The Globalization of Financial Markets and the Effectiveness of Monetary Policy Instruments

Since the early 1970s financial markets around the world have been moving toward fuller integration. At least in principle, this trend could have significant implications for each country's financial markets and the workings of its domestic monetary policy. In the case of the United States, the globalization of financial markets could at times diminish the compatibility of the Federal Reserve's goals for inflation, employment, and external balance. Moreover, the closer integration of domestic and foreign financial markets could conceivably impair the Federal Reserve's ability to implement a change in its monetary policy. This article focuses on this last aspect of globalization and monetary policy. More specifically, we seek to determine whether globalization has loosened the linkage between the instruments of monetary policy—the discount rate and open market operations—and short-term interest rates.

Intuition suggests that closer integration makes the total demand for dollar-denominated money market instruments more interest-rate elastic. The domestic component of this demand would be more elastic because debt instruments issued by foreigners are more readily available to U.S. investors and hence provide closer substitutes for domestic instruments than ever before. The foreign component of this demand would also be more elastic because U.S.-issued instruments appear more often in foreign portfolios. Similarly, the supply side of the market would be more elastic since the issuers of short-term debt instruments have more options. Consequently, a change of a given magnitude in a policy instrument and the corresponding movement of the federal funds rate—other things equal—would have a smaller proximate impact on domestic short-term rates; and a smaller impact on short-term rates implies, according to virtually all descriptions of the monetary transmission mechanism, a diminished effect on the ultimate goals of policy. So, changes in bank reserves would need to be larger than before to alter the three-month interest rate by, say, half a percentage point and thereby tighten policy.

By increasing the participation of foreign investors in U S financial markets, globalization may also have made the U.S. money market more sensitive to developments in foreign credit markets and the foreign exchange markets. As a result, the effect of any change in a monetary policy instrument may now be less certain, in the sense that the financial markets' response to discount rate changes or open market operations may not be anticipated as well as before, when the reactions of only the domestic credit markets had to be considered. In these other terms, the effectiveness of monetary policy may also have been diminished because policymakers might turn more cautious when the impact of their actions cannot be gauged in advance

But the changes brought about by globalization need not be as substantial as such speculation might suggest. It may be argued that globalization has deeply affected the determination of U.S. capital and money market rates and has altered the linkages between money market and capital market rates; nevertheless, its effects may not have significantly reduced the size or the predictability of the proximate impact of policy instrument changes on domestic short-term interest rates. The overnight rate is determined by the supply of nonborrowed bank reserves and this rate is insulated

from any open-economy impacts. If the linkage between the overnight rate and three-month money market rates is essentially unchanged, monetary policy's proximate impact on the money market would be preserved and could be anticipated much as before.

To address these issues, we present a general framework that assumes that assets are not generally perfect substitutes either domestically or internationally. Empirical research has usually rejected the assumption of perfect substitutability of assets. But the framework is also consistent with the view that the substitutability of various types of assets has increased over time. Thus, the trend of the past several years toward globalization has the potential to alter the way the markets set U S short-term interest rates. Next, we describe the role of the federal funds market, where policy instrument changes are first felt. Its special function leads us to focus our statistical analysis on the spread between a market-determined short-term interest rate (the three-month Treasury bill rate) and the federal funds rate.

Finally, we specify and estimate an econometric model of that spread in order to gauge the effect of foreign economic conditions on the U.S. money market. On the basis of our regression results, we evaluate the impact of financial market integration on the effectiveness of domestic reserve operations We find, as anticipated, that foreign economic variables exert a statistically significant influence on U.S. short-term interest rates and that their collective influence has been expanding somewhat relative to domestic economic variables. Such a development would, of course, be consistent with increasing international capital mobility and greater integration of national financial markets Nevertheless, our results suggest that the expanding significance of foreign economic variables is more directly traceable simply to a relative rise in their volatility compared with the volatility of domestic variables (although the absolute volatility of both has declined). These comparatively greater movements in the foreign variables affecting domestic credit markets have apparently made the outcome of instrument changes (open market operations and discount rate changes) less certain, and consequently, less effective in a qualitative sense.

Surprisingly, however, the growing influence of foreign factors seems to be associated with a *larger* impact on the money market from a given change in the supply of bank reserves. We find limited evidence that domestic reserve operations are actually gaining potency: a somewhat smaller open market operation can be conducted to achieve a given impact on short-term interest rates. This is the opposite of the anticipated effect from globalization Thus, in this quantita-tive sense, it can be said that despite globalization, policy actions may not be any less effective.

In summary, our results suggest that while the impact of a given reserve change has possibly become larger in the face of international financial integration, the predictability of the response of domestic short-term interest rates has declined. The latter development has occurred principally because the relative importance of movements in foreign economic variables, which may be essentially unpredictable ex ante, has increased.

