THE EQUILIBRIUM FED FUNDS RATE AND THE INDICATOR PROPERTIES OF TERM-STRUCTURE SPREADS

ANTULIO N. BOMFIM*

This paper introduces a model-based measure of the equilibrium federal funds rate and examines the indicator properties of the spread between observed and equilibrium rates. The results are compared to those of existing studies, which implicitly use long-term interest rates to proxy the equilibrium funds rate. Granger-causality tests suggest that different measures of the term-structure spread are dominated by the funds-rate spread as a forecaster of a wide range of macroeconomic variables. These results are supported by variance-decomposition analysis. The paper also estimates simple VARs to discuss how the policy stance responds to macroeconomic shocks. (*JEL* E43, E52, E17)

I. INTRODUCTION

Interest rate spreads figure prominently in the economics literature as monetary policy indicators. For instance, while some writers have focused on the predictive power of the spread between the six-month commercial paper rate and the six-month Treasury bill rate, others have emphasized spreads between short- and long-term interest rates.[1] This paper follows the latter tradition. My analysis is motivated by the work of Bernanke and Blinder [1992] who compare the difference between the federal funds rate and the ten-year government bond rate with other interest rate spreads and find it to be a particularly useful predictor of future economic activity.

The rationale for using term-structure spreads as monetary policy indicators is relatively straightforward.[2] When assessing the stance of monetary policy, it is not just the level of the federal funds rate that matters, but how it relates to some implicit notion of equilibrium interest rates. This insight is not new and can be found in the seminal work of Wicksell [1898, xxv] who wrote that "It is not a high or low rate of interest in the absolute sense which must be regarded as influencing demand...the causative factor is the current rate on loans as compared with what I shall be calling the *natural rate of interest*." The direct empirical implementation of the Wicksellian insight is, however, obviously hampered by the fact that the natural rate of interest is not an observable variable. As suggested by Laurent [1988] and Bernanke and Blinder [1992], the slope of the term-structure is often used as a proxy for the spread between a short-term interest rate and its (unobservable) equilibrium level. Thus, the yield curve steepens as short-term interest rates are perceived to be below their equilibrium levels.

I follow a more direct approach to measuring the stance of monetary policy. Instead of using the slope of the term structure as a proxy for the gap between observed and equilibrium federal funds rates, I introduce a model-based method to constructing a measure of the *level* of the equilibrium funds rate. As described below, this equilibrium rate is calculated for the real sectors of the economy, conditional on the observed rate of inflation. Thus, the equilibrium rate is constructed to be indepen-

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Bomfim: Economist, Division of Research and Statistics, Federal Reserve Board, Washington, D.C.
Phone 1-202-736-5619, Fax 1-202-452-5296
E-mail abomfim@frb.gov

1. Papers emphasizing the commercial paper/T-bill tradition include Stock and Watson [1989] and Friedman and Kuttner [1992; 1993; 1994]. Laurent [1988; 1990] and Bernanke and Blinder [1992] follow the term-structure approach. Bernanke [1990] discusses both approaches.

2. Laurent [1990] has an intuitive exposition.

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dent of the inflation objectives of monetary policy, and the implied difference between actual and equilibrium rates—the funds-rate spread—constitutes my monetary policy indicator. This paper provides an overview of the proposed methodology and compares the funds-rate spread with traditional indicators of the monetary policy stance.

II. A MODEL-BASED MEASURE OF THE SPREAD

I rely on the estimated structure of a macroeconometric model to measure the equilibrium federal funds rate. The theoretical framework is the MIT-Penn-SSRC (MPS) model, which is housed at the Federal Reserve Board. This is a large-scale quarterly model of the U.S. economy; it consists of more than 100 behavioral equations, about 200 identities, and over 100 exogenous variables. In its theoretical foundations, the long-run properties of the model are akin to a neoclassical growth model, whereas the dynamic structure is essentially Keynesian.[3]

The approach used in this paper is a departure from the traditional literature in at least two dimensions. First, I use an explicit, theoretic framework to compute the equilibrium measure, as opposed to the empirically based approach of using long-term interest rates. Second, by focusing on the equilibrium level of the federal funds rate, I have a more direct way to gauge the stance of monetary policy.

The equilibria analyzed here correspond to intermediate-run dynamics, a time frame that seems most relevant for the conduct of monetary policy. Conceptually, the equilibrium notion I explore is a simple one. For a given position of the MPS model's IS block, the equilibrium federal funds rate is defined as the one consistent with unemployment at its natural rate after all lags in the model have fully worked through.[4] To "filter out" low-frequency fluctuations and more directly focus on medium-term relationships, however, I calculate the equilibrium funds rate as a "flow equilibrium" in which the model's "stock" variables are held constant. Stock variables include the capital stocks, wealth, and government debt. Note, however, that the simulations allow for stock-market wealth revaluation as the interest rates change.[5]

The model's IS and interest rate blocks form a complicated set of dynamic equations in which a change in the funds rate affects the level of output through a variety of mechanisms—long-term interest rates, the valuation of assets, and the exchange rate—over a moderately long time horizon (even with stock variables held fixed). The flow equilibrium that obtains when the time horizon is sufficiently long can be thought of as collapsing the dynamics of the IS and interest rate blocks into a contemporaneous relationship between the rate of interest and the level of output (or unemployment). This relationship is shifted from one quarter to the next by the particular values observed for exogenous variables (such as fiscal policy and foreign output) and equation errors. The equilibrium value of the funds rate is determined by the point on the collapsed IS curve consistent with the natural rate of unemployment.

The notion of equilibrium adopted here can be thought of as a compromise between short- and long-run equilibrium concepts. To understand the relationship among the three equilibrium notions, consider the following. In the current analysis, for each historical quarter, the model's IS and interest rate equations are simulated with an iterative algorithm until convergence is achieved. The algorithm holds the model's exogenous variables, selected equation errors, and stock variables constant at their historical values. The simulation setup needed to compute the Wicksellian rates would require that stock variables be endogenized and thus the algorithm would take a much larger number of iterations to converge. The third equilibrium concept—involving the short-run—is just the model solution for interest rates at each point in time.

3. Brayton and Mauskopf [1985] provide a detailed description of the MPS model. Brayton and Tinsley [1993] discuss key properties of the model under alternative monetary policy rules.

4. Over the sample, which extends from 1968 to 1994, the natural unemployment rate is taken to be 6%. This seems to be a reasonable assumption except perhaps for the first years of the sample. A lower value of the natural rate in those years would tend to reduce the calculated equilibrium rate of interest a bit.

5. The data and Speakeasy programs needed to generate the equilibrium funds rate series are available upon request. The programs take about two hours to run on a Solaris-based Sun SPARCstation 10. To request a copy of the data and programs write to: Antulio Bomfim, Division of Research and Statistics, Federal Reserve Board, Washington, D.C. 20551. The programs were written for the UNIX Speakeasy IV Eta software. The Speakeasy software itself is *not* included in the diskettes.

