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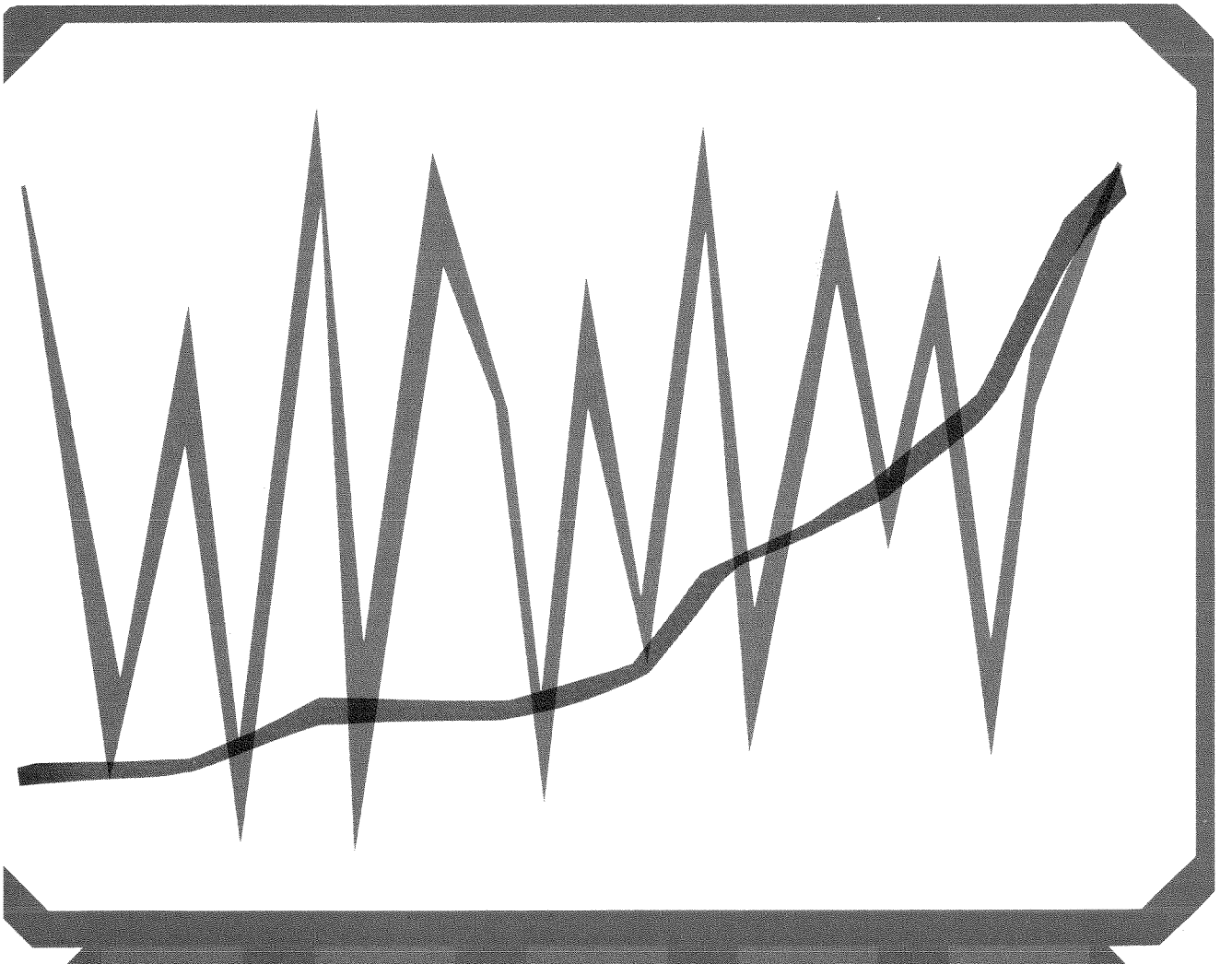
ECONOMIC REVIEW



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MONEY, PRICES, AND EXCHANGE RATES

SPRING 1979

Money and Exchange Rates[1]—1974-79

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Why has the international value of the dollar declined over the past year and a half? There is a popular impression (sometimes reinforced by the rhetoric of government officials) that the dollar has been driven down by speculators who have a vested interest in seeing an undervalued dollar. According to this view, the magnitude of the decline is unrelated to economic fundamentals and represents the irrational behavior of speculators.

Most economists have difficulty with this explanation. A considerable body of evidence shows that speculation tends to drive the value of a currency towards the long-run equilibrium value; i.e., value determined by economic fundamentals. Those who misjudge fundamentals and attempt to drive the dollar away from its long-run equilibrium value will tend to lose money. On the average they will buy when the market value is high and sell when the market value is low. Those speculators who most clearly perceive the underlying fundamentals and accordingly take a position in the exchange market will, on average, make the most profits.

What this means is that stabilizing speculation will tend to be profitable and destabilizing speculation to be unprofitable.[2] The self-selection process of unsuccessful speculators leaving the market to the successful speculators has important implications for the exchange markets. In particular, the observed value of the dollar would not deviate significantly from the level consistent with economic fundamentals for more than a short period of time.

Two types of economic factors affect the exchange rate—real factors and monetary factors. The real factors have to do with the relative attractiveness of any two countries' goods, i.e., how many bushels of U.S. wheat are exchanged for one Japanese color T.V. set. This is called the *terms of trade*. The monetary factors have to do with the purchasing power of a currency. If inflation reduces the domestic purchasing power of the dollar, a parallel decline in the dollar's foreign purchasing power will be achieved by an exchange-rate adjustment. This is called *purchasing power parity*.

The purpose of this article is to explain movements in the exchange value of the dollar against the currencies of seven other major countries (Canada, France, Germany, Japan, Italy, Switzerland and the U.K.), during the period of flexible exchange rates running from roughly 1974 or 1975 through March 1979. The analysis focuses on whether monetary factors can explain a significant share of the movements of the dollar against these seven major currencies. Section I discusses the role of monetary factors in influencing prices in general. Section II discusses the monetary and real determinants of exchange rates, with the aid of a model which permits the empirical estimation of the monetary factors affecting the exchange rate. In Section III, comparative monetary developments in the U.S. and other industrial countries are analyzed and shown to be in close alignment with observed movements of exchange rates. Formal statistical analyses confirm that a significant share of the variation in exchange rates between the dollar and seven other currencies can be explained by monetary factors. That section provides forecasts of exchange rates based on actual monetary developments in 1978 and forecasts of monetary developments in 1979. Section IV gives a summary and conclusion.

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The monetary source of exchange-rate changes is based on two propositions:

1) The exchange rate between two domestic currencies will adjust to reflect changes in the relative domestic purchasing power of the currencies (i.e., purchasing power parity); and

2) Domestic monetary developments are a major determinant of domestic inflation rates, and thus the domestic purchasing power of a given currency.

The second of these propositions is the monetary theory of inflation—too much money chasing too few goods. In its simplest form, this theory can be stated as follows:

$$\% \Delta P = \% \Delta MS - \% \Delta md \qquad (1)$$

In the long run, the inflation rate (% ΔP) is determined by the difference between the growth of the *nominal* money supply (% ΔMS) and the *real* money demand (% Δmd). The nominal money supply is determined by the government through its monetary authority. The real demand for money is determined by the private sector of the economy. The primary motives behind the demand for money are as a means of payment and as a store of value. The means-of-payment desire for money is dependent on the volume of transactions, which in turn is related to the level of a country's real income. A rise in real income leads to a rise in the real demand for money.[3]

The store-of-value desire for money depends upon the following factors:

1) The sophistication of the financial system, and the type and convenience of non-monetary financial assets available to the public;

2) The real interest rate. The higher the real rate paid on monetary assets (e.g., time deposits), the higher the money demand; the higher the real rate paid on non-monetary assets, the lower the real demand for money.

