Commodity Prices, the Term Structure of Interest Rates, and Exchange Rates: Useful Indicators for Monetary Policy?

Jeffrey C. Fuhrer

Senior Economist, Federal Reserve Bank of Boston. *Thanks to Lynn Browne, Richard Kopcke, Jane Little, Brian Madigan, and Geoffrey Tootell for helpful comments.*

The Chairman of the Federal Reserve Board of Governors, in his mid-year 1993 report to Congress, averred: "The historical relationships between money and income, and between money and the price level, have largely broken down, depriving the aggregates of much of their usefulness as guides to policy. At least for the time being, M2 has been downgraded as a reliable indicator of financial conditions in the economy, and no single variable has yet been identified to take its place" (Greenspan 1993). In 1988, then-Federal Reserve Vice Chairman Manuel Johnson, citing the failure of monetary aggregates as indicators of the stance of monetary policy, offered three alternatives for this indicator role: the slope of the term structure of interest rates, a commodity price index, and the foreign exchange value of the dollar (Johnson 1988). Federal Reserve Governor Wayne Angell has been a steadfast proponent of commodity prices as a reliable indicator of emerging inflationary pressures. (See, for example, Angell 1987.)

While it is widely agreed that the monetary aggregates no longer provide reliable indications of the current and future course of inflation and of real activity, it is less widely agreed which variable or variables should replace the aggregates, or exactly how they would be used in conducting monetary policy. The first section of this article discusses the role of indicators in the conduct of monetary policy; the second section provides a simple characterization of the behavior of the proposed indicators; the third section proposes a simple model of the behavior of monetary policymakers; the fourth section explores the hypothetical interaction of monetary policy and policy indicators; and the fifth section examines the actual correlations among the proposed indicators and the ultimate targets of monetary policy over the last ten years. To anticipate, this article finds that on both theoretical and empirical grounds, the proposed indicators would be neither straightforward nor reliable guides to monetary policy. In general, no single indicator bears a stable and statistically reliable relationship to the current or future course of a policy target.

I. The Role of Indicators in Conducting Monetary Policy

For the purposes of this article, monetary policy is assumed to control the federal funds rate. Its ultimate goals are a stable and relatively low inflation rate, and an unemployment rate that does not deviate too far or for too long from its natural rate.[1] Policy is assumed to affect its ultimate goals through a conventional transmission channel: moving the federal funds rate affects other credit market yields, which in turn affect interest-sensitive spending.[2] As pointed out by Milton Friedman (1967), the execution of policy is complicated in part by the lag between a change in the federal funds rate and the response of long-term rates, as well as by the lag between the response in long rates and spending responses. These lags are incorporated in many well-known and widely used econometric models of the U.S. economy; a benchmark model is the Federal Reserve Board's MIT-PENN-SSRC (MPS) quarterly model, which is documented in Brayton and Mauskopf (1985).[3]

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Because of the delays inherent in the effects of monetary policy on its ultimate targets, policymakers desire indicators that signal the current and future course of their ultimate targets. One source of such information is the forecast from a macroeconomic model such as the MPS model. A simple (and simplified) way to conduct monetary policy is to feed the current and projected settings of the policy instrument (here, the path of the federal funds rate) into a macroeconomic model, and then to judge the forecasts of inflation and unemployment that arise from these settings. If the forecasts are not acceptable, the policymaker can determine the funds rate that would yield the desired inflation/unemployment outcome.

This approach appears to obviate the need for other indicators, since presumably all relevant macroeconomic relationships are captured by the model. However, indicators such as those cited by Johnson may be useful for two reasons:

(1) Many economists take a dim view of large macroeconomic models, claiming that they are unlikely to be stable across varying monetary and fiscal regimes, and thus may not be useful guides for conducting monetary policy. A good indicator (or set of indicators) may provide a substitute for a macroeconomic model that does not impose the economist's (possibly misspecified) structure on the relationship between the indicator and the policy target.[4]

(2) The ultimate targets of monetary policy are observed only with a lag, while interest rates, commodity prices, and exchange rates are observed almost continuously. Thus, these indicators may provide up-to-date information about the policy targets that is not contained in lagged observations of the policy targets and indicators. This contemporaneous information can, in principle, be used to better calibrate the near-term (or current-quarter) forecasts of policy targets in a macroeconomic model, or to provide up-to-the-minute forecasts for an indicator (non-structural) model of the policy targets.

What Makes a Good Indicator?

The characteristics required of a monetary policy indicator are probably not universally agreed upon. However, several are likely to be on everyone's list.

- The indicator should be observed at a high frequency. An indicator that is observed only once a year is of limited use to monetary policymakers who meet every six weeks to decide

[1] Equivalently, concern for unemployment could be described as a desire to keep output at "potential," since potential implies full utilization of all resources, including labor and capital.

[2] Thus this study overlooks the debate over the "credit channel" for monetary policy studied by Bernanke and Blinder (1988), Kashyap, Stein, and Wilcox (1993), Gertler and Gilchrist (1992a, 1992b), and Oliner and Rudebusch (1993).

[3] This simple characterization of monetary policy ignores the use of intermediate targets, largely for the reasons cited in Friedman (1975). For additional discussion of the early debate over the targets/instruments/indicators framework of monetary policy, see Tinbergen (1956), Brunner (1969), Hamburger (1970), and Poole (1970).

[4] This argument has a serious flaw as well: if the underlying macroeconomic structure changes, then in almost all circumstances, the reduced-form indicator relationships discussed below will also change. These concerns are addressed in sections IV and V below.

what action to take in light of the economic news accumulated in the inter-meeting period.

- The indicator should provide a contemporaneous or an advance signal of changes in the ultimate policy targets. A series that responds only to local or market-specific conditions, and never to national, macroeconomic conditions, will be of little use to policymakers. Similarly, an indicator that contains a host of information about last year's inflation and unemployment rates is of little value.
- The signal of a change in a policy target should be reliable. An indicator that signals more changes than actually occur, or an indicator that misses important changes in the policy target, is a poor indicator. The stock market, for example, probably should not be considered a reliable indicator; it is said to have signaled nine of the last five recessions.
- The information in the indicator should reflect the information and assessments of a large number of market participants; the thicker the market for the indicator, the better. It would be risky to alter monetary policy based on the movements of an indicator that reflected the opinions of a few.

What Are the Merits of the Proposed Indicators?

