by Campbell R. Harvey

Forecasts of Economic Growth from the Bond and Stock Markets

Although both stock and bond market data contain information relevant for predicting GNP growth, the bond market delivers more accurate predictions. While yield curve measures are able to explain more than 30 per cent of the variation in economic growth over the 1953–89 period, stock market variables explain only about 5 per cent. Furthermore, forecasts based on the yield curve compare favorably with forecasts from leading econometric models, whereas forecasts from stock market models do not.

Inasmuch as firms' earnings are positively correlated with economic growth, one might expect that stock prices would contain information about real economic activity. But variations in stock prices can reflect both changes in expected economic growth and changes in the perceived risk of stock cash flows. Investors' changing perceptions about the riskiness of cash flows can confound the information about expected economic growth.

A yield-based forecast for the third quarter of 1989 through the third quarter of 1990 suggests a slowing of economic growth, but not zero or negative growth.

THE LINK BETWEEN ASSET markets and real economic growth was formalized by Irving Fisher.[1] Fisher suggested that, in equilibrium, the one-year interest rate reflects the marginal value of income today in relation to its marginal value next year. The intuition is straightforward. If a recession is expected next year, there is an incentive to sacrifice today to buy a one-year bond that pays off in the bad times. The demand for the bond will bid up its price and lower its yield. The theory implies that current real interest rates contain information about expected economic growth.

Similarly, the price of a share of stock is the discounted value of expected cash flows. The strength of the economy determines the magnitude of these cash flows. The price of equity thus reflects expectations of real activity, and changes in the value of equity partially reflect revisions in these expectations.

This article measures the relevant information contained in the bond market and the stock market for forecasting real economic activity. Traditionally, the stock market is assumed to contain important information about the future path of economic growth. The Standard & Poor's 500 stock price index (S&P 500) carries an important weight in the Department of Commerce's widely quoted index of leading indicators. Indeed, many forecasters predicted a recession for 1988 solely on the basis of the stock market crash in October 1987. The results presented here suggest that the bond market reveals more information about future economic growth than the stock market. The bond market forecasts also compare favorably with the predictions of seven major econometric forecasting services.

1. Footnotes appear at end of article.

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The Bond Market and Economic Growth

Modern asset pricing theories suggest a relation between expected asset returns and investors' expected consumption plans.[2] The underlying idea is that investors get more benefit from one dollar in a recession (when their consumption levels are low) than from one dollar at the peak of the business cycle (when their consumption is high). As a result, in good times people tend to invest in assets that will provide insurance, or a hedge, against an expected downturn in the economy. The payoffs from these investments are designed to smooth consumption.

Investment in a zero-coupon bond provides one example of trading consumption today for consumption in the future. The intensity at which people are trading today's consumption for tomorrow's consumption is called the *marginal rate of substitution*. This rate of substitution is driven by expectations about the state of the economy (business cycle) and is reflected in asset prices.[3]

Consider the link between the rate of substitution and asset prices. If there is a growing consensus of an economic downturn, investors will want to buy long-term zero-coupon bonds and sell short-term bonds. Obviously, not everybody can buy long term and sell short term. In order to make the other side of the market attractive, the price of the long-term bonds must rise and the price of the short-term bonds fall. In terms of yields to maturity, the yield curve will become flatter, or invert.

Asset pricing theory suggests that the slope of the yield curve may contain information about investors' forecasts of economic growth.[4] Indeed, the yield curve (measured as the difference between a 10-year and a three-month yield) inverted in 1969, 1973, 1979 and 1981. These inversions preceded the last four recessions.[5]

The Stock Market and Economic Growth

There is widespread agreement that the stock market contains important information about real economic activity. The Department of Commerce includes the S&P composite as one of its 12 leading indicators of economic growth.[6] Many empirical studies have measured the comovement of stock returns and real economic activity.[7]

The association between stock market and real activity originates with the fundamental valuation of equity:

$$\text{Stock Price}_t = \sum_{j=1}^{\infty} \frac{\text{Expected Dividends}_{t+j}}{(1+k)^j}, \quad (1)$$

where k is the rate at which (risky) dividends are discounted. It is usually assumed that k is constant.[8]

Recession means lower earnings and dividends for most equities. If investors make a downward revision in their forecast of a firm's earnings (or dividends) because they expect a recession, stock price, according to the above equation, will drop. Of course, a change in equity valuation could also be caused by a change in the discount rate. This may confound the information about real growth contained in stock returns.