3) Inflation expectations. The higher the expected inflation rate, the greater the expected decline in the value of monetary assets and thus the lower the real demand for money.

There are a number of ways of translating these general principles into an empirically testable proposition. Perhaps one of the oldest ways of stating this relation is via the familiar Fisher Equation of Exchange.

$$MV \equiv PT \qquad (2)$$

The stock of money (M) times the velocity of money (V) equals the physical volume of transactions (T) times price level (P).

This is true by definition, analogous to the national-income definition: National Income = Household Consumption plus Business Investment plus Government Spending. Just as the national-income definition can be translated into a statement of economic behavior by making assumptions about consumption and investment behavior, so the Fisher equation of exchange can be by making assumptions about the factors that determine the demand for money, i.e., velocity and transactions.

One can make equation 2 into a behavioral relationship by introducing the demand for real money balances. If we rearrange terms in equation 2, we obtain:

$$M/P \equiv T/V \qquad (3)$$

In long-run equilibrium, demand for real money balances must be equal to actual real balances (M/P). Thus, using equation (3), we identify the long-run equilibrium value of M/P with (md) and the long-run values of T and V with the determinants of money demand. Thus:

$$md = \overline{T}/\overline{V} \qquad (4)$$

In this expression, where the bars refer to long-run equilibrium values, $\overline{T}$ represents the long-run means of payment function of money, while $\overline{V}$ represents the long-run store of value function.

We next substitute this long-run behavioral description of money demand back into the equation of exchange to obtain:

$$\overline{P} = M/md = M/(\overline{T}/\overline{V}) = ME \qquad (5)$$

This relationship states that, in long-run equilibrium, prices ($\overline{P}$) will be equal to the ratio of money supply to the long-run real demand for

money balances. This ratio is defined as excess money balances (ME). An expression similar to equation (1) can, of course, be obtained by taking the time rate of change of all variables in (5) to obtain:

$$\% \Delta \overline{P} = \% \Delta M - \% \Delta(\overline{T}/\overline{V}) = \% \Delta ME \quad (5a)$$

This expression summarizes the main point of the monetary theory of inflation—that ultimately inflation is determined by excess money growth (%Δ ME). This excess money supply is the key element in the monetary factors which determine the exchange rate.

II. Determination of Exchange Rates

The exchange rate between the currencies of any two countries will be determined by two factors, one monetary and one "real." These separate influences can be summarized in the following way:

$$Ex = (\overline{P}_f/\overline{P}us) \cdot t \quad (6)$$

Where Ex is the exchange rate between the U.S. dollar and some foreign currency (f). $\overline{P}us$ is the long-run equilibrium price level in the U.S.; $\overline{P}_f$ is the long-run equilibrium price level in the foreign country; t is the equilibrium terms of trade. The monetary effects are measured by the relative price $(\overline{P}_f/\overline{P}us)$, while the real effects are measured by the terms of trade (t).

1. Real effects: The terms of trade measure the value of one country's goods in terms of the value of another country's goods, e.g., how many bushels of U.S. wheat it takes to "purchase" one Japanese T.V. set. A change in the terms of trade could be caused by a change in technology, the discovery of new sources of raw material, or a substantial change in relative prices of important commodities, such as a rise in the price of oil.

2. Monetary effects: Exchange rates fluctuate to maintain equality between the domestic and foreign purchasing power of a currency, according to the theory of purchasing-power parity (or PPP). A rise in U.S. prices will reduce the domestic purchasing power of the dollar. This will increase the demand for lower-priced foreign goods and assets, which will depreciate the dollar relative to the foreign currency. The incentive to increase demand for foreign goods will subside only when the dollar has depreciated by an amount equal to the decline in its domestic purchasing power, assuming foreign-currency prices are unchanged. Because monetary factors determine the domestic purchasing power of a currency (for reasons already discussed), so they also influence the international exchange value of that currency.

Purchasing-power parity can be explained in a number of interrelated ways. Theoretically, the most general explanation is related to the neutrality of money. If the money supply is doubled, all prices will double—or the purchasing power of money will be reduced by half. For this proposition to hold for all goods, both domestic and foreign, the exchange value of the domestic currency must fall by one-half relative to foreign currency (assuming there is no change in the excess supply of money abroad). In this way, the domestic and international purchasing power of the domestic currency are equal, and the neutrality of money is preserved. If the foreign money supply is doubled at the same time as the domestic money supply, the exchange rate will be unchanged, because foreign prices will go up as much as domestic prices.

The market mechanism by which the adjustment process operates is sometimes called the law of one price. This is based on the proposition that the same goods will have the same price in all markets. For example, the dollar price of wheat in Kansas City will be the same as the yen price in Tokyo, given the dollar/yen exchange rate. If the price of wheat were higher in Tokyo than in Kansas City by more than transportation, tariffs and other costs, then sufficient wheat will be shipped to Japan to drive its price toward equality with the U.S. price.

Short vs. Long Run Considerations

In Section I, we emphasized that the relation between money and prices was a long-run proposition. Equilibrium in the market for goods takes some time to achieve, because households must change their consumption habits and firms

must change their production patterns. It is costly for households to speculate on inflation by purchasing goods in excess of consumption needs, because the cost of holding "inventories" is high. While anticipatory purchases in a period of rising prices will occur, the amount is severely limited. Thus goods prices will adjust only slowly to a rise in excess money supply.

In contrast, the market for assets seems to adjust relatively quickly to changes in supply and demand, because "inventory" adjustments in assets can be achieved at low cost. One can rearrange his portfolio of assets by "instantaneous" buy-and-sell decisions at relatively low transactions cost, and generally zero carrying cost. In general, we assume that goods prices in "flow" markets take longer to adjust to shifts in supply and demand than assets prices in "stock" markets.

This distinction has important implications with respect to the monetary determinants of exchange rates. The exchange rate—the international price of the dollar—can be affected by shifts in the international supply and demand for dollars, which in turn depend upon international trade in goods, services, and financial assets. Trade in goods and services changes relatively slowly in response to changes in income and prices, as is typical of all "flow" markets. But trade in financial assets can change quickly, as is typical of all "stock" markets.

The exchange rate, in the short run, thus is determined by the capital account of the balance of payments. A change in the excess money supply (once recognized) could translate immediately into a change in the exchange rate. The monetary effect on the exchange rate would be the same in magnitude as that on the domestic inflation rate. The only difference would be in terms of timing: the effect on the exchange rate would occur quickly, while the effect on the price of domestically produced goods would be delayed.

This analysis has several important implications. First, the exchange rate between the dollar and any foreign currency will measure the equilibrium purchasing power parity of the two currencies. If the exchange rate adjusts quickly and prices adjust slowly to the same excess money supply, the exchange rate may be a better measure of long-term PPP than are current goods prices. Second, because prices of traded goods increase with a decline in the exchange value of the dollar, and because traded goods are a significant component of the general price index, the time lag between money and prices may be shortened when a country moves from fixed to flexible exchange rates.