The framework for the econometric model
One might reasonably suppose that the globalization of financial markets has had a significant and direct impact on both the U.S. capital and money markets.[1] That is, globalization may well have altered the determination of domestic long-term interest rates and their spreads relative to short-term rates. To be sure, the volume of nonborrowed reserves, as determined by open market operations in conjunction with market factors, retains close influence on the overnight federal funds rate But notwithstanding this influence, it is logical to ask whether globalization has hampered the Federal Reserve's ability to implement monetary policy changes (as measured by nominal short-term interest rates) using its instruments, the discount rate and open market operations.

To look into this matter, we will construct and estimate a single-equation econometric model. This model fits within a general framework for credit markets with cross-country linkages. It relates the spread between the overnight federal funds rate and the three-month Treasury bill rate to domestic and foreign economic factors. The empirical results obtained from this model may provide some insight into the potentially declining efficiency of monetary policy instruments.

A general model of the financial sector
In the most general case, the demand for a particular U.S financial asset depends on: (a) its own rate of return relative to those of all other domestic assets; (b) the return in dollars on foreign assets, equal to their own rates of return, plus the expected change in the exchange rate; (c) the level of financial wealth and the flow of saving, both here and abroad; and (d) other relevant macroeconomic variables that affect perceptions of risks and the future value of the various assets.[2] These relevant variables include foreign-

[1]See Bruce Kasman and Charles Pigott, "Interest Rate Divergences among the Major Industrial Nations," in this issue of the Quarterly Review

[2]This follows from James Tobin, "A General Equilibrium Approach to Monetary Theory," Journal of Money, Credit, and Banking, February 1969, pp 15-29

sector indicators such as the volatility of the exchange rate and the current account position.

Each financial asset substitutes to some extent for every other financial asset. Some pairs of assets are nearly perfect substitutes for each other, such as commercial bank negotiable certificates of deposit and bank holding company commercial paper (provided that they have similar maturities and are issued by similarly rated institutions). Other assets are weak substitutes: for example, low-grade corporate bonds and overnight Eurodollar deposits. The extent to which domestic and foreign assets are substitutes for one another is a function of their similarity in terms of liquidity, maturity, default risk, and other characteristics, as well as the importance the market attaches to distinctions of nationality and currency denomination.[3] Generally, domestic and foreign assets will tend to be more closely substitutable the more open the national financial markets and the lower the barriers to international flows.

The influence of foreign economic factors on U.S interest rates could be growing through any of several routes, each related to the globalization of financial markets and the increasing openness of the U.S economy. First, and most important, the reduction of barriers to international capital flows, a key element of the globalization of financial markets, by itself tends to make domestic and foreign assets closer substitutes by allowing investors greater freedom to choose among alternatives. Consequently, movements in foreign demand and supply, other things equal, should exert through either interest rates or exchange rates greater influence on domestic financial conditions, and vice versa. Second, the real sector of the U.S. economy is more open than before, with the result that the scale of certain variables, such as the volumes of exports and imports and the associated financial transactions, has increased relative to the economy as a whole, and the impact of the exchange rate on the real economy has increased. Third, there may be more variation in important international economic variables (for example, the U.S. exchange rate), such that they are the source — relative to domestic economic factors — of more of the shifts in the demand for financial assets. Greater variability of international economic factors would be likely to increase the number and size of unpredictable shifts in domestic credit demand or supply.

Much of the empirical research on interest rate determination is not particularly helpful in addressing whether and how foreign factors are becoming more important. This research has tended to concentrate mostly on testing the expectations theory of the yield

[3]See Kasman and Pigott, "Interest Rate Divergences "

curve and theories of international interest rate parity. Econometric models of domestic interest rate determination have tended to be constructed on the joint assumptions that all assets (or all assets within a particular class) are perfect substitutes and that expectations of future interest rates are formed "rationally";[4] the models of international rate determination have most often been based on the assumption of perfect capital mobility. Under these assumptions, the demands for domestic financial assets are infinitely sensitive to differentials in expected rates of return, and hence, we should never observe persistent differentials over the same holding period because the marketplace would quickly arbitrage them away. Nor should we observe persistent differentials in yields between similar foreign and domestic assets after adjustment for expected currency changes; the marketplace should arbitrage away differentials across currencies.

Empirical research usually rejects the expectations theory of the yield curve.[5] Instead, systematic deviations between the actual three-month Treasury bill rate and that predicted by the yield curve are observed. Similarly, perfect substitutability among assets that differ only with respect to currency denomination has been tested and generally rejected; significant differentials in ex ante (uncovered) yields have been found.[6] Unfortunately, researchers have had little success in identifying the factors causing these differentials. Thus, we do not have much to build on when we address how the trend toward globalization may have changed the connection between policy instruments and money market rates.