Although most agree that the stock market is an important indicator, its reliability has recently been questioned. Some skepticism undoubtedly stems from the strong economic growth in 1988, following the stock market crash. A popular joke is that the stock market correctly forecast nine of the last four recessions.[9] Of course, an incorrect forecast of a recession is no joke; it is important to assess the reliability of the stock market as an economic indicator.

A Forecasting Model

A version of the consumption-based asset pricing model suggests a simple linear relation between asset returns and the marginal rate of substitution. Many have explored this relation using real personal consumption growth as a proxy for the marginal rate of substitution. The growth rate in real GNP could also be considered a proxy for unobservable consumption. In terms of yields to maturity, we can estimate this as follows:[10]

$$\text{Growth}_{t+1:t+5} = a + b(\text{Yield Spread})_t + u_{t+5}, \quad (2)$$

where

Growth = growth in real (annual) GNP from quarter $t + 1$ to quarter $t + 5$,

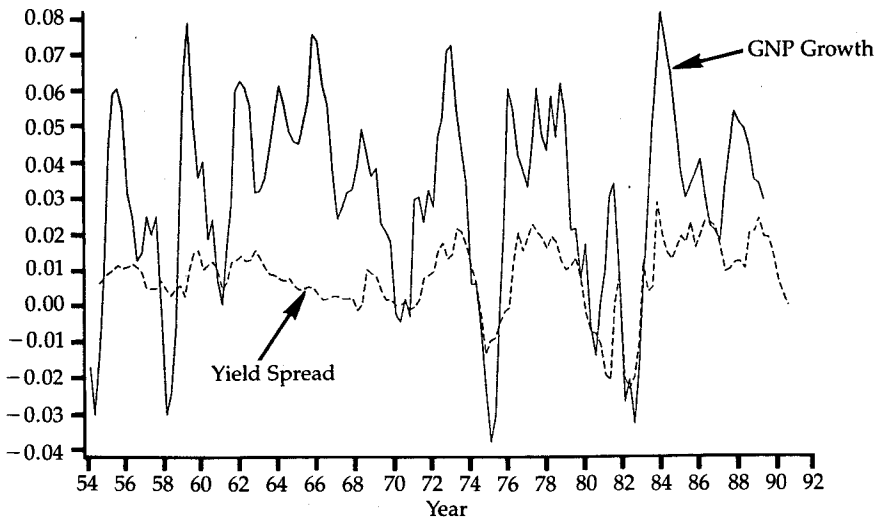
Yield Spread = spread between long-term and short-term annualized yields to maturity observed at time t,

u = an unanticipated result (residual) and

a and b = fitted coefficients.

The model suggests that b is the average risk tolerance in the economy and a the average

Figure A Annual GNP Growth and Lagged Five-Year Yield Spread



annual real economic growth when the term structure has a slope of zero. This is the model used to forecast real economic growth.

The forecasting model is evaluated using two measures of the term structure. The short-term rate is always the three-month Treasury yield. The long-term rates are the five and 10-year yields. The yield spread is the natural logarithm of one plus the long rate divided by one plus the short rate. To compare the reliability of bond market forecasts with that of stock market forecasts, two measures of stock returns (available at time t) are used on the right-hand side of Equation (2). The stock market variables are the one-quarter logarithmic growth in the S&P 500 and annual growth in the S&P 500.

Factors complicating the estimation process include the timing of the variables. Because GNP is available quarterly, a yield spread based on first-quarter financial data is used to forecast annual real growth beginning in the second quarter.[11]

Results

Figures A through D plot the data. It is evident from the figures that the measures of the yield curve move with and lead real GNP growth. In the figures, the financial variable is lagged. Thus, if the GNP growth and financial variable series coincide, the financial variable is a perfect forecast of real economic growth. The yield curve measures show close association with GNP growth, especially from 1966. There are also patterns in the returns that suggest that stocks lead GNP. However, the stock return series are more volatile and have many more false signals than the yield curve measures.

