Does U.S. Money Growth Determine Money Growth in Other Nations?

Richard G. Sheehan

THE money-inflation relationship has been examined extensively for a variety of economies resulting in a consensus that money growth has had a significant and positive impact on inflation.[1] A related, but little studied issue, is the relationship between money growth rates across countries. This issue is important for assessing the extent to which inflation pressures have been transmitted from country to country.

If, for example, U.S. money growth influences the actions of foreign central banks and, therefore, foreign money growth, it also influences foreign inflation. Thus, rapid U.S. money growth may lead both to a higher U.S. inflation rate and to higher inflation rates around the world. In other words, focusing solely on the U.S. impacts of rapid U.S. money growth could substantially understate its total effects.[2]

In this paper we attempt to ascertain whether U.S. money growth has had identifiable impacts on money growth in other industrial countries. We first consider why U.S. money growth might exert effects on foreign money growth under both fixed and flexible exchange rate regimes. We then present some empirical evidence on the significance of this relationship.

PREVIOUS STUDIES OF MONETARY LINKAGES

Since the money-inflation relationship has been examined in detail elsewhere, this article focuses solely on the link between U.S. and foreign money growth rates. This latter relationship has received comparatively little attention. Feige and Johannes (1982) used causality tests to examine the U.S. money-foreign money relationship during the fixed exchange rate period. They found mixed results; U.S. money growth influenced money growth in Australia, France and Germany but had no impact in Norway or Sweden. Batten and Ott (1985) used a small structural model to examine this relationship during the floating exchange rate period. They found that U.S. money growth influenced money growth rates in Canada, Germany, Japan, the Netherlands and possibly the United Kingdom; money growth rates in France, Italy and Switzerland, however, were unaffected by U.S.

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[1]For example, see Cuddington (1981), DyReyes, Starleaf and Wang (1980), Genberg and Swoboda (1977), Gutierrez-Camara and Huβ (1983), Laidler (1976), Mills and Wood (1978), Mixon, Pratt and Wallace (1980), Pearce (1983), Swoboda (1977) and Wahlroos (1985).

[2]We ignore the possible existence of a direct relationship from U.S. money growth to foreign inflation. For theoretical arguments on the existence of such an effect, see Aukrust (1977) and Bordo and Choudhri (1982).

money growth. In a study spanning both fixed and floating exchange rate periods, Sheehan (1983) found significant cross-country differences, with U.S. money growth (M1) influencing Australian and German money growth but having no discernable impact on money growth in Canada, Italy, Japan and the United Kingdom.[3] Here, we re-examine the U.S. money-foreign money relationship using a common methodology to analyze the fixed vs. floating exchange rate periods, extending the analysis to a broader group of countries and updating the analysis through 1985.

WHY SHOULD U.S. AND FOREIGN MONEY GROWTH BE RELATED? THEORETICAL ISSUES

The theoretical relationship between U.S. and foreign money growth may differ substantially depending upon the exchange rate regime.

Fixed Exchange Rate Regime

For a fixed exchange rate system, traditional models of the monetary approach to the balance of payments predict that if the United States is the reserve currency country, an increase in the U.S. money supply leads to increased money stocks in other open economies.[4]

To see why, consider the sequence of events that typically follows an increase in U.S. money growth. Initially, the increase causes an excess supply of U.S. money and an excess U.S. demand for goods and capital. This excess demand results in simultaneous inflows of goods and services to the United States and outflows of funds from the United States to the foreign economy. Attempts to convert some of these dollars to foreign assets result in a lower exchange rate (the price of the dollar in terms of the foreign currency) in the absence of any intervention by the monetary policymakers. To maintain the exchange rate, the foreign monetary authority, and perhaps the Federal Reserve as well, must purchase dollars with foreign assets. The foreign central bank affects these purchases by increasing its own monetary base and, as a result, its own money stock.[5]

There is a potentially important qualification, however, to this traditional approach to the transmission mechanism from U.S. money growth to foreign money growth under fixed exchange rates. McKinnon (1982) has advanced the so-called currency substitution argument based on desired shifts in asset holdings between U.S. and foreign-denominated assets. Assume preferences shift from holding foreign-denominated assets to holding dollar-denominated assets, perhaps in response to changes in perceived long-run productivity growth. Simply to accommodate these changes and prevent exchange rate changes under fixed exchange rates, the Federal Reserve would have to *increase* the U.S. money stock, or the foreign monetary authority would have to *decrease* the foreign money stock, or some combination of the two. Thus, in this case, the U.S. and foreign money stocks would move generally in opposite directions.[6] Whether this negative currency substitution effect is sufficiently large enough or occurs frequently enough to offset or overcome entirely the traditional positive effect is an empirical question.[7]

