Does the Yield Spread Predict Real Economic Activity? A Multicountry Analysis

By Catherine Bonser-Neal and Timothy R. Morley

Forecasts of real economic activity are a critical component of many decisions. Businesses rely on such forecasts in forming their production plans. Policymakers rely on such forecasts when choosing the path of monetary policy or when forming the national budget. The appropriateness of these choices depends, in large part, on the quality of the forecast.

Despite their importance, forecasts of real economic activity can be unreliable. Forecasts based on macroeconomic models are often hindered by the lack of timely and accurate data and the complexity of the forecasting model. These difficulties have led to a growing interest in using financial variables to supplement traditional model-based forecasts of real economic activity. The advantages of forecasts based on financial variables are that such forecasts are simple to implement, and the data are readily available and less prone to measurement error.

One financial variable that has been particularly successful in forecasting U.S. real economic growth is the difference between long-term and short-term interest rates, or the yield spread. In general, a positive yield spread—that is, higher long-term interest rates than short rates—is associated with future economic expansion, while a negative yield spread is associated with future economic contraction. In addition, the magnitude of the spread is related to the level of real economic growth: the larger the spread, the faster the rate of real economic growth in the future.

While evidence on the usefulness of the yield spread as a predictor of real economic activity for the United States is now well-established, evidence outside the United States is limited. Few studies have examined the forecast power of the yield spread in other countries, and those that have are limited in either the sample of countries, the measure of real economic activity, or the length of the forecast horizon. Such evidence on the predictive ability of the yield spread, however, would be useful to businesses and policymakers in the United States as well as abroad. For example, U.S. businesses and policymakers would benefit from better forecasts of foreign real economic activity because projections for U.S. exports depend on forecasts of

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foreign economic growth. In addition, foreign businesses and policymakers would benefit from knowing which variables are useful in forecasting real economic activity in their country.

To obtain such evidence, this article evaluates the ability of the yield spread to forecast real economic activity in 11 industrial countries. The first section of this article defines the yield spread and explains why the spread may be a useful predictor of real economic activity. The second section describes the data and criteria used to evaluate the predictive power of the yield spread. The third section examines whether yield spreads have reliably forecast real economic activity in the 11 countries, using several measures of real economic activity and alternative forecast horizons. The empirical results indicate the yield spread is a statistically and economically significant predictor of real economic activity in several industrial countries besides the United States. In addition, the yield spread forecasting model generally outperforms two alternative forecasting models in predicting future real GDP growth.

I. THE LINK BETWEEN THE YIELD SPREAD AND REAL ECONOMIC ACTIVITY

Understanding the relationship between the yield spread and the economy involves understanding the yield curve and what movements in it may reflect.[1] This section defines the yield curve and the yield spread and discusses explanations for why the yield spread could reliably forecast real economic activity.

What is the yield curve? A yield *curve* plots the yields on debt securities with similar risk, liquidity, and tax considerations relative to the securities' time to maturity. For example, suppose today the yield on a 3-month Treasury bill is 6 percent and the yield on a 10-year Treasury bond is 8 percent. The yield curve for these two securities appears as the solid line in Figure 1. If the 10-year bond rate is 7 percent, then the yield curve is given by the lower dotted line. The yield curve in both cases is linear since the yields of only two securities are plotted. With more than two securities of different maturities, the yield curve need not be linear.

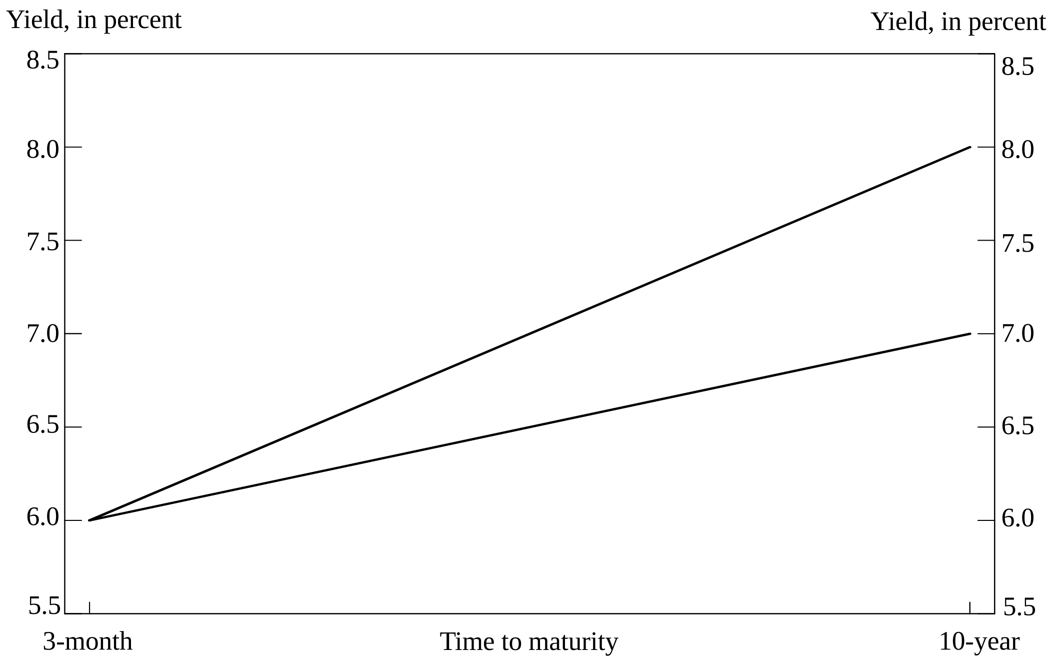
The yield *spread* is the difference at a point in time between the yields on two securities with different maturities. In the above example, the yield spread between the 10-year Treasury bond with a yield of 8 percent and the 3-month Treasury bill with a yield of 6 percent is two percentage points. If the 10-year bond yield falls to 7 percent, with no change in the short rate, the yield spread falls to 1 percent.

