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5 The International Transmission of Inflation Afloat

Michael R. Darby and James R. Lothian

Almost eleven years ago to the day, Anna Schwartz and we began a detailed study of inflation under the Bretton Woods system and in the years that immediately followed its breakdown. At the time, the consensus among economists and in a sizable portion of the financial community was that floating exchange rates, though perhaps not a panacea, certainly were to be welcomed rather than avoided.[1] The conclusions we reached were very much in accord with that line of reasoning. The United States—the reserve currency country under Bretton Woods—embarked on a policy of generally accelerating monetary expansion. The fixed exchange rates in force under the system facilitated the spread of the inflation that resulted.

The actual transmission of inflation, however, was a drawn out process, not the quick adjustment period envisioned in many of the theoretical models. In summarizing the results of the research carried out under the project, we characterized the process as one of "lagged adjustment to lagged adjustment" (Darby and Lothian 1983, 510).

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Anna, in her historical overview of the period (1983, 25), pointed to the reason why:

> A variety of measures, adopted in countries with over- or undervalued currencies to stave off devaluation or revaluation, affected the channels of international transmission of price change. Surplus countries tried to avoid price increases, deficit countries price decline, both as external consequences of their balance-of-payments positions. Intermittently, depending on cyclical conditions, countries in both categories took steps to right payments imbalances.

She went on to conclude that if Bretton Woods was not a textbook-type example of a fixed exchange rate world, neither was the period that followed a classic example of a floating exchange rate world. Instead, "it was a managed system, with substantial official intervention . . . [in which] countries have continued to hold foreign exchange reserves" (1983, 44).

Now, as doubts about the efficacy of floating rates continue to mount, we return, so to speak, to the scene of the crime, not to begin a new project on international transmission with Anna but to present some further evidence on the subject. We examine the behavior of policy variables and other important economic variables across a sample of twenty OECD countries under both exchange rate regimes, and derive a series of test equations to evaluate the extent of the long-run differences in monetary policy behavior between the two systems. We then go on to examine the correspondence between shorter-term movements in economic variables in the various countries under the two systems. We conclude with a discussion of policymakers' reaction functions.

The results of the longer-term analysis are clear-cut: Policymakers gained a considerably greater degree of long-run independence under floating rates. The cross-country variability of nominal variables—average rates of inflation, of monetary growth, and of interest—generally increased dramatically under floating rates. Moreover, the relationship between nominal money stocks and other variables in these countries changed in the way that one would expect given long-run policy independence under floating rates.

The results of the examination of shorter-term behavior are more mixed. Nevertheless, they do not support the notion that short-run linkages common to fixed rates remained fully intact under floating rates. Over such time frames, too, there appear to have been important changes. To the extent that these linkages have remained the same, moreover, one important reason is the tendency for the monetary authorities of various countries to react in the same way to developments abroad. In a number of important instances, their attempts to maintain exchange-rate and interest-rate stability appear to have served as a continued channel of monetary transmission from the United States.

5.1 Theoretical Considerations

To illustrate the potential differences in economic behavior under regimes of fixed and floating exchange rates, let us begin by considering a simple two-country quantity theoretic model. Such a model is implicit in Friedman's (1953) well-known defense of floating rates. It forms the nucleus of the monetary approach to the balance of payments advanced by Harry G. Johnson and others in the early 1970s, and it underlies much of the earlier theorizing on the subject.

The model, as it pertains to the domestic economy, takes the form of a demand for money function, a monetary equilibrium condition, and a purchasing power parity relation.

The demand for money function is of the form

$$m^* = L\,(y,i,u) + p\ , \tag{1}$$

where m^* is the percentage rate of growth of the desired quantity of nominal cash balances demanded, y is the percentage rate of growth of real income, i is the rate of change of the nominal rate of interest, p is the rate of inflation, and u is a portmanteau variable included to represent other factors such as the degree of financial sophistication.

The purchasing power parity relation is of the form

$$p = p' + e\ , \tag{2}$$

where a prime signifies the reserve-currency country, and e is the percentage change in the exchange rate—the price in domestic currency of a unit of the reserve currency.

In the fixed exchange rate case, e is zero and p will take whatever value is consistent with p'. In equilibrium, the growth rate of the nominal quantity of money supplied will equal the growth rate of the nominal quantity of money demanded:

$$m = m^*. \tag{3}$$

Combining (3) with (1) and recalling the discussion in connection with (2), we have

$$m = L\,(y,i,u) - p'. \tag{4}$$

With p' given, the nominal stock of money is proximately determined by the quantity of real cash balances demanded.

Interest rates in this world of long-run equilibrium and fixed exchange rates are assumed to change by the same absolute amount in the domestic economy and in the reserve-currency country. By definition, exchange rates are fixed. If they are expected to remain so, then interest parity implies equality of levels of nominal interest rates among countries. Note that since actual and anticipated rates of inflation within each country are equal on these assumptions, the Fisher relationship implies that real interest rates are also equal in the two countries.

In a floating exchange rate world, equations (1), (2), and (3) and the reserve-country analogues of (1) and (3), are combined into a three-equation system in which the rate of change of the exchange rate is determined by the difference in the growth rates of the excess supplies of money ($m - L$) in the two countries, and each country's inflation rate is determined by the rate of growth of its excess supply of money alone. We can write these equations as:

(5) $$e = m - L(y,i,u) - m' + L'(y',i',u'),$$

(6) $$p = m - L(y,i,u),$$

(7) $$p' = m' - L'(y,i,u).$$

Again, these are to be viewed as long-run equilibrium equations.

Unlike the fixed rate case, there is no necessary connection between growth rates of the supply of, and the demand for, money. Money supply is a variable determined by domestic policy considerations. An increase in the growth rate of the demand for money with no change in the growth of supply would result in a decrease in the rate of inflation. Variations in L affect m only if policymakers choose to stabilize p.

In further contrast to the fixed rate case, nominal interest rates are free to vary among countries. Full interest rate parity is consistent with the differences in the levels of interest rates equal to the percentage rate of increase of the exchange rate. This independence of nominal interest rates does not correspond, of course, to a similar independence of real interest rates which may be even more harmonized as the capital-control impedimenta of fixed exchange rates have been removed.[2]

One of the issues during the Bretton Woods era was how accurately equation (4) described the situation faced by a nonreserve country *in the short run*. Put differently, the question of interest was the degree to which a non-reserve-currency country could affect its money supply and price level over such periods. There was much less debate as to whether such a country could, in the absence of a change in the exchange rate, do so in the long run.

Similar questions have arisen since the advent of floating rates. One difference is that in many of these discussions, particularly in the financial press, little or no distinction has been made regarding the time dimension of the problem. The long run is implicitly viewed as identical in most respects with the short run, with the rise in inflation in the industrialized world near the start of this decade being interpreted as evidence of no change in the transmission properties of the system. Other proponents of the view that flexible exchange rates have not worked as expected argue that exchange rates have tended to move perversely, relative to their purchasing power parity values, and, therefore, have served to transmit fluctuations from one country to another rather than to limit their spread, and that via "ratcheting effects" have themselves been a cause of inflation.[3]

The alternative view is that these intercountry linkages, while perhaps important in the short run, have been of little consequence in the long run. Central banks, according to this argument, may have followed targets of the interest-rate or exchange-rate variety that reduced their degree of short-run monetary control, but those targets were changed often enough and by sufficient amounts that the degree of long-run control was substantial. Purchasing power parity, though not a good predictor of exchange rate movements over shorter time periods, held tolerably well over longer periods. (See Davutyan and Pippenger 1985, and Lothian 1986.)

One test of these competing sets of hypotheses is to examine the long-run variability among countries of money supply growth, of inflation, and of interest rates during the two periods.[4] Increases in the variability of all three during the floating rate period are consistent with the hypothesis that floating rates have increased the autonomy of the various domestic monetary authorities. If the variability has not increased, however, it is difficult to draw any firm conclusion: under Bretton Woods, actual exchange rates did change and exchange controls and the like were used to offset market pressures that otherwise would have led to exchange rate changes. Policy dependence may, therefore, have been less than complete. Correspondingly, under floating rates some monetary authorities may have geared their policies to maintaining interest rate equality with other countries or may have pursued nearly identical domestic inflation targets.

