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What Policymakers Can Learn from Asset Prices

Remarks by

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Central bankers naturally pay close attention to interest rates and asset prices, in large part because these variables are the principal conduits through which monetary policy affects real activity and inflation. But policymakers watch financial markets carefully for another reason, which is that asset prices and yields are potentially valuable sources of timely information about economic and financial conditions. Because the future returns on most financial assets depend sensitively on economic conditions, asset prices--if determined in sufficiently liquid markets--should embody a great deal of investors' collective information and beliefs about the future course of the economy.

I thought you might find it interesting to hear a bit about how the staff of the Federal Reserve uses financial-market information to try to improve forecasts and help guide policy decisions. As you will see, asset prices provide information, particularly about market expectations, that is difficult to obtain elsewhere. However, a recurring theme of my remarks will be that extracting accurate information from asset prices and yields is more difficult and requires greater sophistication than is commonly supposed. Ongoing research in financial economics thus has great potential to provide practical assistance to monetary policy makers.

As usual, the views I will express today are not necessarily those of my colleagues in the Federal Reserve System.[1]

Market Expectations of Inflation: The Information in Inflation-Indexed Securities

I will begin by discussing what financial markets can tell us about inflation expectations. The inflation expectations of financial-market participants are of particular interest to central bankers, for several reasons. First, as price stability is a key

objective of monetary policy, the Federal Reserve puts substantial resources into forecasting inflation. To the extent that financial markets serve to aggregate private-sector information about the likely future course of inflation, data on asset prices and yields might be used to validate and perhaps improve the Fed's forecasts. Second, inflation expectations are of interest to policymakers independent of inflation itself. A considerable literature suggests that successful monetary policies should stabilize, or "anchor," inflation expectations so as to prevent them from becoming a source of instability in their own right (Goodfriend, 1993; Evans and Honkapohja, 2003). Finally, knowledge of the expectations of inflation in financial markets permits the calculation of real interest rates, which are important indicators of both the condition of the economy and the stance of monetary policy.

Although clues about inflation expectations abound in financial markets, inflation-indexed securities would appear to be the most direct source of information about inflation expectations and real interest rates.[2] Government securities whose realized yields depend on inflation, known on the Street as "linkers," have become increasingly common in industrial countries, Japan being the latest nation to introduce an inflation-indexed government bond. The U.S. Treasury began issuing TIIS (for Treasury inflation-indexed securities), more popularly known as TIPS (for Treasury inflation-protected securities), in January 1997. TIPS promise a yield-to-maturity that is guaranteed in real terms. To provide the promised real yield, TIPS coupon and principal payments are escalated based on increases in the consumer price index from the time at which the security was issued.

The difference between the real yield guaranteed by an inflation-linked security and the nominal yield provided by a conventional security of the same maturity is known as the breakeven inflation rate or, alternatively, as inflation compensation. The top panel of Figure 1 shows the yield on nominal ten-year Treasury bonds (top line) and the real yield on ten-year TIPS since 1999 (bottom line). The vertical distance between the two lines is known as breakeven inflation at the ten-year horizon. The bottom panel uses overlapping issues of nominal securities and TIPS to disaggregate breakeven inflation into the rate that applies to bonds maturing five years from now and the implied forward breakeven rate from five to ten years out. The breakeven rate of inflation is often treated as a direct reading of investors' expectations of inflation. Under this interpretation, the lower line in the bottom panel of Figure 1 is an estimate of market inflation expectations over the next five years, and the upper line represents five-year forward expectations of inflation, that is, today's expectation of what average inflation will be between 2009 and 2014.

Unfortunately, as a measure of market participants' expected inflation, breakeven inflation has a number of problems (Sack, 2000; Shen and Corning, 2001). First, and probably the most important, breakeven inflation includes a return to investors for bearing inflation risk, implying that the breakeven rate likely overstates the market's expected rate of inflation. Estimates of the inflation risk premium for bonds maturing during the next five to ten years are surprisingly large, generally in a range between 35 and 100 basis points, depending on the time period studied (Ang and Bekaert, 2003; Goto and Torous, 2003; Buraschi and Jiltsov, 2004). If the inflation risk premium averages 50

basis points, for example, then breakeven inflation will overstate the market's true expectation of inflation by half a percentage point, a substantial amount. A further complication is that inflation risk premiums are not constant but instead appear to vary over time as economic circumstances change.

