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# Longer-Term Perspectives on the Yield Curve and Monetary Policy

*By Sharon Kozicki and Gordon Sellon*

In the spring of 2004, there was widespread expectation in financial markets that the Federal Reserve would shortly begin the process of raising its federal funds rate target back toward a more normal level. At the time, there was considerable concern that removing policy accommodation could lead to a sharp rise in long-term interest rates that might roil financial markets or slow the economic recovery. Much of this concern was based on the sizable increases in long-term rates that occurred when the Federal Reserve tightened policy in 1994-95 and 1999-2000.

In contrast to the conventional wisdom, however, longer-term rates actually declined as the funds rate target rose. Indeed, in August 2005, after the Federal Reserve had raised its federal funds rate target from 1 percent to 3½ percent, the yield on the benchmark 10-year Treasury note remained below its level at the onset of policy tightening. This surprising behavior of long-term rates has been labeled a “conundrum” by Federal Reserve Chairman Greenspan and many financial market participants, and considerable effort has been made to understand the causes of the conundrum and its implications for monetary policy.

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*Sharon Kozicki and Gordon Sellon are vice presidents and economists at the Federal Reserve Bank of Kansas City. This article is on the bank's website at [www.kansascityfed.org](http://www.kansascityfed.org).*

This article provides a framework for understanding the relationship between monetary policy and the yield curve that can be used to analyze the behavior of long-term rates during periods of monetary policy tightening. This framework is used to examine two recent episodes of policy tightening, in 1999-2000 and 2004-05. The analysis reveals that the conundrum period is highly unusual, but it also suggests that the relationship between monetary policy and the yield curve is quite complex and highly variable over time.

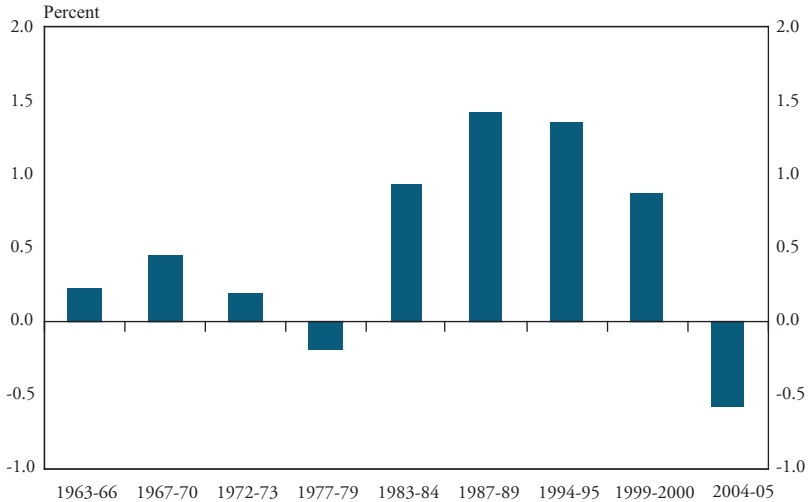
The first section of the article compares the relationship between the yield curve and monetary policy across nine episodes of monetary policy tightening over the past 40 years, highlighting patterns in this relationship that are common to all nine episodes. The second section provides an analytical framework that helps identify economic factors behind each of these patterns. The third section uses this framework to analyze the behavior of the yield curve in the two most recent episodes of monetary policy tightening. The final section summarizes the analysis and discusses its broader implications for understanding the relationship between the yield curve and monetary policy.

## **I. HISTORICAL PERSPECTIVE ON YIELD CURVES AND MONETARY POLICY**

A brief survey of historical episodes of monetary policy tightening supports the view that the recent behavior of long-term interest rates is unusual but also reveals that the relationship between interest rates and monetary policy is quite complex and changes over time. A closer look at the historical evidence highlights three distinct patterns in this relationship and suggests the possibility of identifying a common set of economic factors that can be used to explain historical differences in yield curve behavior.

### *What happens to long-term rates when policy is tightened?*

To begin, it is useful to place the recent behavior of long-term rates in historical context. The nature of a conundrum is that it is both unusual and difficult to explain. How unusual is it for long-term interest rates to fall when monetary policy is being tightened? One

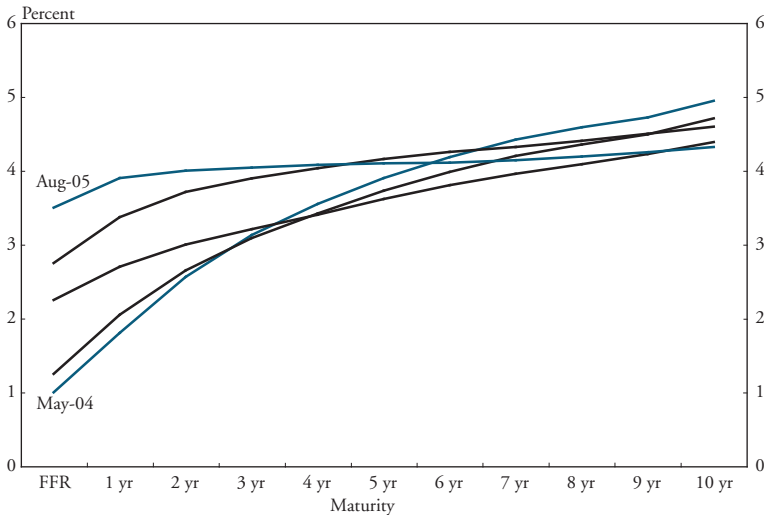
*Chart 1***CHANGE IN 10-YEAR RATE AT START OF POLICY TIGHTENING**

approach is to see what happened to long-term rates in past periods of policy tightening. Chart 1 shows the response of long-term rates during the first stage of policy tightening in the current cycle as compared with eight previous periods of policy tightening over the past four decades. The response of long-term rates is measured as the change in the yield on the 10-year Treasury note during the first 100-basis-point increase in the federal funds rate.<sup>1</sup>

In the current episode, the 10-year Treasury rate fell from 4.94 percent in May 2004 to 4.36 percent in November 2004 as the federal funds rate target was increased from 1 percent to 2 percent. According to Chart 1, a decline in long-term rates in the initial phase of policy tightening is highly unusual. Only in the 1977-79 period did the 10-year Treasury rate decline as policy was tightened, and the magnitude of the decline was considerably smaller than in the current episode.

At the same time, Chart 1 reveals that the response of long-term rates has varied considerably over these episodes. Although the 10-year Treasury rate increased substantially in the four episodes during the 1980s and 1990s, its response was much smaller in the 1960s and

*Chart 2*  
YIELD CURVE IN 2004-2005



1970s. Thus, while the conundrum episode stands in stark contrast to tightening episodes of recent years, it is much less different from the earlier, pre-1980 periods.

