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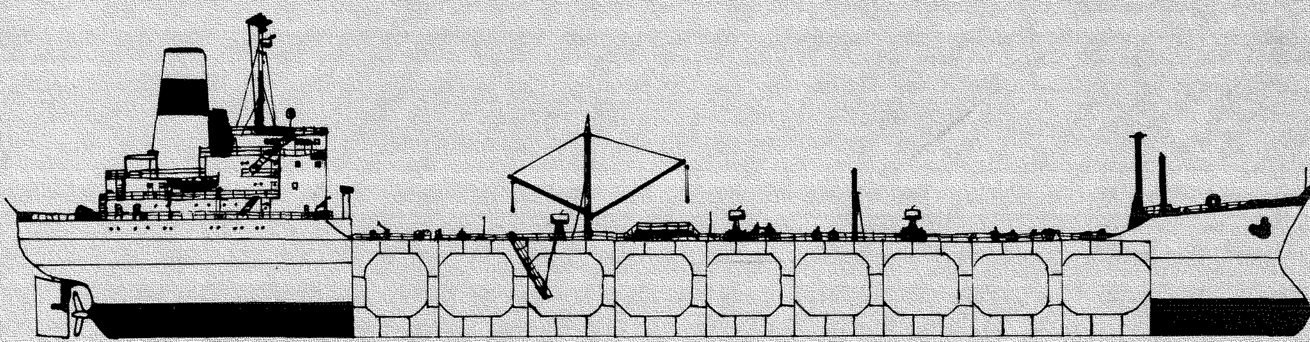

RESPONSES TO INTERNATIONAL INFLATION

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Managed Floating and the Independence of Interest Rates

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The major industrial powers abandoned the Bretton Woods system of fixed exchange rates in March 1973. From a foreign point of view, the Bretton Woods system had a major disadvantage: foreign interest rates moved sympathetically with U.S. interest rates. Studies have indicated that a 100-basis point (one percentage point) change in U.S. short-term interest rates caused short-term rates in industrialized countries abroad to change by about 40 basis points, on average, during that period of fixed exchange rates.

This interest-rate dependence reflected a lack of monetary-policy independence. For example, when U.S. interest rates fell as a result of monetary expansion, investors had an incentive to purchase foreign securities. Such purchases generated a demand for foreign currency and an outflow of dollars — which foreign central banks were obliged to purchase to maintain a fixed exchange rate. The accumulating dollars boosted foreign reserves and, hence, their money supplies. This tended to push down foreign interest rates in sympathy with U.S. rates.

As this example indicates, such interest-rate dependence made it difficult for countries to pursue independent monetary courses. The Bretton Woods system collapsed mainly because nations were no longer willing to accept a lack of monetary independence.

The world's financial authorities replaced Bretton Woods in 1973 with a flexible exchange-rate system, mainly because they believed that this approach would permit a greater independence of monetary policies. Theoretically, with perfectly "clean" floating — that is, without any intervention by central banks in the exchange market — foreign interest rates would be completely insulated from U.S. rates. In practice, however, central banks have intervened in foreign-exchange markets about as frequently under the new system as under the Bretton Woods system. But has "managed floating" decoupled interest rates? This depends not on the amount of intervention *per se*, but rather on the relative amount of intervention in response to interest-rate variations under the two different systems.

This article examines the impact of managed floating on the relationship between U.S. money-market conditions and short-term interest rates in Belgium, Germany, Switzerland, France, Canada, and the United Kingdom. Our conclusion is that managed floating generally has severed short-run linkages between U.S. and foreign interest rates. The reason apparently has been reduced exchange-market intervention in response to variations in interest rates, rather than larger offsetting domestic-monetary operations. Canada and the United Kingdom are exceptions to this general pattern, however, because of policies peculiar to those two countries.

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I. Interest Rates, Risk, and the Exchange Rate Regime

National interest rates can be linked in the short run through the impact of international capital flows on national money supplies. The tightness of this linkage depends upon the substitutability of the financial assets of different countries, which in turn is importantly influenced by the exchange-rate regime. In a completely fixed exchange-rate regime, and with perfect substitutability of financial assets, national interest rates would be perfectly linked.

This case provides a useful point of departure for our analysis.[1] Consider the impact of a decline in U.S. interest rates on foreign interest rates. First, lower interest rates in the U.S. would encourage investors to buy foreign, rather than American, securities. As investors try to obtain the necessary foreign currency to effect these purchases, the dollar value of foreign currencies would tend to increase. However, central-bank intervention to maintain fixed exchange rates, through purchases of dollars and sales of foreign currency, would expand foreign money supplies until foreign interest rates fell to equality with U.S. rates.[2] Thus a change in the U.S. interest rate (i_{us}) precipitates an equivalent change in the foreign interest rate (i_f), or

$$\Delta i_{us} = \Delta i_f. \qquad (1)$$

Of course assets are not perfectly substitutable in practice. But the higher the degree of substitutability, the stronger may be the linkage of interest rates between countries. The financial assets of different countries are imperfect substitutes because of (a) economic and political risk, and (b) exchange-rate risk. To understand the processes which link national interest rates in practice, it is necessary to examine the influence of these factors.

Economic and political risk

Purely economic factors, such as the probability of default, influence the riskiness of financial assets. However, for short-term securities, economic risk is quantitatively less important than political risk.[3] Political risk arises because of official restrictions on the flow of capital, either current or prospective. Prospects of such governmental restrictions make securities issued in different political jurisdictions imperfect substitutes in the eyes of international investors. Due to the imperfect substitutability of the securities, an interest-rate "differential" arises between U.S. and foreign securities, even in the absence of any risk of a change in the exchange rate.

The magnitude of this differential depends upon a number of factors. Obviously the differential would change with any change in investors' perceptions of comparative economic or political risk across countries. More importantly, however, this interest-rate differential would vary with any change in the relative supplies of various countries' securities. If, for example, investors are asked to hold relatively more foreign securities, the foreign interest rate would have to rise relative to the U.S. interest rate, leading to a new differential. The change is necessary to make investors content with the shift in the composition of their security portfolios.

Exchange-rate risk

U.S. and foreign interest rates also may differ because of exchange-rate risk. This type of risk enters the picture because an American investor must (l) obtain foreign currency to purchase a foreign security and then (2) convert the foreign funds obtained at that security's maturity back to dollars. If there is a risk that the exchange rate will change during the maturity period, then the American investor is not assured of a fixed dollar return on his investment. The investor can "cover" himself against this eventuality, however, by contracting to redeem his foreign currency at the currently quoted dollar price of foreign exchange in the forward market (F), while purchasing the needed foreign funds at the spot dollar price of the foreign currency (S).[4]

Market forces will work to equalize returns "covered" for the risk of exchange-rate changes, except for any differential due to economic and political risk. It can be shown that, in equilibrium

$$i_{us} = i_f + fp + d, \qquad (2)$$

where $fp = ((F - S)/S)(^1/\text{contract period})$ is the "forward premium" at an annual rate on a foreign-exchange contract, and d is the differential due to economic and political risk. Since d explains the differential between the U.S. interest rate and the "covered" return on the foreign security, it is called the "covered interest differential."[5]

Thus, in a world where exchange-rate risk exists in addition to economic and political risk, changes in the U.S. interest rate are distributed over three factors: the foreign interest rate, the forward premium, and the covered interest differential. That is,

$$\Delta i_{us} = \Delta i_f + \Delta fp + \Delta d.$$

The questions raised in this paper concern how changes in U.S. interest rates have been distributed over these factors. The first is whether managed floating has led to a decoupling of U.S. and foreign interest rates. That is, does a change in i_{us} now primarily lead to changes in fp and d rather than i_f? Under perfectly "clean" floating, we would expect the money-supply channel that links interest rates to be completely severed.[6] However, this question remains open, in view of the large amount of official intervention in exchange markets in the post-Bretton Woods system.