Second, although the issuance of inflation-protected securities has risen significantly, the outstanding quantities of these securities remain much smaller than those of conventional Treasury securities. Moreover, TIPS are attractive to buy-and-hold investors, in contrast to nominal Treasury securities, which are extensively used for trading and hedging (Sack and Elsasser, 2004). For both reasons, the market for TIPS remains significantly less liquid than those for most Treasury securities. All else equal, the likely presence of a liquidity premium in the TIPS return tends to make breakeven inflation an underestimate of expected inflation, thus offsetting to some degree the effect of the inflation risk premium.[3] Like inflation risk premiums, liquidity premiums on TIPS appear to vary over time, further complicating the interpretation of breakeven inflation.

A third issue is that the real values of the coupon payments on an indexed security are fixed by construction, while the real coupons of a nominal bond usually decline over its life. Hence, an indexed security typically has a longer duration with respect to real interest rate changes than does the nominal security, a difference that affects the relative

riskiness of real and nominal securities.[4] More generally, because TIPS returns are imperfectly correlated with the yields on both nominal Treasuries and stocks, some investors demand TIPS for general diversification purposes--a demand that appears to have increased significantly as investors have become more familiar with this new type of asset. As the supply of TIPS has been fairly limited, the rise in demand by institutional investors and others may push down the equilibrium real return on TIPS and thus raise measures of breakeven inflation.[5]

A separate issue that bears on the relevance of breakeven inflation for policymaking is that TIPS returns depend on the overall consumer price index (CPI), whereas for many purposes policymakers are more interested in the behavior of core inflation, a measure of inflation that strips out volatile food and energy prices. In fact, TIPS returns appear sensitive to fluctuations in oil prices.

As you can see in Figure 1, breakeven inflation rates have proven surprisingly volatile over their short history. For example, when nominal Treasury yields swung sharply during the spring and summer of 2003, ten-year breakeven inflation moved sharply as well, declining about 40 basis points as the bond market rallied, then rising about 80 basis points when nominal yields came back up (top panel). This effect was seen also in inflation compensation at the five-to-ten-year horizon (bottom panel), a rather counterintuitive result.

What should we make of the volatility of breakeven inflation over recent years? One interpretation is that inflation expectations are not as well anchored as policymakers would like (see Bernanke, 2004, for additional evidence on this point). The fact that

inflation compensation tends to react strongly both to releases of macroeconomic data and to unexpected changes in monetary policy (Gurkaynak, Sack, and Swanson, 2003) supports this interpretation.

Still, at this point I think we need to be cautious about drawing strong conclusions about the short-run behavior of expected inflation from the data on breakeven inflation. The fact that the volatility of breakeven inflation is so much greater than that of standard survey measures of inflation expectations (such as those collected by the Federal Reserve Bank of Philadelphia for professional forecasters or by the University of Michigan for consumers) should give us pause. The responsiveness of breakeven inflation to what might be construed primarily as liquidity disturbances, such as the Russian debt crisis and recent bouts of mortgage hedging activity that roiled Treasury markets, suggests that variable liquidity premiums, together with varying inflation risk premiums, contaminate breakeven inflation as a measure of expected inflation.[6]

I have emphasized some reasons to be cautious in interpreting breakeven inflation as expected inflation. Nevertheless, I expect that the usefulness of inflation-indexed securities as a tool for measuring expected inflation will increase over time. The liquidity of TIPS should continue to improve as the share of government debt issued in inflation-linked form continues to rise, particularly if the Treasury decides to expand the range of maturities of indexed bonds that it offers. Moreover, as I will discuss briefly later in the talk, our ability to model risk and liquidity premiums is improving, which will help us control for an important source of volatility in breakeven inflation. Finally, the universe of inflation-linked financial assets seems to be increasing, which will allow for

fruitful comparisons and cross-checking. For example, futures on the CPI were recently introduced on the Chicago Mercantile Exchange. Although these contracts are not yet widely traded, they may at some point provide useful measures of breakeven inflation out to the maturity of the shortest-term TIPS, thereby filling in an important portion of the term structure of breakeven inflation.

Interest Rates and Spreads as Leading Indicators

An alternative approach to extracting information from financial markets is to examine a range of asset prices and yields to determine whether they are useful as leading indicators of economic developments. Financial prices meet several key criteria for being useful leading indicators. As I already noted, asset prices and yields are inherently forward looking and thus may contain information about future economic conditions not evident in other series. Moreover, asset prices, unlike many data series, are available on a timely and continuous basis and are not revised. At least since the 1930s, when Wesley Mitchell and Arthur Burns (1938) published their pioneering work, economists have noted the usefulness of asset prices in forecasting economic activity--though perhaps we should keep in mind Paul Samuelson's wry observation that "the stock market has predicted nine of the last five recessions."