Fortunately, there are several ways of distinguishing between these two states of the world. If equations like (4) and (6) present reasonably accurate alternative long-run descriptions, then under fixed exchange rates we should observe a significant positive one-for-one relationship between the quantities of real cash balances demanded and nominal cash balances supplied in different countries, and under floating exchange rates, little or no relationship. Correspondingly, under fixed rates we should observe no relation between the quantity of real cash balances demanded and the price level, and under floating rates, a zero or negative relation.

The regression coefficient of real money growth in the regression of nominal on real money growth should be unity, and the standard error of estimate for the regression should be relatively low. Under floating rates, we should see very nearly the reverse. The regression coefficients should be much lower in value, and zero in the case in which each country's monetary authorities pursued money supply targets that were independent of growth in the real quantity of money demanded. By the same token, the standard error of estimate should be much higher, reflecting both the lower regression coefficient and the hypothesized higher (cross-country) standard deviation of nominal money growth.[5]

The discussion of interest rate behavior among countries under the two regimes also suggests a further relationship that we can exploit. Under fixed exchange rates, observed variations in inflation rates among countries are likely to be smaller and more heavily dominated by transitory elements than under floating rates. Differences in actual inflation rates are, therefore, less likely to provide useful information about future inflation rates than in a regime of floating exchange rates. As a result, the relationship between average levels of bond yields and of inflation rates is likely to be looser under fixed exchange rates than under floating rates. But, as we point out below, this is not the only possible interpretation of such a difference in the relationship. Accordingly, we place considerably less weight on these results.

5.2 Empirical Results: Longer-Term Relationships

The data we use to compare the two regimes are for twenty OECD countries over the period 1956 to 1986. For all twenty countries there are annual figures for money supply (M1 except for Sweden, where data availability dictated using a broader definition), a cost of living index, and real income (GNP or GDP, depending upon the country). For a subsample of fourteen countries, data for government bond yields are also available. The sources of almost all of these data were the publications and companion computer tapes of the International Monetary Fund.[6]

5.2.1 Cross-Country Variability

Evidence on variability is contained in figures 5.1 and 5.2. Figure 5.1 is for the entire twenty countries. Figure 5.2 is for the subsample of fourteen countries. In both figures we have plotted yearly cross-country standard deviations of rates of monetary growth and of inflation.[7] Figure 5.2 also includes a plot of the yearly cross-country standard deviations of bond yields.

Both measures of variability plotted in figure 5.1 show substantial increases beginning in the early 1970s and becoming fully manifest in the mid-1970s, with the increase in the variability of the rate of inflation

Fig. 5.1 Variability of money growth and inflation; 20 OECD countries; 1956–1986. *Source:* International Monetary Fund. *Note:* Figures are standard deviations of annual data for each country.

being particularly dramatic.[8] Figure 5.2 shows sizable increases in inflation and in interest rate variability at approximately the same time as the increases depicted in figure 5.1, but no overall uptrend in the variability of actual money supply growth. Taken as a whole, therefore, these data are consistent with the hypothesis that national policies have become more autonomous. The one seeming anomaly is the variability of money supply growth under the floating exchange rate regime in the subsample. Further evidence on this issue, and on the variability question in general, is presented in table 5.1.

In this table we list standard deviations of country-average data for both the fixed rate and floating rate periods in their entireties.[9] These standard deviations were computed for the variables shown in the figures and for three additional variables—real income growth, growth in the excess supply of M1, and real M1 growth. The excess supply of money variable was defined as the difference between actual M1 growth and the estimated rate of growth of the real quantity of money demanded.[10] The fixed rate period encompassed the years 1956–73; the

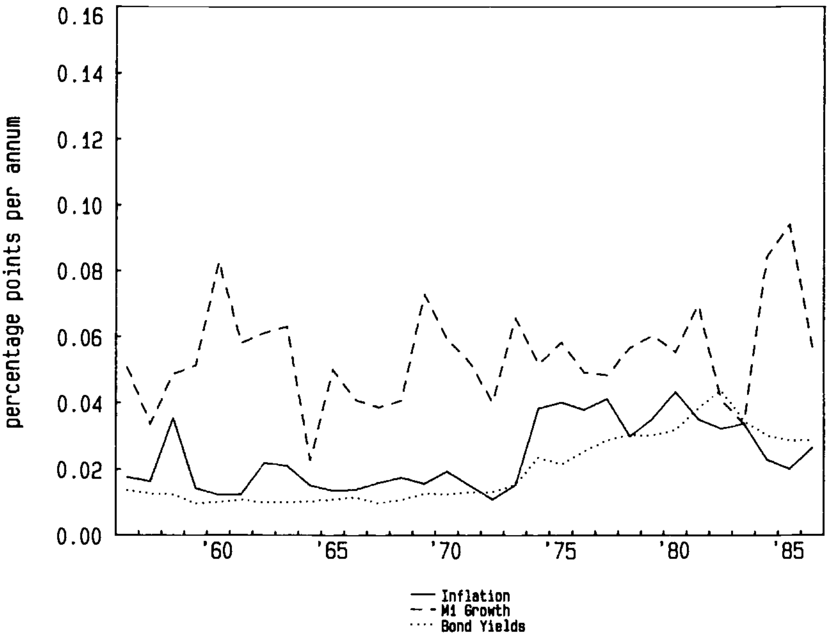

Fig. 5.2 Variability of money growth, inflation, and bond yields; 14 OECD countries; 1956–86. *Source:* International Monetary Fund. *Note:* Figures are standard deviations of annual data for each country.

Table 5.1 Economic Variability under Fixed and Floating Exchange Rates, 1956 to 1986

	Twenty Countries		Fourteen Countries	
	Fixed	Floating	Fixed	Floating
Standard deviation of				
M1 growth	0.038	0.060	0.036	0.031
Inflation	0.014	0.067	0.008	0.028
Bond yields	N.A.	N.A.	0.010	0.027
Excess M1 growth	0.022	0.065	0.019	0.035
Real income growth	0.014	0.009	0.015	0.010
Real M1 growth	0.032	0.022	0.033	0.017
Correlation of				
M1, real M1 growth	0.929	0.142	0.978	0.469

Notes: Standard deviations are of country averages of annual data for the periods 1956–73 and 1974–86, respectively. Rates of growth were computed as changes in the logarithms of the variables. Bond yields were expressed in decimal form.

floating rate period, the years 1974–86. Table 5.1 also lists the correlation coefficient across countries for nominal and real money growth.

With the exception of M1 growth in the smaller sample, all of the nominal variables shown in the figures—M1 growth, bond yields, and inflation—show a marked increase in variability in the floating rate period. By way of contrast, real income growth becomes less variable in both samples under floating rates. We believe that this reduction in cross-country variability of real output growth reflects a natural convergence as the postwar recoveries previously added different magnitudes to normal growth rates according to the relative extent of destruction suffered.

As real output growth rates converge, so do our implied estimates of growth in real money demand. Over such substantial periods our estimates of the real quantity of money demanded do not differ substantially from the actual growth in real money; this explains the decline in variability of real M1 growth for both samples in the floating versus the fixed periods.

It seems paradoxical that the variability of inflation goes up sharply in the smaller sample even though variability of M1 growth actually declines. One way to look at this phenomenon is to note that the variability in excess M1 growth—the difference between nominal M1 growth and our estimate of the growth of the real quantity of M1 demanded—increases.

Another way to analyze it is in terms of the usual formula for the variance of an algebraic sum: By definition, inflation is the difference between nominal and real money growth. Hence the variance of inflation is the sum of the variances in nominal and real M1 growth minus twice their covariance. In the fourteen-country sample, the sum component must decrease since both variances individually decrease. The increase in the variance of inflation is a result of the offsetting covariance term falling much more sharply, as the correlation coefficient between nominal and real money falls from approximately unity to less than half. An even sharper fall is evident in the twenty-country sample.

We interpret this as showing that in the long run, under fixed exchange rates, foreign monetary authorities did not vary money growth substantially from that required by growth in real money and world prices. That is, neither revaluations nor measurement problems caused substantial variations among inflation rates, and the monetary authorities allowed nominal money growth to reflect differences in real money growth.

