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The Monetary Transmission Mechanism: An Empirical Framework

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The purpose of this paper is to present a simple framework for analyzing the monetary transmission mechanism: the process through which monetary policy decisions are transmitted into changes in real GDP and inflation. There are, of course, many different views of the monetary transmission mechanism. These views differ in the emphasis they place on money, credit, interest rates, exchange rates, asset prices or the role of commercial banks and other financial institutions.

The particular framework presented in this paper is one that has been evolving over the last several years as the result of empirical research by many economists, including myself. Some of this research has been conducted as part of the work constructing structural models of international financial markets as summarized in the empirical review by Bryant, Hooper and Mann (1993) or the theoretical exposition of Henderson and McKibbon (1993). In fact, the monetary framework presented here is inherently international in its scope, with changes in the exchange rate playing a key role in the transmission mechanism. Other research relating to this particular framework has been conducted by those designing structural models for the evaluation of U.S. monetary policy, as exemplified by recent work by Fuhrer (1994).

I argue that the results of this research, while not leading to any single specific mainstream model of the monetary transmission mechanism, have a number of common structural characteristics and thereby constitute a general framework for discussion and analysis. I also argue that the framework is a good empirical way to evaluate policy or to assess whether changes in the monetary transmission

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mechanism have occurred over time. The framework passes a number of empirical tests quite successfully. Its structure has foundations in economic theory, and its simplifying assumptions closely match the current institutional structure of the world's highly mobile and increasingly securitized financial markets. Moreover, the framework stands up very well against other frameworks that have been proposed, some of which are discussed in this symposium.

I will begin by describing this framework in general terms, and then offer examples of its key policy implications. I will also consider several important criticisms that have recently been raised about the framework. Because this year is the 25th anniversary of the publication of Milton Friedman's (1970) well-known theoretical framework for monetary analysis, I conclude the paper with a brief assessment of how the framework discussed here differs from Friedman's framework and thereby comment on the progress that has been made in this area during the last 25 years.

The Exchange Rate, the Long Rate and the Short Rate

The most distinguishing characteristic of the view of the monetary transmission mechanism described here is its focus on *financial market prices*—short-term interest rates, bond yields, exchange rates and so on—rather than on *financial market quantities*—the money supply, bank credit, the supply of government bonds, foreign denominated assets and so on. This focus is the result of a number of simplifying assumptions with particular policy applications and data availability in mind. While quantities are no less important than prices in models of financial markets—as in the most basic supply and demand model of any market—it turns out that measurement problems have forced econometric modelers away from the quantity of credit and foreign exchange toward the prices of these items.

Much has been made of the unreliability of any one measure of the money supply because of recent changes in technology and regulation. In fact, the demand for money function—at least for the M1 and the M2 definitions—seems to have shifted substantially in recent years.[1] The measures of credit flows, sometimes proposed as an alternative to the money supply, have been at least as unreliable. Even those researchers who have found an important role for credit have not found a stable structural relationship between an aggregate measure of credit and GDP or inflation. It is for these reasons, in my view, that many empirical researchers inter-

[1] This lack of reliability does not mean that research on alternative measures of the money supply is fruitless. On the contrary, in my view, such research is very useful. If there were a measure of the money supply with a reasonably stable or predictable velocity, monetary policy could focus on such a quantity and place less emphasis on the interest rate. With a more stable velocity, money supply targets would have advantages over interest rate–oriented policies. Money supply targets are explicit about the nominal anchor for the price level and thereby give policy a long-run focus. Money targets also imply a quick and automatic response of interest rates to business cycle fluctuations, and they provide an easy way to convey monetary policy goals and actions to the general public.

ested in estimating structural models have opted for this financial market prices approach rather than one of the quantity approaches.

Which Financial Market Prices?

To explain the impact of a change in monetary policy on real GDP and inflation (that is, to model the monetary transmission mechanism) using a financial market prices framework, it is usually necessary to focus on at least three types of prices: exchange rates, long-term interest rates and short-term interest rates. Of course, there are many exchange rates and interest rates. Most typically, researchers focus on bilateral exchange rates between countries, a single short-term interest rate and a single long-term interest rate.

