Monetary Policy under Alternative Exchange-Rate Regimes: Simulations with a Multi-Country Model

Ernesto Hernández-Catá, Howard Howe, Sung Y. Kwack, Guy Stevens, Richard Berner and Peter Clark*

Introduction

The purpose of this paper is to present some preliminary results on the impact of monetary policy in today's system of managed exchange-rate flexibility. Typical monetary policy actions in the United States, Japan, and West Germany will be investigated with an eye to both their effects at home and abroad, and the extent to which these effects depend on the degree of exchange-rate flexibility and exchange-market intervention.

The emphasis in this paper will be empirical. Although much theoretical work has been done contrasting the effects of policy actions under alternative exchange-market assumptions,[1] little has been done to quantify these effects. The Multi-Country Model which is under development at the Federal Reserve Board provides us with a tool to make such quantitative estimates — in fact, this was one of the primary purposes for its development. The results presented here are some of the first simulations of monetary and intervention policy run with that model.[2]

In the first part of this paper we describe the effects of a contractionary monetary policy in the United States implemented by an open-market operation. To highlight the differential impact obtained by linking the U.S. model with the rest of the Multi-Country Model, we present results both for the U.S. model alone and for the full Multi-Country Model. We then examine the effects of restrictive monetary policies abroad: 1) an increase in the Bank of Japan's discount rate, and 2) an increase in reserve requirements applicable to German banks. In the third part, we report on the results of experiments deal-

*At the time of the writing of this paper the authors were economists in the Quantitative Studies Section of the Division of International Finance at the Board of Governors of the Federal Reserve System. They wish to express their gratitude to a number of co-workers for their contributions to the completion of this paper. Joseph Formoso, Ann Mirabito, Sam Parrillo and Steven Schooler bore much of the responsibility and thus deserve much of the credit for the simulations of the Multi-Country Model. Helpful discussions with various members of the Board's Division of International Finance are gratefully acknowledged. The views expressed in this paper are those of the authors and do not necessarily represent the views of the Federal Reserve System.

[1]For example, Fleming (1962), Mundell (1968) and Girton and Henderson (1976).

[2]Needless to say, therefore, the estimates presented here are preliminary in nature and are in no way official estimates of the Board of Governors or the Division of International Finance.

ing with changes in exchange-market intervention behavior. We look at what would have happened if the monetary authorities had intervened to moderate exchange-rate changes with twice the intensity actually observed over the early floating-rate period between 1973 and 1975. Finally, we investigate how the effects of a contractionary monetary policy in the United States are altered when intervention behavior is modified in the manner just described.

The Multi-Country Model (MCM) is a system of linked national macroeconomic models, at the center of which is a medium-sized model of the U.S. economy. Linked to it, and to each other, are models for Canada, West Germany, Japan, the United Kingdom, and an abbreviated model representing the rest of the world.

These models explain the main domestic variables and international transactions of each country: real and nominal GNP and its components (consumption, investment, exports and imports of goods and services), deflators for domestic spending, exports and imports, as well as the wage rate, capacity utilization and unemployment.[3] Each country model has a monetary sector which determines short- and long-term interest rates together with monetary aggregates. The most important instruments of monetary and fiscal policy — reserve requirements, the discount rate, central bank holdings of domestic and foreign assets, and real government expenditures — are integrated into each country model.

The individual country models are linked through trade flows, prices, interest rates and capital flows. For example, the exports of each country are determined by other countries' imports from that country. In this way a change in one country's foreign trade has an immediate impact on the GNP of other countries. Similarly, the price of imported commodities depends on other countries' export prices and on the exchange rates that convert these prices into domestic currency. Movements in foreign price and cost conditions are transmitted to each country's import price, which in turn directly affects its domestic price level.

The monetary sectors of the various countries in the model are directly linked together through capital flows. A change in monetary conditions in one country will affect its short- and long-term interest rates and funds will move from one country to another insofar as portfolios are readjusted. These international capital movements will directly affect monetary conditions in the receiving countries to the extent that exchange-market intervention is allowed to impinge on the monetary base.[4] In addition, the interest rate changes in one country may affect exchange rates and therefore have an indirect impact on foreign monetary conditions through changes in foreign-trade balances and demand conditions.

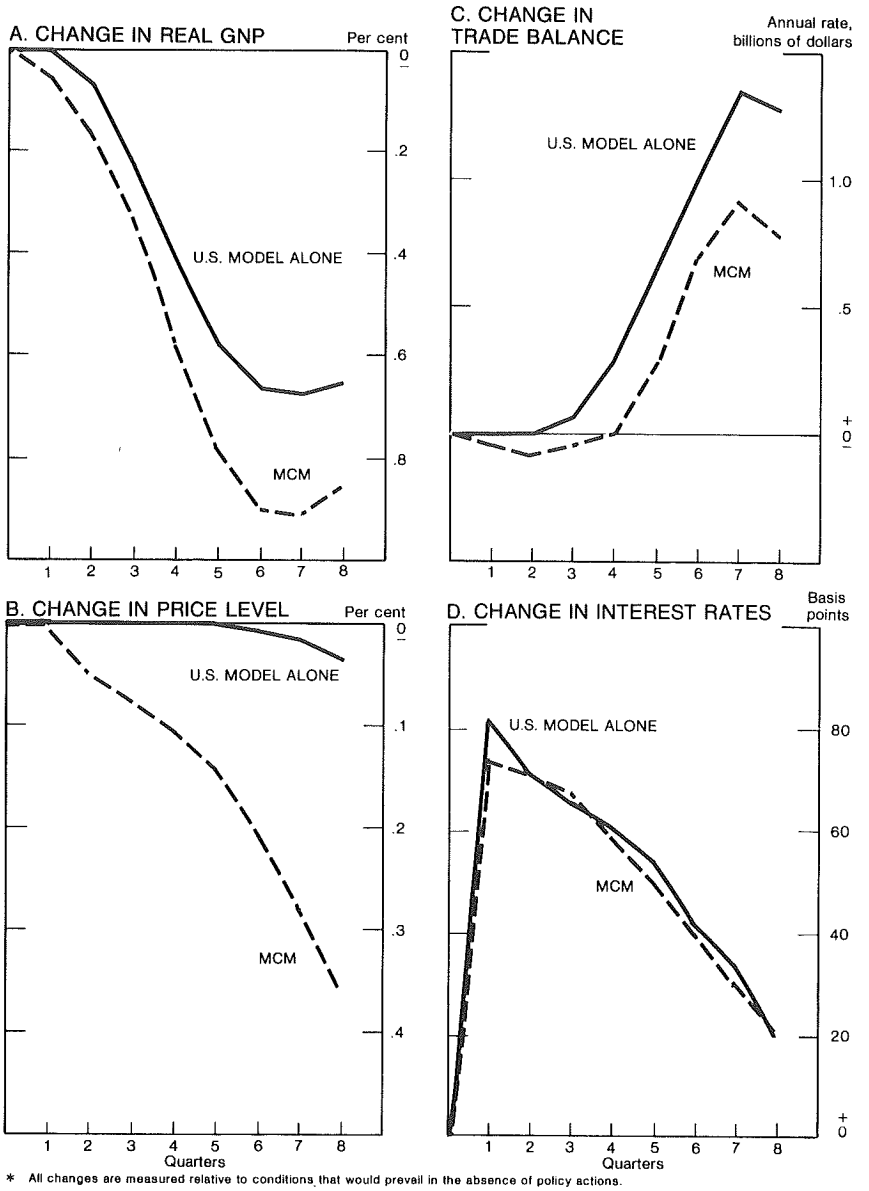
A special feature of the Multi-Country Model is that it can operate under a variety of exchange-rate regimes. When fixed-exchange rates are assumed,

[3]Trade flows of all countries other than the five mentioned above are explained in the abbreviated rest-of-the-world model.