Although many financial quantities have been used in forecasting (an index of stock prices is included in the official index of leading indicators), interest rates on various financial instruments have perhaps been most often cited for their value as leading indicators.[7] For example, in a 1992 paper, Alan Blinder and I found evidence that the federal funds rate, the short-term interest rate used by the Federal Reserve as its

policy instrument, has significant predictive power for a variety of measures of economic activity.

Various yield spreads have also been found to be informative about the future course of the economy. In 1989, James Stock and Mark Watson proposed a new index of leading indicators based on seven variables with exceptionally good forecasting track records up to that date. Among these variables were the spread between the ten-year and one-year Treasury yields (the term spread), the yield differential between commercial paper and Treasury bills (the public-private spread), the change in the ten-year Treasury yields, and the nominal exchange rate.[8] Thus, Stock and Watson found that two of the best seven macroeconomic forecasting variables were interest rate spreads, and four of the best seven forecasters were financial in nature.

Of these variables, the term spread (also known as the slope of the yield curve) had been recognized for some time as a useful indicator of cyclical conditions. Figure 2 shows the historical behavior of the term spread (top panel, here measured as the ten-year rate less the three-month rate), as well as that of the federal funds rate and the spread between commercial paper and three-month T-bill yields for comparison. The shaded areas indicate periods of recession as designated by the National Bureau of Economic Research. It is interesting that the slope of the Treasury yield curve has turned negative (top panel), at least briefly, at between two and six quarters before every U.S. recession since 1964 (Ang, Piazzesi, and Wei, 2003). It has given only one false signal, in 1966, when an economic slowdown--but not an official recession--followed the inversion of the yield curve. The slope of the yield curve is potentially informative for several reasons.

To some extent, it captures the stance of monetary policy. For example, when the yield curve is sharply upward sloping, as is the case today, one can usually conclude that monetary policy is in an expansionary mode (because the short-term policy rate lies below the average of expected future short-term rates). Either an expected pickup in economic growth or higher expected future inflation would also tend to raise long-term rates relative to short rates, steepening the yield curve. Evidence for the predictive power of the slope of the yield curve has been found for other industrialized countries as well as for the United States.[9]

Although the evident information content of the term spread and other yields and spreads is intriguing, these variables--like breakeven inflation--hardly provide a foolproof forecasting tool. For example, the Stock-Watson indicator and other indicators based on interest rates and spreads signaled the 1990-91 recession very weakly and rather late. The yield curve was inverted from June 2000 through March 2001, which presaged the 2001 recession, but other financial indicators (such as the public-private spread) missed the downturn entirely (Stock and Watson, 2003a), as you can see in Figure 2. More generally, Stock and Watson (2003b) have recently documented that simple forecasting relationships are typically quite unstable, presumably because both the nation's economic structure, the conduct of policy, and the mix of shocks that buffet the economy change over time.

Although the use of financial data as leading indicators is not without risks, I suspect that economists will continue to try to find better ways to extract the information in these data. I see two general approaches as being especially promising. First,

forecasting relationships that simultaneously use information from a large number of data series may be more robust than prediction equations based on only a few variables (Stock and Watson, 2003b). One effective way to summarize the information in large data sets is through the estimation of statistical models that extract the common information conveyed by many variables.[10] Currently, the U.S. Treasury uses a model of this type in preparing its forecasts of gross domestic product (GDP), and the Chicago Fed's national activity index, which draws on earlier work by Stock and Watson, is also based on these methods. The Board staff is currently investigating the potential of this approach for forecasting the economy.

The other promising approach is to combine financial and macroeconomic information in a more structured way. For example, Ang, Piazzesi, and Wei (2003) have used modern financial theory to construct a model of the Treasury yield curve that closely links the behavior of real GDP and a few key interest rates. In particular, their framework incorporates the possibility of two-way causality, allowing for both interest-rate effects on the economy and the impact of economic developments on interest rates. These authors show that combining financial and macroeconomic elements in a single model permits better forecasts of both GDP and of interest rates than can be achieved through less formal methods.[11] Other work, for example by Ang and Bekaert (2003), shows how modeling the links between interest rates and the economy may help us obtain more efficient forecasts of inflation. These methods are also being studied at the Federal Reserve Board.

One important advantage of this theory-based modeling approach is that it permits

the estimation of risk premiums. For example, presumably the predictive power of the term spread would be enhanced if we could separate changes in the spread resulting from changes in rate expectations from those arising from changes in risk premiums. Similarly, better estimates of inflation risk premiums would prove useful for adjusting breakeven inflation rates from TIPS to get more reliable measures of expected inflation.

