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Challenges to Monetary Policy

...a country whose long-term rates are linked to another country's short-term rates via expectations of the central bank's long-run exchange rate objectives is one which, to some degree at least, has lost the independence floating exchange rates were thought to promise.

The substantial evidence that does exist suggests that M1 has not been ruined by deregulation...and that it would be advisable for the Federal Reserve to return to its former practice of using M1 as its primary monetary aggregate.

Challenges to Monetary Policy

Two challenges to monetary policy are explored by the authors in this *Economic Review*. In the first article, Joseph Bisignano tests for international linkages among interest rates that may affect the ability of central banks to pursue domestic policies independent of those abroad. The conventional view in economics has been that floating exchange rates allow countries to insulate their economies from foreign disturbances, but Bisignano points out that since 1979 there has been increased financial interdependence among countries, creating difficult policy choices given the strong performance of the U.S. dollar. In the second article, John Judd examines the extent to which recent domestic deregulation of interest rates on bank and thrift deposits has impaired the usefulness of M1 as the Federal Reserve's primary monetary policy guide, as well as the likely impact of future deregulation on that aggregate.

Bisignano focuses on the significant increase in U.S. interest rates that occurred in late 1979 and the difficult set of policy choices it posed for foreign policy makers. Foreign central banks faced the dilemma of whether to allow this shock to be transmitted to interest rates in their own country, or to allow their exchange rates to depreciate to insulate their domestic financial markets. The choice of higher interest rates would have meant reduced economic activity at home, while a depreciating currency implied higher domestic inflation. Which tradeoff was perceived as the more palatable therefore would condition the extent to which foreign central banks would allow the shock of higher interest rates in the U.S. to be transmitted to their domestic economies.

The author examines the relationships between U.S. and German interest rates, and between U.S. and Canadian interest rates, for evidence of how much the German and Canadian central banks accommodated their policies to developments in the U.S. rather than pursued independent policies. Specifically, he looks at the extent to which unanticipated changes in U.S. rates provide information about the behavior of long-term interest rates in Germany and Canada.

Bisignano uses the expectations hypothesis of the term structure of interest rates, and asset market exchange rate determination, to argue that the rate on a long-term German government bond, for example, depends on U.S. short-term rates and expectations about the dollar-mark exchange rate. These expectations in turn are conditioned by perceptions about how much the Bundesbank would be willing to insulate German interest rates from foreign shocks.

Bisignano finds that after the Federal Reserve's adoption of its new Monetary Control Procedure in October 1979, unanticipated changes in the U.S. 3-month Treasury bill rate enter significantly in regressions explaining movements in market interest rates on German federal government securities of differing maturities ranging from one year to ten years. Interestingly enough, however, they are not significant in regressions for the period 1973–1979.

Thus, after the October-1979 change in Federal Reserve operating policy, expectations in the foreign market apparently were that the German authorities would not allow a long-term depreciation of the mark, preferring to allow interest rates to rise in Germany as they had in the U.S. Bisignano conjectures that these expectations were based on the belief that the Bundesbank was willing to follow the U.S. lead, taken after 1979, to pursue a long-run anti-inflation strategy.

In the case of Canada, Bisignano finds that both before and after October 1979, unanticipated movements in U.S. rates often provide explanatory power for movements in Canadian long-term rates. Thus market perceptions appear to have been that the Bank of Canada attempted to protect the Canadian dollar from U.S. developments and as a result was forced to pass U.S. interest rate charges through to Canadian rates. Canadian and U.S. financial markets, therefore, were linked together and Canadian monetary policy was at least partially subordinated to U.S. policy.

John Judd focuses on the most recent and most far-reaching episode of deposit rate deregulation in his article. Both the Money Market Deposit Account, introduced in late 1982, and the Super-NOW account, introduced in early 1983, are accounts on which depository institutions can pay market rates of interest. The argument frequently has been made that the deregulation they represent fundamentally alters the public's demand for transactions money, potentially ruining M1 as a guide for monetary policy.

Judd categorizes this deregulation argument as having three parts. The first is that deregulation may have induced a flow of savings balances into M1, and compromised its traditional character as primarily a transactions medium. As a result, the demand for M1 may become less stable in the sense that it would be less tightly related to income and prices than before.

The second part of the deregulation argument focuses on the point that presumably the demand for M1 would be less interest-sensitive because flexible rates on deposits could be adjusted to offset changes in market rates. One effect of this would be to change the relationships between money and prices and other economic variables. M1, therefore, would be a more uncertain guide to policy until the new relationships were understood. A less interest-sensitive demand also would make the economy more vulnerable to money demand instability, although by the same token, it would insulate the economy better from other shocks.

Finally, Judd notes that a less-interest sensitive M1 demand poses potential problems for short-run control of M1. Thus, relatively precise control might be infeasible because the associated interest rate variability would be too high as well. There is risk that an interest-insensitive money demand would mean that M1 was no longer a leading indicator of policy, further reducing its usefulness as a guide for policy.

Judd points out that theory cannot indicate whether these potential problems actually exist, or, if they do, whether they are important enough to matter. These important issues are empirical ones. Unfortunately, because deregulation is not complete, the evidence accumulated so far cannot be conclusive. Nevertheless, Judd argues that on balance "...substantial evidence...does exist...that use of M1 as an intermediate target has not been ruined by deregulation..."

Judd examines several pieces of evidence to support this conclusion. He begins by noting that the size of the upward shift in M1 demand after deregulation may be an indication of the extent to which it has been "contaminated" by an inflow of savings balances. He refers to an earlier study of his which showed that episodes of deregulation in the 1970s and in 1981 showed small upward shifts; such findings are consistent with the hypothesis that the mixing of transactions and savings balances in M1 had been slight.

To analyze the November 1982 introduction of Super-NOWs and MMDAs, Judd estimates monthly M1 demand equations for the period up to the period of the change, and uses these regressions to forecast M1 demand during and after the change.

If the demand for M1 had shifted up because of the new accounts, the regressions should under-predict M1 after November 1982. Judd estimates two money-demand regressions: one in which the interest elasticity of money demand is constant and one in which it is allowed to vary positively with interest rates. The variable elasticity regression shows a small *over-prediction* of M1 after November 1982, which is in the wrong direction if M1 demand had shifted up. The constant elasticity specification does show under-prediction, but the result is too small to be significant. Judd draws two implications: "First, instability in M1 demand does not appear to have significantly distorted monetary policy in 1983. Second...deposit deregulation has not materially changed the transactions nature of M1."

Finally, Judd notes that problems of short-run monetary control posed by an interest-sensitive M1 could be less severe than suggested if money plays an important buffer-stock role in the public's portfolios. He argues that evidence from the money-demand function in the San Francisco Money Market Model is suggestive, at least, that money does play such a role.

Monetary Policy Regimes and International Term Structures of Interest Rates

Joseph Bisignano*

Changes in macroeconomic policy have had unexpected consequences in recent years. The move to floating exchange rates among industrial countries in 1973 may not have led to the predicted greater policy independence among countries, nor did it completely insulate countries from real and monetary disturbances emanating from abroad. Indeed, some studies have found that monetary growth rates and interest rates across countries have become more, rather than less, correlated since the change to floating exchanges rates.[1] As a result, we have learned more about how alternative exchange rate systems change the nature of real and financial interrelationships and the channels by which shocks and policy changes spill over from one country to another. This article will explore some of these international linkages.

In October 1979, the Federal Reserve changed monetary control procedures to one that de-emphasized the need to target interest rates to influence monetary growth and which placed more emphasis on the control of bank reserves. An unexpected consequence was the increased level and volatility of nominal interest rates in the United States. Some increased volatility in the federal funds rate was anticipated, but the new behavior of long-term U.S. interest rates was not. They appeared to become more sensitive to movements in short-term rates. It is, of course, debatable whether the unexpected interest rate behavior was directly attributable to the change in monetary control procedures, but the coincidence was surprising.

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The level of both real and nominal interest rates in the U.S. following October 1979, together with a renewed anti-inflationary objective of the Federal Reserve, caused some international agencies to attribute the high level of world interest rates since 1980 to U.S. policies. As an example, the 1982 Annual Report of the Bank for International Settlements states:

> "Nonetheless, it can be argued that without the American influence, nominal and real interest rates, in two major countries at least—Japan and the Federal Republic of Germany—would, in the spring of 1982, have been at levels more consistent with the requirements of domestic balance."[2]

One implication of the BIS concern is that a major rise in U.S. interest rates could lead to a policy conflict between domestic and external balances in other large industrial countries. In response to a large rise in U.S. interest rates, a foreign country can permit its exchange rate to adjust, or allow domestic interest rates to adjust and leave the exchange rate unchanged. However, both exchange rates and interest rates are asset prices and are strongly influenced by expectations, particularly expectations of the future value of the currency. Thus, not changing domestic interest rates after foreign interest rates have changed can result in a large exchange rate movement. This movement depends upon expectations of the currency's future value which, in turn, is heavily influenced by private market expectations of public policy. A central bank's concern with the private market's expectation of the long-run value of a currency can be seen in the following statement by G. Thiessen regarding the Bank of Canada's response to a rise in U.S. interest rates:

> ". . . it is useful to look at the options facing the Bank of Canada when, for example, there

is a sharp rise in short-term U.S. interest rates. If the policy response is to maintain Canadian interest rates unchanged, the Canadian dollar would come under downward pressure. In a potentially inflationary situation, the appearance of benign neglect toward the exchange rate by the authorities would risk a substantial overshooting of the exchange rate decline. *The less firmly held are the market expectations about the future value of the currency, the greater the overshooting is likely to be.*" (emphasis ours)[3]

We conjecture that linkages between short-term rates in the U.S. and longer-term rates abroad depend on what private market participants in the financial markets assume to be the long-term exchange rate objectives of the central bank. Given the rapid rise in U.S. nominal and real interest rates after October 1979, and the increased strength of the U.S. dollar in the foreign exchange markets, foreign central banks had to consider two prospects: that of moving their short-term rates, over which they have some control, into line with U.S. rates, or observing a major depreciation of their currency.

Since a depreciation of the currency for a very open economy can lead to rapid increases in domestic prices, the policy question of whether to adopt a strong exchange rate "objective" is similar to confronting the short-run inflation-output trade-off question. If a foreign country should raise interest rates in response to a major rise in U.S. rates, it would risk reducing real output. Alternatively, if it chooses to permit its exchange rate to depreciate, it would face more inflation, at least in the short run. A country that moves its short-rates to prevent a currency devaluation may find that the U.S. short rates strongly influence expected short-term rates in its domestic financial markets because foreign short rates contain useful information in forming expectations about future domestic short-term interest rates. In this manner, a country's entire term structure of interest rates may move in response to a change in U.S. short-term rates.

Purpose and Organization

How short-term interest rates in the U.S., prior to and after the change in U.S. monetary control procedures, affect interest rates along their entire term structure for Canada and the Federal Republic of Germany is the major empirical concern of this study. Investigating these relationships requires that we briefly review two areas of economic theory, the expectations hypothesis of the term structure of interest rates and the asset market approach to exchange rate determination. These two areas are related via the international arbitrage of financial assets which results in movements in interest rates and exchange rates that equalize expected rates of return on financial assets with similar underlying risk characteristics, regardless of their currency of denomination. These financial interrelationships can then create policy interdependencies. Policy interdependencies and conflict between internal and external policy objectives can better be understood when, as this paper will attempt, we consider how interest rate movements in one country are transmitted along the maturity spectrum of interest rates of its financial, interdependent foreign partners.

This paper is organized as follows: Section I will briefly review the expectations hypothesis of the term structure of interest rates. Section II will describe an asset market approach to exchange rate expectations equilibrium and how long-term interest rates are related to private market expectations of central banks' exchange rate objectives. Section III will review exchange rate behavior for Canada and Germany in relation to the U.S. dollar since the introduction of the new Federal Reserve monetary control procedures. The fourth section will statistically test the impact of changes in U.S. short-term interest rates on the maturity spectrum of interest rates in the Federal Republic of Germany and Canada. Section V provides a summary and considers policy implications of the study.

I. The Expectations Hypothesis of the Term Structure

Simply stated, the expectations hypothesis of the term structure of interest rates suggests that individuals arbitrage financial assets (bonds) of varying maturities and that this results in an "equilibrium" in which the (known) return on a long-term bond equals the average of the return on an available short-term bond and the *expected* returns on future short-term bonds over the same holding period. This hypothesis implies that bonds of like risk characteristics, but different maturities, are good substitutes for one another. Hence, their average expected return over a given time horizon should be approximately equal.

Formally, the term-structure relationship as of period t between the yield on an n-period discount bond, R, and the yield on one-period bonds, r, is often written:

$$R_t \cong \frac{1}{n} E_t(r_t + r_{t+1} + \cdots + r_{t+n-1} | I_t). \tag{1}$$

This equation is written as an approximation since the original relationship is multiplicative, with the approximation being that $\ln(1+r)=r$. This relationship must be modified if the bonds are coupon-bearing, in which case the long-rate would be a weighted, and not a simple, average of current and expected future short-term interest rates. The symbol E denotes that the relationship requires the explicit specification of how expectations of future short-term rates are formed, conditioned on some set of information I available at time t.[4] This information set is assumed to include the policy rule of the central bank.

Equation (1) is often empirically implemented by regressing the level of the long-term bond rate on the levels of current and past short-term interest rates. One argument for the use of past short-term interest rates as explanatory variables is that a forecast of future short-term rates can be formed by an appropriate weighting of past interest rates.[5] The structure of the weights on past short-term interest rates depends, in theory, on the stochastic structure of short-term interest rates and the economic structure (e.g., the monetary control regime) determining the short-rate.

Most formal textbook macroeconomic models "determine" one interest rate, usually that which influences the public's desire to hold money balances. Demands for such items as long-term household assets, such as housing, or business capital assets are often conjectured to be determined by "long-term interest rates." A term structure relationship, which defines the long-term bond rate as dependent on the current and past short-term interest rates, is often treated as a "structural" relationship in empirically estimated models and is estimated by the regression of the long rate on a distributed lag of short-term interest rates.

A recent criticism of the standard empirically implemented term structure relationship is that it *cannot* be taken to be a structural economic relationship with fixed coefficients. As emphasized by a number of critics of the standard expectations approach to the term structure, the expectations described in Equation (1) are conditional on policy rules, and hence, the expectations structure will change if there is a change in the policy rule or an expected change in the policy rule. Such "policy rules" may involve domestic monetary control rules or exchange rate intervention rules. In any case, the relationship between the long-term bond rate and short-term rates is argued to be crucially dependent on both monetary and fiscal rules. Since part of the transmission mechanism of monetary policy to the real economy depends on how changes in policy feed to the long-term segment of the term structure, the role of the policy rules in affecting this relationship is of considerable importance to policymakers.[6]

Consider a typical term-structure equation of the following form

$$R_t = \sum_{i=0}^{n} c_i r_{t-i} + v_t \tag{2}$$

where v is a stochastic error term. First differencing (2) yields

$$R_t - R_{t-1} = c_0(r_t - r_{t-1}) + \sum_{i=0}^{n-1} c_i(r_{t-1-i} - r_{t-2-i}) + (v_t - v_{t-1}). \tag{3}$$

Written in this form the term structure equations state that the *change* in the long-term bond rate in period t depends on the current change in the short rate and *previous* changes in the short-term rate. It is this latter implication which is currently in dispute. That is, it is argued that only new information (or "surprises") should change the long-term rate. Previously available information, such as the level of short-term rates, or their changes, should not cause the current long-term rate to change; such previous information is presumably already captured in R_{t-1}.

Having said this, we must note that it may be an overly strong statement, not completely supported by the theoretical literature on the determination of the term structure interest rate under the assumption of rational expectations.[7] For our purposes, it is sufficient to say that we expect the coefficient on the most recent change in the short-rate, c_0, to dominate all other coefficients on past changes in the short-rate.

The basic point of the above argument is that if individuals form their expecations in (1) in an efficient manner, that is, by exploiting all available information, any information that was available "yesterday" should not cause security prices to change "today," if the movement in the short-rate follows a random walk. Similarly, only information that was unavailable "yesterday" should cause the long-term bond yield to change "today." Technically, changes in past short-term rates may affect the change in the current long-term rate in an efficient market if the short-rate does not follow a random walk. For our purposes, it is only necessary to assume that most of the movement in the long-rate will be due to the current change in the short-rate, that is, the short-rate is close to a random walk.

Our testing of the international interrelationships between long- and short-term interest rates thus must acknowledge current criticism of the standard expectational statement of the term-structure of interest rates. These criticisms, to repeat, are that: (1) the term-structure relationship cannot be considered a "structural" macroeconomic relationship, since such an interpretation is not consistent with the assumption that capital markets are "efficient"; (2) the relationship between long- and short-term interest rates (both within and between countries) depends on the policy rule, which will influence the formation of expectations of future short-term interest rates; and (3) "new information," such as contemporaneous change in short-term rates, should dominate past information in causing long-term interest rates to vary. Point (3) simply says that the long-term bond rate moves quickly to reflect fully any new information. In our empirical work we will begin by *assuming* that past changes in short-term interest rates do not significantly explain the contemporaneous changes in the long-term interest rate.