[4]In the model describing the U.S. economy it is assumed that the monetary base is insulated from changes in international reserve assets by offsetting open market operations, whereas for other countries a change in international reserves will have some impact on the monetary base.

Chart 1

Effects of a Change in U.S. Monetary Policy*



* All changes are measured relative to conditions that would prevail in the absence of policy actions.

each country's overall balance of payments determines the change in its stock of international reserve assets. When the model operates under a managed floating system, the change in a country's international reserves is determined (for countries other than the United States) by the discretionary intervention behavior of the central bank; these official purchases and sales of foreign exchange, together with all the other items in the balance of payments, jointly determine the bilateral dollar exchange rates of these countries.

I. The Effects of U.S. Open Market Operations

The first set of simulations relates to a tightening of U.S. monetary policy: an open market sale of $1 billion in government securities carried out in a period of flexible-exchange rates.[5]

In order to illustrate the effects introduced by the MCM, among which are the endogenization of the exchange rate, the results will be presented in two stages. First, we will analyze the effect of the monetary tightening in the context of the model of the U.S. economy taken in isolation, i.e., when it is not linked with the other country models. In this case, the world outside the United States is assumed to be unaffected by the change in U.S. monetary policy, and all bilateral exchange rates are held exogenous. The results will then be discussed for the same policy change, but when the U.S. model is integrated into the multicountry system; in this case changes in U.S. variables are allowed to affect exchange rates and economic variables abroad, and these latter changes feed back onto the U.S. economy.

The heavy lines in Chart 1 show the changes in the key variables for the case where the U.S. model is not linked with the other country models. The results are generally consistent with those of most existing models of the U.S. economy, models that, by and large, do not allow foreign variables and exchange rates to vary. Panel A shows the expected negative impact on U.S. real GNP; the effect increases gradually, reaching a maximum after six quarters of some 7/10 of a percent below what it otherwise would have been.

This decline is caused in large part by the primary impact of the open-market operation, the rise in the interest rate (Panel D); the interest rate jumps by 80 basis points initially and, as aggregate demand falls off, declines slowly thereafter. In line with the weakening of aggregate demand, there is a small decline in the price level and an improvement in the trade balance.

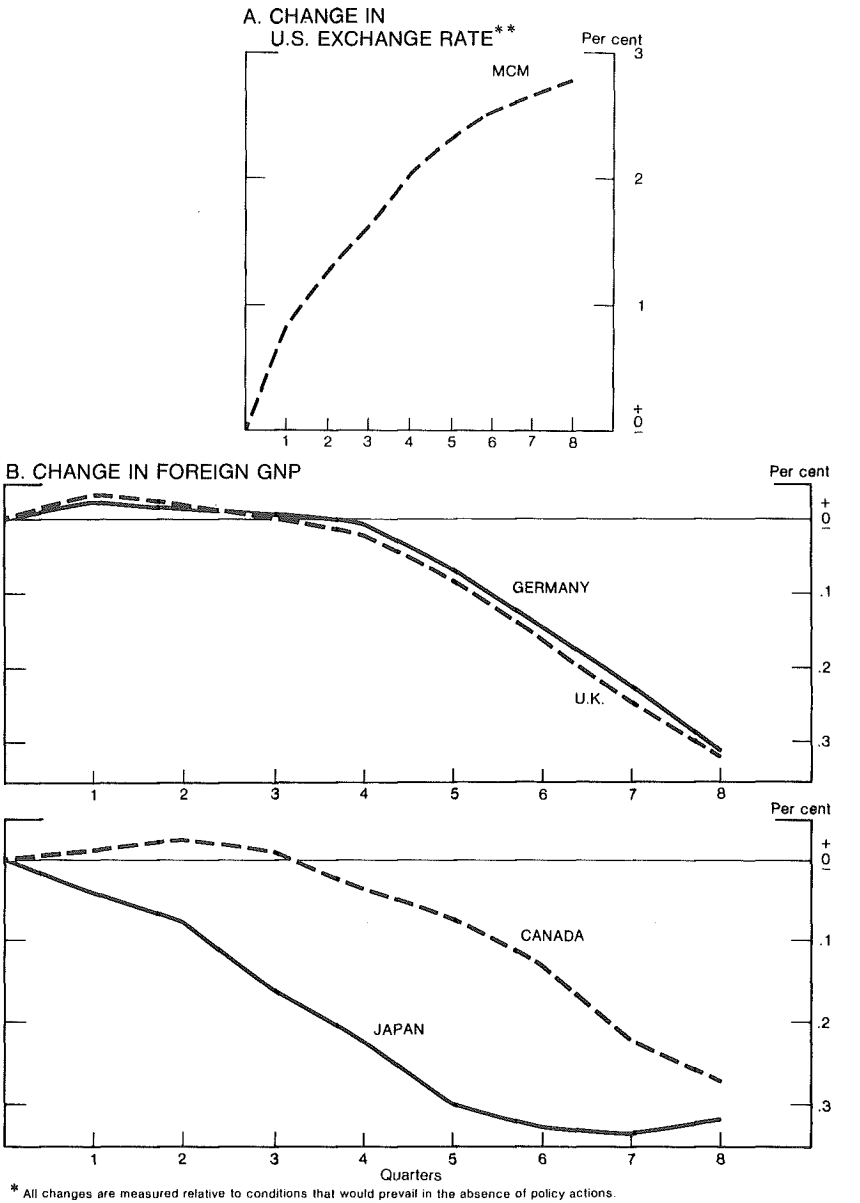
When the U.S. model is linked to the other five country models, the effects of the same change in U.S. monetary policy are modified significantly. As can be seen from the dashed line in the first panel of Chart 1, the negative impact on GNP is magnified: the maximum effect, seven quarters after the tightening of monetary policy, is some 2/10 of a percent more than when induced changes in external influences on the U.S. economy are ignored.

The most dramatic difference between the two sets of results is for the

[5]The simulations reported in this paper were for the period 1973:2 through 1975:1; in some cases the simulations have been repeated for other time periods and, to date, the conclusions have been largely unaltered by the period of simulation.

Chart 2

Effects of a Change in U.S. Monetary Policy*



* All changes are measured relative to conditions that would prevail in the absence of policy actions.

** Weighted-average of the bilateral exchange rates of the U.S. dollar vis-à-vis the German mark, the Japanese yen, the U.K. pound and the Canadian dollar, respectively.

price level; it falls by a full 1/3 of a percent after eight quarters. There is also a significant reduction in the trade-balance effect.

The large differences between the results are traceable both to exchange-rate changes, which become endogenous in the MCM, and to feedback effects from the foreign economies. The dollar appreciates with respect to every foreign currency and, consequently, as seen in Chart 2, the weighted-average exchange rate appreciates by almost 3 percent at the end of two years. Because of this appreciation of the dollar, the price of imports falls by 1½ percent over the period; this feeds directly and indirectly into the U.S. price level. Moreover, the appreciation reduces U.S. exports and increases imports; this relative reduction in the trade balance adds a second depressing effect on U.S. GNP, in addition to the direct effect of the monetary tightening.