Market Expectations of Monetary Policy

What do markets expect about the future course of monetary policy? The question is important to policymakers, not because we are concerned necessarily that we should meet the market's expectations--such a strategy quickly degenerates into a hall of mirrors--but as a check on the efficacy of our communication. If the policy expectations of the market differ significantly from the policy expectations of central bankers, then the two leading possibilities are, first, that the policy committee has not accurately communicated its outlook and objectives or, second, that the market hears the policy committee's message but is skeptical of it.

A number of financial instruments provide readings on the market's policy expectations. Two of the most useful are federal funds futures contracts and eurodollar futures contracts. These contracts are traded in highly liquid markets.[12] Moreover, by their nature they are closely tied to expectations of monetary policy changes, as both reflect rates paid in the interbank market, the market that is targeted by the Federal Reserve's open-market operations.[13]

Implied forward values of short-term interest rates at various horizons can be extracted from federal funds and eurodollar futures contract prices in a straightforward

way. Figure 3 provides an illustration. The lower, dashed line shows the path of the expected federal funds rate through 2008 as implied by federal funds and eurodollar futures at the close of the market on April 1, 2004, with an adjustment for the average level of term premiums. The upper, solid line shows the path of expected funds rates as of the market close on the next day, April 2. As you probably know, the payroll employment numbers announced on April 2 significantly exceeded market expectations. Figure 3 shows that the payroll data seems to have caused the market to price in an expectation of a higher federal funds rate target over the entire policy horizon. Of course, that change in policy expectations is consistent with the significant rise in Treasury yields that occurred after the employment report.

Observing market expectations of policy provides useful feedback to the policymakers. Yet again, however, caution is needed in interpreting these data. As with inflation-indexed securities, forward interest rates implied by futures contracts do not necessarily correspond to market expectations of the short-term rate, because of the presence of premiums for interest-rate risk.[14] Indeed, research suggests that risk premiums in federal funds and eurodollar futures contracts are not trivial and may vary over time. For example, a study by Piazzesi and Swanson (2004) has found that risk premiums on federal funds futures are both strongly countercyclical and predictable at longer horizons. The implication is that, although futures prices provide good estimates of market expectations of policy at short horizons of six months or so, at longer horizons they can be misleading. In particular, Piazzesi and Swanson (2004) find that if analysts ignore risk premiums in federal funds and eurodollar futures, they will estimate

longer-horizon policy expectations that "lag behind" actual market expectations, remaining too high when the Fed is easing and too low when the Fed is tightening.[15] Fortunately, this research also shows how to correct the futures data to account for the time variation in risk premiums. Once again, we see that some subtlety is required to extract the information available in asset prices.

A great advantage of market-based measures of policy expectations, relative to periodic surveys that ask market participants about their expectations, is that market measures are available essentially continuously.[16] These measures thus lend themselves to "event studies" of two types, both of which are employed at the Board of Governors. The first type analyzes how various events, such as Federal Reserve statements; the release of minutes, testimony, or speeches by members of the Federal Open Market Committee (FOMC); and macroeconomic news affect market expectations of monetary policy. One simply compares the implied policy expectations before and after the event being studied. We have already considered an example, the effects of the most recent payroll report, in Figure 3. Analyses of this type provide insights for policymakers into the question of what economic factors the "market," viewed collectively, is focusing on at a given time.

The second type of event study uses market-based measures of policy expectations to analyze the effects of policy changes on the economy. In particular, when

the FOMC chooses to set the target for the federal funds rate at a value different from that expected by the market, asset prices tend to react strongly. For example, in a recent paper, Kenneth Kuttner and I (2004) studied the effects on stock prices of unanticipated changes in monetary policy, as measured by settings of the federal funds rate target that differ from those implied by federal funds futures market. We found that a surprise increase of 25 basis points in the funds rate target typically results in a decline in broad equity indexes of about 1 percent, whereas a change in the funds rate that is expected by the market has essentially no effect on stock prices.[17] Our work is just one example of a number of event-study analyses that may well shed light on the effects of monetary policy and the channels of monetary policy transmission.