Under floating exchange rates, nominal money growth appears to have been chosen largely independently of variations in real money demand. In one sense, this independence (especially apparent for the twenty countries) is surprising since it suggests that foreign monetary authorities have selected nominal money targets with inflation being a residual, rather than selecting target trend inflation rates and then choosing M1 growth trends which would achieve those targets. We turn next to further evidence in support of this interpretation.

5.2.2 Real Money Growth, Nominal Money Growth, and Inflation

Table 5.2 lists summary statistics from regressions of money supply growth and inflation on the growth of real money balances for both samples.[11] For the fixed rate period we see that cross-country differences in trend growth rates of nominal money supply are essentially explained one-for-one by differences in growth in real cash balances in both cases. The R^2's are 0.86 and 0.95 in the large and small samples, respectively, and the regression coefficients have values insignificantly different from one. For the floating rate period, in contrast, the R^2's are low, the standard errors considerably higher, and the regression coefficients are not significantly different from zero at the 0.95 level.

Now, turn to the duals of the above relationships, the regressions of inflation on real cash balances. During the fixed rate period, as the theory suggests, we observe no significant relationship between the two variables. During the floating rate period, we observe negative relationships between the two—again, as the theory suggests, provided

Table 5.2 **Regressions of Money Growth and Inflation on Real Money Growth for Country-Average Data**

Dependent Variable	Period	Constant	$m-p$	$\bar{R}^2$	SEE
20 Countries					
m	1956–73	0.037	1.102	0.856	0.014
		(6.315)	10.658		
p	1956–73	0.037	0.102	0.001	0.014
		(6.315)	0.989		
m	1974–86	0.110	−0.381	0.034	0.061
		(7.956)	(0.607)		
p	1974–86	0.110	−1.381	0.168	0.061
		(7.956)	(−2.200)		
14 Countries					
m	1956–73	0.035	1.067	0.953	0.008
		(10.191)	(16.239)		
p	1956–73	0.035	0.067	0.003	0.008
		(10.191)	(1.018)		
m	1974–86	0.081	0.832	0.155	0.028
		(9.039)	(1.838)		
p	1974–86	0.081	−0.168	−0.071	0.028
		(9.039)	(0.371)		

Note: Absolute values of *t*-statistics are beneath the coefficients in parentheses.

that monetary authorities switch from an exchange rate to a money growth policy. For the larger sample, this negative relationship is statistically significant; for the smaller, it is not.

One additional point about these results that deserves mention is the problem of measurement error. One set of regressions related nominal M1 growth to real M1 growth—the difference between nominal M1 growth and inflation. The other related inflation to real M1 growth. Measurement errors in nominal money will, therefore, bias the coefficient in a regression of nominal money growth on real money growth toward 1.0. Measurement errors in prices will bias the coefficient in a regression of inflation on real money growth toward -1.0.

Bias, however, does not appear to be the explanation for the differences that we actually observe between the two periods. To see this, consider the situation in which both m and p contain measurement errors. In this instance, the estimated coefficient will be a weighted average of the true coefficient, and the ratio of the error in nominal money growth to the sum of that error and the error in inflation. The weights, respectively, will be the share of the variance of the true value of $m - p$ in its total variance (including both types of error) and one minus that share.[12]

Suppose that in each period the true value of the coefficient in the relation linking nominal and real money growth rates is zero, that is, in both periods monetary authorities determine nominal money growth without regard to its inflationary implications. To obtain our estimates of near unity and close to zero, the variance in the measurement error of nominal money would have to almost completely dominate the total variance of real cash balances under fixed rates, and be an exceedingly small fraction of the total variance under floating rates. The total variance, however, fell from the one period to the next. The variance of the measurement error would, therefore, have to fall by a multiple—close to two, in the case of the full sample, and five, in the case of the smaller sample—of the decline in the total variance. This is totally implausible.

Alternatively, suppose that the true coefficient is unity in both instances, that both regimes behave like the classic fixed rate model. To produce our pattern of estimates, two things would have to happen. The decline in the variance of real money growth would have to be due totally to a decline in the systematic portion of the variance. At the same time, the ratio of the variance of the error in nominal money to the sum of the errors in prices and nominal money would have to become exceedingly small. Both developments, the latter particularly, appear unlikely. By themselves, therefore, measurement errors do not appear capable of accounting for the overall pattern of estimates that we obtained.

5.2.3 Bond Yields

In table 5.3, we report estimates separately for each period of the relationships between the average level of bond yields in each country and both the average rate of money growth and the average rate of inflation. For the fixed rate period there is a positive, but statistically insignificant, relationship between bond yields and inflation, and a positive and barely significant relationship between bond yields and money growth. For the floating rate period, in contrast, both relationships are highly significant.

These results are consistent with the explanation advanced earlier that revolves around differences in the conduct of policy and hence in the longer-term inflation process under the two exchange rate regimes. With completely fixed exchange rates, intercountry differences in rates of inflation will be transitory. Permanent differences require continuously changing exchange rates. Under floating exchange rates, intercountry inflation differentials can exist indefinitely. Hence, the distinction between permanent and transitory components of the inflation rate becomes less relevant. Provided that there were no other factors which changed between the two periods and which affected the ability of current and past rates of inflation and monetary growth to proxy anticipated future rates of inflation, we can view the estimated relationships as a further indication of the essential differences between the two regimes.

One factor that, in principle, could be important is the generally greater variability of nominal variables under floating rates. In the presence of measurement errors, this would produce higher correlations during that period. In practice, however, this cannot be the full explanation since variations in money growth across the fourteen countries do not increase, yet the correlation of money growth and bond yields does.

Table 5.3 **Regressions of Bond Yields on Inflation and Money Growth for Country-Average Data**

Period	Constant	m	p	$\bar{R}^2$	SEE
1956–73	0.050	0.130		0.155	0.010
	(8.025)	(1.842)			
1956–73	0.041		0.506	0.087	0.010
	(3.105)		(1.496)		
1974–86	0.037	0.772		0.770	0.013
	(3.250)	(6.665)			
1974–86	0.037		0.854	0.742	0.014
	(3.240)		(6.190)		

Notes: The dependent variable was the level of government bond yields, expressed as a decimal. Absolute values of t-statistics are beneath the coefficients in parentheses.

Another possible explanation for these results is that there was simply a very long adjustment lag. Market participants, for whatever reason, adjusted extremely slowly to high and rising inflation. Consequently, during the fixed rate period when inflation first started its worldwide rise, bond yields remained relatively low. Only as the process continued into the floating rate era did the adjustment, including necessary institutional and regulatory changes, become more complete. While a lag of this length seems somewhat implausible, this explanation cannot be ruled out.

5.3 Empirical Results: Shorter-Term Relationships

The long-run relationships appear to have changed in a way that is consistent with the simple theoretical analysis, although we were surprised by the lack of stronger evidence that central bank nominal money targets were influenced by their inflationary implications. Now we present evidence of several sorts on the short-run links among the countries and how they fared with the change in the exchange rate regime.

5.3.1 Relationships Between U.S. and Foreign Variables

This evidence is summarized in a series of tables reporting the results of annual regressions of the form

$$x_i = a + bx_{us},$$

where x_i is variable x in country i and x_{us} is its counterpart in the United States. The variables were alternatively nominal M1 growth, real M1 growth, inflation, real output growth, and the level of the government bond yield. In each instance, the regressions were run with contemporaneous values of the variables for both the fixed and floating periods as defined above. There was also some experimentation with lags and with different time periods. Tables 5.4 through 5.8 contain the results of these regressions.

At first glance, these results appear to run totally counter to those already presented. They seem to imply less independence, rather than more, under floating. Consider the inflation rate comparisons reported in table 5.4.

Under floating rates, the correlation between U.S. and foreign inflation rates is actually higher. This is true on average and for a sizable number of cases viewed individually. In going from fixed to floating, the median R^2 for these regressions rises from 0.21 to 0.28. Correspondingly, in 14 of the 19 individual inflation comparisons, the R^2 either rises or stays very nearly constant. Viewed from this perspective, inflation rates appear to have been more similar across countries under floating rates.

