The Predictive Power of the Yield Curve across Countries and Time

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Abstract: In recent years, there has been renewed interest in the yield curve (or alternatively, the term premium) as a predictor of future economic activity. In this paper, we re-examine the evidence for this predictor, both for the United States, as well as European countries. We believe a re-examination is warranted, both because of the phenomenon of the "conundrum" in the mid-2000's, and the advent of the euro in 1999. We examine the sensitivity of the results to the selection of countries, and time periods. We find that the predicative power of the yield curve has deteriorated in recent years. However there is reason to believe that European country models perform better than non-European countries when using more recent data.

Key words: yield curve, term premium, expectations hypothesis of the term premium, industrial production, recession

JEL classification: C22, E37, E43

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1. Introduction

Over two years ago, several observers noted the inversion of the yield curve in the United States. That event served to spark a resurgence in the debate over the yield curve as an indicator of future economic activity, with an inversion indicating a slowdown (and in some formulations, a recession). While this view is commonly held in the United States, the inverted yield curve as recession indicator is not widely used in countries aside the US. Moreover, in the most recent episode, there was widespread discussion that, in light of the increased credibility ascribed to monetary policy, the yield curve no longer served as a useful early warning signal for growth slowdowns.

Motivation for studying the yield curve is of course manifold. There is, first, the policy concern. Policy makers often need to make decisions today, based on expectations regarding future economic conditions. The search for optimal forecasting tools thus is a natural pursuit.

Second, there is the investigation for the sake of understanding why an indicator, such as the yield curve, works to predict future economic activity. The fact that it works for some countries, and not others, might be suggestive of certain channels being important, to the exclusion of others. A similar sort of reasoning applies to examining the goodness of fit over different time periods.

There is, of course, a voluminous extant literature on the subject. Nonetheless, we believe now is an opportune time to re-examine the evidence regarding the yield curve as a predictor of future economic growth. That is because of two developments.

The first is the advent of the euro in 1999. The creation of a more integrated European bond market, and increased economic linkages on the real side, suggests that the old historical links (or nonlinks, as the case may be) between the interest rates and output might have changed. Yet, until recently, there had not been a sustained and significant downturn in the European economy post-EMU.

The second is the "conundrum", i.e., the failure of long-term interest rates to rise along with the short-term policy rate, as the Fed Funds rate rose during 2004-05. Some people ascribed this phenomenon to the disappearance of risk, variously associated with the cross-country decline in inflation and output volatility – what is sometimes called the Great Moderation – or with greater risk-management on the part of financial institutions. Alternatively, attention has been directed to the demand by pension funds for long-term assets, or central bank purchases of Treasury assets.[1] Regardless of the merit of such arguments, we think it of interest to determine whether the previously extant correlations hold in the more recent period.

The paper is organized in the following fashion. In section 2, we lay out a framework for examining what determines the long term interest rate relative to the

[1] See for instance Warnock and Warnock (2006). A contrasting view is in Rudebusch et al. (2006).

short, and relate that to the extant literature on the yield curve as a predictor. In section 3, we describe the data and the empirical tests we implement. In Section 4, we repeat the exercise, but using as a dependent variable a binary dependent variable called "recession". Section 5 concludes.

2. Background

2.1 *Theoretical Framework*

Following previous literature, this paper focuses on the yield spread defined as the 10-year government bond yield less the 3 month treasury yield (or closest equivalent for countries other than the United States)[2].

The linkage between the long-term and short-term interest rates can be decomposed thus:

$$i_t^n = \frac{(i_t + i_{t+1}^e + \cdots i_{t+n-1}^e)}{n} + i_t^n \qquad (1)$$

[2] Using aggregate Euro area data, Moneta (2003) found that the 10-year 3-month spread specification performed better than any other pair of yield maturities that included two of the following: 3-month, 1-year, 2-year, 5-year, 10-year.

Where i_t^n is the interest rate on a bond of maturity n n at time t , is the expected interest rate on a one period bond for period $t+j$, based on information available at time t , and l_t^n i is the liquidity (or term) premium for the n n-period bond at time t t.

This specification nests the expectations hypothesis of the term structure, or EHTS (corresponding to the first term on the right hand side of equation 1), and the liquidity premium theory (corresponding to the second term).

The EHTS merely posits that the yield on a long-term bond is the average of the one period interest rates expected over the lifetime of the long bond. The liquidity premium theory allows that there will be supply and demand conditions that pertain specifically to bonds of that maturity. The presence of idiosyncratic effects associated with a certain maturity of bond is sometimes linked the "preferred habitat theory", the idea that certain investors have a preference for purchasing assets of specific maturities. Since $l_t^n > 0$, then the yield curve will slope upward when short rates are expected to be constant over time.

Now, for the sake of simplicity, consider the case where $l_t^n = 0$ (i.e., the EHTS explains all variation in long rates). Suppose further expected short rates are lower than the short rate today. Then the long rate will be lower than the short rate (i.e., the yield curve inverts). Since low interest rates are typically associated with decreased economic activity, an inverted yield curve should imply a downturn. Given that $l_t^n > 0$, then an inversion should imply a downturn a fortiori.

Why should short interest rates be lower during an economic downturn? The reasoning takes two forms, not mutually exclusive. The first is that decreased economic activity decreases private sector demand for credit; at the same time the monetary authority is likely to have decreased the policy rate in response to the slowdown. The second is that the monetary authorities raise rates that precipitate the subsequent slowdown.

2.2. *Selective Literature Review*

The literature on the usefulness of the yield spread in forecasting future growth is extensive indeed and not all the papers can be discussed here. Publications regarding the relationship between growth and the yield spread began in the late 1980s; Harvey (1988, 1989), Stock and Watson (1989), Nai-Fu Chen (1991), Estrella and Hardouvelis (1991) among others, suggested that an inverted yield curve (in this case a negative yield spread) could be a sign of an impending recession. These early studies were primarily conducted using U.S. financial data to predict future GDP growth.

Subsequent research focused on whether the relationship between the yield spread and future economic growth held up in countries other than the United States. Harvey (1991), Davis and Henry (1994), Plosser and Rouwenhorst (1994), Bonser-Neal and Morley (1997), Kozicki (1997), Estrella and Mishkin (1997) and Estrella, Rodrigues and Schich (2003) studied non-US OECD countries using post-1970 data, and generally conclude that the yield spread can be used to some extent in predicting future economic growth outside the United States. However out-of-sample studies conducted by Davis and Fagan (1997) with data from the United States and Germany, along with Smets and Tsatsaronis (1997) using European data found that parameter estimates are unstable over time and reported poor forecasting capabilities.

While the most simple model structure requires only a bivariate specification, some subsequent research allows for additional variables, such as the short term policy rate, at least when predicting recessions (as opposed to growth). One prominent example of this approach is Wright (2006). In his paper, Wright argues that adding the short-term rate strengthens the in-sample forecasting results when using a probit model to predict recessions.

3. Empirical Model and Results

3.1 *Data*

The compilation of the dataset presents the researcher with many choices, including the set of countries to study, and the choice of both regressors and regressand. We opted to select countries in order to adequately represent the Euro Area. Countries outside the Euro Area provide a basis of comparison to provide perspective and sense of robustness regarding the results.

In addition, to ensure the interest rates represent market-determined rates, we selected countries that have robust, liquid financial markets. We also faced data constraints, in that we needed a large enough sample (1970-2008[3]) which put some limits on the countries we could include. Given these constraints, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom, the United States constitute the sample of countries in this study. An aggregate Euro Area model is also estimated using data from 1990-2008.