The yield spread also measures the steepness—or the slope—of the yield curve. The larger the spread, the steeper the yield curve. Figure 1 illustrates the relation between the yield spread and the slope of the yield curve. The yield curve with a spread of 2 percent is steeper than the curve with a spread of 1 percent.

What does the yield spread reflect? Recent research has shown that the yield spread between long-term and short-term bonds helps predict future real activity in the United States and in some other OECD countries. A positive spread between long-term and short-term interest rates (a positively sloped yield curve) is associated with an increase in real economic activity, while a negative spread (a negatively sloped yield curve) is associated with a decline in real activity. In addition, the larger the yield spread, the higher the level of future real economic activity.[2]

Researchers have offered two reasons for this empirical relationship. First, the yield spread may reflect the stance of monetary policy. When monetary policy is tightened, short-term interest

Figure 1
SAMPLE YIELD CURVES



rates rise; long-term rates also typically rise but usually by less. As a result, the yield spread narrows or even turns negative. In time, higher interest rates reduce spending in interest-rate sensitive sectors of the economy, causing economic growth to slow. Consequently, a small, or negative, yield spread will be associated with slower real economic growth in the future.

An alternative explanation for the link between the yield spread and future growth is that the yield spread reflects market expectations of future economic growth. For example, suppose market participants expect real income to rise in the future. An increase in expected future real income implies an increase in profitable investment opportunities today. In order to take advantage of these investment opportunities, businesses increase their borrowing and issue more bonds. Since these investments are typically longer term, the bonds issued will also be longer term. An increase in the supply of longer term bonds reduces their price and increases their yield. Long-term rates will therefore rise relative to short-term rates, and the yield curve will steepen. As long as these expectations for economic growth are at least partially realized, a steepening of the yield curve will be associated with a future increase in real economic activity.[3]

Which theory is the most likely explanation for the ability of the yield spread to forecast real economic growth? Recent evidence suggests both theories may have merit. Estrella and Hardouvelis (1991) and Estrella and Mishkin (1995), for example, show that proxies for current monetary policy do help forecast future real GDP growth; however, the inclusion of these proxies does not eliminate the significance of the yield curve. These results suggest the yield curve reflects more than just the effects of current monetary policy actions.

II. EVALUATING THE PREDICTIVE POWER OF THE YIELD SPREAD: DATA AND CRITERIA

Before evaluating the forecasting power of the yield spread across countries, several decisions must be made regarding the countries and the variables to be considered. This section describes the data and criteria used to evaluate the predictive power of the yield spread.

Which countries?

A proper evaluation of the predictive power of the yield spread requires a lengthy time series of market-determined interest rates and accurate measures of real economic activity. Two criteria guided the selection of countries to be included in the analysis. First, only industrial countries with well-developed financial markets were included. This criterion ensured that the interest rates used in the forecasts were determined in a liquid and transparent market, and hence reflect market expectations rather than government controls. Second, data on interest rates and real economic activity had to be available for at least the last 20 years. This criterion ensured a sample size large enough that the forecast power of the yield spread could be reliably assessed. The resulting sample consists of 11 industrial countries: Australia, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, the United Kingdom, and the United States.[4]

Which yield spread?

In testing the predictive power of the yield spread, it is important to choose the yields of debt securities which are actively traded and which reflect market expectations. Because several debt securities can satisfy this criterion, there are several alternative measures of the yield spread. In the United States, for example, some of the important interest rates monitored by market participants include the federal funds rate; the 3-month Treasury bill rate; the 1-year, 5-year, 10-year Treasury note rates; and the 30-year Treasury bond rate. A similar range of assets exists in many foreign countries.

In choosing the yield spread, this study seeks to balance comparability with previous studies along with data availability. Previous research on the predictive power of the spread in the United States has focused on the spread between the 10-year Treasury bond rate and the 3-month Treasury bill rate. Consequently, when possible, the yield spread examined for each country is the spread between the rate on the 10-year government bond and the 3-month government bill rate. In countries where these assets are not actively traded, an alternative asset must be used. For example, in countries where a 10-year government bond is not actively traded, the long-term government bond which is actively traded is used. Similarly, in countries where a 3-month government bill rate is not available, an alternative 3-month rate such as the rate on interbank deposits is used.[5]

Which measure of real economic activity?

How well the yield spread predicts economic activity also depends on the measure of real economic activity examined. This article uses real GDP growth as the primary measure of real economic activity. Real GDP is the broadest measure of economic activity, and it is closely monitored by market participants. Real GDP, however, is available only on a quarterly basis. Alternative measures of real economic activity, such as the index of industrial production and the unemployment rate, are available monthly. Hence, to estimate the predictive power of the spread on a monthly basis, this article also measures real economic activity with the index of industrial production and the unemployment rate.

Which forecast?

Once the yield spread and economic activity measures are selected, the next step is to choose forecasting techniques and forecasting horizons. Two types of forecasting techniques can be employed to evaluate the forecast power of the yield spread: in-sample and out-of-sample forecasts. An in-sample forecast estimates the average relationship between the yield spread and real economic activity over the entire period for which data are available. Since it measures an average relationship over the full period, an in-sample forecast is calculated using information which was not available at the time market participants formed their forecast. For example, given quarterly data from 1971:Q1 to 1996:Q1, an in-sample forecast for real economic growth in 1985:Q1 would be calculated based on the yield spread in prior quarters, using the relationship of the yield spread to economic activity estimated over the entire sample through 1996:Q1. An out-of-sample forecast, in contrast, only uses information available to market participants at the time of the forecast. For example, an out-of-sample forecast for real economic growth in 1985:Q1 would be calculated based on the yield spread in prior quarters, using the estimated relationship of the yield spread to economic activity only through 1984:Q4. Because both types of forecasts provide insight into the relationship between the yield spread and real economic activity, this article presents the results of both in-sample and out-of-sample forecasts.