The Model

This discussion can be formalized and an equation specified for empirical testing. Given initial condition values for the exchange rate and excess money, and substituting equation 5 into equation 6, we get:

$$Ex = (ME_f \,/\, ME_{us}) \cdot t \qquad (7)$$

Taking the logs of both sides and making the simplifying assumption that the terms of trade are constant, we can empirically estimate the equation as follows:

$$\text{Log } Ex = a_o + a_1 \log (ME_f \,/\, ME_{us}) \qquad (8)$$

Where a_o is a measure of an unchanged terms-of-trade effect on the exchange rate, and a_1 is a measure of the monetary influence on the exchange rate. Its value is expected to be positive and equal to one. Alternatively, we can express equation 7 in terms of changes:

$$\% \,\Delta Ex = \% \,\Delta(ME_f \,/\, ME_{us}) + \% \,\Delta t \qquad (9)$$

Assuming that the real factors which affect exchange rates—i.e., the terms of trade (% Δt)—change at a constant rate, we obtain the empirically testable equation:

$$\% \,\Delta Ex = a_o' + a_1' \,\% \,\Delta(ME_f \,/\, ME_{us}) \qquad (10)$$

The changes in the exchange rate are equal to a constant term (a_o') which measures the changes in the real factors, plus a coefficient (a_1') which measures the impact on exchange rates of the change in the ratio of the excess money growth in the U.S. and in the foreign country. This is hypothesized to equal unity. The time lag in equations 8 and 10 reflects the length of time needed by market participants to recognize that

the relative excess supplies of money had changed. This might well vary between countries, depending upon the country's past monetary policy and inflation experience.[4] Introducing time lags into equations 8 and 10 produces the basic estimating equations which will be considered in the next section.

$$\log Ex_t = a_o + \sum^{n} a_1 \log (ME_f/ME_{us})_{t-n} \quad (11)$$

$$\Delta\log Ex_t = a_o' + \sum^{n} a_1' \Delta\log(ME_f/ME_{us})_{t-n} \quad (12)$$

Where $\sum^{n}$ refers to the sum of months in which changes in excess money will have their complete effect on the exchange rate.

III. Testing the Monetary Approach

We present evidence here to support the proposition that monetary factors explain a significant share of the recent movements in the exchange value of the dollar against seven other currencies. First, we present a summary of the apparent monetary-policy considerations which shaped monetary developments in the 1975-78 period. Then we show that the actual changes in the excess money supply led to changes in prices and exchange rates in a way consistent with economic theory. Finally, we present formal statistical tests of the relationship between money and exchange rates which confirm and quantify the empirical relations.

Monetary Policy 1975-78

In the summer of 1975, all eight countries in this study faced a common set of economic problems—two or more years of double-digit inflation and the recent emergence of a business recession which, for most countries, was the worst in the post-World War II period. Different governments (and their monetary authorities) responded to these twin problems in different ways.

In the U.S., the primary goal apparently was to deal with the historically high unemployment rate by following a monetary policy which permitted a substantial acceleration in aggregate demand from 1975 through 1978. Other countries such as Germany, Japan and Switzerland, responding to the historically high inflation rate, apparently followed a monetary policy which permitted only a moderate acceleration in aggregate demand.

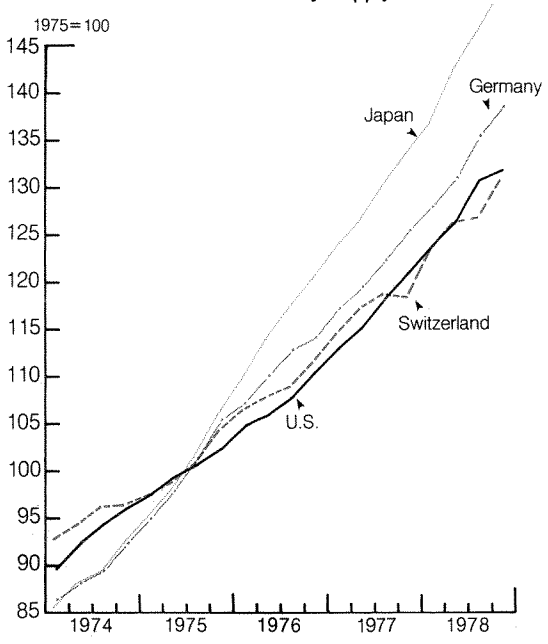
As a result of this divergence in monetary policies, short-run rates of real growth also diverged. The U.S. grew at a rate from 1975 to 1978 which was above its historical average, but the reverse was true for Germany, Japan and Switzerland. Over the longer run, these divergent monetary policies led to divergent inflation rates. From 1976 to 1978 the inflation rate in the U.S. accelerated, while the inflation rates in Germany, Japan and Switzerland decelerated. Finally, the policy divergence between the U.S. and Germany, Japan and Switzerland led to a decline in the exchange value of the dollar with regard to the Deutschemark, yen and Swiss franc.

Marshalling the Evidence

In broad outline, we assert that divergent monetary policies have been the key factor behind the divergent economic developments and exchange-rate movements of the past several years. The evidence in support of this scenario is provided in Charts 1 and 2.[5] Chart 1 shows that from 1975 to 1978, the money supply in the U.S. grew at about the same rate as in Switzerland, and more slowly than in Germany and Japan. However, as discussed in the theoretical section, the relevant measure is not the growth in the nominal money supply, but rather the growth in the excess money supply, which is nominal money less real money demand, as is shown in Chart 2.

In estimating real money demand, the means of payment (i.e., transactions) motive was measured by the trend in industrial production, and the store of value motive for holding money was measured by the trend in velocity. Sixty-month trends of these factors were utilized, to reflect the assumption that reversible cyclical shifts in the components of real money demand would have no effect on the long-term equilibrium price level

Chart 1
Nominal Money Supply



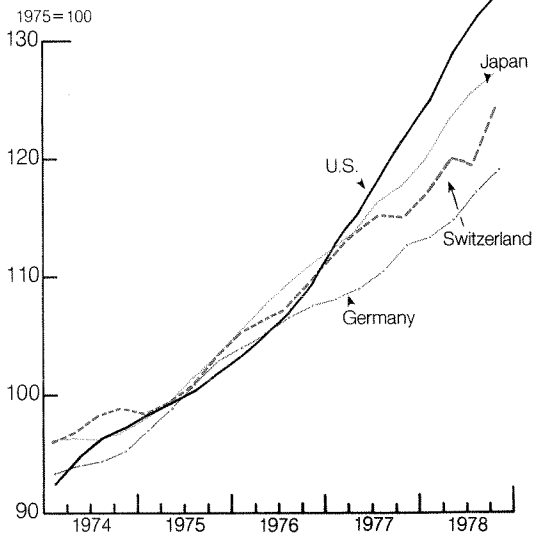
(P), and thus no effect on the exchange rate.[6] Calculated on that basis, excess money growth in the U.S. was higher in the 1975–78 period than in Germany, Japan and Switzerland (Chart 2).