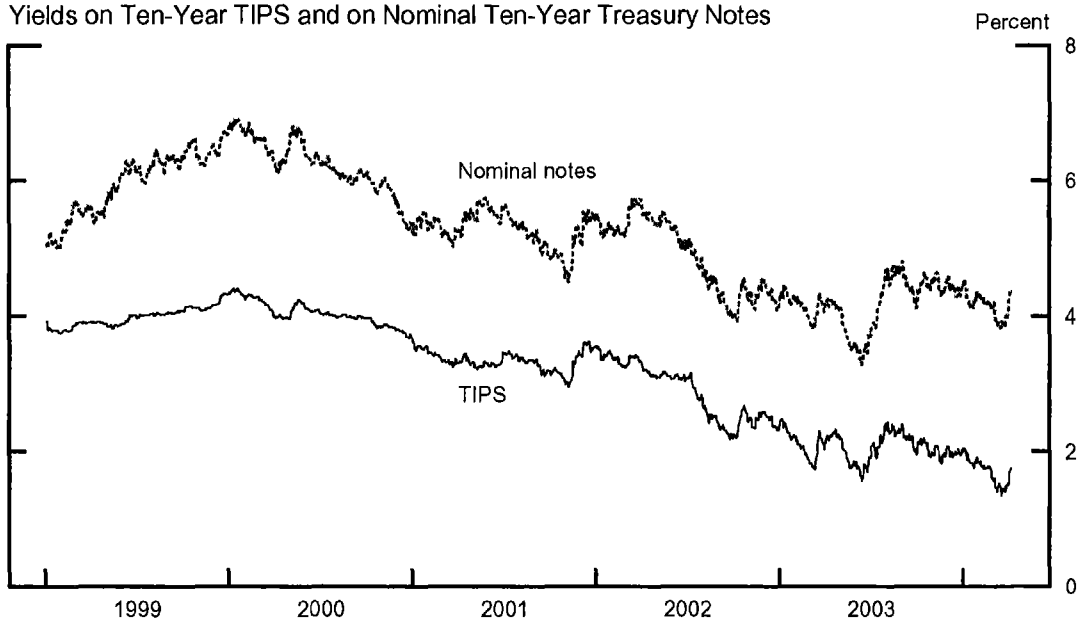
Policymakers are concerned not only about market expectations of output, inflation, interest rates, and other key variables, but also about the extent of market uncertainty about those and other variables. Financial data provide insight about market uncertainty that is obtainable nowhere else. For example, the Board's staff regularly analyzes the prices of options on eurodollar futures to estimate the degree of uncertainty that market participants have about monetary policy at different horizons. Indeed, by examining options with different strike prices, and under some reasonable additional assumptions, one can produce a full probability distribution of market expectations for the level of the federal funds rate at various dates in the future. Likewise, analysis of

various types of options can generate distributions of expectations for economic and financial variables ranging from oil prices to the exchange value of the dollar to future stock prices.[18]

Conclusion

Financial markets aggregate enormous amounts of information and thus provide a rich hunting ground for central bankers trying to learn about the economy. Today I have tried to provide a small taste of the many types of financial data that are analyzed by the staff at the Federal Reserve as well as to give you some sense of the techniques that they bring to bear. A message that I also hope to leave with you is that some of the potentially most valuable information in financial markets often requires considerable theoretical and empirical sophistication to extract. For this reason, and as I mentioned at the beginning, financial research of the type being conducted at the Board, in academia, and in the investment community will prove invaluable to the Federal Reserve in our efforts to support a stronger and more stable economy.

Figure 1


Yields on Ten-Year TIPS and on Nominal Ten-Year Treasury Notes
Percent
8
6
4
2
0
Nominal notes
TIPS
1999
2000
2001
2002
2003