The decision on the type of forecast must also consider the length of the forecast horizon. For example, does the yield curve predict real economic activity one quarter or five years into the future? To keep the presentation of the results manageable, this article estimates the ability of the yield curve to forecast one, two, and three years into the future. Previous research by Estrella and Mishkin (1995), and by Estrella and Hardouvelis (1991) shows that most of the forecast power occurs after one year.

Given the above decisions with respect to the sample of countries, yield spread, measure of real economic activity, and type of forecast, the next section estimates the ability of the yield spread to forecast real economic activity in 11 industrial countries.

III. INTERNATIONAL EVIDENCE ON THE YIELD SPREAD AS A PREDICTOR OF REAL ECONOMIC ACTIVITY

While several studies have examined the forecasting power of the yield spread in other countries, they are limited in either the choice of countries, the measure of real economic activity, or in the forecast horizon examined. This section extends previous work by estimating the predictive power of the yield spread in a wide range of countries across different measures of real economic activity and over different forecast horizons.[6]

To estimate the forecast power of the yield spread, the following equation is estimated for each country:

$$(\textit{change in real economic activity})_{t,t+k} = \alpha + \beta \bullet \textit{spread}_t + \textit{error}, \quad (1)$$

where the change in real economic activity is defined as the average annualized percentage change in real GDP or industrial production or as the cumulative change in the unemployment rate from today to k periods in the future. The subscript *k* represents the forecast horizon in quarters or months, and the variable *spread* is defined as the difference between the long-term and the short-term interest rates.[7] After the equation is estimated, it is used to generate in-sample and out-of-sample forecasts.[8]

In-sample forecasting results

Equation 1 is estimated for each country over the 1971-96 time period.[9] Data over this time period exist for most countries, thereby ensuring that differences across countries are not due to differences in the sample period. In addition, the 1971-96 time period corresponds to the post-Bretton Woods period of floating exchange rates.

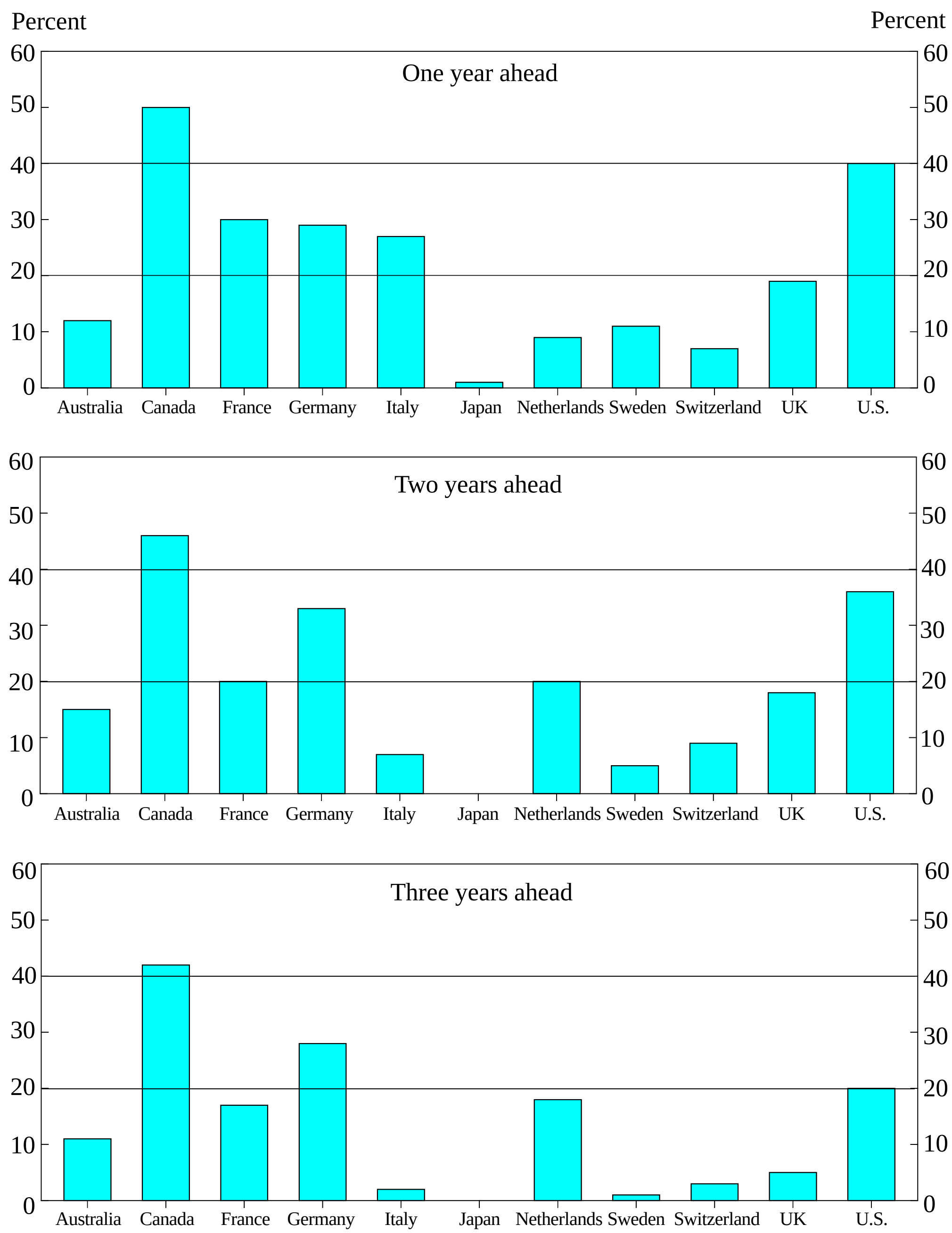
In order to judge the overall performance of the forecasting equation, Chart 1 plots the R-square values from estimating the forecasting equation 1 using real GDP growth as the measure of the change in real economic activity.[10] The R^2 from the regression equation measures the proportion of the variation in real GDP growth that is explained by the yield spread. The R^2 from the estimation of equation 1 range from 1 to 50 percent, depending on the country and the forecasting horizon. In the top panel, for example, the R^2 for Japan is close to zero, indicating that today's yield spread explains virtually none of the changes in real GDP growth over the following year.[11] In Australia, Netherlands, Sweden, Switzerland, and the United Kingdom, the yield spread explains less than 20 percent of the variation in the following year's real GDP growth. In contrast, the yield spread in Canada explains roughly 50 percent of the variation in Canada's real GDP growth over the following year. In France, Germany, Italy, and the United States, the yield curve explains between 25 and 40 percent of the variation in the following year's real GDP growth.