The qualitative merits of the proposed indicators will be briefly discussed here. A more detailed discussion appears in section II. The question of reliability is addressed in the next section.

The slope of the term structure has been proposed as an indicator because in principle it should change in response to changes in expected inflation, and because it is observable contemporaneously and more or less continuously. As long-run inflation expectations increase, holders of long-term bonds will require an additional premium to compensate them for the expected loss in the real value of bonds as the price of goods increases during the holding period, so the yield on long bonds should increase, steepening the slope of the term structure. The converse should hold as well, so a flat or inverted term structure should indicate falling inflation expectations.

Foreign exchange is continuously traded and observable minute by minute. Investors shift from one currency into another in large part because of the expected difference in returns to holding assets denominated in different currencies. If asset returns are expected to increase in country one relative to country two, investors will shift into country one's currency, causing it to appreciate relative to country two's currency. Thus, changes in exchange rates can provide a signal of expected changes in relative interest rates and inflation rates.[5]

Commodities are continuously traded and immediately observed. The prices of commodities are thought to reflect traders' expectations of all the factors that might influence the supply of and demand for the commodity during the time that they hold the commodity. Thus, commodity prices will incorporate expectations of both general and market-specific economic conditions; the former are of interest to policymakers.

What Are the Shortcomings of the Proposed Indicators?

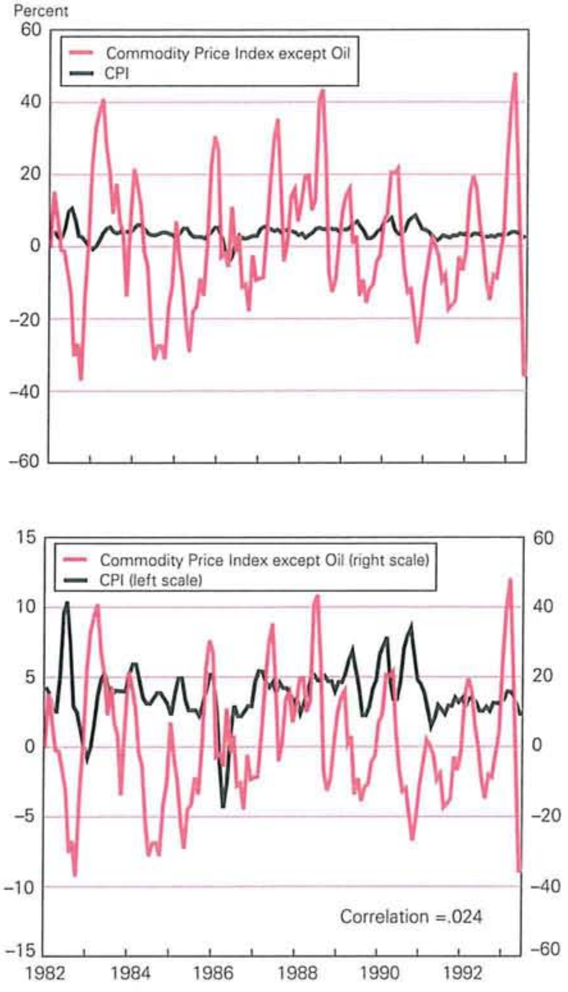
Generally, the shortcomings of each of the proposed indicators depend on the relative influence of market-specific versus aggregate economic conditions on the indicator markets. If the movements in an indicator are caused primarily by market-specific demand and supply factors, then it may be hard to disentangle the information about the aggregate conditions with which monetary policy is concerned from the market-specific information. If so, the indicator becomes useless.

Using an index of the indicators can, in principle, solve the market-specificity problem. An index, properly constructed, can average out many of the idiosyncratic fluctuations in its components. An index means three somewhat different things for the three proposed indicators. For commodities, it is a weighted average of the prices of agricultural commodities, industrial metals, and precious metals. For interest rates, it means a measure of the slope of the entire term structure, from short- to medium- to long-term rates. For exchange rates, it means a (volume-of-trade weighted) average of bilateral exchange rates with our major trading partners. In each case, it is hoped that the index will average over the movements in a particular commodity, bond, or exchange market.

[5] The link between exchange rates and returns may be couched either in nominal terms—nominal exchange rates and nominal asset returns—or in real terms. Note that disentangling the signal provided by exchange rates for nominal output is considerably more difficult. The impact of an exchange rate appreciation on nominal output can be positive or negative, depending on the timing and magnitude of the responses of import and export prices and quantities.

Figure 1

Three-Month Change in CPI versus Three-Month Change in Non-Oil Commodity Price Index



Source: U.S. Bureau of Labor Statistics and Federal Reserve Board.

All three of the indicators can suffer from the market-specificity problem. The most obvious is the commodity price index, shown in Figure 1. When the rate of change in the commodity price index and the inflation rate are plotted on the same scale (top panel), it is clear that the commodity index is far more volatile than the inflation rate. When they are plotted on separate scales, as in the bottom panel, it becomes clear that, regardless of the scale of its movements, the changes in the commodity index are not highly correlated with changes in the consumer price index (CPI); the correlation of the displayed series is 0.024.[6] Thus, even this index of commodity prices varies widely in response to factors that appear unrelated to inflation. Similarly, particular points of maturity along the term structure can register the effects of market-specific developments, such as the special characteristics of certain securities in the repurchase market or differences in call provisions, rather than a general change in expected inflation. The trade-weighted exchange rate can be influenced by unusual movements in one or two of the bilateral exchange rates, or it can signal a general tightening or loosening of foreign interest rates, without any change in expectations for domestic conditions. While these observations do not rule out the possibility of useful information in the indicators, they hint at some of the difficulties that would be encountered in extracting the desired information from such an indicator.

II. A Simple Description of the Indicator Markets

This section will consider the properties of an indicator index that is not influenced by market-specific determinants. An indicator index can be thought of as if it were a single asset in which investors can invest. If investors are willing to hold this asset, it must yield at least as good a return as alternative investments. This general principle underlies the theory of arbitrage: as soon as the real, after-tax return on an asset rises perceptibly above the returns on alternative assets (after adjusting for the term and risk preferences of investors, which we ignore in this article), investors will wish to hold more of that asset, bidding up its price and lowering its return until it equals the returns on other assets. This principle implies that the returns on all assets that are considered as alternative investments will be linked; their tax- and risk-adjusted real returns should deviate from one another only while arbitrage is taking place.[7]

[6] This is a contemporaneous correlation. The correlation between the series is a bit higher when the commodity price index is lagged two months, but it is still not statistically significant.