Floating Exchange Rate Regime

In the traditional model of floating exchange rates, the foreign economy is insulated from U.S. money growth because the foreign monetary authority is not committed to buying (or selling) dollars at any fixed rate. Floating exchange rates, therefore, enable foreign monetary policymakers to base their policy actions on variables other than the exchange rate. An increase in the U.S. money supply, assuming demand constant, simply leads to an excess supply of dollars, a higher rate of U.S. inflation and downward pressure on the exchange rate. Thus, if monetary policymakers fully take advantage of the insulating properties of floating

[3]For results for individual countries, see Layton (1983) and Pearce (1983).

[4]For example, see Barro (1984), pp. 536–39, Frenkel (1986) or Swoboda (1977). This statement assumes fiscal policy is devoted to other goals. A typical assumption is that monetary policy is better suited to deal with exchange rate fluctuations, while fiscal policy is better suited to other objectives. See Frenkel and Mussa (1981).

[5]The foreign monetary base and money stock would not increase if these purchases were sterilized by foreign monetary authorities. See Batten and Ott (1984) for a detailed discussion of the ability of foreign monetary authorities to sterilize.

[6]In theory, zero correlation also could occur if only the U.S. money or foreign money stock changed. In practice, however, it is generally assumed that both the U.S. and the foreign monetary authority would alter their money stocks.

[7]See the debate by McKinnon and others (1984) and the references cited there for alternative views on the importance of the currency substitution argument.

Table 1
Correlation Coefficients of U.S. and Foreign Money Growth Rates

	Fixed exchange rate	Floating exchange rate
Belgium	.238	.168
Canada*		.374
France	.398	.034
Germany	.304	.194
Italy	.139	.138
Japan	.209	.110
Netherlands	.083	.157
Switzerland	−.057	−.103
United Kingdom	.391	.105

*The floating exchange rate period for the tests of independence for Canada begin in III/1973 to maintain comparability with the other countries, even though Canada switched to floating exchange rates in III/1970. Beginning the floating rate period earlier for Canada does not alter the results.

exchange rates, changes in the U.S. money growth rate may have permanent impacts on the foreign exchange rate, but no effect on the foreign money growth.

Even during the floating exchange rate period, however, there is considerable evidence that monetary policy actions have attempted, in part, to manipulate the exchange rate.[8] Moreover, many countries have attempted to keep their exchange rate movement within some wider or narrower range in order to achieve some "target rates."[9] Attempts to manage exchange rates, however, lead inevitably to some loss of monetary independence.[10]

MONEY GROWTH DATA

To determine the impact of U.S. on foreign money growth, we focus on the major world traders for which money data are available: Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland and the United Kingdom.[11] Since this group includes the major countries that have adopted floating exchange rates, we can determine whether the switch from fixed to floating exchange rates altered the U.S.-foreign money growth relationship. These countries also have the most active foreign exchange markets; thus, they may have substantial capital mobility as well.

Table 1 compares the correlation coefficients of U.S. money (M1) growth and foreign money (M1) growth for the fixed and floating exchange rate periods.[12] The fixed exchange rate sample period runs from I/1960 to II/1971, while the floating exchange rate period runs from III/1973 to IV/1985. The intervening period is viewed as transitional and thus is not considered in the analysis.[13]

In general, the correlation coefficients suggest that movements in U.S. M1 growth are partially reflected in movements in foreign money growth. In addition, the correlations generally are larger for the fixed exchange rate period than for the floating exchange rate period. For example, the correlation coefficient between U.S. and U.K. money growth rates is .391 during the fixed rate period but declines to .105 under floating ex-

[8]For example, see Batten and Ott (1985) and Wickham (1985). See also Federal Reserve Bank of New York's regular summary of "Foreign Exchange Operations," e.g. (1986).

[9]The International Monetary Fund (IMF) classifies countries by type of exchange rate regime. For example, see IMF (1985). See Heller (1978) for an alternative classification procedure. While the period since 1973 is generally acknowledged to be one of floating exchange rates, in fact, relatively few countries are classified as "floaters." For example, as of December 1983, the IMF classified just nine countries as having independently managed floating exchange rates.

[10]The ability of floating exchange rates to insulate foreign money growth from U.S. money growth, however, may be even less complete than suggested by this discussion, even when foreign monetary authorities allow the exchange rate to fluctuate. As with fixed exchange rates, currency substitution may result in a negative correlation between U.S. and foreign money growth. In addition, capital mobility also may reduce the insulating ability of floating exchange rates.