The measure of economic activity chosen for this paper is industrial production. While GDP is the broadest indicator of economic activity, the use of industrial production presents some substantial advantages in terms of timeliness and reliability.[4] In any case, growth rates of industrial production tend to follow GDP closely[5]. All of the countries in the data set (including the Euro Area) report industrial production at a monthly frequency while GDP is almost universally reported at a quarterly frequency, which affords us a bigger data set. In order to have enough observations using quarterly data, the data set must be large enough (i.e. span enough time) to elicit robust results. Monthly data provides an opportunity to study smaller time spans while conserving degrees of freedom

[3] For Italy and the Netherlands, the data begin in 1971 and 1972 respectively.

[4] By reliability, we mean that the industrial production series do not get revised as significantly as GDP.

[5] For instance, the correlation between GDP and IP growth in the US and UK are .76 and .72 respectively.

3.2 *In-sample Results*

We start with a simple bivariate model:

$$IPGrowth_{t,t+k} = \beta_0 + \beta_1 Spread_t + \varepsilon_{t+k} \qquad (2)$$

Where $IPGrowth_{t,t+k}$ is the annualized growth rate over the period t t and $t+k$ t+k, and $Spread_t = i_t^{10yr} - i_t^{3mo}$.

In words, the yield spread at time t t is predicted by the annual growth rate of industrial production from time t t to time period $t+k$ t+k months. We examine this model with k k equal to 12 and then with k k equal to 24 (i.e. growth over a one and two year time horizon). Adjacent year over year growth figures will be drawing from overlapping data points, as a result the error terms will be serially correlated. To account for serial correlation, we conduct our statistical inferences using heteroscedasticity and serial correlation robust standard errors. [6]

We turn first to the results from the model using the complete data set (1970-2008), displayed in table 1. All countries exhibit a significant slope parameter over the one year forecast horizon (at the 5 percent significance level for all but the Euro Area where it is significant at the 10 percent level), suggesting the yield spread may hold some forecasting value. The magnitude of the parameter estimate is also economically

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[6] We have investigated whether the variables are stationary or not. Unit root tests indicate that the spreads and industrial production changes are stationary.

significant. Take the slope coefficient of 1.37 for France, for example; this point estimate implies that for each percentage point increase in the yield spread, French industrial production growth will increase by 1.37 percentage points.

Figure 1 displays the estimated slope coefficients for all countries in the data set. These coefficients vary markedly across countries, ranging from a high of 1.83 in Canada to a low of 0.78 in the United Kingdom. The variation in coefficients confirms the fact that the relationship between the yield spread and economic growth is not identical across countries.

Despite the existence of statistically significant parameter estimates in each country, the goodness of fit for the model (according to the R-squared statistic), varies substantially across country models. That being said, the relative proportion of variation across countries is of interest. The yield spread in United States, Germany, France and Canada explains more than 20 percent of the changes in annual industrial production growth. In contrast, the yield spread explains less than 10% of the variation in output in Italy, the Netherlands, and Sweden.

Following Bonser-Neal and Morley (1997) and Kozicki (1997), we also examine the corresponding specification for growth over a two year horizon. While many of the variables are still significant, the explanatory power of the model deteriorates for many countries. Additionally, in every case the magnitude slope coefficient is smaller in the two-year model relative to the one-year model. The decrease in explanatory power and magnitude of the coefficient estimates at the two-year versus one-year horizon suggests most of the explanatory power is concentrated at the former horizon.[7] Figure 2 displays the goodness of fit according to the R-squared coefficient across countries over one and two-year growth forecast horizons. Only the German, United Kingdom and United States models exhibit better fit in the two-year model relative to the one-year model.

In order to investigate the time variation in the strength and nature of the yield curve/growth relation, we split the sample at 1997/98. The choice of that specific date is primarily pragmatic in nature; it sets each subsample to be roughly similar in size. At the same time, the choice is somewhat fortuitous, as the latter subsample then conforms approximately to the post-EMU period.

Tables 2 and 3 contain results from the two sub-samples of data, and highlight a key finding. The detection of a statistically significant relationship between term spreads and subsequent output growth is driven by the early portion of the sample. The regressions on date from the early sample (1970-1997) yield coefficients that are significant for every country at the 95 percent confidence level. In contrast, the coefficient estimates when using more recent data (1998-2008) are not significantly different from zero in all countries, with the exception of Sweden over a one-year horizon and Japan over a two-year horizon, suggesting a general deterioration in the relationship between the yield spread and economic growth in recent years.[8]

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[7] For an empirical investigation into this issue see Kozicki (1997).

[8] Interestingly the level of the coefficient for Sweden is three-fold higher in the later sample relative to the early sample.

Examining the goodness of fit across sub-samples in figure 3 leads to similar conclusions. Only the Sweden and Italy models exhibit a better fit when using the later data subset. In Italy's case the slop coefficient is not significant at the 95 percent confidence level. Only in four (very important) cases – the US, France, Germany and Italy -- does the the goodness of fit hold steady. Japan exhibits the sharpest dropoff in goodness of fit from the two subsets, starting at nearly 0.2 in the 1970-1997 subsample and reaching nearly zero in the 1998-2008 subsample. This data period coincides with the Asian financial crisis and may reflect Japan's short term rates hitting the zero interest lower bound.

One interpretation of this finding could be as follows: typically a central bank will lower the policy rate to stimulate the economy, to the extant that the long term rate is less responsive to policy rates compared to short-term rates a lowering of the policy rate correlates with an increase in the yield spread. When the policy rate hits zero and the central bank engages in quantitative easing to replace reductions in the policy rate, longer term interest rates fall. The result is a narrowing of the yield spread. If succesful, these lower rates should (and flattend yield spread) spur the economy and future growth should be on the horizon. If this were the case we would expect the relationship between the yield spread and future growth when the policy rate is at zero to be inverse to the reationship when the policy rate is positive. One implication of the Japanese results, relevant to current debates is that going forward, is that we might expect a degraded fit for the US yield curve/output relationship, given the effective Fed Funds rate has essentially hit zero.

Haubrich and Dombrosky (1996) and Dotsey (1998) suggest that the relationship between the yield spread and future growth diminishes using data since 1985. The results of our analysis suggest that the relationship continues to deteriorate post 1997, but with a couple of exceptions.

3.3 *Out-of-Sample results*

A common critique of in-sample estimation is that the model estimates the fitted values using data that would not have been available at the time of the observation being fitted. The results of an in-sample forecast will be using extra information to fit the parameters to the data and could therefore overstate the predictive power of the independent variable. If we were to attempt to forecast growth from today to one year into the future, we would not be privy to the information in the interim.

One way to circumvent this potential problem is by conducting a pseudo out-of-sample regression analysis. Each yield spread observation is used to predict future growth with truncated data such that the only data used is data that existed prior to the observation. For example, if we have a data set that ranges from 1970-2008 and we want to predict industrial production growth from January 1980 to January 1981, we could restrict our regression to only use data from 1970-1979 in calculating the constant and slope parameters for our estimation of 1980-1981 growth. Then, to estimate IP growth from February 1980 to February 1981, we re-run the regressions adding the January 1980 data and use the newly generated parameter estimates to predict growth over that time period.

The parameter estimates from the recursive regressions are used to generate a series of fitted values for year-over-year growth for each country. We opt to compare the root mean square error (RMSE) criterion, and compare against a naïve forecast RMSE. In this case, our naïve forecast is a simple AR1 model of growth.

The results can be succinctly summarized. We conclude that there exists a marginal benefit to estimating a growth model with the yield spread (as opposed to the simple AR1model) if the RMSE from the yield spread model specification is less than that of the AR1 model. Figures 4.1 and 4.2 display the fitted values for the United Kingdom, first using the yield spread as the independent variable and then from the AR(1) model. Figures 5.1 and 5.2 do the corresponding comparison for the United States. While extreme fluctuations of 1985 and increases volatility in the early 2000s were not well predicted, the general shape of the data was better represented with the yield curve as opposed to the AR1 results in this case. None of the models, including those that outperformed the AR1 models, were able to predict the most recent contraction of industrial production.