### *The response of the yield curve to policy tightening*

To get a better understanding of these differences in the behavior of long-term rates, it is useful to take a closer look at how the entire yield curve evolved during each of the nine tightening cycles. The behavior of the Treasury yield curve during the most recent tightening cycle is shown in Chart 2. This chart shows the maturity structure of the yield curve from one to ten years at selected dates.<sup>2</sup> Prior to the beginning of tightening, the yield curve had a steep, upward slope with longer-term rates considerably above the federal funds rate. As shown in the chart, as the federal funds rate rose from 1 percent in May 2004 to 3½ percent in August 2005, rates on short-term securities increased while long-term rates decreased. Visually, Chart 2 suggests that short-term rates and long-term rates appear to pivot around unchanged medium-term rates.

To put this recent yield curve behavior in perspective, Charts 3 and 4 show how the yield curve evolved as policy was tightened in the preceding eight tightening episodes.<sup>3</sup> Several stylized facts emerge from a comparison of yield curve behavior in these historical episodes. First, the relative response of short-term and long-term rates varies greatly across episodes. In the pre-1980 tightening episodes, short-term rates tended to increase considerably more than long-term rates over the tightening cycle. This feature is especially pronounced in the 1972-73 and 1977-79 periods as shown in Chart 3. In contrast, in the four post-1980 periods, increases in short-term rates are associated with considerably larger changes in long-term rates. The 1983-84 and 1994-95 periods shown in Chart 4 are particularly representative of this behavior.

Second, while long-term rates sometimes decline as short-term rates increase, this phenomenon typically occurs toward the end of policy tightening, rather than at the beginning of a cycle—for example, in 1987-89, 1994-95, and 1999-2000. Thus, what is particularly unusual about the current episode is that the decline in long-term rates occurred at the beginning of a tightening cycle rather than at the end. As indicated earlier, only the 1977-79 episode shows yield curve pivoting at the beginning of the tightening cycle, and this phenomenon is less pronounced than in the current episode.

Finally, Charts 3 and 4 suggest that, even within a tightening episode, the response of long-term rates can vary considerably. For example, in the 1987-89 period long-term rates rose substantially as policy was tightened in the months before the stock market crash but generally declined as policy was tightened in 1988 and 1989. Similarly, in 1994-95 and 1999-2000, long-term rates increased much more at the beginning of the tightening cycle than at the end.

### *Yield curve patterns*

At first glance, the large differences in yield curve behavior across tightening episodes suggest that it may be difficult to isolate the economic factors behind these differences. However, a closer look at Charts 2, 3, and 4 shows three distinct patterns common to these episodes. Indeed, each episode can be viewed as being made up of one or more of these three patterns.

*Chart 3*  
YIELD CURVES DURING POLICY TIGHTNING

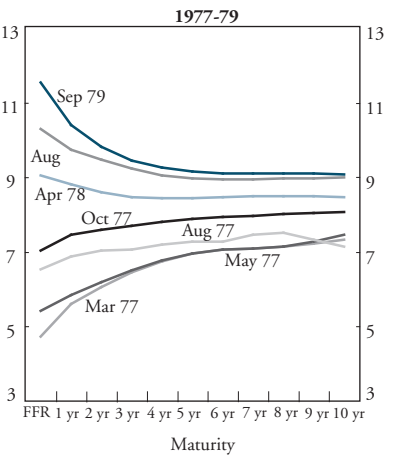
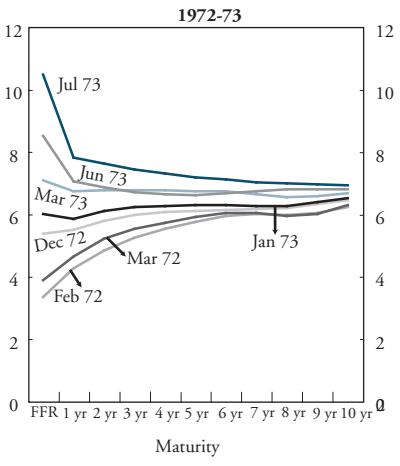
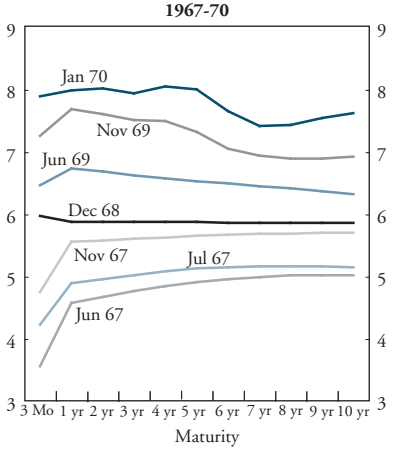
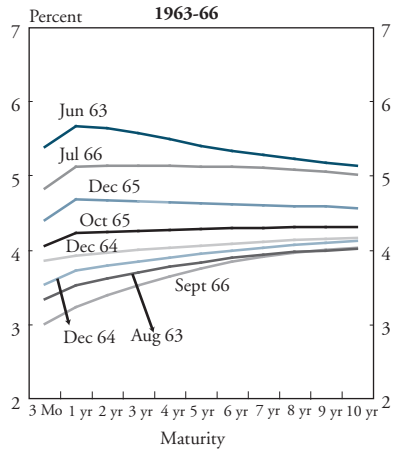
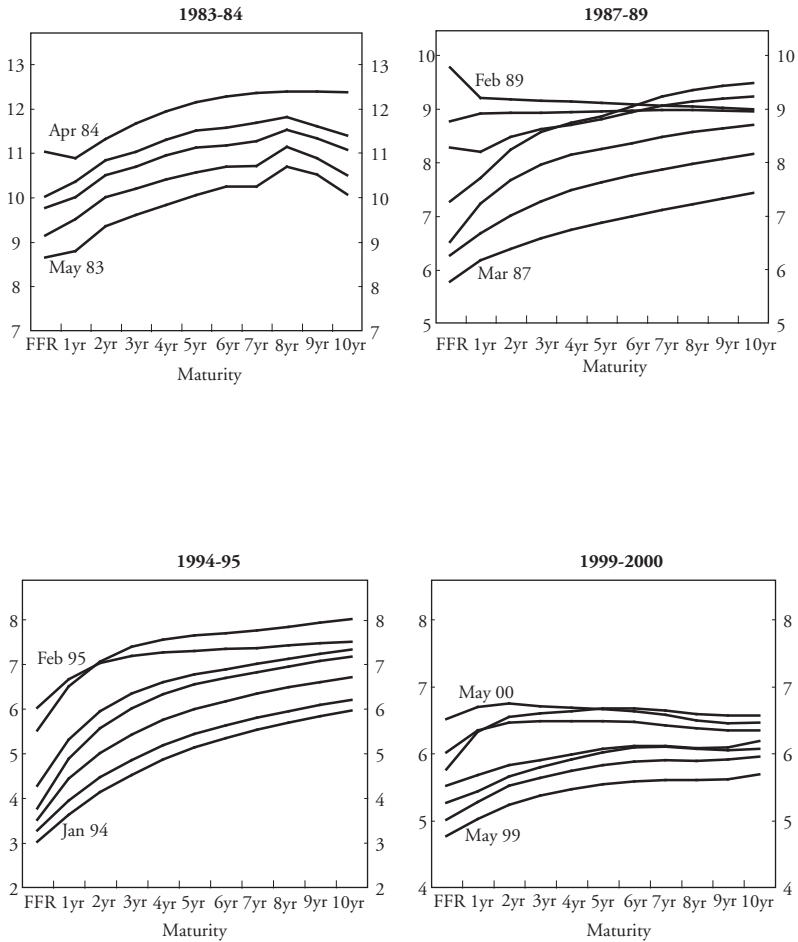


Chart 4

YIELD CURVES DURING POLICY TIGHTENING



One distinct yield curve pattern, which was identified earlier, is *pivoting*, where short-term rates and long-term rates pivot around unchanged medium-term rates. Pivoting is associated with a decline in long-term rates during policy tightening. The current tightening episode is a good example of pivoting (Chart 2).