II. Asset Markets and the Term Structure of Exchange Rate Expectations

If financial assets in Germany and the U.S. were reasonably good substitutes and the U.S. and Germany were to agree to fix their bilateral exchange rate, short-term interest rates in the two countries would be identical by reason of interest rate parity. The long-term interest rate in Germany could then be said to be a function of expected future short-term rates in either country, and the exchange rate system would determine this dependency. The German central bank could also create the impression that it desired a long-run exchange rate objective in the absence of a formal agreement with the U.S. It could intervene periodically in the exchange market, or reposition its short-term interest rates in line with movements in U.S. short-term rates. In either case, U.S. short-term interest rates again would likely be significant in explaining German long-term bond rates.

The above example illustrates what should be an obvious interrelationship: long-term bond rates in country A will be influenced by movements in short-term rates in country B only if the central bank of country A is perceived as having a long-run desired exchange rate objective in relation to the currency of country B. Interest rate interrelationships between two countries depend on the extent to which the two central banks will not permit their bilateral exchange rate to move away from some desired level. To see the formal interrelationship of short- and long-term rates between countries, we begin by reviewing some theory on the term structure of exchange rates.

Just as in the standard term structure of interest rate argument, an arbitrage relationship holds for assets of identical maturity but different currency of denomination in exchange rate term structure theory. Again, in equilibrium, the assets' risk-adjusted expected returns should be equal in the absence of transaction costs. Consider the relationship between the returns on two n-period bonds, one denominated in the domestic currency and one denominated in a foreign currency. For the two returns to be equivalent in equilibrium, the compounded yield differential between the two securities should exactly equal the expected change in the rate at which the two currencies can be traded, that is, the expected change in the exchange rate. We can write this relationship as follows:

$$\left(\frac{1+R}{1+R^{\star}}\right)_t^n = \frac{E_t(S_{t+n}|I_t)}{S_t} \tag{4}$$

where a star indicates the foreign variable. In (4), S is the spot exchange rate, the domestic currency price of a unit of the foreign currency. R and $R^{\star}$, the market yields on the domestic and foreign bonds, respectively, are defined in decimal units, for example, 0.05. The numerator on the right-hand side of Equation (4) is the expected exchange rate n periods hence, given information available in period t. Let us rewrite Equation (4) by first taking logs and using the approximation $\ln(1+R)=R$:

$$R_t - R_t^{\star} = \frac{E_t(s_{t+n}|I_t) - s_t}{n} \tag{5}$$

where the small s denotes the log of the exchange rate, S. Equation (5) states that arbitrage will force the yield differential between two similar assets of like maturity but different currency of denomination to equal the expected average annual change in the exchange rate.

Equation (5) is an arbitrage condition. It cannot be interpreted as implying that interest rates *cause* exchange rate changes, or the reverse. This arbitrage condition depends on a statement of exchange rate expectations. As stated in Equation (5), the exchange rate in period t expected to hold in period t+n depends on some set of information available in period t.

To derive a relationship between long-term rates in one country and short-term rates in another country, we can begin by combining the two interest rate arbitrage conditions discussed above, defined in Equations (1) and (5). Solving Equation (5) for R_t and equating this to Equation (1), we have for $R_t^{\star}$, the foreign n-period bond rate:

$$R_t^{\star} = \frac{1}{n}\left[\, E_t(r_t + r_{t+1} + \cdots + r_{t+n-1}|I_t) - (E_t(s_{t+n}|I_t) - s_t)\,\right] \tag{6}$$

Equation (6) states that the foreign (n-period) long-term rate is equal ***in equilibrium*** to the average of current and *expected* future domestic short-term interest rates less the average *expected* change in the exchange rate over the existing maturity of the bond.

Equation (6) is the statement of two arbitrage conditions and cannot be empirically estimated until the hypothesis of how expectations of future short-term rates in the "domestic" economy and the future exchange rate are made explicit. The two components of the long-term "foreign" bond rate are expectational variables. The set of information which conditions these expectations will have a good deal to say about the form of the estimating equation and the assumed stability of that equation to changes in policy rules.

To empirically use Equation (6), we first assume that it is a stochastic relationship; that is, arbitrage will make the long-term bond rate approximately consistent with the two expectations. Second, we assume that in forming expectations of *future* short-term interest rates, it is primarily information unavailable in the previous period that will significantly change the current long-term interest rate. International financial arbitrage implies that expectations of future domestic interest rates will depend on expectations of foreign rates and the expected changes in the exchange rate. We, therefore, also assume that expectations of exchange rate change, particularly short-run expectations, depend on perceptions of the exchange rate policy of the central bank.

Equation (6) may be rewritten to show more clearly how the "foreign" long-term rate is linked to expected future "domestic" short-term rates plus the expected future short-term (period-by-period) exchange rate changes. Consider the expected exchange rate change in equation (6); it is obvious that

$$E_t(s_{t+n}|I_t) - s_t = E_t[(s_{t+1}-s_t) + (s_{t+2}-s_{t+1}) + \cdots + (s_{t+n}-s_{t+n-1})\,|I_t] \tag{7}$$

That is, the expected change in the exchange rate between period t and period t+n given information available at time t is equal to the sum of the expected changes for each intervening period. Using this fact, we can rewrite Equation (6) using (7), as:

$$R^\star_t = \frac{1}{n}\left\{E_t\ [r_t - (s_{t+1} - s_t) + r_{t+1} - (s_{t+2} - s_{t+1}) + \cdots + r_{t+n-1} - (s_{t+n} - s_{t+n-1})\ |I_t\ ]\right\} \quad (8)$$

Equation (8) states that the long-term, n-period, bond rate in, say, Germany, is equal to the average of the expected future short-term interest rates in the U.S., plus expected exchange rate changes between DM and the U.S. dollar. The long-term bond rate in Germany thus captures both expectations of future U.S. short rates and future movements in the exchange rate.

It is the potential for central bank action to prevent the exchange rate from moving that is useful in forming expectations about future German short-term rates. Expected future changes in the exchange rate depend on perceptions of the exchange rate objectives of the central bank. If the central bank is perceived not to have any exchange rate objective, short-term interest rate movements in the United States would convey no information for the German bond market *independent* of the current German short-term rate. In such a case, expected movements in the exchange rate and U.S. rates would be extraneous information; all the relevant information would be captured in the current German short-term rates. If, on the other hand, the German central bank is perceived to have some exchange rate objective, U.S. interest rates, as signals of potential future interest rate movements initiated by the German central bank, would contain useful information to the German bond market.

The expectation in Equation (8) is conditioned on some information set I. This information set includes the assumed policy rule of the central bank and some knowledge of the central bank's exchange rate objectives. Changes in these objectives would alter the way unanticipated changes in U.S. rates affect German long-term rates.

Since the components on the right side are nothing more than current and expected future German short-term interest rates, conditional on current information, we argue that these expectations will change in response to changes in the current German short rate and *unanticipated* movements in U.S. short rates. That is:

$$\Delta E_t[r_{t+j} - (s_{t+j+i} - s_{t+j})] = d_o + d_1 \Delta r^\star_t + d_2 \hat{Z}^{US}_t + x_t \quad (9)$$

Equation (9) suggests that only new and/or unanticipated information will alter expected future German short-term rates and, by implication, the current long-term bond rate. The $\hat{Z}^{US}$ variable represents the unanticipated component in U.S. short-term interest rates. Since (9) holds for all future periods, with coefficients differing for different future periods, we can rewrite an approximation to Equation (8) in first difference form as:

$$\Delta R^\star_t = a_o + a_1 \Delta r^\star_t + a_2 \hat{Z}^{US}_t + w_t \quad (10)$$

This formulation tests, for example, whether German bond holders perceive the German central bank as following an exchange rate rule and, hence, as partially dependent on U.S. central bank interest rate policy. Such a dependence would be revealed in the significance of the coefficient on the unanticipated component of U.S. short-term interest rates, a_2. Analogously, Equation (10) can be estimated for the changes in U.S. long-term rates as dependent, for example, on the change in U.S. short-rates and the unanticipated change in German short-rates.

We will estimate Equation (10) with changes in Canadian and German long-term bond rates dependent on, respectively, changes in Canadian and German short-term rates and the "surprise" or unexpected movement in U.S. short-term rates. And we will reverse the relationship to see whether the long-term U.S. bond market used unexpected changes in foreign short-term rates as information variables in forming expectations about future U.S. short-term rates.[8]

If the German short-term rate were found to be statistically significant in (10), and the unanticipated U.S. short-term rate not, we could assume that holders of long-term German bonds are revealing their expectation that the German central bank is following a policy that is at least partially independent of U.S. monetary policy—independent in the sense that the German central bank is allowing some flexibility in exchange rate movements. If, on the other hand, U.S. short-term interest rates were also statistically significant in explaining German long-term bond rates, the holders of long-term German bonds would be revealing their expectation that the Bundesbank may have a long-run exchange rate objective with regard to the U.S. dollar. Strong "leaning-against-the-wind" exchange rate policy could be detected in the coefficient in the U.S. interest rate variable.

Since our equation will be estimated in first-differenced form, we argue that the current changes in the short-term rate should be the primary explanation for movements in the long-term bond rate. For this reason, we do not include lagged short-term interest rates as explanatory variables.[9]

One final empirical approximation is made to implement equation (10). We assume that only *unanticipated* changes in U.S. short-term interest rates affect German and Canadian bond rates. As an approximation for this unanticipated change in the U.S. short-term rate, we regressed the U.S. three-month Treasury bill rate on itself, lagged one and two periods, and treated the estimated residuals from this equation as our unanticipated U.S. short-rate variable. This unanticipated U.S. interest rate variable is defined as Z. (Alternative methods of deriving this "surprise" variable did not appear to make a significant difference in the empirical results.)

Evidence that long-term German bond holders should be concerned with Bundesbank exchange rate policy can be obtained from statements by the German central bank regarding its exchange rate intentions.

> "But the Bundesbank has not been under any obligation to intervene against the U.S. dollar since the Spring of 1973. However, the Bundesbank has intervened in the dollar market ever since the dollar rate was freed, largely to smooth out erratic day-to-day exchange rate fluctuations and so maintain orderly market conditions. In addition, . . . the Bundesbank has on occasion intervened more heavily in the foreign exchange markets in an attempt to curb exaggerated exchange rate movements and thus ease the adjustment pressure on the economy."[10, 11]

If holders of German bonds perceive the German central bank to be running an independent monetary policy *with no overriding exchange rate objective*, only changes in German short-term interest rates should contribute to changes in longer-term German interest rates. However, if the German central bank does have a major exchange rate objective, movements in foreign (for example, U.S.) short-term interest rates contain important information about *future* German short-term rates. In this manner, movements in U.S. short-term rates can affect foreign long-term rates.

III. The Term Structure of Exchange Rate Expectations

Shortly after the Federal Reserve's change in monetary control operating procedures, a major policy dilemma emerged. The cause of the dilemma was the major, and largely unexpected, rise in both short- and long-term U.S. interest rates. The nature of the dilemma for foreign central banks was whether to raise their domestic interest rates or to permit their exchange rates to depreciate.

The U.S. 3-month Treasury bill rate averaged 10.26 percent in September 1979. It rose after the change in monetary control procedures of October 6, 1979, and, as seen in Chart 1, continued to rise to a monthly average high of 15.20 percent by March 1980 before credit controls were imposed. Considerably more surprising than the behavior of short-term rates was the level to which long-term rates rose. Some economists had anticipated that a switch to a reserve control procedure by the Fed would result in a "decoupling" of interest rates. Short-rates were expected to rise due to a more stringent supply of bank reserves but, some thought, long-term rates would be stable since they were thought to be influenced primarily by inflationary expectations.

Instead, long-term rates rose by over 300 basis points in six months, from a monthly average of 9.33 percent in September 1979 to 12.75 percent in March 1980, for the U.S. Treasury's ten-year constant maturity bond rate. While both short- and long-term rates fell sharply after the imposition of credit control in the spring of 1980, both rose sharply after the removal of control and surpassed their March highs by December 1980.

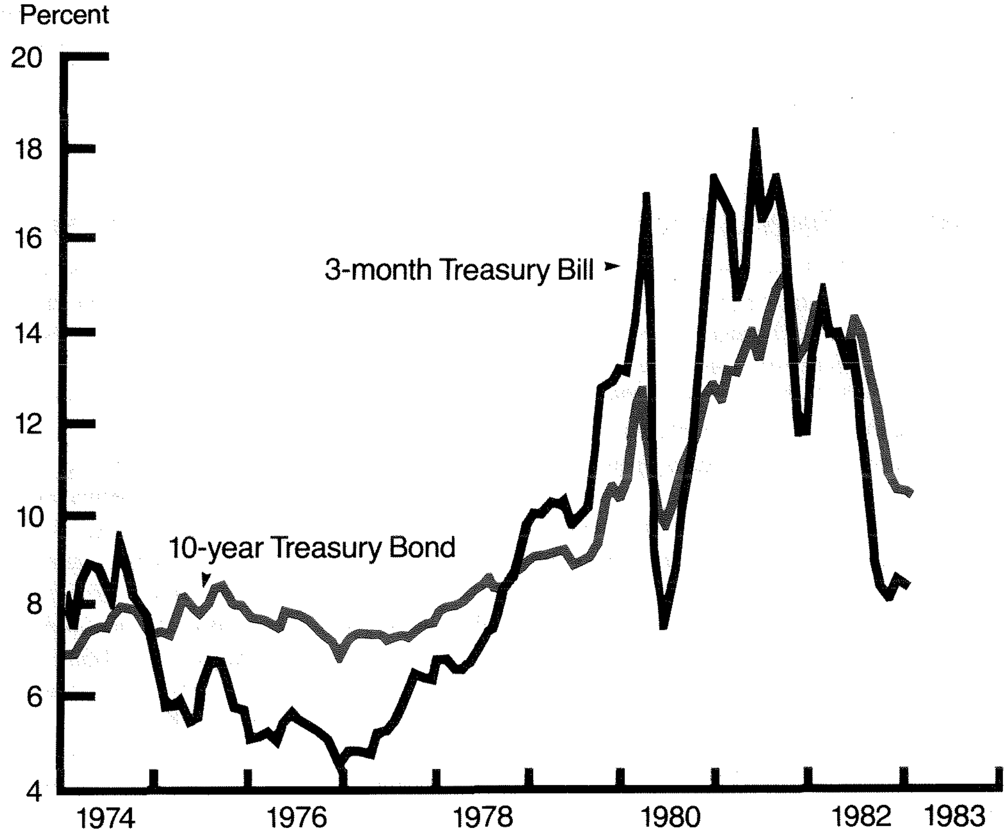
The extent to which there might have been any linkage between U.S. short-term rates on the one hand and German and Canadian long-term rates on the other depends on how private market participants view the longer run behavior of the exchange rate. Expectations of the exchange rate over the longer run, in turn, are tied to expectations of the central bank's desired exchange rate objectives. Consider now how expectations of the exchange rate for the Canadian dollar and Deutschemark in relation to the U.S. dollar changed after October 1979.

Charts 2 and 3 describe the bilateral exchange rates for Germany and Canada, respectively, against the U.S. dollar, together with the evolving term structure of exchange rate expectations. The term structure of exchange rate expectations can be roughly captured by assuming that the compounded interest differential between two fixed-term financial assets with different currency denominations approximates the expected percentage change in the exchange rate over the maturity of the asset.[12]

The U.S. dollar had depreciated substantially against the Deutschemark from early 1976 through the fall of 1979. In early 1976, interest differentials between U.S. and German government bonds suggested that the DM/$U.S. rate was expected to remain around 2.6 DM/$U.S., with some modest depreciation over the long run. It was not until late 1977, when the U.S. dollar had depreciated rather steadily for two years against the DM that the DM/$U.S. exchange rate term structure changed considerably. The long-term outlook then was that the U.S. dollar would depreciate steadily against the DM, reaching a 2.0 DM/$U.S. rate by the end of 1987. The long-run view of the U.S. dollar in relation to DM, measured by a ten-year horizon, continued to worsen in 1978 and 1979. The DM/$U.S. rate was expected to fall to nearly 1.5 by 1987.