Secondly, how is foreign central-bank behavior responsible for decoupling interest rates, assuming this has actually occurred? Interest rates could be decoupled either because foreign central banks have decreased their exchange-market intervention in response to U.S. interest-rate changes or because they have increased "sterilization" actions designed to remove foreign influences from their money supply. Thus, it would be useful to devise an empirical means of distinguishing between these two approaches. The distribution of the effect of a change in i_{us} between changes in fp and d will provide us with the necessary clue.

II. Foreign Impact of Changes in the U.S. Interest Rate

As we have just seen, changes in the U.S. interest rate must affect either the foreign interest rate, the forward premium, or the covered interest differential. The most significant factors determining the outcome are (1) the extent of official intervention in the exchange market and (2) the degree of sterilization of reserve-flow effects on the foreign monetary base. Before considering some examples, we should examine what each of these factors involves.

A foreign central bank's official intervention in exchange markets — that is, its "support of the exchange rate" — involves spot-market purchases or sales of currency. For example, if the dollar price of a foreign currency tends to rise above the level desired, the foreign central bank could sell its currency and buy dollars. Such actions would tend to drive its currency's spot dollar price back down. Just as importantly, however, such intervention causes the foreign central bank's dollar holdings to rise. Since these dollars represent a form of reserves, the foreign economy's monetary base expands, thereby expanding its money supply and depressing its interest rate. It is also important to note that the foreign central bank generally holds these additional dollar reserves in interest-bearing form. Typically, the central bank uses these dollars to purchase U.S. securities, thereby exchanging non-interest-bearing reserves for interest-bearing reserves. Thus intervention increases the demand for U.S. securities while also increasing the foreign money supply.

If the foreign central bank wishes to avoid having its domestic monetary policy affected by its intervention activity, it can "sterilize" the effects of that activity by contracting the domestic component of reserves by exactly as much as the intervention has increased the foreign component of reserves. The central bank accomplishes this by selling foreign securities in its own domestic market — what we would call open-market operations. This sops up the undesired liquidity and "sterilizes" the effect of the intervention. This action, however, tends to increase the supply of foreign securities in world markets.[7]

With this background in mind, the impact of changes in the U.S. interest rate can be explored under alternative scenarios of foreign central-bank behavior. The relevant cases are: (1) no official intervention; (2) support of the exchange rate with sterilization; (3) support of the exchange rate without sterilization. These cases are best analyzed through the use of the modern theory of forward exchange.[8] We limit ourselves here to a heuristic analysis. The appendix demonstrates the conclusion rigorously for the interested reader.

Case 1: No official intervention

Consider the impact of a decline in the U.S. interest rate when there is no attempt by the foreign central bank to intervene in support of its currency. First, without intervention, there is no reason for foreign central-bank reserves to change. Thus, the foreign money supply and the foreign interest rate remain unaffected. Second, without intervention there is no change in the supplies of U.S. and foreign securities available to private investors — and no reason for a change in investors' perception of political and economic risk. Therefore, the covered interest differential will not change either.

It follows, then, that the decline in the U.S. interest rate must only affect the forward premium on the foreign currency. U.S. investors, eager to buy foreign securities, must buy foreign currency in the spot market and sell it in the forward market. This bids up the spot exchange rate and bids down the forward rate on the foreign currency, thereby depressing the forward premium. The forward premium will fall until covered returns are once more equal.

In Case 1, then, the entire reduction in the U.S. interest rate is absorbed by a decline in the forward premium.

Case 2: Exchange-rate support with sterilization

In this case, the decline in the U.S. interest rate puts upward pressure on spot foreign currency as U.S. investors buy foreign currency as before. But the support operation keeps the exchange rate from rising. Moreover, the sterilization action insulates the foreign money supply and the foreign interest rate from the impact. However, as noted above, the support operation typically causes the foreign central bank to acquire U.S. securities, while sterilization results in an official sale of foreign securities — making U.S. securities scarce relative to foreign securities in private markets. Even without a change in investors' risk perceptions, this will cause a reduction in the covered interest differential, which allows the change in relative supplies of securities to be absorbed. In addition, as U.S. investors sell foreign currency in the forward market to cover their investments in foreign securities, the price of forward exchange is driven down, and the forward premium declines despite the support of the spot rate.

Thus, in Case 2, the reduction in the U.S. interest rate is absorbed by both a decline in the forward premium and a decline in the covered interest differential.

Case 3: Exchange-rate support with no sterilization

In this case, the effects of a decline in the U.S. interest rate are spread over all three factors. The forward premium changes for the same reasons as in Case 2. The covered differential also changes in the same fashion because, once again, the foreign central bank's support operations typically result in an increase in demand for U.S. securities, thereby affecting the balance of supplies available to private portfolios. But now the lack of sterilization causes the foreign money supply to be

Table 1

		Impact of Δi_{us}
Case 1:	No official intervention	$\Delta i_{us} = \Delta fp$
Case 2:	Exchange rate supported with complete sterilization abroad	$\Delta i_{us} = \Delta fp + \Delta d$
Case 3:	Exchange rate supported without sterilization abroad	$\Delta i_{us} = \Delta fp + \Delta d + \Delta i_f$

affected by the support operation. This causes the foreign interest rate to fall in sympathy with the U.S. rate.

Case 3, then, is the only one in which the foreign interest rate is affected.

Implications for empirical analysis

The above cases are summarized in Table 1. We see that there are two ways in which interest rates could have become decoupled after Bretton Woods. Decoupling could occur either because official intervention ceased to be associated with changes in the U.S. interest rate (Case 1) or because intervention was accompanied by complete sterilization (Case 2). If lack of intervention were the sole cause of the decoupling (Case 1), changes in the forward premium should absorb all of the impact of changes in U.S. interest rates. In contrast, if complete sterilization were the sole cause (Case 2), the impact should be felt in both the forward premium and the covered interest differential.[9]

III. Measured Impact of Managed Floating on Linkages Between Interest Rates

In this section, we examine empirically the impact of managed floating on the interest-rate linkages for six industrialized countries. Our methodology tests for the direct linkage of interest rates, allowing for two other factors that may impinge upon foreign interest rates.[10]

The first such factor is the cyclical variation in the demand for money, and hence interest rates, that occurs over the business cycle. To measure this influence, we use as a proxy the percentage deviation of industrial production from its trend.[11] Other things equal, when the cyclical component of industrial production is relatively high, the demand for money, and hence the real interest rate, also tends to be high. A second factor to consider is the inflation-expectations premium in interest rates. A major part of the movement in foreign interest rates can be attributed to variations in the inflation premium.[12] Unless we allow for such variations, measured changes in monetary effects on interest rates might be spurious and simply due to common inflationary trends.

The following equations relate U.S. interest rates to comparable foreign interest rates:[13]

$$i_f = a_0 + a_1 D + a_2 i_{us} + a_3 D i_{us} + a_4 Q + \sum_{i=0}^{8} a_{5+i} \dot{CP}_{t-i} + e_1 \qquad (3)$$

$$fp = b_0 + b_1 D + b_2 i_{us} + b_3 D i_{us} + b_4 Q + \sum_{i=0}^{8} b_{5+i} \dot{CP}_{t-i} + e_2 \qquad (4)$$

where

i_f = foreign interest rate,
fp = forward premium on the foreign currency,
i_{us} = U.S. interest rate,
D = dummy variable having a value of one for the Bretton Woods system and zero for the period of managed floating,
Q = percentage deviation of industrial production from trend,
$\dot{CP}$ = rate of change of the consumer-price index,
e = error term.

In equation (3), the foreign interest rate (i_f) depends on domestic and foreign components of the foreign monetary base, as well as the foreign demand for money. The exchange rate regime influences the components of the foreign monetary base, and therefore the foreign money supply. Variations in the foreign demand for money (relative to supply) are explained by cyclical variations in output (Q) and inflationary expectations ($\dot{CP}$). Expected inflation is measured by a (nine quarter) fourth-degree polynomial distributed lag on current and past quarterly changes in the consumer-price index. The sum of the coefficients on this distributed lag is expected to be positive, but not necessarily equal to one, as would be true in the long run in the absence of tax effects.