The second pattern, *rotation*, appears more frequently in the historical data, especially pre-1980. Rotation describes a situation in which short-term rates rotate around a relatively fixed long-term rate so that the yield curve flattens and then inverts as policy is tightened. Rotation is associated with a relatively small increase in long-term rates during policy tightening. The 1972-73 tightening episode is a good illustration of rotation (Chart 3).

The third pattern, *shifting*, also appears frequently and is especially prominent in the first four post-1980 tightening episodes. Shifting describes a situation in which short-, medium-, and long-term rates move by roughly similar amounts so that the entire yield curve shifts upward in a parallel fashion when policy is tightened. Shifting is associated with relatively large increases in long-term rates during policy tightening. The 1983-84 episode provides a good example of shifting (Chart 4).

While some historical episodes are dominated by one of the three patterns, others are a mixture of two or more patterns. For example, the 1977-79 period shows pivoting at the beginning of tightening, then shifting, and then rotation. In contrast, the 1987-89 episode is initially characterized by shifting and then pivoting, while the 1994-95 and 1999-2000 periods are marked by shifting in the initial stages of policy tightening, followed by rotation and pivoting.

To the extent that yield curves are characterized by one or more of these three patterns, we may be able to understand both the conundrum and historical differences in yield curve behavior by isolating possible economic factors behind each pattern. The next section provides an analytical framework to explain how pivoting, rotation, and shifting can originate from differing views in financial markets about the economic outlook and monetary policy.



## II. A FRAMEWORK FOR ANALYSIS

The model most frequently used to evaluate the interplay between policy actions and long-term interest rates is the expectations theory of the term structure of interest rates. This section uses the framework of the expectations theory to identify the key economic factors that determine how the yield curve responds to monetary policy and then relates these economic factors to the three yield curve patterns that appear in historical tightening episodes.

### *Bond yields, forward rates, and expected policy*

According to the expectations theory, the interest rate on any security contains two elements: information about financial market expectations of monetary policy over the life of the security and a term premium to compensate for risk. What this theory implies about near-term versus distant expectations can be used to build a framework for understanding how the yield curve responds to monetary policy.

In the expectations theory, the average annual return to holding a long-term bond is equal to the average expected return from a sequence of investments in shorter-term bonds. For instance, the yield on a 10-year bond can be expressed as the average return from investing in a 5-year bond today and reinvesting in a new 5-year bond that would be purchased five years from now:

$$(1) \text{ 10-year yield} = (1/2) \text{ (5-year yield)} + \\ (1/2) \text{ (5-year forward rate 5 years from now)},$$

where the term forward rate denotes the annual return expected from committing today to a transaction that does not take place until some future date.<sup>4</sup> In this example, the 5-year forward rate five years from now is the current expectation of the yield on a 5-year security with a term commencing in five years time plus a term premium.<sup>5</sup>

The expectations hypothesis provides a simple way to link monetary policy actions to fluctuations of bond yields and forward rates. Since the 10-year rate is just an average of a shorter-term rate and a longer-horizon forward rate, the 10-year rate will change whenever these rates change. The most important factor influencing these two rates is likely to be investors' views about how monetary policy will

evolve over the next ten years (Kozicki and Tinsley 2001a). However, policy expectations are likely to have very different effects on these two components of the 10-year rate.

Generally speaking, short-term yields move with near-term expectations of policy, which often reflect cyclical considerations. In the early stages of business-cycle recoveries, policy tightening is typically needed to remove accommodation originally intended to help the economy escape from a recession. In the late stages of business-cycle expansions, policy tightening is generally instituted to suppress excess demand and inflationary pressures. Thus, short-term rates will be heavily influenced by investors' views about how monetary policy will be used to stabilize business cycle fluctuations.

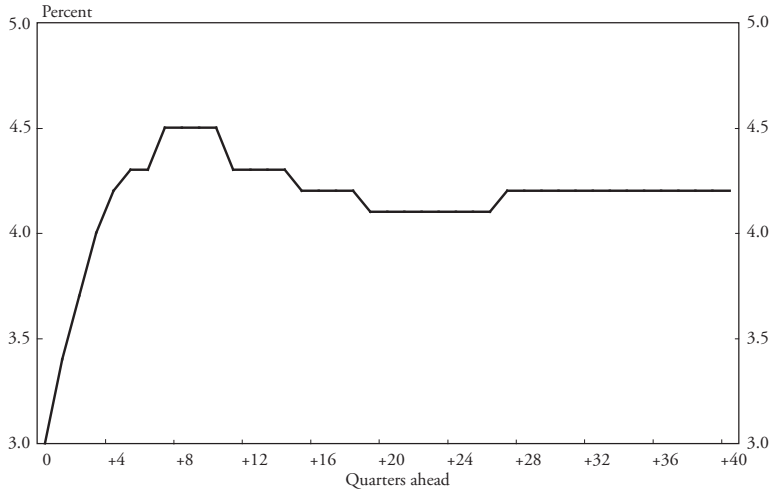
In contrast, changes in longer-term expectations of policy that influence distant forward rates are more likely to reflect investors' changing views of structural features of the economy, including long-run policy objectives.<sup>6</sup> This is because investors are likely to forecast that, with appropriate monetary policy, the effects of cyclical disturbances will be fully dissipated after several years, bringing economic activity back to potential and returning the federal funds rate to its long-run equilibrium or neutral level.

Support for this view can be found in investor surveys of expected policy at long horizons. Chart 5 shows the expected path of the federal funds rate target over the next ten years as reported in the Blue Chip Financial Forecasts in May 2005. At the time of the survey, the funds rate target was 3 percent. It was expected to rise to 4½ percent before falling back to a long-run or neutral level of about 4¼ percent in approximately three years.<sup>7</sup>

It is especially important to recognize that information on investors' perception of the inflation objective of the Federal Reserve is built into the long-run expected policy component of distant forward rates. This component reflects the financial market view of the neutral federal funds rate, which equals an estimate of the equilibrium real rate plus investors' long-run inflation expectations. Given the long horizon of the expectations, this inflation rate can be interpreted as the market's view of the Federal Reserve's inflation objective (Kozicki and Tinsley 2001a and 2001b).<sup>8</sup>

Chart 5

### EXPECTED FEDERAL FUNDS RATE MAY 2005



A second key factor influencing both near-term and longer-term rates is a term premium. A term premium represents the extra compensation for risk that an investor may require for extending the maturity of his investment. Even when investors expect no change in future policy, term premia may cause long-term rates to be higher than short-term rates, giving an upward slope to the yield curve. In addition, there is considerable evidence suggesting that term premia are time varying and so may contribute to changes in the yield curve over time (Dai and Singleton; Rudebusch and Wu).