[7] An extensive literature has tested this hypothesis. Generally, if the test is cast in the form "Could a well-informed investor consistently have made money by making trades at the realized yields on securities?", the answer is no. To a first approximation, then, arbitrage appears to operate well in most securities markets.

The Long-Term Bond

To illustrate the theory of arbitrage, consider the return on a long-term bond. Under the assumption that investors view shorter-term and longer-term bonds as reasonable substitutes, the return (R_t) to holding a long-term bond should equal the expected discounted return ($E_t f_{t+i}$) from holding a sequence of short-term bonds from today until the maturity m of the long-term bond, rolling the principal and the interest of each short bond into the next short bond.[8] If this were not true, investors could shift funds into the bond that earned the higher return; this would raise the price and lower the yield on that bond. Investors would continue to do so until there was no further incentive to reallocate their portfolios.[9]

$$R_t = \sum_{i=0}^{m} \beta^i E_t f_{t+i}. \tag{1}$$

The same logic applies to the real (inflation-adjusted) return to holding a long-term bond. The real return on the long bond, ρ_t, should be equivalent to the discounted expected real return, $E_t(f_{t+i} - \pi_{t+i})$, from investing in a sequence of short bonds.[10]

$$\rho_t = \sum_{i=0}^{m} \beta^i E_t(f_{t+i} - \pi_{t+i}). \tag{2}$$

Commodities

The return to holding (a basket of) commodities or currencies can be considered similarly. The expected real after-tax return on a basket of commodities should equal the expected real after-tax return on competing investments. The real one-period yield on commodities, R_c, may be decomposed into the real "service yield" or "use value" derived from the commodity, s (for example, platinum may be used for jewelry or high-tech manufactures), and the expected capital gain, or change in the price of the commodity from the current to the next period, $E(\Delta P_c/P_c)$, adjusted for the rate of inflation in the general price level during the period, π.

$$R_{c,t} = s_t + E(\Delta P_{c,t+1}/P_{c,t}) - \pi_t.$$

For simplicity, assume that the real service yield is constant over time ($s_t = s$). Thus, the arbitrage condition links the current commodity price to the expected commodity price next period, the real service yield, and the real return on short-term bonds. This implies that the real return to holding commodities will equal a discounted sum of expected real returns on future short bond rates.

$$R_c = E\sum_{i=0}^{T} \beta^i(f_{t+i} - \pi_{t+i}). \tag{3}$$

Foreign Exchange

The real exchange rate is assumed to be determined by two factors. Trade patterns among countries will determine the long-run real exchange rate, E. In the short run, the real exchange rate is determined by "uncovered interest parity." That is, the real return to investing in short-term domestic bonds, adjusted for the change in the real exchange rate, $\Delta e_t/e_t$, should equal the return to investing in short-term foreign bonds, $f_t^* - \pi_t^*$.

$$f_t - \pi_t + \Delta e_t/e_t = f_t^* - \pi_t^*.$$

The return on domestic assets can fall short of the return on foreign assets only to the extent that the increasing value of the dollar compensates investors for the difference. This arbitrage condition implies that the real exchange rate is an *undiscounted* sum of the difference between expected future domestic real rates and expected future foreign real rates.

$$e_t = E + \sum_{i=0}^{\infty}[(f_{t+i} - \pi_{t+i}) - (f_{t+i}^* - \pi_{t+i}^*)]. \tag{4}$$

Thus, when domestic short-term real rates are expected to exceed foreign short-term real rates, investors will buy domestic securities, bidding up the real exchange rate. The exchange rate will be above but falling towards E, its long-run, trade-determined equilibrium.

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[8] Yields on short-term bonds far in the future are discounted more highly than yields in the near future. In many standard formulations of this arbitrage condition, the weights decline exponentially into the future.

[9] Equality of long-term and expected short-term yields abstracts from any term or risk premium that investors in the long bond require. In addition, investors presumably care about their after-tax return; this discussion abstracts from differential tax treatment.

[10] We have no direct evidence bearing on the validity of this hypothesis, since there is no such thing as a real long-term bond, so the expected real return on long-term bonds is not observable.

The importance of the arbitrage conditions for long-term bonds, commodities, and the real exchange rate (equations (1), (3), and (4)) is that in each case, the yield is tied to expectations of future (real) yields on the short-term bond. In the next section, the importance of this relationship for the role of indicators in the conduct of monetary policy will be demonstrated. Note that in each case, the deck has been stacked in favor of each asset as an indicator, by abstracting from market-specific influences, term premia, and other factors that weaken the link between the conditions in the aggregate economy and the behavior of the indicator.

III. A Simple Characterization of Monetary Policy

Monetary policy is characterized here as setting an *instrument* in response to deviations of *policy goals* from their desired targets. The instrument of monetary policy is assumed to be the short-term nominal interest rate; most economists take the rate that the Fed can control to be the federal funds rate. Monetary policy's ultimate concerns are the rate of inflation and the level of output relative to potential. Policymakers are assumed to have a specific target rate of inflation, and they are assumed to dislike deviations of output from potential output.[11] Specifically, monetary policy is assumed to increase the federal funds rate by α_π for each 1 percentage point deviation of inflation from its target, and to lower the federal funds rate by α_y for every 1 percentage point deviation of output from potential.[12]

$$f_t - f_{t-1} = \alpha_\pi(\pi_t - \pi^*) + \alpha_y(y_t - y^*) \qquad (5)$$

The parameters α_π and α_y determine the vigor with which monetary policy "leans against the wind": the larger are α_π and α_y, the more vigorously the Fed moves the funds rate in response to deviations of inflation or output from their targets.

Turning back to the arbitrage relationships for the indicators (indexes) in the previous section, equation (5) has two important implications for the conduct of monetary policy:

(1) Long-term bond yields depend on expectations of the future path of short-term rates. But the path of future short-term rates is determined by the systematic response of monetary policy as summarized in equation (5). Thus, the combination of systematic monetary policy and arbitrage in the long bond market provides a *transmission channel* for monetary policy. When the Fed is expected to hold short-term rates down, long-term rates will fall, stimulating real economic activity.

