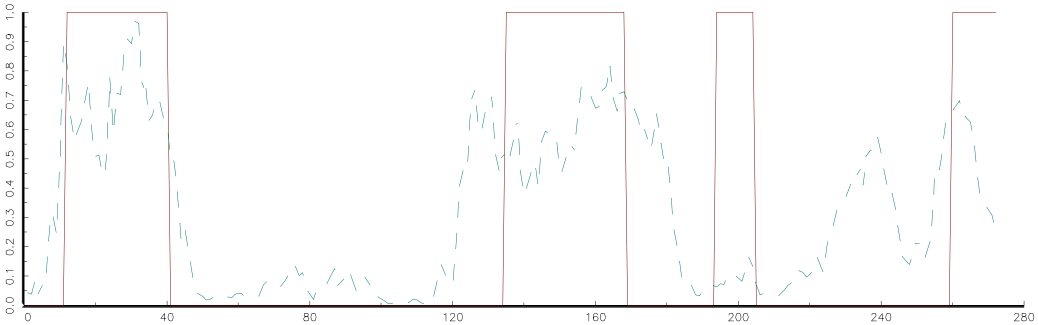



Figure 5b:
Domestic, German and US Spreads
Fitted value of probability of recession: 2 quarters ahead

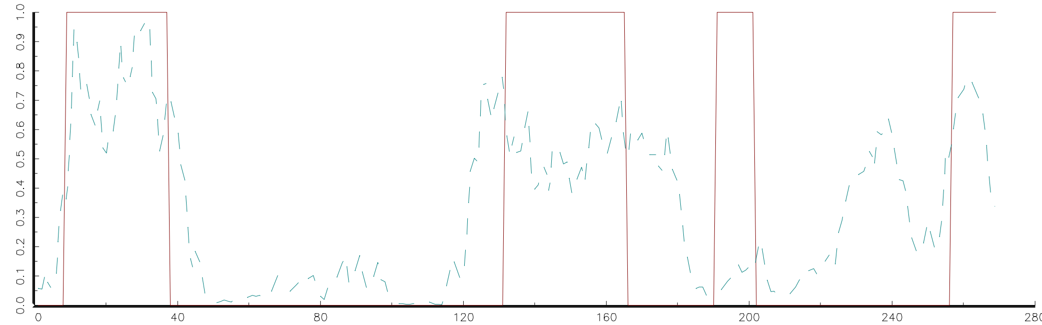



Figure 5c:
Domestic, German and US Spreads
Fitted value of probability of recession: 3 quarters ahead

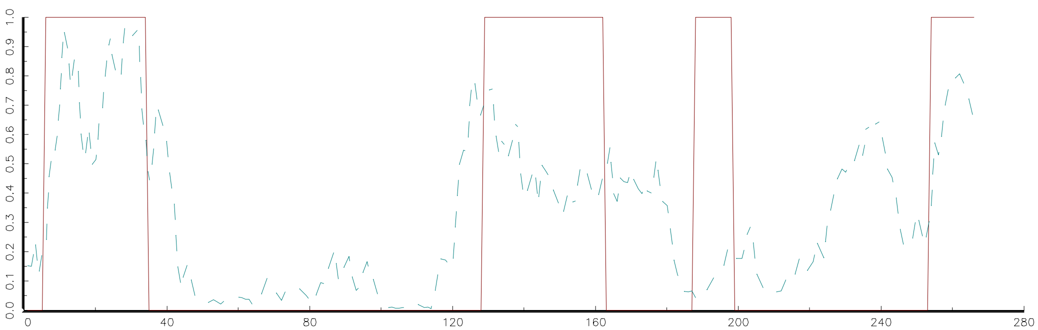



Figure 5d:
Domestic, German and US Spreads
Fitted value of probability of recession: 4 quarters ahead

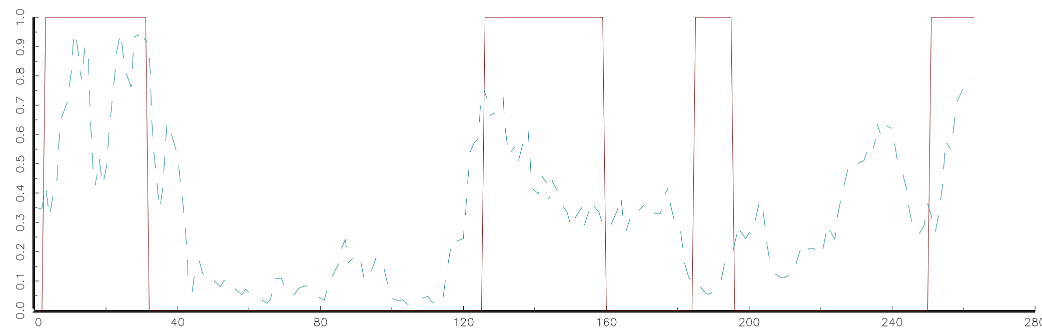



Figure 5e:
Domestic, German and US Spreads
Fitted value of probability of recession: 5 quarters ahead