Term premia can change for several reasons. For example, institutional features such as variation in the relative supply and demand for Treasury securities may be reflected in changes in term premia. In addition, the term premium component of the forward rate may be influenced by investors' inflation perceptions. For instance, this component includes compensation for inflation risk due, for example, to uncertainty about the numerical inflation objective of policy (Cogley). Even when investors have an unchanged estimate of the Federal

Reserve's long-run inflation objective, if the range of uncertainty around this estimate changes, there may be a change in term premia that causes the yield curve to change.

### *Understanding yield curve patterns*

The framework outlined above can generate the three patterns that characterize yield curve responses to policy tightening. In all three patterns—rotation, shifting, and pivoting—expectations of tighter policy shift the short end of the yield curve upward. The patterns primarily differ because longer-horizon forward rates may shift up or down depending on the direction of revisions to longer-term perspectives. These diverging movements reflect different adjustments to perceived policy objectives for inflation, financial markets estimates of the long-run equilibrium real interest rate, or term premia.

To see how these yield curve patterns can be obtained from the expectations theory, it is useful to look at some simple numerical examples. In Table 1, the federal funds rate initially is expected to rise from an average level of 2 percent in the first year to 4.5 percent in the third year. The panels illustrate different outcomes one year later: Panel A shows rotation; Panel B, parallel shift; and Panel C, pivoting. Charts 6, 7, and 8 illustrate how the yield curve changes in each of the three examples.

Yield curve *rotations* occur when shorter-maturity yields shift up by more than longer-term yields. One way this pattern can be generated is by changes in current rates and near-term forward rates that push up short-term yields but with little or no accompanying change in distant forward rates. In this situation, the long-term rate rises much less than the short-term rate because it is an average of the short-term rate and the unchanged forward rate. A second way rotation could occur is when a relatively large increase in short-term rates is offset by a decline in distant forward rates. Because the long-term rate is an average of short-term rates and distant forward rates, it shows little change.

The example summarized in Chart 6 and Panel A illustrates the first type of rotation. After one year, the federal funds rate has risen from an average level of 2 percent to an average level of 3.5 percent. However, estimates of the neutral federal funds rate are not revised and remain at 4.5 percent. Term premia are also assumed to remain con-

*Table 1*  
**EXAMPLES OF YIELD CURVE PATTERNS WITH  
 POLICY TIGHTENING**

	Year					
	1	2	3	4	5	6-10
<b>Initial</b>						
Average exp policy	2.0	3.5	4.5	4.5	4.5	4.5
Term premium	.0	.1	.2	.5	.7	1.1
Forward rate	2.0	3.6	4.7	5.0	5.2	5.6
Yield	2.0	2.8	3.4	3.8	4.1	4.9
<b>One year later</b>						
<i>Panel a: Rotation</i>						
Average exp policy	3.5	4.5	4.5	4.5	4.5	4.5
Term premium	.0	.1	.2	.5	.7	1.1
Forward rate	3.5	4.6	4.7	5.0	5.2	5.6
Yield	3.5	4.1	4.3	4.5	4.6	5.1
<i>Panel b: Shift</i>						
Average exp policy	3.0	4.5	5.0	5.0	5.0	5.0
Term premium	.0	.1	.2	.5	.7	1.1
Forward rate	3.0	4.6	5.2	6.0	6.2	6.6
Yield	3.0	3.8	4.3	4.7	5.0	5.8
<i>Panel c: Pivot</i>						
Average exp policy	3.5	4.0	4.0	4.0	4.0	4.0
Term premium	.0	.1	.1	.2	.3	.3
Forward rate	3.5	4.1	4.1	4.2	4.3	4.3
Yield	3.5	3.8	3.9	4.0	4.0	4.2

Note: Entries are rounded.

Entries apply to the period in the column label. Thus, for example, forward rates are one-year forward rates in columns labeled 1, ... 5, and 5-year forward rates in the column labeled 6-10. In the year 1 column, the forward rate entry is equal to the one-year yield. In the year 2 column, the forward rate is the one-year forward rate one year from now. Yields are 1-, ... 5-year yields in columns labeled 1, ... 5 and 10-year yields in the column labeled 6-10.

stant. As a result, the 5-year forward rate is unchanged at 5.6 percent.<sup>9</sup> Such stability at the long end may reflect unchanged market expectations of the long-run equilibrium real rate in combination with well-anchored inflation expectations. The latter outcome might be expected to occur when near-term changes in monetary policy are viewed as consistent with views of the inflation goal of monetary policy embedded in distant forward rates. In other words, throughout the policy tightening, financial markets do not revise their opinions about what inflation will be in the long run. Alternatively, an unchanged forward rate could also result from equal but opposite movements in policy expectations and the term premium.

Chart 6  
A ROTATING YIELD CURVE

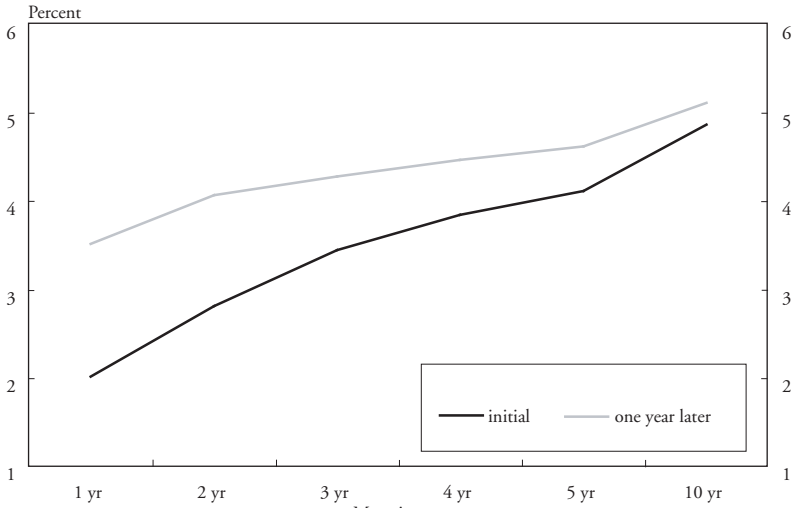
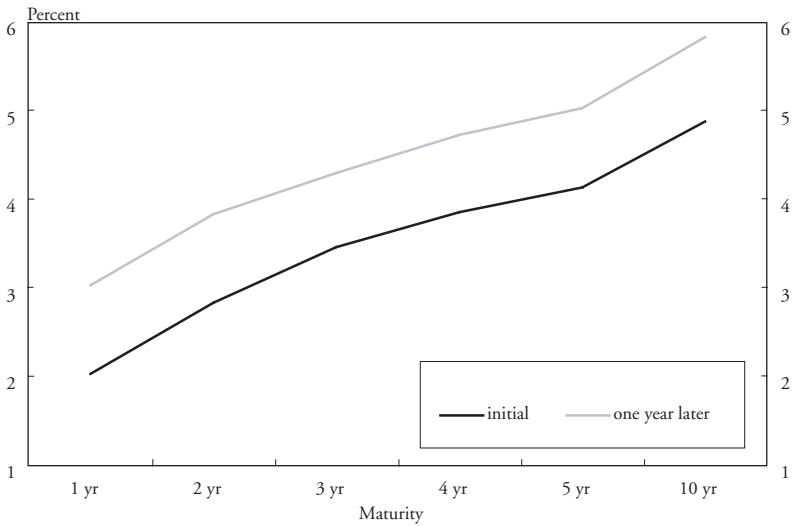