Computational Approach

Perhaps a simple abstract example will best illustrate the computational strategy used to obtain the equilibrium funds rate measure. We can think of it as a backward recursive algorithm that follows the spirit of contraction mapping methods. In essence, what the algorithm does is to collapse the model dynamics into a system of *static* equations in the "equilibrium" value of the endogenous variables. For each quarter, this system is solved repeatedly until a fixed point is found.[6]

Let the function $f(\cdot)$ denote the structure of the IS block of the MPS model

$$(1) \qquad f[(y_{t-s},\ x_{t-s},\ \varepsilon_{t-s})\ _{s=0}^{m}] = 0,$$

with reduced form

$$(2) \qquad y_t = g[(y_{t-s-1},\ x_{t-s},\ \varepsilon_{t-s})_{s=0}^{m}],$$

where y_t and x_t are vectors of endogenous and exogenous variables, respectively, and ε_t is the vector of equation errors.[7] The vector y_t includes variables such as the unemployment rate, GDP, consumption, and investment; x_t includes fiscal policy parameters, foreign GDP, and the exchange rate. Inflation expectations, which are proxied by functions of lagged inflation, are also treated as exogenous. One would also typically include the federal funds rate, r_t, in the vector of exogenous variables, under the view that the IS block determines the level of output for a given rate of interest. However, in this analysis I am interested in finding that particular value of the funds rate that is consistent with output at its full-employment level. Therefore, I augment the IS block with an interest rate reaction function that achieves the desired result. Thus, the federal funds rate (r_t) is included in the set of endogenous variables, along with other interest rates and financial variables that appear in the transmission mechanism of federal funds rate movements to various components of final demand.

The computation procedure proceeds as follows. As a first step, we drop all time subscripts in (1) and replace all lagged endogenous variables with the current model solution, which we denote as $y^{(0)}$. In addition, we set all lagged exogenous values, x, and selected equation errors, ε, to their current values.[8] What we have now is a system of static equations in y:

$$(3) \qquad f(y,\ y^{(0)},\ x,\ \varepsilon) = 0.$$

Let $y^{(1)}$ be the value of y that solves the above system. Substitute it into $y^{(0)}$ and again solve the system for y:

$$(4) \qquad f(y,\ y^{(1)},\ x,\ \varepsilon) = 0.$$

This back-substitution of the previous solution continues until $y^{(i)} = y^{(i-1)}$ for $i \geq 1$. Therefore, in the end, we have

$$(5) \qquad f(y^*,\ y^*,\ x,\ \varepsilon) = 0$$

where *starred* symbols indicate "medium-term" equilibrium values. Therefore, r^* denotes the equilibrium federal funds rate measure.

Computed Equilibrium Federal Funds Rates

Based on the algorithm described above, the model was simulated and historical estimates of the equilibrium federal funds rate series were computed for the period 1968:Q1 to 1994:Q1. The resulting series is plotted in the first panel of Figure 1. Over the sample period, the equilibrium funds rate averaged 8.4%. For the early 1990s, however, the equilibrium rate has been trending down, reflecting a combination of tighter fiscal policy, lower inflation, and weak to moderate economic conditions abroad. As the figure shows, the equilibrium funds rate displays considerable fluctuations over time. In addition, the plot suggests that during recessions the equilibrium funds rate appears to rebound just before each trough.[9]

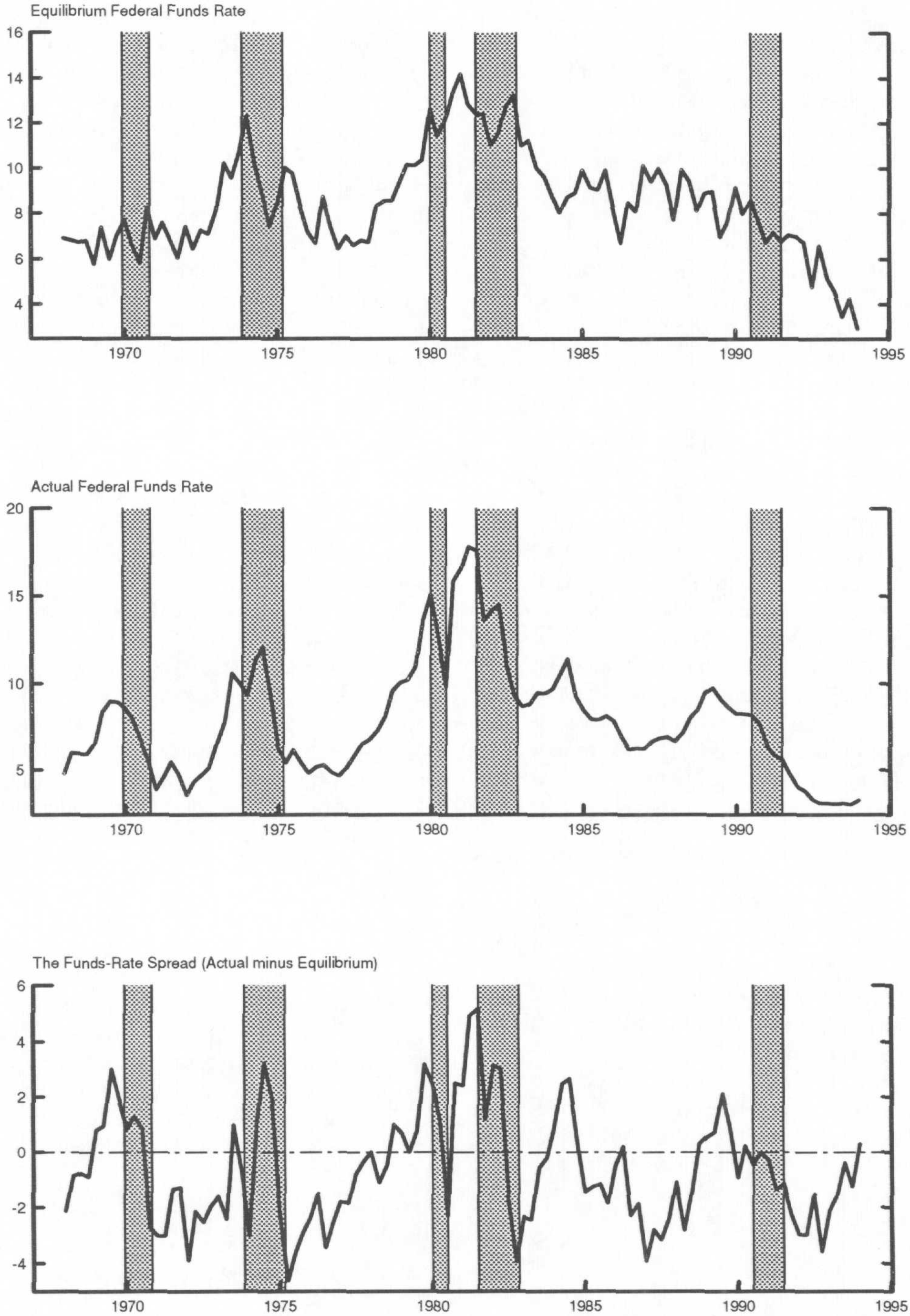
6. The thrust of this approach can be traced back to the work of Ragnar Frisch [1936].

7. Note that given the flow-equilibrium notion discussed above, the model's stock variables are included in the x_t vector.

8. These were the equation errors whose estimated autocorrelation coefficients were greater than 0.95. All other equation residuals were set to zero.

9. The predictive power of the equilibrium funds rate will be analyzed more formally in the next section.

FIGURE 1
The Federal Funds Rate: Equilibrium and Actual Values*



*Shaded intervals denote NBER dates (peak to trough).