The middle and bottom panels of Chart 1 plot the R-squares for the two-year and three-year forecasts, respectively. In general, the explanatory power of the yield spread falls with the lengthening of the forecast horizon. In the United States, for example, the proportion of variation in future real GDP explained by the yield spread is 40 percent at the one-year horizon, but only 20 percent at the three-year horizon. The explanatory power of the yield spread also falls with the lengthening of the forecast horizon in Canada, France, Italy, Sweden, and the United Kingdom, although in Canada the R^2 falls only slightly from 50 percent at the one-year horizon to 42 percent at the three-year horizon. For some countries (Australia, Germany, the Netherlands, and Switzerland), however, the predictive power of the yield spread is slightly stronger at the two-year horizon, compared with the one-year horizon. In the Netherlands, the R^2 of the yield spread forecasting equation at the two-year and three-year horizons is twice that of the one-year horizon.

While the R^2 statistic provides an indication of the explanatory power of the spread for real GDP growth, the coefficient β from equation 1 measures how much real GDP growth changes following a one-percentage-point change in the yield spread. A positive β would imply a positive relationship between the current yield curve and future economic growth. That is, the larger the spread is between long-term and short-term interest rates, the stronger real growth will be in the future.

Chart 2 provides estimates of β for the one-year-ahead, two-year-ahead, and three-year-ahead forecasts for each country. The coefficient β is positive in all three panels, and the statistical significance of β is indicated by a solid bar. For

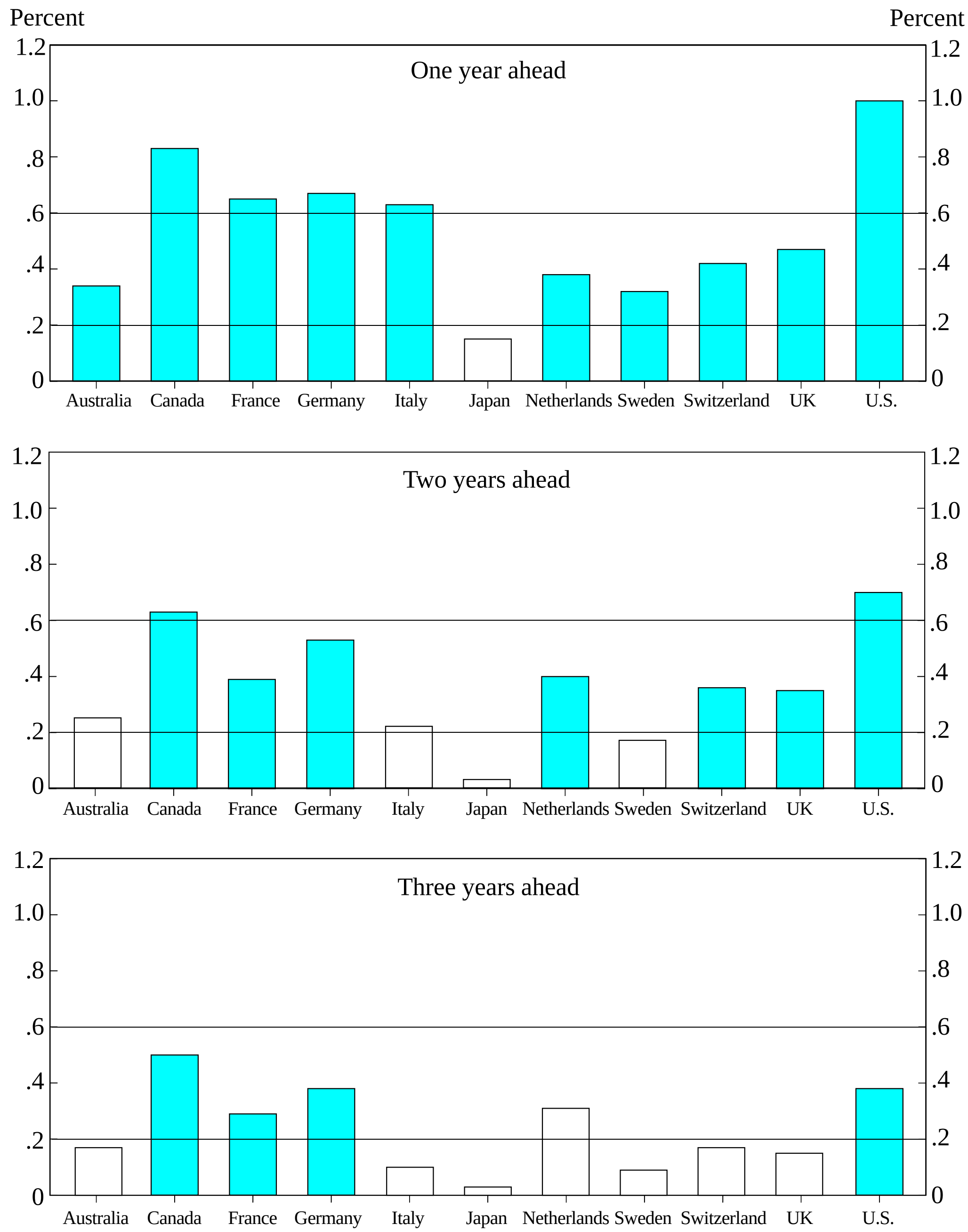
Chart 1
EXPLANATORY POWER OF THE YIELD SPREAD FOR REAL GDP