While in theory many other interest rates are relevant to monetary policy, the many short rates are highly correlated during cyclical fluctuations, and it is difficult to provide a stable structural model of the systematic spreads between the various short rates (due perhaps to risk or credit constraint factors). Hence, research has focussed on a single short rate (Brayton and Marquez, 1990). That rate is usually a short-term private market rate, such as the "federal funds" rate in the United States or the "call money" rate in Germany. Similarly, there is a great degree of correlation between the various long rates for any one maturity. A simplifying assumption is thus to concentrate on a single rate for a single maturity—like 10-year government bonds.

Decisions about how many different interest rates to include or what particular interest rates are most relevant are empirical judgments similar to the decisions that must be made when estimating a demand curve for any product. There are many different types of tea, and there is a price for each of these many types; to estimate the demand for tea one has to decide which of these many prices to use. In practice, the price of a representative type of tea, or an average of several types, is used.

Real Versus Nominal Interest Rates and Exchange Rates

The distinction between real interest rates and nominal interest rates is, of course, crucial when studying the monetary transmission mechanism. The relationship between real interest rates and nominal interest rates is guided by two key assumptions that underlie most financial market price models: rational expectations and rigidities of wages and goods prices. Although rational expectations is sometimes thought to imply perfectly flexible wages and goods prices, most empirical rational expectations models of the transmission mechanism assume temporary wage or price rigidities. In such models, rational agents are assumed to make forecasts assuming prices are sticky in the near future. For example, the expected rate of inflation is assumed to be based on a rational expectations forecast of the percentage change in the average level of prices in the economy taking account of the stickiness in this average price level. While this assumption may not be empirically accurate in all cases, it is a convenient baseline assumption that can be modified in particular applications.

An increase in the nominal interest rate will bring about an increase in the real interest rate if the rationally expected inflation rate does not increase by the same amount. Because of slow adjustment of goods prices, the expectation of changes in goods prices over short time horizons will also adjust slowly if expectations are rational. Hence, an increase in the nominal interest rate results in a change in the real interest rate, over the time period where prices and expectations are adjusting.

The distinction between real exchange rates and nominal exchange rates is also important. Because of slow adjustment of wages and goods prices, an increase in the nominal exchange rate usually brings about an increase in the real exchange rate in the short run. Over the long run, however, the real exchange rate will converge to its equilibrium value as prices and/or nominal exchange rates adjust.

Brief Schematic Overview

To understand how this monetary transmission mechanism works, first consider a brief, highly simplified overview. Suppose that a monetary policy action is taken that changes the short-term interest rate. In turn, the change in the short-term interest rate has an effect on both the exchange rate and on the long-term interest rate. Of course, one should remember that the short-term interest rate is only one of many factors affecting the exchange rate and the long-term interest rate, and the effects of the short-term interest rate on both are uncertain and variable over time. In any case, given the rigidities in the economy, these changes in *nominal* exchange rates and interest rates in turn affect *real* exchange rates and *real* interest rates. The changes in real rates then have a short-run effect on real net exports, real consumption and real investment and thereby on real GDP. After the short run, however, wages and goods prices begin to adjust, and as they do, real GDP returns to normal. In the long run the real interest rate and real exchange rate return to their fundamental levels.

Thus, the linkage is from short-term interest rates, to exchange rates and long-term interest rates, and finally to real GDP and inflation. But, for an important reason, this is not the end of the story. As described below, the links of the monetary transmission actually form a circle, with the circle being closed by linking the movements in real GDP and inflation back to the short-term interest rate through a policy rule or reaction function.

Determining the Short-Term Interest Rate

Textbook stories of how monetary policy affects short-term interest rates usually begin with a stable demand for money, in a model in which aggregate money demand depends on the short-term interest rate as well as on income. The central bank can then affect interest rates by controlling the supply of money; for example, increasing the supply of money would result in lower short-term interest rates.