Equation (3) is used to test if managed floating has decoupled interest rates. A dummy variable (D) having a value of one during the fixed-exchange-rate period and zero otherwise is included, both as a multiplicative term on the U.S. interest rate and as a shift parameter for the constant term.[14] If a_2 is not significantly different from zero, we may conclude that i_{us} and i_f have generally not moved together during the floating-rate period. The coefficient on a_3, on the other hand, registers the additional impact attributable to the fixed-exchange-rate regime, so that we would expect a_3 to be positive if i_{us} and i_f were more closely linked during that period.

Equation (4), which accounts for the impact of these same variables on the forward premium, provides evidence on the reason for a decoupling of U.S. and foreign interest rates under managed floating — assuming this has actually occurred. If the major factor is a lack of market intervention in response to U.S. interest-rate changes, the forward premium would change by as much as the U.S. interest rate, making the value of b_2 close to one. On the other hand, if interest-rate linkages were severed by complete sterilization, changes in the U.S. interest rate would affect both the forward premium and the covered interest dif-

Table 2
Impact of U.S. Interest Rate on Foreign Interest Rates and Forward Premiums on Foreign Currencies

$$i_f = a_0 + a_1 D + a_2 i_{US} + a_3 D i_{US} + a_4 Q + \sum_{i=0}^{8} a_{5+i} \dot{C}P_{t-i} \qquad fp = b_0 + b_1 D + b_2 i_{US} + b_3 D i_{US} + b_4 Q + \sum_{i=0}^{8} b_{5+i} \dot{C}P_{t-i}$$

Country	Dependent Variable	a_0 or b_0	a_1 or b_1	a_2 or b_2	a_3 or b_3	a_4 or b_4	$\sum_{i=0}^{8} a_{5+i}$ or $\sum_{i=0}^{8} b_{5+i}$	S.E.	Rho	D.W.
Belgium	i_f	5.32	−1.92	.255	.178	.211	.348	.978	.657	1.56***
		(1.64)*	(−.662)	(1.15)	(.545)	(2.27)**	(1.63)*		(6.22)***	
	fp	−6.84	4.76	.973	−.550	−.271	−.488	1.452	——	1.82***
		(−1.77)*	(1.67)*	(3.32)***	(−1.80)**	(−2.84)***	(−2.72)***			
Germany	i_f	−.973	−6.71	.181	.508	.192	.935	9.14	.982	1.12**
		(−.150)	(−1.60)*	(.960)	(1.57)*	(2.16)**	(1.53)*		(36.8)***	
	fp	3.23	−2.49	.748	−.0734	−.211	−1.58	1.470	.548	1.74***
		(1.05)	(−.760)	(2.86)***	(−.157)	(−1.67)*	(−3.44)***		(4.67)***	
Switzerland	i_f	1.79	−1.77	−.0385	.456	.0801	.465	.533	.560	1.78***
		(1.40)*	(−1.26)	(−.324)	(2.66)***	(2.02)**	(6.64)***		(4.82)***	
	fp	−1.10	4.50	1.01	−.924	−.141	−.712	1.112	.610	1.82***
		(−.405)	(1.49)*	(4.03)***	(−2.51)***	(−1.72)**	(−4.47)***		(5.50)***	
France	i_f	12.5	−7.61	−.196	.843	.0678	−.192	.716	.886	1.55***
		(4.44)***	(−2.85)***	(−1.27)	(3.10)***	(2.17)**	(−.820)		(13.1)***	
	fp	−12.0	8.81	1.21	−.863	−.0578	.158	.884*	.815	1.34***
		(−3.68)***	(2.82)***	(6.43)***	(−2.58)***	(−14.5)*	(.588)		(9.66)***	
Canada	i_f	.894	−.314	.652	.0833	.0297	.390	.588	.712	1.54***
		(.865)	(−.160)	(6.05)***	(.326)	(.427)	(3.02)***		(7.24)***	
	fp	−1.26	.368	.480	−.188	−.00152	−.346	.770	.549	1.82***
		(−1.15)	(.178)	(3.45)***	(−.655)	(−.0178)	(−2.51)***		(4.69)***	
United Kingdom	i_f	9.72	−3.49	.195	.0501	−.0741	−.0509	1.265	.884	2.14***
		(2.07)**	(−.736)	(.670)	(.108)	(−.492)	(−.251)		(13.5)***	
	fp	−10.7	8.42	.730	−.713	.183	.166	2.013	.742	2.08***
		(−1.51)*	(1.19)	(1.53)*	(−.970	(.726)	(.574)		(7.92)***	

Estimated Coefficients of Independent Variables

t-statistics are in parentheses.
*** indicates a coefficient that is significantly different from zero at the one-percent level on the basis of a single-tailed test.
** indicates significance at the 5-percent level; and * signifies a 10-percent level of significance.
With respect to the Durbin-Watson statistic (D.W.), the absence of significant positive serial correlation in the residuals is denoted by *** at the 5-percent level and ** at the 2.5-percent level.

ferential, resulting in a value of b_2 significantly below one.[15]

The coefficients on the "control" variables, b_4 and b_5 in equation (4), are expected to be nearly equal in absolute value to a_4 and a_5 in equation (3), but opposite in sign. Changes in the foreign demand for money—as measured by the Q and CP variables—would affect the foreign interest rate, and this in turn would produce opposite changes in the forward premium. The U.S. interest rate would not be affected by such variations, because the U.S. dollar was a reserve currency throughout the periods of both fixed and floating exchange rates.

Belgium, Germany, Switzerland, and France

Estimates of these equations for a sample of six industrialized countries, using ordinary least squares and a first-degree Cochrane-Orcutt adjustment for serial correlation, are shown in Table 2. The a_2 coefficient is not significantly different from zero for Belgium, Germany, Switzerland and France — which suggests that under managed floating there was no transmission of U.S. interest rates to those countries' interest rates through direct monetary effects. Also, the b_2 coefficient is not significantly different from one, indicating that with managed floating a change in the U.S. interest rate resulted in nearly an equal movement in the forward premium on the foreign currency.

On average in these four countries, a 100-basis-point change in the U.S. interest rate is estimated to have produced a 99-basis-point change in the forward premium on the foreign currency, but only a 5-basis-point change in the foreign interest rate, and also hardly any change in the (implied) covered interest differential. This result corresponds most closely to Case 1, in which there is no official intervention in the foreign-exchange market in response to incipient capital flows induced by differences in interest rates.

The overall magnitude of central-bank intervention has been about as large for these four countries under managed floating as under the Bretton Woods regime (Table 3).[16] But whether managed floating has brought about a lesser degree of foreign interest-rate dependence on U.S. rates does not depend on the amount of intervention per se. Rather, it depends on the relative amount of intervention under the two regimes, in response to variations in U.S. interest rates and associated incipient capital flows. Because the forward premium is seen to have changed, on average, by just about the full amount of the change in the U.S. interest rate (with hardly any change in the implied covered interest-rate differential), we infer that official intervention has ceased to be associated with interest-sensitive movements of capital.