Chart 7  
A SHIFTING YIELD CURVE

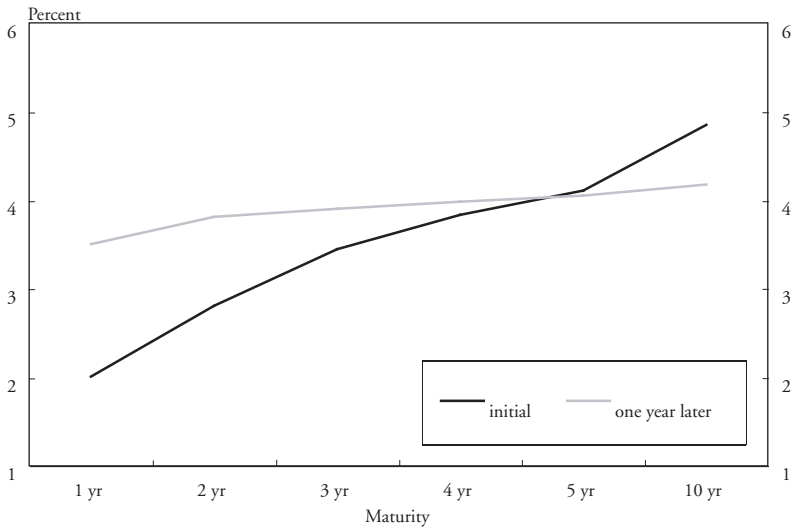


*Parallel shifts* in the yield curve occur when yields of all maturities increase by roughly the same amount (Chart 7 and Panel B). Thus, for instance, changes in the 5-year forward rate are about the same as changes in short-term bond yields. Parallel shifts can occur when the neutral rate increases at the same time that policy is tightened.<sup>10</sup> Neutral rate shifts may be largely unrelated to policy tightening, as when market expectations of the long-run equilibrium real rate are revised up, perhaps because of a perceived increase in trend productivity growth. Of course, even as policy is tightened, upward adjustments in market perceptions of inflation may occur when anticipated policy actions are not viewed as sufficient to keep inflation under control. Episodes with parallel upward shifts in yield curves that are driven by rising inflation fears have sometimes been referred to as inflation scares (Goodfriend). In Chart 7 and Panel B, the 5-year forward rate increases from 5.6 to 6.6 percent with a one-percentage-point increase in the neutral rate.

*Pivoting* in the yield curve occurs when near-term and longer-term expectations are revised in opposite directions—as happens when tighter policy is accompanied by a decreasing distant forward rate (Chart 8 and Panel C). Two scenarios are most likely to lead to this unusual outcome. One possibility is that tighter policy leads to lower distant forward rates. This may occur if tighter monetary policy leads to a revision in perceptions of the inflation objective of policy. Tighter than expected monetary policy could lead financial market participants to lower their estimate of the implicit inflation target of monetary policy, which, in turn, would lead to a lower neutral federal funds rate (Kozicki and Tinsley 2005). Alternatively, the tighter policy might lead to a perceived increase in the resolve of the central bank to achieve its inflation objective, to decreased uncertainty about long-run inflation, and consequently to a decline in an inflation risk component of the term premium.

A second possibility is that distant forward rates may decline for reasons unrelated to the policy tightening. As noted earlier, a perceived decrease in trend productivity growth could lead to lower market expectations of the long-run equilibrium real rate and a lower neutral federal funds rate. In addition, the term premium could decrease with an increase in the relative demand for long-term bonds through events that are largely unconnected with policy tightening. In the example shown

*Chart 8*  
**A PIVOTING YIELD CURVE**



in Panel C, the yield curve pivots because, although policy tightening leads to a rise in short-term rates, the 5-year forward rate declines with a smaller term premium and a lower neutral rate.

### III. EXPLAINING THE YIELD CURVE RESPONSE TO POLICY TIGHTENING

The preceding section showed how changes in long-horizon forward rates can generate historical patterns in the yield curve and identified some of the economic factors that might lie behind these patterns. This section attempts to quantify the relative influence of these economic factors in the two most recent episodes of Federal Reserve policy tightening.

#### *Relating economic factors to forward rates*

To apply the analytical framework developed in the previous section, it is necessary to formalize some of the relationships discussed there and then identify the data that will be used in the analysis. The



key relationship connects forward rates to market estimates of the neutral federal funds rate. By combining the expectations theory of the term structure with the insight that long-horizon forward rates should be free of short-term cyclical and policy influences, a distant forward rate can be expressed as the sum of the neutral federal funds rate and a term premium:

$$(2) \quad \textit{Forward Rate} = \textit{Neutral Rate} + \textit{Term Premium}.$$

The neutral rate can, in turn, be broken into real rate and expected inflation components:

$$(3) \quad \textit{Neutral Rate} = \textit{Long-Run Equilibrium Real Rate} + \textit{Long-run Expected Inflation}.$$

And, the term premium can be split into an inflation risk premium and other risk premium components:

$$(4) \quad \textit{Term Premium} = \textit{Long-Run Inflation Risk Premium} + \textit{Other Risk Premium}.$$

Combining these relationships, the forward rate can be expressed as the sum of the real rate, expected inflation, and the two risk premia:

$$(5) \quad \textit{Forward Rate} = \textit{Real Rate} + \textit{Expected Inflation} + \textit{Inflation Risk Premium} + \textit{Other Risk Premium}.$$

In this framework, changes in the forward rate can originate from changes in each of the four explanatory factors.