A third negative influence on U.S. GNP is the reduction in foreign economic activity. As shown also in Chart 2, after an initial period,[6] GNP in each foreign country is affected adversely. This lower level of foreign demand feeds back to the United States, reducing U.S. exports and GNP and diminishing the improvement in the U.S. trade balance.

To summarize, this exercise shows that estimates of the effects of U.S. policy changes on important U.S. variables are altered significantly when international effects are taken into account. The general equilibrium framework of the MCM permits us to capture these international effects and their feedback on the U.S. economy.

Although these estimates do not amount to a conclusive test, their direction corresponds well to the theoretical results presented by Mundell (1963) and others on the comparison of the effects of monetary policy between exchange-rate regimes: in particular, a monetary tightening has a more powerful impact on GNP and prices under flexible-exchange rates.

II. The Effects of Restrictive Monetary Policies Abroad

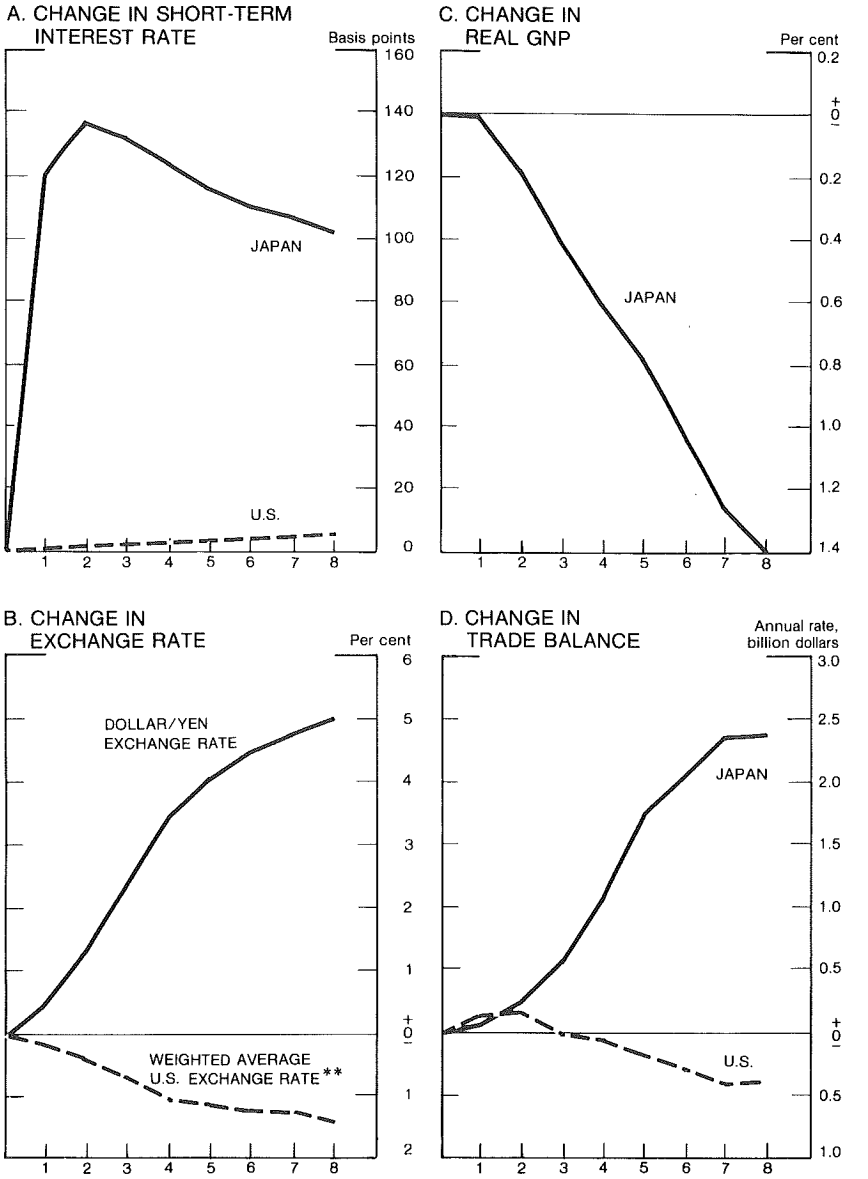
The following two simulations illustrate how the MCM can be used to trace the effects of monetary actions in foreign countries. This capability is illustrated with respect to (i) an increase in the Bank of Japan's official discount rate, and (ii) an increase in the reserve requirements applicable to German banks.

The effects of an increase in the Bank of Japan's discount rate by 1 percentage point are shown in Chart 3. In panel A, the Japanese short-term interest rate is seen to increase sharply in the first two quarters and to decline gradually thereafter. Although the U.S. short-term rate rises moderately, there is, initially, a substantial increase in the interest-rate differential in favor of Japan. This increase reduces the relative attractiveness of borrowing from the U.S. and Eurodollar markets, thus leading to an appreciation of the yen

[6]The GNPs of Germany, the United Kingdom, and Canada experience slight increases in the first three periods in response to the U.S. monetary contraction. The appreciation of the dollar vis-à-vis other currencies, by itself, would tend to improve foreign trade balances and stimulate foreign GNPs. Offsetting this exchange-rate effect, and dominating it in the later periods, is the reduction in U.S. imports due to the decline in U.S. GNP.

Chart 3

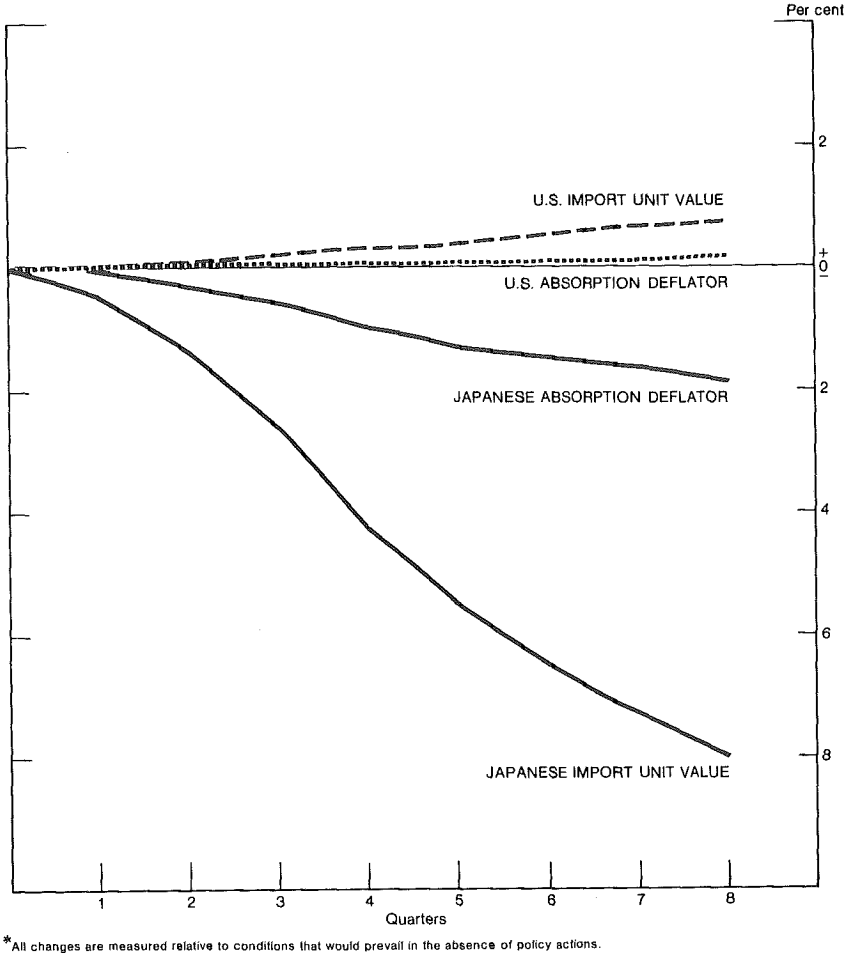
Effects of a One Percentage Point Increase in Japan's Discount Rate*