Interest-rate independence might also occur if foreign central banks intervened to support the exchange rate but fully sterilized the impact on foreign money supplies (Case 2). However, in that case the impact of the change in the U.S. interest rate would be split between a change in the forward premium and a change in the covered differential between interest rates. Under managed floating, the forward pre-

Table 3
Average of Absolute Values of Quarterly Percent Changes in Official Reserves*

	Bretton Woods	Managed Floating
Belgium	2.50	4.05
Germany	8.35	3.62
Switzerland	3.32	5.00
France	5.17	6.83
Canada	4.39	6.37
United Kingdom	4.40	12.97

*Reserves are denominated in SDR's as tabulated in *International Financial Statistics*. Since world reserves have been growing over time, this in itself would result in an observed "use" of reserves. To correct for this trend effect, percentage changes in world reserves were subtracted from corresponding country figures. The formula used to measure the average absolute percentage change in quarterly values of reserves is:

$$\left(\sum_{i=1}^{T} \left| \frac{R_t^c - R_{t-1}^c}{R_{t-1}^c} - \frac{R_t^w - R_{t-1}^w}{R_t^w} \right| / T\right) \times 100$$

The periods of fixed and managed floating correspond to those used in estimating the interest-rate and forward-premium equations, as described in footnote 14. For a discussion of this and various alternative measures of intervention, see Suss (1976).

mium is estimated to have responded by approximately the full amount of a change in the U.S. interest rate. Thus a lack of exchange-market intervention in response to interest rate variations, rather than sterilization, apparently accounted for most of the interest-rate insulation for those countries under the floating-rate regime.[17]

In contrast, their insulation from the U.S. interest rate was far less complete in the period of fixed exchange rates. The estimated value of a_3, the coefficient on the multiplicative dummy variable in the interest-rate equation, is positive in all cases, and significantly so in all cases but one. Thus, the U.S. interest rate significantly affected interest rates in these countries during the Bretton Woods years. The estimated value of b_3, the coefficient on the multiplicative dummy in the equations explaining the forward premium, is negative for all these countries, and significantly so in all but one case. Thus, the impact of U.S. interest rates on the forward premium of these countries' currencies was significantly less during the fixed exchange-rate period, as would be expected in the case of stronger intervention in response to interest-induced capital flows.

The four countries' results for the fixed-rate period correspond most closely to Case 3. Our estimated responses of foreign interest rates to the U.S. interest rate, equal to the sums of the a_2 and a_3 coefficients, are consistent with those obtained by Herring and Marston (1977). On average, we find that a 100-basis-point change in the U.S. rate produced a 55-basis-point change in the foreign interest rate. In Case 3, the difference between the changes in U.S. and foreign interest rates is split between changes in the forward premium and the covered interest differential. We find the average estimated response of the forward premium for the fixed-rate period, equal to the sum of the b_2 and b_3 coefficients, to be 38 basis points. The implied change in the covered interest differential, obtained by subtracting the sum of the above two values from one, is significantly smaller at 7 basis points.

The variables influencing the demand for money have highly significant effects on foreign interest rates for these four countries, which suggests the need to consider those variables when testing for the effect of managed floating on the short-run interdependence of interest rates. In all four cases, the cyclical component of output has significantly positive effects on the foreign interest rate and significantly negative impacts on the forward premium. Similarly, except for France, the measure of expected inflation significantly and equally affects the foreign interest rate and the forward premium, but with opposite signs. The sum of the coefficients on past inflation is generally less than one, as would be anticipated in the short-run when output and employment are variable.

Canada and the United Kingdom

Canada is an exception to this general pattern of money-market insulation from U.S. interest rates under the managed-float regime. The estimated a_2 coefficient indicates that a change of 100 basis points in the U.S. short-term interest rate affected the Canadian short rate by about 65 basis points even during managed floating. The insignificance of the a_3 coefficient indicates further that the impact of U.S. on Canadian interest rates was not very different under a fixed exchange-rate system. Similarly, the impact on the forward premium is estimated to have been about the same under fixed and floating exchange rates.

Although the Canadian dollar was ostensibly freed to float on the foreign-exchange market in May 1970, the Bank of Canada continued to make the U.S.-Canadian dollar exchange rate an important policy target, and it viewed domestic monetary and fiscal policies as primary instruments for achieving the desired exchange rate.[18] However, the target range for the Canadian dollar turned out to be a relatively static one, which did not allow for any significant movement in the exchange rate.[19] After floating in 1970, the Canadian dollar appreciated immediately against the U.S. dollar by about 10 percent, and then remained in that range throughout most of the decade. To maintain this exchange rate, Canadian authorities keyed nominal interest rates quite closely to U.S. interest rates, continuing the traditional interest differential in favor of Canada.

Another unique case is the United Kingdom, where interest rates apparently were fully insulated from U.S. interest rates during both the fixed-rate and floating-rate regimes. The estimated value of the a_2 coefficient, measuring the impact of the U.S. interest rate on the U.K. rate during the managed float, is not significantly different from zero; and neither is the value of the a_3 coefficient that registers the difference made by the fixed-exchange-rate regime.[20]

The absence of any observable transmission may be explained by the existence in the United Kingdom, as in the United States, of a highly developed short-term market for credit, which allows the authorities easily to sterilize the impact of reserve flows on the money supply and interest rates. Indeed, sterilization occurs almost automatically as a consequence of the normal operation of the British Government's Exchange Equalization Account. When this Account purchases foreign exchange to support the exchange rate, it obtains the necessary sterling by issuing Treasury bills to the public, thereby preventing a new injection of bank reserves and deposits into the monetary system. Similarly, when it sells foreign exchange it uses the sterling proceeds to purchase a like amount of Treasury bills from the market, thereby preventing a contraction of bank reserves and a tightening of credit-market conditions.[21]

IV. Summary and Conclusions

Advocates of a system of flexible exchange rates, such as the managed floating adopted in 1973, claim that it permits a greater independence of monetary policies by weakening linkages between national interest rates. Variations in U.S. interest rates affect international capital flows, which in turn put pressure on exchange rates. When exchange rates are supported by central-bank intervention, as under the Bretton Woods system, foreign money supplies are affected. Such changes in foreign money supplies, unless they can be sterilized by offsetting central-bank action, in turn impact on foreign interest rates.

Quantitatively, central-bank intervention in exchange markets has been about as large under managed floating as under the Bretton Woods system. Whether managed floating has actually weakened interest-rate linkages therefore depends upon whether intervention now offsets the effects on exchange rates induced by interest-rate differentials to a lesser extent. It also depends on the extent of utilization of sterilization policies. This study has analyzed the question by comparing the linkages between U.S. and foreign interest rates in six industrialized countries under the two exchange-rate regimes.

Canada and the United Kingdom were atypical. In both countries, linkages to U.S. interest rates did not change significantly during the two exchange-rate regimes, although for different reasons. In Canada, interest rates continued to be pegged to U.S. interest rates after the shift to managed floating, simply as a matter of policy. In contrast, the Bank of England was both willing and able to prevent any linkage between U.S. and U.K. interest rates by sterilization operations under both exchange-rate regimes.

The more typical pattern was exhibited by Belgium, Germany, Switzerland, and France. For all four of these countries, U.S. interest rates exerted a strong impact on foreign interest rates under the Bretton Woods system of fixed exchange rates. A 100-basis-point (one percentage point) change in the U.S. short-term interest rate, on average, produced a 55-basis-point change in the comparable foreign interest rate. The results for this period, thus, conform most closely to Case 3 of our theoretical analysis, in which the exchange rate is supported by central-bank intervention with little or no sterilization. Case 3 is the only one in which the foreign interest rate is affected. In it the difference between the changes in

U.S. and foreign interest rates is split between a change in the forward premium on the foreign currency and a change in the covered interest differential.

Under the Bretton Woods system, a 100-basis-point change in the U.S. interest rate produced, on average in these countries, a 38-basis-point change in the forward premium required by the market to provide the forward cover needed by investors. The average change in the covered interest differential needed to induce investors to move their capital internationally was much smaller, at only 7 basis points. These results indicate that: (1) In the absence of exchange-rate risk, securities in different national markets are fairly close but not perfect substitutes for one another, and (2) the elasticity of supply of forward cover to investors was not very high even in the Bretton Woods period, suggesting that the market required a significant risk premium for bearing the risk of change in the exchange rate.[22]

In contrast to the Bretton Woods years, during the period of managed floating a 100-basis-point change in the U.S. short-term interest rate produced a 99-basis-point average change for the four countries in the forward premium on the foreign currency, but no significant change in either the foreign interest rate or the covered interest differential. These results for the period of managed floating correspond to Case 1 of our theoretical analysis, where monetary independence flows from an absence of foreign-exchange market intervention by foreign central banks in response to a change in the U.S. interest rate. Without such exchange-market intervention, there can be no impact on foreign money supplies and foreign interest rates.