To use this framework for empirical analysis, interest rate data and financial market survey data are combined to calculate the contribution of each factor to changes in the forward rate. The forward rate used in the empirical analysis is the 5-year forward rate discussed in Section I. This rate is calculated from the zero coupon Treasury yield curve using Equation 1. For this article, survey data from the *Blue Chip Financial Forecasts* are used to measure the neutral federal funds rate and long-run expected inflation. The neutral rate is the survey measure of the expected federal funds rate at a horizon of six to ten years in the future. Similarly, the long-run expected inflation rate is the Blue Chip survey measure of the expected CPI inflation rate at a horizon of six to ten years ahead.<sup>11</sup>

To separate the term premium into its two components, information from the Treasury Inflation Protection Securities (TIPS) market is used to compute a measure of long-run inflation compensation at a horizon of six to ten years ahead.<sup>12</sup> This measure is calculated as the dif-

ference between the 5-year forward rate derived from the zero coupon Treasury yield curve and the 5-year forward rate derived from the TIPS yield curve. Inflation compensation contains long-run expected inflation and an inflation risk premium:

$$(6) \quad \textit{Long-Run Inflation Compensation} = \textit{Expected Inflation} + \textit{Inflation Risk Premium}.$$

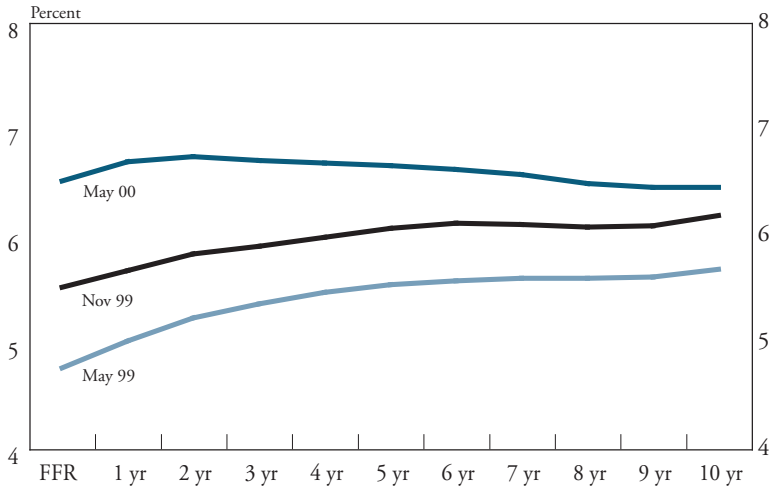
By subtracting the survey measure of long-run expected inflation from this estimate of inflation compensation, an estimate of the inflation risk premium can be obtained. The other risk premium can then be calculated as a residual using Equation 5. Because the Blue Chip survey data and the TIPS data are only available from 1997, the empirical analysis is restricted to the two most recent episodes of Federal Reserve tightening: 1999-2000 and 2004-05.

### *The 1999-2000 tightening episode*

After easing policy in the fall of 1998, in the midst of the financial market turmoil associated with the Russian debt default, the Federal Reserve began to remove the policy accommodation in June 1999. From June 1999 to May 2000, the federal funds rate target was raised from 4.75 percent to 6.5 percent. To analyze the response of the yield curve to policy tightening, it is useful to divide the entire period into two parts: from May 1999, the month prior to the beginning of tightening, to November 1999; and from November 1999 to May 2000.<sup>13</sup>

The behavior of the yield curve is very different during the two subperiods (Chart 9). During the first subperiod, the yield curve exhibits a nearly parallel upward shift. In contrast, the second subperiod is characterized by rotation. The behavior of the term structure in the two periods is shown in Table 2a. During the first subperiod, the 0.75-percentage-point increase in the funds rate target is associated with large increases in the 5-year rate and the 5-year forward rate, contributing equally to the rise in the 10-year rate. In contrast, during the second subperiod, the 1 percent increase in the funds target is associated with a sizable increase in the 5-year rate and an unchanged forward rate, resulting in a much smaller increase in the 10-year rate.

Chart 9  
YIELD CURVE IN 1999-2000



A variety of economic factors appear to be behind the yield curve behavior in the two periods. Using the framework set out above, Table 2b attempts to identify the key factors in each subperiod. From May 1999 to November 1999, there was a large increase in the estimate of the neutral funds rate, driven primarily by an increase in the market's perception of the equilibrium real rate. Inflation compensation (the sum of expected inflation and the inflation risk premium) also increased considerably.<sup>14</sup> Overall, the large increase in the 5-year forward rate during this subperiod appears to reflect both a large increase in the equilibrium real rate and a minor inflation scare.

The factors behind the rotation shown in the second subperiod are very different. During this time, there was little change in inflation compensation. There was, however, an increase in the perceived equilibrium real rate that was twice the size of the increase in the first subperiod. The forward rate was essentially unchanged, though, because of a very large offsetting reduction in the other risk component of the term premium.

While these empirical estimates are likely to be imprecise, they appear generally consistent with descriptions of the economy during this time. The very large increase in the market's estimate of the equilib-

*Table 2a*  
YIELD CURVE BEHAVIOR 1999-2000

Period	BEHAVIOR OF YIELD CURVE				EXPLANATORY VARIABLES		
	Target	5yr	10yr	For5yr	Expected Inflation	Inflation Compensation	Neutral Rate
Change May 99 to Nov 99	+ .75	+ .53	+ .50	+ .47	+ .10	+ .24	+ .40
Change Nov 99 to May 00	+ 1.0	+ .59	+ .27	- .05	+ .10	- .05	+ .80

*Table 2b*  
CONTRIBUTION TO CHANGES IN FORWARD RATES

				May 1999 – Nov 1999	Nov 1999 – May 2000
Neutral Rate	}		Real rate	+ .30	+ .70
			Expected Inflation	+ .10	+ .10
Term Premia	}	Inflation Compensation	Inflation Risk	+ .14	- .15
			Other Risk	- .07	- .70
			5-year forward rate	+ .47	- .05

Source: Blue Chip Financial Forecasts; Federal Reserve Board; Authors' calculations

Note: Entries are changes over the indicated period, expressed in percentage points.

The real-rate change is calculated as the difference between the change in the neutral rate and the change in expected inflation. The change in inflation risk is calculated as the difference between the change in inflation compensation and the change in expected inflation. The change in other risk is calculated as the difference between the change in the 5-year ahead 5-year forward rate and the sum of the changes in the neutral rate and inflation risk.

rium real rate may reflect a response to discussions by Federal Reserve policymakers suggesting that the surge in productivity growth indicated the need to raise estimates of the neutral rate (Meyer). Similarly, the large change in the other risk premium is consistent with an increased demand for long-term government securities in an environment in which the Treasury was beginning a buyback program due to a rising fiscal surplus.<sup>15</sup>

Taken as a whole, the sizable increase in long-term rates during 1999-2000 appears to have been driven primarily by a higher estimate of the equilibrium real rate, which substantially raised financial market estimates of the neutral rate. This increase probably would have been even larger in the absence of special factors in the Treasury market that led to an increased demand for long-term Treasury securities. Notably, much of the rise in inflation risk during the first subperiod was unwound in the second subperiod, so that inflation concerns played only a small role in the overall behavior of long-term rates during this period.