* All changes are measured relative to conditions that would prevail in the absence of policy actions.
** Units of foreign currency per dollar

Chart 4

Effects on Prices of a One Percentage Point Increase in Japan's Discount Rate*

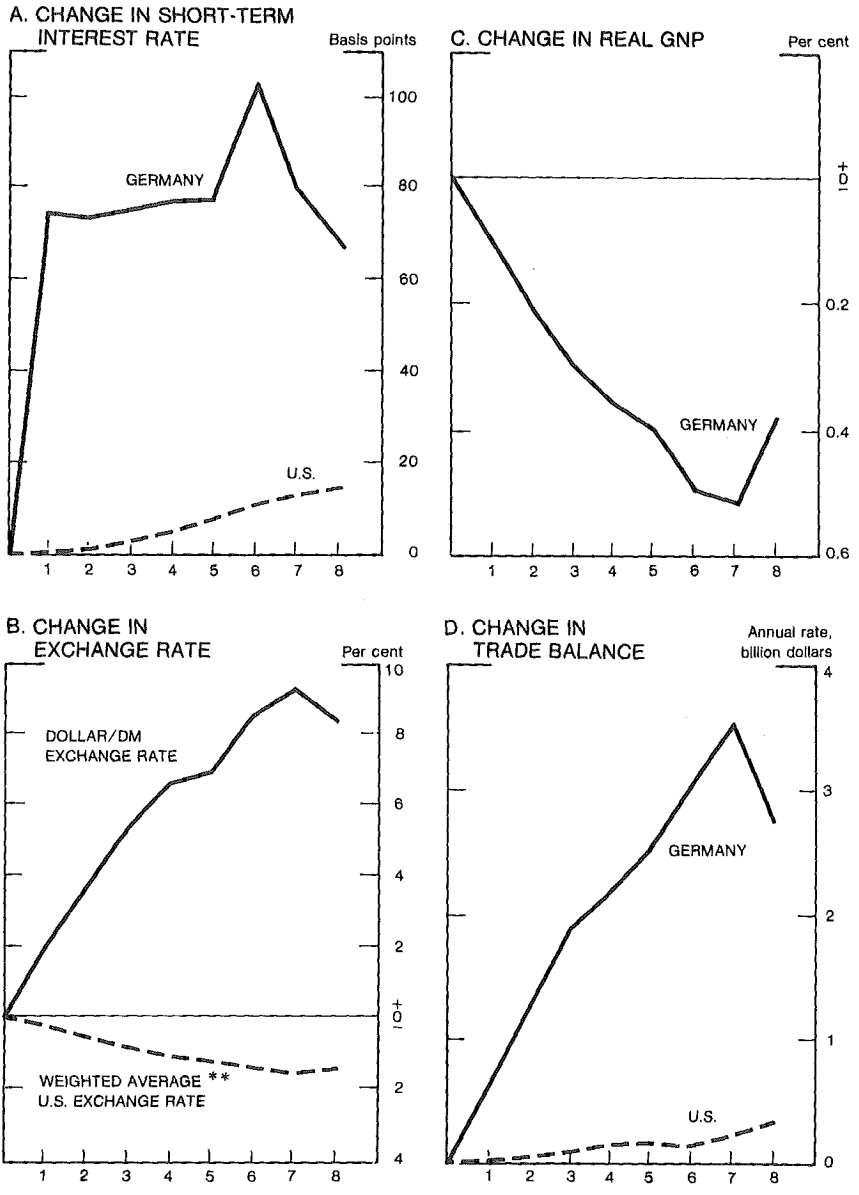


*All changes are measured relative to conditions that would prevail in the absence of policy actions.

against the dollar, as shown in panel B. The rise in domestic interest rates also has an adverse impact on fixed investment in Japan, resulting in a contraction of aggregate demand. This leads to an improvement in the Japanese trade balance (as seen in panel D) and to additional upward pressure on the yen. Finally, as indicated in Chart 4, Japanese prices decline under the combined effects of reduced capacity utilization, increased unemployment and exchange-rate revaluation; and there is also some upward pressure on U.S. prices stemming from the devaluation of the dollar.

Chart 5

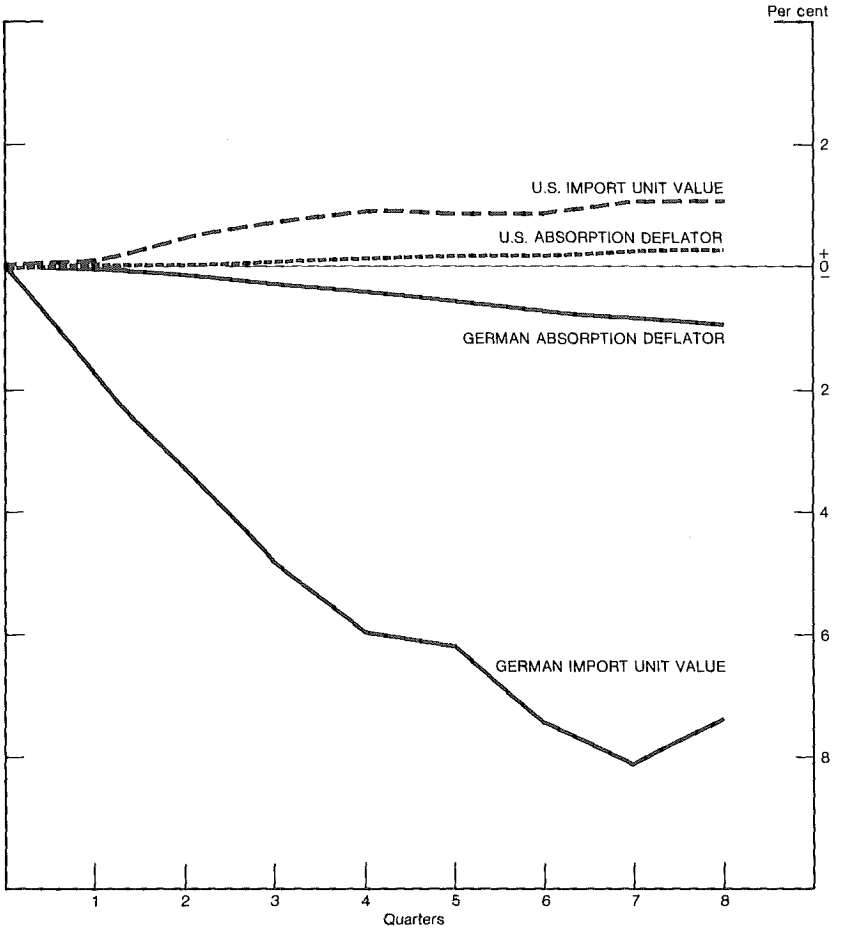
Effects of a One Percentage Point Increase in German Reserve Requirements*



* All changes are measured relative to conditions that would prevail in the absence of policy actions.
** Units of foreign currency per dollar.