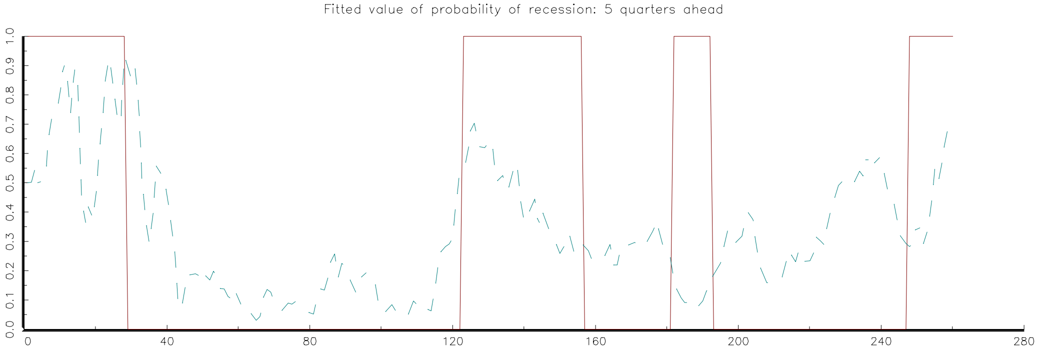



Figure 5f:
Domestic, German and US Spreads
Fitted value of probability of recession: 6 quarters ahead

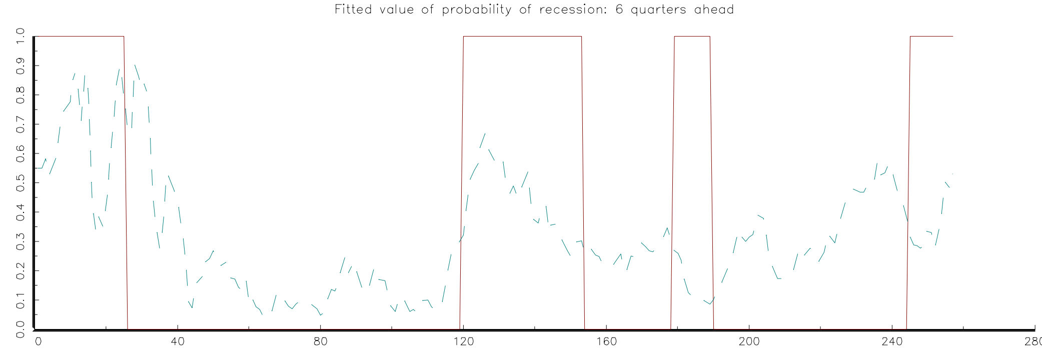



Figure 5g:
Domestic, German and US Spreads
Fitted value of probability of recession: 7 quarters ahead

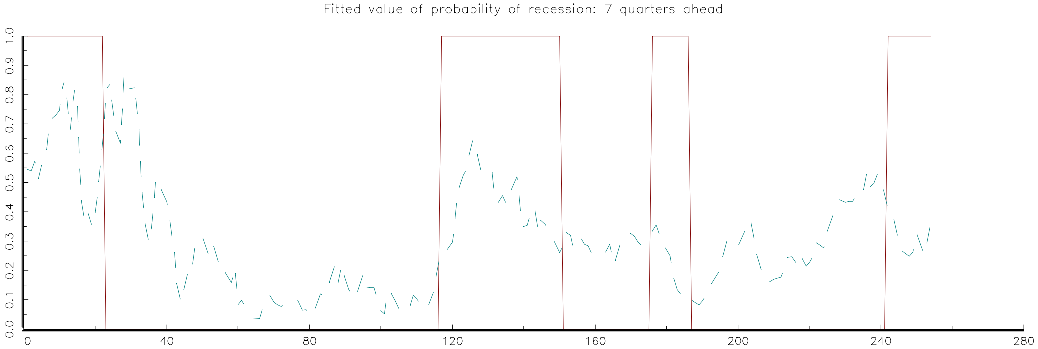
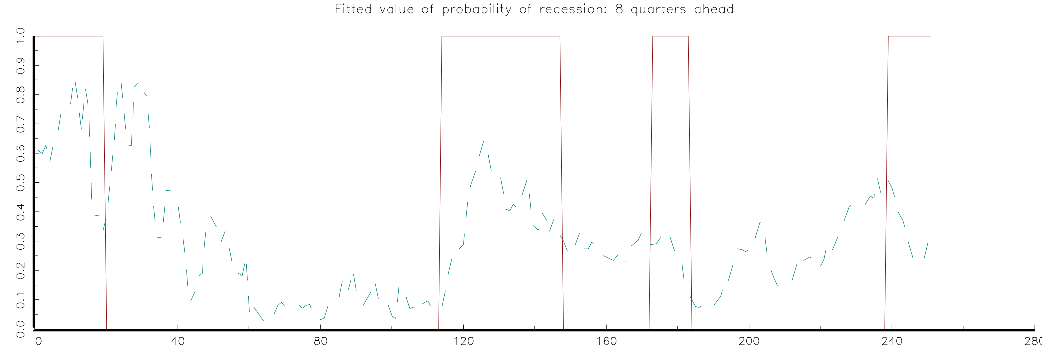