Chart 1

Treasury Bill and Treasury Bond Rates

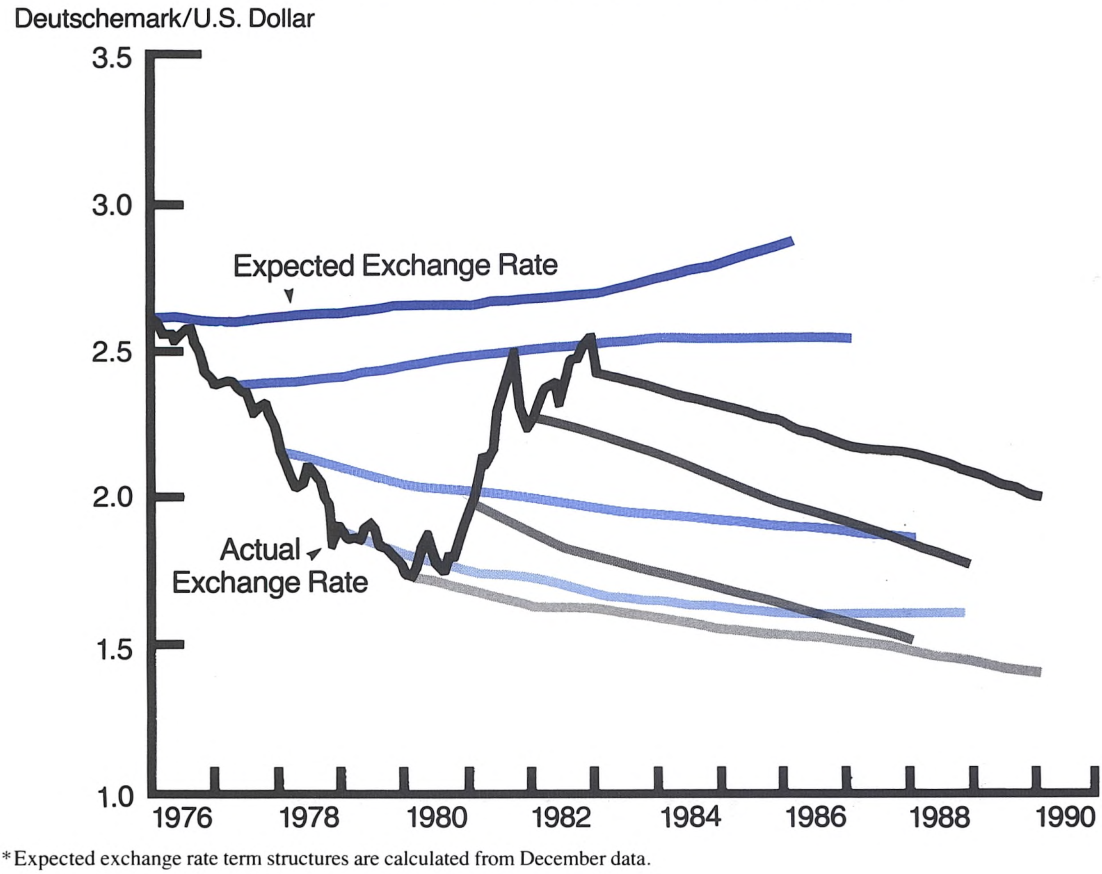


During the Fall of 1980, the U.S. dollar started a rapid climb against DM. Interestingly, even given the major appreciation of the U.S. dollar, DM was still expected to appreciate against the dollar over the long-run. Market participants apparently did not expect the levels the U.S. dollar reached against DM to be sustainable. Even by late 1982, when a 2.5 DM/$U.S. rate was reached, the longer-run view was for DM to appreciate towards 2.0. Market participants were expecting the German central bank to pursue policies over the long-run that would result in a major appreciation of DM against the U.S. dollar. Overall, the impression one obtains from Chart 2 is that during the period of the major depreciation of DM against the U.S. dollar—1980 through 1982—the market expected the German central bank to follow policies that would result in a longer-run appreciation of the Deutschemark.

The case of Canada is in many ways different from that of Germany. While the U.S. dollar was depreciating against DM from 1976 to the Fall of 1979, the U.S. dollar appreciated significantly against the Canadian dollar ($C) during the same period. In addition, a major depreciation of the Canadian dollar did not follow the rise in U.S. rates late in 1979 to the end of 1980. The $C/$U.S. rate averaged 1.16 in September 1979 and 1.197 in December 1980. Both short- and long-run expectations of a depreciation of the Canadian dollar existing prior to October 1979 continued to persist after that date. The only exception was the term structure of the expected exchange rate as of December 1980, which slopes downward; it implies a $C appreciation. In general, Chart 3 implies that the Candian dollar was expected to depreciate even further after October 1979. It cannot be argued, however, that

Chart 2

German Term Structure of Exchange Rates*



*Expected exchange rate term structures are calculated from December data.

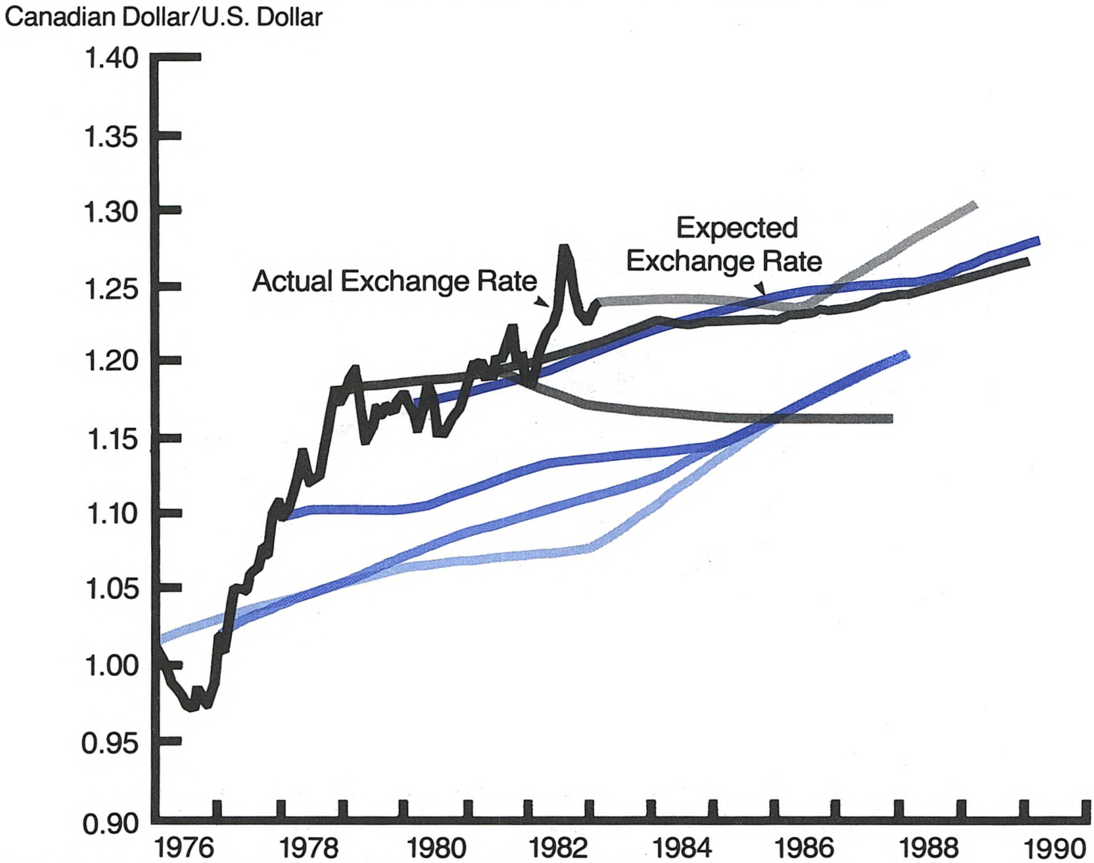
expectations of a Canadian dollar depreciation were results, or indeed closely associated with, the change in Federal Reserve operating procedures.

The picture that emerges from Charts 1–3 is that the rise in U.S. interest rates, across the entire term structure after October 1979, appear related to the considerable depreciation of the Deutschemark against the U.S. dollar, but not, at least through 1981, with a similar depreciation of the Canadian dollar. Despite actual exchange rate movements, market participants expected DM to appreciate after 1979 over several years, but they thought $C would depreciate. The German central bank appears to have been expected to resist a long-run depreciation of its currency against the U.S. dollar, even after a major depreciation occurred. Thus, "strong currency expectations" might be used to describe the sequence of the term structure of exchange rate expectations seen in Germany. "Weak currency expectations" could be used to describe the expected exchange rate term structure for Canada; its currency was expected to depreciate against the U.S. dollar even during a period of relative exchange rate stability.

Studying the term structures of exchange rate expectations permits us to conjecture whether the financial market might think short-run interest rate movements in a large nation like the U.S. contains information that could signal future interest rate movements, short- and long-run, in other countries. Such a linkage between short-term interest rates in the U.S. and long-term rates in another country are likely to occur if financial markets perceive that the "other country" will attempt to maintain its cur-

Chart 3

Canadian Term Structure of Exchange Rates*



*Expected exchange rate term structures are calculated from December data.

rency within a given range in relation to the U.S. dollar. The term structure of exchange rate expectations viewed in Charts 2 and 3 imply that a rise in short-term interest rates in the U.S. is not likely to worsen the long-run view of the DM/$U.S. rate, even if the Deutschemark depreciates in the short-run. Individuals in the post-1979 period apparently did not expect the U.S. dollar to remain strong. We may surmise that the Bundesbank is viewed as unwilling to permit a "permanent" depreciation of its currency against the dollar, where permanent means lasting for more than five years. In contrast, in the Canadian case, the rise in U.S. rates after October 1979 and the subsequent depreciation of the Canadian dollar was expected to lead to a "permanent" depreciation, in spite of the fact that the Bank of Canada resisted a depreciation of the Canadian dollar after the change in U.S. monetary control procedures.

These conjectures imply that short-term rate movements in the U.S. after October 1979 were likely to affect German long rates. If this were not the case, Chart 2 would have shown the expected DM/$U.S. term structures sloping upward. That is, expectations of a weak DM in the future would imply that U.S. short-rates could move without being followed by similar movements in German interest rates. The "strong currency expectations" effectively linked German long-rates to U.S. short-rates. The "weak currency expectations" for the Canadian dollar may have broken such a link. The empirical analyses will decide whether these linkages in fact resulted after October 1979.

It is important to note, finally, that a clear case cannot be made from Charts 2 and 3 that a change in the term structure of exchange rate expectations occurred shortly after October 1979. In the German case, we see an upward sloping term structure in December 1976 reversing and sloping downward in December 1977. In the Canadian case, all exchange rate term structures, save one, remain upward sloping.

While visual evidence may not demonstrate that exchange rate expectations changed after October 1979, it is possible to determine statistically how the rise in U.S. short-term rates may affect foreign long-term rates. Our expectation is that German long-term rates will rise with a rise in U.S. short rates but Canadian long-term rates will be unaffected because of the market view that the Canadian authorities would allow the Canadian dollar to absorb fully the impact of U.S. interest rate changes and not intervene in the foreign exchange market or adjust domestic interest rates in response. In other words, the market thought that the Canadian authorities did not have an exchange rate objective.

IV. Term Structure Interdependence: The Empirical Evidence

The estimation of Equation (10) for Germany for the period 1973.03 to 1979.09 is seen in Table 1. During this period the Federal Reserve may be interpreted as having had a monetary control regime which placed primary emphasis on the management of the Federal funds rate. Policy-induced variations in this rate were designed to influence the domestic demand for money and credit. The dependent variables in the Table 1 regressions are the change in the average market yields on bonds of the German federal government (including the Federal Railways and Post Office) for maturities of one to ten years. The explanatory variables are the change in the three-month German interbank rate and the unanticipated change in the three-month U.S. Treasury bill rate.[13]

The results of Table 1 confirm the hypothesis that changes in the longer-term German bond rates were influenced primarily by movements in German short-term rates prior to October 1979. The contemporaneous change in the German three-month interbank rate has a statistically significant impact on bond yields extending from maturities of one to five years; the remaining maturities showed little sensitivity to the change in the German interbank rate.

Table 1 also suggests that the unanticipated change in U.S. short-term interest rates had no impact on German long-term rates. The coefficients on the unanticipated change in the U.S. three-month bill rate are consistently statistically insignificant and very small.

When the German term structure equations were estimated over the period following the change in Federal Reserve operating procedures, the results were drastically different. Estimated over the period 1979.12 to 1982.12, we found considerably reduced significance for the coefficients on the German three-month interbank rate. As shown in Table 2, only in the first three maturity classes is the German interbank rate statistically significant at the 5 percent level for a one-tail test.

Contrary to the results for the earlier period, we find in Table 2 that the coefficient on the unanticipated component of the three-month U.S. Treasury bill rate was significant throughout the German term structure. An unanticipated one percentage point increase in the U.S. three-month bill rate was found to have increased one-year German rates by about 20 basis points. Quite surprisingly, this impact does not die out the longer the maturity of the asset. The "surprise" of a one percentage point rise in U.S. short rates appears to have lifted the entire German term structure by about 17–22 basis points. U.S. short-term interest rate "surprises" therefore appear to have contained more relevant information about future German short rates than in the earlier sample period.

Another surprising result in Table 2 is the improvement in explanatory power of the equations over those seen in Table 1, particularly for the longer maturities. Forty to fifty percent of the variance in the change in German rates of five- to ten-year

Table 1
German Term Structure Equations in Response to Unanticipated U.S. Interest Rate Movements (Sample Period 1973.03–1979.09)+

Years to Maturity	Constant	Explanatory Variables Δr^*_t	$\hat{Z}^{US}_t$	RHO	$\bar{R}^2$	D.W.	SER
1	.000	.372	.145	−.20	.189	2.01	.463
	(.01)	(4.43)	(1.32)	(−1.79)			
2	.002	.159	.006	.44	.365	2.21	.250
	(.04)	(2.62)	(.12)	(4.40)			
3	−.006	.136	−.011	.15	.136	2.07	.278
	(−.16)	(2.07)	(−.19)	(1.34)			
4	−.005	.145	−.040	.36	.237	2.14	.237
	(−.12)	(2.57)	(−.84)	(3.39)			
5	−.011	.132	−.004	.23	.144	2.07	.250
	(−.29)	(2.32)	(−.08)	(2.14)			
6	−.010	.074	−.011	.35	.162	2.02	.234
	(−.25)	(1.32)	(−.23)	(3.32)			
7	−.009	.090	−.038	.27	.108	2.04	.254
	(−.23)	(1.54)	(−.71)	(2.47)			
8	−.007	.060	−.057	.30	.099	2.10	.244
	(−.17)	(1.05)	(−1.13)	(2.77)			
9	−.010	.069	−.035	.178	.039	2.06	.264
	(−.28)	(1.17)	(−.61)	(1.61)			
10	−.008	.133	.040	.025	.027	1.99	.362
	(−.18)	(1.79)	(.48)	(.22)			

+ Dependent Variable is the change in the German "longer-term" bond rate. ($\hat{Z}^{US}$) is the set of residuals from the following regression for the U.S. three-month Treasury bill rate, on a bond-equivalent basis:

$$r^{US}_t = .136 + 1.292\, r^{US}_{t-1} - 0.315\, r^{US}_{t-2} + \hat{Z}^{US}_t$$

(2.23) (25.58) (−6.23)

$\bar{R}^2 = .969$; D.W. = 1.86; SER = .625

Sample period: 1953.06–1983.01

In all cases t-statistics appear in parentheses. r* is the rate on 3-month interbank loans in the Frankfurt am Main money markets.

maturities is explained for the 1979.12–1982.12 period, compared with only 3 to 16 percent in the pre-October 1979 sample period. For example, 45 percent of the variance in the change in the ten-year German rate is now accounted for by the equation, compared with only 3 percent in the earlier sample period. If one relied on the expectations hypothesis to explain German long-term rates, expectations of future German short rates would appear to have been greatly influenced by unanticipated movements in contemporaneous U.S. short rates.[14]

To determine whether U.S. rates over the term structure were influenced by unanticipated changes in German short-term rates, Equation (10) was estimated for U.S. Treasury securities with maturities of 1, 3, 5, 7, 10 and 20 years. We used the change in the U.S. three-month Treasury bill rate and the unanticipated component of the German three-month interbank rate as explanatory variables. Table 3 reveals that German interest rate "surprises" had no statistically significant impact on U.S. rates, with all coefficients in the German interest rate surprise variable clearly insignificant at conventional significance levels.

Moreover, the coefficients on the change in the U.S. three-month bill rate do not appear to have changed greatly between the two sample periods, although U.S. interest rates were considerably more variable in the post-October 1979 period, as seen by the large increase in standard errors. These results may be interpreted as suggesting that in both periods German short-term interest rates contained no information of use in forming expectations of future U.S. short-term interest rates. U.S. monetary policy, in this sense, appeared "independent" of interest rate and exchange rate policy in the Federal Republic of Germany.

Using data on Canadian government securities, where the Canadian short-term rate is the three-month Treasury bill yield, we estimated Equation

Table 2
German Term Structure Equations in Response to Unanticipated U.S. Interest Rate Movements (Sample Period 1979.12–1982.12)

Years to Maturity	Constant	Explanatory Variables Δr^*_t	$\hat{Z}^{US}_t$	RHO	$\bar{R}^2$	D.W.	SER
1	−.028 (−.37)	.382 (3.30)	.203 (4.20)	−.05 (−.33)	.414	2.00	4.87
2	−.028 (−.35)	.254 (2.52)	.207 (5.06)	.14 (.87)	.480	1.91	.408
3	−.025 (−.32)	.186 (1.96)	.221 (5.77)	.20 (1.21)	.519	1.89	.383
4	−.020 (−.27)	.160 (1.76)	.220 (6.02)	.18 (1.11)	.529	1.88	.366
5	−.012 (−.18)	.151 (1.71)	.209 (5.82)	.14 (.84)	.509	1.90	.358
6	−.012 (−.20)	.153 (1.80)	.209 (6.02)	.09 (.53)	.520	1.94	.347
7	−.013 (−.19)	.093 (1.10)	.197 (5.87)	.22 (1.35)	.504	1.87	.337
8	−.015 (−.21)	.076 (.90)	.189 (5.60)	.23 (1.43)	.480	1.88	.339
9	−.011 (−.16)	.090 (1.09)	.182 (5.44)	.159 (.98)	.463	1.91	.334
10	−.010 (−.15)	.095 (1.18)	.176 (5.39)	.131 (.80)	.455	1.94	.326

(10) for the four maturity segments of the Canadian term structure, with maturity breakdowns of 1–3, 3–5, 5–10 years and 10 years and over. The estimated regressions appear in Table 4.