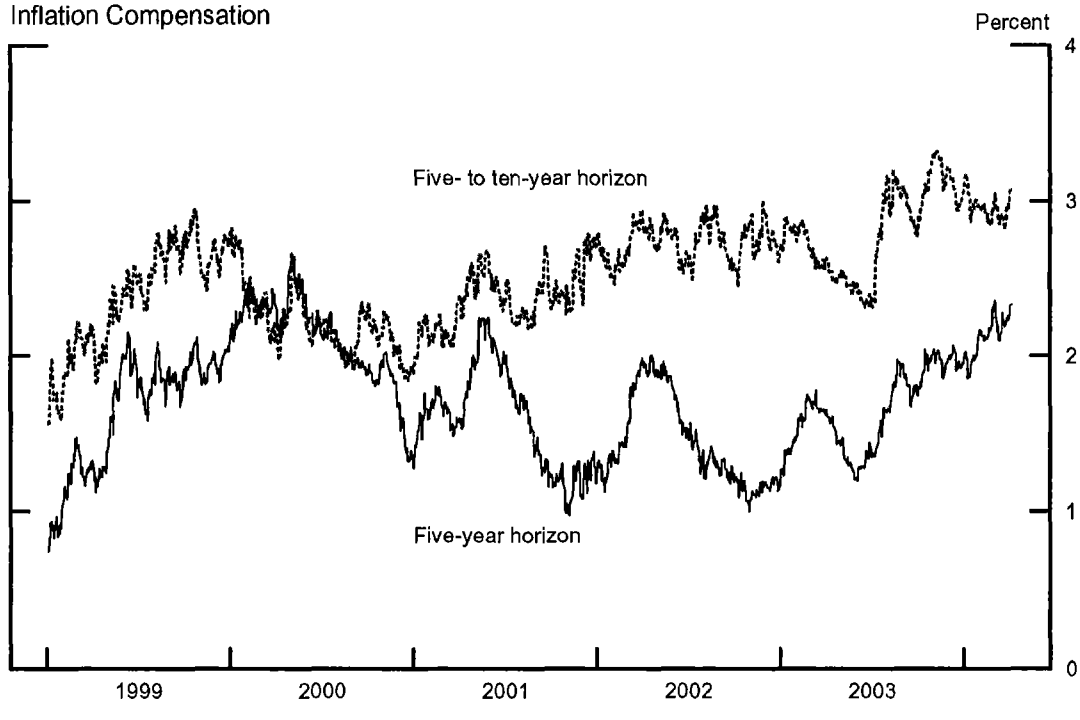
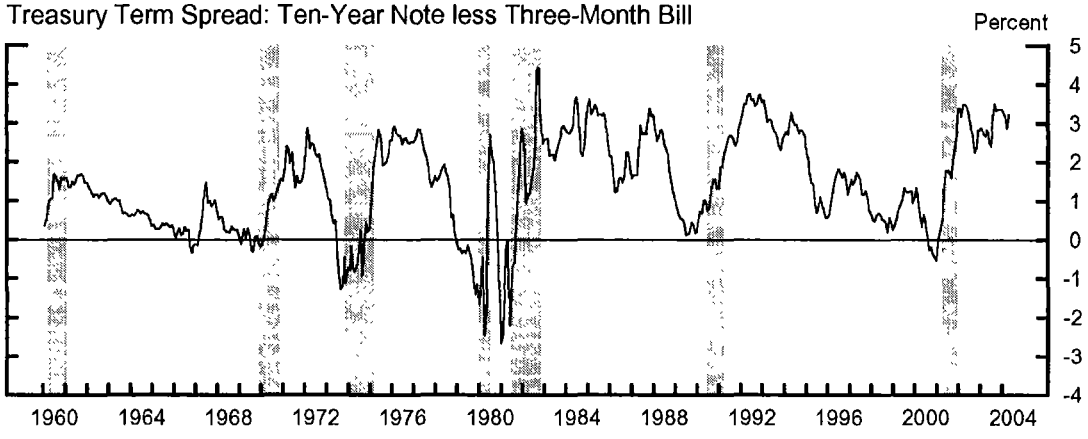
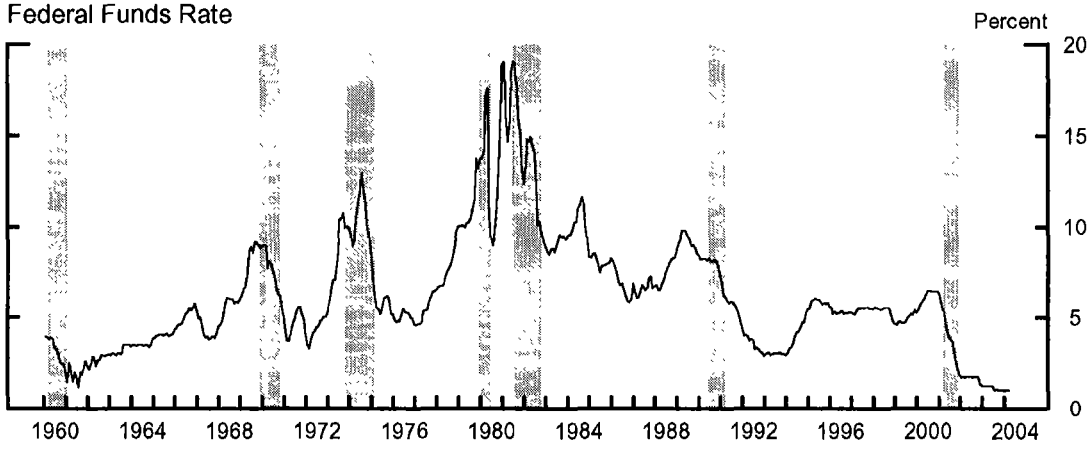
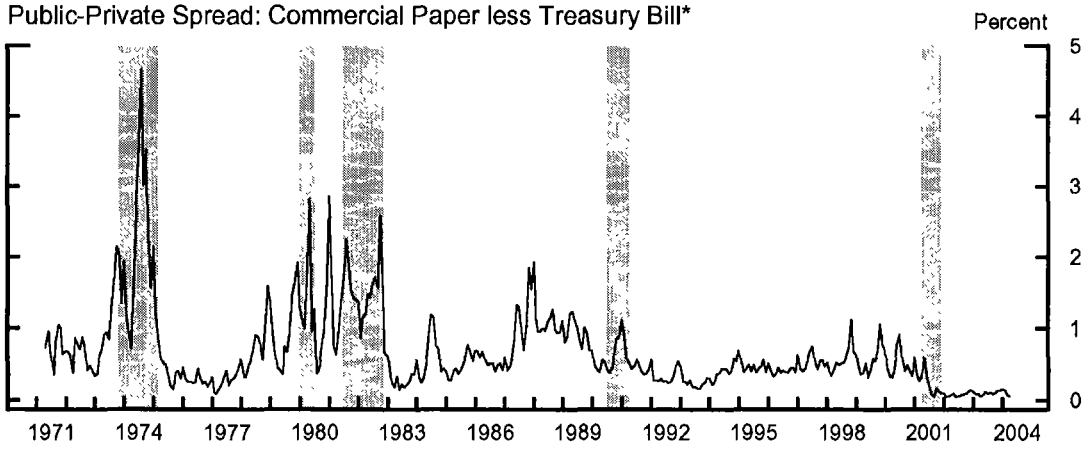