Results across all countries were mixed. Table 4 displays the results of the RMSE scores for both model specifications. Five of the nine country models scored lower

RSME from the yield curve specification as opposed to the AR1 model, while the remaining four increased.

4. The Yield Curve and "Recessions"

In some respects, we now move to a nonlinear version of the same question we asked earlier, to the extent that recessions are a specific characterization of (negative) output growth. Following Montea (2003) and Wright (2006), we test if the yield spread is a predictor of recessions, defined as a binary dependent variable.

Clearly there is little agreement in terms of the findings in the literature, especially in this cross-country context. While Montea (2003) finds the yield curve alone is a useful predictor of recessions when using aggregate Euro area data, Wright (2006) argues there is no reason to believe that an increase in the short-term interest rate should have the same consequence as a decrease in the long term rate. Consequently, augments the conventional recession/yield curve specification with the Federal funds rate to isolate the effect of changes in the short-term rate. Indeed, Wright's model performed better when adding the federal funds when using United States data. Following the literature, the models we use are as follows:

$$\mathbf{Pr}(R_{t+1,t+k} = 1) = \phi(\beta_0 + \beta_1 Spread_t)$$

$$\mathbf{Pr}(R_{t+1,t+k} = 1) = \phi(\beta_0 + \beta_1 3mo_t + \beta_1 Spread_t)$$

Where t t is the current time period and k k is the forecast period and $\varphi(\ldots)$ denotes the standard normal cumulative distribution function. We use the 3-month interest rate to isolate the effect of movements in short-term interest rates. The recession indicator equals one if there is a recession in any month between $t+1$ t and $t+k$ t, inclusive[9]. We estimate both models using k k equal to 6 and again with k k equal to 12 (i.e. a six month and one year forecast).

Table 5 displays the results from the probit model estimates for each country. The first two columns are the results from a six-month forecasting horizon, while the third and fourth columns display the twelve-month forecasting results. The pseudo R-squared statistic (which does not penalize for increased model size) is shown as an indicator of goodness of fit. Generally the models that include the short-term interest rate out-perform those that only include the yield spread.

For the United States, our results differ somewhat from the results obtained by Wright (2006); the yield spread parameter is significant over both the six-month and twelve-month forecasting periods. However, the 3-month interest rate parameter is statistically insignificant over either horizon. Additionally, we do not see a significant increase in goodness of fit when adding the short-term rate.

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[9] Recessions for the United States as defined by the NBER, for all other countries as defined by the ECRI institute.

The results from the Germany model are very similar to the United States model: model performance improves very little when adding the short-term interest rate and the short-term interest rate parameter is not statistically significant. Interestingly, results for the remaining countries outside the United States are starkly different. Across many other non-US countries, adding the short term rate to the model reduces both the magnitude and significance of the yield spread, while increasing the overall goodness of fit. In Canada, Sweden and the United Kingdom the short-term rate is statistically significant while the yield spread coefficient actually becomes statistically insignificant. The most dramatic instance of this is the Canada where the magnitude of the t-statistic for the yield spread parameter declines from negative 5 to just negative 0.5 when adding the short-term rate in the six-month forecast; at the same time the pseudo R-squared statistic jumped from 0.31 to 0.48. In all countries excluding Japan, the coefficient on for the short-term interest rate is positive, suggesting high relative short-term interest rates precede periods of slower growth.

To highlight some specific characteristics of our findings, we display in Figure 6.1 the estimated probabilities of recession in the subsequent 6 months for Germany using only the yield spread, and in figure 6.2 the estimated probabilities using both the yield curve and 3-month interest rate. In general the results are very similar. The estimated probabilities peaked near one prior to the recessions in the 1970s and 1980s, as anticipated. However the peak estimated probability preceding the 1990 recession was considerably lower and in fact reached a second peak in the midst of the recession. In both cases however, models ascribed a probability greater that 50 percent preceding the 2001 recession and exceeded that prior to the most recent recession. The most marked difference between the two models seems to be dip before the 1990 recession and the peak in the late 1990s. The model including both yield curve and 3-month interest rate data dipped significantly less just before the 1990 recession and the peak in the late 1990s was lower.

The results for the United Kingdom are displayed in figures 7.1 and 7.2. Probabilities generated by the model containing only the yield spread spiked in times of recession but only exceeded 50 percent once since 1970. The model containing both the yield spread and the short-term rate performed much better for recessions previous to the recession beginning in 2008. However, this model was unresponsive in the months leading up to the 2008 recession, the predicted probability of recession remained below 10 percent. In fact most of the European models performed similar to the United Kingdom model. These performances suggest a deterioration in the predictive power of the yield curve. It is tempting to speculate on the impact of Economic and Monetary Union on this phenomenon, since the 2001 recession is the

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[11] Note that CEPR, using a methodology reminiscent of NBER's, did not declare a recession for this period. See CEPR at http://www.cepr.org/data/Dating/info1.asp .

first one occurring when the ECB was setting short term rates, and long rates had converged to relatively small differentials.[11]

Results in Japan are unique across this data set. When using only the yield spread as in independent variable the coefficient is not statistically significant and the model explains almost nothing. When adding the short-term interest rate, both coefficients become highly significant and the explanatory power of the model increases markedly. Additionally, the sign of the short-term interest rate coefficient is negative, suggesting that lower relative short-term interest rates tend to precede times of slower growth in Japan.

5. Conclusion

This paper has explored the importance of the yield spread in forecasting future industrial production growth and recession. Generally speaking, when using the entire data series from 1970-2008, in-sample results suggest the yield spread is indeed important and has significant predictive power when forecasting industrial production growth over a one-year time horizon. The results deteriorate when forecasting growth two years ahead. Moreover, it appears that the predictive power of the yield curve for subsequent one-year growth is much weaker in the more recent period. However, four out of six European country models exhibited relatively high R-squared statistics (above

0.1) when using data from 1998-2008, and for two countries (Italy and Sweden) the significance actually increased. While the explanatory power is somewhat less for certain models estimated over the 1970-1997 data, the data still suggest the yield curve might possess some forecasting power for European countries. The marked deterioration of the significance in the Japan model when using data corresponding to Japan's period of zero interest rate policy (ZIRP) might presage a weakening of the significance of the relationship in the United States, given the Federal funds rate has reached the zero lower bound.

The results we obtained in the out-of-sample forecasting exercises were less convincing. Of the European countries examined, only for Germany, Sweden and France did the yield curve possess greater predictive power than a simple AR(1). Certainly the relationship between the yield spread and growth has declined in recent years; however it appears that the relationship has held up best in some European countries.

The contrast between the US and the non-U.S. countries was most marked for the probit models. The short-term rate was significant in several instances; however inclusion of the short rate often resulted in a decrease in the economic and statistical significance of the yield spread. The Japanese case is distinct from all the others. Low short-term rates appear to precede future economic slowdownl and the model performs very poorly without the short-term rate.

In other words, we do not obtain a simple story for the yield curve's predictive power. The yield curve clearly possesses some forecasting power. However, there is also some evidence that it is perhaps most visible in the US case. And overall, the predictive power of the yield curve seems, with some notable exceptions, to be declining over time.