This story is logically precise and easily incorporated into the monetary transmission framework, but it also suffers from two grave inadequacies and has not been followed by most empirical researchers in recent years. First, the money demand equations appear to be too unstable to yield a reliable estimated effect of a given change in the money supply. Second, central bank behavior is not accurately described by such one-time changes in the money supply. Instead, most central banks today are taking actions in the money market to guide the short-term interest rate in a particular way. In other words, rather than changing the money supply by a given amount and then letting the short-term interest rate take a course implied by money demand, the central banks adjust the supply of high-powered money so as to give certain desired movements to the federal funds rate.

A complete story of the monetary transmission mechanism should thus include a description of the central bank's reaction function showing how the central bank adjusts the short-term interest rate in response to various factors in the economy, including real GDP and inflation. Bryant, Hooper and Mann (1993) provide a review of many examples of such central bank reaction functions, or policy rules, that appear in the literature.

Using this expanded framework of the monetary transmission mechanism—that is, one which includes a reaction function for the Fed other than a fixed money supply—policy analysis involves finding alternative reaction functions for the central bank. By examining different types of reaction functions within this framework, monetary economists can determine which reaction functions work well and which do not. The advice to policymakers that evolves from such a framework is how much to raise or lower the interest rate in response to given changes in the economy. For example, I have proposed a simple interest rate rule in which the federal funds rate reacts to two variables: the deviation of inflation from a target rate of inflation; and the percentage deviation for real GDP from potential GDP, with the reaction coefficient being one-half for each variable (Taylor, 1993b).

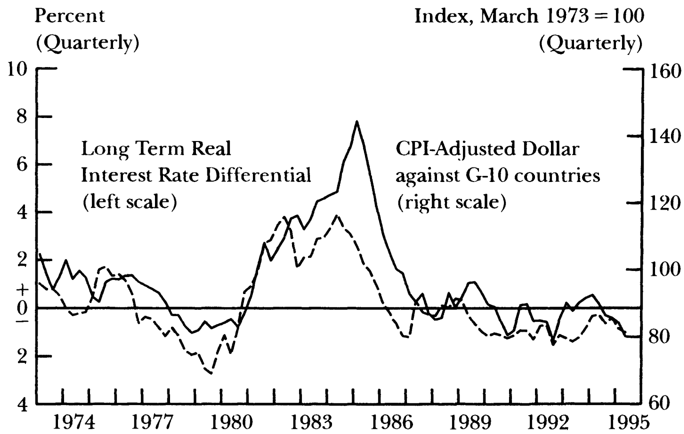
Determining the Exchange Rate

As summarized above, the exchange rate is a key variable in the monetary policy transmission mechanism. But how does monetary policy affect the exchange rate and thereby affect net exports? A high degree of international financial capital mobility currently exists around the world. As Robert Mundell (1962) showed long ago, capital mobility implies a very simple relationship between short-term interest rates and the exchange rate: the *interest rate parity relationship* states that the interest rate differential between any two countries is equal to the expected rate of change in the exchange rate between those two countries.[2] If this relationship did not hold, of course, then capital would flow to the country with higher returns until the expected returns were again equalized in both countries.

Hence, one sees in theory how monetary policy can affect the exchange rate: if the central bank takes actions to raise the short-term interest rate, then, according

[2] Mundell (1962) assumed static exchange rate expectations so that the expected rate of change in the exchange rate is zero. With the replacement of static expectations by rational expectations, the Mundell assumption becomes the one stated here.

Figure 1
The Relationship Between the Real Exchange Rate and the Real Interest Rate Differential in the United States



to this interest rate parity relationship, the exchange rate should rise in order that expectations of an exchange rate decline can equalize rates of return at home and abroad. A positive relationship should exist between the exchange rate and the interest rate differential between any two countries. Figure 1 illustrates how empirically accurate the theory has been in recent years; the larger and longer swings in interest rates and exchange rates seem to be described accurately, though the high frequency movements are not.