Historical values of the actual federal funds rate are plotted in the second panel of Figure 1, and the last panel shows the difference between the two. In this latter panel, negative [positive] values imply accommodating [tight] monetary policies. The figure depicts monetary policy as accommodative in the 1970s, a suggestion broadly consistent with the accelerating rates of inflation over that period. The estimates also capture the disinflation of the early 1980s, a period when the Federal Reserve set the federal funds rate well above its historically high equilibrium level.

Over the most recent historical period, the findings suggest that, given the weak economic conditions of the early 1990s, monetary policy was generally stimulative, though to a much smaller extent than in the 1970s.[10] Note, however, that the characterization of policy as stimulative in the early 1990s is conditional on the stance of fiscal policy (perhaps best characterized in terms of the level of the high-employment budget deficit) over the same period. Because the equilibrium funds rate in any particular quarter does not explicitly take into account subsequent changes in fiscal policy, a value of the funds rate calculated as below equilibrium in a particular quarter would not necessarily lead to an eventual undershooting of the natural unemployment rate if fiscal policy (or other factors) changed over time.

III. THE PREDICTIVE POWER OF THE FUNDS-RATE SPREAD

If the funds-rate spread is a good measure of the stance of monetary policy, then it should also perform well as a predictor of economic activity. In the spirit of Bernanke and Blinder [1992], this section conducts Granger-causality tests and variance decompositions to assess the forecasting ability of the proposed funds-rate spread measure.[11] To allow for comparisons with other existing work, I also include results for the forecasting performance of traditional measures of term structure spreads.

Granger-Causality Tests

Bernanke and Blinder [1992] documented the high predictive power of the spread between the fed funds rate and the ten-year government bond rate. They showed that this spread dominates traditional monetary aggregates (M1 and M2), as well as the spread between the one-year and ten-year government bond rates and the difference between the six-month commercial paper rate and the six-month Treasury bill rate.[12] Rather than trying to replicate their results, I will take the fed funds/ten-year government rate spread as the benchmark empirical measure of the stance and compare it with the funds-rate spread measure constructed in this paper. For the sake of comparability, I examine the predictive power of the funds-rate spread with roughly the same variables and methodology used in the Bernanke-Blinder analysis.[13]

Table I compares the predictive power of the funds-rate and term-structure spreads from the perspective of Granger-causality tests. Accordingly, for each measure of economic activity presented in the table, I estimated a simple regression equation that allows for a constant and four lags of each of the following: the variable being forecasted, inflation—as measured by changes in the personal consumption deflator—the funds-rate spread, and the term-structure spread. Table I shows the marginal significance levels associated with the joint hypothesis that the lags of each interest-rate spread measure are insignificant in the forecast equation. Each spread measure is considered separately. For instance, the funds-rate spread, with a *P*-value of 6.9E-4, is by far a better predictor of the growth in industrial production than the term-structure spread, a *P*-value of .66. As the table shows, the superiority of the funds-rate spread is also evident in all other forecasting equations, suggesting that, for the variables considered here, the funds-rate spread far dominates the term-

10. In the first half of the 1970s easy policy co-existed with actual unemployment below its target.

11. The equilibrium funds rate series is a constructed variable that depends on the structure of the quarterly model. This issue is not addressed in the computation of test statistics reported in this paper.

12. In fact, Bernanke and Blinder report most of their results using the *level* of the funds rate. Nevertheless, they do indicate that their findings are not changed when the spread between the funds rate and the ten-year government bond rate is used.

13. One important direction in which I differ from the Bernanke-Blinder approach is in the frequency of observations. While their analysis is based on monthly data, I work with quarterly variables. This is simply a consequence of using a quarterly model to derive the equilibrium funds-rate series.

TABLE I
Granger-Causality Tests[a]
Forecasting Economic Activity with Term-Structure and Funds-Rate Spreads

Economic Activity Measure	Term-Structure Spread[b]	Funds-Rate Spread[c]
Industrial Production	.65952	6.8991E-4
Capacity Utilization	.64835	8.0825E-4
Employment	.63645	9.969E-4
Unemployment Rate	.206	1.9502E-4
Personal Income	.43951	.24549
Retail Sales	.6873	.15018
Personal Consumption	.83762	.038416
Durable-Goods Orders	.53117	3.8918E-4
Real GDP	.78699	.047881

[a]All tests performed over 1969:Q1–1994:Q1. Table entries are marginal significance levels for the hypothesis that all lags of the relevant spread do not help forecast the economic activity measure. Trending variables are expressed in annualized growth rates. Each forecasting equation includes four lags of the variable being forecasted, inflation, and the two interest-rate spreads.

[b]The term-structure spread is defined as the difference between the federal funds rate and ten-year constant-maturity government bond rate.

[c]The funds-rate spread is defined as the difference between the actual and equilibrium values of the federal funds rate.

structure spread as an indicator of the future direction of the economy.

The stronger predictive power of the funds-rate spread is also confirmed by Table II. In it I allow for an alternative definition of the term-structure spread to enter the forecasting equation, namely, the difference between the one-year and ten-year government bond rates. The funds-rate spread far outperforms the other two as a forecaster of all but one measure of economic activity. The superiority of the funds-rate spread is even stronger if, instead of the 10-year government bond rate, the 30-year AAA corporate bond rate is used in the term-structure spread.

Figure 2 shows the historical evolution of the three interest spreads examined in Tables I and II. As suggested by Laurent [1990], these spreads appear to move together for most of the sample. In fact, the simple correlation coefficient between the funds rate–10-year bond rate spread and the funds-rate spread is .70, a magnitude that potentially explains why so many others have found this particular term-structure spread so valuable for forecasting economic activity.

Variance Decompositions

As shown in Tables I and II, the Granger-causality criterion suggests that the funds-rate spread unambiguously dominates different measures of the term-structure spread as a predictor of economic activity. The fact that the different spreads are highly correlated with each other suggests, however, that we should interpret this result with some caution. For instance, suppose the term-structure spread is really what matters for the evolution of economic activity, and the funds-rate spread is simply responding to changes in the former. Thus, it would not be surprising that the funds-rate spread shows up as a good predictor of economic activity.[14]

I turn to variance decompositions to address the issue of non-orthogonality in the regressors. In particular, I consider fourth-order vector-autoregressions that include the same variables depicted in each of the regression equations in Table I. As is well known, vari-

14. This argument follows Bernanke and Blinder [1992] and is based on the influential work of Sims [1980] and Litterman and Weiss [1985].

TABLE II
Granger-Causality Tests[a]
Forecasting Economic Activity with Term-Structure and Funds-Rate Spreads

Economic Activity Measure	10-1 Year Spread[b]	Bond-Funds Spread[c]	Funds-Rate Spread[d]
Industrial Production	.77089	.91532	.0021884
Capacity Utilization	.42208	.79229	.0076122
Employment	.96815	.94167	.0053229
Unemployment Rate	.56787	.83064	9.92E-4
Personal Income	.31467	.10859	.51678
Retail Sales	.83186	.77946	.28472
Personal Consumption	.93744	.9468	.059741
Durable-Goods Orders	.69776	.42036	.0014595
Real GDP	.73811	.71652	.11764

[a]All tests performed over 1969:Q1–1994:Q1. Table entries are marginal significance levels for the hypothesis that all lags of the relevant spread do not help forecast the economic activity. Trending variables are expressed in annualized growth rates. Each forecasting equation includes four lags of the variable being forecasted, inflation, and the three interest rate spreads.

[b]The 10-1 year spread is defined as the difference between the rates on one- and ten-year constant-maturity government bonds.