Chart 6

Effects on Prices of a One Percentage Point Increase in German Reserve Requirements *



* All changes are measured relative to conditions that would prevail in the absence of policy actions.

Charts 5 and 6 show the effects of increasing by 1 percentage point the reserve requirements applicable to four types of deposit liabilities issued by German banks. The results are generally similar to those reported in the Japanese experiment. It may be noted, however, that the U.S. trade balance improves in response to the monetary contraction in Germany, because U.S. exports are stimulated by the sharp depreciation of the dollar. In the Japanese stimulation this exchange-rate effect is also present, but it is more than offset by the depressing impact on U.S. exports of a large reduction in Japanese GNP.

III. Changes in Central Bank Intervention and Monetary Policy

The structure of the Multi-Country Model makes it possible to analyze central bank intervention in foreign exchange markets and the effects of such intervention on exchange rates and other variables. The strategies of central banks in foreign exchange markets are too complex to be fully captured by any model and, in fact, have varied over recent years. Nevertheless, in estimating the equations of the MCM, it was found that the monetary authorities of Canada, Germany, and Japan have attempted, with some regularity, to moderate movements in exchange rates by exchange-market intervention. To investigate the sensitivity of the model to changes in intervention behavior, two simulations are analyzed in this section.

First, monetary authorities abroad were assumed to have intervened to resist exchange-rate changes with twice the intensity actually observed over the early floating-rate period. This increased exchange-market activity is found to reduce noticeably exchange-rate fluctuations.

The second simulation investigates how the effects of a monetary contraction in the United States are altered when the tendency of the central banks to resist exchange-rate changes is doubled. In other words, the assumptions concerning central bank intervention underlying the first simulation of this section are superimposed on the U.S. monetary contraction reported in Section II. The results of this experiment indicate that "leaning against the wind" with greater intensity does not necessarily reduce the impact of a monetary tightening on GNP and prices.

The first simulation investigates the extent to which the amplitude of exchange-rate movements during the early period of floating-exchange rates would have been reduced if the authorities of Canada, Germany, and Japan had all intervened with twice the resistance to exchange-rate changes as actually observed during that period. For example, it was estimated that from 1970:3 to 1975:4 the Bank of Canada sold, on average, about Can$110 million for each percentage point rise in the dollar value of the Canadian dollar and purchased the same amount for each percentage point fall in the Canadian dollar. For the purpose of this exercise, the amount was doubled to some Can$220 million per percentage point. Analogous changes were made for Germany and Japan.[7]

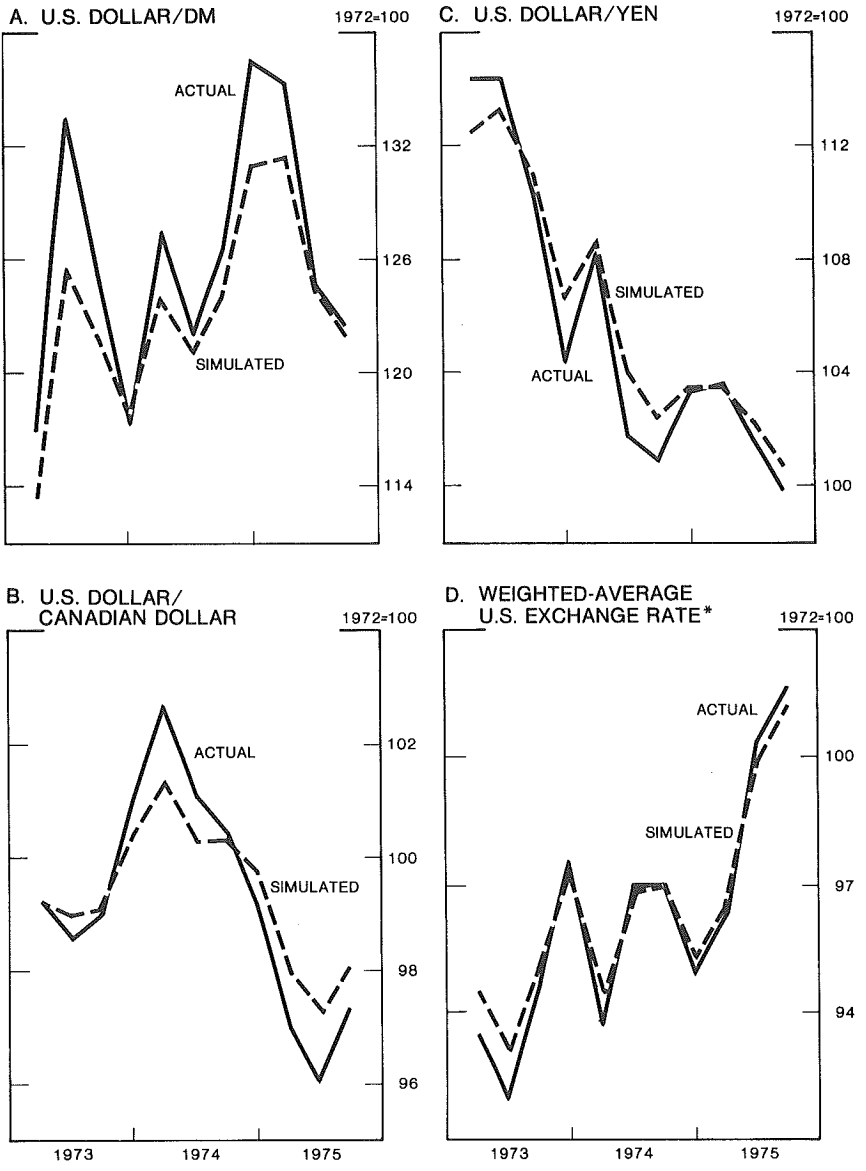
Chart 7 shows the actual and hypothetical paths of the dollar exchange rates for the deutsche mark, the yen and the Canadian dollar, as well as for the weighted average exchange rate of the U.S. dollar over this period. For each of the three currencies, the amplitude of exchange-rate movements would have been reduced if central banks had "leaned against the wind" with greater intensity, although large fluctuations would not have been eliminated. Reductions in the variability of the deutsche mark, the yen, and the average U.S. dollar exchange rate would have been on the order of about 20 percent; the reduction for the Canadian dollar would have been about 40 percent.[8]

[7]The intervention coefficients for Japan and Germany implied purchases of about $250 million and $140 million, respectively, per percentage point increase in the dollar value of the yen and the deutsche mark.

[8]These reductions were calculated as the percentage difference between the standard deviations of the historical and the simulated exchange-rate paths.