A considerable literature has developed to try to explain the higher frequency deviations from the interest rate parity relationship.[3] A well-accepted explanation has yet to be found. Changes in risk premia on foreign assets or deviations from rational expectations (perhaps speculative bubbles) may explain the discrepancy. McCallum (1994) argues that monetary policy itself may explain the discrepancy if an endogenous monetary policy is leaning against the wind and resisting exchange rate changes.

A structural model that in principle can explain deviations from interest rate parity is a portfolio balance model with assets denominated in different currencies treated as imperfect substitutes for each other. Such an approach of course has theoretical merit, but the lack of data on bilateral capital flows between countries has made such an approach difficult in practice as a way to explain deviations from interest rate parity in any systematic way. A portfolio balance approach also adds a great deal of complexity to any model of the transmission mechanism. Because no

[3] To be sure, this interest rate parity relationship holds very closely when the exchange rate risk is covered in forward markets. It is the uncovered interest rate parity that is less accurate.

single explanation for deviations from interest rate parity has been widely accepted, it is typical to use an interest rate parity equation with a stochastic term, similar to the residual from an estimated regression equation, as explained by Helliwell, Cockerline and Lafrance (1990).

Interest rate parity explains why changes in nominal short-term interest rates would affect nominal exchange rates. Given the temporary rigidities in the prices of goods and services, as described earlier, lower short-term rates would reduce the real exchange rate in the short run. In the long run, however, the change in monetary policy would have no effect on real GDP; the price level would be higher by the same percentage amount by which the central bank increased the money supply as implied by the initial reduction in short-term interest rates, and the exchange rate would return to its previous base line path.

There is substantial empirical evidence from many countries that a change in the real exchange rate affects the demand for real exports and real imports. In particular, there is a statistically significant negative relationship between the real exchange rate and real net exports: that is, a higher exchange rate leads lower real exports and higher real imports (Taylor, 1993). Since real net exports are a component of real GDP, a change in real net exports implies that real GDP will change if the other components of real GDP—consumption, investment and government purchases—do not immediately shift by the same amount in the opposite direction. With the slow adjustment of wages and goods prices assumed in this framework, a change in real net exports does change real GDP. The inverse relationship between the exchange rate and net exports is one of the more robust in empirical economics. The United States went through a vivid illustration of the relationship in the mid-1980s when the real exchange rate peaked at about the same time as net exports reached a trough (Taylor, 1995).

Determining the Long-Term Interest Rate

It is difficult to determine on theoretical grounds whether the short-term interest rate or the long-term interest rate has a greater effect on consumption and investment; changes in the form of debt instrument—for example, the introduction of variable rate mortgages—are likely to change the relative importance of long versus short rates. However, there is surely some a priori reason to believe that for long-term decisions like buying a house or investing in plant and equipment, the long-term interest rate should be the variable of greater interest. To the extent that it is the long-term interest rate that is important for consumption and investment demand, the monetary transmission mechanism depends on how monetary policy affects the long-term interest rate.

The *expectations model of the term structure* is the key relationship between short rates and long rates according to the financial market prices view of the monetary transmission mechanism presented here; that is, the long rate is given by the expected weighted average of future short rates appropriate for the maturity of the long bond. If the central bank takes actions to raise short-term interest rates and market participants expect the short-term rate to decline gradually back to the starting value in the future, then the long rate will rise less than the short rate. On the other hand, if the central bank takes action to raise the short-term rate and market participants expect that this increase is just the first stage of a longer sequence of increases, then the long rate will rise by more than the short rate.

Certainly, there are factors other than short-term interest rates or their expectations that are influencing bond prices.[4] As with exchange rates, changes in risk premia or speculative bubbles are possibilities; my own empirical estimates indicate that these other factors are at least as important as changes in short rates. Also, as with foreign exchange market models, there have been attempts to structure a portfolio balance model consisting of bonds of different maturities, as a way of improving on the expectations model. However, while researchers sometimes find bond supply effects—that is, a change in the supply of long bonds affects the term structure—the effects are too small to explain the errors in the term structure equations on a systematic basis. For this reason the supplies of long bonds versus short bonds have not been the focus of empirical models of the monetary transmission mechanism. Nevertheless, despite these concerns, it remains true that changes in short rates are empirically significant factors in changes in long rates.