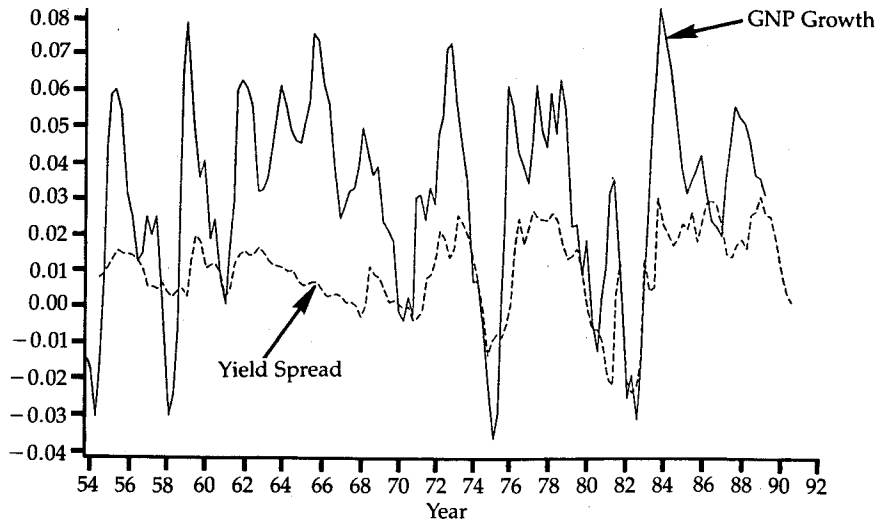
Table I provides some model results. The first panel documents the predictive power of the financial variables over the 1953:2–1989:2 period. The two measures of the yield curve are able to explain more than 30 per cent of the variation in economic growth. By contrast, the stock return variables explain only about 5 per cent of the variance in economic growth.

The next two panels in Table I look at two more recent subperiods. Figures A and B suggest a closer relation between the yield curve and economic growth in the more recent data. This is confirmed by the analysis. In the 1966:1–1989:2 and the 1976:1–1989:2 subperiods, the yield curve can explain more than 40 per cent of the variation in GNP growth.

Table II provides out-of-sample forecasting evaluation. In the first panel, models estimated over the 1953:2–1975:4 period are used to forecast for the period beginning in 1976:1. The models are then reestimated with data through 1976:1 and new out-of-sample forecasts calculated. This procedure is continued through the second quarter of 1989.

The table gives three forecast evaluation statistics. The first is an out-of-sample adjusted R-squared. This is calculated like the usual R-squared except the fitted values are the out-of-sample forecasts. Mean absolute errors and

Figure B Annual GNP Growth and Lagged 10-Year Yield Spread



root mean square errors are also provided. The results suggest that the yield spread model has substantial out-of-sample forecasting power; the adjusted out-of-sample R-squared is about 35 per cent. The stock return model has substantially less explanatory power.

The second panel in Table II documents similar forecasting results (over the same period) when the initial estimation is over the 1966:1–1975:4 period.

Commercial GNP Forecasts

To offer some perspective on how good (or bad) these forecasts are, the forecasts from the financial variables are compared with forecasts from some of the leading econometric models. Table III provides unpublished data on the performance of the forecasting services.[12] The forecasts from six of these models—Chase Econometric Associates, Data Resources, Inc., Economic Forecasting Project (Georgia State