Chart 7

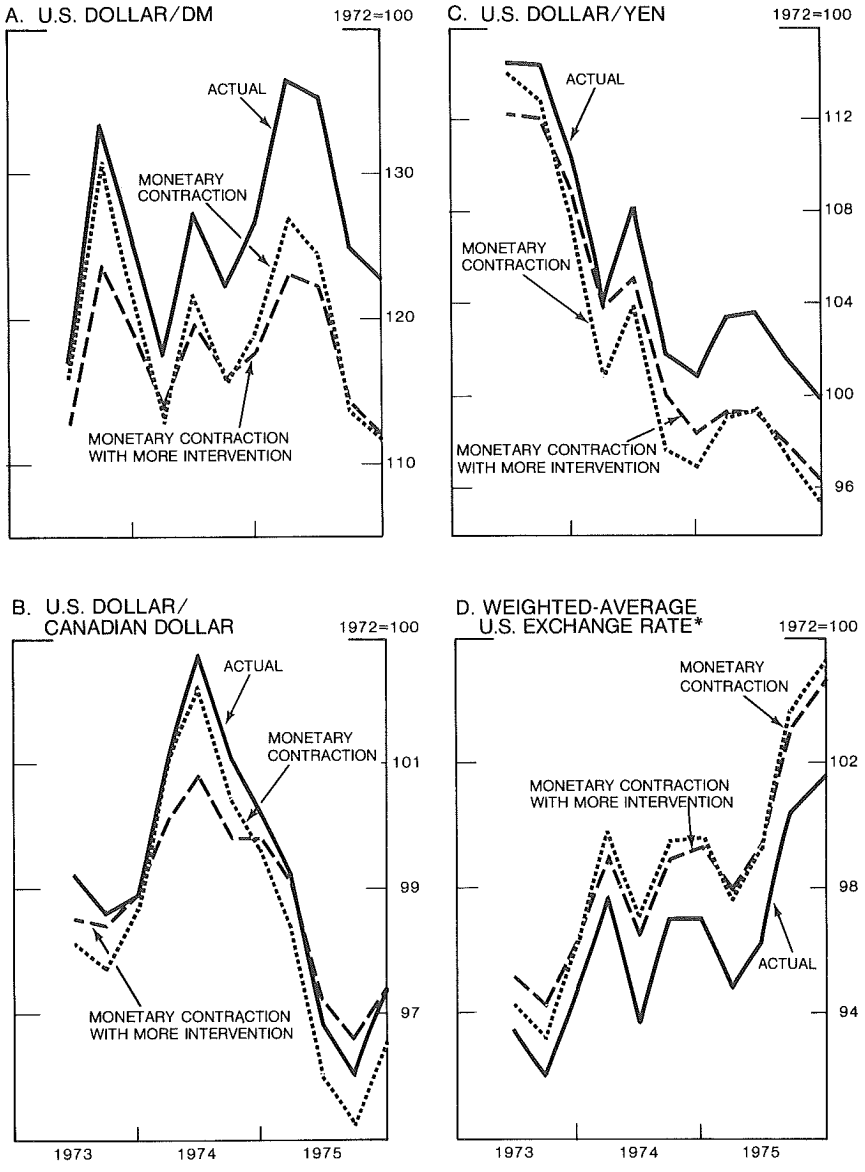
Effects of Increased Exchange Market Intervention on Exchange Rates



*Units of foreign currencies per dollar.

Chart 8

Effects of a Contraction in U.S. Monetary Policy Coupled With an Increase in Exchange Market Intervention



* Units of foreign currencies per dollar.

The effects of the increased exchange-rate smoothing on output would have been small — GNPs would have deviated by no more than 2/10 of 1 percent from their historical levels. Prices and trade flows would have differed more noticeably from their actual values although the changes would have been largely transitory. The increased exchange-market intervention would have led to substantial interest-rate variability in all countries, primarily because of the impact of the larger reserve changes on the monetary bases of these countries.

In the second simulation, the doubled intervention coefficients were combined with the $1 billion open market sale by the Federal Reserve. The joint effects of increased smoothing and the monetary contraction can be seen in Chart 8. Monetary restraint has led to an appreciation of the U.S. dollar and, in addition, the increased intervention has smoothed the paths of the three bilateral exchange rates. As compared to the case of the U.S. monetary contraction alone, the variabilities of the exchange-rate paths with the contraction and increased smoothing were lower by about 40 percent for the Canadian dollar, about 35 percent for the deutsche mark, about 10 percent for the yen, and approximately 15 percent for the U.S. weighted-average exchange rate.[9]

The effects of the increased intervention on the U.S. monetary policy multipliers are mixed. In Chart 9, the effects of the compound experiment on GNP, the trade balance, and the U.S. price level are compared with those of the simple monetary contraction. Panel A indicates that the GNP multiplier is slightly greater over the early part of the period for the simulation with more intervention. However, after the fifth quarter, the increased intervention reduces the GNP multiplier by about 1/10 of a percentage point. This seems to be a result of the reduced price level and consequent relative improvement in the real trade balance in the sixth quarter.

As shown in panel C, the initial effect of greater intervention is to increase the effect of the monetary contraction on the trade balance. The trade balance is the channel through which the effects of increased intervention are transmitted to GNP. The much larger initial appreciation of the U.S. weighted-average exchange rate (panel D) acts to enhance the reduction in the U.S. trade balance and thereby to reduce GNP further than in the case of the simple monetary contraction.

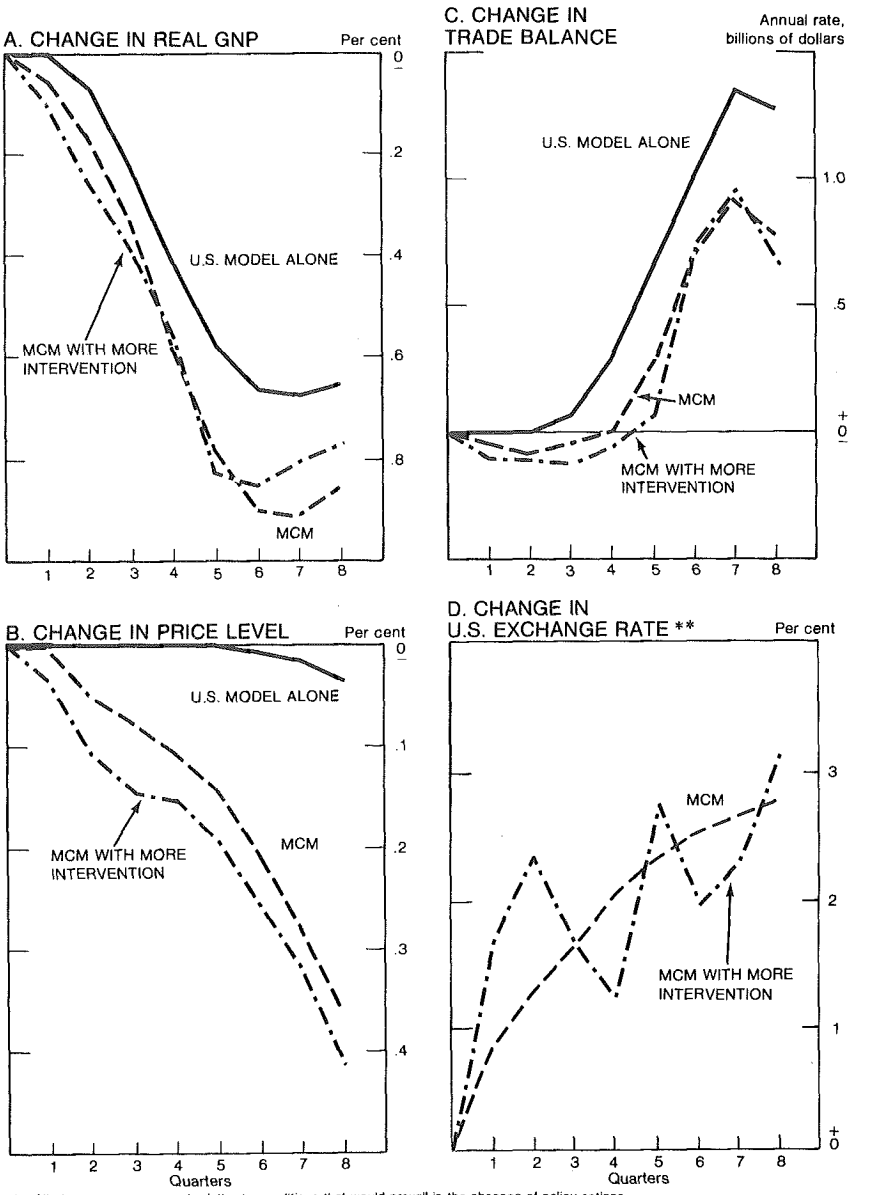
Panel B indicates the effect of increased intervention on the price level. Reflecting the greater impact on GNP in the earlier period, the price multiplier is greater under increased intervention than under "normal" intervention. In the early part of the period, this is a direct result of the greater contractionary effect on GNP. Later in the period, when increased intervention diminished the GNP effect, the price level remains below that for the normal intervention case. This is most likely a result of the dependency of price and wage changes in the model on past price changes.