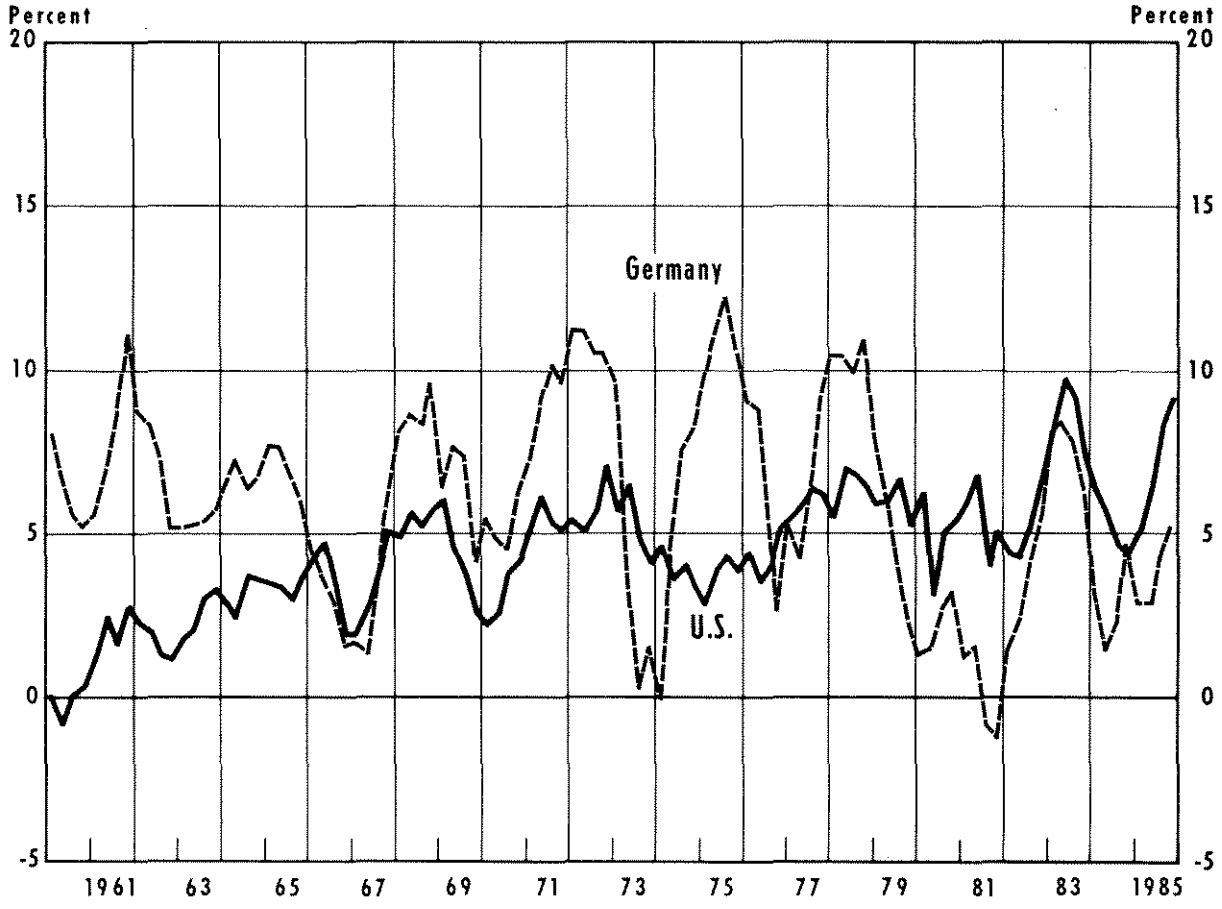
[11]This set of countries is the so-called Group of 10 plus Switzerland. Sweden is excluded due to lack of data.

[12]Given seasonally unadjusted data with trend, we use the second difference, that is: $\Delta(\ln M_t - \ln M_{t-4})$. The change from one year ago removes seasonality, while first differencing the result removes any remaining trend. The sample ends in IV/1984 for Switzerland due to a break in the data and in III/1985 for Italy since that is the most recent available. In addition, Canadian data for the fixed exchange rate period is omitted due to breaks in the data. Other breaks in the data — Canada in IV/1981, France in IV/1977, Germany in I/1968 and the United Kingdom in II/1975 and IV/1980 — appear to be relatively unimportant.