Table 5.4 Regressions of Foreign on U.S. Inflation

	1956 to 1973					1974 to 1986				
Country	*a*	*b*	$\bar{R}^2$	SEE	DW	*a*	*b*	$\bar{R}^2$	SEE	DW
Australia	0.014	0.693	0.23	0.0195	1.06	0.075	0.325	0.06	0.0280	0.90
	(1.541)	(2.474)				(4.031)	(1.337)			
Austria	0.025	0.383	0.12	0.0147	1.02	0.026	0.380	0.28	0.0184	0.70
	(3.634)	(1.809)				(2.144)	(2.379)			
Belgium	0.013	0.628	0.38	0.0128	0.71	0.045	0.355	0.08	0.0288	0.47
	(2.103)	(3.400)				(2.331)	(1.417)			
Canada	0.005	0.832	0.69	0.0092	0.90	0.033	0.661	0.65	0.0159	1.31
	(1.160)	(6.296)				(3.099)	(4.783)			
Denmark	0.034	0.585	0.10	0.0237	1.15	0.037	0.737	0.68	0.0166	1.32
	(3.032)	(1.713)				(3.325)	(5.104)			
Finland	0.050	0.296	−0.04	0.0321	1.17	0.052	0.659	0.27	0.0327	0.48
	(3.299)	(0.640)				(2.395)	(2.314)			
France	0.036	0.420	−0.01	0.0308	2.41	0.042	0.743	0.66	0.0175	0.71
	(2.470)	(0.948)				(3.616)	(4.896)			
Germany	0.016	0.445	0.20	0.0135	0.51	0.008	0.446	0.56	0.0127	0.76
	(2.576)	(2.285)				(0.983)	(4.038)			
Greece	0.004	0.928	0.20	0.0284	0.97	0.153	0.306	−0.03	0.0428	0.86
	(0.264)	(2.273)				(5.380)	(0.823)			

Italy	0.024	0.448	0.03	0.0247	0.65	0.076	0.914	0.56	0.0262	1.15
	(2.090)	(1.262)				(4.366)	(4.016)			
Japan	0.027	0.737	0.15	0.0256	0.90	−0.003	0.915	0.24	0.0478	0.48
	(2.214)	(1.997)				(0.108)	(2.205)			
Netherlands	0.020	0.829	0.33	0.0189	1.58	0.015	0.548	0.35	0.0233	0.51
	(2.238)	(3.046)				(0.962)	(2.710)			
Norway	0.021	0.789	0.28	0.0197	2.08	0.065	0.288	0.09	0.0223	1.36
	(2.276)	(2.782)				(4.378)	(1.490)			
Portugal	0.009	1.174	0.53	0.0181	1.26	0.189	0.114	−0.08	0.0415	1.37
	(1.099)	(4.518)				(6.871)	(0.315)			
Spain	0.063	0.195	−0.05	0.0348	1.22	0.101	0.532	0.16	0.0335	0.97
	(3.878)	(0.389)				(4.525)	(1.830)			
Sweden	0.028	0.523	0.21	0.0155	1.46	0.058	0.444	0.39	0.0174	1.84
	(3.855)	(2.341)				(5.038)	(2.938)			
Switzerland	0.014	0.671	0.23	0.0188	0.62	0.009	0.417	0.24	0.221	0.73
	(1.637)	(2.475)				(0.595)	(2.169)			
Turkey	0.062	0.757	−0.02	0.0668	0.90	0.207	1.701	0.05	0.1533	0.96
	(1.997)	(0.788)				(2.032)	(1.277)			
U.K.	0.014	0.976	0.45	0.0175	1.23	0.024	1.220	0.48	0.0403	0.95
	(1.764)	(3.876)				(0.901)	(3.484)			

Note: The symbols *a* and *b* represent the intercept and slope coefficient; *t*-statistics are beneath in parentheses.

Table 5.5 **Regressions of Foreign on U.S. Money Growth**

	1956 to 1973					1974 to 1986				
Country	*a*	*b*	$\bar{R}^2$	SEE	DW	*a*	*b*	$\bar{R}^2$	SEE	DW
Australia	0.014	0.974	0.15	0.0525	2.08	0.099	−0.110	−0.09	0.0660	2.32
	(0.609)	(1.977)				(1.864)	(0.172)			
Austria	0.055	0.705	0.24	0.0298	1.58	0.051	0.033	−0.09	0.0675	3.02
	(4.366)	(2.524)				(0.950)	(0.051)			
Belgium	0.016	1.028	0.33	0.0360	1.49	0.068	−0.225	−0.06	0.0400	1.60
	(1.078)	(3.046)				(2.110)	(0.580)			
Canada	0.021	1.113	0.18	0.0550	1.59	0.006	1.169	0.09	0.0817	1.87
	(0.913)	(2.157)				(0.086)	(1.476)			
Denmark	0.071	0.570	0.10	0.0360	2.05	0.145	−0.145	−0.09	0.0849	2.10
	(4.652)	(1.690)				(2.136)	(0.176)			
Finland	0.043	1.408	0.22	0.0625	1.76	0.236	−1.535	0.21	0.0770	2.39
	(1.638)	(2.402)				(3.818)	(2.056)			
France	0.095	−0.038	−0.06	0.0455	1.24	0.190	−1.296	0.62	0.0294	2.04
	(4.945)	(0.090)				(8.061)	(4.541)			
Germany	0.072	0.319	0.00	0.0354	1.55	0.066	0.060	−0.09	0.0458	1.76
	(4.772)	(0.959)				(1.799)	(0.135)			
Greece	0.138	−0.038	−0.06	0.0470	1.65	0.238	−0.961	0.43	0.0315	2.36
	(6.925)	(0.087)				(9.401)	(3.144)			

Italy	0.108	0.800	0.14	0.0439	1.46	0.156	−0.179	−0.08	0.0498	0.79
	(5.767)	(1.945)				(3.910)	(0.371)			
Japan	0.152	0.469	−0.03	0.0674	1.92	0.085	−0.209	−0.07	0.0485	1.69
	(5.310)	(0.743)				(2.177)	(0.443)			
Netherlands	0.021	1.372	0.45	0.0380	1.18	0.096	−0.224	−0.07	0.0528	1.83
	(1.272)	(3.849)				(2.259)	(0.438)			
Norway	0.026	1.315	0.60	0.0275	1.95	0.134	−0.366	−0.06	0.0689	2.01
	(2.191)	(5.103)				(2.422)	(0.547)			
Portugal	0.063	0.713	0.03	0.0622	1.08	0.231	−1.319	0.07	0.0652	2.25
	(2.404)	(1.223)				(3.232)	(1.363)			
Spain	0.104	0.859	0.11	0.0524	1.40	0.140	−0.132	−0.08	0.0461	0.91
	(4.685)	(1.749)				(3.776)	(0.295)			
Sweden	0.053	0.665	0.33	0.0230	1.78	0.119	−0.346	−0.02	0.0418	1.83
	(5.448)	(3.083)				(3.544)	(0.855)			
Switzerland	0.053	0.529	0.02	0.0483	0.96	0.013	0.252	−0.08	0.0753	2.23
	(2.609)	(1.169)				(0.216)	(0.346)			
Turkey	0.154	0.088	−0.06	0.0671	1.22	0.276	0.526	−0.05	0.0832	1.55
	(5.401)	(0.140)				(4.143)	(0.652)			
U.K.	−0.007	1.358	0.38	0.0433	2.23	0.072	0.732	0.12	0.0462	2.64
	(0.381)	(3.349)				(1.947)	(1.632)			

Note: The symbols a and b represent the intercept and slope coefficients; t-statistics are beneath in parentheses.