In the theoretical Case 2, the exchange rate is supported in response to a change in the U.S. interest rate, but monetary independence flows from sterilization of the impact of international reserve flows on the foreign money supply. In Case 2, both the covered interest differential and the forward premium change in response to a change in the U.S. interest rate, while in Case 1 only the forward premium is affected. The general absence of a significant response of the covered interest differential to the U.S. interest rate in the period of managed floating suggests that sterilization policies were not the main cause of the observed monetary independence under this regime.

APPENDIX
Interest Arbitrage in the Modern Theory of Forward Exchange

The modern theory of forward exchange recognizes that both covered-interest arbitragers and speculators are important forces in determining the response of the foreign interest rate, the forward premium, and the covered interest differential to a change in the U.S. rate of interest. As discussed in footnote 4, uncovered interest arbitrage can be decomposed into covered-interest arbitrage and speculative activity in the forward market, and therefore does not have to be treated separately.

We abstract from growth and therefore focus on short-run equilibrium at a point in time, in which the total stock of private wealth and supplies of U.S. and foreign securities are given. Conditions of portfolio balance determine interest rates and the spot and forward exchange rates. Figures 1 through 3 show the supply and demand for the stock of forward commitments in a foreign currency. The vertical axis measures the price of forward exchange, and the horizontal axis indicates the stock of forward exchange either supplied or demanded at a point in time. The spot price of foreign exchange is initially equal to S in the diagram. To simplify the analysis, we assume initially that the U.S. interest rate and foreign interest rate are equal. We also assume that, given this condition, tastes and portfolio sizes are such that at a forward rate equal to the spot rate, there is initially no supply of or demand for forward exchange by investors hedging against the risk of exchange-rate changes.

Arbitragers, who cover their investments against exchange risk with contracts in the forward market, constitute one side of the market for forward exchange. If the forward price of foreign currency declines, given the current spot rate, covered rates of return on U.S.-dollar-denominated securities exceed those on foreign-currency-denominated securities; and arbitragers demand foreign currency forward to cover additional holdings of dollar-denominated assets. Conversely, if the price of forward exchange rises, assets denominated in foreign currencies now become more attractive; and to achieve portfolio equilibrium arbitragers supply foreign currency forward. Thus, the amount of forward exchange that arbitragers wish to hold is a downward-sloping schedule (AA). It is less than infinitely elastic, because financial assets in different national markets are imperfect substitutes even when covered against exchange-rate risk.

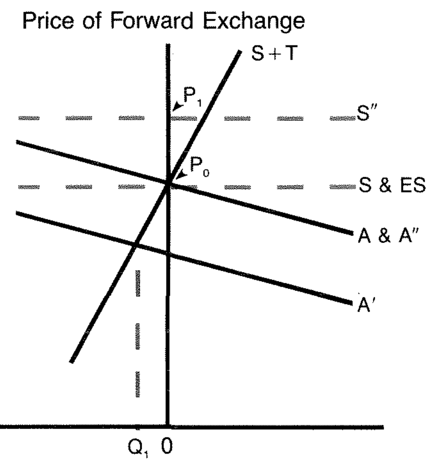
Speculators and traders (i.e., importers and exporters) constitute the other side of the forward market. For simplicity, we initially assume that the value of the future spot rate expected by traders and speculators, ES, is equal to the current spot rate, S. Unlike arbitragers, speculators and traders take positions with respect to exchange-rate risk — speculators outright and traders by not covering commercial commitments. When the forward rate rises above the expected future spot rate, ES, speculators and traders will supply foreign currency forward. Since both are to some extent averse to risk, a higher forward price of foreign currency, and hence a larger risk premium, will be required to draw forth a larger supply. Conversely, when the forward rate falls below the expected future spot rate, speculators and traders demand foreign currency forward. Thus, the amount of forward exchange made available by speculators and traders (S & T) is an increasing function of price.

Case 1: No Official Intervention

Figure 1 shows the effect of a change in the U.S. interest rate with no official intervention in the spot market. Under the conditions specified, the initial equilibrium price of forward exchange is equal to the current spot rate, S. Now suppose the U.S. interest rate falls because of either an increase in supply or a decrease in demand for money in the United States. With the spot price of foreign exchange initially at S, the arbitrage schedule shifts down to A′ by an amount equal to the decline in the U.S. interest rate. This occurs because, with a given demand by arbitragers for forward exchange, the price of forward exchange must fall by an amount equal to the decline in the U.S. interest rate, leaving covered returns on U.S. and foreign-currency-denominated assets as before. At the intersection of the S&T and A′ schedules, arbitragers desire to shift Q_1O assets from the United States to foreign financial markets. But this incipient capital outflow puts upward pressure on the spot price of foreign exchange, which operates to shift the arbitrage schedule back up.

Figure 1

Transmission of U.S. Monetary Policy with No Official Intervention



Supply of Forward Foreign Currency from Arbitragers and Demand by Speculators and Traders	Demand for Forward Foreign Currency by Arbitragers and Supply from Speculators and Traders

For simplicity, we may assume that exchange-rate expectations are perfectly inelastic, so that speculators and traders expect an unchanged spot rate to prevail in the future. In that case, pressure in the spot market pushes the spot exchange rate to S″ until the A′ schedule returns to its old position. The spot rate rises by an amount equal to the decline in the U.S. interest rate. The net result is that, under a fully flexible exchange rate, the discount on forward exchange becomes sufficiently large to offset the difference in interest rates, preventing an actual capital outflow. In terms of the basic equation in the text. Δi_{us} impacts only on Δfp (equals P_0P_1), and not at all on Δd or Δi_f.

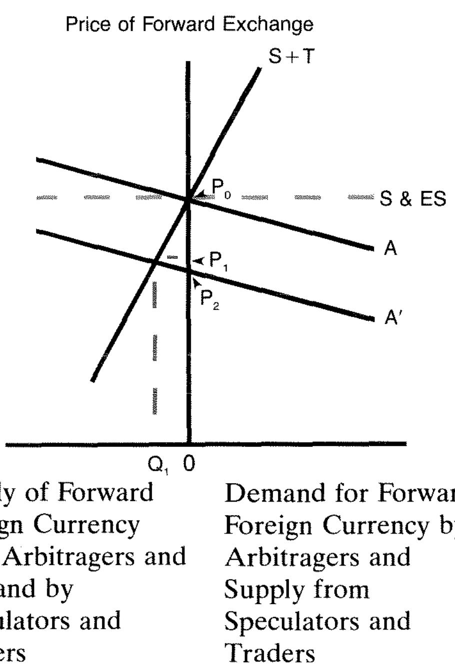
More realistically, if the future spot rate is expected to rise, but by less than the change in the current spot rate, the S&T schedule then shifts up as well. However, the new equilibrium involving higher S&T and A schedules would still intersect on the vertical axis and generate the same discount on forward exchange as shown in Figure 1, but simply at higher levels of spot and forward rates. Once again, Δi_{us} does not impact on Δd or Δi_f.[23]

Case 2: Exchange Rate Support With Complete Sterilization

Figure 2 shows the impact on the forward-exchange market of a decline in the U.S. interest rate when the exchange rate is supported, and when the foreign central bank sterilizes the effects of international reserve flows on its monetary base by offsetting operations. The decline in the U.S. interest rate shifts the A schedule down to A′ as before. But now, because of central-bank support operations in the spot market for foreign exchange, the incipient capital outflow, Q_1O, becomes an actuality. The upward pressure on the spot price induces foreign central banks to sell foreign exchange in order to maintain the exchange rate. In addition, when the foreign central bank sterilizes the effects of this operation on the foreign money supply, say, by sales of securities in the foreign money market, it prevents the foreign interest rate from falling.

