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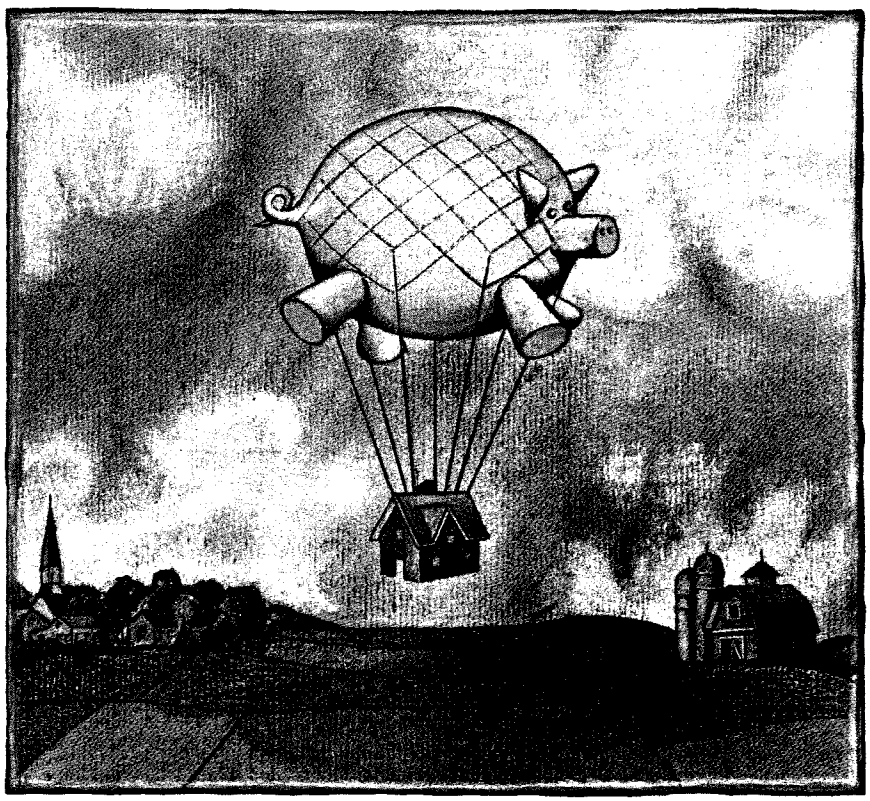

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Term Structure Forecasts Economic Growth

Campbell R. Harvey

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Guest Speaker

Term Structure Forecasts Economic Growth

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A theory's success is often judged by its out-of-sample performance. Four years ago, I argued that the term structure of interest rates could be used to forecast economic growth.[1] While the evidence was impressive (almost 50% of the variance in real GNP growth could be explained, and the forecasts were not beaten by any commercially available projections), the model was "fit" on historical data. Since the writing of the paper, we have experienced a complete business cycle. Now we can perform a *post mortem* on the out-of-sample performance.

I will show that the term structure model provided accurate and timely forecasts of the most recent business cycle. The model predicted a downturn five quarters before the recession officially began. The model forecast the duration of the recession to be three quarters, which is now considered the official length.

Consider the basic intuition behind the model. Interest rates are *ex ante* measures representing expected future payoffs. When market rates are set, it is plausible to assume that expectations of future economic growth influence this process.

Consider a simple example. Assume that investors want to insure their economic well-being. Most would prefer a reasonably stable level of income, rather than very high income in one stage of the business cycle and very low income in another stage. This preference for stability drives the demand for insurance, or hedging.

Suppose the economy is presently in a growth stage and the general consensus is for a slowdown or recession during the next year. The desire to hedge will lead consumers to purchase a financial instrument that will deliver payoffs in the slowdown. Such an instrument is a one-year discount bond.

If many people are buying the one-year bond, the price of the security will increase and the yield to maturity will decrease. To finance the purchase of the one-year bonds, consumers may sell their shorter-term assets. This selling pressure will drive down the price of the short-term instrument and, as a result, raise its yield.

So, if a recession is expected, we will see long rates decrease and short rates increase. As a result, the term structure or yield curve (difference between long rates and short rates) will become flat, or inverted. The shape of the term structure of interest rates today provides a forecast of future economic growth.

From this example, it should be clear that the interest-rate-based model is very simple. It contains only two components. The first component is the slope of the term structure, or the long-term–short-term yield spread. The second component is a measure of the average propensity to hedge in the economy (a measure provided in my 1989 paper).

In previous research, I have shown that more elaborate (and expensive) econometric models are unable to deliver predictions that outperform the simple term-structure model. I have tested this model on the U.S. economy and on the other G-7 countries.