Table 5.6 **Regressions of Foreign on U.S. Bond Yields**

	1956 to 1973					1974 to 1986				
Country	*a*	*b*	$\bar{R}^2$	SEE	DW	*a*	*b*	$\bar{R}^2$	SEE	DW
Australia	0.028	0.538	0.74	0.0038	1.18	00.040	0.793	0.53	0.0158	0.62
	(7.559)	(7.067)				(1.872)	(3.825)			
Belgium	0.030	0.682	0.77	0.0046	1.73	0.014	0.900	0.94	0.0048	1.55
	(6.613)	(7.525)				(2.111)	(14.296)			
Canada	0.007	1.044	0.96	0.0026	1.07	0.013	0.963	0.95	0.0051	1.54
	(2.785)	(19.859)				(1.911)	(14.406)			
Denmark	−0.001	1.606	0.92	0.0059	1.21	0.063	0.851	0.42	0.0208	0.72
	(0.214)	(13.780)				(2.262)	(3.122)			
France	0.019	0.859	0.79	0.0054	0.53	0.006	1.072	0.85	0.0099	1.22
	(3.605)	(8.010)				(0.449)	(8.247)			
Germany	0.044	0.545	0.43	0.0074	0.97	0.047	0.318	0.15	0.0139	0.58
	(6.047)	(3.700)				(2.535)	(1.750)			
Italy	0.042	0.529	0.37	0.0081	1.00	0.017	1.299	0.66	0.0203	0.94
	(5.291)	(3.297)				(0.620)	(4.879)			
Japan	0.072	−0.016	−0.05	0.0017	1.87	0.069	0.078	−0.07	0.0141	0.51
	(43.728)	(0.477)				(3.655)	(0.424)			
Netherlands	−0.001	1.197	0.90	0.0048	0.73	0.054	0.339	0.24	0.0119	0.43
	(0.299)	(12.604)				(3.399)	(2.174)			
Norway	0.029	0.472	0.73	0.0034	1.05	0.020	0.819	0.44	0.0195	0.53
	(8.500)	(6.914)				(0.776)	(3.205)			
Sweden	0.014	0.912	0.84	0.0048	1.09	0.035	0.746	0.79	0.0083	0.90
	(2.987)	(9.614)				(3.142)	(6.871)			
Switzerland	0.005	0.734	0.88	0.0033	1.01	0.048	0.006	−0.09	0.0112	0.53
	(1.625)	(11.094)				(3.188)	(0.044)			
U.K.	0.005	1.349	0.94	0.0042	1.60	0.134	−0.069	−0.08	0.0179	0.42
	(1.167)	(16.160)				(5.577)	(0.294)			

Note: The symbols *a* and *b* represent the intercept and slope coefficients; *t*-statistics are beneath in parentheses.

Table 5.7 **Regressions of Foreign on U.S. Real Money Growth**

	1956 to 1973					1974 to 1986				
Country	*a*	*b*	$\bar{R}^2$	SEE	DW	*a*	*b*	$\bar{R}^2$	SEE	DW
Australia	0.014	0.262	−0.05	0.0528	1.95	−0.008	0.069	−0.09	0.0717	1.99
	(1.059)	(0.493)				(0.404)	(0.194)			
Austria	0.041	0.559	0.13	0.0294	1.60	−0.001	0.347	0.02	0.0628	3.32
	(5.442)	(1.893)				(0.079)	(1.113)			
Belgium	0.014	1.193	0.43	0.0321	1.92	−0.021	0.288	0.18	0.0304	1.86
	(1.652)	(3.694)				(2.507)	(1.907)			
Canada	0.020	1.536	0.33	0.0499	1.81	0.009	1.112	0.32	0.0870	1.94
	(1.588)	(3.061)				(0.355)	(2.576)			
Denmark	0.039	0.365	−0.01	0.0414	2.04	0.041	0.578	0.04	0.0957	2.20
	(3.701)	(0.878)				(1.546)	(1.217)			
Finland	0.034	0.472	−0.04	0.0762	1.44	0.021	−0.290	−0.05	0.0859	2.19
	(1.753)	(0.616)				(0.873)	(0.681)			
France	0.043	0.374	−0.04	0.0574	1.75	−0.003	−0.136	−0.01	0.0294	2.15
	(2.945)	(0.648)				(0.355)	(0.932)			
Germany	0.050	0.535	0.04	0.0403	1.02	0.028	0.383	0.12	0.0474	1.73
	(4.867)	(1.323)				(2.131)	(1.630)			
Greece	0.103	0.406	−0.01	0.0437	2.19	−0.008	−0.333	0.00	0.0651	1.29
	(9.275)	(0.925)				(0.465)	(1.030)			
Italy	0.101	0.018	−0.06	0.0436	1.17	−0.001	0.463	0.12	0.0571	1.13
	(9.085)	(0.042)				(0.072)	(1.634)			

(*continued*)

Table 5.7 (continued)

	1956 to 1973					1974 to 1986				
Country	*a*	*b*	$\bar{R}^2$	SEE	DW	*a*	*b*	$\bar{R}^2$	SEE	DW
Japan	0.116	0.647	0.00	0.0647	2.07	0.004	0.589	0.29	0.0491	2.54
	(7.052)	(0.995)				(0.259)	(2.417)			
Netherlands	0.016	1.352	0.35	0.0420	1.13	0.022	0.403	0.18	0.0430	2.33
	(1.515)	(3.207)				(1.830)	(1.889)			
Norway	0.027	0.551	0.10	0.0328	1.19	0.019	0.153	−0.07	0.0744	1.97
	(3.192)	(1.671)				(0.932)	(0.414)			
Portugal	0.049	−0.113	−0.06	0.0536	1.01	−0.069	−0.704	0.12	0.0695	2.13
	(3.604)	(0.209)				(3.440)	(1.560)			
Spain	0.063	0.525	0.00	0.0507	1.73	−0.010	0.265	0.03	0.0456	1.39
	(4.880)	(1.031)				(0.821)	(1.169)			
Sweden	0.030	0.603	0.19	0.0266	1.87	0.003	−0.065	−0.08	0.0394	2.04
	(4.401)	(2.258)				(0.288)	(0.322)			
Switzerland	0.037	0.271	−0.05	0.0561	0.77	−0.009	0.524	0.04	0.0855	1.89
	(2.623)	(0.480)				(0.390)	(1.235)			
Turkey	0.072	0.169	−0.06	0.0677	1.45	−0.011	0.306	−0.07	0.1268	1.69
	(4.169)	(0.248)				(0.296)	(0.485)			
U.K.	−0.008	1.069	0.20	0.0467	2.34	0.011	1.163	0.61	0.0532	2.42
	(0.671)	(2.276)				(0.710)	(4.407)			

Note: The symbols *a* and *b* represent the intercept and slope coefficients; *t*-statistics are beneath in parentheses.

Table 5.8 Regressions of Foreign on U.S. Real Income Growth

	1956 to 1973					1974 to 1986				
Country	*a*	*b*	$\bar{R}^2$	SEE	DW	*a*	*b*	$\bar{R}^2$	SEE	DW
Australia	0.038	0.372	0.04	0.0231	1.91	0.020	0.356	0.23	0.0155	2.07
	(3.451)	(1.317)				(3.465)	(2.149)			
Austria	0.064	−0.416	0.13	0.0181	2.32	0.020	0.157	−0.02	0.0174	2.66
	(7.387)	(1.880)				(3.067)	(0.846)			
Belgium	0.039	0.115	−0.05	0.0200	1.24	0.014	0.116	−0.07	0.0213	3.12
	(4.119)	(0.470)				(1.803)	(0.512)			
Canada	0.026	0.640	0.32	0.0173	1.75	0.017	0.619	0.50	0.0160	1.27
	(3.220)	(3.024)				(2.864)	(3.605)			
Denmark	0.030	0.444	0.15	0.0183	2.49	0.010	0.424	0.19	0.0202	2.44
	(3.446)	(1.983)				(1.400)	(1.962)			
Finland	0.046	0.094	−0.06	0.0389	1.41	0.030	−0.148	−0.04	0.0195	1.09
	(2.506)	(0.197)				(4.214)	(0.713)			
France	0.047	0.232	0.11	0.0108	2.08	0.016	0.211	0.08	0.0138	1.94
	(9.129)	(1.756)				(3.222)	(1.429)			
Germany	0.058	−0.147	−0.05	0.0346	1.81	0.005	0.586	0.62	0.0122	2.41
	(3.528)	(0.349)				(1.169)	(4.495)			
Greece	0.070	−0.063	−0.06	0.0242	2.39	0.014	0.451	0.11	0.0270	1.86
	(6.115)	(0.214)				(1.413)	(1.559)			
Italy	0.059	−0.129	−0.05	0.0218	1.05	0.011	0.386	0.09	0.0244	2.49
	(5.726)	(0.484)				(1.255)	(1.477)			