The net result for the foreign central bank is an exchange of foreign securities for U.S. securities. Q_1O of private capital can flow abroad even in the short run, with the total stock of wealth given, because an equal amount of foreign official capital flows in the opposite direction. The result in the forward exchange market is an allocation of the impact of Δi_{us} on Δfp (equals P_0P_1) and Δd (equals P_1P_2), depending upon the degree of substitutability of financial assets and the degree of exchange-rate certainty. The greater the substitutability of financial assets in the absence of exchange-rate risk, the greater is the elasticity of the A schedule; and the greater the certainty about future exchange rates, the more elastic is the S&T schedule. If the A schedule is elastic relative to the S&T schedule, as drawn, then Δi_{us} mostly affects Δfp, with relatively little impact on Δd. The empirical results in the text suggest that these relative

Figure 2
Transmission of U.S. Monetary Policy with Supported Exchange Rate and Complete Sterilization



elasticities are indeed a realistic configuration. But in any case, the forward premium changes by less than the change in the U.S. interest rate, which creates a change in the covered interest differential, Δd, inducing investors to substitute foreign assets for U.S. assets.

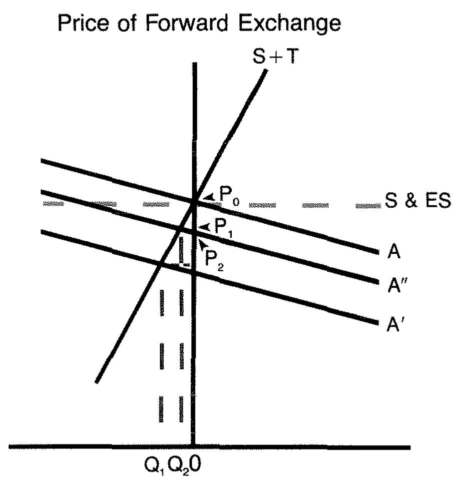
Case 3: Exchange Rate Support Without Sterilization

Figure 3 shows the impact of a decline in the U.S. interest rate when the exchange rate is supported, but the foreign central bank does not offset the effects of exchange-market intervention on its own money supply. The decline in the U.S. interest rate once again shifts the A schedule down to A′, resulting in an incipient capital outflow equal to Q_1O. As arbitragers increase their (covered) investment abroad, however, the foreign interest rate declines because of the increase in the foreign money supply. The foreign central bank supports the exchange rate by purchasing an excess supply of dollars in the spot market and investing these dollars in U.S. securities. The arbitragers use the foreign currency that they purchase from the foreign central bank to bid up the price of foreign securities and reduce the yield, until the original holders of the securities are willing to exchange them for the newly created foreign money. But the decrease in the foreign interest rate shifts the arbitrage schedule to A″ and consequently reduces the size of the actual capital outflow to Q_2O.

The outflow of private capital can occur even in the short run, with the total stock of private wealth given, because an equal amount of foreign official capital (the exchange of foreign money for U.S. securities) flows in the opposite direction. The relative impacts on Δfp (P_0P_1) and Δd (P_1P_2) depend upon the relative elasticities of the A and S&T schedules, with the impact on Δfp (P_0P_1) being greater if the A schedule is relatively elastic, as drawn. Empirical results in the text for the Bretton Woods period correspond most closely to this case. They indicate the existence of a relatively inelastic schedule for the net forward commitments of speculators and traders, implying that speculators and traders require a relatively large risk premium in order to bear the risk of exchange-rate changes.[24]

Because national financial assets are not perfect substitutes, even in the absence of exchange-rate risk, the foreign interest rate does not decline by as much as the U.S. interest rate. Thus the arbitrage schedule does not shift all the way from A′ to A, but rather to an intermediate position A″ where a positive covered interest differential, P_1P_2, induces arbitragers to increase their holdings of foreign assets. Because the increase in the covered differential is less than in the case where the monetary effects on the foreign economy are sterilized, the size of the capital outflow, Q_2O, is less also.

Figure 3
Transmission of U.S. Monetary Policy with Supported Exchange Rate But No Sterilization



Supply of Forward Foreign Currency from Arbitragers and Demand by Speculators and Traders	Demand for Forward Foreign Currency by Arbitragers and Supply from Speculators and Traders

1. This is an instance of perfect capital mobility internationally. The pioneering treatment of the effects of perfect capital mobility under different exchange-rate regimes is contained in a series of papers by Mundell (1968). More recently, the assumption of perfect capital mobility has become an important ingredient of the "global monetarist" approach to international adjustment. See Whitman (1975).

2. Since the U.S. dollar is a reserve currency, international capital flows normally have no impact on the U.S. money supply. Dollar reserves purchased by foreign central banks in exchange-rate support operations are returned to circulation when they are invested in U.S. money-market instruments. But in the case of adjustment between two nonreserve-currency countries, reserve flows would reduce the money supply and increase interest rates in the home country (where interest rates had originally fallen) and produce opposite reactions abroad, until interest levels at home and abroad were equalized.

Moreover, it would be impossible for foreign central banks to sterilize the impact of capital flows on their money supplies and interest rates through offsetting policies when financial assets are perfectly substitutable. If foreign central banks decrease the domestic component of their monetary bases by sales of securities in the open market, or by other means, all that would occur is a one-for-one substitution of the international reserve component for the domestic component of the monetary base, as new capital outflows from the United States were stimulated.

3. Aliber (1973) has shown that securities issued in the same political jurisdiction—such as Eurodollar and Euromark deposits in London—show nearly equal returns covered for exchange-rate risk. In contrast, covered returns on securities originating in different countries differ from one another to a larger extent, and also exhibit less covariation.

Results similar to those of Aliber (1973) have been obtained by Frankel and Levich (1975) and Minot (1974). Studies showing less than perfect integration among national capital markets, even on securities covered for exchange-rate risk, include those of Grubel (1966), Stoll (1965), and Stein (1965).

4. The alternative—holding foreign securities without the exchange risk being covered in the forward market—is completely equivalent to holding foreign securities with the exchange risk covered combined with a simultaneous and equal speculative holding of a forward contract. Speculation in the forward market involves the acquisition of contracts to buy (sell) foreign exchange at some future date in the hope that the future spot rate will be higher (lower) than the current forward rate. When the contract becomes due, the speculator sells (buys) foreign currency in the spot market to discharge (obtain) the foreign exchange obtained (necessitated) by his forward contract.

Because of this equivalence, the portfolio equilibrium of American investors can be analyzed completely in terms of holdings of domestic securities, holdings of foreign securities with exchange risk covered in the foreign market, and holdings of speculative positions in the market for forward exchange. A similar analysis also holds for foreign investors. Therefore, the portfolio position for American and foreign investors combined can be analyzed in terms of the net amount of covered interest arbitrage and the net size of the speculative positions undertaken by both.

We can easily demonstrate the equivalence of holding foreign securities without the exchange risk being covered in the forward market to the combination of holding foreign securities with the exchange risk covered and a simultaneous and equal speculative holding of a forward contract. Suppose an American investor has $1 to invest in foreign securities of one year's maturity. Let S_1 be the current price of foreign exchange in the spot market, and S_2 be the price when the foreign security matures. Also let i_f be the foreign interest rate and F equal the current price of foreign exchange in the forward market. If the investor does not cover his exchange risk by a transaction in the forward market, the value of his investment in dollars at maturity equals

$$\frac{1}{S_1}(1 + i_f)S_2$$

Alternatively, the American investor can hedge his investment against exchange risk by entering into a forward contract to sell foreign currency to be received at maturity. The value of his investment in dollars at maturity is

$$\frac{1}{S_1}(1 + i_f)F$$

If at the same time he speculates in the forward market by buying forward

$$\frac{1}{S_1}(1 + i_f)$$

of foreign currency, he will make an additional gain or loss. The gain or loss is equal to the dollar value in the spot market of this amount of foreign currency, which he gets by selling the proceeds from the forward contract, less the dollar cost of buying this amount of foreign currency in the forward market.