The two Canadian sample periods are the same as those in the German case, the floating rate period before and after October 1979 ending in 1982.12.

The regressions for the earlier period show that the unanticipated changes in the U.S. Treasury bill rate significantly influenced Canadian longer-term interest rates over the entire term structure, unlike the German case for the same period. While Canadian short rates also had a significant effect on that country's longer rates, the impact of a change in the

Table 3
U.S. Term Structure Equations in Response to Unanticipated German Interest Rate Movements+

Years to Maturity	Constant	Explanatory Variables Δr_t^{US}	$\hat{Z}^{\Delta G}$	RHO	$\bar{R}^2$	D.W.	SER
Sample Period 1973.03–1979.09							
1	.006	.793	−.049	−.08	.734	2.00	.228
	(.23)	(15.14)	(−.88)	(−.70)			
3	.006	.483	−.092	−.05	.505	2.01	.227
	(.25)	(9.21)	(−1.64)	(−.45)			
5	.010	.362	−.091	.01	.439	2.01	.198
	(.45)	(7.86)	(−1.86)	(.09)			
7	.015	.284	−.071	.07	.392	2.00	.176
	(.71)	(6.95)	(−1.63)	(.66)			
10	.019	.218	−.054	.07	.324	1.98	.155
	(1.01)	(6.07)	(−1.40)	(.59)			
20	.016	.201	−.028	.05	.341	1.98	.135
	(.98)	(6.40)	(−.85)	(.48)			
Sample Period 1979.12–1982.12							
1	−.010	.714	.089	.14	.862	1.88	.513
	(−.10)	(14.28)	(.71)	(.86)			
3	.019	.477	.147	.13	.699	1.87	.572
	(.18)	(8.57)	(1.06)	(.83)			
5	.022	.376	.129	.16	.611	1.83	.557
	(.20)	(6.91)	(.96)	(1.00)			
7	.028	.319	.083	.13	.515	1.88	.564
	(.26)	(5.82)	(.60)	(.77)			
10	.029	.287	.060	.14	.497	1.88	.522
	(.29)	(5.64)	(.48)	(.89)			
20	.034	.247	−.046	.19	.447	1.86	.503
	(.34)	(5.00)	(.38)	(1.17)			

+ Dependent Variable is the change in the U.S. longer term bond rate. $(\hat{Z}^{\Delta G})$ is the set of residuals from the following regression for the German three-month interbank rate:

$$r_t^G = .188 + 1.414\, r_{t-1}^G - .441\, r_{t-2}^G + \hat{Z}_t^{\Delta G}$$

(1.96) (21.46) (−6.69)

$\bar{R}^2 = .971$; D.W. = 2.08; SER = .526

Sample period: 1967.10–1982.12

Canadian three-month bill rate tapered off significantly the longer the maturity of the government security considered.

It has been argued that Canadian interest rates following October 1979 were "more influenced by swings in U.S. rates than were those of the European countries and Japan."[15] The results in Table 4 for the post-October 1979 period provide some confirmation of this opinion. Unlike the earlier period, changes in the three-month Canadian Treasury bill rate had no statistically significant impact on Canadian bond rates beyond the 1–3 maturity class. We found that the unanticipated U.S. short-rate variable is significant primarily at the short-end of the maturity spectrum and that the coefficients are larger than in the earlier sample period. Whereas in the pre-October 1979 period an unanticipated change of 100 basis points in the U.S. bill rate would raise Canadian 1–3 year rates by about 16 basis points, the effect in the post-October 1979 period was 25 basis points.

The impact on longer maturities also was considerably larger. In fact, the coefficients on the U.S. interest rate surprise variable for the second sample period were larger and more significant than the coefficients on the Canadian short-rate variable for all but the shortest maturity. It is interesting to note that after the change in U.S. monetary control procedures, the impact on Canadian and German term structures of a 100 basis point "surprise" increase in the U.S. three-month Treasury bill rate were quantitatively not that different. An unanticipated one percentage point increase in the U.S. bill rate causes a rise in both German and Canadian five-year bond rates of about 20 basis points. Expected future short-term Canadian rates appear to have been strongly influenced by U.S. rates after October 1979. The similarity with the German results

Table 4
Canadian Term Structure Equations in Response to Unanticipated U.S. Interest Rate Movements+

Years to Maturity	Constant	Explanatory Variables Δr_t^*	$\hat{Z}_t^{US}$	RHO	$\bar{R}^2$	D.W.	SER
Sample Period 1973.03–1979							
1–3 years	−.019 (−.64)	.829 (8.92)	.161 (2.49)	−.06 (−.52)	.557	2.00	.272
3–5 years	−.019 (−.81)	.691 (9.29)	.140 (2.54)	−.14 (−1.23)	.558	1.95	.227
5–10 years	−.022 (−.85)	.591 (7.50)	.161 (2.84)	−.09 (−.83)	.485	2.02	.235
10 years & over	−.004 (−.23)	.381 (7.09)	.101 (2.70)	−.04 (−.38)	.469	1.98	.157
Sample Period 1979.12–1982							
1–3 years	−.055 (−.35)	.344 (2.10)	.256 (2.05)	.01 (.08)	.410	1.99	.923
3–5 years	−.037 (−.24)	.229 (1.35)	.252 (1.89)	−.06 (−.39)	.273	2.02	.989
5–10 years	−.001 (−.01)	.195 (1.39)	.212 (1.94)	−.05 (−.33)	.288	2.01	.811
10 years & over	.023 (.19)	.165 (1.25)	.182 (1.74)	−.07 (−.45)	.240	2.01	.775

+ Dependent Variable is the change in the Canadian "longer-term" bond rate. t-statistics in parentheses.

also extends to the lack of significance of the German or Canadian short-term rate except for the shorter maturities.

To test the hypothesis that U.S. rates were influenced by unanticipated Canadian short-term rates, we estimated Equation (10) with U.S. rates as the dependent variable. The results for the pre-October 1979 period suggests that the financial markets considered unanticipated movements in Canadian rates to carry useful information about future U.S. short rates. This is quite plausible *if* the U.S. central bank was considered to have had an exchange rate objec-

Table 5
U.S. Term Structure Equations in Response to Unanticipated Canadian Interest Rate Movements+

Years to Maturity	Constant	Explanatory Variables Δr_t	$\hat{Z}^C_t$	RHO	$\bar{R}^2$	D.W.	SER
Sample Period 1973.03–1979							
1	−.017	.712	.388	−.13	.786	2.03	.204
	(−.80)	(14.23)	(4.43)	(−1.14)			
3	−.009	.411	.292	−.06	.545	2.00	.218
	(−.39)	(7.68)	(3.10)	(−.51)			
5	−.004	.302	.259	−.02	.480	1.99	.191
	(−.17)	(6.44)	(3.13)	(−.18)			
7	.003	.239	.213	.04	.432	1.98	.170
	(.17)	(5.75)	(3.89)	(.38)			
10	.010	.183	.157	.07	.355	1.96	.151
	(.54)	(4.97)	(2.40)	(.65)			
20	.007	.169	.150	.06	.392	1.95	.130
	(.44)	(5.34)	(2.66)	(.56)			
Sample Period 1979.12–1982							
1	−.018	.659	.116	.17	.864	1.81	.509
	(−.18)	(8.70)	(1.02)	(1.08)			
3	.010	.415	.136	.17	.699	1.78	.572
	(.08)	(4.87)	(1.06)	(1.07)			
5	.015	.328	.105	.20	.610	1.76	.558
	(.13)	(3.96)	(.85)	(1.22)			
7	.021	.277	.089	.15	.517	1.83	.562
	(.19)	(3.29)	(.69)	(.93)			
10	.023	.245	.088	.16	.502	1.84	.520
	(.22)	(3.17)	(.75)	(1.01)			
20	.032	.236	.025	.21	.446	1.83	.504
	(.31)	(3.17)	(.22)	(1.29)			

+ Dependent Variable is the change in the U.S. "longer-term" bond rate. ($\hat{Z}^C$) is the set of residuals from the following regression for the Canadian three-month Treasury bill rate:

$$r^C_t = .081 + 1.388\, r^C_{t-1} - .400\, r^C_{t-2} + \hat{Z}^C$$
$$(1.96) \quad (29.33) \quad (-8.45)$$

$\bar{R}^2 = .986$; D.W. = 1.97; SER = .471

Sample period: 1951.03–1982.12

tive in relation to the Canadian dollar. Given the long history of near parity between the two currencies, such a result is not surprising. Nonetheless, there is little evidence in policy records to suggest that the U.S. monetary authorities had such an exchange rate objective.[16] In the post-October 1979 period, the Canadian interest rate surprise coefficient is much smaller and insignificant in all equations.

Putting the results of Tables 4 and 5 together, one is led to the conclusion that in the post-October 1979 period, financial markets viewed the Bank of Canada as being strongly influenced by unanticipated movements in U.S. rates. U.S. rate movements were, in a sense, good leading indicators of future Canadian short-term rates under the assumption that the Bank of Canada had some exchange rate objective with regard to the U.S. dollar. Thus, the results for Canada in the post-October 1979 period are similar to those found for Germany: unanticipated movements in U.S. interest rates provided useful information in forming expectations of future foreign short-term interest rates, expectations which were then translated to the foreign long-term bond markets.

V. Summary and Policy Implications

The empirical results above suggest that, following the October 1979 adoption by the Federal Reserve of alternative monetary policy control procedures, the Federal Republic of Germany found that its financial markets were more "tied" to U.S. financial markets than before. One could interpret the results as suggesting that the linkage emerged because of strong expectations that the German central bank would not permit a long-run currency depreciation against the U.S. dollar. In this manner, expected future short-term interest rates in Germany were strongly influenced by changes in U.S. short-term rates. This linkage depends on a reliance on the expectations theory of the term structure and the assumption that international interest rate differentials approximate expected rate changes.

Section III's analysis suggested that even during significant DM depreciation from 1980–1982, financial markets expected DM to appreciate against the dollar five to six years into the future. This implies that if the U.S. were to follow a tight monetary policy which in the short-run might lead to higher short-term rates, German monetary policy would follow the U.S. lead. Thus, U.S. rates appeared to have influenced the entire German term structure because of expectations that the German central bank would not permit a long-run depreciation of its currency against the U.S. dollar.

Canada was pictured in Section III as having "weak currency expectations" in the sense that interest rate differentials implied a long-term depreciation of the Canadian dollar. Nonetheless, the statistical results suggest that unanticipated interest rate movements in the U.S. continued in the post-October 1979 period to result in substantial increases in Canadian interest rates across the term structure. Contrasting these two facts, the empirical results of Table 4 with Chart 3, suggest that even though the Canadian dollar was expected to depreciate over the long run, the Bank of Canada resisted any further depreciation. That is, despite a "weak" currency, the exchange rate objectives of the Bank of Canada were as strong as Germany's.

The results of Section IV also revealed that there was a substantial rise in both German and Canadian short-term rates following the October 1979 Federal Reserve policy move. Indeed, as noted in a Federal Reserve staff study of the effect of the new monetary control procedures, when the Bank of Canada raised its Bank Rate on October 9, 1979, Governor Bouey mentioned the change in Federal Reserve operating procedures as part of the reason for the rate increase. With respect to Germany that Federal Reserve staff study argued that,

> "...when dollar interest rates rose, German interest rates seemed to rise in response, but the rise in German interest rates seemed to be based on domestic considerations, as was noted by the Bundesbank at the time. ...In sum, authorities in continental European countries were affected by the new operating procedures; they were affected by both the higher level and, to a much lesser extent, the volatility of U.S. interest rates. However, the problems caused were not great, given that internal and external objectives were broadly consistent.

Any problems stemmed primarily from Germany policy actions and conflicts and were thus at most only indirectly related to the Federal Reserve's new operating procedures.[17]

If the private market thinks that the central bank has a *long-run* objective of not accepting a higher rate of inflation via a major depreciation of their currency, short-term rates in the country pursuing strong anti-inflation objectives can become a "determinant" of long-term rates in foreign countries. Such a linkage, in our view, is firmly based on expectations of the long-term objectives of the central bank.

The empirical results above imply that following October 1979 the new "linkage" between German and U.S. financial markets arose because private financial markets viewed the German central bank as having a strong anti-inflation objective and that it would, in the long-run, link DM to the dollar as long as the Federal Reserve and the Bundesbank shared the same long-term inflation objectives. Indeed, in the post-October 1979, German financial markets appear as closely linked to U.S. financial markets as were those of Canada.[18]

At the policy level, a country whose long-term rates are linked to another country's short-term rate via expectations of the central bank's long-run exchange rate objectives is one which, to some degree at least, has lost the independence floating exchange rates were thought to promise. The existence of an international business cycle through such interest rate linkages becomes more plausible and may be a reason to promote greater coordination of international monetary policies.

FOOTNOTES

1. See R. Dornbush, "Flexible Exchange Rates and Interdependence," and A. K. Swoboda, "Exchange Rate Regimes and U.S.-European Policy Interdependence," in **Conference on Exchange Rate Regimes and Policy Interdependence, IMF Staff Papers,** (March 1983).

2. Bank of International Settlements, **Fifty-second Annual Report,** (14 June 1982). p. 6, Basle.

3. G. Thiessen, "The Candian Experience With Monetary Targeting," in **Central Bank Views on Monetary Targeting,** p. 103, P. Meek, editor, Federal Reserve Bank of New York, (1982).

4. T. J. Sargent, "Rational Expectations and the Term Structure of Interest Rates," **Journal of Money, Credit and Banking,** (February 1972, Part I) and F. Modigliani and R. Shiller, "Inflation, Rational Expectations, and the Term Structure of Interest Rates," **Economica,** (1973), were two of the early articles to emphasize the rational expectations efficiency argument, underlying equation (1) in the expectational statement of the term structure. A strong attack on the expectations theory of the term structure may be seen in R. J. Shiller, J. Y. Campbell and K. L. Schoenholtz, "Forward Rates and Future Policy: Interpreting the Term Structure of Interst Rates," **Brookings Papers on Economic Activity,** 1, (1983).

5. Regarding the structure of optimal linear forecasts, see P. Whittle, **Prediction and Regulation by Linear Least-Square Methods,** D. Van Nostrand Co., Inc., (1963) and T. J. Sargeant, **Macroeconomic Theory,** Chapter X, Academic Press, (1979).

6. For example, see W. Poole, "Rational Expectations in the Macro Model," **Brookings Paper on Economic Activity,** 2 (1976) and F. S. Mishkin, "Efficient-Markets Theory: Implications for Monetary Policy," Brookings Papers on Economic Activity, 3 (1978). One of the first to warn that the simple one-sided distributed lag term structure relationship should not be treated as a structural relationship was R. Shiller. See "Rational Expectations and the Term Structure of Interest Rates: A Comment," **Journal of Money, Credit and Banking,** (1973). On the methodology of testing for rationality and market efficiency in the face of changes in policy rules see F. S. Mishkin, **A Rational Expectations Approach to Macroeconomics,** the University of Chicago Press, (1983).

7. L. Phillips and J. Pippenger, the "Preferred Habitat vs. Efficient Market: A Test of Alternative Hypotheses," Federal Reserve Bank of St. Louis, (May 1976), were among the first to test an equation similar to equation (3) and argue that past short-term rates provided little if any explanatory power in explaining the movement in long-term rates, as, they suggest, is an implication of the efficient market theory. For a contrary view of such tests, see F. Modigliani's comments on Mishkin's **Brookings Papers** article cited above. J. E. Pisando argues that the Phillips-Pippenger argument is correct if the current change in the short-term rate is exactly equal to the innovation in the short-term rate; that is, that the change in the short-term rate is a random walk. However, he argues that the proposition that the change in the short-rate follows a random walk in an efficient market can only be established by assumption. See "On the Random Walk Characteristics of Short-and Long-Term Interest Rates in an Efficient Market," **Journal of Money, Credit and Banking,** (November 1979).

8. A lagged long-rate was alternatively included in equation (9). When the model was estimated in first-difference form it was rarely significant and therefore it is dropped in the above exposition. One can obviously make a theoretical case for its inclusion.

9. See F. S. Mishkin, **A Rational Expectations Approach to Macroeconomics,** Chapter 4, The University of Chicago Press, on the role of "new information" in affecting, in our case here, the **change** in the long-term bond rate. A purely econometric argument for why the term structure equation should be estimated in first-differential form can be obtained from C. W. J. Granger and P. Newbold, "Spurious Regressions in Econometrics," **Journal of Econometrics,** 2, (1974).