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Data Appendix

Data for this paper came from two sources. All of the recent data came from Haver Analytics. When the series in Haver did not extend back to 1970, the Haver series were spliced with data from the Bonser-Neal and Morely (1997) dataset. These data include the following:

Canada:

- 3-month interest rate from 1/1970 to 12/1979 (IFS)
- Industrial Production from 1/1970 to 12/1980 (BIS)

France:

- 3-month interest rate from 1/1970 to 5/1989 (BIS)
- 10-year interest rate from 1/1970 to 8/81 (BIS)

Germany:

- 10-year interest rate from 1/1970 to 12/1979 (OECD, FRB)

Italy:

- 3-month interest rate from 1/1971 to 12/1979 (IFS)
- 10-year interest rate from 1/70 to 12/79 (BIS, IFS)
- Industrial Production from 1/60 to 12/79 (BIS)

Japan

- 3-month interest rate from 1/70-4/79 (BIS)
- 10-year interest rate from 1/70 – 8/87 (BIS)

Netherlands

- 3-month interest rate from 10/72 – 12/81 (BIS)
- 10-year interest rate from 1/70-4/82 (IFS)
- Industrial Production from 1/70 – 12/79 (IFS)

Sweden

- 3-month interest rate from 1/70 – 12/82 (IFS)
- 10-year interest rate from 1/70 – 12/86 (IFS)
- Industrial Production from 1/70 – 12/89 (FRB)

UK

- 3-month interest rate from 1/1970-12/1985 (FRB)

Where OECD indicates Organization for Economic Cooperation and Development, BIS indicates Bank for International Settlements, IFS indicates IMF, *International Financial Statistics*, and FRB indicates Federal Reserve Board internal database.

Table 1: Yield Curve/Growth Recessions, Full Sample (1970-2008)

	1 Year			2 Year		
	Constant	Slope	R^2	Constant	Slope	R^2
Canada	0.544	**1.828**	0.316	1.247	**1.135**	0.237
Standard Error	0.589	0.241		0.504	0.217	
France	0.677	**1.368**	0.223	1.280	**0.526**	0.076
	0.600	0.403		0.453	0.240	
Germany	0.573	**1.233**	0.246	0.976	**0.976**	0.320
	0.572	0.238		0.429	0.167	
Italy	1.612	**0.806**	0.067	1.737	-0.041	0.001
	0.697	0.342		0.484	0.213	
Japan	1.780	**1.184**	0.120	2.253	0.330	0.019
	0.861	0.495		0.711	0.329	
Netherlands	0.588	**0.878**	0.100	0.878	**0.476**	0.096
	0.508	0.244		0.317	0.129	
Sweden	0.903	**0.850**	0.072	1.878	0.026	0.000
	0.959	0.330		0.884	0.305	
United Kingdom	0.900	**0.782**	0.131	0.960	**0.559**	0.154
	0.454	0.231		0.362	0.133	
United States	0.037	**1.651**	0.247	0.571	**1.306**	0.285
	0.793	0.356		0.576	0.232	
Euro Area	0.328	1.142	0.156	0.830	0.689	0.122
(1990-2008)	0.958	0.595		0.808	0.429	

Notes: OLS regression coefficients. HAC robust standard errors below OLS estimates. **Bold entries** indicate significance at 5% msl.

Table 2: Yield Curve/Growth Recessions, Early Sample (1970-1997)

	Constant	1 Year Slope	R^2	Constant	2 Year Slope	R^2
Canada	0.938	**1.991**	0.411	1.595	**1.295**	0.333
Standard Error	0.604	0.212		0.528	0.213	
France	1.116	**1.559**	0.288	1.543	**0.644**	0.112
	0.647	0.423		0.502	0.254	
Germany	0.377	**1.203**	0.272	0.584	**0.949**	0.362
	0.638	0.240		0.464	0.161	
Italy	2.617	**1.168**	0.129	2.268	0.185	0.009
	0.849	0.357		0.603	0.259	
Japan	2.438	**1.409**	0.191	2.602	0.477	0.042
	0.946	0.491		0.810	0.326	
Netherlands	0.434	**0.911**	0.120	0.770	**0.481**	0.110
	0.576	0.251		0.358	0.132	
Sweden	0.805	**0.795**	0.067	1.628	-0.001	0.000
	1.163	0.330		1.043	0.306	
United Kingdom	1.181	**0.783**	0.131	1.273	**0.554**	0.158
	0.589	0.247		0.453	0.146	
United States	-0.056	**1.897**	0.287	0.682	**1.452**	0.315
	0.958	0.429		0.686	0.274	

Notes: OLS regression coefficients. HAC robust standard errors below OLS estimates. **Bold entries** indicate significance at 5% msl.

Table 3: Yield Curve/Growth Recessions, Late Sample (1997-2008)

	Constant	1 Year Slope	R^2	Constant	2 Year Slope	R^2
Canada	0.39366	0.6652	0.026	1.20666	-0.0147	0
Standard Error	0.946	2.182		1.899	0.801	
France	-0.746	1.274	0.120	0.039	0.671	0.070
	1.049	0.654		1.068	0.523	
Germany	0.695	1.683	0.121	1.076	1.309	0.111
	1.742	1.045		1.559	0.882	
Italy	-1.626	1.320	0.158	0.277	-0.085	0.002
	0.987	0.710		0.984	0.478	
Japan	2.847	-1.058	0.004	7.057	**-3.950**	0.152
	3.429	2.312		1.752	1.580	
Netherlands	1.714	0.203	0.002	1.607	0.154	0.003
	1.362	0.925		1.034	0.551	
Sweden	-0.904	**2.444**	0.171	2.433	0.224	0.004
	1.759	1.148		1.376	0.715	
United Kingdom	-0.160	-0.100	0.002	-0.212	-0.292	0.047
	0.339	0.533		0.250	0.387	
United States	0.445	0.712	0.093	0.415	0.672	0.177
	1.305	0.481		0.949	0.415	
Euro Area	0.322	1.276	0.124	1.262	0.523	0.037
	1.189	0.796		1.249	0.660	

Notes: OLS regression coefficients. HAC robust standard errors below OLS estimates. **Bold entries** indicate significance at 5% msl.

Table 4: Out of Sample Forecasting Performance

	Yield Spread RSME	AR1 RSME	
Canada	4.140393	4.798523	***
France	3.07171	2.915627	
Germany	3.328575	3.785737	***
Italy	4.233276	3.986558	
Japan	5.491521	4.902213	
Netherlands	3.945189	3.889603	
Sweden	4.253046	5.513141	***
UK	2.720546	2.8979	***
US	3.425576	3.388179	***

Notes: *** indicates yield spread specification out-performs the AR1 model.