Inflation Compensation
Percent
4
3
2
1
0
Five- to ten-year horizon
Five-year horizon
1999
2000
2001
2002
2003

Figure 2



Note. In each panel, shaded bars are periods of recession as determined by the National Bureau of Economic Research.

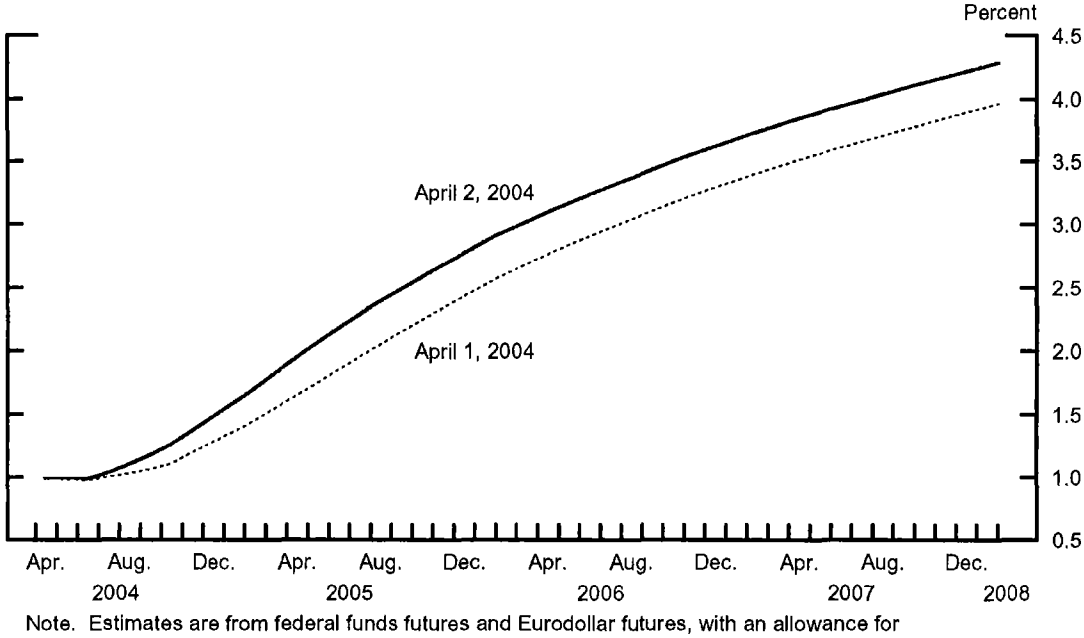




*Three-month securities.

Figure 3

Expected Federal Funds Rate



Note. Estimates are from federal funds futures and Eurodollar futures, with an allowance for term premia and other adjustments.