(2) Like the long-term bonds, the yields on the other assets that might serve as indicators depend on the expected future path of short-term rates. Thus, the yields (or prices) for the potential indicators depend on the current and expected monetary response in effect over the lifetime of the assets. Put simply, the behavior of the indicators depends critically on the behavior of monetary policy. Significant changes in the response of monetary policy to its ultimate targets could significantly alter the behavior of the indicators.

How important are these observations? In the next section, simple simulations will illustrate how the behavior of these indicators changes when the behavior of monetary policy changes.

IV. The Behavior of Indicators under Different Monetary Policies

To understand the impact of different policy regimes on the behavior of the indicators, a simple model is simulated that includes the arbitrage conditions for the indicator variables, the monetary policy reaction function, and a simple description of the inflation process.[13] In the simulations, the inflation rate begins 2 percentage points above the Fed's target, and the fed funds rate begins 2 percentage points below its equilibrium level. The target rate of inflation is 3 percent, and the equilibrium real rate is set arbitrarily at 5 percent. These initial conditions are chosen so as to approximate a period in which the inflation rate has risen above its target in part owing to low short rates. In the long run, the inflation rate will settle to its target (3 percent), the short nominal

[11] The target rate of inflation may be set arbitrarily by the monetary authority. The rate of potential or full-employment output is independent of the actions of the monetary authority; monetary policy may force the economy temporarily from full employment, but it cannot hold it away from potential permanently.

[12] Specifying the reaction function with the change in the funds rate rather than the level captures the interest rate smoothing motive that appears to characterize Fed behavior over the last 30 years.

[13] See Fuhrer and Moore (1992) for a detailed exposition of the model.

rate will settle to the sum of the equilibrium real rate plus the inflation target (8 percent), and the long nominal rate will settle to the level of the short nominal rate plus a 2 percent term premium (10 percent).[14]

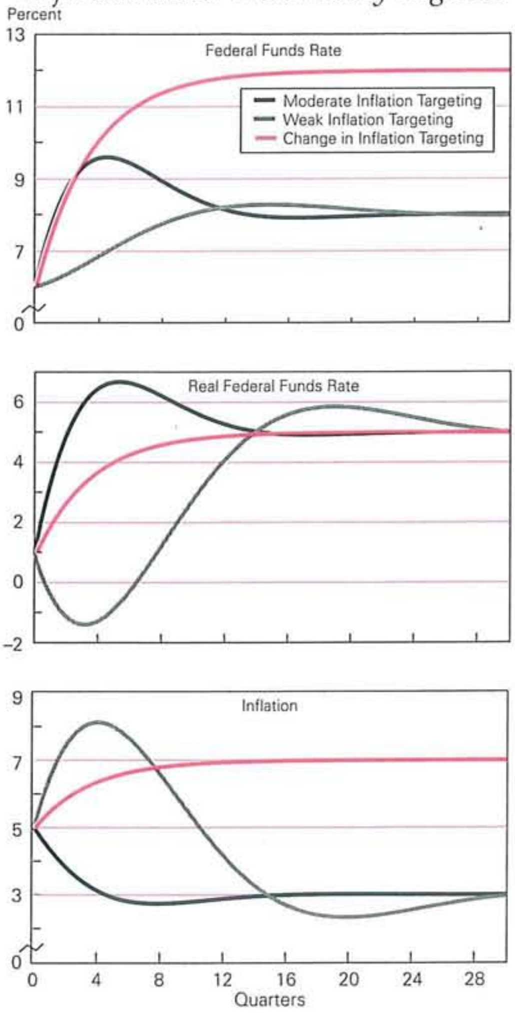
To begin, three policy regimes that target only the rate of inflation ($\alpha_y = 0$) are contrasted.[15] In the first, labeled "moderate inflation targeting," the Fed raises the funds rate by 1 percentage point per year in response to a 1 percentage point deviation of inflation from its target. In the second regime, labeled "weak inflation targeting," the Fed raises the funds rate by 5 basis points per year in response to the same deviation of inflation from target. In the third, labeled "change in inflation targeting," the Fed targets the *change* in the rate of inflation: it has no specific target level for inflation, but it raises the funds rate as long as inflation is increasing (and vice versa). As shown in Figure 2, the expected paths of inflation, the funds rate, and short- and long-term real rates differ significantly for these three policy regimes. Under moderate inflation targeting, the Fed quickly raises the nominal funds rate above its long-run equilibrium, raising the short-term real rate and the expected long-term real rate, depressing output, and lowering the inflation rate smoothly to its target. Under weak inflation targeting, the funds rate slowly rises to its long-run equilibrium, leaving the short-term and long-term real rates below their equilibrium values for over five years, and only very gradually bringing inflation under control. Under change in inflation targeting, the inflation rate drifts upward, gradually stopping at about 7 percent, while the real rates gradually approach their long-run equilibrium from below.

Given the markedly different paths of short-term real rates in these simulations, and given the dependence of the indicator variables on the expected path of short-term real rates, it should not be surprising to find that the patterns in the indicator variables for these simulations are markedly different. Remember that all the simulations begin from the same set of initial conditions; the only difference is in the degree of vigor with which monetary policy responds to deviations of inflation from target.

Figure 3 depicts the rate of inflation and the slope of the term structure, defined here as the difference between the yield on the long-term nominal bond and the federal funds rate, for the three policy regimes. Depending on how monetary policy behaves, the correlation between inflation and the slope of the term structure can be positive (the top panel, moderate inflation targeting), approximately zero (the middle panel, weak inflation targeting), or negative (the bottom panel, change in inflation targeting). Thus, the signal that the slope of the term structure provides about future inflation depends critically upon

Figure 2

Comparison of Federal Funds Rate, Real Federal Funds Rate, and Inflation under Three Policy Regimes