Figure C Annual GNP Growth and Lagged One-Quarter Return on S&P

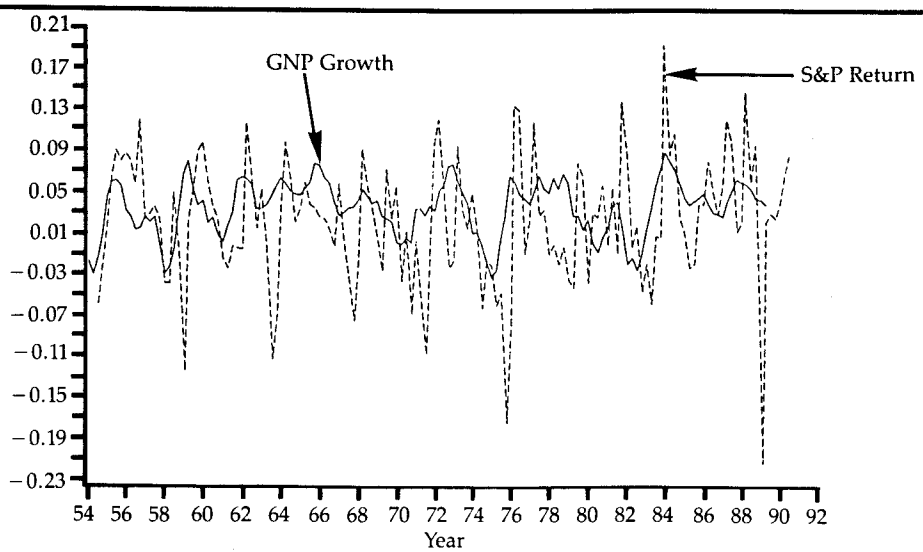


Figure D Annual GNP Growth and Lagged Four-Quarter Return on S&P

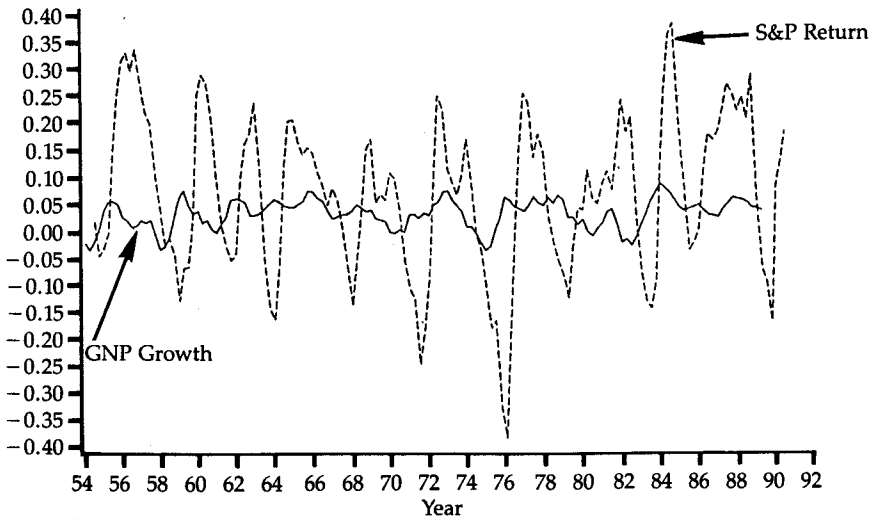


Table I The Forecasting Performance of the Yield Spread and Stock Market Return Models, 1953:2–1989:2*

Variable	*a*	*b*	$\bar{R}^2$
1953:2–1989:2 (140 observations)			
Five-Year Yield Spread	0.020	1.479	0.304
	[5.169]	[5.566]	
10-Year Yield Spread	0.020	1.294	0.320
	[5.359]	[5.763]	
One-Quarter Stock Return	0.029	0.095	0.045
	[7.451]	[2.464]	
Four-Quarter Stock Return	0.030	0.010	−0.004
	[7.199]	[0.495]	
1966:1–1989:2 (94 observations)			
Five-Year Yield Spread	0.019	1.450	0.411
	[4.928]	[5.458]	
10-Year Yield Spread	0.020	1.228	0.403
	[5.051]	[5.421]	
One-Quarter Stock Return	0.027	0.092	0.042
	[5.893]	[2.464]	
Four-Quarter Stock Return	0.030	0.010	−0.004
	[7.199]	[0.495]	
1976:1–1989:2 (54 observations)			
Five-Year Yield Spread	0.020	1.270	0.435
	[4.343]	[4.620]	
10-Year Yield Spread	0.019	1.117	0.446
	[4.243]	[4.653]	
One-Quarter Stock Return	0.030	0.053	0.001
	[4.831]	[1.004]	
Four-Quarter Stock Return	0.032	−0.009	−0.016
	[5.506]	[−0.329]	

* The model estimated is $\Delta GNP_{t+1:t+5} = a + bX_t + u_{t+5}$. ΔGNP is the annual logarithmic growth in real Gross National Product. The data for the second quarter of 1989 are based on the first release available on July 27, 1989. X is one of: the logarithm of the ratio of one plus the five-year yield divided by the three-month Treasury bill rate, the logarithm of the ratio of one plus the 10-year yield divided by the three-month Treasury bill rate, the one-quarter return on the Standard & Poor's 500 stock index, or the four-quarter return on the Standard & Poor's 500; t-ratios are in brackets.