Note: Charts give the adjusted R^2 from the regression of future real GDP growth on the yield spread.
Source: See appendix and authors' calculations.

Chart 2

CHANGE IN FUTURE REAL GDP GROWTH FOLLOWING A ONE-PERCENTAGE-POINT CHANGE IN THE YIELD SPREAD



Note: Each bar represents the beta coefficient from the regression of future real GDP growth on the yield spread. Statistical significance is indicated by a shaded bar.
Source: See appendix and authors' calculations.

the one-year forecast, the solid bars also show that the yield spread is a significant predictor of real GDP growth in all countries except Japan. The middle and bottom panels show that the number of countries for which the yield spread is a statistically significant predictor of future real GDP growth declines with the forecast horizon. The yield spread remains a statistically significant predictor of real GDP growth over a two-year horizon in seven countries (Canada, France, Germany, Netherlands, Switzerland, the United Kingdom, and the United States), and is a statistically significant predictor of real GDP growth over a three-year horizon in only five countries (Canada, France, Germany, Netherlands, and the United States).

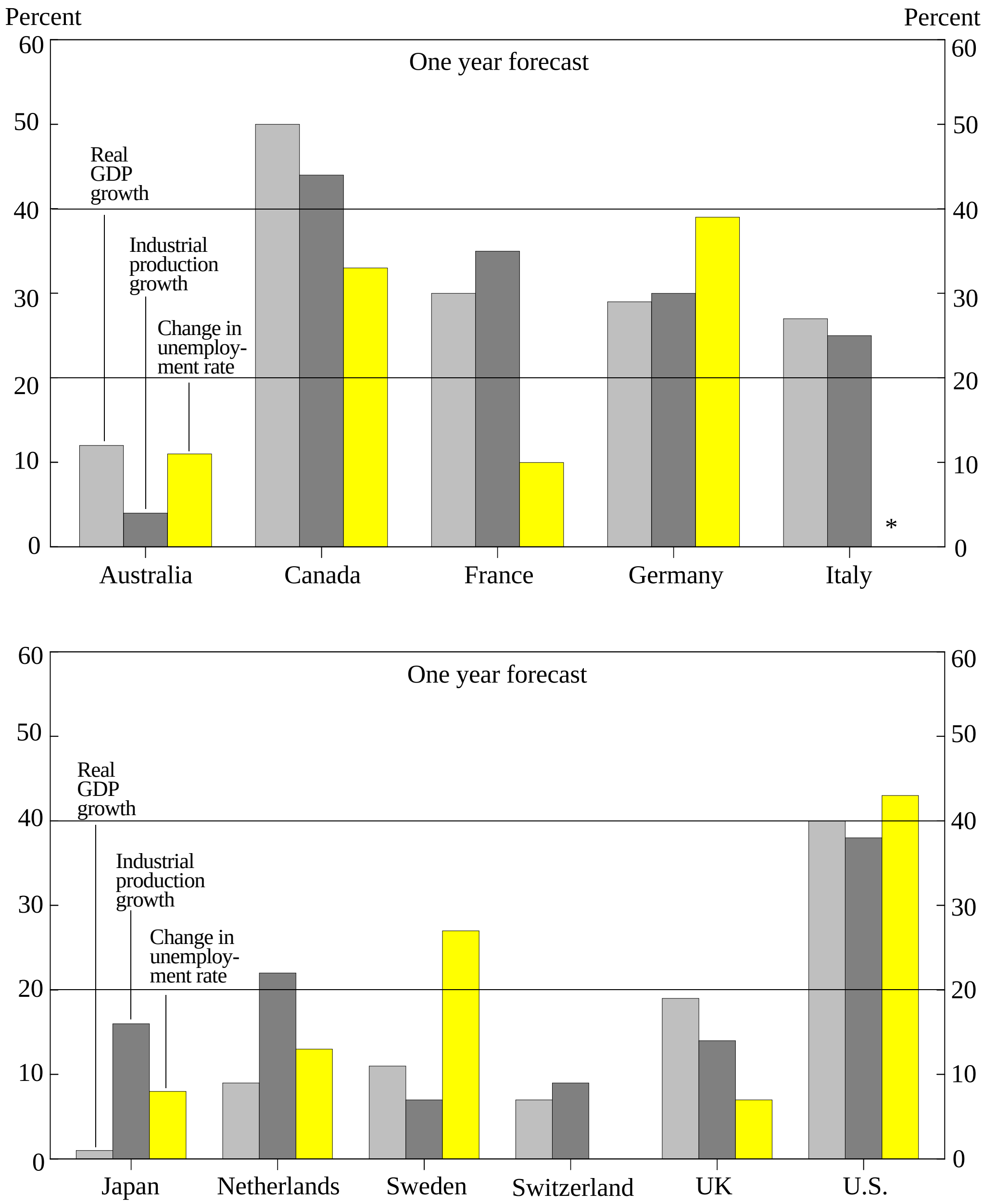
Estimates of the β's themselves from equation 1 also provide an indication of the *economic* significance of the yield curve as a predictor of future real economic growth. In particular, the coefficient β measures the change in real GDP growth for a given one-percentage-point change in the yield spread. In the United States, for example, the three panels show that a one-percentage-point increase in the yield spread today is associated with a one-percentage-point increase in real GDP growth next year, an annualized 0.7-percentage-point increase in growth over the next two years, and an annualized 0.4-percentage-point increase in real GDP growth over the next three years. Hence, all else constant, if real GDP growth in the United States was 2 percent, a widening of the yield spread by one percentage point would imply an increase in real GDP growth to 3 percent (2 + 1 x 1) over the next year, to 2.7 percent (2 + 0.7 x 1) on average over the next two years, and to 2.4 percent (2 + 0.4 x 1) on average over the next three years.[12]