The expectations model of the term structure explains why changes in nominal short-term interest rates would affect nominal long-term rates. Given the temporary rigidities in the prices of goods and services, as described earlier, lower short-term rates would reduce the real longer-term rate, at least for a time. In the long run, however, the change in the money supply would have no effect on real GDP. As already described, the real long-term rate would return to the path determined by fundamental economic factors.

In theory, an increase in the real interest rate raises the price of currently purchased goods compared to goods purchased in the future and thereby reduces demand. In fact, there is strong empirical evidence that both consumption and investment are negatively related to the real interest rate. This point is frequently disputed. In fact, the opposite position that there is little or no relationship between real interest rates and consumption or investment is frequently offered as a criticism of the financial market prices framework. I will come back to this point when discussing the criticisms of this framework below. Durable consumption, business fixed investment, residential investment and even inventory investment are negatively related to the real interest rate in many countries.

[4] The expectations model of the term structure works very well when the risks of interest rate changes are covered, but like the interest rate parity assumption for exchange rates, it appears to be much less accurate when the risks are not covered.

Policy Implications

I consider two examples of the types of policy results that can emerge from such a framework for the monetary transmission mechanism.

Fixed or Flexible Exchange Rates?

Central bankers must decide whether the exchange rate should be an explicit goal of monetary policy. Will fixed or flexible exchange rates yield better economic performance? To answer this question, one can simulate two different types of policy rules for central banks using the above framework.

One policy rule targets the exchange rate; with a high degree of capital mobility this implies a loss of international monetary independence, in that countries with fixed exchange rates must have their short-term interest rates moving together. But such a rule results in less exchange rate volatility and therefore less real export volatility; these factors work to reduce real GDP variability and inflation variability.

The second monetary policy rule does not target the exchange rate at all; rather, the monetary authorities adjust the interest rate in response to domestic developments. In this case the central bank maintains monetary independence and thereby can take actions to reduce real GDP and inflation variability, although exchange rates are more volatile.

Which rule works better? Simulations of these two types of rules have generally yielded the result that flexible exchange rate policies work better in keeping the variability of real GDP and inflation low. According to my calculations, this is true for exchange rate policies among the United States, Japan and Europe.

The Choice of Monetary Policy Rule

A second important policy question concerns the optimal monetary policy rule for the central bank to use within a flexible exchange rate system. Results are less definitive on this question than on the question of fixed versus flexible exchange rates. My reading of the results reviewed in Bryant, Hooper and Mann (1993) is that an interest rate reaction function that responds partly to inflation (or the aggregate price level) and partly to real GDP works well. As described above, I have proposed a simple rule based on that finding in Taylor (1993b). That rule has turned out to describe recent Federal Reserve policy very accurately.

However, much more research is needed on the question of the optimal monetary policy rule, not only for the United States but for other countries as well. What should be the size of the reaction coefficients? What should be the role of discretion in implementing the policy rule? Using a different monetary transmission framework than the one presented here, but a similar policy evaluation methodology, McCallum (1994) has found that a policy rule based directly on the monetary base works well in both the United States and Japan. More research is needed to sort out these different policy evaluation results.

Changes in the Monetary Policy Transmission Mechanism

Questions about whether the monetary transmission mechanism has changed seem to recur at about the same frequency as the business cycle. During the boom of 1987 and 1988, for example, when inflation was rising and the Fed was raising interest rates, many speculated that the impact of monetary policy had changed from earlier business cycles, and that higher interest rates would now be required to dampen demand and remove inflationary pressures from the economy. At the same time, many thought that the response of inflation to the boom seemed unusually low, and studies were conducted exploring whether the relationship between unemployment and inflation had shifted. About one business cycle later—in 1994 and 1995—similar questions were being raised. Why has investment remained so strong despite the rise in interest rates? Why has inflation seemed so low as the economy passes full capacity levels? More generally, has the monetary transmission mechanism changed since the last cycle?

