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What Makes the Yield Curve Move?

One common misperception about monetary policy is that the Federal Reserve controls *all* interest rates. In fact, the Fed controls only a very short-term rate, the federal funds rate; this is the rate banks charge each other for overnight loans of reserves. Yet Fed policymakers—and central bankers generally—are vitally concerned with the behavior of interest rates of all maturities. In particular, policymakers would like to understand how a change in short-term rates will affect medium-term and long-term rates, because these latter rates determine the borrowing costs people and firms face, which, in turn, determine aggregate demand in the economy.

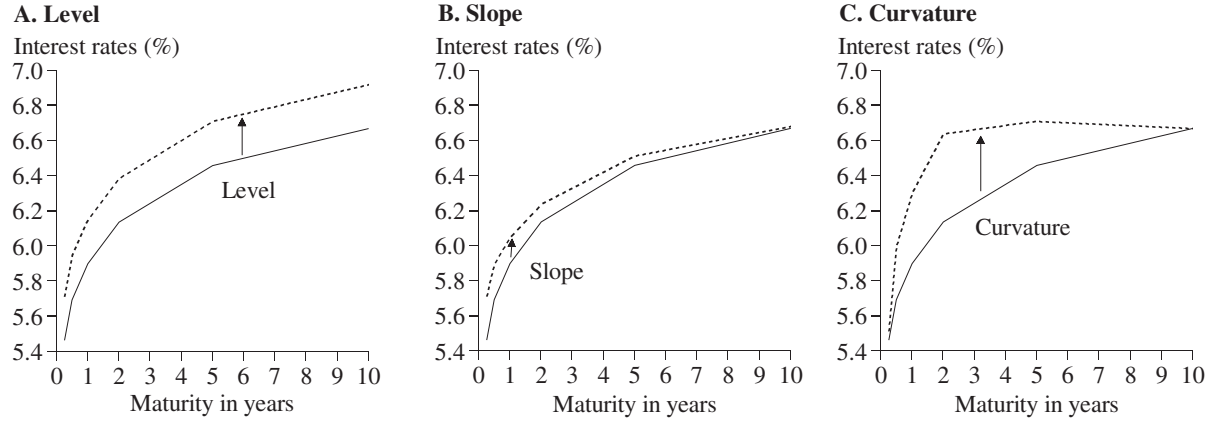
The yield curve, which plots a set of interest rates of bonds of different maturities, describes the relationship among short-term, medium-term, and long-term rates at a given point in time. It has been the subject of much research in the finance literature, because it is the natural starting point for pricing fixed-income securities and other financial assets. While this research has provided useful statistical explanations of movements in the yield curve, it has not focused on what causes the yield curve to move. This *Economic Letter* reviews some of the latest studies in both finance and macroeconomics that have explored the macroeconomic determinants of the yield curve.

Finding the common factors

Typically, the yield curve depicts a line that rises from lower interest rates on shorter-term bonds to higher interest rates on longer-term bonds. Researchers in finance have studied the yield curve statistically and have found that shifts or changes in the shape of the yield curve are attributable to a few unobservable factors (Dai and Singleton 2000). Specifically, empirical studies reveal that more than 99% of the movements of various Treasury bond yields are captured by three factors, which are often called "level," "slope," and "curvature" (Litterman and Scheinkman 1991). The names describe how the yield curve shifts or changes shape in response to a shock, as shown in Figure 1. Panel A of Figure 1 illustrates the influence of a shock to the "level" factor on the yield curve. The solid line is the original yield curve, and the dashed line is the yield curve after the shock. A "level" shock changes the interest rates of all maturities by almost identical amounts, inducing a parallel shift that changes the *level* of the whole yield curve. Panel B shows the influence of the "slope" factor on yield curve. The shock to the "slope" factor increases short-term interest rates by much larger amounts than the long-term interest rates, so that the yield curve becomes less steep and its *slope* decreases. Panel C shows the response of the yield curve to a shock to the "curvature" factor. The main effects of the shock focus on medium-term interest rates, and consequently the yield curve becomes more "hump-shaped" than before.