University), Research Seminar on Quantitative Economics (University of Michigan), the Benchmark forecast of Charles R. Nelson Associates and Wharton Econometric Forecasting Associates, Inc.—are sold for a fee. The Bureau of Economic Analysis forecasts are for internal use by the Department of Commerce.

Many problems arise in comparing the forecasts. The first is the timing issue. The yield spread and stock return models use information at the end of time t to forecast growth from $t + 1$ to $t + j$. The econometric models use more recent information. A second factor is revisions

Table II Out-of-Sample Forecasting Performance of the Yield Spread and Stock Market Return Models, 1976:1–1989:2 (54 forecasts)*

Variable	*Out-of-Sample Adjusted R-Squared*	*Mean Absolute Error*	*Root Mean Squared Error*
Initial Estimation 1953:2–1975:4			
Five-Year Yield Spread	0.346	0.0170	0.0201
10-Year Yield Spread	0.347	0.0169	0.0201
One-Quarter Stock Return	−0.045	0.0200	0.0255
Four-Quarter Stock Return	−0.061	0.0198	0.0257
Initial Estimation 1966:1–1975:4			
Five-Year Yield Spread	0.342	0.0171	0.0202
10-Year Yield Spread	0.364	0.0169	0.0199
One-Quarter Stock Return	−0.068	0.0205	0.0257
Four-Quarter Stock Return	−0.199	0.0207	0.0275

* The model estimated is that described in Table I. The coefficients, a and b, have time subscripts to denote that the regressions are reestimated at every point in the time series.

Table III Yield Spread Model Forecasting Performance vs. Other Econometric Models, 1976:1–1985:1*

Model	*Mean Absolute Error*	*Root Mean Squared Error*
Five-Year Yield Spread	1.7	2.1
10-Year Yield Spread	1.7	2.1
One-Quarter Stock Return	2.4	3.0
Four-Quarter Stock Return	2.5	3.0
BEA	1.7	2.4
BMARK	2.1	2.5
Chase	2.0	2.4
DRI	1.6	2.1
EFP	1.7	2.1
RSQE	1.7	2.1
WEFA	1.5	2.1

* The parameters of each model are reestimated at each point in the time series during 1975:4–1984:4. These parameters are used to forecast annualized percentage growth in the 1976:1–1985:1 period. The initial estimation period is 1953:2–1975:4. All figures are in annualized percentage growth. BEA is Bureau of Economic Analysis; BMARK is the Benchmark forecast from Charles R. Nelson Associates, Inc.; Chase is Chase Econometric Associates, Inc.; DRI represents Data Resources, Inc.; EFP is the Econometric Forecasting Project at Georgia State University; RSQE denotes the Research Seminar on Quantitative Economics at the University of Michigan; and WEFA represents Wharton Econometric Forecasting Associates, Inc. The forecast evaluation statistics for the seven models are from McNees (see footnote 12). The forecast evaluation statistics for the model are based on Gross National Product data available in mid-1985.

in the data. The yield spread model is fitted with revised data, whereas the commercial models do not have these data available.