Finally, as seen in panel D, the schedule showing the response of the aver-

[9]There was no change in the variability of the dollar/pound rate because no change in intervention was assumed in the case of the U.K. monetary authorities.

Chart 9

Effects of a Change in U.S. Monetary Policy*



* All changes are measured relative to conditions that would prevail in the absence of policy actions.

** Weighted-average of the bilateral exchange rates of the U.S. dollar vis-a-vis the German mark, the Japanese yen, the U.K. pound and the Canadian dollar, respectively.

age U.S. exchange rate exhibits greater variability in the case where the contraction is coupled with greater intervention than in the case of the simple monetary contraction. This is a result of the functioning of the intervention rules in the model which assumes that foreign monetary authorities intervene in such a way as to moderate exchange-rate changes. Given these rules, increasing the intensity of exchange-market intervention will result in smoothing the path of exchange rates and will therefore introduce deviations between the simulated and historical paths of these exchange rates.

References

Fleming, J. Marcus (1962) "Domestic Financial Policies Under Fixed and under Floating Exchange Rates." *IMF Staff Papers,* vol. 9, No. 3, pp. 369-79.

Mundell, Robert A. (1968) "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates." Chapter 18 of *International Economics,* MacMillan.

Girton, Lance and Henderson, Dale (1976) "Critical Determinants of the Effectiveness of Monetary Policy in the Open Economy." In Michele Fratiani and Karel Tavernier, eds., *Bank Credit, Money and Inflation in Open Economies,* Supplement to *Kredit und Kapital* (Heft 3), Berlin: Duncker and Humblot.

Discussion

Charles Freedman*

The Multi-Country Model (MCM) developed at the Federal Reserve Board is a welcome addition to the class of large macroeconometric models. These large models have the advantage of allowing for a variety of channels through which policy changes can influence the economic system. Furthermore, while most theoretical models of the international economy allow either prices or output to adjust but not both, the MCM has no difficulty in allowing for both kinds of effects and in tracing out the lagged responses of a variety of variables to policy changes. The disadvantage of large models is, of course, their complexity. Simulation results that are counter-intuitive can be telling us that we have ignored in our theoretical models a channel that is important empirically or that there is a weakness in the large model that is giving us a "wrong" answer. To distinguish between these two possibilities requires an in-depth understanding of the large model and a willingness to track down and evaluate the channels that are causing the surprising result.

A potentially important weakness of the MCM, which it shares with almost all empirical models, is that it does not deal with the incorporation of new information in its modeling of expectations formation. Unlike the efficient-markets literature, which emphasizes market responses to policy changes, most macroeconometric models tend to assume very simple expectational mechanisms, usually of an autoregressive form. In addition to leading to biased estimates, the lack of attention to expectations formation can at times lead to rather strange simulation results. Although it will be difficult to remedy this omission empirically, it is perhaps the most important order of business for the next generation of empirical international models.

There are two related aspects of this problem on which I would like to focus in discussing the MCM — (i) the response of the exchange rate to interest rate changes, and (ii) the specification of the equation for the expected exchange rate.

Empirical studies of exchange-rate determination often show results broadly similar to the MCM on the effect of an interest rate change on exchange rates. The two major results of these models are, first, that in the long run exchange rates move by a multiple of the change in interest rates, and, second, that the exchange rate adjusts with a lag.[1] Recent theoretical

*Charles Freedman is Deputy Chief, Department of Monetary and Financial Analysis, Bank of Canada. The views expressed in these comments are those of the author and no responsibility for them should be attributed to the Bank of Canada.

[1]See, for example, the results in Rudiger Dornbusch, "What Have We Learned from the Float?" (mimeo, February 24, 1977) or Richard D. Haas and William E. Alexander, "A Model of Exchange Rates and Capital Flows: The Canadian Floating Rate Experience," *Journal of Money, Credit and Banking* (forthcoming).

developments indicate that the effect of an interest rate change on exchange-rate movements depends on whether the interest rate change is a result of a temporary change in the level of the money supply, a permanent change in the level of the money supply[2], or a change in the rate of growth of the money supply. Figure 1 graphs the effects of the three types of money supply changes on short-term interest rates and on the exchange rate defined as the domestic-currency price of a unit of foreign currency. In Figure 1A a temporary change in the money supply leads to a temporary change in interest rates. The effect of this change on the exchange rate will depend on the length of time the temporary interest rate increase is expected to last. Thus, for example, a 1 percentage point increase in interest rates that is expected to last for three months will initially lead to a ¼ percent change in the exchange rate. If the same 1 percentage point increase in the interest rate is expected to last for a full year, it will lead initially to a full 1 percent change in the exchange rate.[3] Note that the domestic currency will gradually depreciate back to its initial equilibrium over the period during which the interest rate change is in effect.

Figure 1B depicts the effect of a permanent change in the level of the money supply. Here the expected long-run equilibrium exchange rate falls proportionately to the decline in the money supply. The impact effect on the exchange rate is even greater since the interest rates will remain high during the transition period to the new equilibrium. In this case an interest rate change of 1 percentage point will be associated with a substantially larger change in the exchange rate.

For completeness, Figure 1C presents the results of a decrease in the rate of growth of the money supply. In the standard macroeconomic model interest rates will rise for a period before falling to their new long-run lower level reflecting the lower rate of inflation. The domestic currency will appreciate continuously in the long run. In the short run, there is an overshoot since for a period interest rates remain temporarily higher in the domestic country and this requires a depreciating currency to equalize returns internationally.

Thus, theory tells us that the relationship between interest rate movements and exchange-rate movements depends crucially on the sort of shock that has brought about the interest rate movements. Nor will a comparison of actual movements of the money supply be sufficient to distinguish between the cases portrayed in Figures 1A and 1B since it is expected movements that lead to the difference and not these actual movements, which are the same in the short run. The empirical equations therefore must attempt to incorporate variables capturing the different cases or the results of both estimation and simulation will be questionable. As mentioned above, this is not done in the MCM.

Another aspect of the theoretical results is that one gets sharp overshoots in response to a change in money supply, not the gradual change portrayed in all of the shocks in the MCM paper. One way of reconciling the gradual

[2]This is the case discussed in Rudiger Dornbusch, "Expectations and Exchange Rate Dynamics," *Journal of Political Economy*, Vol. 84, Number 6 (December 1976), 1161-76.

[3]In principle one could use the domestic term structure of interest rates to determine the length of time the market expects the interest rate change to last.