[c]The bond-funds spread is defined as the difference between the federal funds rate and the ten-year constant-maturity government bond rate.

[d]The funds-rate spread is defined as the difference between the actual and equilibrium values of the federal funds rate.

ance decompositions are sensitive to the ordering of the VAR variables. Therefore, Tables III and IV show the contributions of right-hand-side variables to the variances of different measures of economic activity for two alternative orderings of the spread variables. In both orderings the spreads are placed last, an assumption that potentially works against the hypothesis that they are important in forecasting economic activity. In each case, the variables are ordered as shown in the columns of Tables III and IV.

The ordering assumption in Table III allows the fund-rate spread to respond contemporaneously to all other variables, including the term-structure spread. As the results show, the funds-rate spread still accounts for 6% to 28% of the variance of the different measures of economic activity. The term-structure contribution ranges from 8% to 26%. However, it is no longer the case that the funds-rate spread dominates the term-structure as a predictor of economic activity for all variables. In fact, it does not do as well as the term-structure spread for five out of the nine variables.

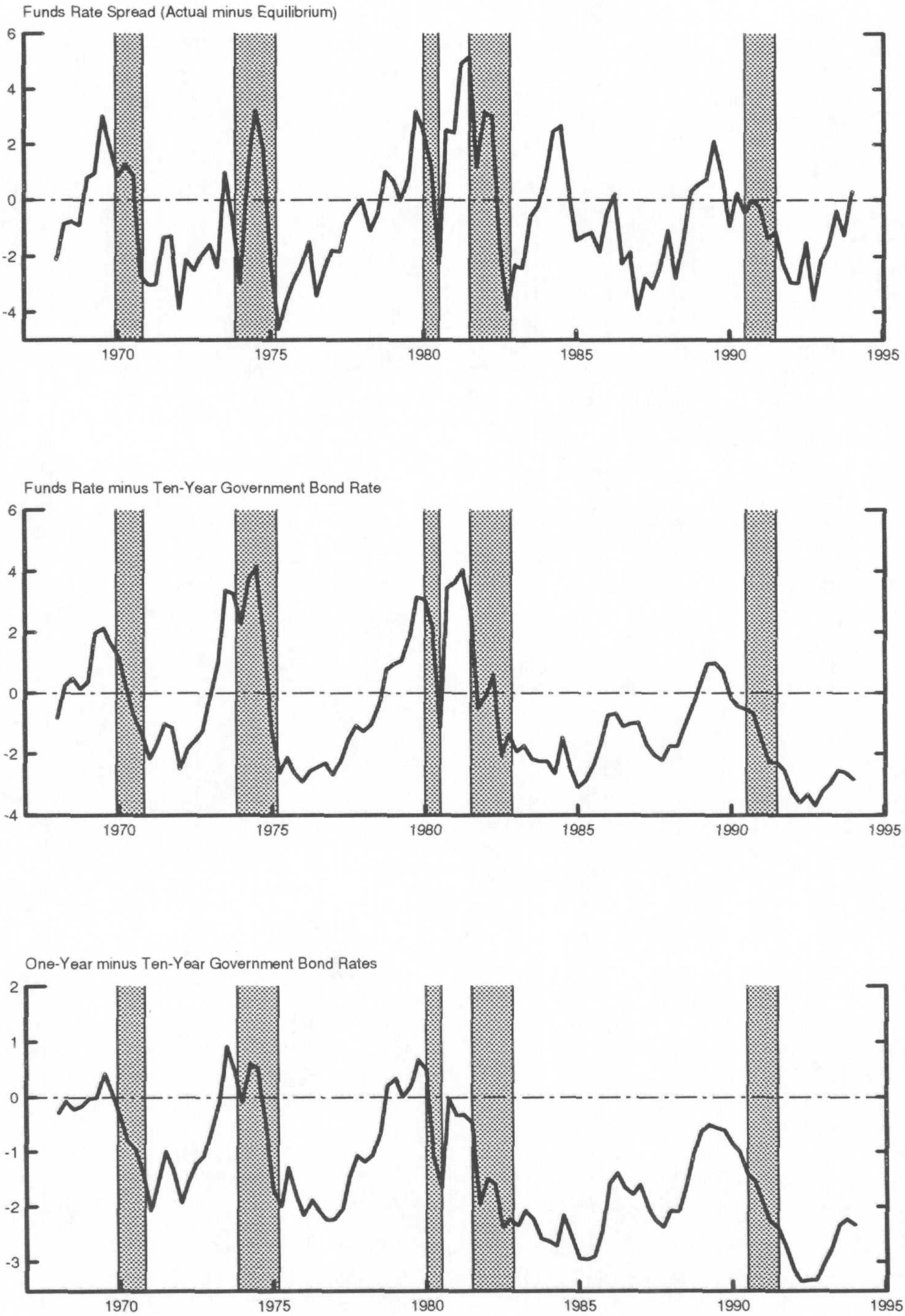
Suppose however that the Fed does not respond contemporaneously to shocks in the term-structure spread. Instead, suppose that, within the period, it is the financial markets that respond to deviations of the fed funds rate from its equilibrium value. This plausible scenario changes the results of the variance decompositions shown in Table III dramatically. As shown in Table IV, the contribution of innovations in the funds-rate spread to the variance of the different economic activity measures now ranges from 9% for personal income to 48% for capacity utilization. At the same time, the contributions of innovations to the term-structure spread now range from 2% for capacity utilization to 14% for employment. Moreover, under this ordering the funds-rate spread unambiguously dominates the term-structure spread as a predictor of economic activity.

Thus, while the variance decompositions displayed in Table III provide mixed support to the Granger-causality tests, the results reported in Table IV strongly point out the superiority of the funds-rate spread as an indicator of future economic activity.[15]

15. The results are similar for the variance decompositions with the variables in Table II.

FIGURE 2

Historical Evolution of Alternative Interest Rate Spreads*



*Shaded intervals indicate NBER dates (peak to trough).

TABLE III
Variance Decompositions[a]
Contribution of Term-Structure and Funds-Rate Spreads
to the Variances of Different Economic Activity Measures

Economic Activity Measure	Own Lags	Inflation	Bond-Funds Spread[b]	Funds Spread[c]
Industrial Production	61.42	1.613	17.3	19.67
Capacity Utilization	48.46	1.209	21.96	28.37
Employment	52.96	0.332	26.28	20.43
Unemployment Rate	50.49	2.183	19.97	27.36
Personal Income	79.22	7.104	7.982	5.698
Retail Sales	61.28	12.97	18.19	7.564
Personal Consumption	58.59	11.84	21.52	8.043
Durable-Goods Orders	67.83	3.75	11.36	17.06
Real GDP	69.99	2.16	18.7	9.151

[a]The decompositions refer to an eight-quarter forecast horizon. The sample goes from 1969:Q1 to 1994:Q1. Table entries are the percentage of the variance of the economic activity measure attributable to the variables in each column. Trending variables are expressed in annualized growth rates. Each VAR includes four lags of each variable.

[b]The bond-funds spread is defined as the difference between the federal funds rate and the ten-year constant-maturity government bond rate.

[c]The funds-rate spread is defined as the difference between the actual and equilibrium values of the federal funds rate.