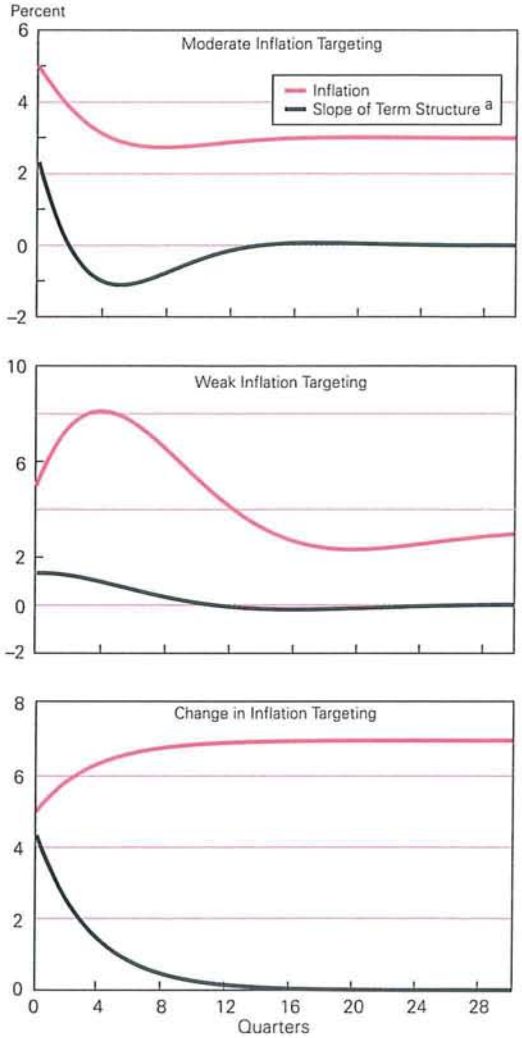
Source: Author's calculations.

[14] The simulations in this section are derived from those in Fuhrer and Moore (1992).

[15] Including emphasis on the output gap does not alter any of the qualitative conclusions.

Figure 3

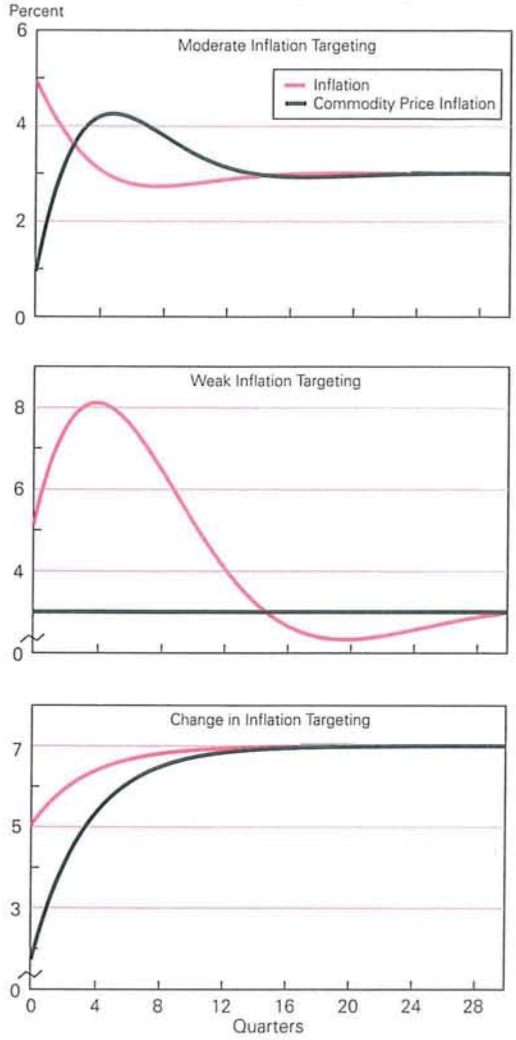
Inflation Signal Provided by Slope of Term Structure



a) As defined by the spread between the yield on the long-term nominal bond and the federal funds rate.
Source: Author's calculations.

Figure 4

Inflation Signal Provided by Nominal Commodity Price Inflation



Source: Author's calculations.

the monetary policy rule currently and expected to be in effect.[16]

A similar pattern emerges in Figure 4, in which the rate of inflation is plotted against the rate of nominal commodity price inflation for the three policy regimes. Again, the correlation between commodity inflation and price inflation can be negative (moderate inflation targeting), zero (weak inflation targeting), or positive (change in inflation targeting).

The important conclusion to draw from these simulations is that simple indicators, even the styl-

[16] The correlation between the slope of the term structure and the rate of inflation is determined by the vigor with which policy responds to inflation. A vigorous response, as in the top panel, raises the funds rate sharply, inverting the slope of the term structure, and bringing inflation down quickly. Thus the slope of the term structure falls (turns negative) at the same time that inflation is falling, generating a positive correlation.

ized indicators simulated here, cannot be used to give an unambiguous signal about the state of inflation or the stance of monetary policy. Even the sign of the simple correlation between indicators and ultimate targets depends on the monetary policy rule in effect.[17]

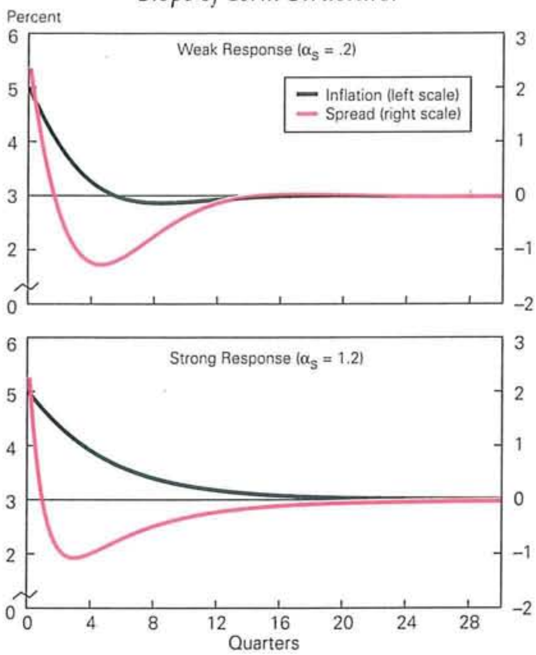
Responding to the Indicators

In the simulations described above, the signal from the indicators depends on the policy in effect, even though policy does not respond to the indicators. However, if policy responds modestly to an indicator in the "natural" way—for example, if policy raises the funds rate when the slope of the term structure steepens—it can also reverse the sense of the indicator. For example, Figure 5 displays the inflation rate and the slope of the term structure for two degrees of term-structure responses. In the first, the Fed raises the funds rate one-for-one with inflation, and also by two-tenths of a percentage point for each percentage point of steepening in the slope of the term structure. In the second, the emphasis on the slope of the term structure is increased to about 1.2 percentage points for each percentage point steepening in the slope of the term structure.

As the figure shows, the correlation between the slope of the term structure and the inflation rate reverses from the first to the second policy regime. The correlation between inflation and the slope of the term structure is 0.4 for the first regime, and −0.2 for the second. The sense of the indicator has changed: an inverted yield curve signals a high expected inflation rate.[18] Note that the inflation response of policy has not changed across these two simulations; only the response to the indicator has changed.