[13]The Smithsonian Agreement in 1971 replaced the Bretton Woods fixed exchange rate system. It was not until 1973, however, when the Smithsonian Agreement broke down, that exchange rates were allowed to fluctuate freely. This practice of omitting the period from III/1971 to II/1973 follows Mixon, Pratt and Wallace (1980). Studies of the floating exchange rate period generally begin after mid-1973. For example, see Batten and Ott (1985). Studies of the fixed exchange rate period generally end before mid-1971. For example, see Feige and Johannes (1982).

Chart 1

Money Growth in the United States and Germany



change rates. This finding is consistent with the ability and willingness of countries to conduct independent monetary policy under floating exchange rates. Differences among foreign countries should also be noted. For some countries including France and the United Kingdom, the correlation is quite strong during the fixed-rate period; for others, such as the Netherlands and Switzerland, the relationship is much weaker.

To further illustrate the relationship between U.S. and foreign money growth rates, charts 1 to 3 present the annualized money (M1) growth rates for Germany, Italy and the United Kingdom relative to U.S. money growth for the period I/1960 through IV/1985. These countries are chosen to reflect a diversity of monetary behavior, both between countries and over time within a country.[14]

For Germany there appears to be a regular association with U.S. money growth throughout the period. In contrast, the Italian money growth rates bear little resemblance to U.S. rates until mid-1981. For the United Kingdom, there appears to be a close relationship with U.S. money growth until 1971. After that, the

[14]Neither the graphs nor the correlations allow us to investigate the causes for the diversity of money growth rates in detail. An examination of the causes of this diversity, while an interesting topic for further research, is tangential to the goal of this paper.

rates diverge substantially. The charts also suggest that the period may be divided into the fixed and floating exchange rate regimes, and there are no other obvious breaks in the data.

ARE U.S. AND FOREIGN MONEY GROWTH INDEPENDENT?: RESULTS USING THE HAUGH TECHNIQUE

The simple correlations and graphical analysis discussed above are generally not sufficient to discover many statistical regularities, in particular, lagged relationships. To find whether such statistical regularity exists requires more refined techniques. To investigate this issue, a statistical technique developed by Haugh (1976) was used to test for independence of U.S. and foreign money growth rates. Although the Haugh technique previously has been used to consider questions of causality, it is used here only to test independence.[15] The direction of causality is *assumed* to run from U.S. to foreign money growth.[16] For example, if U.S. and Belgian money growth are statistically dependent, this result is interpreted as implying that U.S. money growth causes Belgian money growth.

The Haugh procedure ascertains statistical independence between two series based on their cross-correlations. In particular, it considers both the contemporaneous correlation between U.S. and foreign money growth and the correlations between these series across time. For example, the contemporaneous correlation between two series, X and Y, can be defined as $r_{xy}(0)$, while the correlation between X in one period and Y in the following period can be defined as $r_{xy}(1)$ and the correlation between X in one period and Y in the preceding period as $r_{xy}(-1)$. Haugh's test statistic for small samples is

$$N^2 \sum_{k=-m}^{m} (N-|k|)^{-1} \hat{r}_{xy}(k)^2,$$

where N is the number of observations, m is the maximum lag (and lead) length and $\hat{r}$ is the estimated cross-correlation coefficient. Thus, this statistic is based on the cross-correlations from X with Y lagged m periods to X with Y led m periods (or equivalently, Y with X lagged m periods). Haugh has demonstrated that this statistic follows a χ^2 distribution with $2m+1$ degrees of freedom (the number of cross-correlation coefficients calculated).

In the statistical results reported below, we vary m, the maximum lag (and lead) length. In all cases, however, the maximum lag length is relatively short. The rationale for short lags is quite simple. If exchange markets are efficient, any adjustment of foreign to U.S. money growth, either to avoid exchange rate changes or to accommodate currency substitution or mobile capital flows, should occur relatively quickly. This hypothesis implies that longer lags and the corresponding cross-correlations should be insignificant, which is supported by the empirical results.

EMPIRICAL RESULTS

Table 1 presents the significance levels for the Haugh statistic for alternative values of m in both the fixed and floating exchange rate periods.[17] For the fixed exchange rate period and for each value of m, the null hypothesis of independence between U.S. and foreign money growth can be rejected for four of the eight countries using a 10 percent significance level.[18]

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[15]For example, see Feige and Johannes (1982).