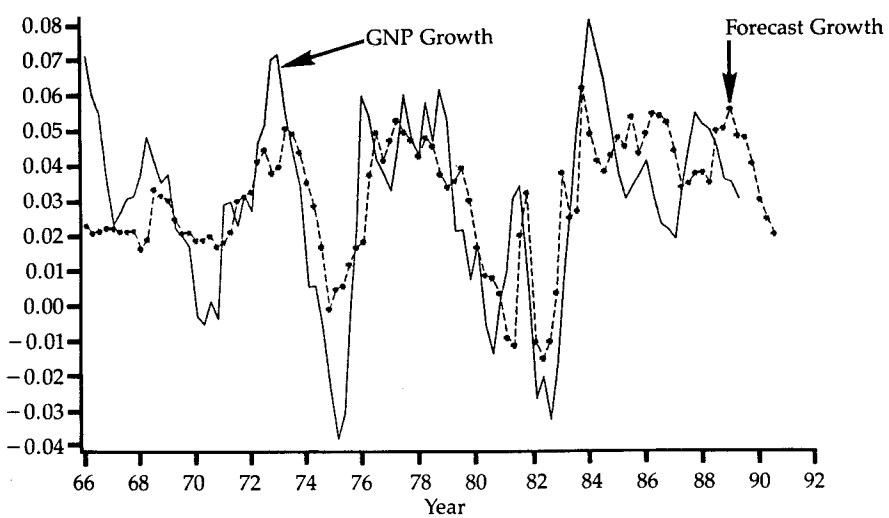
Table III presents the summary statistics for the predictions.[13] All the growth measures are annualized and in percentage terms. The yield spread model's forecast evaluation statistics compare favorably to the forecasts from the econometric services. None of the seven econometric forecasting services is able to deliver a lower root mean squared error than the yield spread model. Only two of the econometric models show lower mean absolute errors (Wharton's 1.5 and DRI's 1.6). The difference between the yield spread model's predictions and the best of the econometric models' predictions is probably not economically significant, but one must pay for the commercial models' forecasts.

Of course, mean absolute error and root mean squared error are only two ways to evaluate forecasts. A possible disadvantage is that these measures treat forecast errors symmetrically through the business cycle. That is, a forecast error of 3 per cent during a strong growth period may be less serious than a forecast error of 3 per cent just before the economy slips into recession. One advantage of the yield curve model is that it correctly forecasts the business cycle turning points.

As expected from the results in Tables I and II, the stock return model does not do as well as the yield spread model in Table III. In addition, the stock market model does worse than the forecasts from the econometric services.

Figures A through D and the results provided

Figure E Annual GNP Growth and Forecast GNP Growth*



*Forecasts for 1989: 3–1990: 3 are out-of-sample

in Tables I, II and III suggest that the bond market contains more information about economic growth than the stock market. Figure D confirms that the stock market has predicted nine downturns in the last four business cycles. Figure C shows the dramatic stock market drop of October 1987, signaling a short, sharp decrease in GNP growth from 1988Q1–1989Q1, which was not realized.[14] It is also interesting to note that the stock market appears to be forecasting strong economic growth for 1989–90.

Because firms' earnings are positively correlated with economic growth, there are good economic reasons why stock price should contain information about real activity. However, investor reevaluation of the riskiness of equity cash flows may also affect value. As a result, variations in stock price could reflect changes in expected economic growth, changes in the perceived risk of the cash flows or a combination of the two.[15] It is less likely that the riskiness of government bond cash flows will change. This may be why we can extract more information about economic growth from bond market variables than from stock market variables.

A Forecast for 1989Q3–1990Q3

There is much concern on Wall Street that the recent inversion of the yield curve could be signaling a recession for 1989. Figure E plots the fitted values based on coefficient estimates for the full sample. The forecasts for 1989Q3–1990Q3 are out-of-sample. Note that the direction of growth is down, but not negative. The graphic evidence suggests a slowdown or "soft landing" in 1989Q3–1990Q3 compared with the previous two years.

We can also use the model regression results to develop a forecast for growth from the third quarter of 1989 to the third quarter of 1990. The parameter values in the last panel of Table I are used with average yield spread data available in the second quarter of 1989:

(Five-Year Yield Spread)
$0.020 + [1.270 \times -0.001533] = 1.8\%,$

(10-Year Yield Spread)
$0.019 + [1.117 \times -0.002084] = 1.7\%.$

The value of -0.001533 can be roughly interpreted as a -15.33-basis-point difference in the five-year bond yield and the three-month Treasury yield. Both models suggest a slowing of growth to about 1.7 per cent in 1989Q3–1990Q3. The long rate must be more than 100 basis points below the three-month rate to imply zero or negative growth. ■