### *The 2004-05 tightening episode*

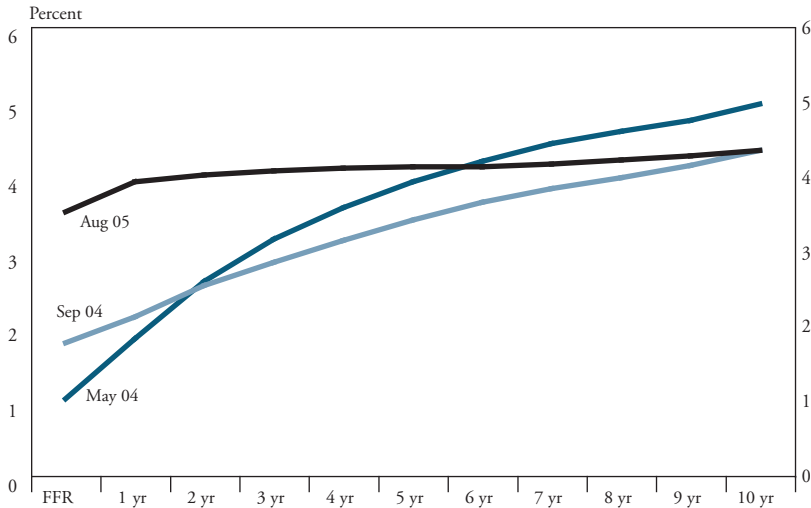
The most recent tightening episode shows a very different response of financial markets to monetary policy. After an extended period of accommodative monetary policy that began in January 2001, the Federal Reserve began to raise the federal funds rate target in June 2004. From June 2004 to August 2005, the FOMC raised the target from 1 percent to 3.5 percent. Unlike the 1999-2000 period, however, long-term rates fell instead of rising as the funds rate target increased.

As in the previous episode, it is useful to divide the whole period into two subperiods: from May 2004, the month before tightening began, to September 2004; and from September 2004 to August 2005. The reason for this decomposition is that, while long-term rates in August 2005 remained below their levels in May 2004, most of the decline in long-term rates occurred in the first subperiod. In fact, long-term rates, while volatile, showed little net change during the second subperiod.

The yield curve exhibits two distinct patterns in the two subperiods (Chart 10). During the first subperiod, the yield curve shows pivoting. Even as the federal funds rate target was increased, rates beyond one to two years declined. In the second subperiod, the yield curve shows rotation. While short-term and medium-term rates rose considerably, longer-term rates showed little change.

The behavior of key interest rates is highlighted in Table 3a. During the first subperiod, a 0.75-percentage-point increase in the funds rate target was associated with large decreases in the 5-year rate, the 5-year forward rate, and the 10-year rate. In contrast, during the

*Chart 10*  
YIELD CURVE IN 2004-2005



second subperiod, the 1.75-percentage-point increase in the funds target was associated with a relatively large increase in the 5-year rate and an offsetting decline in the 5-year forward rate, leaving the 10-year rate unchanged.

The economic factors behind these yield curve patterns are summarized in Table 3b.<sup>16</sup> During both subperiods, in sharp contrast to the 1999-2000 episode, financial market perceptions of the neutral federal funds rate were unchanged. The estimated neutral rate remained near 4.25 percent throughout. Moreover, neither the underlying equilibrium real rate nor long-term inflation expectations appear to have changed. Thus, the main factors responsible for yield curve shifting in 1999-2000 were absent in this period. Indeed, the large decline in the 5-year forward rate in each subperiod was driven entirely by changes in the term premium. As indicated in Table 2b, about half of the decline in the total term premium in each subperiod was due to lower estimates of inflation risk and about half was due to a reduction in the other risk component.<sup>17</sup>

Table 3a

## YIELD CURVE BEHAVIOR 2004-2005

BEHAVIOR OF YIELD CURVE					EXPLANATORY VARIABLES		
Period	Target	5yr	10yr	For5yr	Expected Inflation	Inflation	Neutral Rate
Change May 04 to Sept 04	+0.75	-0.52	-0.62	-0.73	0.0	-0.35	0.0
Change Sept 04 to Aug 05	+1.75	+0.72	0.0	-0.72	+0.10	-0.30	0.0

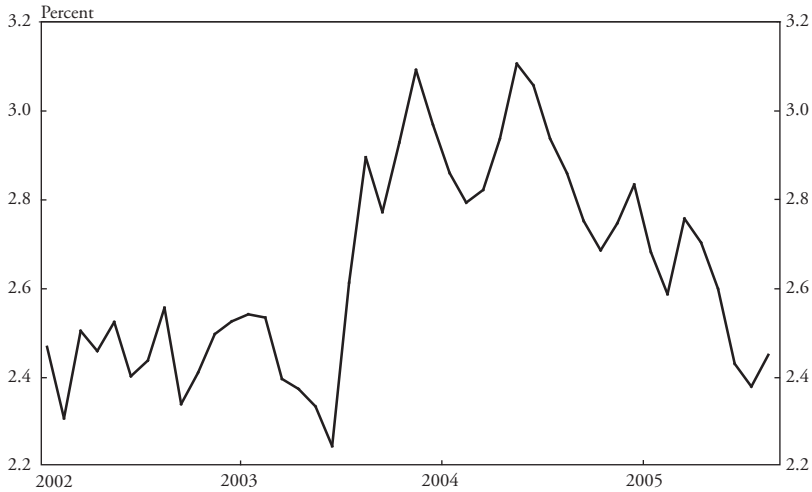
Table 3b

## CONTRIBUTION TO CHANGES IN FORWARD RATES

		May 2004 – Sept 2004	Sept 2004 – May 2005		
Neutral Rate	{	Real rate	0	-0.10	
		Expected Inflation	0	+0.10	
Term Premia	{	Inflation Compensation {	Inflation Risk	-0.35	-0.40
			Other Risk	-0.38	-0.32
			5-year forward rate	-0.73	-0.72

Taking a closer look at the behavior of the two risk components of the term premium, the sizable drop in the inflation risk component appears to largely reflect an unwinding of a buildup of inflation concerns that occurred prior to the beginning of policy tightening (Chart 11). The large decline in the other risk component remains puzzling. Unlike the 1999-2000 episode where the fall in the term premium can plausibly be linked to the perceived effects of debt buybacks on the Treasury market, in this episode there is not an obvious explanation for why there should be an increased demand for long-term securities by investors.<sup>18</sup> Thus, in this respect, the interest rate conundrum remains partly unresolved.<sup>19</sup>

*Chart 11*  
**FORWARD INFLATION COMPENSATION**



Although an unexplained drop in the term premium appears to lie behind the recent interest rate conundrum, it should be stressed that the behavior of the term premium does not account for why this episode differs so greatly from the 1999-2000 tightening episode. As shown in the preceding subsection, a declining term premium also played an important part in the 1999-2000 period. In fact, the key difference is that the neutral rate was unchanged as the funds rate target was increased in the current episode. By contrast, a large increase in the market's estimate of the neutral rate appears to be the principal factor responsible for the rise in long-term rates in 1999-2000.

#### **IV. SUMMARY AND CONCLUSIONS**

This article was motivated by the recent decline in long-term rates in the midst of Federal Reserve tightening, the so-called interest rate conundrum. While the recent behavior of long-term rates is certainly unusual compared to historical experience, it is much less clear what



constitutes normal behavior. Indeed, what is particularly striking about the connection between long-term rates and monetary policy is how variable this relationship has been over time.