The investor's gain or loss on his speculative activity is therefore equal to:

$$\frac{1}{S_1}(1 + i_f)S_2 - \frac{1}{S_1}(1 + i_f)F$$

The total value in dollars of the covered interest-arbitrage transaction plus the speculative transaction at the maturity of the security is therefore:

$$\frac{1}{S_1}(1+i_f)F + \frac{1}{S_1}(1+i_f)S_2 - \frac{1}{S_1}(1+i_f)F = \frac{1}{S_1}(1+i_f)S_2$$

This return is precisely the same as for the uncovered interest-arbitrage transaction. Thus, uncovered interest arbitrage can be decomposed into covered interest arbitrage and a simultaneous speculative position in the forward market; and there is therefore no need to treat it separately.

5. The total covered return is actually only approximately equal to $i_f + fp$. For example, the yield, at an annual rate,

from covered interest arbitrage on the 90-day securities used in this study is:

$$\left(\frac{1}{S}(1 + i_f/4)F - 1\right) \times 4$$

The forward premium (fp), or percent gain (or loss if a discount) on the spot and forward market transactions, at an annual rate, is:

$$\left(\frac{F - S}{S}\right) \times 4$$

Therefore, by substitution, the yield on covered interest arbitrage reduces to:

$$fp + \frac{F}{S} i_f$$

But this is approximately the same as $fp + i_f$, since $\frac{F}{S}$ normally has a value close to one.

6. As has been emphasized by Mundell (1968), even under a perfectly clean float it is theoretically possible for interest rates to be linked through money-demand effects, rather than money-supply effects, if capital continues to be highly mobile internationally. For example, with a decline in U.S. interest rates, capital tends to flow abroad and produce an appreciation in the dollar values of foreign currencies. This appreciation eventually reduces foreign net exports (and strengthens U.S. net exports), contributing to a decline in aggregate demand and interest rates abroad (and to opposite effects in the United States). In the extreme case of perfect capital mobility, where capital flows are infinitely sensitive to differences in nominal interest rates (despite the presence of exchange-rate risk), these movements would continue until interest rates in the United States and abroad were equalized.

However, Mundell's mechanism for the linking of nominal interest rates under floating exchange rates is not likely to be important in practice. First, in the short-run the trade balance tends to respond perversely to changes in the exchange rate. (For a summary of the evidence on this point, see Goldstein and Young (1979).) This "J curve" effect tends to drive interest rates apart initially, rather than together, leading to further capital flows and exchange-rate movements until investors begin to take into account an expected future reversal of exchange-rate movements. Therefore, the response of foreign interest rates to U.S. rates is not unidirectional. Secondly, over a longer period differing inflation rates between the United States and foreign countries produce differential inflation premiums in interest rates, as well as exchange-rate movements that tend to maintain approximate purchasing-power parity between currencies. Thus, expected changes in exchange rates—corresponding to inflation differentials—tend to offset differences in nominal interest rates attributable to inflation premiums, severing any systematic response of capital flows to differences between nominal interest rates. The mechanism that is supposed to drive nominal interest rates together is therefore effectively destroyed. In other words, Mundell's argument has more applicability to real rates of interest than to nominal ones. The question of whether national real rates of interest continue to be closely related under managed floating of exchange rates lies outside the scope of this study. However, for some partial evidence on this question, see Howard (1979).

7. A useful analysis of sterilization policies and their tendency to short-circuit the transmission mechanism is found in Herring and Marson (1977, Ch. 2). Empirical work in the same volume, however, shows that sterilization was not complete under Bretton Woods, leading to some interdependence between U.S. and foreign interest rates. For more recent work on sterilization policies, see Hickman and Schleicher (1978) and Laney (1980).

8. Expositions of the modern theory of forward exchange include Argy and Hodjera (1973), especially section III; Grubel (1966); and Stoll (1965).

9. The shift to managed floating could also affect the distribution of effects between Δfp and Δd under conditions of exchange-rate support. But this effect is probably not large. The split between Δfp and Δd when the exchange rate is supported depends upon the substitutability between U.S. and foreign securities relative to the elasticity of the supply of forward cover from speculators. The willingness of speculators to supply forward cover to interest arbitragers depends importantly upon the degree of uncertainty about exchange rates. Even under the Bretton Woods system, there was a substantial amount of exchange-rate risk. The spot rate was allowed to fluctuate by $\pm$ 1 percent around the official parity, and official parities were sometimes changed. Indeed, a recent study by Farber, Roll, and Solnick (1977) concludes that exchange rates were neither more nor less certain in the Bretton Woods period. Although exchange-rate changes have occurred with greater frequency under the managed float, such changes were larger and more unpredictable under Bretton Woods. Thus, the elasticity of the speculator supply of forward cover may have been made neither more nor less elastic by the shift to managed floating.

Governmental controls over capital movements have been the most important factor affecting substitutability between domestic and foreign securities. Such controls have been used under managed floating to help stabilize the exchange rate and under the Bretton Woods system to affect reserves. It is not clear that either the incidence or threat of capital controls has generally been any less under managed floating than before. Moreover, in neither case were capital controls highly effective. So substitutability between domestic and foreign securities may not have been importantly affected by the exchange rate-regime either.

10. Previous empirical work on this question generally has not allowed for the influence of such other factors. For example, Logue, Salant, and Sweeney (1976) use factor analysis to measure the degree of covariation in interest rates among industrialized countries during the fixed exchange-rate period. They find that a single factor explains a fairly high proportion of the covariation in interest rates across countries. However, factor analysis sheds no light on the causes of this common variation. It could be due to events that have impinged more or less simultaneously on all financial markets, such as common business-cycle and inflation trends; or it may be the result of the transmission of interest-rate changes from one country to another through money-supply channels.

White and Woodbury (1980) extend this type of analysis to the floating-rate period, and find a significant reduction in the covariation of interest rates associated with the shift to managed floating. (The main body of their paper compares the covariation in **covered** interest rates between the two periods, finding little change. But in footnote 10, the analysis is applied to **uncovered** yields on a set of financial assets in a manner similar to that used by Logue, Salant, and Sweeney (1976). The result is a significant reduction in the covariation of interest rates in the period of managed floating). Since inflation differentials have widened and become more variable during the period of managed floating, and since nominal interest rates incorporate inflationary premiums, such a result is not unexpected. But this result does not necessarily imply a reduction in the degree of short-run interdependence of interest rates operating directly through money-supply effects. It could be caused merely by more variable inflation differentials, a weaker degree of synchronization of national business cycles, or a combination of the two.

11. The trend level of industrial production was calculated recursively by multiplying last quarter's trend level by the actual rate of growth over the previous 20 quarters. Thus, the trend in period t of industrial production is:

$$\overline{P}_t = \overline{P}_{t-1}(1+R_t) \text{ where } R_t = \sqrt[20]{P_t/P_{t-20}} - 1, \text{ and } \overline{P}_t = P_t$$

for the first observation. The source of the quarterly data on industrial production was the IMF's **International Financial Statistics.**

12. Recent work in this area suggests that, in the post-World War II period, inflationary expectations generally have adjusted relatively rapidly to inflation actually experienced. In the United States, for example, inflation expected by money-market participants appears to be mainly a function of actual inflation over the previous eight quarters. A similar formulation is used here to account for the variation in expected inflation, and hence inflation premiums, in foreign interest rates. A representative study for the United States is Yohe and Karnosky (1969). The consumer-price index was used as the measure of inflation, and the source of quarterly changes in this index was the IMF's **International Financial Statistics.**

13. The interest rates used are 3-month representative money-market rates for all countries except Switzerland, where the bank time-deposit rate is used instead. Quarterly averages were calculated from end-of-month data. The data source is Morgan Guaranty Trust's **World Financial Markets.** The 3-month forward premium was calculated on an annual-rate basis as a quarterly average from end-of-month data on spot and forward rates, as compiled by the International Monetary Fund. The data were obtained from the Chase Econometrics data bank covering various issues of the IMF's **International Financial Statistics.**

14. For all countries in the sample except Canada, the fixed exchange-rate period is 1966-I through 1971-I, and the period covering the managed float is 1973-III through 1978-IV. Canada floated earlier, and its respective periods are 1966-I through 1970-I and 1970-III through 1978-IV.