The independence of the federal funds rate

Before describing the econometric model used in this paper and discussing our regression results, it is useful to clarify the special role of the federal funds rate in the money market. The overnight market for federal funds is largely independent of, but not disconnected

[4]That is, investors base their expectations on all information economically available about the future behavior of interest rates

[5]For a summary of this line of research, see Robert J Shiller, John Y Campbell, and Kermit L Schoenholtz, "Forward Rates and Future Policy Interpreting the Term Structure of Interest Rates," Brookings Papers on Economic Activity, 1 1983, pp 173-217, and N Gregory Mankiw, "The Term Structure of Interest Rates Revisited," Brookings Papers on Economic Activity, 1 1986, pp 61-96 For a collection of papers on the domestic and international determinants of interest rates, see Nominal and Real Interest Rates Determinants and Influences, Bank for International Settlements (Basle, Switzerland, 1985)

[6]Paul Boothe and others, International Asset Substitutability Theory and Evidence for Canada, Bank of Canada, 1985, and M A Akhtar and Kenneth Weiller, "Developments in International Capital Mobility A Perspective on the Underlying Forces and the Empirical Literature," Federal Reserve Bank of New York, Research Paper no 8711, in International Integration of Financial Markets and U S Monetary Policy, December 1987

from, the rest of the money market. As a practical matter, if we look at the average funds rate calculated over intervals longer than a month, we find that it is set within a range by the demand for and supply of bank reserves independently of other short-term rates, and thus it is subject to the influence of open market operations. Changes in other interest rates do feed back onto the fed funds rate, but only to a limited extent. In the opposite direction, the federal funds rate is connected to the rest of the money market, such that domestic operations set off a chain reaction affecting other money market rates. Thus, in the classification scheme for economic models, the financial sector is not a fully simultaneous system. Instead, it is block recursive, the funds market constituting the first block and the rest of the financial markets the second and main block.[7]

The demand for bank reserves is created by (a) reserve requirements and (b) each bank's need to post a positive reserve balance in its account at the Federal Reserve every night. The supply of bank reserves is essentially determined by (a) the actions of the Manager for Domestic Operations and (b) the administration of the discount window. "Market factors" such as float and Treasury fiscal operations cause unintended fluctuations in supply to the extent that the open market Desk does not perfectly foresee and allow for them. The funds market thus redistributes reserves among banks so that they can meet reserve requirements and avoid overnight overdrafts.

The specialized nature of the federal funds market is manifested in rate movements that take place late in the trading day. When a significant shortage or surplus of reserves appears on a settlement day, the fed funds rate will soar or plunge far outside of its recent trading range. These movements, typically occurring after 4:00 p.m., do not correspond to changes in the closely related markets for overnight repurchase agreements (RPs) and overnight Eurodollars, because by that time these markets are effectively closed for the day. Movements in the fed funds rate can also occur if the Fedwire is down or if some large bank is having computer problems.[8]

As noted, however, the funds rate is not totally disconnected from the rest of the money market in the short run—its independence can be overstated. The federal funds rate trades within a range even when no policy moves are being made. Developments in the RP market or very short-term Eurodollar market can spill over and affect the overnight funds rate, particularly

within a single two-week reserve maintenance period. Expectations of an imminent policy move will also cause overnight funds to trade high or low relative to other money market rates.

In sum, by virtue of the conservation of reserves in the domestic banking system, there is no reason to presume that globalization has directly had any measurable effect on the determination of the overnight federal funds rate—except perhaps within the reserve averaging period. Within such periods, the possibility exists that the increasing integration of world financial markets may have had some minor effects on the behavior of the overnight funds rate. For example, globalization may have increased the size and depth of the overnight Eurodollar market and made overnight Euros a better substitute for overnight fed funds. In addition, by increasing the volume or variance of clearings of money-center banks, globalization may have raised the demand for excess reserves.[9]

The connection to other interest rates
Immediately available funds are lent to the banking sector by private firms and municipalities through RPs, and by thrift institutions and credit unions through federal funds purchases. (Transactions in "immediately available funds" are those in which the transfer of money is made during the same business day and not at the end of the day or on the next day.) Moreover, immediately available funds are channeled downstream from small banks to large banks through the federal funds market. To some extent, these participants can shift to or from other instruments (term fed funds, term RPs, very short maturity Eurodollar deposits, "short" Treasury bills) if the overnight fed funds rate is out of line with slightly longer-term rates. The possibility of substitution creates a connection between the overnight funds rate and other money market rates. (In a generalized model of the financial sector, the federal funds rate would appear in the demand equations of other short-term instruments.) Thus, open market operations can influence money market rates directly by affecting the federal funds rate and indirectly by changing the markets' expectations of the future values of this rate.

All this implies that the spreads between the federal funds rate and other money market rates can be quite variable from one month to the next. The Treasury yield curve may be upward sloping, and yet the overnight federal funds rate may be well above the one- or three-month bill rate because monetary policy is plac-

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[7]In such a system, the endogenous variables are determined in sequence, either individually or in groups

[8]There are also quarter-end and year-end effects

[9]No increase in the clearing banks' demand for excess reserves has been detected, however, during the past several years as the volume of transactions handled by CHIPS (Clearing House Interbank Payments System) has grown rapidly

ing considerable pressure on banks' reserve positions; or the funds rate may be below the Treasury bill rates if modest reserve pressure is being imposed.