Domestic Results. The relationship between excess money growth and real output growth is a short-run phenomenon. Thus, we would expect that those countries with the highest excess money growth would, in the short run, exhibit the most rapid growth in real output. The results in Table 1 and Chart 2 confirm that result. The U.S., where growth in excess money has been fastest among the four countries since 1975, has also had the fastest rate of real growth. Germany, with the slowest growth of excess money, has had the slowest real growth, and Japan and Switzerland have fallen in between.[7]

The relationship between excess money growth and prices is a long-run phenomenon. Thus, excess money-growth patterns would not necessarily be completely reflected in the observed price patterns for consumer and wholesale prices to date. (Tables 2 and 3). For all four countries and for both price indexes, the inflation rate has dropped substantially since 1974. The U.S. and Japan recorded almost the same average consumer-price inflation rate in the last four years (close to 7 percent)—substantially higher than that observed in Germany (4 percent) and Switzerland (2 percent). In the period 1977.3–1978.3, however, Japan's inflation rate had decelerated to 4 percent, and the German and Swiss rates have also decelerated, while the U.S. rate has accelerated to almost 8 percent. As a result, the spread in the consumer inflation rates between the U.S. and the other three countries has widened recently in line with the differences in their excess money growth.

The same basic pattern emerges with respect to wholesale prices, but with an even wider spread since 1977.3. For one reason, there is a larger weight of traded goods in the wholesale index than in the consumer index. Thus, changes in the exchange rate which directly affect internationally-traded goods prices will have a larger and more immediate impact on the WPI than on the CPI. This may be the genesis of the vicious vs. virtuous cycle argument. Countries whose monetary policies tend to decelerate inflation experience an immediate favorable impact on the exchange rate which reduces the inflation rate promptly; while countries whose monetary policies tend to accelerate inflation suffer an immediate unfavorable effect on the exchange rate which promptly adds to domestic inflation. This vicious/virtuous cycle should be considered a

Chart 2
Excess Money Measure



reflection of the timing of the monetary impact on prices, rather than as a new destabilizing phenomenon. This subject is discussed further in Section IV.

Exchange Rate Results. These domestic results are broadly consistent with the assumptions of relatively easy monetary policy in the U.S. and relatively tight monetary policies in Germany, Japan and Switzerland. To measure the impact of these assumed divergent policies on exchange rates, we have computed a "monetary index"—the ratio of the excess money supply in the U.S. to the excess supply in each of the other countries. Each monetary index is scaled to the corresponding exchange rate by the coefficients estimated in the equation in the appendix of this article. As indicated in Chart 3, this monetary index shows a high degree of correspondence with the movement in the bilateral exchange rate between the dollar and each of these three currencies. In each case, the monetary index declined in 1974, rose slightly in 1975 and early 1976, and then declined substantially through the end of 1978. This movement in the monetary index is paralleled by a similar movement in the exchange rate. The major decline in the exchange value of the dollar was accompanied by a major expansion in the excess money supply in the U.S. relative to the other three countries.

In general, adjustments of exchange rates to changes in the monetary index appeared to occur quickly—within a quarter of a year or so. And the magnitudes of these exchange-rate adjustments were approximately the same across countries for any given change in the monetary index. This observation is consistent with the hypothesis developed in Section II, that the exchange rate in the short run is dominated by the capital account of the balance of payments, and that it thus responds quickly—in a way analogous to any domestic-asset market response to changes in supply and demand.

The same broad relationship of monetary indexes and bilateral exchange rates holds for Canada, France, Italy and the U.K.. The results for France and Italy are detailed in Chart 4. With these four countries, however, the lags between changes in the monetary index and the exchange rate seem to be longer and the degree of relationship weaker, than in the case with Germany, Japan and Switzerland for a number of reasons. First, Germany and Japan are leading economic powers in their own right, so that their currencies are potential replacements for the dollar as an international currency. Also, the Swiss franc has a unique role as an international store of value, and the Swiss monetary authorities have followed a more restrictive monetary policy than most of the countries studied.

Second, excess money-supply growth has been even greater in Canada, Italy and the U.K. than in the U.S. over the 1974-78 period. (French growth has been slightly less expansionary). As a consequence, the dollar generally strengthened against these currencies before weakening in the second half of 1977. The recent weakness of the dollar may in part reflect a spill-over of the appreciation of the Swiss franc and especially the D.M. onto other European currencies. This

Table 1
Industrial Production
(Annual Rate of Change)

	1963-73	1973-75	1975.1-1978.3
Germany	5.1	-4.3	2.1
Japan	12.3	-7.5	6.7
Switzerland	4.6	-6.7	3.0
United States	5.4	-4.7	7.8

Table 2
Consumer Price Index
(Annual Rate of Change)

	1973.4-1974.4	1974.4-1978.3	1977.3-1978.3
Germany	6.5	4.0	2.5
Japan	24.4	7.3	4.0
Switzerland	8.7	2.0	1.0
United States	12.1	6.8	7.9

Table 3
Wholesale Price Index
(Annual Rate of Change)

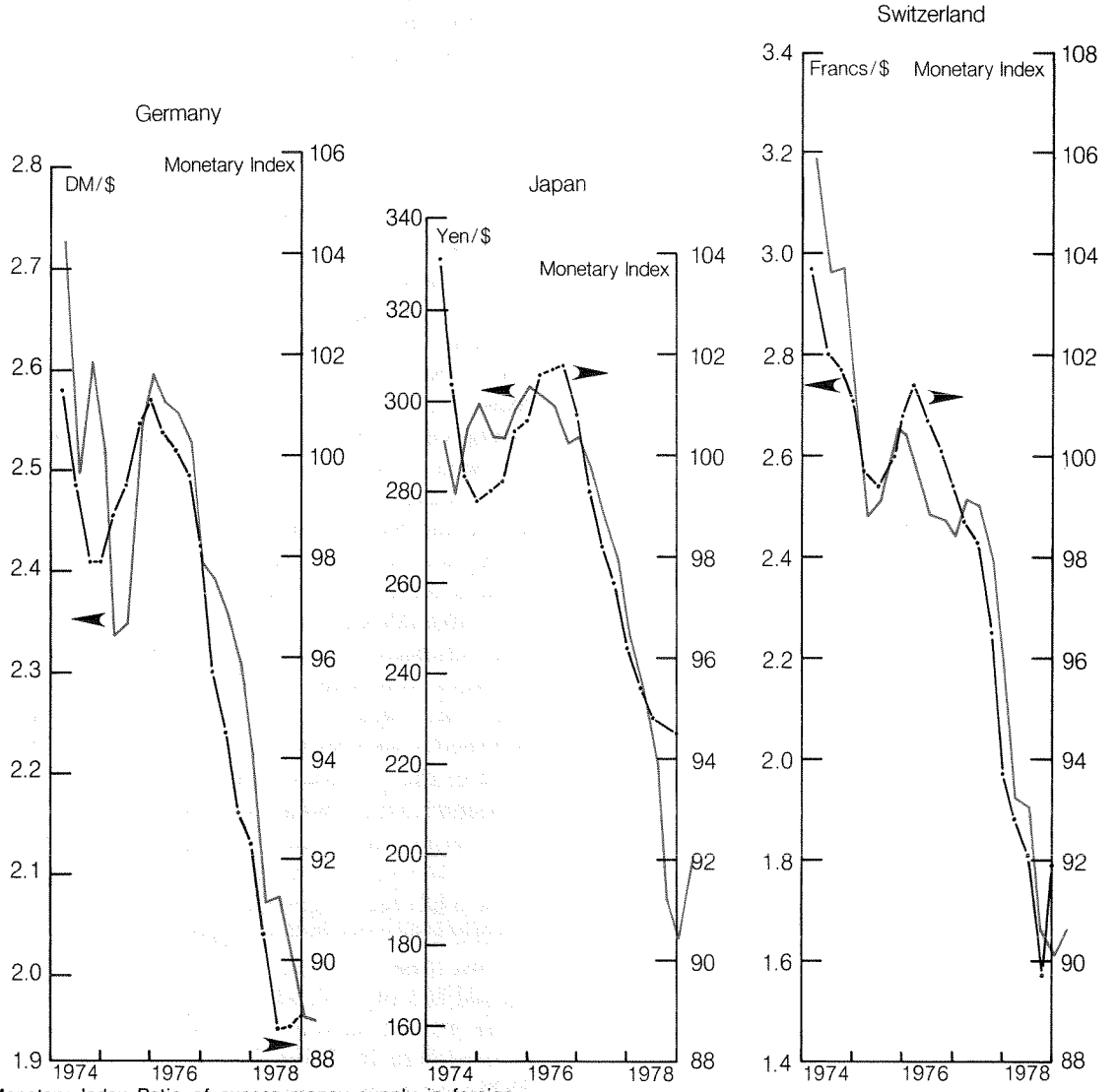
	1973.4-1974.4	1974.4-1978.3	1977.3-1978.3
Germany	13.4	2.5	1.2
Japan	23.5	0.9	-3.3
Switzerland	12.7	-2.4	-4.0
United States	22.2	5.6	8.3