Footnotes

1. I. Fisher, *The Rate of Interest* (New York: Macmillan, 1907).
2. See R. C. Merton, "An Intertemporal Capital Asset Pricing Model," *Econometrica* 41 (1973), pp. 867–887; R. E. Lucas Jr., "Asset Prices in an Exchange Economy," *Econometrica* 46 (1978), pp. 1429–1445; and D. T. Breeden "An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities," *Journal of Financial Economics* 7 (1979), pp. 265–296.
3. Another important factor is the degree of aggregate risk-aversion in the economy. For a good discussion, see D. T. Breeden, "Consumption, Production and Interest Rates: A Synthesis," *Journal of Financial Economics* 16 (1986) pp. 3–39.
4. R. A. Kessel, "The Cyclical Behavior of the Term Structure of Interest Rates" (National Bureau of Economic Research, Occasional Paper 91, 1965), was the first to describe the business-cycle variation in the yield curve. C. R. Harvey, "The Real Term Structure and Consumption Growth," *Journal of Financial Economics* 22 (1988), pp. 305–334, measures the ability of the yield curve to forecast growth in real personal consumption expenditures.
5. Furthermore, the yield curve came close to inverting at the end of 1959. This preceded the National Bureau of Economic Research's official trough in the first quarter of 1961.
6. Interestingly, the term structure of interest rates is not included in the Composite Index of 12 Leading Indicators. The other components are average weekly hours of production workers, labor turnover in manufacturing (layoff rate per 100 employees), manufacturing new orders of consumer goods and materials, index of net business formation, contracts and orders for plant and equipment, housing authorized (index of new private housing units), vendor performance (percentage of companies reporting slower deliveries), change in inventories on hand and on order, percentage change in sensitive prices, change in total liquid assets, and the money stock (M2).
7. E. F. Fama, "Stock Returns, Real Activity, Inflation, and Money," *American Economic Review* 71 (1981), pp. 545–565 and G. Kaul, "Stock Returns and Inflation: The Role of the Monetary Sector," *Journal of Financial Economics* 18 (1987), pp. 253–276 examine the relation between stock returns and growth in GNP and industrial production. Harvey, "The Real Term Structure," *op. cit.*, provides evidence on the relation between stock

returns and growth in real personal consumption expenditures.

8. However, it is unlikely that this discount rate is constant. It will change as the marginal rate of substitution changes and as the riskiness of cash flows changes through time.
9. From 1961 to 1988, there were nine troughs in the year-to-year change in the S&P 500. In this same period, there were four recessions. See Figure D.
10. Harvey, "The Real Term Structure," *op. cit.*, tests a model similar to the above using the growth in real personal consumption expenditures. The model relates expected real yield spreads to real consumption growth. However, if inflation follows a first-order integrated moving-average process, the nominal yield spread equals the expected real yield spread. Further, the intercept contains another variable, the expected real short-term rate of interest, which Harvey shows does not contribute to the explanatory power of the model with one to three-quarter forecasting horizons. Finally, the yield spread should be between a bond that has five quarters to maturity and a bond that has one quarter to maturity. Because the yield on a bond with five quarters to maturity is not available for the entire sample, a longer-term yield is used.
11. The left-hand-side variable is overlapping, so t-statistics from an ordinary-least-squares regression will be incorrect. We use the technique of Newey and West to recalculate the t-statistics. W. K. Newey and K. D. West, "A Simple, Positive Semi-Definite, Heteroskedasticity Consistent and Autocorrelation Consistent Covariance Matrix," *Econometrica* 55 (1987), pp. 703–708. These t-statistics are also robust to conditional heteroskedasticity in the regression residuals.
12. Computer printouts (dated 1985) called "Root Mean Square Errors" and "Mean Absolute Errors" were obtained from S. K. McNees at the Federal Reserve Bank of Boston.
13. For this comparison, the forecasting model was estimated using an older set of GNP data available in 1985, so that all the forecasts could be compared with the same realized growth rates.
14. If the stock market leads the economy by less than one year, then a short recession would have been predicted in 1988. This recession did not materialize. Further, the lead time does not change the fact that there have been nine troughs in the stock market since 1961 (five false signals).
15. C. R. Harvey, "Is the Expected Compensation for Market Volatility Constant Through Time?" (Working paper, Duke University, 1989), provides evidence that expected compensation to the investor for taking on stock market volatility changes through time. The ratio of reward to risk moves in a countercyclical way.