(continued)

Table 5.8 (continued)

	1956 to 1973					1974 to 1986				
Country	*a*	*b*	$\bar{R}^2$	SEE	DW	*a*	*b*	$\bar{R}^2$	SEE	DW
Japan	0.080	0.452	0.03	0.0296	1.51	0.027	0.397	0.29	0.0152	1.35
	(5.686)	(1.250)				(4.916)	(2.448)			
Netherlands	0.047	0.083	−0.06	0.0287	1.60	0.008	0.380	0.24	0.0163	1.91
	(3.441)	(0.236)				(1.372)	(2.173)			
Norway	0.030	0.356	0.15	0.0145	2.09	0.034	0.336	0.20	0.0156	1.35
	(4.391)	(2.005)				(5.903)	(2.017)			
Portugal	0.046	0.449	0.10	0.0214	1.98	0.023	0.201	−0.06	0.0328	1.67
	(4.504)	(1.712)				(1.883)	(0.572)			
Spain	0.053	0.230	−0.04	0.0303	1.50	0.020	0.069	−0.07	0.0148	1.37
	(3.668)	(0.619)				(3.623)	(0.438)			
Sweden	0.038	0.013	−0.06	0.0163	1.63	0.018	−0.010	−0.09	0.0162	1.49
	(4.965)	(0.064)				(2.957)	(0.058)			
Switzerland	0.039	0.105	−0.05	0.0229	1.56	−0.004	0.322	−0.02	0.0333	1.93
	(3.625)	(0.376)				(0.293)	(0.904)			
Turkey	0.049	0.218	−0.03	0.0260	2.18	0.047	−0.111	−0.08	0.0348	1.36
	(3.997)	(0.688)				(3.679)	(0.299)			
U.K.	0.017	0.367	0.12	0.0164	1.93	0.002	0.518	0.37	0.0169	2.18
	(2.195)	(1.830)				(0.380)	(2.863)			

Note: the symbols *a* and *b* represent the intercept and slope coefficients; *t*-statistics are beneath in parentheses.

The inference, however, does not follow. Underlying it is a common confusion, confusion between a ratio and an absolute amount. The R^2 is, so to speak, the proportion of the glass that is full. The R^2 tells us very little when the size of the glass—the variability of the dependent variable and hence the total sum of squares, the denominator of the ratio—has changed.

This is the case throughout our sample. Temporal variations in inflation, nominal money growth, and bond yields in the United States and most foreign economies were generally much greater in the floating rate period than in the fixed. A higher R^2 can, therefore, be consistent with more residual variation and more slack in the relationships under floating rates—the empty portion of the glass being larger—or the converse.[13] What we want to look at instead are direct measures of the slack, the standard errors of estimate of the regressions. In most cases, these are substantially greater during the floating rate period. The median for the inflation rate regressions is 0.025 under floating versus 0.019 under fixed. In the individual inflation regressions, we see increases in 14 of the 19 instances.

Very much the same thing holds for nominal money growth and for bond yields—increases in the median standard errors in going from fixed to floating (from 0.044 to 0.053 for money; from 0.005 to 0.014 for yields) and in the standard errors of most of the relationships viewed individually (15 of 19 for money; 12 of 13 for yields). Two major differences between these relationships and those for inflation are the much lower correlations in both periods for money, and the declining, but still high, second-period correlations for yields. Another is the much larger residual variability in the money relationships than in the other two sets of relationships.

Comparing one period with the other, we see a pattern in the real money regressions largely similar to those described for the three nominal variables. Standard errors under floating are generally much higher than under fixed. Median figures are 0.047 and 0.065, respectively, and in only four individual instances (Belgium, France, Japan, and Spain) do we see a decline. At the same time, however, the R^2's in several of these regressions are higher under floating than in the comparable nominal money regressions, and in five of these cases there is a statistically significant relationship at close to, or better than, the 0.95 level. Canada and the United Kingdom, in particular, stand out. For both countries, we see an approximate one-to-one relationship with the United States under floating. The close, long-term correspondence of velocity behavior documented by Milton Friedman and Anna Schwartz (1982) for the United States and the United Kingdom has therefore continued to hold. Canada, evidently, has also become part of the process.

The real money regressions, thus, point to some continued nonmonetary transmission abroad from the United States under floating, while the bond-yield regressions point to capital-market transmission in particular, but those channels apparently were neither ubiquitous nor dominant.[14] Noticeably absent under both exchange rate regimes are the significant negative relationships between U.S. and foreign real money growth that would signal currency substitution as suggested in Brittain (1981).

The closest we come to observing stronger relationships under floating are those reported in table 5.8 for real income growth. Standard errors of estimate on average decline under floating (from a median figure of 0.022 to one of 0.017), are lower or approximately the same in over half of the individual comparisons, and decline markedly in the case of Austria, Germany, Japan, the Netherlands, and Spain. And in the first four instances, as well as in the cases of Canada, Norway, and the United Kingdom, the R^2 is also noticeably higher. In the other countries, no similar tendencies are apparent.[15]

This last set of results is not inconsistent with the theoretical proposition of increased independence under floating. The independence posited by theory is of nominal magnitudes rather than real magnitudes. To the extent that floating is accompanied by removal of barriers to trade and investment, international interdependence of real variables could increase.

In addition to removal of such barriers, two other real factors that could be influencing the real-income results is the convergence of trend real growth rates noted above and common oil-price shocks. Neither, however, can completely explain the results. Other comparisons we have made using first differences of real growth rates produce largely similar results to these reported for the growth rates themselves; although such differencing should largely eliminate trend effects. By the same token, oil-price shocks should have affected all of the relationships. This is obviously not the case.

The other possibility is that monetary factors are playing a role here, that domestic monetary policy remains linked under floating exchange rates—albeit less loosely over the longer run and to greatly varying degrees among countries—and that common monetary shocks in many countries have led to common real fluctuation. We explore this question further immediately below.

5.3.2 Monetary Authorities' Reaction Functions

The weight of the evidence in the *International Transmission* volume supported the view that foreign monetary authorities exercised considerable short-run monetary control under both fixed and (the then new) floating exchange rates. The long-run harmonization of inflation rates documented in section 5.2 above came about because of the persistent pressures of reserve flows on money growth whenever price-level divergences became significant. Such a Humean reserve-flow mechanism worked slowly and with lags, but the cumulative effects were clearly overwhelming in the long run. Since monetary authorities have been neither maintaining a clean float nor totally eschewing intervention, an interesting issue is whether this Humean reserve-flow channel still leads to international transmission of monetary impulses. The question is whether or not the effects on the money supply of official intervention are sterilized.

We address this question here, as in *International Transmission*, by examining whether reserve flows scaled by high-powered money have a significantly positive effect on money growth in a reaction function which also allows for response to inflation and the pace of economic growth. We had hoped to analyze it analogously to the approach followed in the earlier volume, to apply a consistent functional form to quarterly data for each country in the period since 1974. Unfortunately, we soon confronted data and modelling problems nearly as severe as those reported in the earlier study. Rather than take on that task at this juncture, and without the good counsel of Anna and our other colleagues, we instead report some exploratory results which we trust will be persuasive as to the value of pursuing these issues further.

Table 5.9 summarizes the results of what Leamer (1978) has termed specification searches for the thirteen countries for which quarterly data were available. A variety of lag structures were examined in an attempt to find a compact, minimal standard error of estimate representation of the data. Significance levels must, therefore, be viewed with considerable skepticism. For 11 of the 13 countries, plausible reaction functions were estimated in which monetary authorities tighten if real output or prices grow rapidly and do not fully sterilize the effects of intervention on money growth, at least in the long run. The Australian and French equations were not successfully fitted.

The results suggest that exchange-market intervention has continued to provide some degree of monetary linkage among these countries. The greater variability of inflation across countries since 1973 apparently reflects the quantitatively greater importance of money-growth versus exchange-rate goals, not the complete elimination of Humean reserve flows due to the exclusive pursuit of sterilized intervention. A surprising result is the apparent influence of reserve changes on American money growth. This differs sharply from the results reported in chapter 16 of our 1983 volume.