would occur among the European currencies if a common set of "real" exchange rate influences operated. (The dollar's relative strength against the Canadian dollar supports this conjecture.)

Third, in the case of the U.K., a special real factor may explain the relative weakness of the dollar. That factor is the recent favorable effect of North Sea oil on the British balance of payments.

The evidence presented above tends to support a monetary interpretation of much of the recent movements in the exchange value of the dollar, especially against the D.M., the yen and the Swiss franc—and substantially with respect to the Canadian dollar, the Italian lira, the French franc and the British pound. The next step is to present evidence in a more formal econometric setting. This will help show whether the relationship between the monetary index and the exchange rate is significant and stable within a rigorous statistical testing procedure. Those readers who are not interested in this necessarily technical discussion should proceed to the section on forecasting exchange rates on page 30.

Chart 3
Money* and Exchange Rates



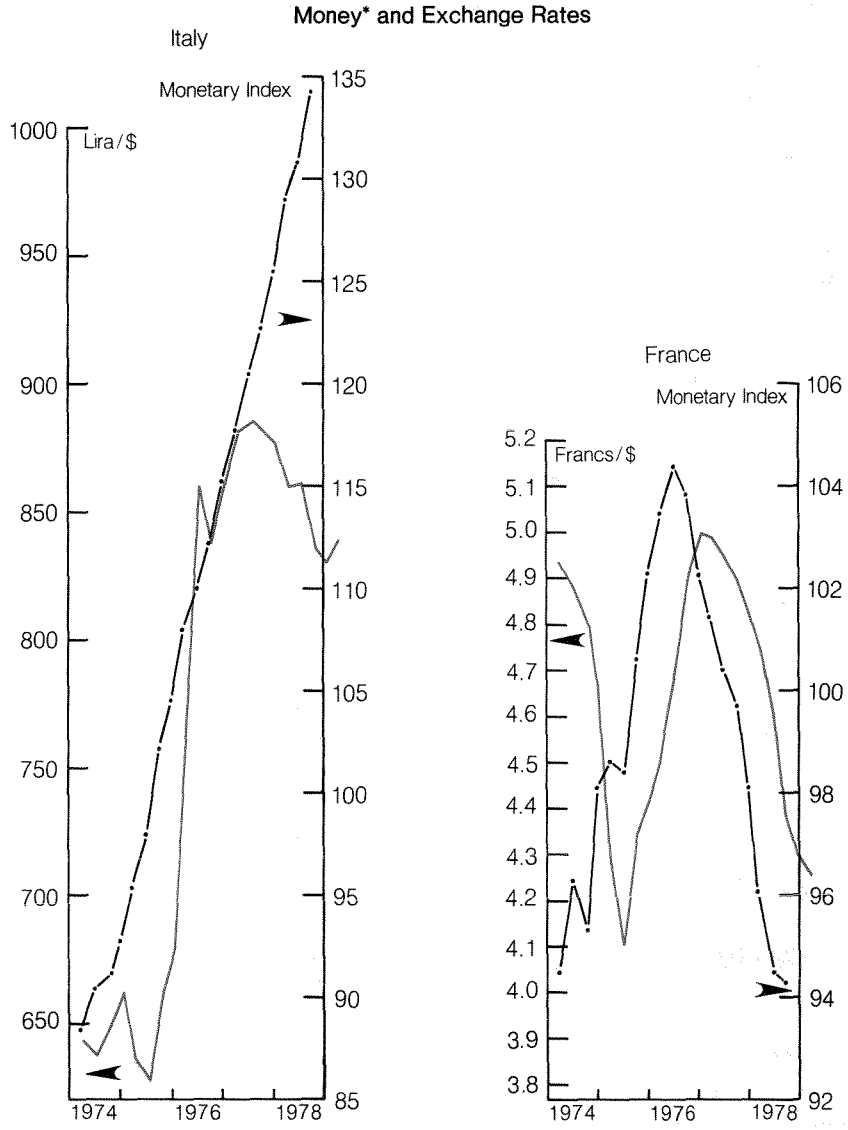
*Monetary Index=Ratio of excess money supply in foreign country to excess U.S. money supply.

Formal Statistical Tests

The exchange rates to be tested are the bilateral rates between the U.S. dollar and the seven foreign currencies discussed above. The countries were selected on the basis of data availability and importance in international trade and finance. All regressions were estimated with ordinary least-squares (OLS) using a third-degree (or less) polynomial distributed lag (PDL). The equations were estimated with two alternative measures of money published in *International Financial Statistics*—money, and money plus quasi-money. The former is the narrow definition of money including currency and demand deposits. This primarily statisfies the means-of-payment motive for holding money. The latter is the broader definition which includes currency, demand deposits and quasi-monetary deposits of commercial banks. This measure includes a substantial store-of-value motive for holding money.

While statistically significant results were obtained with both definitions of money, the broader measure gave results which were gener-

Chart 4
Money* and Exchange Rates



*Monetary Index=Ratio of excess money supply in foreign country to excess U.S. money supply.

ally superior. Given the dollar's role as both an international means of payment and store of value, the superiority of the broader measure of money is not surprising.

The equations for the seven bilateral exchange rates were estimated monthly from January 1974 (or January 1975) to December 1977 in both level and rate-of-change form, i.e., matching equations 11 and 12. The level results are presented in the appendix, and the rate-of-change (difference) results are presented in Table 4. The percent of variation explained (R^2) is much higher in the level form than in the difference form, because the unsystematic variance is necessarily greater in the latter. However, a better measure of goodness of fit is provided by the standard error, which measures the percentage error in explaining the exchange rate. The standard errors are about the same for both forms of estimation.[8]

The major conceptual difference between the level and difference form is the implicit treatment of real factors which affect the exchange rate. In both forms, the real factor is captured by the constant term. In the level equation, we assume that the real factors are unchanged over time, but in the difference equation, we assume that they change at a constant rate over time. However, as the constant term is both large and statistically significant only for Italy in the difference form, there is only weak general evidence for a strong real factor affecting the exchange rate.[9] This suggests that either form of the equation would represent the underlying structure without major systematic bias. The remainder of the discussion will be in terms of the rate-of-change equations except where otherwise stated.