TABLE IV
Variance Decompositions[a]
Contribution of Term-Structure and Funds-Rate Spreads
to the Variances of Different Economic Activity Measures

Economic Activity Measure	Own Lags	Inflation	Funds Spread[b]	Bond-Funds Spread[c]
Industrial Production	61.42	1.613	25.87	11.1
Capacity Utilization	48.46	1.209	47.89	2.444
Employment	52.96	0.332	32.23	14.49
Unemployment Rate	50.49	2.183	41.04	6.289
Personal Income	79.22	7.104	8.742	4.938
Retail Sales	61.28	12.97	16.01	9.746
Personal Consumption	58.59	11.84	19.23	10.34
Durable-Goods Orders	67.83	3.75	17.74	10.67
Real GDP	69.99	2.16	18.39	9.462

[a]The decompositions refer to an eight-quarter forecast horizon. The sample goes from 1969:Q1 to 1994:Q1. Table entries are the percentage of the variance of the economic activity measure attributable to the variables in each column. Trending variables are expressed in annualized growth rates. Each VAR includes four lags of each variable.

[b]The funds-rate spread is defined as the difference between the actual and equilibrium values of the federal funds rate.

[c]The bond-funds spread is defined as the difference between the federal funds rate and the ten-year constant-maturity government bond rate.

IV. MONETARY POLICY AND THE FUNDS-RATE SPREAD

The previous section made the case for the usefulness of the funds-rate spread both in single-equation and VAR forecasts of several key measures of economic activity. A related but different issue is the extent to which changes in this spread capture significant shifts in the stance of monetary policy.

An Informal Overview: Romer Dates

As a first pass at assessing the ability of the funds-rate spread to measure the stance of monetary policy, I use the episodes of money tightening identified by Romer and Romer [1989]. In my framework, periods of monetary tightening are those where the federal funds rate is persistently above its equilibrium level. As the first panel of Figure 3 shows, the Romer dates, depicted as vertical lines, do a good job in terms of identifying such periods. The one exception to this result is the up-turn in the funds-rate spread in the mid 1980s, which does not correspond to any of the dates picked by the Romers.

According to the Romer date criterion, the funds-rate spread captures the stance of monetary policy at least as well as the other traditional alternatives considered here, namely, the level of the funds rate and the term-structure spread. Compared to the term-structure spread, the funds-rate spread appears to do a better job in terms of capturing the tightening episode of 1974:Q1. However, unlike the term-structure spread, the funds-rate spread suggests a brief tightening period in the mid 1980s, which is not captured either by the Romers or the term-structure measure. Note that the level of the funds rate also suggests such tightening in the mid 1980s.

To summarize, there is a reasonably close match between the evolution of the funds-rate spread and the Romer dates. Given that these dates do not enter in the specification of the MPS model, we take this as independent, informal confirmation to the fact that positive values of the funds-rate spread constitute periods of tight money.

Policy Analysis with the Funds-Rate Spread

In this subsection, I use a simple vector-autoregression to generate a more formal scenario to evaluate the links between the funds-rate spread and the stance of monetary policy. The VAR is given by

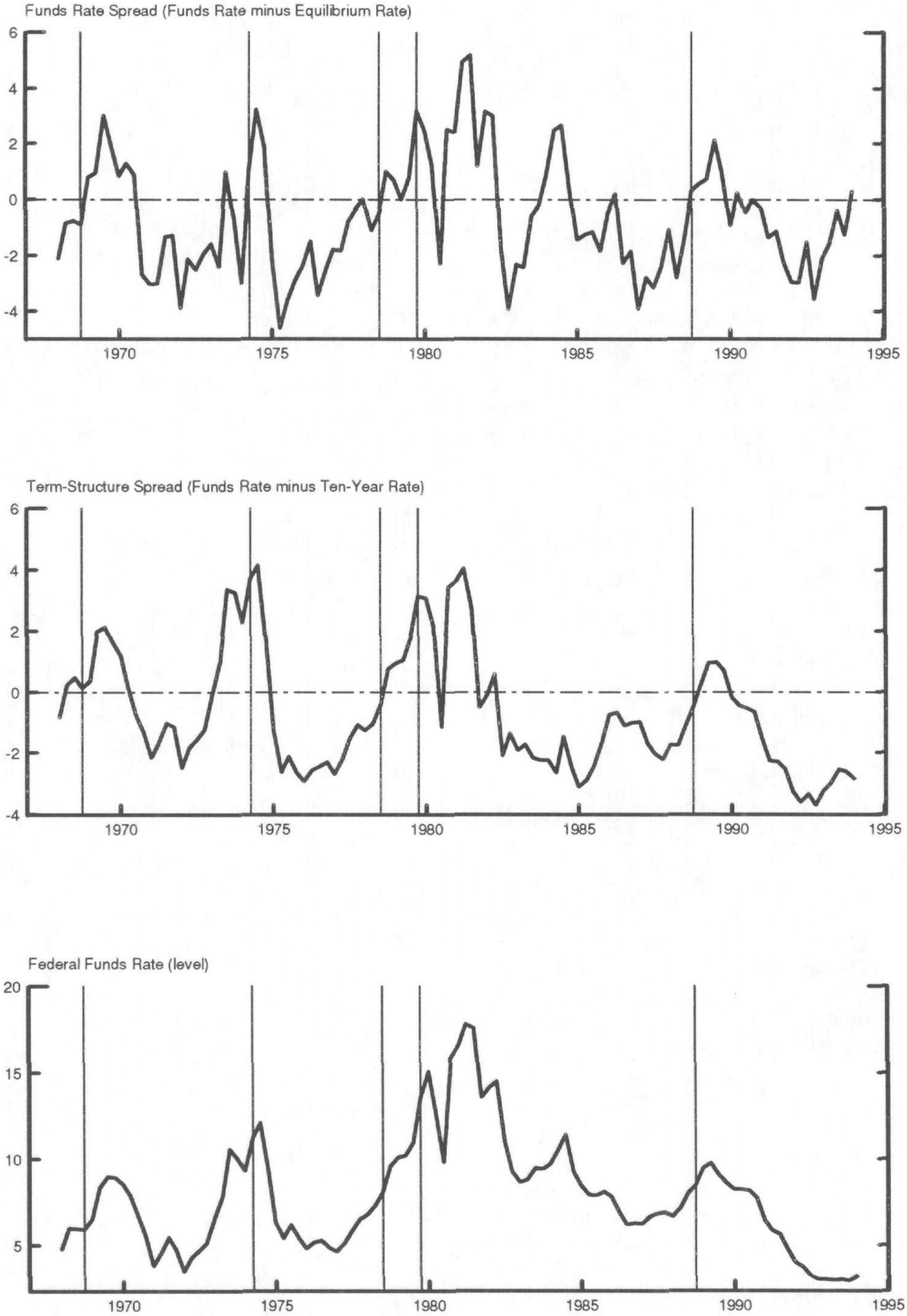
$$(6) \qquad x_t = \sum_{i=1}^{4} B_i x_{t-i} + A_0 \varepsilon_t$$

where $x_t \equiv [y_t, \pi_t, r_t^*, r_t]$; y_t is the unemployment rate; π_t is the rate of inflation; r_t^* and r_t are the equilibrium and actual federal funds rates, respectively, and ε_t is a vector of orthogonal innovations. The only *structural* assumption I make on equation (6) is embedded in A_0, which I assume to be a lower-triangular matrix. Accordingly, given the ordering in x_t, I allow the actual value of the federal funds rate to respond contemporaneously to surprises in all other variables. Consistent with our notion of equilibrium, the equilibrium value of the funds rate is allowed to respond contemporaneously to unemployment and inflation, but not the actual funds rate itself. In other words, the equilibrium federal funds rate (r_t^*) responds contemporaneously only to the non-policy variables. These, in turn, are affected by policy variables only with a lag.