10. **The Deutsche Bundesbank: Its Monetary Policy Instruments and Functions,** Deutsche Bundesbank Special Series No. 7, (October 1982). On the subject of Bundesbank intervention in the DM/$ market see F. Scholl, "Implications of Monetary Targeting for Exchange Rate Policy," in **Central Bank Views on Monetary Targeting,** P. Meek, ed., Federal Reserve Bank of New York, (1982).

11. The relationship between German and Canadian "long-term" bond rates and U.S. short-term rates is subject to the Lucas criticism that behavioral coefficients in econometric models are themselves functions of perceptions of current and expected future government policy. Because the expectations formed in equation (8) are dependent on the policy regime, in the particular case here, the U.S. monetary control regimes prior to and after October 6, 1979, this criticism is important for our purpose here because we argue that the Federal Reserve's change in monetary control procedures in October 1979 fundamentally changed the expectational structure described generall in equation (6). On that date the Federal Reserve changed its techniques from controlling monetary growth via control of the rate on Federal funds to the control of money by controlling the reserve growth of the banking system. Whether this change in control procedures had an impact on the relationship described in equation (10) will be empirically tested by estimating equation (10) with data prior to and following the change in U.S. monetary control procedures. See Robert E. Lucas, Jr., "Econometric Policy Evaluation: A Critique," in **The Phillips Curve and Labor Markets,** K. Brunner and A. H. Metzer, eds., North-Holland, (1976). The Lucas argument implies that the "informational content" of the two interest rates can change with a change in policy rules. A variable representing the policy rule does not explicitly appear on the right-hand side of (6) and therefore we cannot capture directly how the policy rule alters the relationship between essentially endogenous variables, the domestic and foreign short-term interest rates and their relationship to long rates. However, a change in the policy regime will alter the underlying stochastic distribution of endogenous variables and thereby change the estimated coefficients. The policy regime could be thought of as a missing variable in (6). A change in the correlation between the missing variable, the policy regime, and the included variables, the short-term rates, will cause the estimated coefficients in (6) to change.

12. The term structure of exchange rate expectations are obtained by using interest rate date for December dates, from 1975 to 1982, on comparable maturity U.S., Canada and German government bonds. One of the earliest proponents of this technique is M. G. Porter, "A Theoretical and Empirical Framework for Analyzing the Term Structure of Exchange Rate Expectations," IMF **Staff Papers,** (November 1971). The expected percent change in the exchange rate over the next n periods is computed as simply

$$\left[\left(\frac{1+R}{1+R^*}\right)^n - 1\right] \times 100,$$

where R is the domestic n-period bond yield and R* the n-period foreign bond yield. Another paper which emphasizes how the term structure of domestic interest rates reflects the foreign term structure and particularly how the rate differential is related to maturity is P. Minford, "A Rational Expectations Model of the United Kingdom Under Fixed and Floating Exchange Rate," in **On the State of Macro-Economics,** Carnegie-Rochester Conference Series on Public Policy, Volume 12, K. Brunner and A. H. Meltzer, eds., North-Holland, (1980).

Note, however, that the existence of risk aversion will cause domestic and foreign bonds to be less than perfect substitutes resulting in the foreign-domestic interest rate differential not being equal to the expected rate of depreciation. See C. A. Wyplosy, "The Exchange and Interest Rate Term Structure Under Risk Aversion and Rational Expectations," **Journal of International Economics,** (1983).

13. My thanks to Dr. H. Dudler of the Bundesbank for providing the German term structure data. Two review articles of use in understanding the behavior of the German bond market are "Interest Rate Movements and Changes in the Interest Rate Structure in the Federal Republic of Germany Since 1967," **Monthly Report of the Deutsche Bundesbank,** (April 1978) and "Interest Rate Movements Since 1978," **Monthly Report of the Deutsche Bundesbank,** (January 1983).

14. One minor technical note needs mentioning. Above we argued that the estimated residuals from an autoregression of the U.S. three-month Treasury bill rate could be considered to be the "news" or the "unanticipated" element which might influence German long-term interest rates. As a check on this assumption we reestimated equation (10) using simply the first difference of the three-month Treasury bill rates. The results were very similar to those reported here. Moreover, we obtained similar results when lagged (changes in) German short-term rates were included as explanatory variables.

An unpublished study by Dr. W. GeBauer, of the Deutsche Bundesbank, provided to me by Dr. H. Dudler, found an insignificant sum of the coefficients on changes in lagged short-term rates for a German term structure equation. See "Empirische Uberprufung von Zinsstrukturhypotheses," (April 1978). My thanks to Ms. Mary Byrd Nance for help in translation. The change in the role of the German interbank rate in the long-term rate expectations could also be reflecting the fact that the change in the Federal Reserve's operating techniques affected the risk characteristics of U.S. and German financial assets, and thereby affected the structure of asset demand equations for these securities. On how such changes in asset demand equations might occur given a change in policy regimes, see C. E. Walsh, "The Effects of Alternative Operating Procedures on Economic and Financial Relationship.," **Monetary Policy Issues in the 1980s,** a Symposium sponsored by the Federal Reserve Bank of Kansas City, (1982).

15. Quoted from C. Freedman, "The Effect of U.S. Policies on Foreign Countries: The Case of Canada," in **Monetary Policy Issues in the 1980s,** Federal Reserve Bank of Kansas City, (1982).

16. While it is admitted that the significance of the unanticipated Canadian interest rate variable in the U.S term structure equations is surprising, this result is consistent with earlier work by Kevin Hoover and the author. This earlier work suggested that U.S. interest rates were not insensitive, as might be expected, to the stocks of Canadian financial assets. See "Some Suggested Improvements to a Simple Portfolio Balance Model of Exchange Rate Determination with Special Reference to the U.S. Dollar/Canadian Dollar Rate," **Weltwirtschaftliches Archiv,** Heft 1, (1982).

17. Quoted from "The New Federal Reserve Operating Procedures: An External Perspective," by Edwin M. Truman and others, published in **New Monetary Control Procedures,** Federal Reserve Staff Study—Volume II, Board of Governors of the Federal Reserve System, February 1981.

18. While it is arguable that the post-October 1979 relationship between unanticipated U.S. rate movements and changes in German and Canadian long-term bond rates could have been related to some change in policy other than the October 1979 change in monetary control procedures of the Federal Reserve, this is not easy to establish by selecting other pivot dates on which to split the available sample. For example, using data prior to the period of floating exchange rates and estimating relationships similar to those above, the move from fixed to floating exchange rates in 1973 had little, if any, effect on the foreign bond market's response to U.S. interest rate movements. The policy move of October 1979 was closely followed by a rise in real interest rates in the U.S. and real appreciation of the U.S. dollar. These facts made U.S. interest rates important "leading indicators" of interest rates for those countries with strong exchange rate objectives.

Deregulated Deposit Rates and Monetary Policy

John P. Judd*

Events in recent years have highlighted the important relationships between monetary policy and the regulations governing financial markets and institutions. In particular, deposit-rate ceilings have emerged as one of the most important of these financial regulations, and the deregulation of these ceilings has triggered speculation as to the continued usefulness of the narrow transaction measure of the money supply—M1—that has most often been used by the Federal Reserve as its primary monetary policy guide. This paper analyzes how the effectiveness of M1 targeting has been affected by the recent round of deposit rate deregulation which occurred with the introduction of Super-NOW and Money Market Deposit Accounts. It also assesses the prospects for successfully implementing an M1-targeting approach to policy in the future, when all deposit-rate ceilings are removed.

Some economists and policymakers have argued that deposit rate deregulation is prima facie evidence that targeting the monetary aggregates, especially the narrow M1 aggregate, will no longer be desirable. In the second half of 1982, the Federal Reserve expressed its doubts about the reliability of M1 by placing less than the usual weight on this measure in formulating policy.

Some analysts have argued that deregulation will make the relationship between money and economic activity unstable by fundamentally altering a key relationship in the economy—the public's demand to hold transaction money.[1] There are two basic ways in which the demand for money, as measured by M1, may be permanently altered by deregulation. First, deregulation may induce a flow of savings balances into M1, and thus contaminate its basic transactions function. This could make the public's demand for M1 highly unstable because savings balances tend to be more sensitive than transaction balances to small changes in the broad range of interest rate spreads and in investors' sentiments. If this occurred, it would make the relationship between money and the economy more difficult to predict. However, the results of the empirical tests presented in this paper cast doubt on the view that such contamination has already occurred. The analysis also demonstrates that it is by no means certain that M1 will be seriously contaminated even when all deposit rate ceilings are removed in the future.

Another important effect of deregulation is that with flexible deposit rates, the opportunity cost of holding M1 may become fairly insensitive to changes in the general level of market rates of interest. The associated decline in the responsiveness of the quantity of money demanded to changes in the level of market interest rates has both disadvantages and advantages. One temporary disadvantage is that more flexible deposit rates would change the (reduced-form) relationships going from money to income and other variables. This would increase the uncertainty in policy decisions for the Federal Reserve until it understands and becomes proficient at working with the new relationships.

A permanent disadvantage is that the economy would become more sensitive to instability in money demand. However, the evidence thus far indicates that deregulation has not made M1 noticeably less stable. Moreover, the lower responsiveness of M1 demand to the overall level of interest rates has the advantage that it insulates the economy from instability in the public's demand for goods and services and from unexpected changes in inflation expectations.

Given these pluses and minuses, it is inappropriate to conclude that an economy with flexible

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deposit rates is not conducive to M1 targeting. Although it is too soon to tell for sure, there appears to be an equally good chance that M1 will have an even closer relationship with the macroeconomic variables when deposit rates are completely deregulated.

Deposit deregulation also raises issues concerning short-run monetary control. A lower interest-responsiveness of M1 demand could possibly make it less feasible or desirable for the Federal Reserve to achieve monetary targets in any precise way, since this precision might involve an unacceptably high degree of interest rate volatility. Moreover, even if precise control were exercised, M1 might become only a contemporaneous or even a lagging indicator of economic developments, rather than a leading indicator as it has been in the past. In this case, even a perfectly predictable demand for money would not be of high value for monetary targeting.

The analysis in this paper shows that the seriousness of this potential problem in part depends on whether or not M1 plays the role of a buffer-stock in the public's portfolio. If it does play this role, these problems are not likely to be great. If buffer-stock effects are small, M1 targeting could be seriously hampered by deposit rate deregulation. Only a small amount of evidence on this issue is now available, but it does support the existence of significant buffer-stock effects.

The conclusion that we draw from the arguments and evidence in this paper is that theory is silent on whether or not M1-targeting is more or less effective under flexible deposit rates. The test is an empirical one. Unfortunately, because deregulation is not yet complete, conclusive evidence is not available. The substantial evidence that does exist suggests that the use of M1 as an intermediate target has not been ruined by deregulation and that it would be advisable for the Federal Reserve to return to its former practice of using M1 as its primary monetary aggregate.

The rest of the paper is organized as follows. Section I presents the theoretical framework used for analysis in the paper. Section II discusses the effects of deregulation on the stability of money demand. Section III concerns the effects of deregulation on the responsiveness of money demand to market interest rates, and how this responsiveness alters the sensitivity of the economy to various types of uncertainty. Section IV analyzes potential monetary control problems. Finally, conclusions and policy implications are discussed in Section V.

I. Framework of Analysis

The model used in this paper is the standard IS-LM representation of the economy expanded to include a flexible deposit interest rate. The IS-curve represents combinations of nominal market interest rates (i) and real income (y) that produce equilibrium in the goods market, for given levels of expected inflation ($\dot{P}^*$) and the high employment federal expenditures (G) (Equation 1). The LM-curve represents combinations of nominal market interest rates and real income that equate the public's demand for money with the quantity supplied by the Federal Reserve, given the rate of return on deposits (z) and the level of prices, P (Equation 2).

The relationship explaining the rate of return on the deposits in the money stock is contained in a third equation (Equation 3). In the absence of deposit rate ceilings, the banking system is assumed to pay the competitive rate of return on these deposits. This competitive return is held below market rates by the extra costs and risks incurred by banks in

$$(1)\ y = y(\underset{+}{G},\ \underset{-}{i-\dot{P}^*})$$

$$(2)\ M/P = M(\underset{+}{y},\ \underset{-}{i-z})$$

$$(3)\ z = z(L,\ \underset{+}{i})$$

offering transaction deposits as compared with other debt instruments. These extra costs fall into two categories: those that vary systematically with market interest rates and those that do not. The importance of this distinction will become clear in the analysis below.

Reserve requirements are the primary example of costs that vary with market yields.[2] If transaction deposits carry a reserve requirement of x percent, banks incur a reserve requirement "tax" of xi per dollar of deposit. In a competitive banking system, banks will pass this "tax" on to the depositors by holding the rate on deposits (z) below the rate on market instruments to the extent of xi. For example, if the reserve requirement ratio is 12 percent and the market interest rate is 10 percent, the reserve requirement wedge between market and deposit rates would be 1.2 percentage points. Thus, reserve requirements can be an important factor in determining the opportunity cost of holding money (i-z), which, in turn, is a key determinant of the public's demand for money (Equation 2). Reserve requirement costs also cause the opportunity cost of holding money (i-z) to vary positively with market rates. For example, with a reserve requirement ratio of 12 percent, an increase in the market rate of 1 percentage point induces a rise in the deposit rate of 0.88 percentage point. The opportunity cost of holding money therefore increases by 0.12 percentage point.

There also may be factors holding interest rates on trasaction deposits below market rates that do not vary systematically with market interest rates (represented by the variable L in Equation 3). The primary example is the liquidity premium that can be expected to stand between transaction deposit rates and rates on less liquid substitutes. From the bank's viewpoint, this premium should exist because of the added risk incurred when institutions borrow funds through instruments payable on demand (transaction deposits) and lend the funds out through longer-term instruments.[3] Banks "produce" liquidity by transforming maturities in this way. However, the "production" process involves the risk of potential losses that would occur if (market determined) borrowing costs rose above (fixed) lending rates. Banks protect themselves from this added risk by maintaining equity cushions, and by making the yield on transaction deposits lower than that available on other less liquid deposits and on open market instruments. The depositor is willing to accept a lower interest rate on a transaction deposit because its added liquidity has economic value. The price that this liquidity commands in the market is the reduction in the interest rate on transaction deposits. Thus, for example, a liquidity premium can be expected to stand between the yields on transaction deposits and Treasury bills in much the same way as a premium stands between three-month and one-year Treasury bills.[4]

When deposit rate ceilings are in place, the parameters of Equation 3 obviously are different from when deposit rates are deregulated. If fixed deposit rate ceilings (such as the 5¼ percent ceiling on regular NOW accounts) were fully effective, the variable L simply would represent the negative of the constant ceiling rate, and the variable i would drop out of the function. However, it is unrealistic to assume that deposit rate regulations have been fully effective in the U.S., since there are various ways in which implicit forms of compensation can be paid by banks. It is reasonable to assume that competition for deposits will induce banks to exploit these methods. Thus, even under deposit-rate ceilings, it is more accurate to assume that z varies with i (although not as fast as without regulations) and that the level of compensation is above the fixed legal ceiling by some unspecified amount.

A final characteristic of all three equations is that they are not known with certainty. If this uncertainty were not present, the Federal Reserve would always be able to achieve what ever nominal income goal it set for itself. In other words, the uncertainty is the source of monetary policy problems. Although uncertainty cannot be eliminated, there are means of altering its probable effects on the economy. These include changing the way in which monetary policy is conducted by the Federal Reserve (for example, using monetary aggregates rather than interest rate targeting), or changing the regulations and laws that govern the financial system. The latter issue is the main subject of this paper.

The complete model can be summarized in terms of the familiar IS-LM diagram in Chart 1. The IS-curve is simply the plot of Equation 1 in terms of interest rates and income, for given levels of expected inflation and fiscal policy stimulus. A band is plotted to reflect the degree of uncertainty. The LM-curve is obtained by substituting the deposit rate setting Equation 3 into the money demand Equation 2. A band is plotted to denote the degree of uncertainty. For given monetary policy settings, defined by M under monetary aggregates targeting, the model predicts an outcome for real income of $\overline{y}$. However, the uncertainty about the relationships in the model means that y could end up anywhere in the range of y_1 to y_2 with some specified confidence level.

The analysis below focuses on how deposit rate deregulation affects the risks present in a monetary policy conducted in terms of monetary targeting. It shows how deregulation affects the width of the $y_1 - y_2$ range. Deposit-rate deregulation potentially can alter these risks by changing two important properties of the LM-curve. First deregulation could affect the stability or predictability of the public's demand for money, both temporarily during a transition period, and also permanently. In other words, deregulation might increase the size of the band of uncertainty around the LM-curve. This potential "instability" effect and its influence on the effectiveness of monetary aggregate targeting is discussed in Section II. Second, deregulation could reduce the responsiveness of the LM-curve to changes in market interest rates by allowing the deposit rate to move more closely with market rates. This "interest-elasticity" effect, which makes the LM-curve more vertical, is discussed in Sections III and IV.