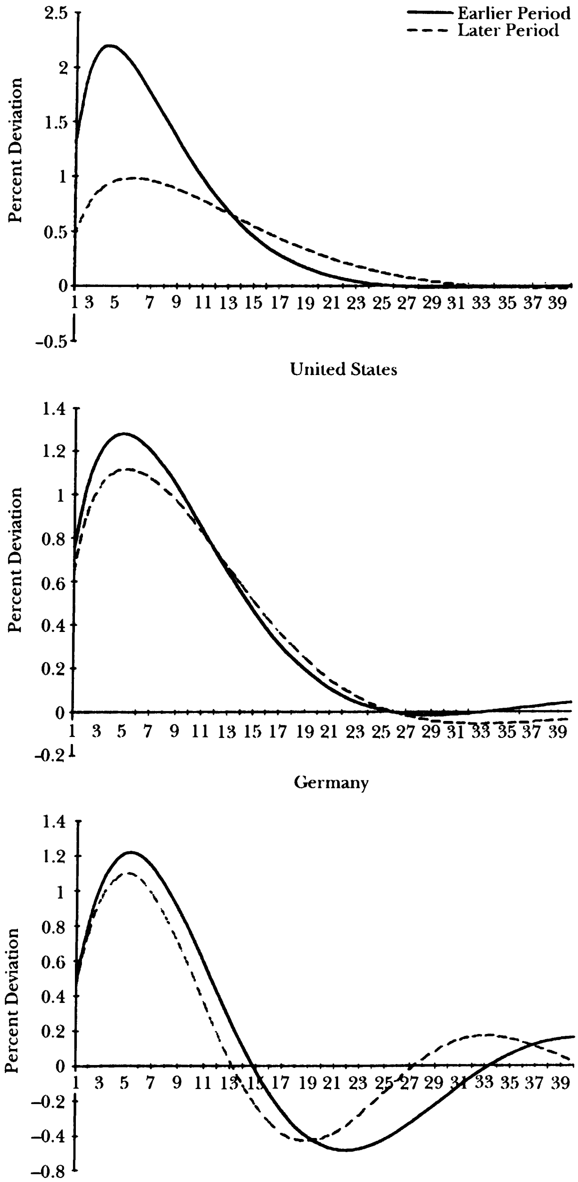
The financial market prices framework for the monetary transmission mechanism can be used to answer these questions. For example, I estimated an empirical model of the monetary transmission mechanism in the United States, Canada, Germany, France, Japan, Italy and the United Kingdom.[5] Elasticities were estimated with data from two sample periods, one from the early 1970s through the mid-1980s and the other through the mid-1990s. A comparison of these two sets of estimates gives a sense of the magnitude of change in the monetary transmission mechanism over time. In the United States, the interest rate elasticity of investment has declined, but the interest rate elasticity of consumption has increased. However, there is no general pattern of change in these interest rate elasticities when looking at the group of seven major economies.

The differences in the impact of monetary policy are illustrated in the three panels of Figure 2. The three panels show the response of real GDP to a shift in the monetary policy reaction function in the United States, Germany and Japan. In each case, the shift is equal to a 3 percent increase in the path of the target price level in the central bank's reaction function, equivalent to a temporary increase in the target rate of inflation, which implies a temporary reduction in the interest rate and thereby a temporary boost to real GDP.

The real GDP responses are shown for the coefficients estimated through both the earlier and the later period. The figures should make clear that real output responds differently to monetary policy in the three countries and that on balance the monetary transmission mechanism has changed so as to reduce the impact of a given change in short-term interest rates. The change in the United States is larger than in Germany and Japan.

[5] Functional forms of all the equations, as well as empirical results for the seven countries, are available on request from the author. Taylor (1993a) offers additional details on estimation and simulation.