Figure 5h:
Domestic, German and US Spreads
Fitted value of probability of recession: 8 quarters ahead



GAUSS Sat Jul 06 10:41:52 2002

Figure 6:
Full Model
Fitted value of probability of recession: 1 month ahead

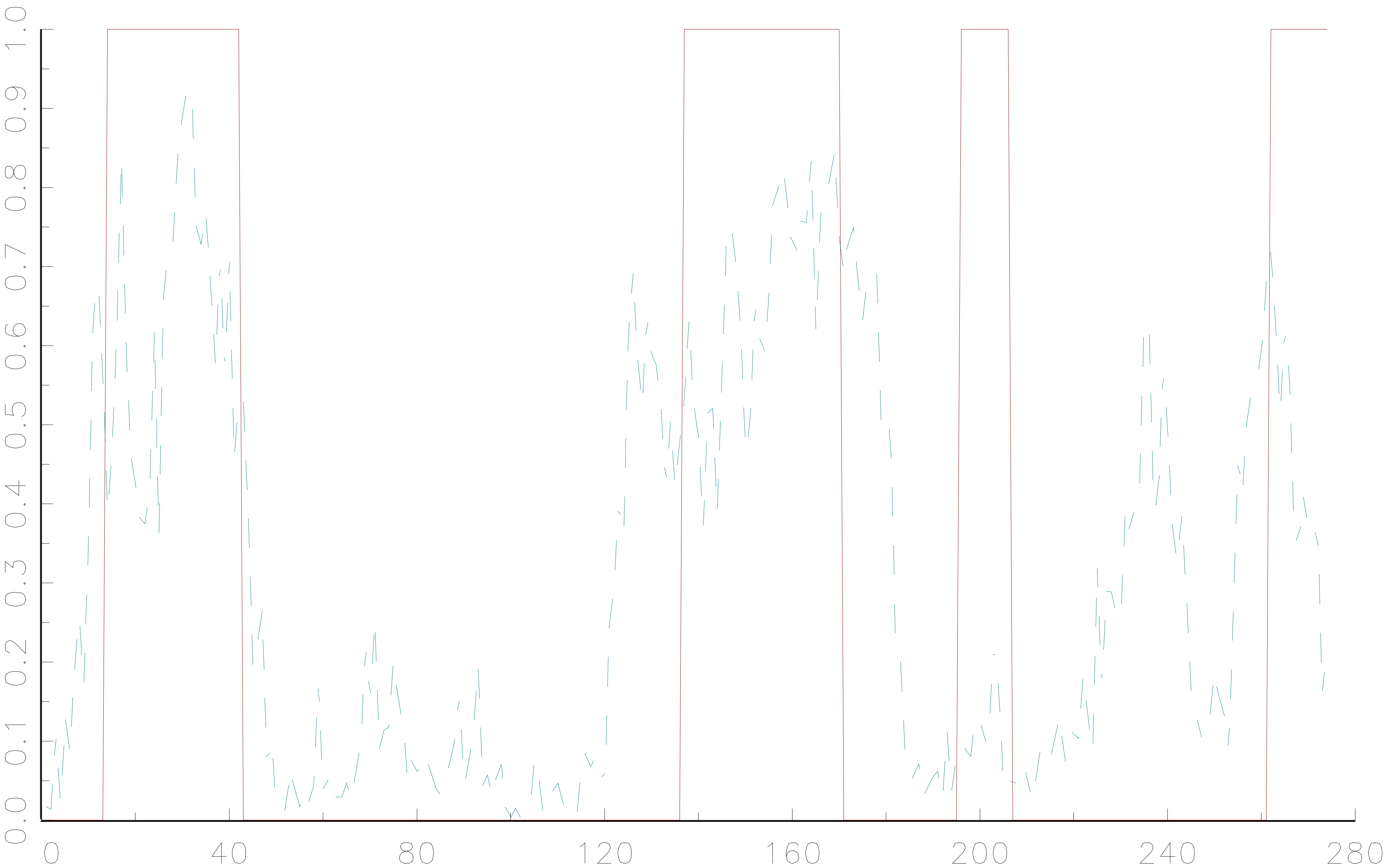


Figure 7a:
Full Model
Fitted value of probability of recession: 1 quarter ahead

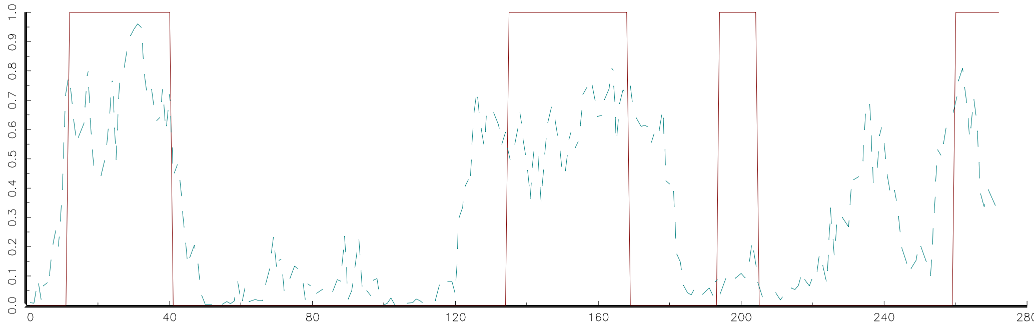



Figure 7b:
Full Model