The monetary effect is measured by the sum coefficient value ($\Sigma a_1'$). It is a sum because it measures the combined effect of the current and lagged values of the monetary influence on the exchange rate. The coefficient values are statistically significant in all cases. The lags between the monetary influence and the exchange rate measure the total number of months needed for the monetary effect to operate. The lag periods were selected on the basis of the minimum standard

Table 4
Monetary Factors and Exchange Rates: Difference Form

$$\Delta \log Ex_t = a_o' + \sum_{n} a_1' \Delta \log (ME_f / ME_{us})_{t-n}$$

Country	Estimation Period	Lags	Degrees of Freedom	a_o'	$\Sigma a_1'$	Corrected R^2	S.E.	RHO	D.W.
Canada*	1974.01-1977.12	6-18	44	-.003506	1.076	.096	.0097	—	1.83
				(-1.21)	(2.16)				
France	1975.01-1977.12	12	32	-.000053	1.761	.168	.0168	—	1.70
				(-.17)	(1.95)				
Germany	1975.01-1977.12	9	32	-.000023	2.565	.137	.0177	—	1.45
				(.07)	(2.69)				
Italy	1974.01-1977.12	9	44	-.03392	5.487	.332	.0193	.42	1.85
				(-1.80)	(2.27)			(3.17)	
Japan	1975.01-1977.12	6	32	-.004021	2.887	.205	.0132	—	1.73
				(-1.75)	(3.17)				
Switzerland	1974.01-1977.12	2	45	-.002440	2.649	.135	.0227	—	1.54
				(-.62)	(2.96)				
U.K.**	1975.01-1977.12	15	32	-.015769	3.060	.352	.0170	.44	1.61
				(-1.29)	(2.01)			(2.90)	

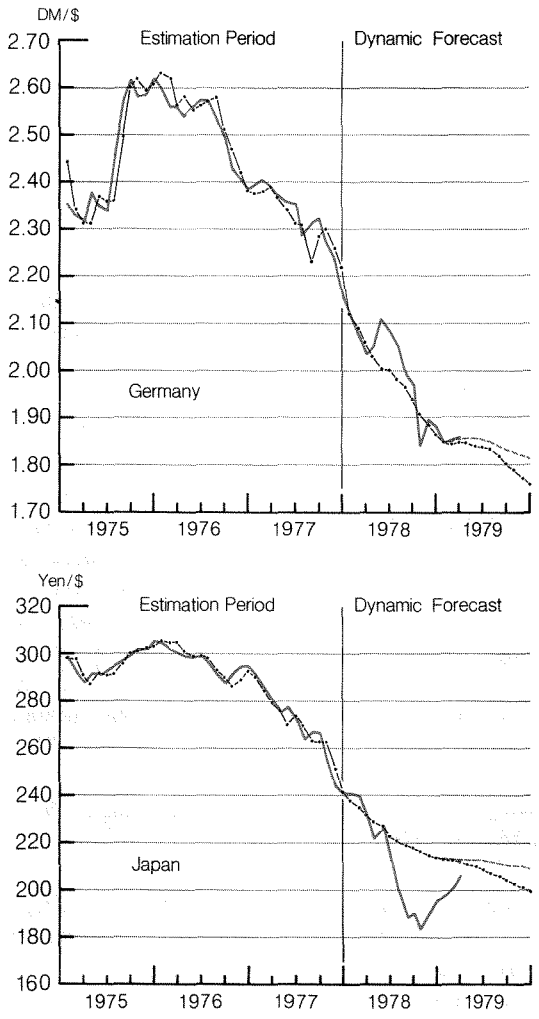
t-statistics in parentheses

* Includes only lags t-6 to t-18

** Uses log of deviation of $\frac{M_1 \text{ UK}}{M_1 \text{ US}}$ from trend

error of estimate. In general, the lags varied substantially between countries. They were the shortest for Switzerland (2 months), and Japan (6 months)—the countries with the shortest lags between the monetary index and the exchange rate (Chart 3). The lags were longest for Canada (18 months), the U.K. (15 months), France (12 months), and Italy (9 months). Germany provided the only exception to the general parallelism of the formal statistical results and the informal results in Charts 3 and 4, with its relatively long (9 months) lag compared to those of Japan and Switzerland.

Chart 5
Exchange Rate Estimates

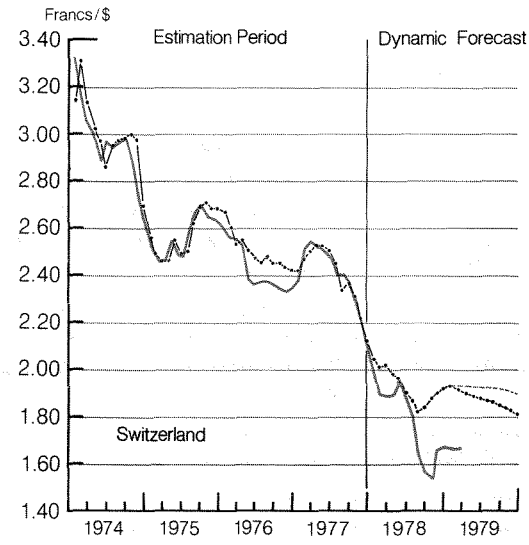


In the theoretical discussion (Section II), we hypothesized that the expected value of the monetary influence on exchange rates would be positive and equal in value to 1.0. This results from the method of calculating the monetary influence—the ratio of excess money in the U.S. to excess money in each of the other countries. Excess money is, in turn, defined as the difference between the change in nominal money supply and the change in real money demand. If money is homogeneous of the degree one in prices, i.e., if neutrality conditions hold, a permanent 1-percent increase in excess money will lead to a 1-percent increase in the long-run equilibrium price level and, thus, to a 1-percent decrease in the exchange value of the dollar, assuming no change in excess money in other countries.

The estimated coefficient values are positive for all of the countries considered in this study. However, only in the case of Canada and France are the coefficient values close to one. In the case of Germany, Japan, Switzerland and the U.K., the coefficient values fall within a narrow range of 2.5 to 3.1. Italy, on the other hand, falls significantly outside the range, with a coefficient value of 5.5.[10]

One factor which can explain the divergence between the expected theoretical value and the actual measured value of the monetary influence

Chart 5 (cont.)



is measurement error with respect to the public's real demand for money. Errors of this type can occur when there is a permanent shift in the demand for money which is not captured by the 60-month trend procedure. As discussed in Section I, inflation can have an important effect on real demand for money. In countries which have been more successful than the U.S. in reducing inflation (such as Germany, Japan and Switzerland) the real demand for money may be higher than our measured demand for money. Conversely, in countries which have been less successful than the U.S. in reducing inflation (such as Italy and the U.K.), the real demand for money may be less than measured demand. Assuming that the real demand for money is accurately measured in the U.S., the errors in the other countries could bias the monetary index. In all cases the bias would tend to make the observed index move in a narrower range than the true monetary index, with a smaller decline for those countries with a lower inflation rate than the U.S., and a smaller increase for those countries with a less successful record than the U.S. in controlling inflation. In each case, the measured monetary index would have a greater coefficient value than would the true monetary index. This analysis is broadly consistent with the observed coefficient values. Those countries with coefficient values close to one (Canada and France) experienced roughly the same amount of inflation as the U.S., while those countries with coefficient values substantially greater than one recorded inflation rates which were significantly above or below the U.S. inflation rate.[11]

Forecasting the Exchange Rate

The results presented above, although tentative, provide a reasonable basis for making short term forecasts of exchange rates. Such forecasts would be useful because our equations were estimated with data only through December 1977 (Table 4), while some of the largest declines in the dollar's value occurred in 1978 and were only partially reversed by the dramatic dollar-rescue operations announced on November 1, 1978. We can estimate the degree of monetary influence on the exchange rate in 1978 by conducting dynamic simulations of our equations.