Figure 1

Effect on Interest Rate and Exchange Rate of Money Supply Change

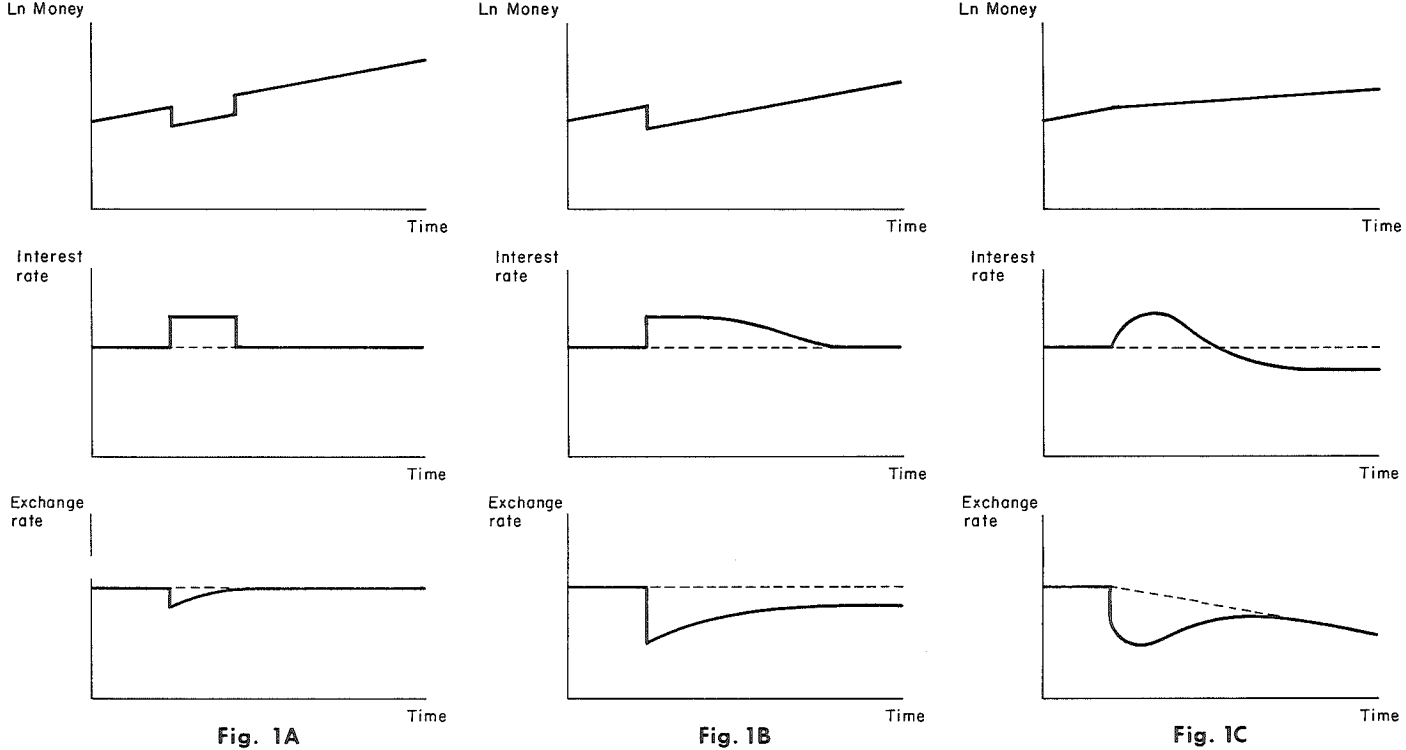


Fig. 1A
Temporary Change in Money Supply

Fig. 1B
Permanent Change in Money Supply

Fig. 1C
Change in Money Growth

response shown in many empirical studies (and quite often in the real world) with the sharp movements of the theoretical models is as follows. When interest rates change, it is not always clear which type of shock is occurring. As time passes, the market receives more information or is able to interpret the information received with a greater degree of assurance. Suppose, for example, the market is not certain when interest rates rise whether this signals a temporary or permanent change in the money supply. Suppose, further, that the longer interest rates remain high, the more likely the money supply change is permanent.[4] In such a model, whereas the initial change in the exchange rate would be only, say, ¼ percent in response to a 1 percentage point change in the interest rate, over time as interest rates remain high the currency would gradually appreciate in response to changed perceptions of the nature of the shock.

A second and related aspect of exchange-rate determination in the MCM that is problematical is the specification of the expected exchange-rate equation. In the MCM, for simulation purposes, the expected exchange rate is either a function of past exchange rates (Canada) or of the country's export price divided by other countries' export prices[5] (Germany, Japan, United Kingdom, United States). Since the latter moves more slowly than the exchange rate in response to a simulated shock, an appreciation of the currency gives rise to the expectation of a depreciation in the next period. At the risk of oversimplifying one might characterize as follows the short-run to intermediate-run behavior of short-term capital and the exchange rate in response to a shock that gives rise to a current-account surplus. Short-term capital outflows must be induced as an offset item to the current-account surplus.[6] Thus, the domestic currency must appreciate to yield the anticipated depreciation that results in the short-term capital outflow.[7] As indicated above, this anticipated depreciation apparently occurs because the expected exchange rate moves more slowly than the actual exchange rate in response to the shock. There are two major problems with this approach. First, if the shock that gives rise to the current-account surplus involves a change perceived to be permanent (e.g., a change in raw materials prices or a structural change), this information will likely be quickly incorporated into expected exchange rates by the market and, as a consequence, will lead to sharp changes in the latter. Second, no matter what the cause, current-account surpluses are highly autocorrelated, in part because of adjustment lags on the real side. Hence, there will be a long period in which a short-term capital outflow (induced by an expected depreciation in the domestic currency) is required to offset the current-account surplus. But the model results in a gradual appreciа-

[4]I am assuming that the lags are such that the price declines induced by the money supply decrease take a long time to be worked out.

[5]The ratio of imports to net foreign assets is also included as a variable in the expected exchange-rate equation; it is particularly useful in the fixed-rate period. See Richard Berner et al, "A Multi-Country Model of the International Influences on the U.S. Economy: Preliminary Results," Board of Governors of the Federal Reserve System, International Finance Discussion Paper, Number 115, December 1977.

[6]This assumes that reserve increases do not offset the entire current-account surplus.

[7]In the long run the appreciation causes the current-account surplus to disappear.

tion of the domestic currency such that the anticipation of a depreciation is continually falsified. In the particular shock shown in Chart 3 (5) for example, there is a short-term capital outflow at a time when interest rates are high in Japan (Germany) and the yen (mark) is continuously appreciating. Thus, speculators will be making losses over the short to intermediate run.[8]

Several other aspects of the results of the monetary shocks in the MCM require comment. The comparison of the closed economy with the open economy responses to a U.S. interest rate shock (Chart 1) illustrates well the point that exchange-rate changes have a relatively more important and faster impact on prices than on real output. What is surprising in these simulations is that the decline in U.S. GNP should have a somewhat smaller effect on Canada than on Japan, Germany, or the United Kingdom (Chart 2). Given the close trade relationships between the United States and Canada one would have expected the reverse result. Another interesting result is that the combination of a decline in the U.S. GNP and an appreciation of the U.S. dollar leads, after an initial increase, to declines in foreign GNP. In no case does the exchange-rate effect dominate the income effect and lead to expansion in foreign economies.

[8]This criticism applies also to other portfolio-balance models of exchange-rate determination.