Moreover, because federal funds and Treasury bills are imperfect substitutes, there is some scope for the internationalization of financial markets to have an effect. The rate spread between them is not determined exclusively by the expected future path of domestic short-term interest rates, other factors matter. So, since the overnight fed funds rate is influenced by changes in the supply of nonborrowed reserves, movements in the spread between the fed funds and Treasury bill rates reflect changes in the stance of monetary policy—as well as developments in domestic and foreign credit markets.[10] Whether movements in the rate spread now reflect changes in Federal Reserve instruments to a lesser degree because of globalization is the focus of the remaining sections of this article.

Estimation and analysis of the model
To investigate the effect of the globalization of financial markets on the linkage between open market operations and domestic short-term interest rates, we estimated a single-equation econometric model based on the generalized framework of the preceding section. This model explains the movements in the spread between the overnight federal funds rate and the three-month U.S. Treasury bill rate.

The spread is most obviously and directly affected by changes in the instruments of monetary policy The overnight federal funds rate is expected to rise relative to the three-month Treasury bill rate as the supply of bank reserves is tightened; the funds rate is expected to fall relative to the bill rate when reserve supply is easing. Thus, on average the spread widens as reserve supply tightens, and narrows (and may even turn negative) when supply eases. Of course, the spread can narrow or widen without any policy-related change in the supply of reserves; many other factors influence the spread between these two interest rates. In any

case, the best choice among possible measures of the influence of policy actions on the funds rate is clearly borrowed reserves (or the related measure, free reserves).[11]

Another important factor affecting the federal funds-Treasury bill rate spread is the U.S. bond rate (the long end of the domestic yield curve). Changes in the bond rate, through arbitrage up and down the yield curve, should be positively correlated with changes in the bill rate. The bond rate, though labeled a domestic-economy variable, may be an important channel through which foreign financial shocks or impulses are transmitted to the domestic credit markets. In the past few years, the foreign demand at some auctions of U.S. Treasury bonds has been estimated by primary dealers to be on the order of 40 to 50 percent. It would seem then that the influence of economic developments outside the country can be introduced by variables that are nominally labeled domestic; and it is probably futile to categorize variables as purely domestic or purely foreign.

In addition to these two "domestic economy" variables, any number of explicitly foreign economic factors could also affect the federal funds-Treasury bill spread:

- First, movements in foreign interest rates would be expected to be correlated with movements in domestic interest rates, especially as foreign assets become increasingly substitutable for domestic assets; more than one connection between foreign and domestic rates could be imagined. Thus, weighted averages of foreign short- or long-term interest rates were included in the regressions as explanatory variables.
- Second, the exchange rate would be expected to influence the spread directly or indirectly. The anticipated change in the exchange rate is a component of the anticipated total return from assets denominated in a foreign currency. Moreover, with a much longer lag, a significant change in the exchange rate affects the competitiveness of an economy's products in world markets and thus adds or subtracts from its aggregate demand. Such shifts would in turn affect the demand and supply of credit. Through these channels domestic financial markets could be affected by actual or anticipated exchange rate movements. To capture these

[10]That the slope of the Treasury yield curve, measured from three or six months to 10, 20, or 30 years, is an indicator of the stance of monetary policy is a view held by many participants in the credit markets, including economists working in the area For example, see Drexel Burnham Lambert Government Securities Inc , "Treasury Market Comment October 1987 " A variation is Laurent's use of the spread between the long-term bond rate and the federal funds rate as an indicator of policy See Robert D Laurent, "An Interest Rate-Based Indicator of Monetary Policy," Federal Reserve Bank of Chicago Economic Perspectives, January-February 1988, pp 3-14 The spread used in this paper is still another variation As the next section will show, this spread is affected by many factors, only some of which are identifiable by statistical analysis, and thus is far from an unambiguous indicator of policy changes First, the long-term bond rate and foreign factors affect the spread, second, short-term shifts in the demand for Treasury bills—as in a "flight to quality" by investors—distort it

[11]Because policy changes can be accomplished through changes in the discount rate instead of, or in conjunction with, open market operations, one would expect the discount rate to be one of the factors appearing in the regression equation The discount rate, however, is omitted for several reasons a discount rate change is often widely anticipated before it is announced, a surcharge was imposed during 1981, and additional multicollinearity would be introduced

effects, we tried two proxies as explanatory variables: changes in the exchange rate and its forward premium. The actual change in the exchange rate, besides altering competitiveness, represents the realized currency gain or loss, since expectations are not measured well, the actual change may have to substitute for the anticipated change in the exchange rate

- Third, the amount of currency risk incurred by investing in foreign assets—the risk that an investor takes by later having to convert the return from a foreign-currency-denominated asset into dollars—should be relevant. The greater the risk, the less attractive the foreign assets. Thus, the variance of the exchange rate was used as a measure of volatility in the foreign exchange market.