Fitted value of probability of recession: 2 quarters ahead

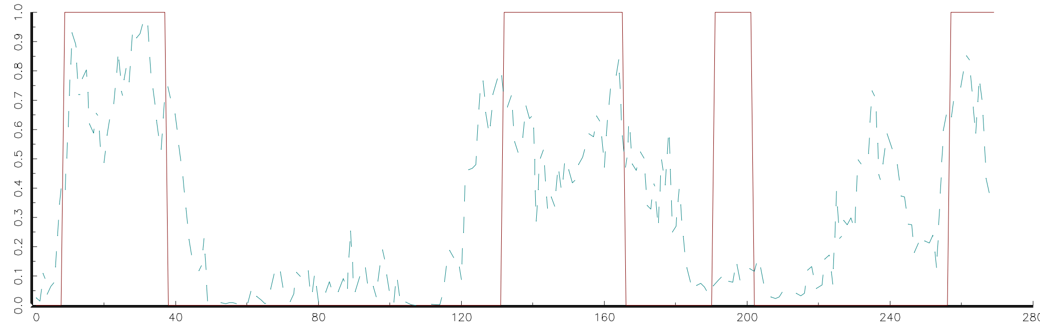



Figure 7c:
Full Model
Fitted value of probability of recession: 3 quarters ahead

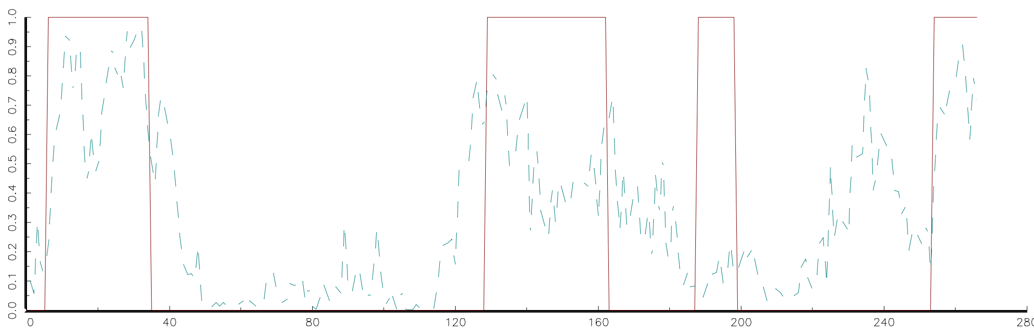



Figure 7d:
Full Model
Fitted value of probability of recession: 4 quarters ahead

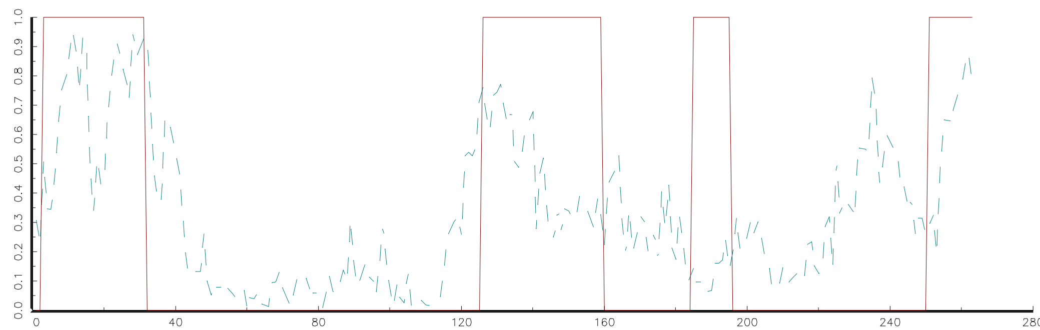



Figure 7e:
Full Model
Fitted value of probability of recession: 5 quarters ahead