The difference is evidently due to our inclusion here of data for the latter part of the 1970s and for 1980. One of the major factors—perhaps *the* major factor—influencing Federal Reserve policy at that time was

Table 5.9 **Money Supply Reaction Functions Quarterly Data, 1974–86**

Country (Period)	Constant	Coefficients or Coefficient Sums: r/h	y_T	p	rho	$\bar{R}^2$	SEE	DW
Austria	0.04	1.71	−1.13	−3.72	0.40	0.686	0.029	1.88
(74Q1–86Q2)	(2.99)	(3.46)	(9.80)	(3.83)	(3.05)			
Australia	0.05	0.05	−3.40	−1.35	−0.10	0.020	0.049	2.06
(74Q1–86Q1)	(2.94)	(0.63)	(1.34)	(1.92)	(0.73)			
Canada	0.22	2.76	−7.22	−9.72	−0.06	0.212	0.092	2.00
(74Q1–86Q3)	(4.19)	(1.55)	(3.18)	(3.75)	(0.41)			
Finland	0.05	0.18	−1.63	−1.08	−0.72	0.160	0.042	2.08
(77Q1–86Q2)	(2.63)	(1.65)	(2.31)	(1.71)	(6.47)			
France	0.04	0.01	−2.73	−0.88	−0.60	−0.006	0.040	2.13
(74Q1–86Q2)	(2.15)	(0.08)	(1.06)	(5.28)	(5.28)			
Germany	0.04	0.52	−1.68	−3.03	−0.81	0.452	0.026	1.66
(74Q1–86Q4)	(9.56)	(3.71)	(3.31)	(6.65)	(9.84)			
Italy	0.06	1.63	−2.31	−1.11	−0.51	0.159	0.049	2.05
(74Q1–86Q3)	(4.39)	(2.76)	(1.93)	(2.79)	(4.21)			
Japan	0.02	1.25	−2.87	−0.99	−0.62	0.118	0.039	2.07
(74Q1–86Q4)	(3.36)	(2.48)	(2.64)	(2.57)	(5.67)			
Spain	0.05	0.37	−3.38	−0.87	−0.72	0.234	0.044	1.80
(74Q1–84Q4)	(2.94)	(3.44)	(2.82)	(1.72)	(6.91)			
Sweden	0.03	1.50	−0.38	−1.51	0.53	0.129	0.037	2.12
(76Q1–85Q2)	(1.47)	(2.23)	(2.02)	(1.93)	(3.84)			
Switzerland	0.01	0.69	−0.77	−1.36	−0.41	0.529	0.031	1.90
(74Q1–85Q4)	(1.35)	(5.43)	(2.26)	(2.38)	(3.09)			
United Kingdom	0.05	0.09	−1.61	−0.68	−0.14	0.172	0.024	1.85
(74Q1–86Q4)	(7.54)	(2.53)	(3.11)	(3.04)	(1.01)			
United States	0.04	0.56	−0.73	−1.19	−0.71	0.350	0.019	1.73
(74Q1–86Q4)	(7.04)	(2.13)	(2.46)	(4.28)	(7.36)			

Source: IMF, *International Financial Statistics.*

Notes: Figures in parentheses are absolute values of *t*-statistics. All regressions were run using the Cochrane-Orcutt method to take account of first-order autocorrelation. The dependent variable was the change in the logarithm of M1. The symbols r/h, y_T, and p represent the three independent variables: scaled reserves—the ratio of the change in the level of central bank holdings of foreign reserves to the level of high-powered money at the start of the period; (transitory) real income growth—the difference between the change in the logarithm of real GNP and the slope coefficient from a regression of logarithm of real GNP on time during the previous twenty quarters; and inflation—the change in the logarithm of the cost of living index. The specific variants of all three were determined empirically for each country separately and took the forms noted below.

Austria: r/h was the sum of lags 0 to 11 constrained to a uniform distribution; y_T was the sum of lags 1 to 3 constrained to a uniform distribution; p was the sum of lags 2 and 3.

Australia: r/h was the contemporaneous value; y_T was the sum of lags 1 to 20 constrained to a Pascal distribution; p was lag 2.

Canada: r/h was the sum of lags 0 to 20 constrained to a Pascal distribution; y_T was the sum of lags 2 to 5 constrained to a first-degree polynomial with a tail constraint; p was the sum of lags 2 to 5 constrained to a first-degree polynomial with a tail constraint.

Finland: r/h was the sum of lags 0 to 20 constrained to a Pascal distribution; y_T was the sum of lags 3 to 6 constrained to a uniform distribution; p was lag 3.

France: r/h was lag 2; y_T was the sum of lags 0 to 12 constrained to a Pascal distribution; p was lag 3.

Germany: r/h and y_T were the sums of lags 0 to 20 constrained to a Pascal distribution; p was the contemporaneous value.

Italy: r/h was the sum of lags 0 to 12 constrained to a first-degree polynomial; y_T was the sum of lags 0 to 8 constrained to a first-degree polynomial; p was lag 1.

Japan: r/h and y_T were the sums of lags 0 to 20 constrained to a Pascal distribution; p was lag 1.

Spain: r/h was the contemporaneous value; y_T was the sum of lags 0 to 16 constrained to a Pascal distribution; p was lag 4.

Sweden. r/h was the sum of lags 0 to 20 constrained to a Pascal distribution; y_T was the sum of lags 4 to 6; p was lag 2.

Switzerland: r/h was the sum of lags 0 to 20 and y_T the sum of lags 0 to 12, both constrained to Pascal distributions; p was the contemporaneous value.

United Kingdom: r/h was the contemporaneous value; y_T was the sum of lags 2 to 5 constrained to a uniform distribution; p was lag 3.

United States: r/h was lag 2; y_T was the sum of lags 0 to 20 constrained to a Pascal distribution; p was lag 3.

the combination of a falling dollar, a balance of payments deficit, and resultant pressures from policymakers abroad. When the impact of a change in reserves is allowed to vary between the intensive intervention period (defined as 1978 fourth quarter to 1981 first quarter) and the rest of the period, only the intervention-period effect appears to matter. The separate coefficients estimated in a regression that is otherwise nearly identical to the one reported in table 5.9 for the United States was 1.29 with a t value of 2.99 for scaled reserves during the intervention period, and 0.18 with a t value of 0.59 for the same variable during the remainder of the period.

5.4 Conclusions

The principal finding of this paper is that flexible exchange rates have indeed been accompanied by greater long-run monetary policy independence. Across the sample of twenty OECD countries that we have examined, nominal variables have behaved differently under flexible exchange rates than under fixed. The differences, moreover, are exactly the sort that theory suggests under the two regimes.

Inflation rates, nominal bond yields, and monetary policy became more variable under floating rates, and the positive, longer-term covariance between nominal and real rates of money growth that was necessarily a hallmark of the fixed rate system became weak or virtually nonexistent.

This does not mean, however, that we interpret our findings as indicating that the world became less interdependent across the board or that policymakers in one country actually operated without regard to policy and other developments abroad. On the contrary, both actual observation of what went on in this period and a number of the empirical findings reported in the paper—most notably the continued substantial or rising correlations between bond yields in the United States and abroad, and the apparent continued relationship between the scaled balance of payments and monetary growth in most major countries—suggest that interdependence of capital markets, in particular, increased and that central bankers often hesitated to go it completely alone. The Humean monetary channel of transmission, though greatly weakened, did not entirely cease to exist, while other channels may have strengthened.

If long-run independence increased, then how can we explain the two waves of inflation that shook most of the industrialized world in the middle and late 1970s, as well as the disinflation and now apparently increasing inflation in many countries during this decade?

The first episode of inflation, as our earlier work with Anna Schwartz indicated, is best understood as a lagged response to coordinated expansive monetary policies in place under Bretton Woods, with the initial oil-price shock lending a helping hand. The second bout, we believe, can be explained by vestiges of the same type of process. Policymakers, according to our results, in most instances continued to react to balance-of-payments inflows and outflows. In many instances, too, the desire for stability of either interest rates or exchange rates, and sometimes both, continued to exert a powerful attraction. Central bankers' reactions evidently were much more sporadic, and the coordinated movements in domestic monetary policies were, therefore, much more attenuated than under fixed exchange rates.[16] Hence, we find a continued commonality in the movements of inflation rates internationally, but a much greater disparity around the averages.