Historical Performance

Recessionary periods are classified by the National Bureau of Economic Research (NBER). A recession is the period between an economic trough and peak. The NBER Business Cycle Dating Committee decided the most recent recession began in July 1990 (peak) and ended in March 1991 (trough)—a duration of about three quarters.

Consider the record of the term structure over the past 25 years.

- *Recession 69Q4-70Q4* (total GDP decline 0.1%): Term structure begins inversion 68Q3, correctly signalling a recession four quarters in advance.
- *Recession 73Q4-75Q1* (total GDP decline 4.2%): Term structure begins inversion 73Q2, correctly predicting the recession with a two-quarter lead time.
- *Recession 80Q1-80Q3* (total GDP decline 2.6%): Term structure begins inversion in 78Q4, correctly forecasting the downturn with a five-quarter lead.
- *Recession 81Q3-82Q4* (total GDP decline 2.7%): Term structure inverts 80Q4, indicating a recession with a four-quarter advance signal. Note that the term structure accurately predicted this "double-dip" in the business cycle.
- *Recession 90Q3-91Q1* (total GDP decline 1.8%): Term structure inverts in three consecutive quarters, 89Q2-89Q4, providing a five-quarter lead.

The recent inversion in 89Q2-89Q4 was mild compared with other inversions. For example, in 89Q3, the magnitude of the inversion was about 30 basis points (long-term rates 0.3% below short-term rates). In contrast, the inversion in 80Q4 was 340 basis points, or 3.4%.

The magnitude of the inversions reveals the severity of the recession. The term structure forecast in late 1980 predicted a serious recession beginning in mid-1981. This forecast turned out to be accurate.

Based on the inversion in the summer of 1989, I forecast reduced economic growth. However, the mild inversion indicated that the recession would not be as serious as the previous three episodes. My model also correctly predicted the end of the recession. To quote Leonard Silk (*New York Times*, July 20, 1990), "the Harvey model ... now predicts that ... the economy is likely to be sluggish until mid-1991 and then turn gradually upward."

Overall, the model delivered a five-quarter advance signal of the downturn in July 1990. In addition, the model also caught the upturn. The recession lasted three quarters and the term structure inversion also lasted three quarters. The model also predicted that the downturn would be less severe than the three previous episodes. All of these predictions have been validated out of sample.

Updated Estimate of GDP Growth

The updated regression equation estimation (using Gross Domestic Product rather than GNP, which was reported in my 1989 article) shows that the explanatory power is still highly significant with the most recent data (67Q2-92Q4) included.[2] The estimation (Table I) shows that almost half the variance in annual real GDP growth is explained by movements of the term structure. The heteroskedasticity-consistent and moving-average-adjusted t-ratio is 6.47 on the difference between five-year Treasury bond and three-month bill yields. Figure A plots GDP growth and the lagged spread.

Table I Estimating GDP Growth

Model: $GDP_{t+5} - GDP_{t+1} = \alpha + \beta Spread_t + Error_{t+5}$

α	β	R^2
0.015	1.429	44.2%
[4.49]	[6.47]	

Analysis of Model Predictions

As with any model, the term structure does not perfectly forecast economic growth. Although the model correctly predicted the most recent turning point, the forecasts of economic growth were higher than the realized growth.

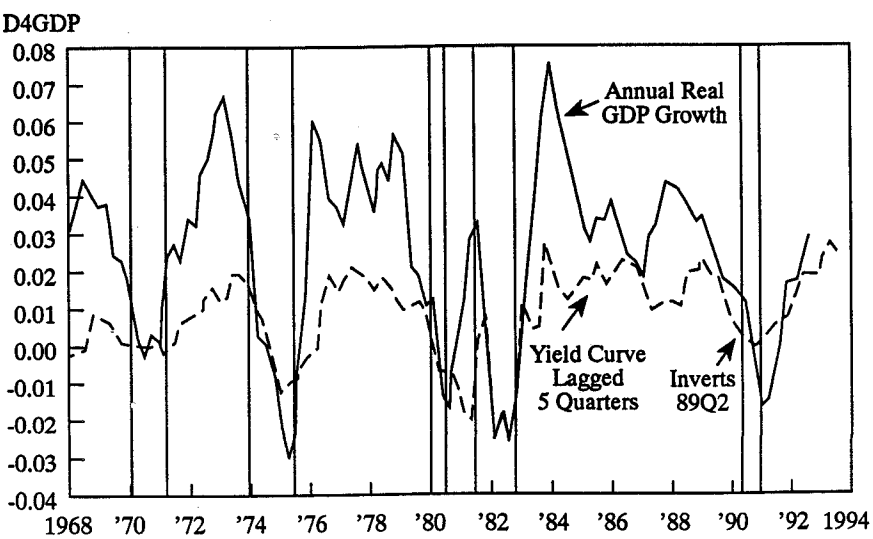
A number of simplifying steps have been taken in developing the model. The intercept, α, is assumed to contain the volatility of both the business cycle and the spread. If there is time-varying volatility, then the intercept should be adjusted.