Figure 5

Inflation Signal Provided by Slope of Term Structure.
Monetary Policy Responds to Slope of Term Structure.



Source: Author's calculations.

Could Monetary Policy Make Use of the Indicators?

The preceding analysis has shown that, even under the most optimistic of circumstances, the signal provided by an indicator will depend strongly on the monetary policy regime in effect. As monetary policy changes the vigor with which it responds to deviations of inflation from target, for example, the correlation between the indicators and inflation can change sign, as well as magnitude. Given a moderate emphasis on inflation deviations, a modest policy response to the indicators themselves can also reverse the sense of the indicators. However, an alternative approach is to use the indicators in a purely statistical manner, simply relying on historical correlations between the indicators and the policy targets to extract the macroeconomic information in the indicators from the idiosyncratic. If the monetary policy regime has been fairly stable, this approach has some promise. This possibility is pursued in the next section.

V. An Empirical Assessment of the Value of Asset Prices as Indicators

This section will empirically assess whether the asset prices proposed in section I could have been

[17] Changes in the fiscal or monetary policy of other nations, to name two, can also affect the behavior of the indicators and their correlation with ultimate targets. These possibilities are abstracted from here, but note that they further complicate the interpretation of indicators.

[18] Once again, these are contemporaneous correlations. However, the correlations of the lagged term structure slope with inflation also change sign, just as dramatically.

Table 1
Variables Used in Test of the Value of Indicators in Forecasting Policy Targets

Variable	Definition
Policy Target Variables	
CPI inflation rate	3-month log change, annual rate
Industrial production growth rate	Total industrial production, 3-month log change, annual rate
Civilian unemployment rate	
Indicator Variables	
Federal funds rate	All interest rates converted to continuous compounding basis
3-month Treasury bill rate	
6-month Treasury bill rate	
30-year Treasury constant maturity rate	
6-month commercial paper rate	
Moody's BAA corporate bond rate	
Nominal commodity price inflation	FRB non-oil experimental commodity price index, 3-month log change, annual rate
M2 growth rate	3-month log change, annual rate
Exchange rate	Multilateral trade-weighted G-10 foreign exchange rate, 3-month log change

helpful historically in forecasting the ultimate goals of monetary policy. Two questions of interest will be addressed, both related to the characteristics of a good indicator in section I. First, do the indicators provide an advance signal of changes in the policy targets? Empirically, this translates into a test of whether today's observations on the slope of the term structure, commodity prices, and the real exchange rate significantly improve our forecasts of future inflation and real activity relative to forecasts made using only information on the policy targets themselves. Second, are the indicators useful because they (unlike the policy targets) are observable contemporaneously? Specifically, given lagged observations on both the indicators and the ultimate targets, do current observations on the indicators improve our forecasts of current inflation and real activity?

To answer these questions, a simple forecasting model will be used that explains current observations on indicators and targets with lagged observations on indicators and targets (a "vector autoregression" or VAR). As indicated by the results in section IV, indicator relationships are extremely likely to change when the monetary policy regime changes. Thus this VAR forecasting model is estimated over a range believed to constitute the most recent approximately stable policy regime. The monthly sample begins in November 1982, the end of the nonborrowed reserves operating procedure, and ends in June of 1993. Monthly data are used because the information delays for the price and real activity measures are typically one month. For example, the employment data for June are available in the first week in July; the producer price index (PPI) and CPI for June are available in the second or third week in July; and industrial production for June is available in the third week in July. The data definitions for the series used for interest rates, commodity prices, the exchange rate, inflation, and real activity are described in Table 1. The growth rate in M2 is included as a benchmark. Given the recent poor performance of M2, the indicators ought at least to exceed its performance as an indicator.[19]

Do Lagged Indicators Significantly Improve the Forecast of Targets?

To test the incremental value of lagged indicators in forecasting monetary policy targets, a VAR is estimated in which the target variables listed in Table 1 are regressed on their own lagged values, on the lags of the other target variables, and on the lags of the indicator variables listed in Table 1. Note that in

[19] The individual interest rate series are used here, rather than interest rate spreads or a summary of the overall slope of the term structure. Using spreads or slopes imposes more restrictions on the ways in which interest rates can forecast policy targets, and thus gives them less of a chance. The use of individual series gives the interest rates the benefit of the doubt.

Table 2
Value of Lagged Indicators in Forecasting Policy Targets
Percent Decrease in Average Error (Numerical Decrease in Parentheses)

Indicator	CPI Inflation	Unemployment	Growth in Industrial Production
Average Error with All Lagged Data			
Baseline Model,[a] Percent	.63	.16	2.37
Reduction in Error			
All Indicators	16.7 (.11)**	−.4 (−.00)	8.4 (.20)*
Interest Rates Only	17.3 (.11)**	−1.9 (−.00)	3.4 (.08)
Commodity Inflation	2.3 (.01)	1.1 (.00)	1.8 (.04)
Exchange Rate	1.2 (.01)	−.9 (−.00)	−1.0 (−.02)
M2 Growth	7.4 (.05)**	−1.8 (−.00)	4.6 (.11)*
All Indicators (with Spreads)	3.0 (.02)	.5 (.00)	5.7 (.14)*
Spreads	3.7 (.03)*	−.9 (−.00)	.8 (.02)

[a]The Baseline Model includes lags of all three policy targets and lags of all the indicator variables listed in Table 1. The following lines in the table indicate the increase in the standard error of regression that arises when the listed variables are excluded from the model. Components may not add to totals because of correlation among the indicators. The average error is corrected for degrees of freedom.
*indicates significance at the 5 percent level.
**indicates significance at the 1 percent level.

this "baseline" model, we include the individual interest rates, rather than spreads, as indicators. Equation (6) summarizes this forecasting system,

$$X_t = AX_{t-1} + \varepsilon_t, \qquad (6)$$

representing the set of policy targets and indicator variables as X_t, the coefficients that link current X to lagged X's as A, and the errors made by the forecasting system as ε_t.[20] Subsets of the indicator variables are then dropped from the system. If the lags of the indicator variables are important in forecasting the targets, then the fit of the regressions should deteriorate significantly. The "F-tests" reported in Table 2 measure the significance of the indicator variables in forecasting the targets, according to this criterion.