[16]Granger causality relies on time precedence in regression analysis. As Sims (1972) has admitted, it is a sophisticated version of *post hoc, ergo propter hoc*. Simply stated, regressing X on lags of Y is assumed to reveal if Y preceded — and thus "Granger-caused" — X. Zellner (1979) reviews the methodological criticisms of this approach. The Haugh technique tests only for the independence of two series. The direction of causation can then be tested, subject to the timing problems discussed by Zellner. Alternately, the direction of causation can simply be assumed. The assumed lack of causality running from foreign money growth to U.S. money growth should not be troubling for the smaller foreign countries examined. For Germany and Japan, in particular, one might argue that causality may run in both directions. To date, however, there is no evidence in the U.S. reaction function literature to support the hypothesis that U.S. money growth is influenced by any foreign money growth rate.

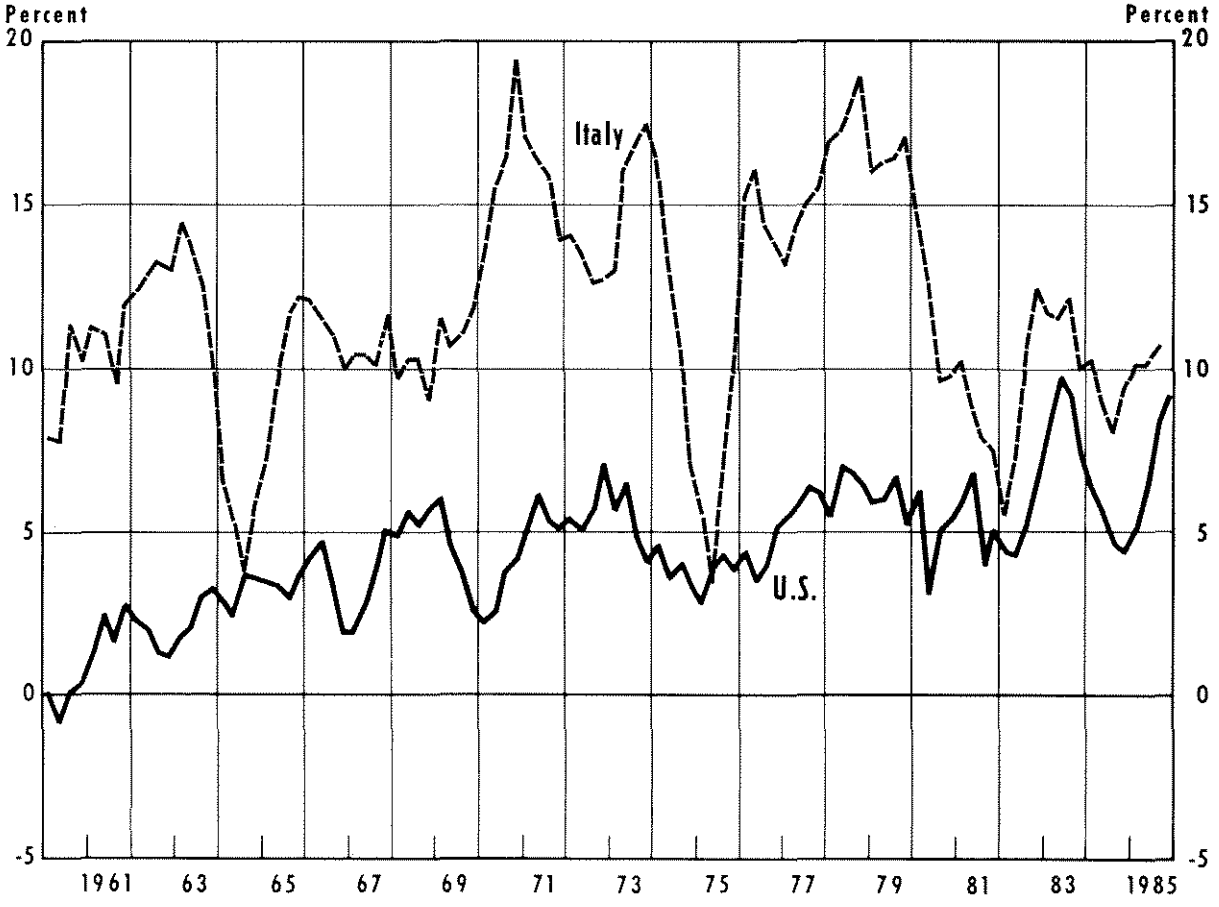
The Haugh technique is also not without its limitations. In particular, it requires filtered data as discussed below, and the results may be sensitive to the choice of filter employed. See footnote 17. In addition, since the Haugh technique uses cross-correlations rather than regression analysis, it is not possible to hold other factors constant. This limitation is discussed by Schwert (1979).