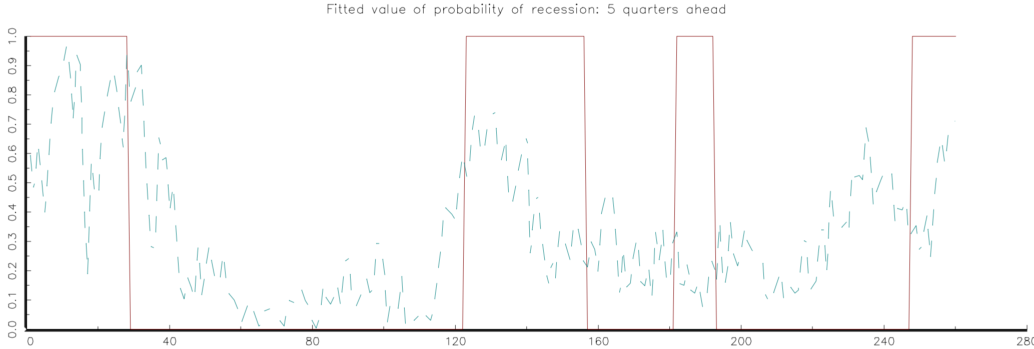



Figure 7f:
Full Model
Fitted value of probability of recession: 6 quarters ahead

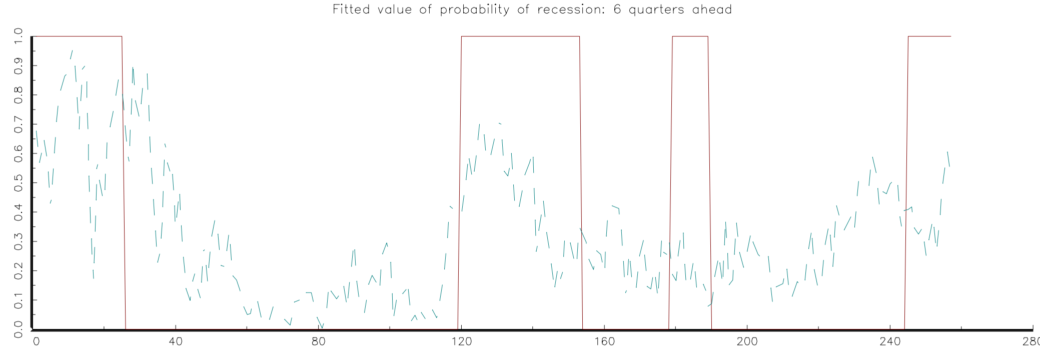



Figure 7g:
Full Model
Fitted value of probability of recession: 7 quarters ahead

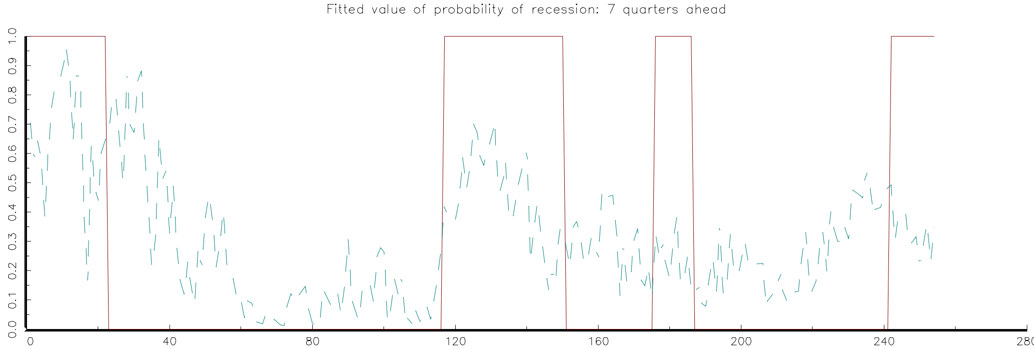



Figure 7h:
Full Model
Fitted value of probability of recession: 8 quarters ahead

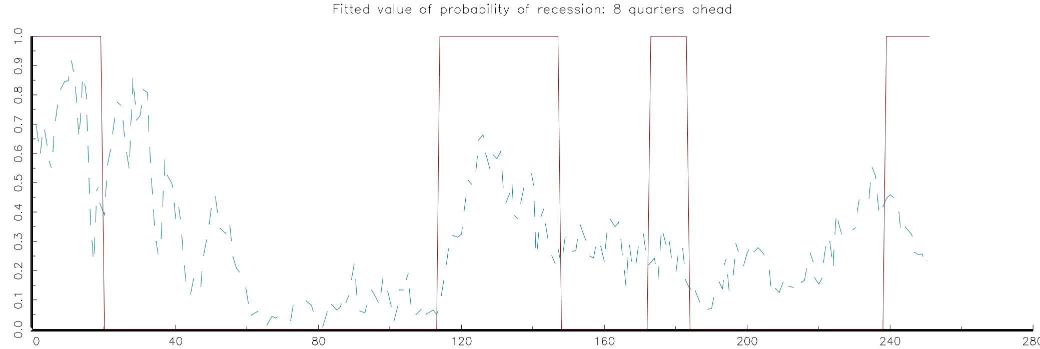