Despite the complexity of this relationship, however, common patterns emerge from the historical data. This article provides a simple analytical framework that helps understand these patterns and the economic forces behind them. In this framework, the behavior of long-horizon forward rates is crucial to understanding the relationship between long-term rates and monetary policy.

This framework is used to analyze the factors behind the interest rate conundrum and to compare the recent experience with the 1999-2000 period of monetary policy tightening. The analysis suggests that the key factor behind the conundrum is a large reduction in the term premium. Approximately half of the decline in the premium can be attributed to an unwinding of an inflation risk premium; the other half remains unexplained. In comparing the conundrum period to the 1999-2000 period, however, the key difference is not the behavior of the term premium but, rather, the behavior of financial market estimates of the neutral federal funds rate. In 1999-2000, a very large increase in the neutral rate offset a decline in the term premium causing long-term rates to rise as policy tightened. In contrast, in the more recent period, market estimates of the neutral rate did not change and so did not provide an offset to the declining term premium.

The analysis in the article also has broader implications for thinking about the relationship between the yield curve and monetary policy. Many discussions of the behavior of long-term rates focus almost exclusively on the importance of inflationary expectations in the determination of long-term rates. This article suggests that other factors are important as well and, moreover, that the relative importance of inflation expectations and other economic and financial factors has changed over time. The analysis also suggests caution in interpreting yield curve changes as a harbinger of future economic activity. Recently, some have suggested that the combination of rising short-term rates and falling long-term rates may be a signal of near-term economic weakness. As shown in this article, however, the recent behavior of long-

term rates has been driven primarily by lower long-horizon forward rates, which are unlikely to reflect short-term business cycle considerations.

Finally, the analysis provides some insight for how the yield curve might behave going forward. The U.S. economy has achieved a remarkable degree of price stability in recent years. To the extent that financial markets believe that the Federal Reserve will act to maintain this environment, inflation concerns are likely to be less important than they have been historically. In this event, long-term rates are likely to be less volatile in future periods of monetary policy tightening. At the same time, however, the importance of term premia in recent yield curve behavior suggests there is still much to be learned about the relationship between long-term interest rates and monetary policy.

## ENDNOTES

<sup>1</sup>The response is measured from the month prior to the first policy action to the month in which the federal funds rate target was 100 basis points higher than its initial level. All rates are from the zero-coupon Treasury yield curve.

<sup>2</sup>Looking at the left side of the chart, the lowest line shows the yield curve in the month before policy tightening began when the federal funds rate target was 1 percent. The higher lines show how the yield curve evolved as the federal funds rate target was increased.

<sup>3</sup>Each chart shows the evolution of the Treasury yield curve from the month before policy tightening began to the month of the last increase in the federal funds rate. To make the charts easier to read, only selected dates are included, generally corresponding to major changes in the level of the federal funds rate. Because the federal funds market was not fully developed until the late 1960s, the 3-month Treasury bill rate is used instead of the federal funds rate as the index for policy changes for the two tightening episodes in the 1960s.

<sup>4</sup>While bond yields are reported directly in the financial press, forward rates are not. However, the same theory that relates bond rates to forward rates can be used to solve for forward rates from bond rates. Translating bond yield data into implied forward rates assists in determining the relative role of shifts in near-term versus distant expectations in explaining movements in yields.

<sup>5</sup>For simplicity, the 5-year forward rate 5 years from now will be referred to as the 5-year forward rate in the remainder of this article.

<sup>6</sup>Gürkaynak, Sack and Swanson provide evidence that private agents' views of long-run inflation are not strongly anchored.

<sup>7</sup>The information in this chart is from the June 2005 issue of the Blue Chip Financial Forecast, which reports results from a survey taken in late May 2005. The chart combines short-run forecasts out to the next five quarters, which are available monthly, with longer-horizon forecasts which are only taken in May and November. The longer horizon forecasts are only available from 1997.

<sup>8</sup>To be sure, the average inflation rate expected 5 to 10 years in the future might only be interpretable as an intermediate-run objective. Historically, if policymakers were following an opportunistic approach to disinflation, then market participants might admit to the potential for future declines in inflation at some unspecified horizon—but, after the next recession (Orphanides and Wilcox).

<sup>9</sup>The 5-year forward rate five years from now is equal to the sum of the federal funds rate expected to obtain over the 5 years starting 5 years from now and the average term premium over those latter 5 years. As shown in the chart, the average federal funds rate and term premium are expected to be 4.5 percent and 1.1 percent, respectively.

<sup>10</sup>Changes in term premia are unlikely to lead to a parallel upward shift in the yield curve. The similarly-sized changes in term premia at many horizons that would be necessary for a parallel upward shift would be implausible because term premia are generally smaller for shorter horizons.

<sup>11</sup>Both surveys are only made twice a year, generally in May and November and are reported in the June and December *Blue Chip Financial Forecasts*.

<sup>12</sup>To the extent that the TIPS market is not as liquid as the market for nominal Treasury securities, the estimate of inflation compensation may be distorted by a liquidity risk premium. For a further discussion see: Shen and Corning and Carlstrom and Fuerst.

<sup>13</sup>The justification for this split is two-fold. By November 1999, the Federal Reserve had increased the funds rate target by .75 percentage point, completely unwinding the additional accommodation provided during 1998. The later increase in the target represented additional tightening. In addition, the year-end 1999 period was accompanied by unique actions by the Federal Reserve in managing liquidity during the century date change. An alternative approach would be to omit the period from November 1999 to January 2000 and begin with the next policy action in February 2000. In this event, the February 2000 to May 2000 period would exhibit pivoting partly resulting from the unwinding of a large increase in long-term rates and long-horizon forward rates that occurred in January 2000.

<sup>14</sup>The level of inflation compensation and the calculation of the inflation risk premium are likely distorted by a liquidity risk premium in TIPS yields. The effect of this distortion is likely to be smaller by looking at first differences.

<sup>15</sup>The announcement of the debt buyback program was made on January 13, 2000.

<sup>16</sup>Because the Blue Chip survey data are only available for May and November, the November 2004 survey is used to calculate the September 2004 decomposition and the May 2005 survey is used to calculate the August 2005 decomposition.

<sup>17</sup>Other researchers have noted this behavior of term premia ( Macroeconomic Advisors, Kim and Wright). Estimates of the breakdown of the total term premium into its components may differ somewhat among studies because of different sample periods and methods of estimation.

<sup>18</sup>There is some empirical evidence connecting foreign investment flows into the U.S. with the decline in long-term rates although the reason for these flows remains unclear (Warnock and Warnock). Others have suggested that foreign official purchases related to exchange rate objectives or increased demand by pensions funds may also have contributed to the decline in the other risk premium.

<sup>19</sup>It is interesting to note that the yield curve exhibited very different behavior in the two subperiods even though the 5-year forward rate declined by a similar amount. The difference reflects the behavior of short and medium-term rates. In the first subperiod, the 5-year rate declined substantially while, in the second subperiod it rose. The decline in the 5-year rate appears to reflect a lower term premium as policy expectations did not change much during this period. The rise in the 5-year rate in the second subperiod appears to reflect the actual tightening that occurred plus higher inflation compensation.

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