As shown in the table, neither commodity inflation nor the exchange rate provides a significant reduction in the average forecast error for either inflation or the two measures of real activity. But taken together, the lagged indicators appear to significantly improve the fit of the CPI inflation and the industrial production growth regressions, reducing the average error by 8 to 17 percent. The majority of the improvement may be attributed to the interest rate variables. None of the lagged indicators aids significantly in predicting the unemployment rate. In all cases, greater than 80 percent of the explanatory power for each of the policy targets comes from the information in the lagged policy targets.

Note that the results in Table 2 are also consistent with the standard macroeconomic relationship among short rates, credit market yields, interest-sensitive spending, and inflation. That is, interest rates may be useful in forecasting inflation and real activity because they play a part in the standard monetary transmission channel from rates to interest-sensitive spending to inflation, not because they reflect market participants' expectations about future inflation and real activity.

To distinguish between interest rates that enter because of their role in the transmission channel and interest rates that enter because of their indicator properties, the interest rates are restricted to enter the forecasting system only as *spreads* that reflect the slope of the term structure or risk differentials. Thus, instead of the full list of interest rates in Table 1, the VAR includes only a Treasury term spread (the difference between the 30-year constant maturity rate and the 6-month bill rate); a long-term risk spread (the difference between the 30-year Treasury constant maturity rate and the BAA corporate bond rate); and a short-term risk spread (the difference between the 6-month commercial paper rate and the 6-month Treasury bill rate).[21] The federal funds rate and the 3-month Treasury bill rate are excluded.

[20] Lag lengths for the vector autoregression are chosen using conventional methods.

None of the individual spreads significantly reduces the average error in predicting inflation. The long-term risk spread makes a marginal improvement to the forecast of industrial production growth. As shown in the bottom row of Table 2, the three spreads jointly improve the forecast error for inflation and industrial production growth by 3.7 percent and 0.8 percent, respectively, but insignificantly so for growth in industrial production and with only moderate statistical reliability for inflation. These results suggest that lagged interest rates help predict inflation and real activity because of their role in the standard monetary transmission mechanism, not because of their indicator properties. Altogether, these results do not suggest that the lagged indicator variables contain much important information for monetary policy targets.

Does Contemporaneous Information on Indicators Improve the Current Forecast of Targets?

The appeal of using commodity prices, exchange rates, and the slope of the term structure to aid in the conduct of monetary policy lies in part in the timeliness of these potential indicators. When information on the targets of monetary policy arrives only with a lag, the immediate observations that are available for commodities, foreign exchange, and interest rates may be of use in assessing the current state of the economy. Thus another important role for these indicators could be in providing reliable indications of the as yet unobserved current state of the economy.

One way to assess the validity of this hypothesis is to partition the information available for forecasting policy targets into lagged information and current information. The VAR is an uninterpreted set of regression equations that does just that: it assumes that each variable to be explained, x_t, depends on the contribution of lagged information, AX_{t-1}, plus the current information that could not have been predicted last period, ε_t.[22] The information can be partitioned further into policy target variables, X^T, and indicator variables, X^I, so that the current information represented by ε_t consists of "news" about the policy targets, ε^T, and news about the indicators, ε^I.

$$\begin{bmatrix} X_t^T \\ X_t^I \end{bmatrix} = \begin{bmatrix} A_{TT} & A_{TI} \\ A_{IT} & A_{II} \end{bmatrix} + \begin{bmatrix} \varepsilon_t^T \\ \varepsilon_t^I \end{bmatrix} \qquad (7)$$

The analysis in the preceding section abstracted from the current information, assessing only which lagged variables (X_{t-1}) were important in predicting today's policy targets.

Current observations on the indicators will improve the current forecast of the unobservable policy targets if the news about indicators is correlated with the news about policy targets (that is, if ε_t^T is correlated with ε_t^I). To make the discussion concrete, consider a forecast of the CPI inflation rate for June 1993. Suppose the forecast for June 1993 using all the information up through May 1993 is 3 percent. The CPI for June will not be released until July of 1993; however, monetary policymakers would still like to know if the current readings of the indicators are signalling a significant change in inflation. Because they can observe interest rates, commodity prices, and exchange rates for June, they can (in principle) use that information to improve their forecast of the CPI for June. They will be able to improve their forecast if, on average over history, the news (the incremental information above and beyond that contained in the lagged data) in the current month's indicators has been correlated with the news in the policy targets.

Suppose that, historically, exchange rates that were higher than the lagged data would have predicted were associated with inflation rates higher than those that the lagged data would have predicted. Then, if the June observation for the exchange rate is higher than the lagged data predicted for June, policymakers would revise the 3 percent inflation forecast upward. The amount would depend on the correlation between exchange rate and inflation news over history. The term "indicator coefficient" will denote the numbers that tell how to revise a forecast of a policy target, given a contemporaneous observation on an indicator. In the VAR forecasting system summarized in the equations in (7), these coefficients are obtained by regressing the forecast error for a policy target on the forecast errors for the indicators.

Table 3 presents the average forecast error made by the forecasting equations summarized in (7) using only lagged data (the top row), and the percentage decrease in the average forecast error from including

[21] The private term spread, the difference between the BAA corporate rate and the 6-month commercial paper rate, is not included because it can be formed as the government term spread plus the long-term private risk spread less the short-term private risk spread. It is thus perfectly collinear with these other regressors, and cannot be included in the regression.

[22] See Fuhrer (1993) for a discussion of this methodology. For this monthly VAR, 2 to 5 lags of each of 12 variables are included, leaving 79 to 91 degrees of freedom from 128 observations.