- Fourth, the closer integration of U.S. financial markets with those in the rest of the world may affect the spread by enhancing international capital mobility as well as asset substitutability. Increased capital mobility and the process of financial market integration may be reflected in the growing volume of international financial and nonfinancial transactions. We tried two proxies to capture this trend toward greater internationalization: the sum of all private financial inflows and outflows and direct investments, and the sum of U.S. merchandise exports and imports (both scaled by nominal GNP).

Regression results
In each of the regressions in the first set, we added one of a number of foreign factors to an equation that otherwise contained only domestic-economy variables. Thus, the spread between the federal funds rate and the Treasury bill rate was initially explained by (a) discount window borrowing, (b) the domestic bond rate, and (c) one of the foreign variables. In these regressions, with all variables appearing in first-difference form, statistically significant coefficient estimates were found for discount window borrowing, for the domestic bond rate, and among the foreign variables, for foreign short-term interest rates; but none of the other foreign variables proved significant. Thus, insignificant estimates were found for foreign long-term rates, for foreign trade (the ratio of U S. exports and imports to GNP), for foreign financial transactions (the ratio of financial inflows and outflows to GNP), and for the exchange rate, its forward premium, and its volatility. The coefficient for the foreign trade variable came closest to achieving the usual significance levels and hence it was included in later regressions.

The regression results for the equation that included foreign short-term rates but not foreign trade are reported in column 1 of Table 1. The estimated long-run

impacts of borrowed reserves, the bond rate, and foreign short-term rates on the spread are in the expected direction and seem reasonable in magnitude:

- If borrowed reserves rise $100 million while the domestic bond rate and foreign money market rates are constant, the spread between federal funds and Treasury bills immediately grows 4 basis points and eventually widens by a total of 11 basis points.[12] Intuition suggests that the bill rate should rise more and the spread should widen less than the model indicates But it must be remembered that the bond rate is held constant so that pressure is being placed on the bill rate only from shorter maturities. On average, a tightening of policy would also cause the domestic bond rate to rise; pressure would then be applied to the bill rate from the long end of the market as well (and if foreign short-term rates rise, from the international money market too).

- If the bond rate falls by 100 basis points with monetary policy unchanged and foreign short-term rates constant, then the spread of the federal funds rate over the Treasury bill rate widens by 50 basis points in the same month, but later narrows, ending with a net increase of 23 basis points.[13] Essentially, the bill rate moves down less than the bond rate, and the Treasury yield curve flattens; with the funds rate nearly constant and a lower bill rate, the spread between the overnight and three-month rates widens.

- When foreign short-term interest rates fall while domestic long-term rates and discount window borrowing are constant, the spread between the federal funds rate and the bill rate initially widens, as would be expected. According to the equation, given a 100 basis point fall in foreign short-term rates, the bill rate falls by 36 basis points. In the longer run, though, the spread is relatively unaffected The coefficient estimates imply that the spread will eventually be a little narrower than it was initially but the effect may be too small to be significant.[14] In any event, it is difficult to interpret the coefficient on foreign short-term rates in a conventional fashion. Changes in foreign rates may

[12] The short-run effect is the sum of the two borrowed reserves coefficients (-4 78 + 26 66) divided by a scaling factor ($58 7 billion, total reserves as of December 1987), the long-run effect is the sum of the simple change in the bond rate plus 2 5 times the change in the bond rate from its average over the four previous months (-4 78 + (2 5)(26 66)) divided by a scaling factor

[13] These effects are calculated in the same way as those for the borrowed reserves variable

[14] The effects are again calculated in the same way as for the borrowed reserves

well be a response to U S. rates or may reflect, at least to some extent, industrial countries' efforts to coordinate monetary and exchange rate policies

Having found that foreign short-term rates contributed significant explanatory power to the equation, we

then reestimated the regression equation by adding the other foreign variables one at a time. In this second set of regressions, none of the additional foreign variables was significant The variable coming closest to significance was foreign trade (t-statistic of 1 72). The results of this regression are reported in column 2 of Table 1. A rise in foreign trade is correlated with an increase in the spread between federal funds and Treasury bills

In sum, foreign variables do seem to be playing a role in determining the federal funds-Treasury bill spread. Foreign short-term rates clearly contribute; foreign trade, as a proxy for international activity generally, may also To be sure, the inclusion of foreign short-term rates, with or without a foreign trade variable, only modestly improves the equation's fit (R^2). The degree of improvement in the overall fit, however, is likely to be a deceptive indicator of the role of foreign factors and may be a poor way to measure the effect of globalization In the presence of a high degree of multicollinearity, as is the case here, the marginal increase in the regression's explanatory power should not be interpreted as meaning that only a negligible share of the movements in the spread can be attributed to foreign sources. The marginal increase is biased toward understating the contribution of the foreign factors

Gauging the impact of globalization
The next step was to apportion the explained variability in the spread between the domestic and foreign factors and to make an inference regarding the importance of globalization But before taking this step, we calculated the actual and predicted variability of the spread, measured by the standard deviation, within 12-month intervals, moving through the sample one month at a time from January 1980 to December 1987. The predicted variability is the degree of variability expected given the movements in the factors incorporated in the model, it is derived using the coefficient estimates of the regression model (version 2, which includes the foreign trade variable) Chart 1 compares predicted variability with actual variability. (The predicted variability is shown by the dashed line, the actual variability by the solid line)