II. Effects of Deregulation—Stability of Money Demand

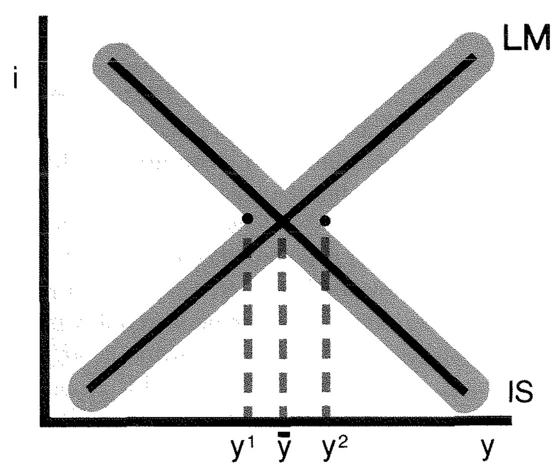
In cataloging the effects of deposit rate deregulation on money demand, it is useful to distinguish between the adjustment effects during the transition period after a regulatory change and the equilibrium effects which persist after full adjustment has been made. During the adjustment period, the level of M1 the public wishes to hold at given levels of income, prices and market interest rates may change. These changes have been called "shifts" in the demand for money. The deregulation of yields on transaction deposits temporarily causes the demand for M1 to shift *up*, as the public pursues the more attractive yields. The introduction of NOW accounts on a national basis in 1981 is a case in point. It raised the questions, by how much would the demand for M1 (including NOWs) rise in response to the higher ceiling rate available on checkable deposits, and how long would this adjustment take to run its course? Whenever such an upward shift is taking place, the LM-curve shifts to the left and tends to make policy more contractionary than would otherwise be the case. This can temporarily throw monetary policy off course as it is difficult to estimate the size and duration of the shift while it is occurring.

More important than the transitional problem is the potential *permanent* instability in money demand that could result from deregulation: it could become more difficult to predict the quantity of M1 the public demands. This problem could arise because higher yields on the deposits in M1 could induce the public to use it as a savings vehicle to a more significant degree than in the past.

Conceptually, one would expect the public's demand for a transaction aggregate (such as M1) to have a closer relationship with income and prices than a savings-type aggregate (such as M2) because there are few close substitutes for the medium of exchange. But if the public were to comingle in M1 the funds it holds for investment purposes, M1 would become more like the various financial assets held for investment purposes, and changes in M1 could be dominated at various times by shifts in the composition of the public's portfolio rather than by changes in income and prices.

For example, the demand for M1 might become

Chart 1



more highly responsive to fluctuations in the "normal" spreads between the rate of return on M1 and rates paid on a wide range of liquid financial instruments not included in M1. It also might become more sensitive to changes in yields on long-term bonds and common stocks. Shifts in investors' preferences for various maturities and liquidity characteristics would have larger effects on M1 demand, as would changes in precautionary motives over the business cycle. Since the demand for M1 might respond sensitively to a number of difficult-to-measure incentives, it might be difficult to predict the quantity of M1 demanded by the public. Put differently, an M1 demand function estimated in terms of the traditional arguments of income, prices and a market interest rate might frequently show signs of instability.

The problems that such instability can cause for a monetary policy oriented around M1-targeting can be illustrated with the IS-LM diagram in Chart 1. Greater instability in M1 demand would show up as a wider band of uncertainty in the LM-curve. This wider band would increase the range of outcomes for income (y_1—y_2 would become larger) for any given setting for M1.

NOWs, Super-NOWs, and MMDAs

There is a considerable amount of evidence available concerning the effects of deregulation on money demand during transition periods. This evidence also sheds light on the seriousness of potential permanent problems with instability in money demand resulting from the mixing of savings and transaction balances. If M1 were contaminated by savings balances, this would show up first as a temporary shift in the demand for M1, as savings balances were shifted into that aggregate. There should therefore be a positive association between the size of *upward* shifts during the transition period following deregulation and the probability that M1 has been permanently contaminated.

An earlier paper surveyed and analyzed the evidence of money demand instability during the transition periods following two episodes of deregulation prior to 1982–83.[5] Both episodes were related to growth in regular NOW accounts (with fixed ceilings): the introduction of NOW accounts in New England in the 1970s and the nationwide introduction of NOW accounts in January 1981. The study found that these effects on M1 demand have been relatively small. In New England's case, NOW accounts caused an upward M1 shift of not more than 5 percent over five years; in the nationwide case, NOWs raised the demand for M1 by no more than 3 percent in 1981. Moreover, some evidence suggests that the effect on M1 in 1981 was far smaller than the study quoted or even non-existent.[6]

The most recent and far-reaching example of deposit-rate deregulation occurred when federal regulators authorized commercial banks and thrift institutions to issue the Money Market Deposit Account (MMDA) in December 1982 and the Super-NOW account in January 1983. The MMDA is free of interest rate ceilings, has a $2,500 minimum denomination, and allows six transfers to third parties per month (three of which may be checks). The Super-NOW account (which is not available to businesses) is also subject to a $2,500 minimum denomination and is free of interest rate ceilings. An important distinguishing feature is that it has unlimited check-writing privileges.

Taken together, these two accounts mean that for the first time since the Great Depression, depository institutions are permitted by law to offer checkable deposits that are not subject to interest rate ceilings. This case of deregulation differs from the introduction of nationwide NOWs in 1981 in two important respects. First, the recent case completely removed interest rate ceilings instead of imposing a new higher, but fixed ceiling. (This feature of Super-NOWs is the focus of the analysis in Section III.) Second, ceilings were removed not only from transaction accounts (Super-NOWs), but also from close substitutes for transaction accounts (MMDAs).

The latter point means that unlike earlier cases of deregulation, the direction of the potential shift in money demand cannot be determined from theory. The effects of the introduction of Super-NOWs should induce positive flows of funds into M1 from unregulated instruments and especially from accounts that carry interest rate ceilings. Other potential sources of funds include passbook savings accounts and time deposits with interest rate ceilings, and money market mutual funds.

In contrast, the introduction of the MMDA should temporarily depress M1 growth. The public may, for one, use it as a cash management tool to reduce holdings of true transaction balances. Within the regulatory limitations on MMDAs, regular transfers of funds between them and the fully checkable deposits in M1 would allow the public to reduce the level of M1 needed to conduct a given volume of transactions. Another reason for shifts out of M1 into the MMDA is that the new account is, to a limited extent, a transaction instrument itself. Use of the MMDA to write a few large checks, such as mortgage or credit card payments, would mean that some transaction funds in the new account never have to pass through an M1 balance. Finally, M1 presumably contains some savings-type balances that are not actually used by the public for making transactions. These funds are probably lodged in traditional NOWs, which carry maximum yields that are competitive with passbook savings accounts. The higher yields and liquidity of MMDAs, however, should attract most of these funds away from M1.

In sum, shifts into MMDAs add up to a potentially significant reduction in the public's demand for M1. The extent to which these shifts depress M1, and thereby offset the expansionary effects of the Super-NOW account, depends partly on the pricing policies institutions adopt for the two accounts. That is, it depends on the parameters in the deposit-rate setting Equation 3. If yields on MMDAs are considerably more attractive than those on Super-NOWs (because of a liquidity premium and the difference in reserve requirements), there could be a net outflow of M1 funds into MMDAs. It is also possible that Super-NOWs are priced attractively enough to offset the outflow from M1, or to cause a net inflow. For these reasons, theory cannot tell us very much about the direction of the transitory effects. M1 demand could have shifted upward, making policy tighter than it appeared in 1983, or the opposite could have occurred. Similarly, theory cannot tell whether deregulation contaminated M1 by attracting savings balances into Super-NOWs, or purified M1 by attracting savings balances already in M1 into MMDAs.

Empirical Evidence in 1983

As noted earlier, there is good reason to expect that MMDA yields should exceed yields on Super-NOWs. This expectation has been borne out by subsequent events. The average interest paid on Super-NOWs from March through September 1983 has been below that of MMDAs by from 1.07 to 1.41 percentage points (see Chart 2). Using the one-month commercial paper rate as the interest rate, reserve requirement costs can be seen to account for between one and 1⅛ percentage point of this spread in March through September 1983, so there does appear to be a small additional spread due to other factors.

The explicit rates of interest quoted here may not give a very accurate indication of the true yields available on these instruments for certain deposits, the reason being that many institutions have attached various fees, including fixed monthly charges that are larger for smaller deposits,[7] to the instruments. However, these fees are not likely to affect a consumer's decision *at the margin* to add an additional dollar of savings balances to a Super-NOW versus an MMDA since the fixed charges that must be paid are unaffected by the decision. Thus, the interest rate spreads shown in Chart 2 probably give a good indication of the spread of yields (at the margin) that help determine where savings balances end up.

Although it is clear that consumers can earn more on their savings balances if they put them into MMDAs than in Super-NOWs, it is still possible that the premium on MMDAs is not large enough to prevent substantial mixing. This could be the case, for example, if explicit or implicit transaction costs between the two accounts were large enough to overcome the yield advantage associated with MMDAs. Unfortunately, it is extremely difficult, if not impossible, to obtain reliable estimates of these transaction costs, especially since they necessarily include the value consumers place on the time and "trouble" associated with managing liquid funds.

This paper employs two other methods of estimating how much M1 has been distorted by recent deregulation: work done by the Staff of the Board of Governors of the Federal Reserve System using surveys of depositors and cross-sectional econometric techniques to estimate the magnitudes of the various flows of liquid funds following the recent deregulation,[8] and econometric estimates and simulations of a demand-for-transaction-deposits equation to see if there is evidence of a "shift" in the function.

As of September 1983, MMDAs had reached \$367 billion (about 17 percent of M2), while Super-NOWs reached \$35 billion (about 6½ percent of M1).[9] The survey and econometric cross-section evidence suggests that the net distorting effect of this growth in Super-NOWs and MMDAs on M1 was small. With respect to MMDAs, the major sources of huge increases appear to be passbook savings accounts, small denomination time deposits, large denomination time deposits and money market mutual funds. Small amounts of funds are estimated to have been transferred from Treasury securities, other market instruments, demand deposits and regular NOW accounts. The last two categories are the only ones that would affect M1 growth, and they would apparently have contributed to a small downward shift in M1.

This same evidence indicates that the bulk of dollars placed in Super-NOWs came from other transaction accounts in M1, including demand deposits and regular NOWs. A small amount of funds probably came from non-M1 sources, including passbook savings and small time deposits. These latter movements would contribute a small upward shift in M1 demand that would tend to offset the small downward shift caused by funds transferred from transaction accounts to MMDAs.

Our own method of analysis consists of examining temporal econometric evidence on the behavior of the public's demand for transaction balances in the period after the dergulation of deposit rates—in December 1982 and January 1983. We employed conventional equations for the public's demand for transaction deposits. The equations specify M1 as a function of the six-month commercial paper rate, the personal consumption expenditure price deflator, and real personal income. Two alternative variations of this equation were used, one which restricted the interest elasticity to be constant, and another which allowed that elasticity to vary positively with the level of interest rates.

These equations were used to determine if growth in M1 after November 1982 was consistent with the historical demand relationship. We estimated the equations over the January 1970 through November 1982 period (see Table 1) and (dynamically) simulated them over the period December 1982–August 1983. We then compared the simulated M1-growth rates to actual growth. If the demand for M1 shifted with the introduction of the new accounts, this should show up as large cumulative under-forecasts by the end of the period.

Table 1
Transaction Deposit Demand Equations

A. Variable Interest Elasticity Specification

$$
\begin{aligned}
LTRD_t = {} & \underset{(0.86)}{0.091} - \underset{(7.11)}{0.0021}\,CPRT_t + LPCE_t \\
& + \underset{(5.20)}{0.069}\,(LYPERS_t - LPCE_t) \\
& - \underset{(4.83)}{0.0016}\,T_t + \underset{(3.04)}{0.000037}\,T_t^2 \\
& + \underset{(45.51)}{0.90}\,(LTRD_{t-1} - LPCE_t) \\
& + \underset{(2.00)}{0.16}U_t - \underset{(1.00)}{0.08}U_{t-1}
\end{aligned}
$$

Estimation Period: 1970.01 – 1982.11

$\bar{R}^2 = 0.999$
SEE = 0.0050
DW = 1.96

B. Constant Interest Elasticity Specification

$$
\begin{aligned}
LTRD_t = {} & \underset{(0.64)}{0.071} - \underset{(5.82)}{0.014}\,LCPRT_t + LPCE_t \\
& + \underset{(4.10)}{0.054}\,(LYPERS_t - LPCE_t) - \underset{(3.77)}{0.0013}T_t \\
& + \underset{(2.29)}{0.000029}T_t^2 \\
& + \underset{(47.7)}{0.92}\,(LTRD_{t-1} - LPCE_t) + \underset{(2.23)}{0.18}U_t - \underset{(1.24)}{0.10}U_{t-1}
\end{aligned}
$$

Estimation Period: 1970.01 – 1982.11

$\bar{R}^2 = 0.999$
SEE = 0.0052
DW = 1.97

Variables:

LTRD	=	log of (M1 minus currency).
LCPRT	=	log of 4–6 month commercial paper rate
CPRT	=	4–6 month commercial paper rate
LPCE	=	log of personal consumption expenditure deflator.
LYPERS	=	log of nominal personal income.
T	=	1,2, ...24 in 1974.07–1976.06; zero prior to 1974.07; 24 after 1976.06.
U	=	error term.

The results of our experiment are presented in Table 2. They show that the variable interest elasticity M1 demand equation *over*-forecasted M1 growth by a small amount. This result is inconsistent with the hypothesis that M1-demand shifted *up* with recent deregulation. The constant elasticity equation under-forecast M1 growth by 0.9 percent (at an annual rate), but this is a very small error compared with the standard error of the regression. These results therefore tend to confirm the survey and cross-sectional results which failed to find evidence of a shift in the public's demand-for-transaction-deposit equation following the recent deregulation.[10]

This evidence has two implications. First, instability in M1 demand does not appear to have significantly distorted monetary policy in 1983.[11] Second, if M1 were to be permanently contaminated by an inflow of savings balances, this would most likely have shown up as an upward shift in M1 demand during the transition period following deregulation. By not finding such a shift, this paper supports the view that the recent important round of deposit deregulation has not materially changed the transaction nature of M1.[12]

Prospects for the Future

The preceding analysis and evidence pertain only to deposits held by households. Although household deposits have been largely deregulated, corporations still are prohibited from holding any interest-bearing account that is fully checkable. This leaves open the possibility that M1 could be adversely affected by the deregulation of corporate demand deposits at some time in the future. There are, however, two reasons to believe that the effects of this deregulation on M1 may not be large. First, the evidence presented earlier suggests that the introduction of Super-NOWs has not caused a major inflow of savings balances into M1. If the yield spread between MMDAs and Super-NOWs has been large enough to preserve a reasonable separation of household savings and transaction balances, the same may also be true of corporate balances. Corporations, even small ones, are likely to manage their liquid balances more closely than do most households, and they have a wider variety of liquid investment alternatives available to them than do households.

Second, at least since the mid-1970s, deposit rate ceilings have effectively been circumvented by many large corporations. Banks often pay implicit returns on demand deposit balances through arrangements whereby the balances that corporations wish to hold are counted as payment for operational and credit services. For example, business customers can pay for loan commitments with dollars held in demand deposit accounts. In the case of operational services, dollars held in the checking account are multiplied by the implicit rate of return to be paid on the account, and the result of this calculation is counted as payment for services. Services not paid for by these deposits often can be covered through explicit fees.[13]

With regard to operational services, interviews with corporate treasurers and bankers suggest that (implicit) returns on checking account balances generally have been set at some open market rate (for example, the three-month Treasury bill rate) minus the cost to the bank of reserve requirements, and usually have been adjusted according to market rates on a monthly or quarterly basis. Thus, many corporations appear to have earned (marginal) returns roughly at the competitive rate, presumably close to the rate they would have earned under deregulated deposit rates. The interviews also suggest that these competitive yield spreads were large enough to induce most of the corporations to minimize their checking account balances for a given

Table 2
Growth in M1 minus Currency
(at Annual Rates)

Period	Actual	Dynamic Simulation	Actual minus Simulated
A. Variable Interest Elasticity Specification:			
December 1982 through August 1983	12.8 percent	13.6 percent	−0.8 percent
B. Constant Interest Elasticity Specification:			
December 1982 through August 1983	12.8 percent	11.9 percent	+0.9 percent

volume of transactions. Liquid funds in excess of this transaction demand were put into higher yielding savings-type instruments. In this way, the transaction and investment funds are effectively separated. There is thus a sizable component of corporate transaction balances that is unlikely to be significantly affected by future deposit-rate deregulation because it has already been "deregulated de facto."

III. Effects of Deregulation—Responsiveness of Money Demand to Market Interest Rates

The second aspect of concern over interest rate deregulation is related to the potential for permanent changes in the responsiveness of the demand for M1 to movements in market rates of interest, and how these changes will affect the money-to-income relationship. A key question in this regard is how sensitive depository institutions will be to movements in market yields when they adjust their offer rates on checkable deposits. Since the opportunity cost of holding M1 is the spread between the market rate and the deposit rate, adjusting deposit rates to closely follow market rates would make the opportunity cost of M1 vary much less than market rates. Thus, changes of a given size in the demand for M1 would correspond to large changes in market interest rates: that is, the elasticity of M1 with respect to market rates would be smaller.