Table 3
Percentage Reduction in Average Forecast Error from Including Contemporaneous Observations on Indicator Variables

	Policy Target		
Information Included	CPI Inflation	Unemployment	Growth in Industrial Production
Lagged Variables Only (Average Error)	.63	.16	2.37
Lagged plus All Contemporaneous	3.6	8.4	9.7
Lagged plus Interest Rates	2.7	4.7	5.6
Lagged plus Commodity Prices	.0	.0	.0
Lagged plus Exchange Rate	.1	.1	.0
Lagged plus M2 Growth	.8	1.9	4.2

Table 4
Indicator Coefficients[a] and Significance of Individual Indicators for Each Policy Target

	Policy Target		
Indicator	CPI Inflation	Unemployment	Growth in Industrial Production
Federal funds rate	−.13	−.17*	−.25
3-month T-bill rate	1.13	.37	−4.98
6-month T-bill rate	−.49	−.49	7.72
30-year Treasury rate	.59	−.29*	3.03
6-month commercial paper rate	−.48	.19	−1.05
BAA corporate bond rate	−.62	.32*	−2.17
Commodity inflation	−.00085	−.00014	.00041
Exchange rate appreciation	−.0019	−.00051	.0018
3-month growth in M2	−.085	−.032*	.73**

[a]Percentage point revision in the target variable that accompanies a 1 percentage point surprise in the indicator variable.
*indicates significance at approximately the 10% level, ** at the 5% level.

contemporaneous observations on the indicators.[23] As the table indicates, adding contemporaneous observations on all the indicators decreases the average forecast error by 3.6 percent for inflation, 8.4 percent for unemployment, and 9.7 percent for industrial production growth. The interest rate indicators account for most of the inflation improvement, more than half of the unemployment improvement, and more than half of the industrial production growth improvement. Growth of nominal M2 improves the inflation forecast by a bit less than 1 percent, while it improves the industrial production growth forecast by 4.2 percent. Remember that these are percentage decreases in forecast errors: a 3.6 percent decrease in the average inflation error lowers the error from 0.63 percentage points to 0.61 percentage points.

The next table shows which individual indicators contribute most to improving the contemporaneous forecast of policy targets, in terms of both economic significance and statistical reliability. Perhaps the most notable feature of Table 4 is the relative scarcity of statistically reliable indicators of policy targets. (Reliability is denoted by one (weak reliability) or two (stronger reliability) asterisks.)[24] All of the data are expressed in equivalent units (percent per year), so the indicator coefficients should be interpreted as the percentage point revision in the target variable that accompanies a 1 percentage point surprise in the

[23] The results in Table 3 are based on an unrestricted vector autoregression in the levels of the variables listed in Table 1. In addition, vector autoregressions that explicitly include interest rate spreads (the risk spread between the 6-month commercial paper rate and the 6-month Treasury bill rate, the risk spread between the BAA corporate bond rate and the 30-year Treasury constant maturity rate, and the term spread between the 30-year Treasury constant maturity rate and the 6-month Treasury bill rate), and vector autoregressions that imposed cointegrating restrictions using Johansen's method were estimated (Johansen and Juselius 1990). The qualitative results did not depend upon these alterations or combinations of them. Including the spreads explicitly imposes simple linear restrictions on the unrestricted vector autoregression. Imposing cointegrating restrictions based on data from such a short sample is generally undesirable. However, since monetary policy can certainly affect the order of integration and the dynamic correlations of all of the nominal variables in the data set, using data from earlier monetary regimes would also be unadvisable.

[24] Because the indicator coefficients depend upon the estimated forecasting coefficients in equation (6), more stringent measures of statistical reliability must be applied. As a rough approximation, the cutoff points in the standard t-distribution for 5 percent and 1 percent significance are used as the significance levels for 10 percent and 5 percent, respectively.

indicator variable.[25] Note that none of the indicator variables reliably signals changes in CPI inflation. Of all the indicator/policy target pairs, only M2 growth provides a strongly reliable signal about contemporaneous growth in industrial production.

Interestingly, the money growth indicator performs as well as any other indicator in the set considered. This places the modest "success" of the indicators in predicting inflation and output in perspective. After all, as the beginning of this article notes, the Federal Reserve System has abandoned money growth as the primary indicator of the stance of monetary policy, because its relationship with the ultimate targets is too unreliable.

Finally, the modest improvements to forecast performance afforded by the indicators should be taken as upper bounds to the indicator information unique to the proposed indicators. We have included only three measures of inflation and real activity in the lagged data. A host of other measures have been excluded: disaggregated expenditure categories such as consumption, investment, trade balance, and fiscal stance; and other high-frequency (but still observed with a delay) data, such as orders and housing starts, that are thought to provide early, direct measures of changes in the state of the macroeconomy. The inclusion of these data in the vector autoregression would almost certainly decrease the importance of both the lagged and the contemporaneous observations on the indicators in forecasting policy targets.

VI. Conclusions

A good indicator of the ultimate targets of monetary policy is hard to come by. Most variables that are contemporaneously observable are quite volatile and do not respond primarily to changes in aggregate real activity and inflation. Even indexes that combine the more disaggregated variables exhibit large swings that are only weakly correlated with movements in policy targets.

If it were possible to construct an ideal indicator that averaged away all idiosyncratic market influences, it might still be hard to interpret its signals. As shown in section IV, the expected correlation between ideal indicators and policy targets varies dramatically across different monetary policy regimes. If policy were to respond directly to signals from the indicators, this would make it more difficult to interpret their signals.

Putting these *a priori* concerns aside, the accuracy and reliability of potential indicators can still be tested by measuring their contribution to forecasts of policy targets during the most recent, presumably stable, monetary policy regime. This study tests to see whether indicators provide significant incremental information about future or contemporaneous policy targets. The results suggest that the lagged indicators taken together can reduce the average forecast error for inflation by about 10 basis points, for unemployment by essentially zero, and for growth in industrial production by about 20 basis points. The modest improvement in inflation appears to arise primarily from the inclusion of interest rate variables, and not commodity prices or the exchange rate. The improvement in the industrial production forecast is attributed evenly to the interest rate variables and to M2 growth, which accounts for about 10 basis points.

The contemporaneous observability of the indicators, while in principle an appealing characteristic, in practice appears to be of relatively little use. Using the contemporaneously observable indicators to update a forecast based on lagged information yields very modest improvements. The results presented here suggest that this information would improve the current-period forecast error by less than 4 percent for inflation—about 2 basis points—and by 8 to 9 percent for unemployment and industrial production growth. Moreover, no single indicator provides an economically important and statistically reliable signal of inflation or real activity. This complicates the proposed simplicity of the indicator approach, as the net effect of movements in a combination of indicators must be understood in order to reliably improve a forecast of policy targets. Overall, this study suggests that using indicators as guides to monetary policy is neither less complicated nor more reliable than the macroeconomic modeling approach described in section I.

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[25] As indicated in Figure 1, commodity price inflation is much more volatile than CPI inflation, so its indicator coefficient is much smaller than the coefficients on more stable indicators, such as the 3-month Treasury bill rate. The same is true of the change in the exchange rate. Industrial production growth is the most volatile of the policy targets, and thus all of its indicator coefficients are larger than their counterparts for the other two policy targets.

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