The period from late 1979 to mid-1982, when the Domestic Trading Desk used a nonborrowed reserves operating target, clearly coincides with a high degree of volatility in the spread Moreover, the larger movements in borrowed reserves, the bond rate, and the foreign variables in that period are the sources of much, but by no means all, of this higher variability; some of the variability cannot be attributed to factors identified in the model This increase in residual variance could be the by-product of the monetary policy

Table 1

Regression Results for the Model

Sample Period November 1979 to December 1987

Independent Variables	Coefficient Estimates (t-statistics in parentheses)	
	Version 1	Version 2
Constant	0 019 (0 5)	0 019 (0 5)
$BR_t - BR_{t-1}$	-4 78 (-0 7)	-6 54 (-1 0)
$BR_t - BR4_{t-1}$	26 66 (4 6)	28 35 (4 8)
$BOND_t - BOND_{t-1}$	-0 68 (-3 7)	-0 56 (-2 9)
$BOND_t - BOND4_{t-1}$	0 18 (1 3)	0 10 (0 8)
$FST_t - FST_{t-1}$	-0 70 (-2 2)	-0 79 (-2 5)
$FST_t - FST4_{t-1}$	0 34 (2 0)	0 35 (2 0)
$FRTRD_t - FRTRD4_{t-1}$	–	148 0 (1 7)
	Summary Statistics	
R^2	0 42	0 44
Durbin-Watson	2 51	2 51
Standard error	0 54	0 53

Note All variables entered the regression in first-difference form

Dependent variable	= Federal funds rate less the three-month Treasury bill rate
BR	= Borrowed reserves (in hundreds of millions of dollars), divided by total reserves (in billions)
BR4	= The average of borrowed reserves (divided by total reserves) over the previous four months
BOND	= The 10-year Treasury bond rate
BOND4	= The average of the bond rate over the previous four months
FST	= An average of foreign short-term interest rates
FST4	= The average of foreign short-term rates over the four previous months
FRTRD	= The sum of nominal exports and imports, divided by GNP (all in billions of dollars)
FRTRD4	= The average of FRTRD over the previous four months

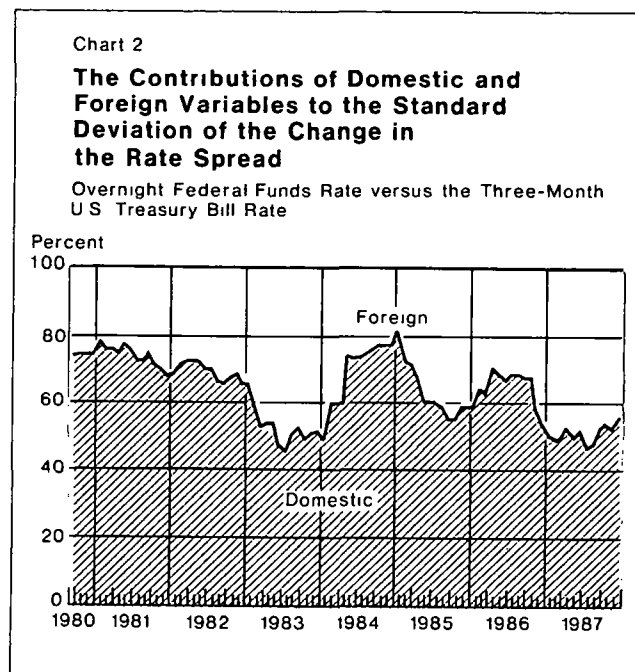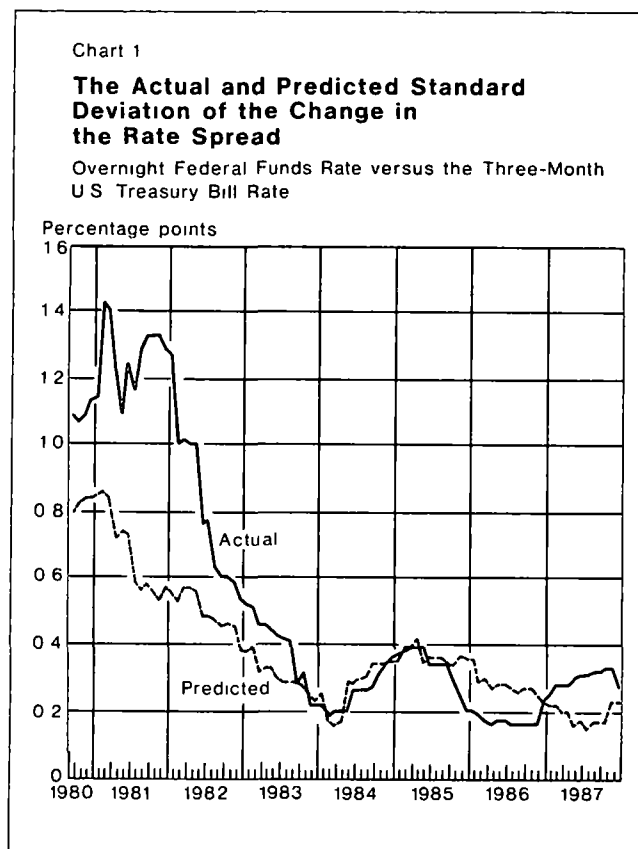A complete description of the variables is provided in the Appendix