Figure 2
Real Output Effect of Shifts in Monetary Policy: United States, Germany, Japan



Note: The shift in policy is an unanticipated permanent 3 percent increase in the target price level in the monetary policy rule assumed for the Fed, the Bundesbank or the Bank of Japan. This implies an eventual 3 percent increase in the level of the money supply. The effect is shown for parameters estimated both from 1972 through 1986 (earlier period), and through 1993 (later period).

Response to Criticism

The financial market price framework presented in this paper is one of several views of the monetary policy transmission mechanism that have been proposed. Other frameworks emphasize the importance of credit (Bernanke, 1986; Stiglitz and Greenwald, 1993) or money (Brunner and Meltzer, 1972b; McCallum, 1994; Meltzer, this issue). It is not surprising that the financial market prices framework described in this paper has come under criticism. In this section I discuss some of this criticism, with a particular emphasis on that posed by Eichenbaum (1994), Stiglitz and Greenwald (1993) and King and Watson (1996).

A frequent criticism of a price-oriented rather than quantity-oriented approach to the monetary transmission mechanism is that the price elasticities are not statistically significant (Stiglitz and Greenwald, 1993; Eichenbaum, 1994). However, many empirical studies reported by many authors working with data from many countries suggest otherwise. Consider, for example, two recent studies. Reduced form estimates by Romer and Romer (1994) show that there is a large negative effect of changes in the federal funds rate on real GDP. Their regression output shows that the effect is highly significant in postwar U.S. data. Or, consider structural estimates. In my estimated multicountry model (Taylor, 1993a), I find that all three components of fixed investment—business equipment, business structures and residential—are significantly related to the real interest rate in the United States. In every one of the G-7 countries, fixed investment is negatively related to the real interest rate. I also have found that consumption and inventory investment are highly sensitive to real interest rates in most of these countries.

These recent studies are just the latest in a long history of empirical research finding negative interest rate effects. Building on his 1963 paper, Dale Jorgenson alone has created volumes of empirical studies that show a negative interest rate elasticity of investment. Many econometric models based on the Jorgenson approach have found negative interest rate effects on investment. To be sure, like any piece of empirical work, all these empirical studies can be criticized. But at a minimum, they demonstrate that there is little ground for claiming a consensus that interest rate effects on real spending are insignificant.

Moreover, empirical studies have found a strong negative relationship between exchange rates and net exports as mentioned above. As interest rate changes cause exchange rate changes, this adds to the negative effect of interest rates on real GDP.

A second criticism is that economists do not know which interest rate matters for investment and that only one or two interest rates cannot do justice to all the other price effects that are important in the monetary transmission mechanism. Eichenbaum (1994) rhetorically asks "Which rate?" matters for investment, implying that we do not know. As a theoretical matter, I plead guilty to this criticism. Yes, the five-year bond rate and the mortgage rate are also important. Tobin's q may be a better measure of the impact of monetary policy than a single long-term interest rate. Indeed, many unobservable shadow interest rates on durable assets will affect the demand for consumption and investment, as Brunner and Meltzer

(1972a) have long argued. As an empirical matter, however, one must choose a limited number of prices if one is to estimate a demand curve. This is the nature of empirical work in any area of economics. In estimating the demand for peanuts, one is likely to settle on a single price index for peanuts rather than include the prices of 15 or 20 different types of peanuts in the demand equation. There are clearly other choices than the real long-term interest rate suggested here, but one has to make some choice to get any answer in empirical work.

A third point, also raised in Eichenbaum (1994), is that the framework implies a tradeoff between the *variability* in inflation and the *variability* in real GDP, while such a tradeoff is not observed empirically across different countries. To be sure, Eichenbaum is not referring to a long-term Phillips curve–type tradeoff between the *levels* of real GDP and the *levels* of inflation, which is neither implied by the financial market prices framework nor present in the historical data. But, in any case, I think it is an open question whether a variability tradeoff is observed in international data. A recent study by Owyong (1994), in a Ph.D. dissertation at Stanford, has found that if one controls for central bank independence—perhaps a measure of central bank efficiency—then there is a strong negative relationship between the variability of inflation and the variability of real GDP across countries.