In the theoretical development of the model, the real business cycle is matched with the term structure of *real* interest rates. These real rates are not available. I assume that the spread between nominal rates is approximately equal to the spread between real rates. This involves two levels of inflation assumptions.

First, I assume the expected real rate to be the difference between nominal rates and expected inflation. This is the so-called "Fisher effect." It is not necessarily true. A risk premium may be wedged between the expected real rate and the nominal rate deflated by the expected inflation.

Second, I assume that the *term structure of expected inflation* is flat. That is, the expected annualized inflation component for the three-month Treasury bill is identical to the annualized inflation part of the five-year bond. This assumption could potentially account for some of the model errors. Indeed, one could argue that the term structure of expected inflation has been positively sloped for the last two years. The CPI rose only 2.6% in 1992. Given that long-term bonds are still yielding about 7%, most believe that expected long-term inflation exceeds expected short-term inflation.

Figure A Yield Curve and the Business Cycle



A positive term structure of inflation could account for why the term structure inversion in the summer of 1989 was so mild and for the steep upward slope since then. Incorporating the term structure of inflation could lead to improved forecasts.

Future Work

There are a number of promising directions for further research. Harvey and Morrison have shown that the term structure model works in most of the G-7 countries.[3] Differences in the countries' yield curves can even predict differences in economic growth. Alvarez et al. have successfully applied the model in the context of a developing country.[4]

Roma and Torous have extended the formulation to allow for a time-varying intercept.[5] They show that the term structure forecasts should be applied to the cyclical component of growth (the deviations from stochastic trend). Their empirical work suggests an improvement in the forecasts.

Given that the term structure forecasts economic growth, a number of studies have explored the possibility that the term structure also forecasts stock returns. Campbell, Fama and French, and Harvey use the term structure to forecast U.S. equity returns. Harvey shows that the term structure also forecasts international equity returns. Finally, Boudoukh, Richardson and Whitelaw provide evidence that the relation between the term structure and stock returns is nonlinear.[6]

Footnotes

1. *See C. R. Harvey, "Forecasting Economic Growth with the Bond and Stock Markets,"* Financial Analysts Journal, *September/October 1989 and C. R. Harvey, "The Real Term Structure and Consumption Growth,"* Journal of Financial Economics *22 (1988), pp. 305–34.*
2. *Based on the preliminary fourth-quarter 1992 GDP released on January 28, 1993.*
3. *The application to the G-7 countries is contained in C. R. Harvey, "The Term Structure and World Economic Growth,"* Journal of Fixed Income *1 (1991), pp. 4–17; C. R. Harvey, "Interest Rate Based Forecasts of German Economic Growth,"* Weltwirtschaftliches Archiv *127 (1991), pp. 701–18; C. R. Harvey, "Les Taux d'Intérêt et la Croissance Economique en France,"* Analyse Financière *86 (1991), pp. 97–103; C. R. Harvey, C. Kirby and S. Kaul, "La Capacità Previsiva della Struttura per Scadenza dei Tassi d'Interesse Italiani in Relazione alla Crescita Economica Reale" (Working paper, Gruppo IMI, 1992); C. R. Harvey, "The Yield Curve, Stock Returns and the Prediction of Canadian Economic Growth" (Working paper, Duke University, 1993); and D. Morrison, "The Currency Markets: How Much Volatility Ahead?" (Goldman Sachs, London, 1992).*
4. *For application to a developing country, see C. Alvarez, D. Cademartori, M. Galea, O. Gonzalez and C. Romo, "Harvey's Model for Forecasting Economic Growth: An Exploratory Study in Chile" (Working paper, Catholic University of Valparaiso, 1992).*
5. *See A. Roma and W. N. Torous, "The Cyclical Behavior of Interest Rates" (Working paper, University of California at Los Angeles, 1992).*
6. *Some of the papers that use term structure variables to predict stock returns are: J. Y. Campbell, "Stock Returns and the Term Structure,"* Journal of Financial Economics *18 (1987), pp. 373–400; E. F. Fama and K. R. French, "Business Conditions and Expected Returns on Stocks and Bonds,"* Journal of Financial Economics *25 (1989), pp. 23–50; C. R. Harvey, "Time-Varying Conditional Covariances in Tests of Asset Pricing Models,"* Journal of Financial Economics *24 (1989), pp. 289–317; C. R. Harvey, "The World Price of Covariance Risk,"* Journal of Finance *46 (1991), pp. 111–57; and J. Boudoukh, M. Richardson and R. Whitelaw, "The Equity Risk Premium and the Term Structure: Two Centuries of Evidence" (Working paper, New York University, 1993).*