tactics of the period, or the effect of atypically large real or financial shocks to the economy, such as the credit control program. Thus, besides greater variability of the right-hand side variables in the regression, there is a larger element of unexplained variation—variation that cannot be attributed to factors explicitly included in the regression model.

We next calculated the relative contributions of domestic and foreign factors to the variability of the spread, as predicted by the equations, and plotted the results in Chart 2. This statistical procedure does not allow precise attribution, but it does seem that (a) foreign factors introduce less variability than domestic factors into the spread, but (b) the share introduced by foreign forces is gradually increasing over time, although with a highly irregular trend. In the early 1980s, foreign factors were responsible for about 25 percent of the spread's variability, most recently, about 40 percent on average. This increase is one indication that, relatively speaking, foreign economic factors are having a greater effect than before on the determination of U.S. short-term interest rates

If one channel of influence for monetary policy is its

impact on short-term interest rates, and if this impact, in turn, operates in part through the effect of open market operations on the market for reserves and the funds rate, then any nonpolicy factor that may influence the spread between the funds rate and the bill rate can be an impediment to policy if its influence is not easily forecastable Thus, a growing influence of foreign factors on this rate spread may represent a problem for policy if these foreign influences are hard to predict and hence hard to allow for Foreign influence on the spread may be difficult to estimate for several reasons: despite improved communications, developments in foreign economies are not as well understood as those in the domestic economy; the actions of foreign central banks are not known in advance, and foreign investors respond somewhat differently from domestic investors to changes in the economic outlook. Under these circumstances it can be argued that the effectiveness of policy has declined as the role of foreign factors has increased

The procedure used in our regression analysis to this point does not permit us to say whether the increased variability in the rate spread attributable to foreign factors reflects the direct impact of the increased globalization of financial markets Indeed, the use of a constant coefficient model automatically rules out the possibility of any such inference. One way to test for an increased impact of rising international financial integration would be to see if the estimated

Chart 1

The Actual and Predicted Standard Deviation of the Change in the Rate Spread

Overnight Federal Funds Rate versus the Three-Month U S Treasury Bill Rate

Chart 2

The Contributions of Domestic and Foreign Variables to the Standard Deviation of the Change in the Rate Spread

Overnight Federal Funds Rate versus the Three-Month U S Treasury Bill Rate

coefficient on the foreign factors rises over time In another set of regressions, one coefficient in each equation was allowed to rise or fall steadily through the sample period [15] These time-varying regression results do *not* indicate increasing foreign-variable impacts on the spread The hypothesis that the coefficient for foreign short-term interest rates has remained essentially constant is not rejected on the basis of conventional statistical tests This may simply mean that globalization of the money markets was substantial by the early 1980s and progressed more slowly thereafter, while still occurring apace in the capital markets For the foreign trade variable, however, a constant coefficient can be rejected, but surprisingly, the coefficient is declining,

[15]Allowing all coefficients to vary through time in a single regression consumes too many degrees of freedom and introduces too much collinearity

not rising as anticipated (See column 4 of Table 2)

On the domestic side, a constant coefficient for the bond rate can not be rejected Because globalization of capital markets has supposedly been progressing rapidly this decade, it might have been expected that this coefficient would have increased over time. In the case of the borrowed reserves variable, a constant coefficient can be rejected, but the regressions indicate that the coefficient *falls* during the sample period For the change in borrowed reserves from the previous month (but not for the change from the average over the previous four months), a constant coefficient can be rejected at the 95 percent level The results appear in the first three columns of Table 2

If the finding of a declining coefficient is correct, the implication is that a given increase—in, say, the level of borrowings induced by open market operations— may produce approximately the same upward pressure on the funds rate as in earlier years but may now have a larger effect on the other short-term rates presumed to affect the economy at large That is, the rise in the funds rate is now more nearly matched by a rise in the bill rate, so that the impact on the spread is smaller than in earlier years Even if this finding is true, however, its practical significance is doubtful since it simply means that a smaller volume of open market operations is needed, other things equal, to produce a given impact on bill rates and other short-term rates

In any case, the power of the test used is unknown, it may have the tendency to indicate incorrectly a changing coefficient value more often than the test's significance level suggests Moreover, this finding could also be the product of mixing two somewhat different time periods, 1979-82 and 1983-87 The earlier period corresponds to the time when the path for nonborrowed reserves was directly tied to the growth of the money supply Finally, greater coordination of monetary policies may invalidate the "other things equal" assumption underlying this analysis That is, domestic and foreign monetary policies may now be changed in concert, causing the location of the shift in the regression equation to be misidentified