A fourth criticism is that the financial market prices framework is not consistent with the empirical regularity that interest rates are negatively correlated with lead values of real GDP (King and Watson, 1996), nor with the regularity that interest rates are positively correlated with lead values of inflation (Eichenbaum, 1994)—that is, interest rates in one time period Granger-cause real GDP or inflation in the next few periods. Fuhrer and Moore (1995) have shown this criticism to be misguided. If one views monetary policy as described by the interest rate policy rule mentioned above, then higher interest rates occur as the central bank responds to higher inflation; these interest rates then lead to a decline in real GDP for the reasons described above. And because wages and prices are sticky, inflation is persistent, so that the increase in interest rates may be followed by higher rates of inflation before inflation again begins to decline.

Conclusion

It was 25 years ago this year that Milton Friedman (1970) laid out his views of the monetary policy transmission mechanism in a paper entitled "A Theoretical Framework for Monetary Analysis." That paper, along with a companion piece published the following year, brought forth heated criticism and comment from many leading monetary scholars including Allan Meltzer, Karl Brunner, James Tobin and Don Patinkin. Their criticism and Friedman's reaction were collected first in a special issue of the *Journal of Political Economy* and later in a book edited by Robert J. Gordon (1974).

Friedman's (1972, p. 909) aim in those papers was to "outline a general approach that could suggest what empirical issues required study, an approach that could then be elaborated in further detail in connection with such empirical studies." How have models of the monetary transmission mechanism—using the framework described in this paper as a basis of comparison—progressed in the 25 years since Friedman and his critics wrote? It appears to me that the progress has been substantial.

First, the framework has been internationalized; changes in exchange rates are now a key part of the monetary transmission mechanism, and we now have an explicit empirical analysis of the fixed versus flexible exchange rate question.

Second, through the use of rational expectations, the financial market price framework distinguishes quantitatively between real interest rates and market interest rates. That earlier frameworks had not effectively made this distinction is indicated by the Brunner and Meltzer (1972a, p. 846) criticism of Friedman's framework: "In the IS-LM analysis, interest rates are generally taken as measures of borrowing costs. There is no distinction between market and real interest rates in the usual statement or in Friedman's restatement."

Third, the key question about the degree to which short-run changes in nominal GDP are split between changes in real GDP and inflation (the "missing equation" in Friedman's terms) has been addressed by some form of empirically estimated staggered price-setting equations. Such equations incorporate both long-run monetary neutrality and short-run nonneutrality due to rigidities in goods and labor markets. These rigidities have at least some microeconomic rationale. To be sure, this is an area where more research would pay off, as evidenced by the recent formulations of the staggered price setting equations by Fuhrer and Moore (1995).

Fourth, I believe we have learned considerably more about what simplifying assumptions work for certain questions and those that do not. For example, the usefulness of Robert Mundell's assumption of perfect capital mobility has been amply demonstrated in my view, especially with the greater amount of financial capital mobility that now exists around the world. Similarly, the expectations model of the term structure appears to be a useful framework to study the impact of future changes in monetary policy on long-term interest rates.

Fifth, as the subtitle of this paper indicates, the framework reviewed here is "empirical," not simply "theoretical." Having numerical parameter values for a complete model is invaluable for many types of policy applications—as in the examples given in this paper of designing of a good monetary policy and determining whether the monetary mechanism has changed significantly over time.

Despite this progress, there is plenty of room for improvement in the framework reviewed in this paper. It is quite likely that the extensive research on credit and the role of financial intermediaries in recent years may deliver an improved empirical framework—perhaps better estimates of the parameters. Continuing work on the monetary aggregates—both their demand and supply—is likely to have payoffs in improving monetary policy, especially as new technology changes the nature of financial markets in the future.

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