[17]The Haugh technique requires stationarity in both series. Given seasonally unadjusted data, all variables were converted to log differences, then time series techniques were used to obtain white noise residuals. The filters employed are available upon request. The results are basically unchanged when using Sims' (1972) filter.

[18]Canada had to be dropped from the fixed exchange rate period because of a break in the data. In addition, Canada had fixed exchange rates only for the III/1962 to II/1970 period.

Chart 2

Money Growth in the United States and Italy



The countries rejecting independence vary, however, based on the value of m. The French and Japanese results reject independence for $m=0$ but not for higher values; the results for Belgium and the Netherlands, however, cannot reject independence for $m=0$ but can for higher values. The null hypothesis of independence of foreign money growth from U.S. money growth cannot be rejected for any value of m only for Italy and Switzerland.

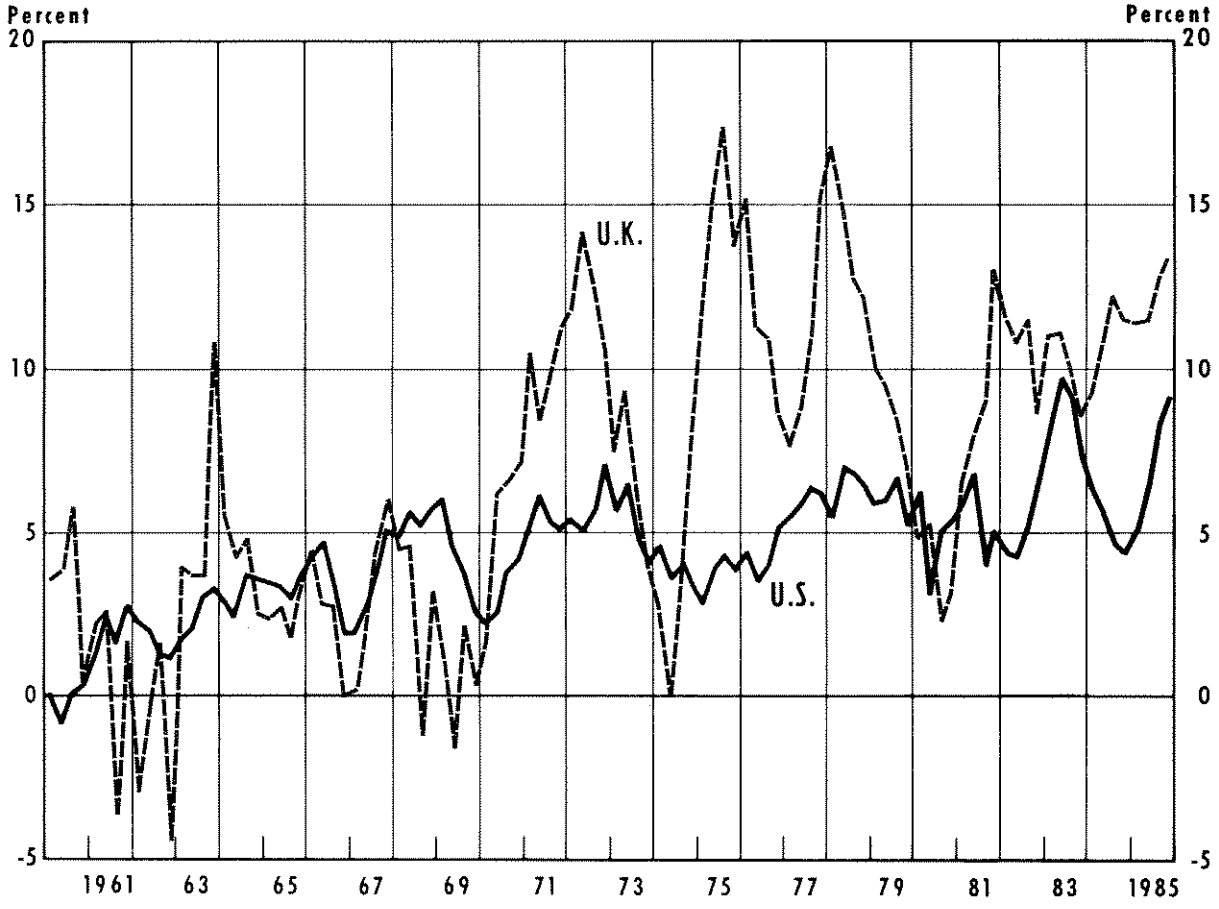
What do these results mean? If foreign money growth responds to U.S. money growth *within* one quarter, the Haugh test should reject independence for $m=0$. Higher order values for m may not be able to reject independence, however, because the power of the test declines for higher values of m when the true relationship exists only at short lags.[19] Alternately, if foreign money growth responds with a lag (or with a lead if foreign monetary authorities anticipate U.S. policy actions and change their policy in advance), the contemporaneous correlation would suggest independence, while higher values of m would capture the true dependence.[20] Thus, a rejection of the null hy-

[19]Consider a simple, albeit extreme, example: $r(0) = .4$, $r(i) = 0$ for $i \neq 0$ and $N = 50$. For $m = 0$, the Haugh statistic is significant at the 1 percent level. For $m = 2$, the Haugh statistic is insignificant even at the 10 percent level.