Various models have been developed and estimated to characterize the movement of these unobservable

Figure 1
Effects of level, slope, and curvature on yield curve



factors and thereby that of the yield curve by financial economists and bond traders in asset-pricing exercises. Few of these models, however, provide any insight about what these factors are, about the identification of the underlying forces that drive their movements, or about their responses to macroeconomic variables. Yet these issues are of most interest to central bankers and macroeconomists.

Macroeconomic interpretations of why the yield curve moves

Macroeconomists view the Federal Reserve as controlling the short end of the yield curve, that is, the federal funds rate, in response to fundamental macroeconomic shocks in order to achieve its policy goal of a low and stable inflation and maximum sustainable output. Therefore, macroeconomic variables, through defining the state of the economy and the Federal Reserve's policy stance, will be useful in explaining movements in the short end of the yield curve. Furthermore, expectations about future short-term interest rates, which determine a substantial part of the movement of long-term interest rates, also depend upon macroeconomic variables. For instance, when the Federal Reserve raises the federal funds rate in response to high inflation, expectations of future inflation, economic activity, and the path of the federal funds rate all contribute to the determination of the long-term interest rates. Therefore, one would expect macroeconomic variables and modeling exercises to be quite informative in explaining and forecasting the yield-curve movements. However, until very recently, standard macroeconomic models have not incorporated long-term interest rates or the yield curve. And even when they have, as in Fuhrer and Moore (1995), most of the attention is still on the correlation between the real economy and the shortest-term interest rate in the model rather than on the whole yield curve.

Several recent economics and finance papers have explored the macroeconomic determinants of the unobservable factors of the yield curve identified by empirical finance studies. Wu (2001) examines the relationship between the Federal Reserve's monetary policy "surprises" and the movement of the "slope" factor of the yield curve in the U.S. after 1982. His study identifies monetary policy "surprises" in several ways to make the analysis more robust; the results indicate a strong correlation between such monetary policy "surprises" and the movement of the "slope" factor over time. In particular, he finds that the Federal Reserve's monetary policy actions exert a strong but short-lived influence on the "slope" factor: they explain 80% to 90% of the movement of "slope" factor, but such influences usually dissipate in one to two months. At the same time, monetary policy "surprises" do not induce significant changes in the "level" factor, implying that during this period the Federal Reserve affects the yield curve primarily through changing its slope.

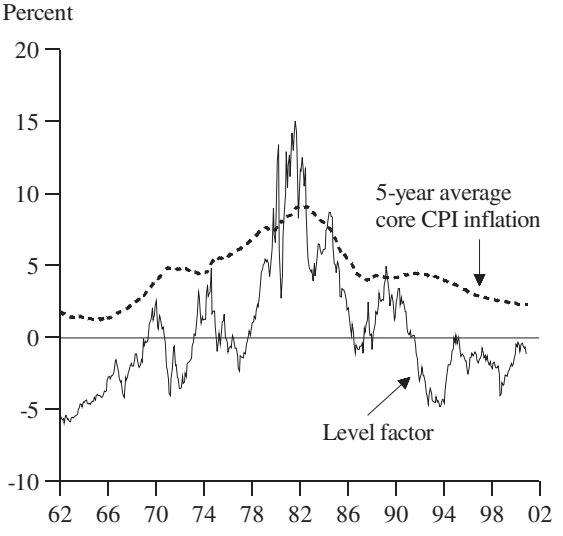
Ang and Piazzesi (2001) examine the influences of inflation and real economic activity on the yield curve in an asset-pricing framework. In their model, bond yields are determined not only by the three unobservable factors—level, slope, and curvature—but also by an inflation measure and a real activity measure. They find that incorporating inflation and real activity into the model is useful in forecasting the yield curve's movement. However, such effects are quite limited. Inflation and real activity and medium-term bond yields (up to a maturity of one year), but most movements of long-term bond yields are still accounted for by the unobservable factors. Therefore, they conclude that macroeconomic variables cannot substantially shift the level of the yield curve.