For the remaining countries, a one-percentage-point increase in the yield spread is associated with a less-than-one-percentage-point increase in real GDP growth at all forecast horizons. For example, the top panel shows that in Canada, France, Germany, and Italy a one-percentage-point increase in the yield spread is associated with a 0.6- to 0.8-percentage-point increase in real GDP growth one year from now. In the Netherlands, Sweden, Switzerland, and the United Kingdom, a one-percentage-point increase in the yield spread is associated with a 0.3- to 0.5-percentage-point increase in real GDP growth. As with the United States, the β coefficients fall as the forecast horizon is lengthened.

Together the results indicate that while the yield spread does help explain future real GDP growth in many countries, the strength of the predictive power varies by country. The explanatory power of the yield spread is highest in Canada and the United States, and lowest in Japan. However, real GDP growth is not the only measure of real economic activity of concern to market participants: changes in industrial production and the unemployment rate provide alternative measures of real economic activity.

Because different measures of real economic activity may produce different forecasts of real economic growth, the ability of the yield spread to predict real economic activity may be sensitive to the measure of real activity employed in the forecasting equation. The forecasting equation 1 is therefore reestimated using either industrial production or the unemployment rate as the measure of real economic activity. The R-squares for the one-year forecasts, displayed in Chart 3, indicate that yield spread forecasts are sensitive to the measure of real economic activity employed in the forecasting equation. In Germany and Sweden, for example, the share of variation in real activity explained by the yield spread is greatest when real activity is measured by the change in the unemployment rate. In Germany, the yield spread explains 40 percent of the variation in the unemployment rate over the following year compared with 29 percent of

Chart 3
EXPLANATORY POWER OF THE YIELD SPREAD FOR DIFFERENT MEASURES OF ECONOMIC ACTIVITY



Note: For each country, the bars indicated the adjusted R^2 from the regression of real GDP growth, industrial production growth, or the change in the unemployment rate, on the yield spread. There is no estimate of the unemployment rate in Switzerland.
* The R^2 for Italy for the change in the unemployment rate is zero.
Source: See appendix and authors' calculations.

real GDP growth. In Japan, the use of an alternative measure of real economic activity increases the ability of the yield spread to predict future real activity. When the percent change in industrial production is used as the measure of real economic activity, the yield spread explains 16 percent of the variation in real activity compared with none of the variation using real GDP growth. In the United States, the predictive power of the yield spread is similar across the three measures of real activity, but is slightly higher with unemployment as a measure of real activity.

Out-of-sample forecasting results

As noted earlier, one disadvantage with in-sample forecasts is that they allow the forecasts to depend on data which were not available at the time of the forecast. As a result, the empirical results of the previous section may provide a misleading indication of the true ability of the yield curve to forecast real activity. To provide a check on the usefulness of the yield spread as a predictor of activity, out-of-sample forecasts of real GDP growth are estimated. Specifically, forecasts for each period are based on an estimate of equation 1 using only data up to the previous period. For example, the forecast for 1980:Q1 is estimated using coefficients from the regression estimated over the 1971:Q1 to 1979:Q4 period, while the forecast for 1980:Q2 is estimated using coefficients estimated over the 1971:Q1 to 1980:Q1 period.

The quality of the out-of-sample forecast is evaluated using the root mean squared error (RMSE) statistic. The RMSE provides an estimate of the out-of-sample forecast error, and hence measures the accuracy of the forecast. The lower the RMSE, the better the forecast. In evaluating the out-of-sample forecast power of the yield spread, the RMSE from the yield spread forecast is compared with the RMSEs of alternative forecasts of real economic activity. Indeed, one advantage of the RMSE measure is that, for a given country, it can be compared across different forecasting models.

In this study, the out-of-sample predictive power of the yield spread model is compared with that of two alternative forecasting models over a one-year horizon.[13] In the first alternative model, past changes in real economic activity are used to predict future changes. Specifically, the forecast for next year's real GDP growth is estimated using the following equation:

$$(\%\ change\ real\ GDP)_{t,t+k} = \alpha + \gamma \bullet (\%\ change\ real\ GDP)_{t-\mathrm{k},\,t} + error. \quad (2)$$

The second alternative model combines both forecasting variables—the yield spread and current real GDP growth—into one forecasting equation:

$$(\%\ change\ in\ real\ GDP)_{t,t+k} = \alpha + \gamma \bullet (\%\ change\ in\ real\ GDP)_{t-\mathrm{k},\,t} + \beta \bullet (spread)_t + error. \quad (3)$$