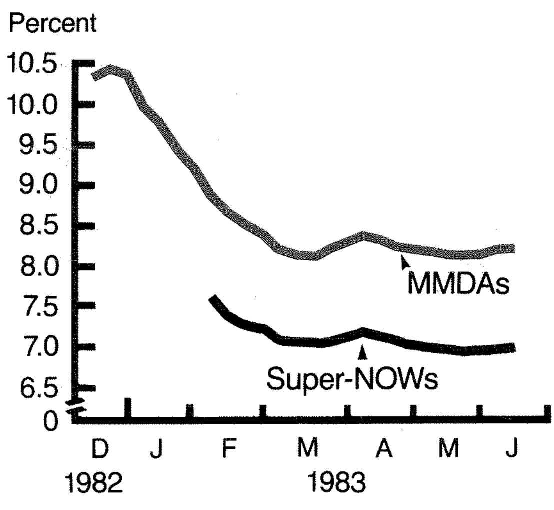
This point is illustrated by Equations 2 and 3. Equation 2, the money demand function, states that the public's demand for money varies inversely with the opportunity cost of holding money $(i - z)$. Equation 3, the bank deposit-rate setting equation, defines how this opportunity cost varies with market rates. When deposit-rate ceilings are fully effective, deposit rates do not vary with market rates. In such a case, changes in the opportunity cost of holding money would be equal to changes in market interest rates, and the LM-curve would have a positive slope as shown in Chart 1. At the other extreme, banks might vary deposit rates in tandem with market rates. In this case, the opportunity cost of holding money would be invariant with changes in market rates, and the opportunity cost variable $(i - z)$ would drop-out of the money demand equation. In this situation, the LM-curve in Chart 1 would be completely vertical.

As noted earlier, these assumptions obviously are overstatements of the regulated and deregulated worlds, respectively, since regulations on rates of return paid on transaction deposits have not been fully effective. Implicit returns on (large) corporate checking accounts apparently have responded fairly sensitively to market rates. However, it does appear reasonable to conclude that rates on consumer deposits will be more flexible and move significantly more closely with market rates after full deregulation than before.[14]

Implicit returns paid to households prior to the authorization of Super-NOWs appeared to have responded quite sluggishly to movements in market rates. Since part of that sluggishness presumably reflected the costs of adjusting implicit compensation, Super-NOW rates for consumers should be more variable than implicit returns. This expectation has been borne out so far by the experience with yields on Super-NOWs. As shown in Chart 2, Super-NOW rates appear to have moved fairly flexibly along with MMDA rates. However, this evidence is not conclusive because market rates have not changed very much since Super-NOWs were introduced.

Chart 2

Rates on MMDA's and Super NOW Accounts



There has not been a real test of how quickly banks will change Super-NOW rates in response to a sizeable change in market rates. Possibly more convincing is the evidence that banks have quite flexibly varied rates on other consumer deposits that were deregulated in recent years. A good example is the money market certificate authorized in mid-1978. Rates on these instruments have moved virtually in tandem with the six-month Treasury bill rate. Corresponding to this regulatory change, the responsiveness of M2 demand to changes in market rates fell sharply in mid-1978 (the elasticity is estimated to have dropped from −0.28 in 1960/Q4-1978/Q2 to −0.06 in 1978/Q3-1981/Q4.)[15]

Of course, it is unlikely that the opportunity cost of holding M1 will be totally invariant in relation to the market rate even when deposit rate ceilings are completely removed. The 12-percent reserve requirement on transaction deposits will be sufficient to impart a small positive movement in the opportunity cost as market rates change. But this positive movement is likely to be significantly smaller than it was prior to full deregulation.

Money Demand Stability

It is important to recognize that deposit-rate deregulation not only raises the possibility that money demand will become less stable, it also increases the importance of having a stable demand function for money. One possible effect of deregulation, then, is that when deposit rates are flexible, unanticipated "shifts" in the demand curve for money, at given levels of money supplied, are likely to have larger effects on income.

To illustrate this point, assume that the public's demand for money shifts up, and that the Fed holds the money supply constant. With more money demand and the same money supply, interest rates rise and income falls. When deposit rates are inflexible, the increase in nominal market interest rates lowers the quantity of money demanded somewhat, and thus causes income to drop by less than if deposit rates rose along with market rates. This partial offset is not as large when deposit rates are flexible, since in that case the increase in market rates has only a small effect on the opportunity cost of holding money, and thus does not affect money demand significantly. This point can be illustrated with the IS-LM diagram in Chart 1. As noted earlier, as the deposit rate moves more closely with the market rate, the LM-curve becomes more vertical. Instability in money demand causes the LM-curve to shift for given levels of the money supply. With a more vertical LM-curve under deregulation, these shifts have larger effects on interest rates and income.

Fiscal Policy

Another effect of interest rate deregulation is that it reduces the impact of fiscal policy on income. As a result, fiscal policy actions would not have to be correctly anticipated by the Federal Reserve for it to achieve its income goals. This should enhance the chance that the Fed will be able to correctly forecast the monetary targets that are consistent with its macroeconomic goals.

The reason that fiscal policy would have less effect on income for given levels of M1 is that there would be more financial crowding-out in the short-run with flexible deposit rates.[16] When the high employment deficit increases, the first round effect is that real GNP rises. However, if the Fed holds to its money target, interest rates will rise as the higher GNP causes money demand to increase in excess of the fixed money supply. With higher interest rates, part of the initial increase in GNP is crowded-out as firms and households cut back on their spending for durable goods. This crowding out is greater with flexible deposit rates because market interest rates rise by more, that is, higher market rates feed back on deposit rates which, in turn, induce further increases in market rates. As a consequence, the link between money and income would be less responsive to changes in fiscal policy with flexible deposit rates. In terms of the IS-LM diagram, a more expansionary fiscal policy causes the IS-curve to shift to the right. The more vertical is the LM-curve, the smaller is the effect of the IS-shift on income.

Inflation Expectations

Interest rate deregulation can also improve the money-to-income relationship by insulating income from changes in inflation expectations. For example, a decrease in inflation expectations (all else being equal) reduces nominal interest rates and thus raises the demand for money when deposit rates are *not* flexible. With higher money demand and the same money supply, income must fall.

These changes in income can be a major problem at various times because expected inflation is inherently uncertain and difficult to estimate. This potential problem is less serious with flexible deposit rates because the opportunity cost of holding money does not vary as much with changes in market interest rates.

The effect on the opportunity cost of holding money would come into play, for example, when inflation falls as the result of past tight monetary policy. With fixed deposit rates, this will necessitate temporarily higher growth rates in the money supply to accommodate the increased money demand associated with lower nominal interest rates. Otherwise, the drop in inflation would lead to a monetary policy that is more contractionary than originally intended. Since it is often difficult to forecast in advance when and by how much inflation will respond to money growth in any given year, potentially large problems can occur as a result of the impact of inflation on velocity. This problem was dramatically illustrated in 1982 and early in 1983, when an unexpectedly sharp decline in inflation led to a decline in nominal interest rates and a surge in the quantity of money demanded.[17] The Fed responded to the continuing weakness in the economy, and to the unusual behavior of M1 by allowing M1 growth to exceed the upper boundary of its 1982 target range by a wide margin. These problems would have been smaller if deposit rates had been flexible, since the drop in market rates would have induced a smaller increase in the demand for money.

Consumption and Capital Investment

A final result to deposit rate deregulation is that it would reduce the effect of unexpected shifts in the IS-curve (due to changes in the public's demand for goods and services) on the money-income relationship. With fixed deposit rates, swings in investment and consumption spending that are not forecasted by the Fed can have sizeable unexpected effects on income, for given levels of M1. Under flexible deposit rates, changes in market interest rates lead to only small changes in the opportunity cost of holding money, and thus, income stays closer to its forecasted value for given levels of M1.

New Relationships

The preceding analysis suggests the following conclusions regarding the impact of deposit rate deregulation. First, deregulation insulates income from a number of factors that otherwise could cause it to change unexpectedly. These factors include fiscal policy actions, changes in inflation expectations, and instability in the public's demand for goods and services. The price paid for these benefits is an increase in the destabilizing effects on income of instability in the demand for money. It is therefore crucial in an assessment of the effectiveness of monetary targeting under flexible deposit rates to gauge the impact on money demand stability.

The empirical evidence examined in Section II suggests that problems with unstable money demand may be small. However, it is important to recognize that even if the LM-relationship were more stable and predictable after deregulation than before, deregulation still may *temporarily* raise uncertainties for monetary targeting by quantitatively altering the responses of changes in income and interest rates to changes in money. This would occur if deregulation made the LM-curve significantly more vertical. In such a case, a given change in the money supply would have a larger effect on income and interest rates, at least in the intermediate run when income adjusts to monetary policy but prices do not.

In the context of stabilization policy, a more vertical LM-curve means that smaller changes in money would be required to achieve a given change in income. As long as the LM-curve remained stable and predictable, a more vertical LM-curve would not permanently cause problems for monetary targeting. But, the Fed could face considerable uncertainty during the period in which it was learning the new (reduced form) relationships. Of course, these statements apply to stabilization policy only. Deregulation would not affect the important long-run (or steady-state) properties of the macro-economy. Money would still be neutral in the long-run, affecting inflation but not real GNP.

IV. Monetary Control

The successful use of monetary aggregates targets requires that two basic conditions be satisfied: that the money-to-income relationship be relatively stable in the sense of being predictable, and that the Federal Reserve be able to achieve its monetary aggregates targets. In the analysis thus far, we have focused on how money affects income and assumed that monetary control was not a problem. In this section, we analyze the monetary control issue.

Monetary control generally is viewed as occurring in the *short-run* environment in which income and prices are fixed: that is, when the IS-curve is vertical. Analysis of this monetary control environment shows that even if the demand for money were stable under flexible deposit rates, there would be additional reasons to be concerned about the effectiveness of M1 targeting after deposit-rate deregulation. Some observers argue that with flexible deposit rates, M1 will no longer be a *leading* indicator of the pace of economic activity and inflation; it will merely be a contemporaneous reflection of economic conditions.[18] Moreover, they argue that deposit rate deregulation will make it difficult and undesirable for the Federal Reserve to control M1 in the short-run of, say, a calendar quarter because such control could induce disruptive volatility in interest rates.

These points can be illustrated by describing the conventional view of how monetary control works and how this process fits into a full macroeconomic model. Suppose the Fed wants to lower the total spending on goods and services in the economy. If it followed an intermediate targeting procedure, it would lower the target for money. According to the conventional view of monetary control, in the short-run (in which income is exogenous), the Fed would attempt to achieve this lower target by reducing its reserve operating instrument and thereby raising market interest rates. With deposit-rate ceilings in place, "bonds" would become more attractive to the public than the non- or low-interest bearing checkable deposits in money. The public would then demand smaller quantities of money-balances at given levels of income and prices, and the money stock would decline.

By raising the cost of credit, the increase in interest rates also would eventually (over a longer time period) reduce the public's spending on goods and services. Since according to empirical research, the lags from interest rates to M1 are shorter than those from interest rates to the economy, the decline in money occurs before the decline in economic activity. This timing pattern means that money is a *leading* indicator of the economy, and, as a result, has value as an intermediate target.

This view of the M1-targeting process places great emphasis on deposit-rate ceilings. These ceilings ensure that money is a less attractive asset to the public at high money-market rates than at low rates. Thus, "tight" monetary policies, which eventually reduce economic activity, show up first in reductions in money via money demand. Without deposit-rate ceilings, this result is far less certain. If banks raise rates on M1 deposits in tandem with money market rates, higher rates would have little effect on the relative attractiveness of securities versus money and there would be little effect on the quantity of money demanded. Put more formally, there is no equilibrium between the vertical short-run IS-curve and a vertical LM-curve that may be created by deregulation. This would make monetary control difficult at best, and attempts at such control would lead to extreme fluctuations in interest rates in the short-run.

Without the ability to influence the spread between yields on securities and money (and thus money demand), the Fed would not be able to control M1 through that mechanism. Higher interest rates (induced by lower reserves) would still lower economic activity with a lag, and this in turn would reduce the public's demand for M1, but M1 would merely be a contemporaneous indicator of the economy. Since movements in M1 would no longer foreshadow movements in GNP, M1 would no longer be as useful as an intermediate target.

Put differently, the Fed would be forced to formulate short-run policy in terms of the direct linkage between market rates of interest and income; that is, it would need to create an equilibrium between the IS and LM curves by making the LM horizontal through interest rate targeting. Since income affects money demand, it would be possible under such interest rate operating procedures to control money through income. However, there would be no advantage in formulating policy in this way, since income is the ultimate target of policy. Thus, the relationship between money and income could be perfectly stable, and yet be of little use to policymakers because M1 would not be subject to their control in the short run.[19]

The preceding example is obviously an extreme case. It is unlikely that the Fed would have no control of M1 through interest rates under flexible deposit rates. However, it is likely that the responsiveness of M1 to changes in the overall level of money market rates would decline significantly. This, therefore, raises an empirical question: how much will the interest-responsiveness of M1 decline in practice? A cut in half, for example, would not seem to present a significant problem. The Fed could achieve a given reduction in aggregate demand simply by lowering M1 by half as much as would have been required prior to deposit-rate deregulation. However, if the interest-responsiveness were to come close to zero, the conventional view of monetary control implies that the value of M1 as an intermediate target could be damaged significantly.

Buffer Stocks and the Inventory Theory

Even if deregulation caused the interest-responsiveness of M1 demand to become very low, this might not interfere significantly with the Fed's ability to control M1. There is an alternative view of how monetary control works which at least partially neutralizes the potential monetary control problems associated with deposit rate deregulation. This view holds that *in addition* to the interest rate channels noted above, monetary control operates directly through the supply of money provided by the actions of the Fed and the deposit-creating banking system. The rationale for this view is that money acts as a "shock absorber" or buffer stock between the receipts and spending of the public. Short-run variations in the observed stock of money, therefore, would not have to be induced by changes in people's underlying demand for money; they could result from independent changes in the quantity of money supplied that are unrelated to underlying demand factors such as interest rates and income.[20]

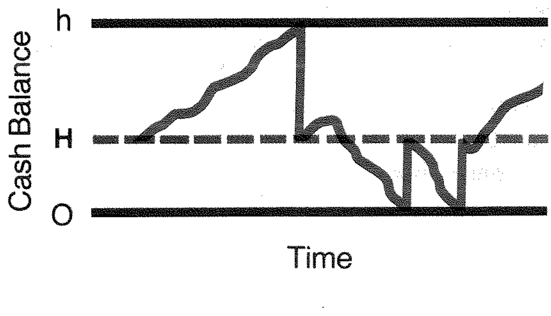
In this view, money demand is partly passive in the short-run, accommodating itself to changes in the supply of money. This view appears to be consistent with the widely accepted inventory theory of the transaction demand for money, which emphasizes the role of transaction costs in determining how closely balances are managed. Sudden inflows or outflows of funds cause inventories of money to be pushed away from their underlying desired levels in the short-run because it is costly for some money holders to make the frequent adjustments needed to bring money balances quickly back to desired levels.

The relationship between the transaction theory and the buffer stock function of money can be illustrated by analysis of the Miller-Orr model of money demand.[21] This model expands the classic inventory-theory of money demand developed by Baumol and Tobin[22] to include a cash flow that is not known with certainty by the moneyholder. More specifically, the Miller-Orr (M-O) model shows how a cost minimizing money holder manages transaction balances in the face of an uncertain cash flow by balancing two competing costs. First, there is the opportunity cost of holding transaction balances (the spread of yields on near money over those on money), which tends to reduce the quantity of money demanded. Second, there is the fixed per transaction fee of raising or lowering money balances by selling or buying securities, which tends to raise the quantity of money demanded.

M-O show that a cost minimizing solution to this problem is to establish what is called a two-param-

Chart 3

Cash Balance Under Miller-Orr Money Demand Model



eter control policy. Under this policy, individuals establish a maximum cash balance (h) and a minimum cash balance (0). The width of this range depends positively on the transaction cost and the variance of the daily cash flow, and negatively on the opportunity cost of holding money. Balances are allowed to wander freely within the h-0 range (see Chart 3). It is only when the cash balance reaches h that a security is purchased, and when it reaches 0 that a security is sold. In both cases, the size of the transaction is chosen to bring the cash balance to some level H, which lies in the h-0 range. In the long run, the average cash balance varies with the opportunity cost of holding money and the other underlying variables noted above. In the short-run, the cash balance can differ from its average, or underlying level of demand, depending on cash flows that are uncertain to the individual. This model can be regarded as a formal representation of the buffer stock role of money. Within the h-0 range, money is simply the residual item in the individual's balance sheet, and changes in money do not reflect changes in the underlying demand for money. Rather, within the h-0 range, changes in money are the side-effects of changes in the demands for goods and services, and real and financial assets.