[20]Consider another simple example: $r(1) = .4$, $r(i) = 0$ for $i \neq 1$ and $N = 50$. For $m = 0$, the Haugh statistic is clearly insignificant. For $m = 1$, the statistic is significant at the 5 percent level, while for $m = 2$, it is again insignificant.

Chart 3

Money Growth in the United States and the United Kingdom



pothesis at any value of m should be considered evidence of non-independence.

Using this criterion, foreign money growth "depends" on U.S. money growth at the 10 percent significance level during the fixed-rate period for six of the eight countries considered. In addition, in all cases in which the null hypothesis of independence is rejected, the correlations are positive. These correlations are consistent with the traditional channel of influence from U.S. money growth to foreign money growth. They are not consistent, however, with the currency substitution hypothesis. These results also are generally consistent with Feige and Johannes' (1982) results that U.S. money growth influenced foreign money growth in most countries.

The failure to reject the null hypothesis of independence for Italian and Swiss money growth, however, appears at odds with traditional theory. Two possible explanations exist for this result. First, Italy and Switzerland's rates may, in fact, have been floating during the period. This rationale, however, conflicts with an examination of the exchange rate data and classifications of exchange rate regimes such as the IMF's which suggest that exchange rates were fixed.

Alternately, the insignificant results may be due to the relatively low power of the Haugh test.[21] With a

[21] See Schwert (1979).

Table 2
Tests of Independence of U.S. and Foreign Money Growth Rates

	Haugh Statistic — Significance Levels					
	Fixed exchange rate			Floating exchange rate		
Country	m = 0	m = 1	m = 2	m = 0	m = 1	m = 2
Belgium	.2767	.0329	.0880	.3599	.4303	.4203
Canada[1]				.0029	.0205	.0242
France	.0352	.2118	.2620	.5891	.1741	.4003
Germany	.0175	.0127	.0005	.1521	.3505	.4032
Italy	.2437	.4247	.2674	.3322	.3280	.5399
Japan	.0539	.1664	.2452	.1831	.0310	.0040
Netherlands	.2396	.0585	.0612	.2406	.5715	.7516
Switzerland	.9854	.2627	.4921	.6460	.5944	.8088
United Kingdom	.0013	.0123	.0448	.1183	.4467	.6836

[1]The floating exchange rate period for the tests of independence for Canada begin in III/1973 to maintain comparability with the other countries, even though Canada switched to floating exchange rates in III/1970. Beginning the floating rate period earlier for Canada does not alter the results.

significance level of 10 percent, the probability of rejecting a true null hypothesis is set at 10 percent, while the probability of correctly rejecting a false null hypothesis — the power of the test — generally is unknown. Although Italian and Swiss money growth, in fact, may depend on U.S. money growth, we may be unable to correctly reject the false null hypothesis of independence.[22]

Floating Exchange Rate Period

The floating exchange rate results differ substantially from the fixed- rate results. We can reject the null hypothesis of independence only for Canada and Japan. In both cases, the correlation is positive, again inconsistent with the currency substitution hypothesis. These results are consistent with Batten and Ott's (1985) finding that some countries — including Canada and Japan — have not fully availed themselves of the insulating properties of floating exchange rates.

Using the Haugh test, it is impossible to determine whether this dependence is due to discretionary policy response to U.S. money growth. For example, foreign monetary authorities may change foreign money growth in response to changes in their real interest rate, and their real rate may change in response to U.S. money growth or a host of other factors, including a change in foreign money demand.[23]

Results Using German Money Growth in Place of U.S. Money Growth

To test further the importance of cross-national monetary linkages, we repeated the tests in table 2 for the European economies using German rather than U.S. money growth as the reference point. Under fixed exchange rates, the traditional theory would allow a relationship between, say, German and Swiss money growth only to the extent that both are correlated with U.S. money growth since both are pegged to the dollar.

[22]A third possible explanation of the insignificant Italian and Swiss results is that the positive correlation associated with the traditional channel and the negative impact associated with currency substitution may be offsetting. Of course, it then is necessary to explain why currency substitution should vary systematically with U.S. money growth.