Evans and Marshall (2001) analyze the same problem using a different approach. They formulate several models with rich macroeconomic dynamics and look at how the "level," "slope," and "curvature" factors are affected by the structural shocks identified in those models. Their conclusion confirms Ang and Piazzesi's (2001) result that a substantial portion of short- and medium-term bond yields is driven by macroeconomic variables. However, they also find that in the long run macroeconomic variables do indeed explain much of the movement of the long-term bond yields, and the "level" factor responds strongly to macroeconomic variables. For instance, their identification results indicate that the changes in households' consumption preferences induce large, persistent, and significant shifts in the level of the yield curve.

Tentative conclusions

Recent literature generally agrees on the effects of macroeconomic variables, especially those of monetary policy, on the slope of the yield curve. A monetary policy tightening generates high nominal short-term interest rates initially, but, because of its anti-inflationary effects, these rates quickly fall back; since long-term rates embed expectations of this behavior of short-term rates, they rise by

Figure 2
Level factor and 5-year average core CPI inflation in the U.S.: 1962 to 2000



only a small amount. As a result, the slope of the yield curve declines when contractionary monetary policy shocks occur.

The conflicting results on the macroeconomy's effects on the movement of the level of the yield curve (Ang and Piazzesi 2001 and Evans and Marshall 2001) suggest a rich field for future research. After all, it is difficult to believe that the structure of the macroeconomy has little effect on long-term interest rates or on the level of the yield curve, since long-term nominal interest rates are the sum of expected long-run inflation and long-term real interest rates. Therefore, any structural macroeconomic movement contributing to the determinations of long-run expected inflation or long-term real interest rates will have a substantial influence on the "level" factor. For instance, in an inflation-targeting monetary regime, the inflation target is a natural anchor of expected long-run inflation, and therefore any changes in the market's perceptions of the inflation target will directly shift the level of the yield curve. Figure 2 plots the "level" factor and the five-year moving average of core consumer price inflation in the U.S. from 1962 to 2002. Clearly, the two series are quite similar. A simple regression shows that the movement of this inflation measure alone can explain 66% of the variability of the "level" factor in this period. Likewise, long-term changes in the structural economy, for example the technology innovations, will also influence the long-term real interest rates and therefore the level of the yield curve.

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References

[URLs accessed May 2003.]

Ang, A., and M. Piazzesi. 2001. "A No-Arbitrage Vector Autoregression of Term Structure Dynamics with Macroeconomic and Latent Variables." Working Paper. Columbia University. Forthcoming, *Journal of Monetary Economics*. http://www-1.gsb.columbia.edu/faculty/aang/papers/bond.pdf

Dai, Q., and K. Singleton. 2000. "Specification Analysis of Affine Term Structure Models." *Journal of Finance* 55 (October) pp. 1,943–1,978.

Evans, C., and D. Marshall. 2001. "Economic Determinants of the Nominal Treasury Yield Curve." FRB Chicago Working Paper 01-16. http://www.chicagofed.org/publications/workingpapers/papers/Wp2001-16.pdf

Fuhrer, J.C., and G.R. Moore. 1995. "Monetary Policy Trade-offs and the Correlation between Nominal Interest Rates and Real Output." *American Economic Review* 85 (March) pp. 219–239.

Litterman, R., and J. A. Scheinkman. 1991. "Common Factors Affecting Bond Returns." *Journal of Fixed Income* 1.

Wu, T. 2001. "Monetary Policy and the Slope Factor in Empirical Term Structure Estimations." FRB San Francisco Working Paper 2002-07. http://www.frbsf.org/publications/economics/papers/2002/wp02-07bk.pdf

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