Table 5: Probit Model Performance

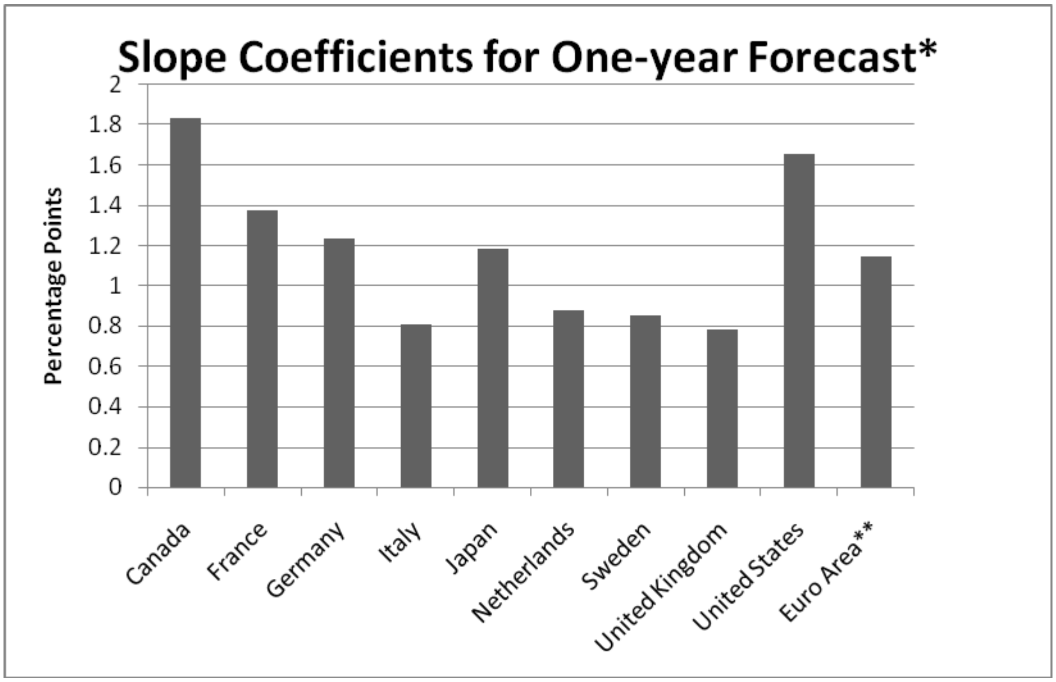
	Next 6 Months		Next 12 Months	
Canada				
Ten-year less Three-Month	**-0.526**	-0.064	**-0.606**	-0.140
	(0.104)	(0.133)	(0.127)	(0.182)
Three-Month Rate		**0.317**		**0.345**
		(0.083)		(0.097)
Pseudo R2	0.307	0.480	0.354	0.533
France				
Ten-year less Three-Month	**-0.351**	-0.219	**-0.402**	**-0.269**
	(0.088)	(0.110)	(0.115)	(0.136)
Three-Month Rate		0.100		0.102
		(0.058)		(0.063)
Pseudo R2	0.100	0.146	0.117	0.163
Germany				
Ten-year less Three-Month	**-0.647**	**-0.541**	**-0.602**	**-0.480**
	(0.148)	(0.199)	(0.159)	(0.201)
Three-Month Rate		0.083		0.102
		(0.098)		(0.110)
Pseudo R2	0.324	0.332	0.286	0.299
Italy				
Ten-year less Three-Month	**-0.256**	-0.152	**-0.202**	-0.111
	(0.081)	(0.105)	(0.091)	(0.124)
Three-Month Rate		0.059		0.052
		(0.040)		(0.048)
Pseudo R2	0.087	0.119	0.054	0.087
Japan				
Ten-year less Three-Month	-0.047	**-0.715**	-0.013	**-0.633**
	(0.088)	(0.156)	(0.113)	(0.170)
Three-Month Rate		**-0.371**		**-0.352**
		(0.074)		(0.091)
Pseudo R2	0.003	0.241	0.000	0.225

Table 5 (Continued)

Sweden				
Ten-year less Three-Month	**-0.286**	-0.123	**-0.290**	-0.147
	(0.109)	(0.131)	(0.126)	(0.154)
Three-Month Rate		**0.125**		0.111
		(0.053)		(0.067)
Pseudo R2	0.105	0.163	0.106	0.154
United Kingdom				
Ten-year less Three-Month	**-0.254**	-0.117	**-0.300**	-0.178
	(0.118)	(0.128)	(0.137)	(0.152)
Three-Month Rate		**0.176**		**0.184**
		(0.069)		(0.079)
Pseudo R2	0.099	0.238	0.130	0.273
United Sates				
Ten-year less Three-Month	**-0.433**	**-0.341**	**-0.652**	**-0.573**
	(0.110)	(0.125)	(0.143)	(0.154)
Three-Month Rate		0.092		0.121
		(0.078)		(0.110)
Pseudo R2	0.139	0.163	0.252	0.284

Notes: OLS regression coefficients. HAC robust standard errors below OLS estimates. **Bold entries** indicate significance at 5% msl.

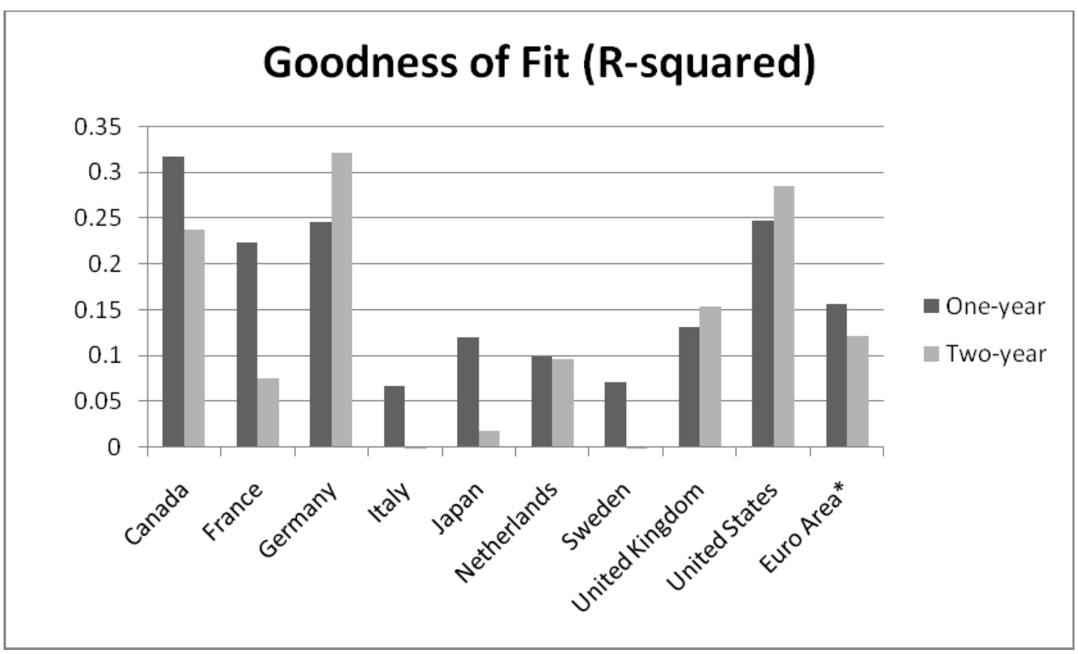
Figure 1



*Effect of a 1 percentage point increase in the yield spread on growth of industrial production