[23]It may be preferable to run the Haugh test not on money growth ($\dot{m}$) but on money growth in excess of money demand growth. Assuming money demand growth can be approximated by income growth ($\dot{y}$), we should examine the relationships of $\dot{m}$-$\dot{y}$ between the United States and foreign countries. Unfortunately, quarterly gross national product data (or gross domestic product data) are unavailable for some or all of the period for Belgium, France, the Netherlands and Switzerland. With one exception, the results for $\dot{m}$-$\dot{y}$ were basically unaltered for the subset of countries with available data. The only exception was the floating exchange rate result for the United Kingdom, which was significant (at m = 0) and negative.

Table 3
Tests of Independence of German and Other Nations' Money Growth Rates

	Haugh Statistic — Significance Levels					
	Fixed exchange rate			Floating exchange rate		
Country	m = 0	m = 1	m = 2	m = 0	m = 1	m = 2
Belgium	.3768	.6623	.7872	.1817	.5797	.0911
France	.4576	.5745	.6809	.6969	.6734	.8333
Italy	.9345	.8499	.8934	.8164	.7850	.5034
Netherlands	.4553	.5809	.7392	.0121	.0323	.0677
Switzerland	.2564	.4738	.7659	.0273	.1814	.0736
United Kingdom	.0380	.1340	.0524	.0578	.0992	.0750

The results in table 3 suggest that the null hypothesis of independence can be rejected during the fixed exchange rate period only for Germany and the United Kingdom. This result likely reflects the common impact of U.S. money growth on both German and U.K. money growth, since these two countries were the most closely correlated with U.S. money growth. The correlation again is positive, which again refutes the currency substitution hypothesis. The inability to reject the null hypothesis of independence for other countries reflects their lower correlations with U.S. money growth.

Under floating exchange rates, German money growth may have an impact on other nations' money growth that it would not have had under the Bretton Woods system. Floating exchange rates, in fact, could mean a different system of pegging for some countries rather than truly floating rates. For example, other nations may choose to peg their exchange rate to the deutsche mark rather than the dollar. The current European Monetary System (EMS) formed in 1979 reflects a movement in that direction. To the extent that other nations peg to the mark, the traditional analysis on the relation between the dollar and other currencies would then hold between the mark and those currencies. Clearly, during the floating exchange rate period, based on the results in table 2, any relation between German money growth and other nations' money growth cannot be attributed to common response to U.S. money growth.

The floating exchange results in table 3 indicate that money growth in Belgium, the Netherlands, Switzerland and the United Kingdom have responded to German money growth using the 10 percent level of significance. Given EMS procedures for maintaining exchange rates within narrow bounds, the results should not be too surprising. The only possible surprise is the Swiss and U.K. results, since Switzerland and the United Kingdom are not part of the EMS.[24] The empirical evidence, however, suggests that they have behaved as if they were.

CONCLUSIONS

The results here both support and extend previous results by Batten and Ott (1985), Feige and Johannes (1982) and Sheehan (1983). Feige and Johannes focused exclusively on the fixed exchange rate period. Batten and Ott, using a different methodology, considered only the floating rate period. Here, a common technique was used to consider the impact of U.S. money growth on foreign money growth for both the fixed and floating exchange rate periods. Under fixed exchange rates, U.S. money growth had a significant impact on foreign money growth in most countries, as predicted by the textbook model of fixed exchange rates. There was no evidence of negative correlation implied by the currency substitution hypothesis.

During the floating exchange rate period, the effect of U.S. money growth was less pervasive, influencing

[24]Although Switzerland is not part of the EMS, it has admitted being influenced by the exchange rate with respect to the mark. See Schiltknecht (1983).

only a relatively small number of countries. This finding is consistent with Batten and Ott's results that some countries have not fully availed themselves of the insulating properties of floating exchange rates. Further buttressing these results, when German money growth replaced U.S. money growth, some European countries' money growth rates were shown to be related to German money growth during the floating rate period, a finding consistent with EMS institutional arrangements as well as Batten and Ott's results.

The results presented here should be considered suggestive rather than definitive for two reasons. First, the finding of dependence between U.S. and foreign money growth may be the result of common response to some third variable rather than a deliberate response of foreign central banks to U.S. money growth. And second, the Haugh test has relatively low power. Nevertheless, the results suggest that U.S. money growth had wide-ranging impacts on foreign money growth rates during the fixed exchange rate period and that these impacts have become much narrower during the floating-rate period.

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