Equation (6) implicitly defines a monetary policy rule. It assumes that the policymaker responds not only to short-term fluctuations in output (unemployment) and inflation, but also to changes in the medium-term prospects of the economy, captured by the equilibrium federal funds rate. Assessing the plausibility of such a policy rule, Figure 4 shows how the actual fed funds rate responds to unit orthogonal innovations to unemployment, inflation, the equilibrium funds rate, and itself. The impulse responses are intuitive and suggest a plausible policy rule. The funds rate reacts to the unemployment and inflation shocks in the directions suggested by theory. We are most interested, however, in the funds rate response to an innovation in its equilibrium level. An increase in the equilibrium federal funds rate suggests a near- to medium-term pick up in economic activity, and thus induces the Fed to gradually raise the actual funds rate for the first six quarters after the shock. This is shown in the lower-left corner of Figure 4.

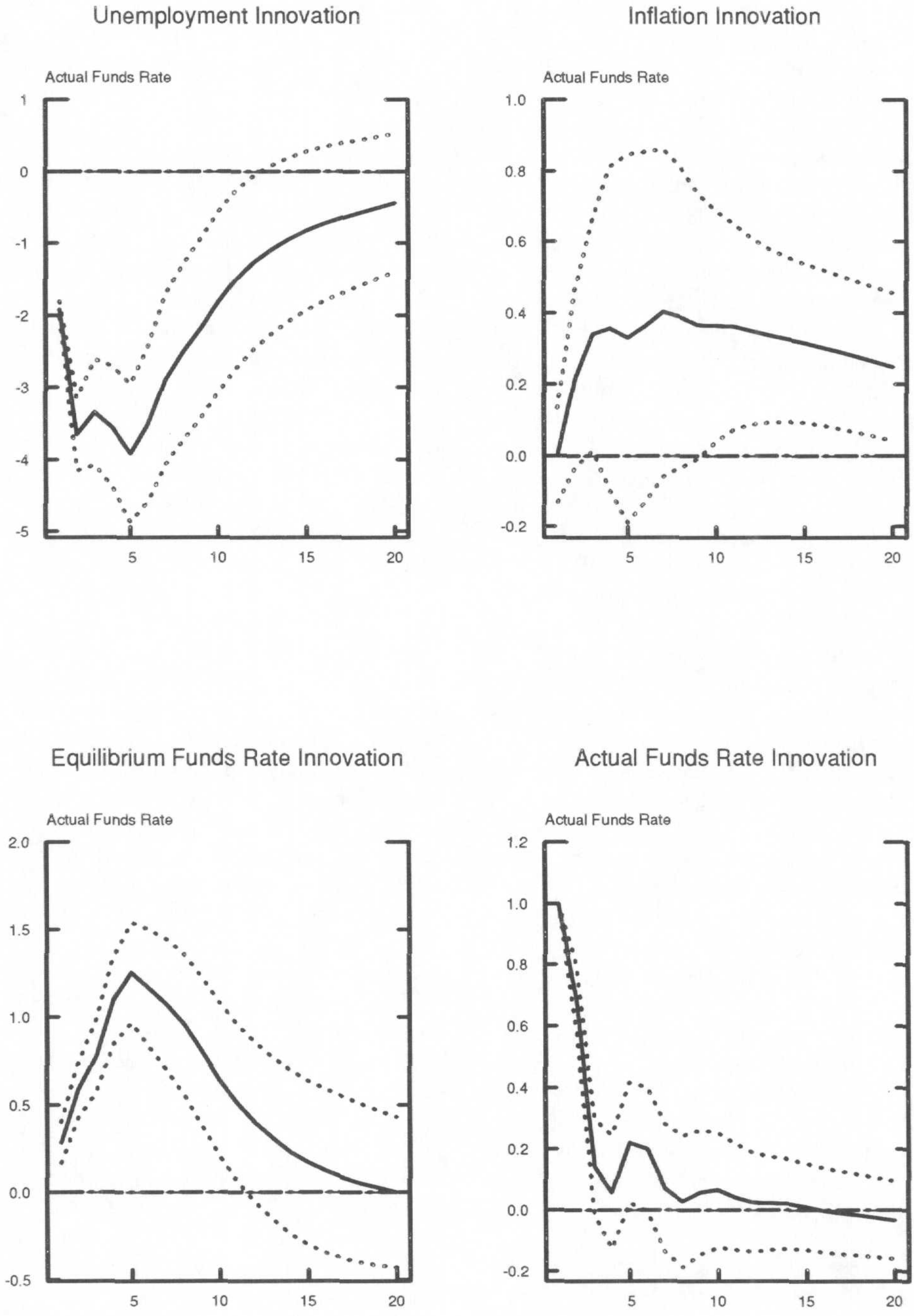
Given the policy rule embedded in equation (6), the next interesting question is how the funds-rate spread responds to the same shocks depicted in Figure 4. This is shown in

FIGURE 3
Interest Rate Spreads and the Stance of Policy*



*Vertical lines indicate Romer dates.

FIGURE 4
Response of the Actual Funds Rate to Orthogonal Innovations*



*Dotted lines are one-standard error bands.

Figure 5. Looking at the unemployment shock first, we see that, as suggested by the decline in the funds rate, monetary policy is initially accommodating. However, about two years after the shock, policy has shifted gears, going back to a more neutral stance. A different picture comes out of Figure 4, which, given a more protracted response of the actual funds rate, would suggest that policy was more stimulative than in Figure 5. This phenomenon is even more pronounced in the response to a shock to the equilibrium funds rate. As shown in Figure 4, the actual funds rate immediately rises in response to a positive shock in the equilibrium rate. The hump-shaped pattern of the response suggests a tightening in policy that lasts about three years. What Figure 4 doesn't show, however, is that, despite the increase in the funds rate, policy actually eases a bit for the first four quarters, turns restrictive in the second year, and then shifts to a more neutral stance for the remainder of the simulation horizon (see Figure 5). This suggests that, given the short-run concerns of policy, the initial increase in the actual fed funds rate only partially offsets the shock in the equilibrium rate. Thus, in the short run we end up with a combination of a higher funds rate and a slightly more stimulative policy.

Finally, Figure 6 shows the impulse response functions associated with an alternative, three-variable VAR that features the unemployment rate, inflation, and the funds-rate spread. As we would expect, the results are essentially the ones derived from the four-variable VAR. In addition, the last column of the figure also shows the response of unemployment and inflation to an unexpected tightening in policy. Most notably, given our measure of the policy stance, this simple VAR does not exhibit a "price-puzzle"; inflation does not temporarily turn up after the monetary tightening. Moreover, even though the tightening is very short-lived, the responses of both the unemployment and inflation rates display considerable persistence.