**Euro area data from 1990-2008

Figure 2



*Euro area data from 1990-2008

Figure 3

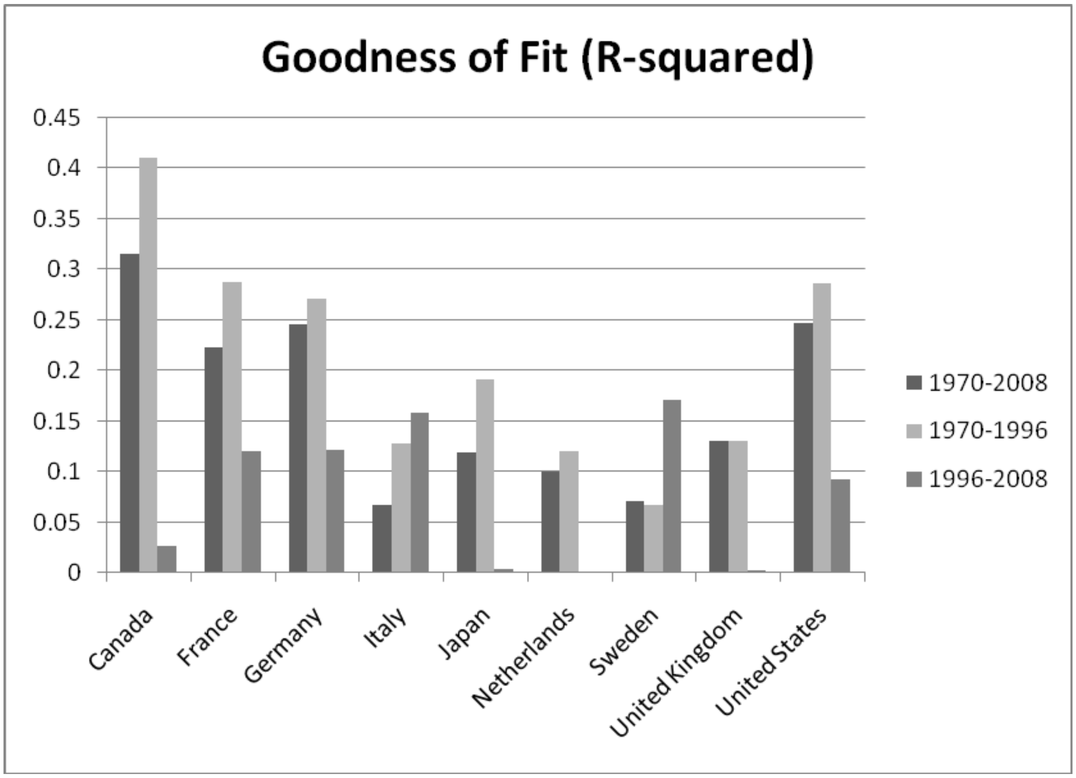

Goodness of Fit (R-squared)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Canada
France
Germany
Italy
Japan
Netherlands
Sweden
United Kingdom
United States
1970-2008
1970-1996
1996-2008

Figure
4.1

Out-of-Sample with Yield Spread (United Kingdom)

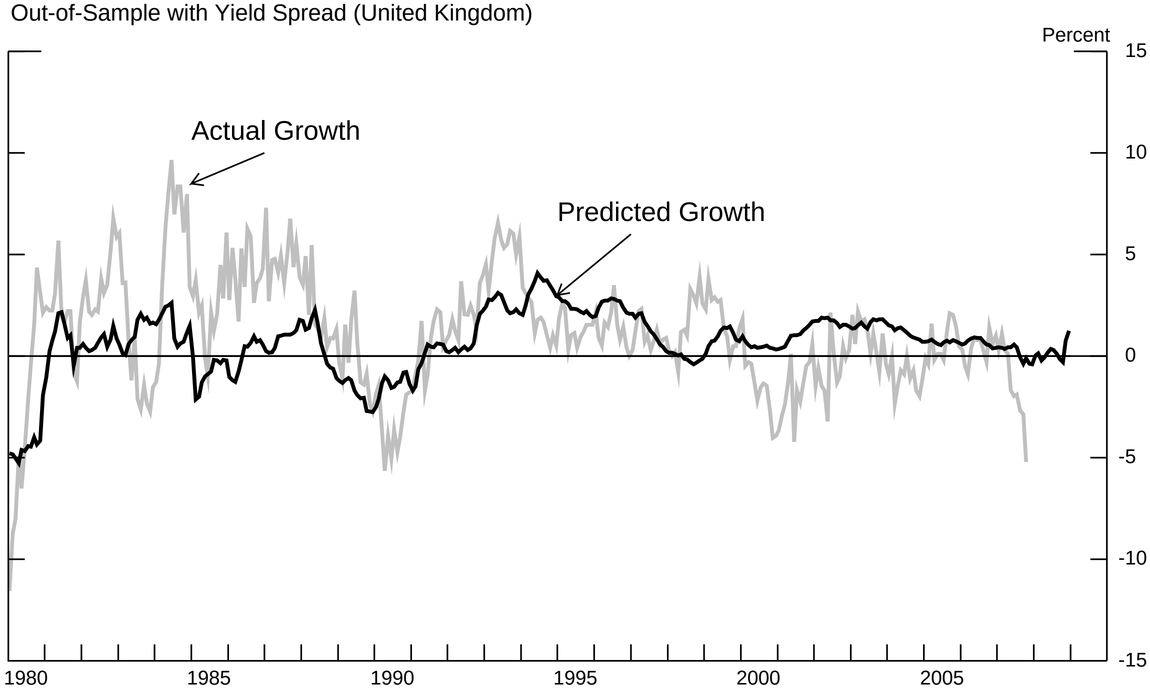


Figure 4.2

Out-of-Sample AR1 Model (United Kingdom)

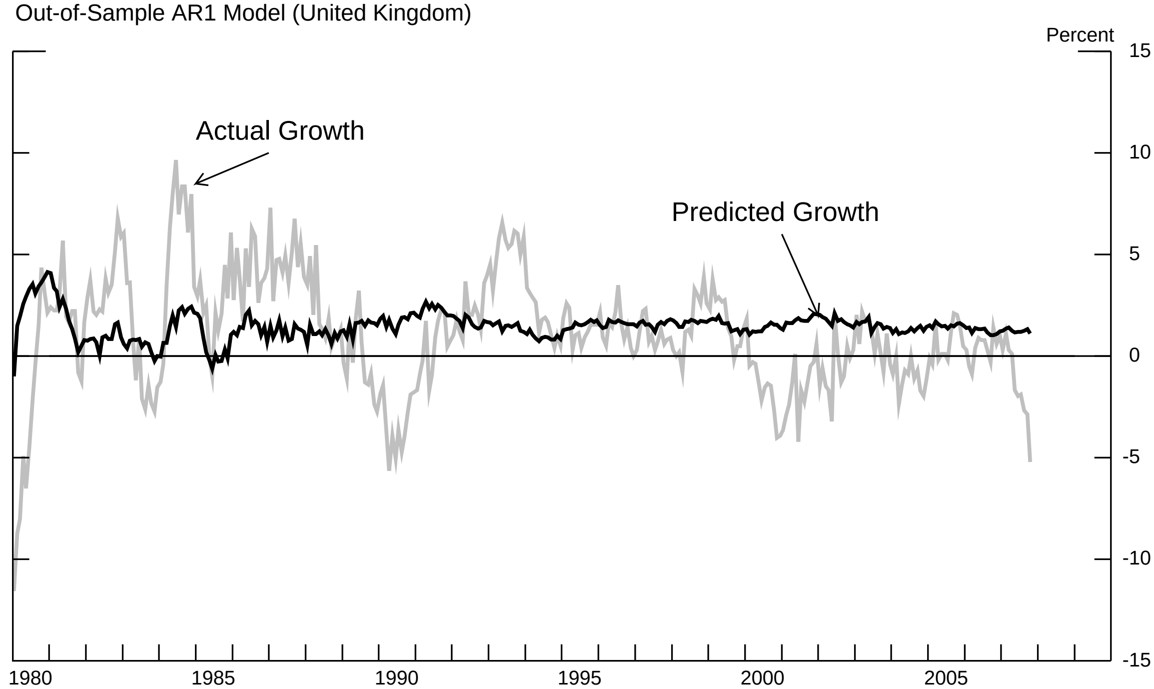
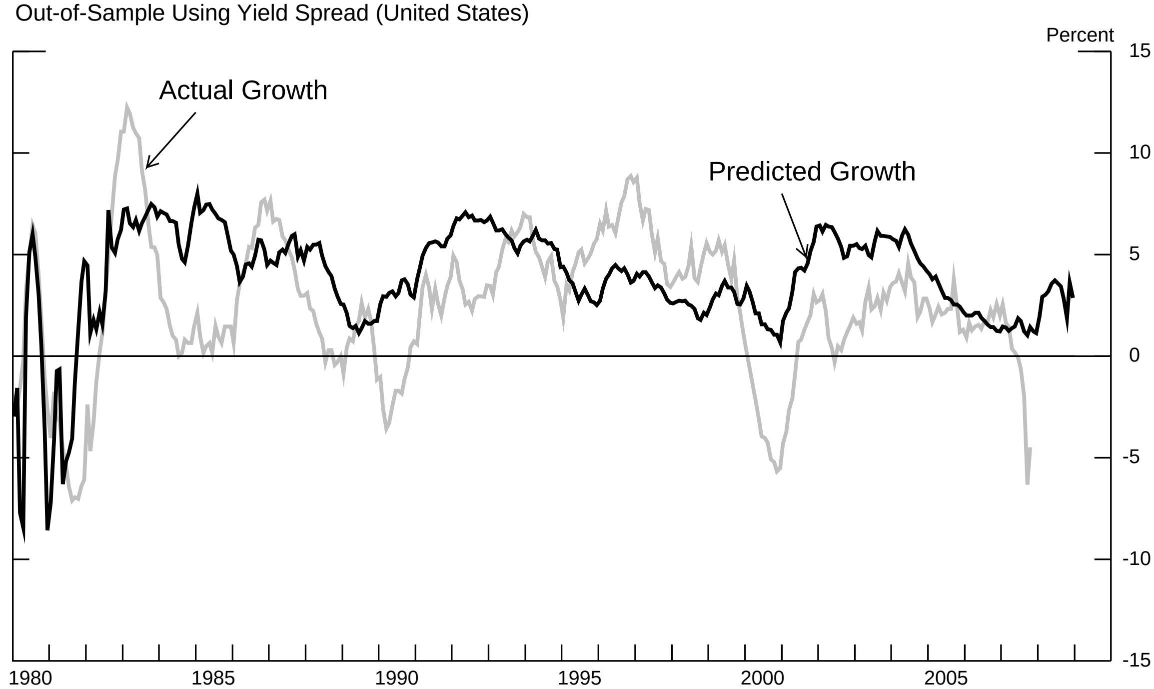