The results are presented for two time periods:

1) An estimation period (1974-1977 for Switzerland, and 1975-77 for Germany and Japan) where the fitted values of the exchange rate (Chart 5) are compared with the actual values of the exchange rate. For all three countries, the equations accurately tracked the monthly movement in the exchange rate.[12]

2) A forecast period (January 1978 to December 1979), with actual money-supply growth used through November or December 1978, and with money assumed to grow thereafter at the same rate as it had grown over the previous 12 months (Table 5).

Table 5
Forecasts of Money Growth Rates for 1979

	Percent
Canada	16.0
France	11.0
Germany	10.0
Italy	22.5
Japan	13.0
Switzerland	9.0
U.K.[13]	15.0
U.S.	8.75/6.5

To demonstrate the effects of U.S. monetary policy on exchange rates, two different sets of forecasts were performed. The first assumes U.S. money growth over 1979 to be equal to the actual rate of growth over 1978: 8.75 percent. The second set of forecasts assumes a lower money-growth rate of 6.5 percent. These two forecasts are indicated by the two dotted lines in Chart 5. No adjustment is made for past forecast errors (i.e., the simulations are dynamic), so that the errors cumulate from the initial condition month (December 1977) to the month being forecast. As Chart 5 indicates, the forecast money-based exchange rate tracks the actual exchange rate with reasonable accuracy. The following table shows the actual and forecast change in the exchange rate from December 1977 to March 1979.

The forecasts of the DM/$ and ¥/$ exchange rates were quite close to the actual decline in value through March 1979. In the case of the Swiss franc (SF/$) rate, the forecast was reasonably accurate through mid-1978 and picked

Table 6
Exchange Rate Changes
(December 1977–March 1979)

	Actual (Percent)	Forecast (Percent)	Error (Percent)
Germany (DM/$)	-13.6	-14.0	.4
Japan (¥/$)	-14.6	-12.0	- 2.6
Switzerland (SF/$)	-19.1	-8.6	-10.5

the turnaround in late 1978, but it erred in forecasting the level of the exchange rate. The reason behind this forecast error was the sharp acceleration in Swiss money growth in the second half of 1978, which seems to have been ignored by the market until now. The model presented here suggests that if the money supply grows at the rates indicated in Table 5, then between March and December 1979 the dollar will appreciate against the Swiss franc, be stable against the Japanese yen, and decline slightly against the German D.M.

Very good results were obtained when the same forecast experiment was conducted with respect to the dollar and the French franc. In France's case, the error was only .6 percent over the forecast period. However, the forecast errors were in excess of 10 percent for Canada, Italy, and the U.K. In two cases (Italy and the U.K.), the actual dollar value was *below* the forecast value, while in one case (Canada), it was above the forecast value. In all three cases, significant non-monetary factors apparently influenced these exchange rates.

IV. Conclusion and Implications

The major conclusion of this article is that an important share of the exchange-rate movements of the dollar against key foreign currencies can be explained by monetary factors, rather than by speculation or changes in such real factors as the terms of trade. In addition, the study suggests two major implications:

1) Foreign-exchange markets adjust much more quickly than domestic commodity markets to changes in domestic monetary conditions.

2) The emergence of flexible exchange rates can shorten the lag between money and prices.

One of the most generally accepted propositions in economics is that money affects goods markets and, therefore, the inflation rate with a relatively long lag. On the other hand, it affects asset markets and, therefore, interest rates with a relatively short lag. The reason for the difference in response is that costs of adjustment are much higher in goods markets than in asset markets. It is difficult for a household to speculate on a rise in the price of bread by buying more bread than it can currently consume. The storage costs are high, and the depreciation on the value of the good is substantial. As a result, household expectations of higher prices, even when strongly held, will not necessarily be translated immediately into higher actual prices. Now consider the case of an asset market, such as that for Treasury bills. If the price of T-bills is expected to rise in the future, it will be instantaneously translated into a higher price of Treasury bills today. For one reason, the transactions cost involved in shifting from one type of asset to another is relatively low, and for another, the storage costs for holding Treasury bills are virtually nil. Thus, we can expect nearly instantaneous adjustment in asset markets to shifts in underlying supply and demand.

This article extends asset-market analysis to the exchange rate. We assert that the exchange rate is, in the short run, determined by the same factors which determine the price of any asset. Thus, a monetary disturbance can be translated relatively quickly into a change in the exchange rate, even though the change in the underlying inflation rate may be delayed. This suggests that the short-run deviation of the exchange rate from purchasing power parity may be substantial, even when the underlying cause of the exchange-rate change is a monetary rather than a real disturbance. Supporting evidence is provided by the relatively short lags observed in the monetary index—the relation between U.S. and foreign excess money-supply growth rates—and in the resulting changes in the bilateral exchange rates of the dollar against foreign currencies. Full lag adjustments for some countries were as short as two to three months, and were never longer than eighteen months. The average lags were

shorter still. On the other hand, most empirical evidence relating money to inflation suggests an average lag of about two years, and full-effect lags of three to four years.

A second implication of this study concerns the shortened link between money and prices as a result of the introduction of flexible exchange rates. A rise in excess money supply in the U.S. would, with a relatively short lag, lead to a decline in the exchange value of the dollar against its major trading partners. For reasons discussed above, this would tend to raise the price not only of imported goods, but of all internationally-traded goods, in dollar terms. American exporters would not sell in the U.S. market for a lower price than they could get for the same product in a foreign market, standardizing for transportation costs. The rise in tradeable-goods prices would increase the average inflation rate in the U.S. by an amount equal to the weight of tradeable goods in overall price indexes. The weights would vary between indexes—high for the wholesale-price index (which includes only goods), but lower for the consumer-price index (which includes services) and for the GNP price deflator (which includes the cost of government).

Direct evidence of a shortening of the lag between money and prices would have to come from econometric tests of the lag structure. It is difficult to acquire such evidence because of the relatively short period in which flexible exchange rates have operated. However, a certain amount of indirect evidence supports this proposition. To the extent that inflation operates through the exchange rate rather than through standard domestic markets, the price of goods (which are internationally traded) may rise relative to the price of services (which are not generally traded internationally) in the short run. This reverses the traditional ordering of the effects of money on prices. Generally, wholesale-price indexes tend to exhibit a lower average inflation rate than consumer-price indexes, as a reflection of the higher productivity of goods industries than services industries. However, since the March 1973 introduction of flexible exchange rates, the rate of inflation in the goods-dominated (wholesale) index has been higher than the rate of inflation in the services-denominated (consumer) index. This is consistent with an international explanation of much of the recent inflation.