To determine the relative forecast performance of the three forecasting models, the yield spread model (equation 1), the GDP growth model (equation 2), and the combined yield spread plus GDP growth model (equation 3) were estimated across three forecast horizons and their out-of-sample RMSE's were compared. Table 1 shows the results of these model comparisons. The table indicates that the yield spread model generally has the lowest RMSE and hence the best out-of-sample forecast performance. The GDP growth model outperforms the yield spread model in only 4 out of 33 cases. In addition, adding lagged real GDP growth to the yield spread as in the combined model (equation 3) generally does not improve the out-of-sample forecast performance: the combined model has the lowest RMSE in only 8 out of 33 cases. These results indicate the ability of the yield spread

Table 1

MODEL WITH LOWEST ROOT MEAN SQUARED ERROR

	Forecast horizon		
Country	1 year	2 years	3 years
Australia	Spread	Spread + GDP	Spread + GDP
Canada	Spread	Spread	Spread
France	Spread	Spread	Spread
Germany	Spread + GDP	Spread	Spread + GDP
Italy	Spread	Spread	Spread
Japan	GDP	Spread	Spread
Netherlands	Spread	Spread + GDP	Spread + GDP
Sweden	Spread	Spread	Spread + GDP
Switzerland	GDP	GDP	GDP
UK	Spread + GDP	Spread	Spread
U.S.	Spread	Spread	Spread

Note: This table shows for each country which of the following models had the lowest root mean squared error:
Spread: $(\%\mathit{change\ real\ GDP})_{t,t+k} = \alpha + \beta * \text{spread}_t + \mathit{error}$
GDP: $(\%\mathit{change\ real\ GDP})_{t,t+k} = \alpha + \gamma * (\%\mathit{change\ real\ GDP})_{t-k,t} + \mathit{error}$

forecasting model to predict real GDP growth generally exceeds that of both the lagged real GDP model and the combined forecasting model.

IV. CONCLUSION

This article has provided evidence on the ability of the yield spread to predict future real economic activity in 11 industrial countries. The results are broadly consistent with the results of previous studies, but are also more comprehensive in that they evaluate the predictive power of the yield spread across multiple countries, measures of real economic activity, and types of forecasts.

The results indicate the yield spread is a statistically and economically significant predictor of economic activity in several countries besides the United States. Increases in the yield spread are followed by increases in real economic growth, while decreases in the spread are followed by decreases in growth. The size of the spread is also related to the level of real economic growth: the larger the spread between long-term and short-term interest rates, the higher the future level of real economic growth. In addition, out-of-sample forecasts of real GDP growth based on the yield spread generally beat forecasts based on past real GDP growth.

The empirical results of this study also show that the strength of the relationship between the yield spread and future real economic growth varies across the 11 countries. The predictive power of the spread is strongest in Canada, Germany, and the United States. In these three countries the yield spread consistently explains roughly 30 to 50 percent of the variation in future real economic activity. Individuals interested in forecasting real economic activity in these countries would benefit by supplementing their existing model forecasts with forecasts based on the yield spread. The ability of the yield spread to forecast real economic activity is weakest in Japan and Switzerland, where the yield spread, on average, explains less than 10 percent of variations in future real economic activity. Thus, in these countries, the yield spread is not a useful indicator of future growth. In the remaining countries, the results are mixed. For example, the yield spread in France explains roughly 30 percent of the following year's real GDP growth but only 10 percent of the change in the unemployment rate. In these countries the benefit to supplementing existing model forecasts with forecasts based on the yield spread will depend on the measure of real economic activity and the forecast horizon.

APPENDIX A

DATA SOURCES

	GDP	Unemployment rate	Industrial production	Short-term interest rate	Long-term interest rate
Australia	BIS	BIS	IFS	IFS	BIS
Canada	IFS	BOG	BIS	IFS	BIS
France	BOG	BOG	BOG	BIS	BIS
Germany	BOG	BOG	BOG	BOG	OECD, BOG
Italy	BIS	BIS	BIS	IFS	BIS, IFS
Japan	BIS	BIS	BIS	BIS	BIS
Netherlands	BIS	BIS	IFS	BIS	IFS
Sweden	IFS	BIS	BOG	IFS	IFS
Switzerland	IFS	N.A.	BIS	BIS	BIS
UK	IFS	BOG	BOG	BOG	OECD
U.S.	BEA	BLS	BOG	BOG	BOG

Note: BEA is the U.S. Dept. of Commerce, Bureau of Economic Analysis. BLS is the U.S. Dept. of Labor, Bureau of Labor Statistics. BOG is the Federal Reserve Board of Governors. BIS is the Bank for International Settlements. IFS is International Financial Statistics. OECD is the OECD Main Economic Indicators. N.A. indicates that data were not available. Two series separated by a comma indicate that a series was formed by combining two sets of data.