Figure 5.1

Out-of-Sample Using Yield Spread (United States)



Figure

5.2

Out-of-Sample AR1 Model (United States)

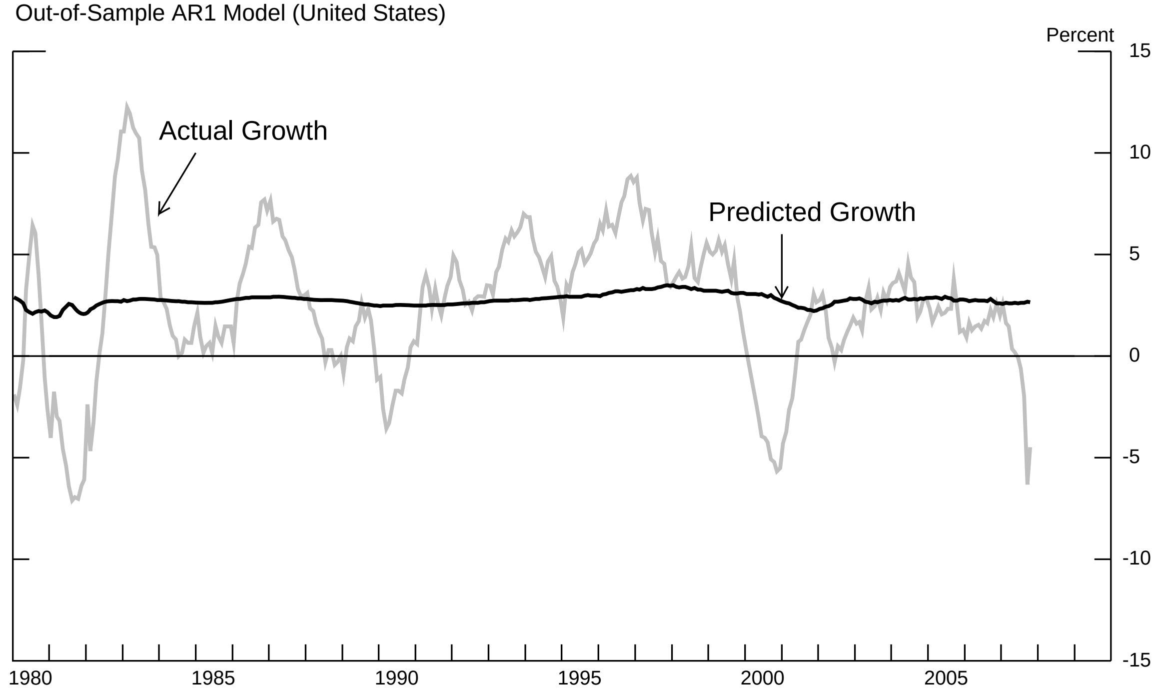
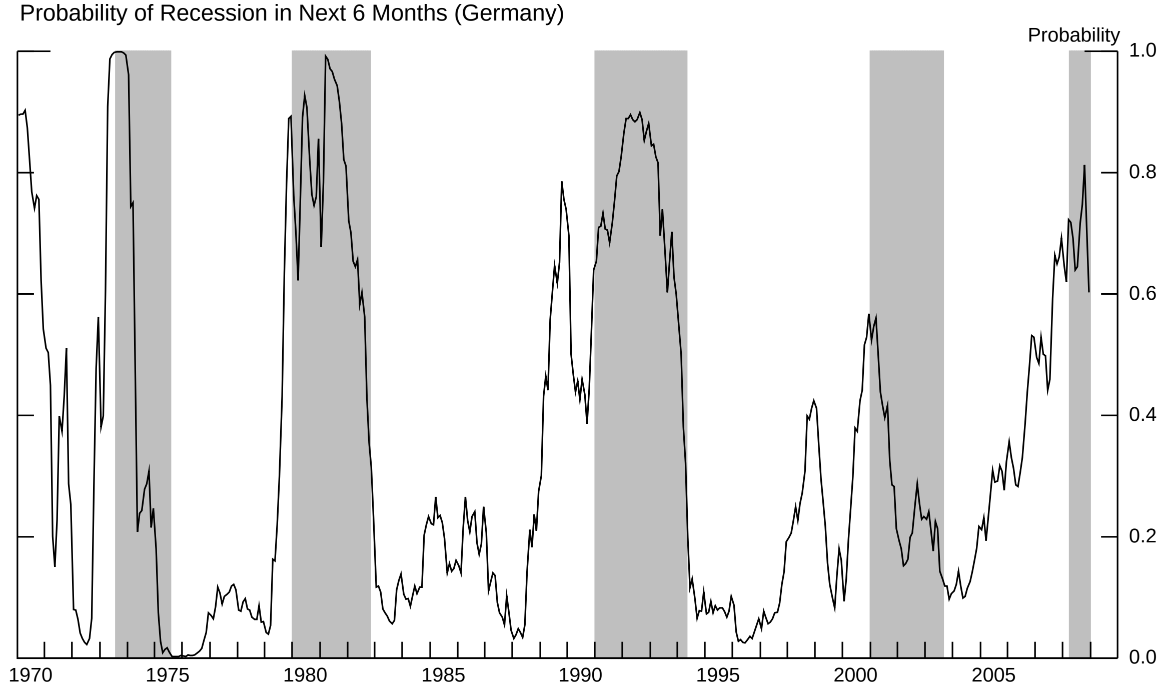


Figure 6.1

Probability of Recession in Next 6 Months (Germany)