V. FINAL REMARKS AND CONCLUSION

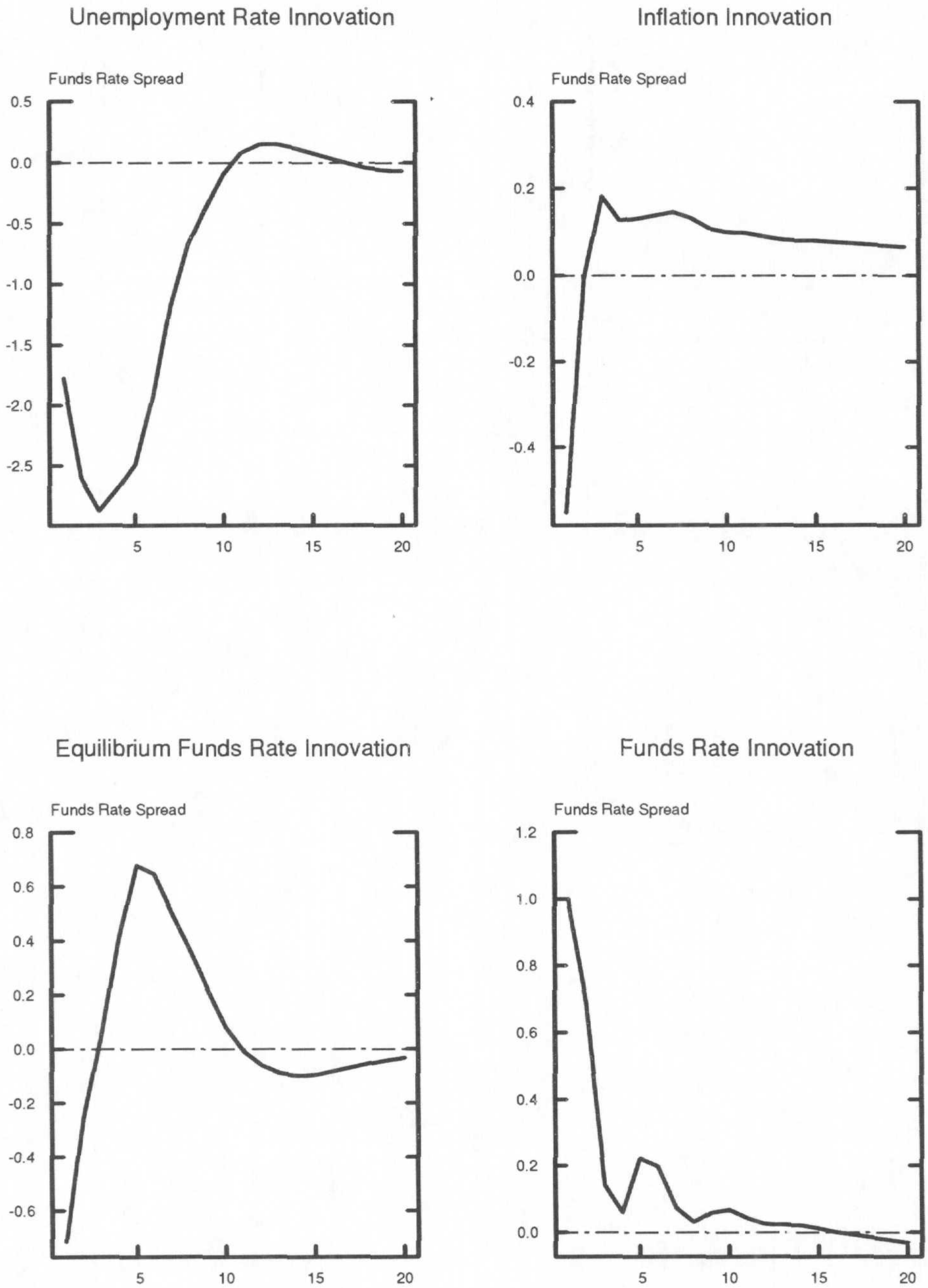
The first part of this paper was motivated by the notion that the usefulness of term-structure spreads as predictors of economic activity stems from the fact that they proxy for the spread between actual and equilibrium fed funds rates. Instead of using long rates as a proxy for the equilibrium rate, I set out to measure the equilibrium funds rate directly through simulations of a large-scale econometric model. Tests of the predictive power of the term-structure and funds-rate spreads suggested that the latter are better indicators of the future state of the economy.

I also included the equilibrium funds rate in simple vector-autoregressions and showed that sensible patterns of impulse response functions can be generated. The impulse responses also highlighted the dynamic effects of shocks to the funds-rate spread and argued that, compared to the level of the funds rate, they constitute a better way to think of shocks to the policy stance.

Note, however, that in making the case for a model-based measure of the disequilibrium associated with a given level of the funds rate, this paper casts some doubts on the value of term-structure spreads as indicators of the stance of monetary policy. A casual look at the historical differences between the funds-rate spread and the term spread illustrates this point. Take, for example, the period between 1983 and 1985. As shown in Figure 7, this was a time when the funds-rate spread measure suggests that policy was tight whereas the term spread points towards an accommodating policy. Clearly, only one measure of the policy stance can be right here.[16] If expectations are formed rationally, the tight policy implied by the funds-rate spread would at least prevent inflation from accelerating in the future (as eventually happened in this particular instance). Thus, high long-term interest rates in this case must be signaling higher real rates and not higher inflation. Therefore, the results concerning the value of term-structure spreads as measures of the policy stance are mixed at best. On one hand, there is a sizable correlation between the funds-rate spread and the term spread, about .70. On the other hand, there are episodes where the two measures yield conflicting signals about the policy stance: long rates might be high [low] relative to short rates not because policy is easy [tight]—so that inflation is expected to rise [fall]—but simply because real rates are expected to increase [decrease].

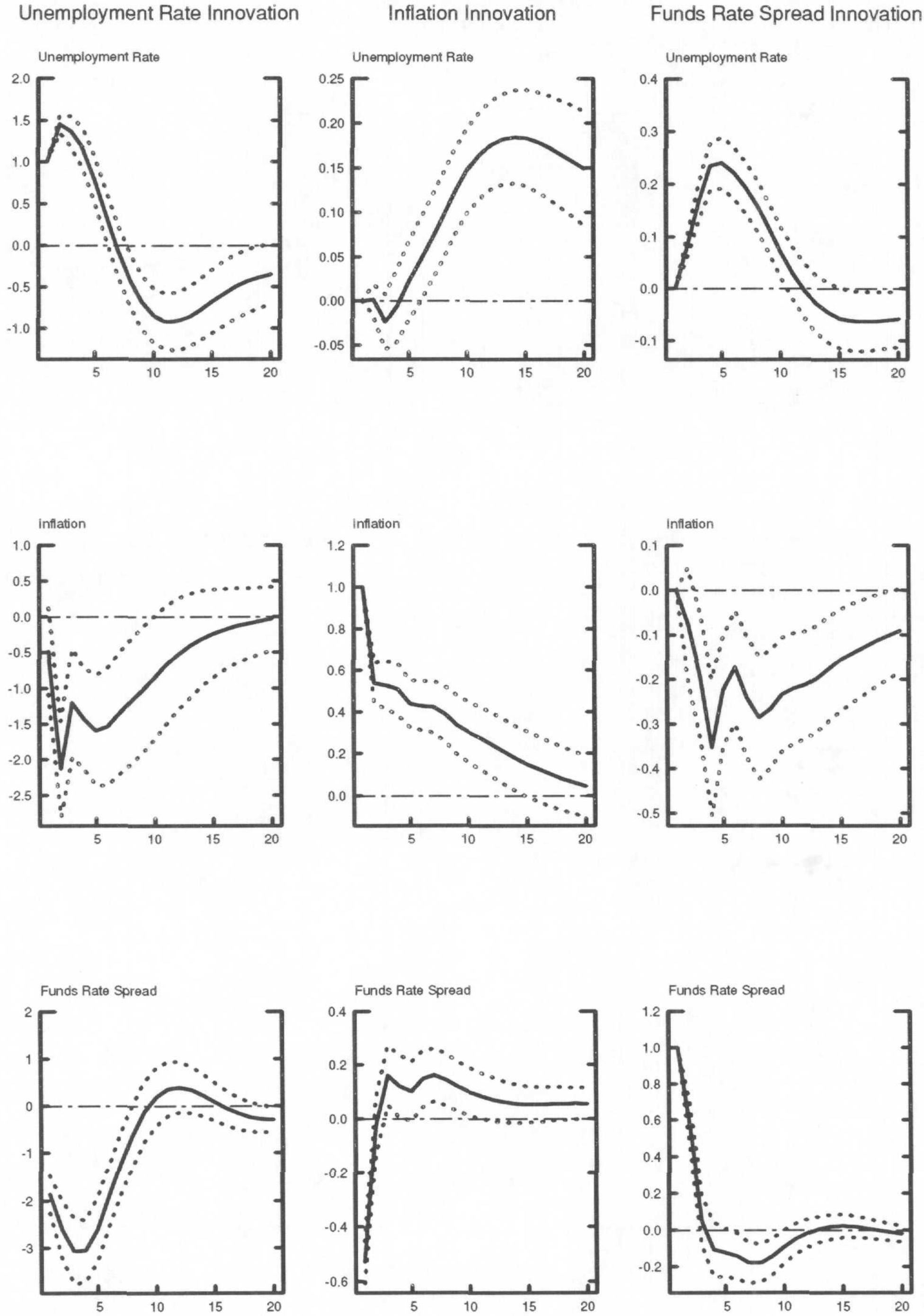
16. Note that the finding of a tighter policy during this period is supported by other independent measures of the stance, such as the index constructed by Boschen and Mills [1995].