The implications of this money demand model can be seen by imagining a world of Miller-Orr cash managers in which deposit rates move in tandem with market rates, making the opportunity cost of money constant. Now assume that the Federal Reserve makes the money supply exogenous through precise short-run monetary control. In an effort to achieve its money target, the Fed buys a Treasury bill from the public. This requires a very small decrease in Treasury bill rates, just enough to make the sale attractive in this highly competitive market. As a by-product of this transaction, the outstanding quantity of transactions money is raised. If the cash balance of the seller of the T-bill is still inside the h-0 range after the transaction, the newly created money resides there for a time. Thus, in the short-run, the quantity of money observed changes in accordance with the money supply, with a very small change in interest rates, and with no change in the underlying demand for money.

Even if the T-bill seller's h-0 range is pierced, the new money may not disappear from the economy. Instead, it may trigger the purchase of a security from another money holder. This string of transactions continues until the money ends up within someone's h-0 range. Each time a transaction is made to rid a portfolio of the newly acquired money, interest rates are affected a little more according to demands and supplies in the securities markets. If, for example, all money holders had very wide ranges, it might take a long time for the new money to be passed around enough for a large interest rate effect. If ranges were small, this might occur quickly. In either case, with the spread between market and deposit rates fixed, the money must continue to be passed around until income increases to the point where the new money is demanded. In other words, the underlying money demand eventually rises enough to absorb the increase in supply.

The conventional view of monetary control can be viewed as being based on the *empirical* judgment that h-0 ranges are very small on average. Thus, injections of new money are passed around so rapidly that they almost immediately cause large declines in interest rates. With fixed deposit ceilings, these declines translate into a lower opportunity cost of holding money and thus a higher underlying demand. Over a period short enough that income and prices cannot adjust, all of the increase in money supply must be abosrbed through such interest rate declines. In this circumstance, deposit rate deregulation would cause serious problems for monetary aggregates targeting if deregulation made the opportunity cost of holding money insensitive to Fed open-market operations. Attempts at short-run monetary control in this environment could have destabilizing effects on interest rates, or, at least, cause wild gyrations in them.

The buffer-stock view of monetary control argues that h-0 ranges are wide enough (on average) that, even with fully flexible deposit rates, changes in the money supply would induce only *gradual* changes in interest rates that ultimately affect income and prices with a lag.[23] M1 can, therefore, be controlled in the short-run even if the demand for it is not very responsive to the overall level of interest rates. Moreover, because of M1's buffer-stock role, changes in M1 will continue to be a useful *leading* indicator of future movements in income and prices.

The purpose of the preceding discussion was to establish that (1) the size of buffer-stock effects is an issue of great importance for monetary policy in an era of flexible deposit rates, and that (2) the existence of these effects is primarily an empircal issue. The theory behind buffer-stock demand appears to be consistent with the inventory theory of the demand for the medium of exchange that has come to be widely accepted by the economics profession. That is why this issue should be decided on the basis of empirical evidence.

A number of studies have used quarterly data to estimate LM-equations under the assumption that the money supply is exogenous. These equations implicitly or explicitly employ buffer-stock specifications.[24] Unfortunately, these equations do not shed much light on the question being raised here: in the short run (for example, weeks or months), would buffer-stock effects significantly moderate the interest rate fluctuations that otherwise might be caused by close monetary control with flexible deposit rates? One problem in obtaining evidence on this question is that the buffer-effects in question would not come into play unless the Fed actually exogenized money in the short-run. There is ample evidence that the Fed has done so only sporadically.[25] Substantial direct evidence is therefore not likely to be available because the Federal Reserve did not systematically "shock" the public's portfolio in an attempt to control money.

There is, however, a source of indirect evidence having to do with "shocks" from the credit markets that can occur when the Fed pursues a policy that stabilizes interest rates. In a world in which there are distinct markets for bonds (credit) as well as for money and commodities, it is possible to have exogenous changes in the supply of money even when the monetary authority pegs interest rates.[26] Suppose, for example, that firms decide to spend more on plant and equipment. They may finance this desired increase in spending by issuing new debt. Their increased demand for commodities (investment goods) is thus matched by an increased supply of debt (demand for credit). Nevertheless, the increased demand for credit puts pressure on interest rates to rise. To prevent the rise, the monetary authority increases bank reserves, allowing the banking system to purchase the new debt through the creation of new deposits (i.e., an increase in money supply). The firms' demand for money therefore has not increased except in a temporary sense: they have borrowed the money to spend, not to hold.

At this point, there is an increase in the supply of money that is not matched by any increase in the demand for money. That is, the change in money supply is exogenous. The firms borrowing the money will spend it. And the recipients of that expenditure will find themselves with excess money balances, at which time, the issue of the size of buffer stock effects comes into play.

If buffer-stock effects initiated by changes in bank lending were found to be significant during periods when the Fed used a short-term interest rate as its instrument, it would be reasonable to expect that buffer-stock effects also would be observed if the Fed actually exogenized money in the short-run. For this reason, evidence of a link between bank lending and the demand for money in the short-run would provide indirect evidence of the buffer-stock effects discussed above. The only available evidence on this point (to the author's knowledge) is in a money market model developed and used at the Federal Reserve Bank of San Francisco.[27] In this model, the short-run (monthly) demand for transaction deposits equation specifies the (log) level of transaction deposits as a function of the (log) levels of prices, real income, a short-term interest rates, *and* the (log) *change* in bank loans. For reasons stated above, the bank loan variable is intended to capture exogenous increases in the money supply at given levels of the short-term interest rate. It was found to be highly significant, both statistically and economically, when monthly data for the 1976–82 period was used. This result is consistent with the view that exogenous changes in the money supply cause transitory increases in observed money relative to the underlying demand for it. While this evidence is not proof in itself, it is sufficient to establish a working hypothesis that buffer-stock effects are significant and to demonstrate that further research in this area is warranted.

V. Conclusions and Policy Implications

This paper has analyzed how the effectiveness of M1-targeting is likely to be affected by the removal of regulatory ceilings on the interest banks are permitted to pay on deposits. A major conclusion is that theory is silent on the issue. There are plausible theoretical arguments both that deregulation will make M1 a less reliable intermediate target and that it will make M1 more reliable. Therefore, substantial empirical evidence is needed. The evidence that is available supports the view that deregulation has not greatly reduced the reliability of M1, but given that deregulation is not complete, policymakers face uncertainty about how M1 will behave in the future, when deposit-rates are further deregulated.

However, uncertainty about the behavior of M1 under deregulation does not by itself justify a deemphasis of M1 in favor of other monetary aggregates, such as M2. A decision to stress other aggregates should be based upon an evaluation of their reliability *relative* to M1. Although studies of M1 have been extensive, the behavior of the broader monetary aggregates in recent years under deposit-rate deregulation have not received the same attention. The deregulation of yields on M2, for example, began in earnest in mid-1978 with the introduction of money-market certificates. The available evidence on M2 suggests that the relationship between it and income has deteriorated significantly since mid-1978, and that M2 has become less controllable.[28] This evidence, together with the evidence presented in this paper on the stability of M1 in the 1980s, suggests that M2 has been more adversely affected by deregulation than M1. Thus, unless solid evidence of a major problem with M1 develops, the Federal Reserve would be well-advised to place more weight on M1 than the broader aggregates as intermediate targets of monetary policy in the future.

FOOTNOTES

1. The theoretical foundations for this viewpoint were developed by James Tobin in a number of articles, including "A General Equilibrium Approach to Monetary Theory," **Journal of Money, Credit and Banking,** February 1969. For discussions of these problems in the current institutional setting, see Stephen A. Axilrod, "Monetary Aggregates and Monetary Policy in a Deregulated Financial World," and Richard G. Davis, "Monetary Targeting in a 'Zero Balance' World," both in **Interest Rate Deregulation and Monetary Policy,** Federal Reserve Bank of San Francisco Conference, Asilomar Conference Center, Monterey, California, November 28–30, pp. 1–12, and 20–60.

2. See Benjamin Klein, "Competitive Interest Payments on Bank Deposits and the Long-Run Demand for Money," **American Economic Review,** December 1974, pp. 931–949, and Stephen M. Miller, "A Theory of the Banking Firm:" Comment, **Journal of Monetary Economics,** January 1975, pp. 123–128.

3. See William Poole, "Discussion of 'Monetary Targeting' in a Zero Balance World," in **Interest Rate Deregulation and Monetary Policy,** pp. 61–69, and James C. Van Horne, **Financial Market Rates and Flows,** Prentice-Hall, Englewood Cliffs, New Jersey, 1978, pp.6–11.

4. See Van Horne, **Ibid,** pp. 86–112 for a review of the theory and evidence on liquidity premiums in the term structure of interest rates. Some authors have argued that these premiums vary systematically with market rates. However, the theory and evidence on this point are inconclusive.

5. John P. Judd and John L. Scadding, "Financial Change and Monetary Targeting in the United States," in **Interest Rate Deregulation and Monetary Policy,** pp. 78–106.

6. See Ibid, pp. 90–91.

7. **Bank Rate Monitor,** Advertising News Service Incorporated, Miami Beach, Florida.

8. See Frederick T. Furlong, "New Deposit Instruments," **Federal Reserve Bulletin,** May 1983, pp. 319–326 for a discussion of this work.

9. These increases appear to represent the bulk of the stock adjustment into the new accounts. While these stock adjustments are taking place, the ratio of Super-NOWs to M1 and the ratio of MMDAs to M2 shold increase sharply, whereas these ratios should be trendless once the stock adjustment is over. These ratios did rise sharply shortly after deregulation (until April 1983), but the rate of increase in them has slowed markedly since then. This observation suggests that we apparently have enough information to do a fairly complete analysis of the response of the public to the new instruments.

10. Qualitatively similar results were obtained from the San Francisco Money Market Model. The transaction deposit demand equation in the model differs from the one used in this paper in that the model's equation includes as an argument changes in bank loans. For a description of the model, see John P. Judd and John L. Scadding, "What Do Money Market Models Tell Us About How to Conduct Monetary Policy?—Reply," **Journal of Money, Credit and**

Banking, November 1982, pp. 868–873, and John P. Judd, "A Monthly Model of the Money and Bank Loan Markets," Working Papers in Applied Economic Theory and Econometrics, Number 83-01, Federal Reserve Bank of San Francisco, May 1983, p. 7.

11. For an analysis of other factors that may have distorted monetary policy in 1982 through 1983, see the articles cited in footnote 17.

12. It might be argued that M1 was contaminated despite the lack of a shift in M1 demand. This could occur if active cash managers transfered transaction balances out of M1 into MMDAs, while less active managers transfered savings balances into Super-NOWs. Although this is possible, it seems unplausible. First, the survey and cross-section evidence contradicts this view, finding small flows from M1 to MMDAs and from non-M1 sources to Super-NOWs. Second, it is difficult to imagine why anyone would move funds that were already acting as savings balances from, say, a passbook savings to a Super-NOW account, when (1) MMDAs have a higher yield than passbook accounts, and (2) when MMDAs have lower transfer costs with checkable deposits than passbook savings.

13. See Thomas D. Simpson, "The Market for Federal Funds and Repurchase Agreements," Staff Studies 106, Board of Governors of the Federal Reserve System, July 1979.

14. Judd and Scadding, "Financial Change and Monetary Targeting in the United States," p. 87.

15. **Ibid,** p. 97.

16. This discussion abstracts from the possible effects of fiscal policy on the economy through changes in net wealth. For a discussion of this issue see Benjamin M. Friedman, "Crowding Out or Crowding In? The Economic Consequences of Financing Government Deficits," **Brookings Papers on Economic Activity,** 1978:3, pp. 593–641.

17. See Michael W. Keran, "Velocity and Monetary Policy in 1982" **Weekly Letter,** Federal Reserve Bank of San Francisco, March 18, 1983; John P. Judd, "The Recent Decline in Velocity: Instability in Money Demand or Inflation?," **Economic Review,** Federal Reserve Bank of San Francisco, Spring 1983, pp. 12–19; John P. Judd and Rose McElhattan, "The Behavior of Money and the Economy in 1982–83," **Economic Review,** Federal Reserve Bank of San Francisco, Summer 1983, pp. 46–51, Brian Motley, "Money, Inflation and Interest Rates," **Weekly Letter,** August 5, 1983, and John P. Judd and Brian Motley, "M1 Versus M2: Which is More Reliable," Working Papers in Applied Economic Theory and Econometrics, No. 83-04, Federal Reserve Bank of San Francisco, October 1983.

18. Richard G. Davis, "Monetary Targeting in a Zero Balance World," in **Interest Rate Deregulation and Monetary Policy.**

19. Money could still be used as an information variable in an optimal control framework—see Benjamin M. Friedman, "Targets, Instruments and Indicators of Monetary Policy," **Journal of Monetary Economics,** 1975, pp. 443–473. In this context, an IS-LM model (expanded to include a money supply function), would be solved in terms of nonborrowed reserves as the exogenous policy instrument. Money would be one among a potentially large number of exogenous information variables, and would not be assigned any special role.

20. For an excellent description of the buffer stock concept, and a bibliography of other papers on the subject, see David Laidler, "The Buffer Stock Notion in Monetary Economics," Research Report 8313, The University of Western Ontario, London, Canada, May 1983.

21. Merton H. Miller and Daniel Orr, "A Model of the Demand for Money by Firms," **Quarterly Journal of Economics,** August 1966, pp. 413–35.

22. See William J. Baumol, "The Transactions Demand for Cash: An Inventory Theoretic Approach," **Quarterly Journal of Economics,** November 1952, pp. 545–56, and James Tobin, "The Interest-Elasticity of the Transactions Demand for Cash," **Review of Economics and Statistics,** August 1956, pp. 421–47.

23. The view that buffer-stock effects are empirically important does **not** deny the emergence of sophisticated money management techniques and new instruments (like repurchase agreements) that have lowered transaction costs and reduced the variance of cash flow for certain money holders, especially large corporations. The demand for M1 by these firms fell sharply in 1975–76. (See John P. Judd and John L. Scadding, "The Search for a Stable Money Demand Function: A Survey of the Post-1973 Literature," **Journal of Economic Literature,** September 1982, pp. 994–1023.) This showed up clearly in a sizable downward shift in money demand. However, there is no indication that corporations' demand for money fell so low in that episode that their buffer stock demand disappeared. Moreover, since the mid-1970s, innovations appear to have been introduced at a markedly slower rate. Finally, smaller or less sophisticated corporations and households are likely to hold more or less than their desired level of money for an extended period of time. Most households and small corporations have relatively low money balances on average, and actions to adjust those balances to desired levels may be costly relative to any resulting benefit. If money finds its way into these "loosely" managed portfolios it may stay there for awhile.

24. For reviews and evaluation of this evidence, as well as a bibliography of the original articles, see David Laidler, "The Buffer Stock Notion in Monetary Economics," and "The Demand for Money—Yet Again," Carnegie-Rochester Conference on Public Policy, **On the State of Macro-Economics,** Eds.: Karl Brunner and Alan H. Meltzer. Amsterdam, North Holland, 1980, pp. 219–71; and John P. Judd and John L. Scadding, "The Search for a Stable Money Demand Function: A Review of the Post-1973 Literature," **Journal of Economic Literature,** September 1982, pp. 994-1023, and "Dynamic Adjustment in the Demand for Money: Tests of Alternative Hypotheses," **Economic**

Review, Federal Reserve Bank of San Francisco, Fall 1982, pp. 19–30.

25. This statement is obviously true for the pre-October 1979 period, when the Fed used the Federal funds rate or free reserves as operating instruments. It also can be argued that a great deal of interest rate smoothing (in the short-run) also occurred under the reserve operating procedures initiated in October 1979. See various articles on these control procedures in **New Monetary Control Procedures,** Volumes I and II, Board of Governors of the Federal Reserve System, February 1981. Especially, see papers by Stephen Axilrod, Fred Levin and Paul Meek, and Peter Tinsley and others. Also, see John P. Judd, "An Examination of the Federal Reserve's Strategy for Controlling the Monetary Aggregates," Federal Reserve Bank of San Francisco, **Economic Review,** Fall, 1982, pp. 7–18.

26. Karl Brunner and Allan H. Meltzer, "An Aggregative Theory for a Closed Economy, in **Monetarism,** edited by J. Stein. Amsterdam: North Holland, 1976, pp. 69–103.

27. John P. Judd and John L. Scadding, "What Do Money Market Models Tell Us About How to Conduct Monetary Policy?—Reply," and John P. Judd, "A Monthly Model of the Money and Bank Loan Markets."

28. For research in the early 1970s evaluating alternative intermediate targets of monetary policy see the series of articles by Michael Hamburger, Frederick Schadrack and Fred Levin under the heading "The Choice of Intermediate Targets," in **Monetary Aggregates and Monetary Policy,** Federal Reserve Bank of New York, 1974. For recent analysis see, Dallas S. Batten and Daniel L. Thornton, "M1 or M2: Which is the Better Monetary Target?" **Review,** Federal Reserve Bank of St. Louis, June/July 1983, and John P. Judd and Brian Motley, "M1 versus M2: Which Is More Reliable?" Working Papers in Applied Economic Theory and Econometrics, Federal Reserve Bank of San Francisco, No. 83-04, October 1983.