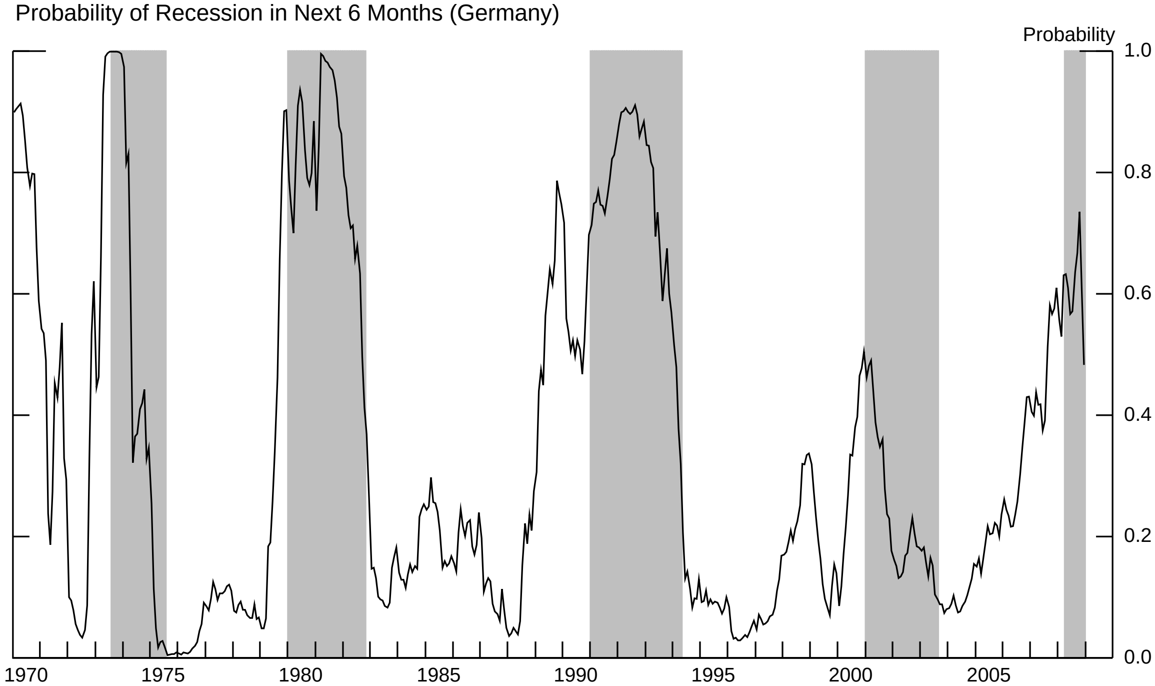


Probabilities generated using only yield spread data.

Figure

6.2

Probability of Recession in Next 6 Months (Germany)

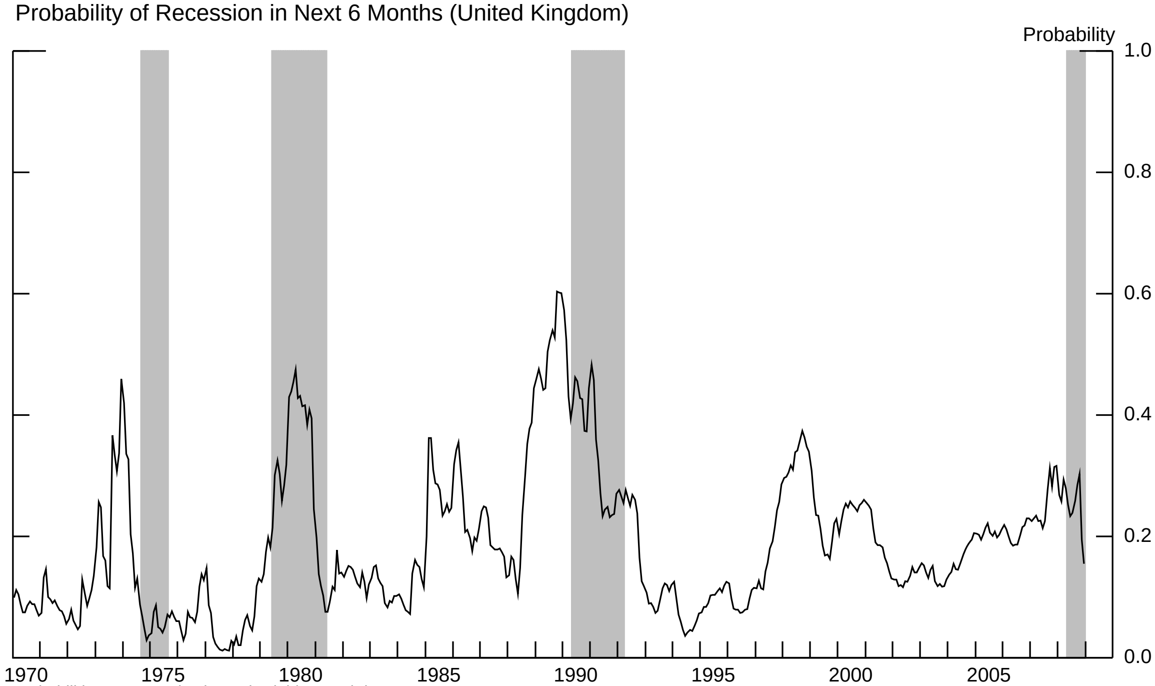


Probabilities generated using both yield spread and 3-month interest rate.

Figure

7.1

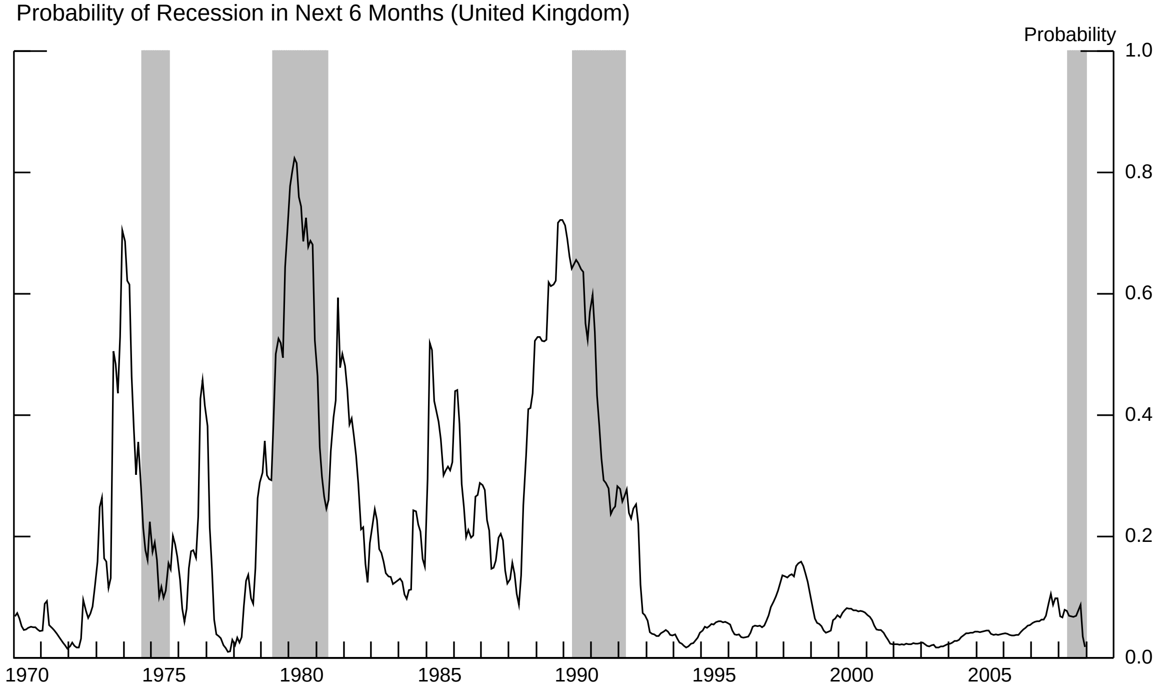
Probability of Recession in Next 6 Months (United Kingdom)



Probabilities generated using only yield spread data.

Figure
7.2

Probability of Recession in Next 6 Months (United Kingdom)



Probabilities generated using both yield spread and 3-month interest rate.