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[1]Thanks are due to James Clouse and Brian Sack for superb assistance.
[2]Indeed, their potential usefulness in this respect was an explicit motivation for their introduction in the United States.
[3]As a partial fix of this problem, the breakeven inflation rates shown in Figure 1 are calculated by comparing the yields of TIPS and so-called off-the-run securities. Within a given class of securities, say Treasury bonds with ten years until maturity, off-the-run securities are securities other than those most recently issued. Because off-the-run securities are less liquid than newly issued (on-the-run) securities, they provide a more appropriate benchmark against which to compare the yields of relatively illiquid inflation-indexed bonds.
[4]As Sack (2000) has pointed out, this difference in duration implies that the breakeven inflation rate may be sensitive to the expected profile of future short real rates or be affected by differences in risk premiums arising from different exposure to interest-rate risk. Sack addressed the issue of differing durations of nominal securities and TIPS by comparing yields on TIPS to yields on artificial securities constructed to provide the same pattern of real payments as a TIPS security, thereby eliminating the differences in duration noted in the text. He found, however, that the duration mismatch is less important quantitatively than differences in liquidity between on-the-run nominal securities and TIPS.
[5] A number of technical issues, such as the lags in the inflation adjustment procedure, affect the relationship of breakeven inflation and expected inflation. One such potential complication arises if the tax rates applicable to the marginal TIPS investor and to the marginal holder of nominal government securities are not the same, in which case the equilibrium breakeven inflation level will be affected. Roll (2004) discusses the effects of taxation on the breakeven inflation rate.
[6]Indeed, Shen and Corning (2001) note that breakeven inflation is correlated with other measures of liquidity premiums, such as the spread between on-the-run and off-the-run securities. Perli and Sack (2003) discuss the volatility in Treasury bond markets associated with mortgage hedging activity.
[7]Stock and Watson (2003b) provide an exhaustive survey of the literature on the predictive power of asset prices for output and inflation. Parts of my discussion in this section draw from their paper.
[8]Friedman and Kuttner (1993) independently recognized the rather remarkable forecasting record of the public-private spread.
[9]For example, Estrella and Mishkin (1997) studied the predictive value of the term premium using data from France, Germany, Italy, the United Kingdom, and the United States. Estrella and Mishkin found that the slope of the yield curve is useful for predicting growth at about a six-quarter horizon, with the link being somewhat stronger in the United States than in Europe. They also found that the slope of the yield curve helps to predict inflation (as measured by the GDP deflator), but at much longer horizons of about five years. Also using international data, Kozicki (1997) found that the term spread is a good short-run forecaster of output, but that the level of yields is a more useful predictor of inflation.
[10]In other work, Stock and Watson (1999) have shown that these so-called factor models can provide superior and more robust forecasts than methods based on only a few

variables. Forni, Hallin, Lippi, and Reichlin (2000) and Bernanke and Boivin (2003) have obtained related results.

[11]Kozicki and Tinsley (2001), Hordahl, Tristani, and Vestin (2002), Ang and Piazzesi (2003), Craig and Haubrich (2003), Diebold, Rudebusch, and Aruoba (2003), and Rudebusch and Wu (2003) are among the many interesting papers in the recent "macro-finance" literature on the term structure.

[12]The volume of federal fund futures contracts traded has grown about sixfold in the past four years, to about 8.3 million contracts 2003.

[13]Gurkaynak, Sack, and Swanson (2002) examined the predictive power of federal funds and eurodollar futures contracts for settings of the federal funds rate target and found that in this respect they outperform other financial instruments. Specifically, they found that the federal funds futures contract dominates alternative instruments for forecasting the funds rate out to a horizon of several months, while eurodollar futures do slightly better than alternative instruments at longer horizons.

[14]Liquidity premiums are less of an issue for these markets.

[15]Sack (2004) also allows for time-varying risk premiums, making the assumption that the risk premium is related to the slope of the eurodollars futures curve at longer horizons. Like Piazzesi and Swanson (2004), he finds that time variation in the risk premium has little effect on estimated policy expectations at shorter horizons (six to twelve months, in his study) but becomes increasingly important at longer horizons.

[16]Another advantage is that, unlike survey participants, traders back up their forecasts with their money--a powerful incentive to make forecasts that are as accurate as possible.

[17]Our analysis used daily data. Using intraday data, Gurkaynak, Sack, and Swanson (2004) found an effect of similar magnitude.

[18]A caveat: These probability distributions are derived under an assumption of risk neutrality. Thus, unobserved risk premiums are potentially a problem here as well.