FIGURE 5
Response of Funds Rate Spread to Orthogonal Innovations*



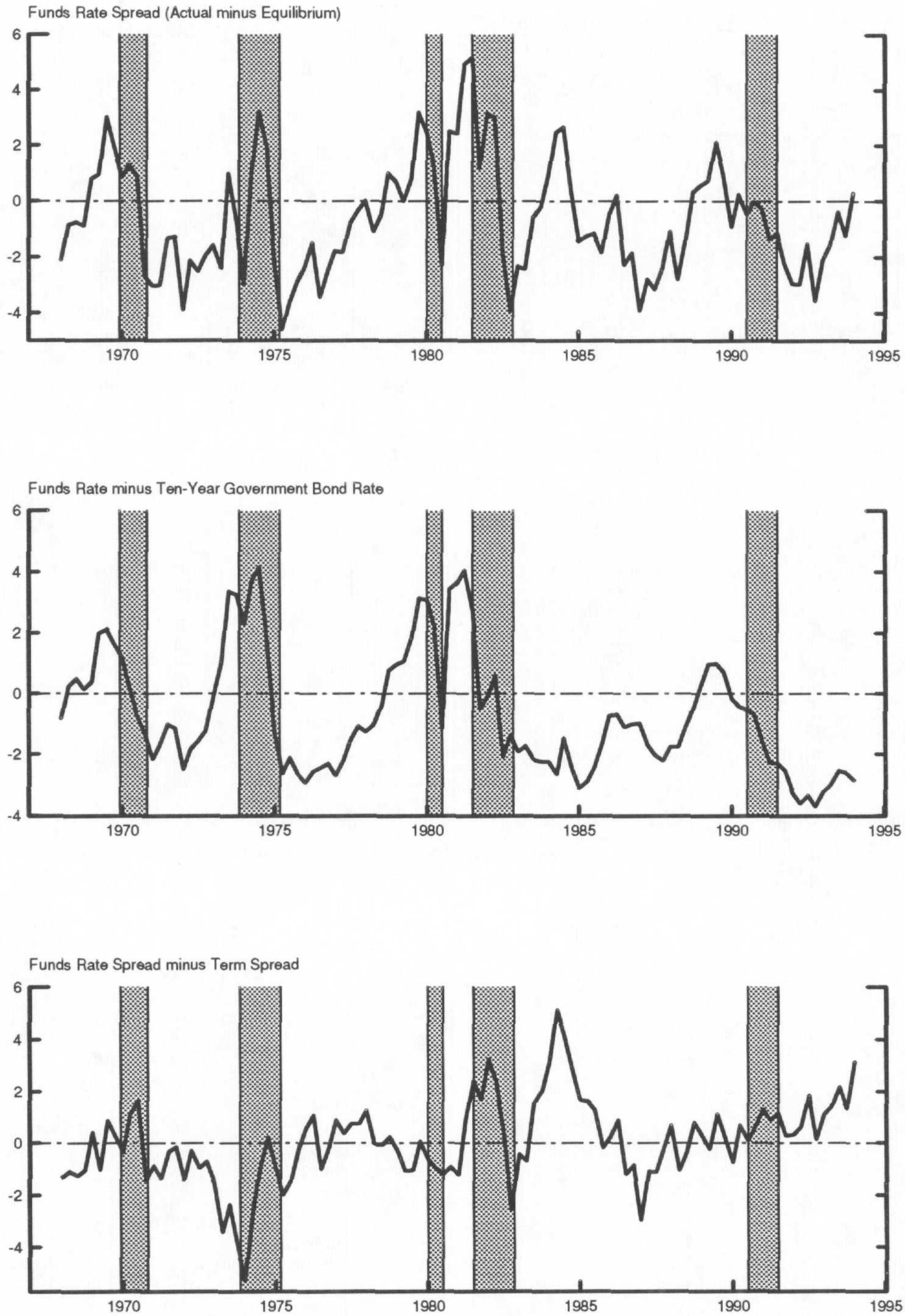
*The Funds-Rate Spread is defined as the difference between the actual and equilibrium Federal Funds Rate.

FIGURE 6
Impulse Response Functions for a Three-Variable VAR*



*Dotted lines are one-standard-error band. The Funds-Rate Spread is defined as the difference between the actual and equilibrium Federal Funds Rates.

FIGURE 7
Funds Rate and Term-Structure Spreads*



*Shaded intervals indicate NBER dates (peak to trough).

Perhaps I should also point out a limitation of the analysis carried out in this paper. The results obviously depend on the nature of the model used to generate the equilibrium federal funds rate series. Had I used a model different than MPS, I would likely have gotten different results.[17] Nevertheless, the fact that the funds-rate spread used here worked so well provides some support both for the structure of the model and for the proposed computational approach.

DATA APPENDIX

All data are quarterly and defined as follows:

Industrial Production: Index of Industrial Production (1987=100);

Capacity Utilization: capacity utilization rate (industry total);

Employment: employment of employees (nonfarm business sector);

Unemployment rate: civilian unemployment rate (Household survey);

Personal Income: NIA personal income;

Retail Sales: sales (1987 dollars), Manufacturing & Trade-Retail Trade;

Personal Consumption: personal consumption expenditures (1987 dollars);

Durable-Goods Orders: new orders (1987 dollars), Durable Manufacturers;

Real GDP: gross domestic product (1987 dollars);

Inflation: deflator for personal consumption expenditures (1987=100).

17. A related issue is the direct estimation of equilibrium interest rates outside the scope of large-scale macro models.

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