APPENDIX B

COEFFICIENT ESTIMATES FOR A REGRESSION OF REAL GDP GROWTH ON THE YIELD SPREAD

	Forecast horizon								
	1 year			2 years			3 years		
Country	Constant (α)	Slope (β)	$\bar{R}^2$	Constant (α)	Slope (β)	$\bar{R}^2$	Constant (α)	Slope (β)	$\bar{R}^2$
Australia	3.08	.34	.12	3.08	.25	.15	3.02	.17	.11
	(9.22)	(2.62)		(10.56)	(1.69)		(12.43)	(1.37)	
Canada	2.82	.83	.50	2.88	.63	.46	2.88	.50	.42
	(9.31)	(6.55)		(8.65)	(4.95)		(8.04)	(4.35)	
France	1.64	.65	.30	1.89	.39	.20	1.94	.29	.17
	(5.82)	(4.52)		(7.35)	(2.87)		(7.17)	(2.80)	
Germany	1.61	.67	.29	1.71	.53	.33	1.81	.38	.28
	(4.21)	(5.48)		(5.13)	(6.42)		(6.98)	(4.24)	
Italy	3.53	.63	.27	2.89	.22	.07	2.60	.10	.02
	(8.13)	(4.39)		(6.59)	(1.49)		(7.24)	(1.24)	
Japan	3.54	.15	.01	3.46	.03	.00	3.37	.03	.00
	(9.14)	(1.26)		(8.64)	(.44)		(8.84)	(.47)	
Netherlands	2.02	.38	.09	2.04	.40	.20	2.06	.31	.18
	(5.89)	(2.35)		(6.04)	(2.56)		(5.78)	(1.95)	
Sweden	1.59	.32	.11	1.55	.17	.05	1.48	.09	.01
	(4.60)	(2.34)		(3.93)	(1.28)		(3.64)	(.71)	
Switzerland	.97	.42	.07	1.00	.36	.09	1.07	.17	.03
	(2.23)	(3.16)		(2.25)	(3.48)		(2.49)	(1.30)	
UK	1.82	.47	.19	1.86	.35	.18	1.86	.15	.05
	(4.40)	(3.33)		(3.96)	(2.73)		(4.07)	(1.09)	
U.S.	1.46	1.00	.40	1.78	.70	.36	2.12	.38	.20
	(4.36)	(6.14)		(6.00)	(6.21)		(6.00)	(3.47)	

Note: T-statistics are in parentheses. The time period is 1972:1 to 1996:4 for all countries except: Sweden (1972:1 to 1995:3), Switzerland (1972:1 to 1995:4), and the Netherlands (1977:1 to 1996:4). The following model was estimated:

$(\%change\ real\,GDP)_{t,t+k} = \alpha + \beta * spread_t +$ errorü*ç /Ç(ç⁄v%çÑåökç9å dç GDPç7/Ç)çf At,çtçÈ D +ç7kçD#çgMÇ=#YÇa#çSMÇ+#MÇbçFÇ*ç

. The results for industrial production growth and unemployment rate change, as the dependent variable, are available upon request from the authors.

ENDNOTES

1 Kessel (1965) was the first to note the relation between the yield curve and future real economic activity.

2 Estrella and Hardouvelis (1991), Harvey (1989), and Haubrick and Dombrosky (1996) find the yield spread predicts real GDP growth in the United States, while Estrella and Hardouvelis (1991) and Estrella and Mishkin (1996) and Dueker (1997) find that the U.S. yield spread forecasts the probability of a U.S. recession. Studies which examine the predictive power of the yield spread in non-U.S. countries include Caporale (1994), Estrella and Mishkin (1995), Hu (1993), and Plosser and Rouwenhorst (1994).

3 Harvey (1988, 1989) presents a related explanation for the relation between the slope of the yield curve and future economic growth. Suppose, as above, bond market participants expect real income to rise in the future. The expectation of increased future income will reduce today's demand for long-term bonds which pay off in the future. A decrease in the demand for the long-term bonds will cause the price of the bonds to fall, or their yield to rise. Thus, the yield curve steepens as long-term interest rates rise. If the expectations for economic growth are realized, a steepening of the yield curve will be associated with a future increase in real economic activity.

4 Because of the difficulties in interpreting data on East Germany prior to the unification of East and West Germany, the analysis focuses on West German economic growth only.

5 When possible, the interest rate data used averages of daily data over the quarter or month, depending upon whether quarterly or monthly forecasts are evaluated. Averaged data are used because it is more likely that measures of real economic activity are related to average yield spreads, rather than to a single end-of-month value.

6 In particular, Caporale (1994) examines the in-sample and out-of-sample forecast power of the yield spread in 13 countries, but restricts her forecast horizon to one year and her measure of real economic activity to real GDP. Estrella and Mishkin (1995) examine the predictive power of the yield spread in five countries, France, Germany, Italy, the United Kingdom, and the United States, over the 1973 to early 1995 period, and also examine the sensitivity of the empirical results to real GDP, industrial production, and unemployment measures of real activity, as well as to forecast horizons up to five years. They do not, however, examine the out-of-sample forecast power of the yield spread. Hu (1993) examines the in-sample and out-of-sample forecast power of the yield spread from the earliest data point possible to 1991 for the G-7 countries, but restricts his forecast horizon to one year. Finally, Plosser and Rouwenhorst (1994) examine in-sample yield spread forecasts for three countries, Germany, the United Kingdom, and the United States, between 1973 and 1988. They consider both real GDP and industrial production measures of real economic activity and forecast horizons of up to five years, but they restrict their forecasts to in-sample forecasts.

7 When the percent change in real GDP is the dependent variable, the long-term and short-term interest rates used to calculate the spread are the quarterly averages of monthly rates in that quarter. When industrial production or the unemployment rate is the dependent variable, the spread is calculated from daily averages of the long-term and short-term interest rates over the month.

8 Estimating this forecasting equation for k=1, 2, or 3 years with quarterly or monthly data causes the error term to be serially correlated. Consequently, the standard errors from the estimation are corrected following Hansen (1982) and Newey and West (1987).

9 Due to data availability, the sample period for the Netherlands is 1977:1 to 1996:4.

10 The R-squares plotted are actually the R-bar squares from the regression, the R-square values adjusted for the degrees of freedom.

11 Prior to 1980, Japanese financial markets were heavily regulated and may not have reflected market expectations.

12 These average growth rates imply real GDP growth in year 2 will be 2.4 percent (2.7 x 2 - 3.0), while real GDP growth in year 3 will be 1.8 percent (2.4 x 3 - 3.0 - 2.4).

13 The results for the two-year and three-year forecasts are very similar.

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