Figure 8a: Pseudo R2 of models with spread variables

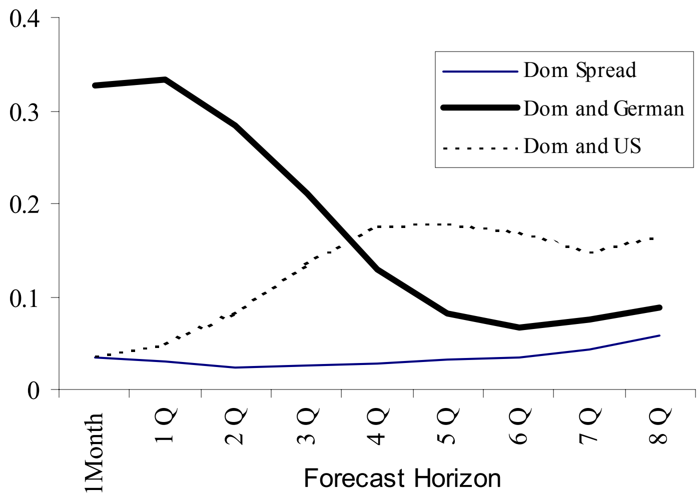



Figure 8b: Pseudo R2 of models with alternative variables

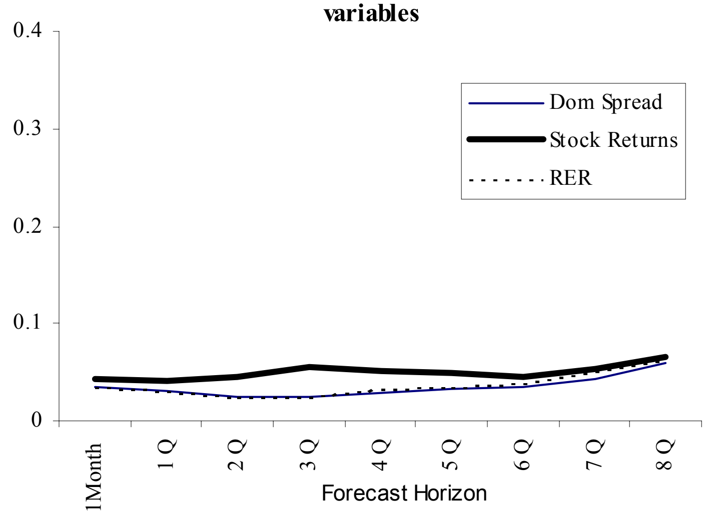



Figure 8c: Pseudo R2 of models with alternative variables

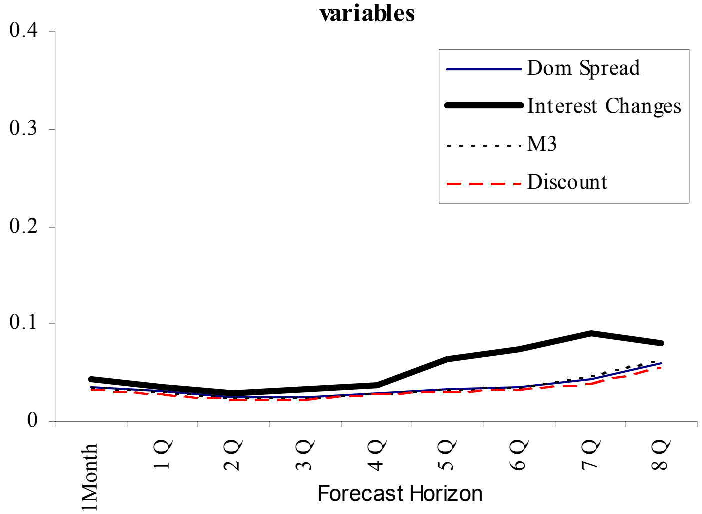
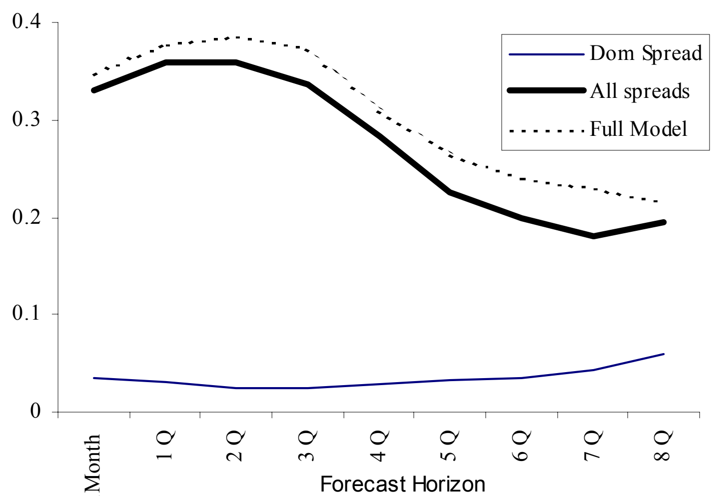



Figure 8d: Pseudo R2 of final models



GAUSS Sat Jul 06 11:42:24 2002

Figure 9:

Full Model

One-step Ahead Fitted value of probability of recession: 1 month ahead

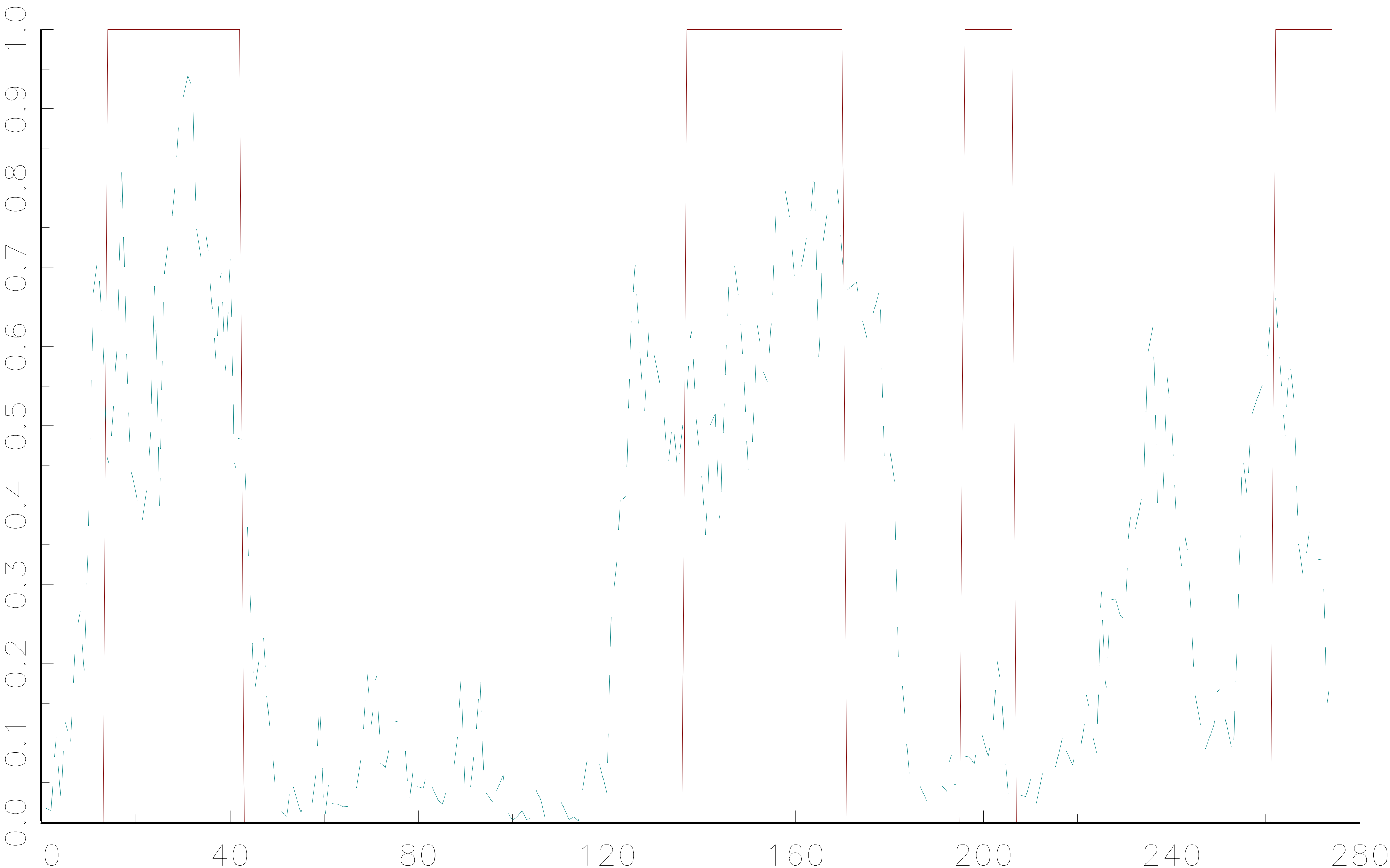


Figure 10a:
Full Model
One-step Ahead Fitted value of probability of recession: 1 quarter ahead

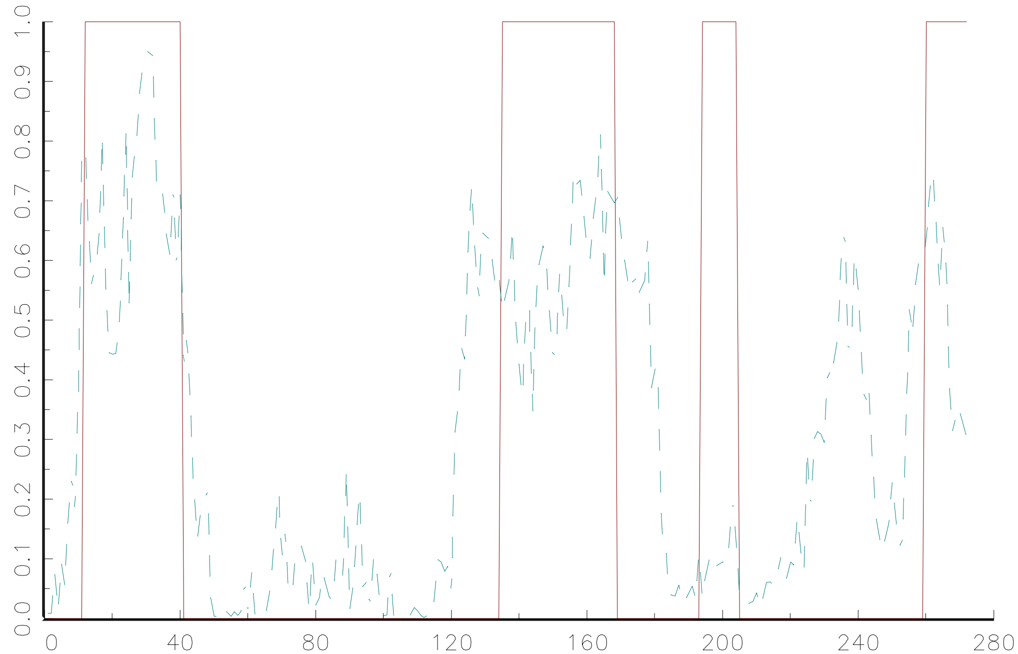



Figure 10b:
Full Model
One-step Ahead Fitted value of probability of recession: 2 quarters ahead