Conclusion

Our study provides some empirical evidence indicating that an increased impact of foreign developments on the U.S money markets may have loosened the linkage between changes in the supply of bank reserves and U S. money market interest rates, and perhaps to some extent complicated the use of monetary policy to influence these rates According to our results, foreign economic factors have been making a greater contribution to the determination of U S short-term rates in recent years A greater role played by foreign factors in

Table 2

Testing for Changing Coefficient Values

Sample Period November 1979 to December 1987

Independent Variables	Coefficient Estimates (t-statistics in parentheses)			
	Equation 1	Equation 2	Equation 3	Equation 4
Constant	0 018 (0 5)	0 011 (0 1)	0 017 (0 1)	0 020 (0 1)
BR_t-BR_{t-1}	45 08 (2 1)	−4 45 (−0 7)	43 96 (2 0)	−6 17 (−0 9)
(BR_t-BR_{t-1}) *Time	−0 44 (−2 4)	−	−0 45 (−2 5)	−
BR_t-BR4_{t-1}	26 71 (4 7)	57 26 (3 1)	28 44 (5 0)	26 75 (4 6)
(BR_t-BR4_{t-1}) *Time	−	−0 29 (−1 7)	−	−
$BOND_t-BOND_{t-1}$	−0 69 (−3 9)	−0 64 (−3 5)	−0 56 (−3 0)	−0 56 (−2 9)
$BOND_t-BOND4_{t-1}$	0 15 (1 2)	0 17 (1 3)	0 078 (0 6)	0 15 (1 1)
FST_t-FST_{t-1}	−0 85 (−2 7)	−0 81 (−2 5)	−0 94 (−3 0)	−0 81 (−2 6)
FST_t-FST4_{t-1}	0 43 (2 5)	0 37 (2 2)	0 44 (2 6)	0 27 (1 5)
$FRTRD_t-FRTRD4_{t-1}$	− −	− −	151 8 (1 8)	854 6 (2 2)
$(FRTRD_t-FRTRD4_{t-1})$ *TIME	−	−	−	−5 38 (−1 9)
	Summary Statistics			
R²	0 46	0 44	0 46	0 46
Durbin-Watson	2 52	2 51	2 53	2 50
Standard error	0 52	0 53	0 52	0 52

the domestic credit markets makes for more uncertainty in anticipating the proximate impact of a policy instrument change. Whether the greater contribution by foreign economic factors indicated by the regression model has been precipitated by globalization is debatable; but a case can be made that the greater volatility in the financial and real sectors of the world economy is attributable to tighter connections among financial markets worldwide

One indication that globalization has loosened the linkage would be regression estimates showing an increasing effect of foreign economic factors on the spread between the federal funds rate and the Treasury bill rate, or a decreasing effect of domestic factors on that spread. Such changes in the effects were not observed, however. Instead, we found some statistical evidence suggesting that the potency of monetary policy instruments may be greater, in the limited sense that a given change in borrowed reserves may have a larger impact on money market rates than in the past.

Lawrence J. Radecki
Vincent Reinhart

Appendix: Description of the Variables Used in the Regression Equations

Variables appearing in reported results
The dependent variable, SPREAD, equals the overnight federal funds rate (monthly average of effective daily rates) less the three-month Treasury bill rate (monthly average of daily rates in the secondary market, bank discount basis). Source: Board of Governors of the Federal Reserve System.

BR equals the sum of adjustment and seasonal borrowing from the discount window, in millions of dollars. Source: Board of Governors of the Federal Reserve System.

BOND equals the 10-year Treasury bond rate (monthly average of daily rate in the secondary market). Source: Board of Governors of the Federal Reserve System.

FST equals the weighted average of the short-term interest rates in 10 countries (Switzerland and the G-10 countries excluding the United States), the weights are the same as those used for the exchange rate. Source: INTMAC database of the Board of Governors' staff.

EXP is the merchandise exports of the United States, seasonally adjusted. Source: Department of Commerce.

Variables appearing in unreported results
Imports are the merchandise imports of the United States, seasonally adjusted Source: Department of Commerce.

Foreign long-term interest rates equal the weighted average of the long-term interest rates in 10 countries; the weights are the same as those used for the exchange rate.

U.S. exchange rate is the index of the weighted average exchange value of the U.S. dollar against currencies of other G-10 countries plus Switzerland. March 1973 = 100 (weights based on the 1972-76 global trade of each of the 10 countries). Source: Board of Governors of the Federal Reserve System.

Volatility of the exchange rate equals the standard deviation of the change from the previous day in the logarithm of the U.S exchange rate, calculated monthly. Source: INTMAC database of the Board of Governors' staff.

The forward premium of the exchange rate equals the difference between the yen-dollar or mark-dollar spot rate and the three-month forward rate. Source: Bank for International Settlements.

The dollar volume of U.S. government securities (Treasury and agency) bought by foreign private investors was obtained from the Treasury Department.