Appendix
Monetary Factors and Exchange Rates: Level Form

$$\log Ex_t = a_o + \sum_{n} a_1 \log (ME_f / ME_{us})_{t-n}$$

Country	Estimation Period	Lags	Degrees of Freedom	a_o	Σa_1	Corrected R^2	S.E.	RHO	D.W.
Canada*	1974.01-1977.12	6-12	44	-.076	.826	.935	.0095	.93	1.82
				(-1.67)	(3.00)			(17.59)	
France	1975.01-1977.12	12	32	1.297	2.682	.962	.0132	.58	1.71
				(49.40)	(9.82)			(4.28)	
Germany	1975.01-1977.12	6	32	1.131	2.018	.892	.0168	.77	1.49
				(22.73)	(5.17)			(7.22)	
Italy	1974.01-1977.12	3	44	6.611	1.163	.976	.0223	.92	.95
				(147.98)	(3.81)			(15.74)	
Japan	1975.01-1977.12	2	33	6.450	2.138	.941	.0145	.95	1.48
				(21.43)	(3.04)			(18.99)	
Switzerland	1974.01-1977.12	3	45	1.097	2.701	.945	.0222	.90	1.56
				(15.97)	(3.33)			(14.07)	
U.K.**	1974.01-1977.12	12	44	-.687	1.148	.980	.0193	.92	1.04
				(-17.30)	(4.33)			(15.78)	

t-statistics in parentheses

* Includes only lags t-6 to t-12

** Uses log of deviation of $\frac{M_1 \text{ UK}}{M_1 \text{ US}}$ from trend

FOOTNOTES

1. The intellectual foundation behind this article is the monetary theory of the balance of payments. One of the original papers by Harry Johnson was published in 1972 in the **Journal of Financial and Quantitative Analysis.** A survey or recent works is presented in J.A. Frenkel and H.G. Johnson (Eds.) **The Monetary Approach to the Balance of Payments,** 1976. Important recent contributions have been made by R. Dornbusch, for example, "The Theory of Flexible Exchange Rate Regimes and Macroeconomic Policy," **Scandinavian Journal of Economics** (1977).

2. There may be short-run situations when destabilizing speculation is also profitable. This occurs when the "greater fool" theory operates. An intelligent speculator may believe that a currency is undervalued and still sell it because he perceives that other speculators believe it is still overvalued. One can make money in the short run by speculating about the actions of other speculators rather than about the economic fundamentals which determine a currency's long-run value. But this "greater fool" approach can be profitable only for a limited period of time.

3. Other important factors which influence the demand for money as a means of payment are various institutional arrangements, such as the frequency with which wages and salaries are paid. However, these factors will change only slowly over time, and are not usually an important source of a *change* in the demand for money.

4. Government intervention can also affect the exchange rate, but we ignore these effects for several reasons. Government intervention can fall under three headings: 1) actions to counter disorderly markets; 2) central-bank purchases and sales of foreign exchange for own account; and 3) Treasury purchases or sales of foreign exchange through sale or redemption of debt denominated in foreign-currency values. The first type of intervention (countering disorderly markets) is by definition transitory and reversible. Thus it has no permanent effect on the exchange rate, the balance sheet of the central bank, or the position of the Treasury. The second type of intervention affects the balance sheet of the central bank. Sustained intervention in the foreign-exchange market will either increase or decrease central-bank holdings of foreign assets, and thus change the domestic money supply. This type of intervention is considered directly by the way the equation is estimated—through the excess money supply. The third type of intervention (sale of foreign-denominated government securities) affects the composition but not the level of Government debt. Its effect on exchange rates is not captured by our empirical estimation procedures. However, this type of intervention is insignificant because of the recency and small scale of such operations. The U.S. Treasury issued its first DM security in January 1979 and its first Swiss franc security in February 1979. The total amount authorized by the Treasury is $10 billion, and the amount actually sold is $3 billion.

5. This broad definition of money includes currency, transactions deposits and quasi-money deposits of commercial banks. A fuller discussion of the monetary measures is given in the following section on statistical tests.

6. More explicitly, $\log ME = \log (M/(\bar{T}/\bar{v}))$, where $\bar{T}$ is the trend level in industrial production, and $\bar{v}$ is the trend level in velocity. Velocity equals industrial production divided by the real money stock. Real money is the nominal money stock (money plus quasi-money) deflated by the wholesale-price index. The trend level estimates are calculated recursively by multiplying last period's trend level estimate by the rate of growth of the actual variable over the past 60 months. For example:

$$\bar{V}_{60} = V_{60}$$

$$R_t = \left(\frac{V_t - V_{t-60}}{V_{t-60}}\right) / 60$$

$$\bar{V}_t = \bar{V}_{t-1} \times (1 + R_t) \quad \text{For all } t > 60$$

This procedure was followed for all countries with the exception of the U.K., for which there was no monthly data for quasi-money, and for which there was insufficient monthly money data to calculate the trends. In the U.K. case, money alone was used, instead of money plus quasi-money, and the trend in real money demand was estimated by extrapolating the average 1963-1973 nominal money growth rates in the U.K. and the U.S.

7. Other factors which could have explained these differential growth rates, such as the size of the previous business-cycle downturn or the trend growth in the economy, do not appear to have been significant. The U.S. growth rate in the last three and a half years—7.8 percent—was significantly above its 1963-73 trend growth of 5.4 percent. On the other hand, Germany's, Japan's and Switzerland's recent growth rates were significantly below their trend growth rates in the decade ending in 1973. The size of the previous business-cycle downturn also does not explain the recent strength in the U.S. growth rate. Both Switzerland and Japan had a more severe downturn in their economy in the 1973-75 period than the U.S., while Germany had a downturn equal to that of the U.S. Thus, it appears that differences in monetary stimulation have been a key factor in differences of real growth rates of these four countries in the most recent business-cycle expansion. The movement in the unemployment rate was consistent with the pattern of growth rates in industrial production. In the U.S., unemployment declined significantly by 1978 from its 1975 peak rate. In Germany, Japan and Switzerland, however, unemployment rates were equal to or above 1975 rates. This suggests that real growth in those three countries had been insufficient to absorb the natural growth in their labor force and productivity, and thus suggests that their growth had been below potential.

8. All of the level equations were estimated with Cochrane/Orcutt adjustment for the first-order serial correlation of the error term.

9. In the case of Japan, the constant term is statistically significant but quantitatively small. In the case of the U.K., the constant term is quantitatively large, but not significant statistically.

10. Italy is the only country in which the constant term has a large and statistically significant value. This suggests that there were important real factors operating on the Italian exchange rate as well as the money factors modeled in the equation.

11. A related source of measurement error is associated with market expectations. Market participants may view current nominal money growth as a precursor of future growth in the nominal money supply. These expectations could affect the exchange rate. For example, when market participants observe the steady deceleration over the last four years in Switzerland's nominal money growth, they might reasonably expect that pattern to continue and, thus, would forecast a lower long-run equilibrium price and lower exchange value of the dollar relative to the Swiss franc than is implicit in the actual trend of nominal money growth. These expectational influences could bias the coefficient values either above or below one—above one if the market extrapolated current monetary developments, and below one if the market expected the monetary authorities to revert to some trend value in the face of an observed deviation in money.

To the extent that expectations have been important in affecting coefficient values, these values may remain unstable over long periods of time. Indeed, if all monetary authorities followed constant money-growth rules, this expectation factor would no longer influence market participants and the coefficient values would move toward unity.

12. The equations in Table 1 were estimated in difference form, while the charts were displayed in level form for convenience in interpretation. This transformation was achieved by conducting a static simulation of the equations over the estimation period.

13. See footnote 6 for an explanation of why the narrower aggregate (money) is used for the UK, as opposed to the broader aggregate (money plus quasi-money) which is used for the other countries. The corresponding growth rate for US money is 6 percent.