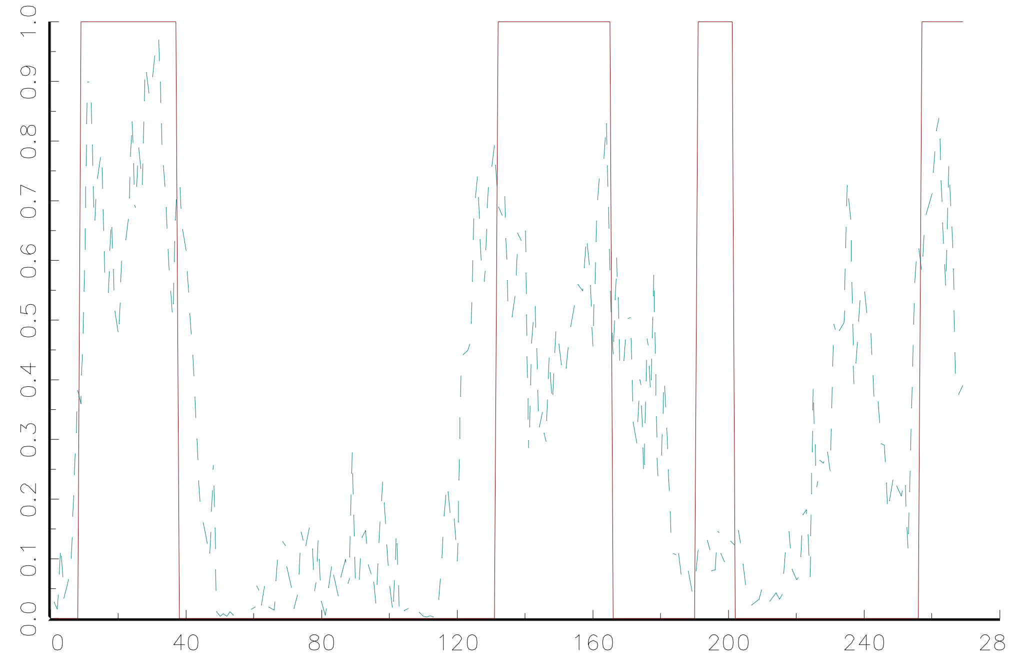



Figure 10c:
Full Model
One-step Ahead Fitted value of probability of recession: 3 quarters ahead

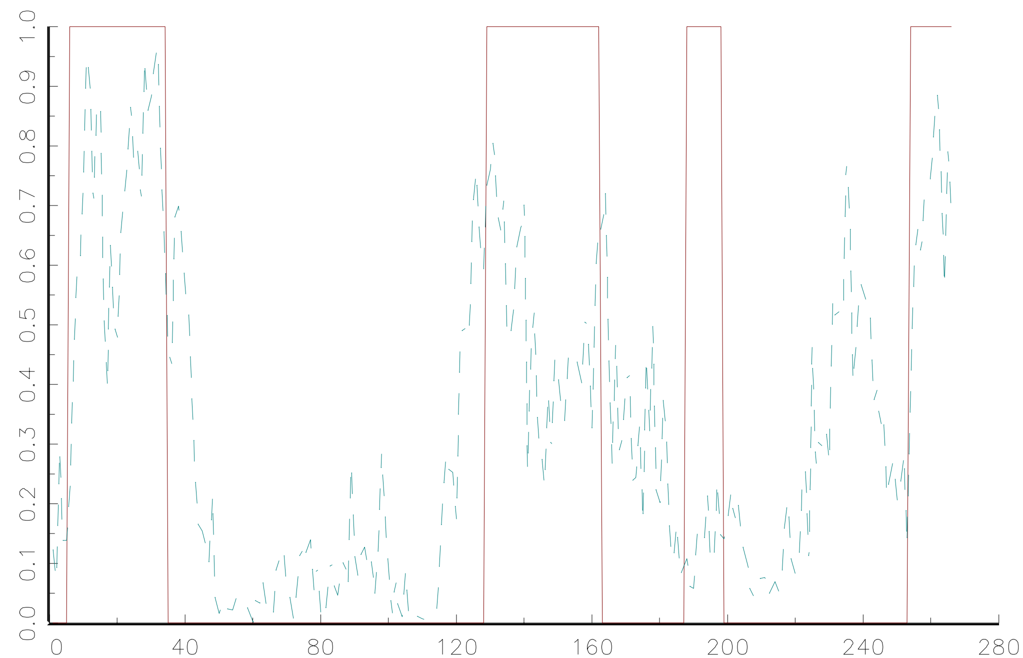



Figure 10d:
Full Model
One-step Ahead Fitted value of probability of recession: 4 quarters ahead