We experimented with additional dummy variables to account for variations in the forward premium and foreign interest rates caused by expectations of devaluation or revaluation during the fixed-rate period. Only in the case of the U.K. did such a speculative dummy variable register a significant effect, and then only for the quarter of the 1967 devaluation. Rather than entering a dummy variable to help explain behavior for this one quarter, that observation was simply dropped from the U.K. sample.

15. It might be objected that with an infinite elasticity of interest arbitrage with respect to the covered interest differential, Δd would equal zero; and Δfp, and therefore b_2, would equal one in this case also. But to anticipate the empirical results, the evidence for the Bretton Woods period indicates that Δd is smaller than Δfp when exchange rates are supported, but that it is still large enough to distinguish between the two hypotheses. If it could be assumed that the Bretton Woods period constituted a pure combination of Cases 2 and 3, then the evidence from the period would suggest that if interest rates had been completely decoupled under managed floating solely because of complete sterilization (Case 2), Δfp, and hence b_2, would equal only .84 on average. But, since the Bretton Woods period contains an admixture of Case 1, due to floating of the exchange rate between intervention points, this estimate of .84 is really only an upper bound; and we would expect the observed value of b_2 to be lower than that if there were complete sterilization.

16. Since exchange-rate variability has indeed increased very significantly under managed floating, this may at first seem surprising. But shocks to the system, particularly those associated with the oil crisis, may well have been larger in the period of managed floating. In addition, the view that there is necessarily a trade-off between exchange-rate changes and reserve changes rests on assumptions that 1) speculative behavior in the foreign-exchange market is independent of the exchange-rate regime, and 2) the exchange market is stable in the short- to medium-run. Neither assumption is necessarily tenable. For stability to occur, the excess demand for foreign exchange must fall (rise) as the exchange rate rises (falls). But "J curve" effects on the current account assure that this will not be true in the short run unless speculation is stabilizing within the relevant range. With a locally unstable market, movements in the exchange rate increase the size of any gap between the demand and supply for foreign currency, increasing the use of reserves for authorities who intervene in order to resist such exchange-rate fluctuations. For a detailed treatment of these points, see Williamson (1976).

17. Thus, a 100 basis-point change in the U.S. interest rate, on average, actually produced a 99 basis-point change in the forward premium on the foreign currency under managed floating, compared to the less than 84 basis-point change that likely would have resulted from the Case 2 model of complete sterilization (see footnote 15). These point estimates strongly suggest that the insulation of these foreign interest rates under managed floating was mainly due to an absence of exchange-market intervention in response to changes in the U.S. interest rate. However, the standard errors of the estimated coefficients are not low enough to allow one to reject with a high degree of certainty the alternative hypothesis of complete sterilization.

18. The Annual Report of the Bank of Canada (1970, p. 9) clearly states this orientation:

The exchange rate is a very important price in a country that trades with the outside world on the scale that Canada does. . . . It is not therefore possible to ignore it, even when it floats. Public financial management must continue to be concerned that the exchange rate is broadly suitable to the development of Canada's international trade, and compatible with the desired structure of our balance of payments, in particular the size of the balance on current account. It is therefore still necessary to seek a mix of fiscal and monetary policy which encourages levels of interest rates in Canada that are consistent with the exchange rate staying within a suitable range.

19. For more extended treatments of this point, see Pesandro and Smith (1973) and Courchene (1976). Toward the end of 1975, the Bank of Canada announced an apparently radical change in monetary policy. Instead of interest rates, the focus of policy henceforth would be the behavior of a monetary aggregate; and policy would be geared to a gradual lowering of the inflation rate. But in practice, interest rates were chosen as the policy instrument for controlling money, and on certain occasions were explicitly used to defend the exchange rate. The econometric results presented here suggest that actual policy remained much the same, despite the change in rhetoric. See also Howitt and Laidler (1980).

20. In contrast, the estimated coefficient on the multiplicative dummy variable, b_3, though not significantly different from zero, is about equal in magnitude but opposite in sign to the estimated response, b_2, of the forward premium to the U.S. interest rate in the period of managed floating. This suggests a smaller impact on the forward premium under fixed exchange rates. However, the reason in this case is different than it is for the other four countries. The explanation apparently is the heavy intervention in the forward exchange market undertaken by the Bank of England early in the fixed exchange-rate period, rather than an increased response of the U.K. interest rate to the U.S. interest rate. The fact that the forward rate was supported by the Bank of England over only a portion of our fixed exchange-rate period (up until the 1967 devaluation) likely accounts for the lack of statistical significance in the observed shift in the impact of the U.S. interest rate on the forward premium. Chalmers (1971) provides a collection of papers detailing this period of forward-exchange intervention by the Bank of England.

21. Hodgman (1974, p. 173) describes the operation of the Exchange Equalization account.

22. Another recent attempt at measuring risk premiums in the forward exchange market is Stockman (1978). His findings suggest that significant risk premiums exist for those taking open positions, but that they are probably not constant. This result is consistent with both the modern theory of forward exchange outlined in the appendix and our empirical results. See also Froewiss (1977).

23. The above analysis assumes that the decline in the U.S. interest rate is a change in the "real" rate, and is unaccompanied by a change in inflationary expectations that might affect the expected future spot rate, ES. But since a major part of the movement in U.S. interest rates during the period examined can be attributed to variations in inflationary premiums, we should consider the case of a decline in the nominal U.S. interest rate that is due to lower inflationary expectations. However, the distribution of this impact of Δi_{us} on Δfp, Δd, and Δi_f when there is no official spot-market intervention turns out to be the same as when the change in the U.S. interest rate is due to a change in the real rate.

If the U.S. interest rate declines because of lower inflationary expectations, in a situation (such as managed floating) where there are no official parities for the spot rate, speculators and traders might expect the future spot rate to fall according to the well known principle of purchasing-power parity. In Figure 1, the initial downward shift in the A schedule would be accompanied by an equal downward shift in the S+T schedule (due to the change in the expected spot rate, ES). The new equilibrium would occur at the same quantity as initially (at 0); and Δfp would be equal to Δi_{us}, leaving no impact on Δd or Δi_f — as is also true in the case of a "real" rate decline.

However, two differences can be cited. When the U.S. interest rate declines purely because of lower inflationary expectations, the decline in the forward premium is produced solely by a decline in the forward rate, with the spot rate given. Whereas when that decline is a "real" change, the reduction in the forward premium tends to be produced by an increase in the spot rate. Secondly, when the decline in the U.S. interest rate is only nominal, arbitragers have no incentive to move their capital abroad. But with a "real" decline in the U.S. interest rate, there is an incipient capital outflow, which then turns the forward premium against arbitragers. Nevertheless, no matter which kind of change occurs in the U.S. interest rate, an equal change in the forward premium indicates a lack of official intervention in the spot market.

24. If the decline in the U.S. interest rate were due to lower inflationary expectations, the S+T schedule might shift downward as described in footnote 23, to reflect a decline in the expected future spot rate based on purchasing-power parity. Then the relative impacts on Δfp and Δd would no longer be determined soley by the relative elasticities of the A and S+T schedules.. However, this probably did not occur to any significant extent in the Bretton Woods period.

To be sure, changes in the U.S. interest rate were partly only nominal, and not "real". But it is unlikely that changes in the inflation premium in U.S. interest rates were significantly associated with concurrent changes in expected future spot rates under the Bretton Woods system. For in that system, anticipations of speculators and traders were conditioned more by the likelihood of imminent changes in official parities, which in turn depended on such things as the size of international reserve holdings and political factors, than by current changes in purchasing-power parity. Consequently, the relative impacts on Δfp and Δd estimated for the Bretton Woods period would appear to be indicative of the actual relative elasticities of the A and S+T schedules.

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