Now let us turn to several puzzling questions. One is the reason for the differences in the year-to-year relationships estimated for money growth and for inflation. Our inclination is to attribute this difference to lags and the generally more random nature of fluctuations in money supply growth than in inflation rates. An additional factor that may be operating is the shift in the demand for money in the United States in the 1980s. It has very likely drastically reduced the accuracy of actual U.S. money growth as an indicator of excess money growth and thus affected the estimated relationships between it and foreign money growth.

The other two puzzles have to do with the underlying causes of monetary policy behavior. For the United States, as we have pointed out, balance-of-payments considerations emerge in our estimated reaction functions as an influence on policy over this sample period, at least for the Carter intervention era. These results stand in contrast to those reported in *International Transmission* for a much more abbreviated set of observations under floating, which exclude the Carter years.

In addition, for all twenty countries taken as a whole, the data point to monetary growth targets apparently being chosen independently of their inflation consequences. This may reflect the existence of a multiplicity of policy goals in most countries, or perhaps merely the statistical dominance of several countries in which growth in the demand for money was ignored by policymakers, being viewed as of only secondary importance.

Notes

1. The most often cited statements on the subject are Milton Friedman's classic article, "The Case for Flexible Exchange Rates" (1953), and Harry G. Johnson's sequel article of a decade and a half later, "The Case for Flexible Exchange Rates: 1969." With regard to Friedman's article it is important to

note that his argument is not that a system of floating rates will provide a country with complete insulation from economic developments abroad, but that there will "be little of no effect through purely monetary channels" (p. 200).

2. In the presence of the Darby (1975) effect and differential tax effects in different countries, the implications for real rates of the "no arbitrage profits" assumption become difficult to determine. Those difficulties are beyond the scope of this paper.

3. See, for example, Williamson (1983, 1985) and the list of references cited in the concluding chapter of the former.

4. A potential problem with examining money growth rates alone is that the behavior of the real quantity of money demanded may differ among countries because of differing rates of real growth, differences in income elasticities, or differences in the behavior of the portmanteau variable. Friedman (1971), Lothian (1976), and Michael Bordo and Lars Jonung (1987) all contain discussions of differing demand-for-money behavior among countries.

5. We can express the standard error of estimate, SEE, as

$$\text{SEE} = [(S_m - bS_{m-p})df]^{1/2},$$

where S_m is the standard deviation of nominal money growth, S_{m-p} is the standard deviation of real money growth, b is the regression coefficient, and df is a correction for the difference in degrees of freedom.

Since df is constant from one period to the next and S_{m-p} should not necessarily change, we can ignore both terms. An increase in SEE in going from fixed to floating will, therfore, require an increase in S_m, a decrease in b, or some appropriate algebraic combination of changes in the two.

6. In a considerable number of instances we encountered breaks in these data, and in several cases, missing observations. Breaks were corrected by interpolation. Publications of the OECD and the *Economist* Intelligence Unit provided most of the missing data. In the case of Portugal we omitted 1986.

7. These standard deviations are of the individual yearly observations about the mean for all countries in that year. For example, for 1956, the first year within the fixed rate period, a standard deviation like the ones plotted in the figures is computed as

$$(\sum_{i}^{n} (x_{i11} - \bar{x}_{.11})^2/(n - 1))^{1/2},$$

where x_{ijt} is variable x in country i ($i = 1, \ldots, n$) in period j ($j = 1,2$) in year t ($t = 1, \ldots, Tj$), and $\bar{x}_{.11}$ is the mean of the observations for all n countries in year 1 of period 1.

8. We have divided the exchange rate periods at 1973, the year during which the Bretton Woods system of fixed-rate parities broke down totally. The break in the behavior of most of the variables plotted in the figures actually comes later. Dummy variable regressions run on these standard deviations generally confirm this impression. The dummy that minimized the standard errors of such regressions necessarily maximizes the regressions (or between-period) sum of squares. This generally occurs for a dividing line between the two periods of 1976.

A relatively late break of this sort, moreover, makes sense. Given an approximate two-year lag between changes in money and in prices, the monetary excesses of the early 1970s would not be felt fully in prices until 1974–75. As inflation neared its peak, most countries' monetary authorities could have been expected to reduce their domestic rates of monetary growth, as most in fact did. Not until 1976 or 1977, therefore, would any large divergences in policies among countries begin to become manifest.

9. Using the same notation as in note 7, we can, for example, write the standard deviation for the first (the fixed rate) period as

$$\left(\sum_{i=1}^{n} (\bar{x}_{i1.} - \bar{x}_{.1.}) / (n - 1)\right)^{1/2},$$

where $\bar{x}_{i1.}$ is the mean of all of the yearly observations for country i in period 1, and $\bar{x}_{.1.}$ is the mean of the yearly observations for all n countries in period 1.

10. The estimates were derived from regressions for the two periods combined of country-average data for each of the periods. For each sample, we regressed the rate of growth of real M1 on the rate of growth of real income and on a measure of the change in the cost of holding money—the change in the government bond yield for the fourteen countries and the average acceleration in inflation for the twenty.

11. The one regression is a linear transformation of the other. The slope coefficient in the regression of nominal on real money growth is equal to one plus the slope coefficient in the regression of inflation on real money growth.

12. Express each variable as the sum of a true value and an error:

(a) $$m = m^* + \epsilon$$
(b) $$p = p^* + \eta$$

where an asterisk now designates a true value. Assume that the errors are independent of one another and of the true values, and that all variables are in the form of deviations from their means. Assume that

(c) $$m^* = \beta\,(m - p)^*.$$

The coefficient b in a regression of m on $(m - p)$ is

(d) $$b = \frac{E[m\,(m - p)]}{\sigma^2_{m-p}},$$

$$= \frac{E\{(m^* + \epsilon)\,[\,(m - p)^* + \epsilon - \eta]\}}{\sigma^2_{m-p}},$$

$$= \frac{E[m^*\,(m - p)^* + \sigma^2_\epsilon}{\sigma^2_{(m-p)^*} + \sigma^2_\epsilon + \sigma^2_\eta}.$$

Substituting from (c) into (d) we have:

(e) $$b = \frac{\beta\sigma^2_{(m-p)^*} + \sigma^2_\epsilon}{\sigma^2_{(m-p)^*} + \sigma^2_\epsilon + \sigma^2_\eta}.$$

We rewrite this in turn as:

(f) $$b = \beta w + (1 - w)\lambda,$$

where

$$w = (\sigma^2_{(m-p)^*}) / (\sigma^2_{(m-p)^*} + \sigma^2_\epsilon + \sigma^2_\eta),$$

and

$$\lambda = \sigma_\epsilon{}^2 / (\sigma^2_\epsilon + \sigma^2_\eta).$$

The estimated coefficient is therefore a weighted average of the true coefficient and the ratio of the variance of the error in money growth to the sum of the variances of the errors in money growth and inflation. The weights are the share of the variance of the true value of $m - p$ in the total variance (inclusive of the two errors) and one minus that share.

13. For example, the standard deviation of the yearly U.S. inflation rate increased from 0.017 in the fixed rate period to 0.033 in the floating rate period. Those figures translated into sums of squared deviations from the period means of 0.0048 and 0.0169, respecitvely.

If we use these as an index and, in effect, view the regressions as reversed, we can calculate what a given correlation under fixed would have to increase to under floating to keep the standard error constant. For a fixed-rate-correlation coefficient of 0.50—roughly the median for the period—the corresponding figure under floating rates turns out to be 0.67. This is almost 35 percent higher than the initial figure and well above the actual period median.

14. Regressions run using first differences of bond yields show higher correlations under floating rates than under fixed. The median R^2 is 0.15 in the floating rate case and 0.34 in the fixed rate case. For all of the countries viewed individually, except Canada, for which the R^2 is constant, we also see an increase under floating. Consistent with the level results, however, standard errors of estimate in these regressions also generally rise. Hence, while long-run differences in the levels of interest rates among countries increased under floating, the shorter-run correspondence of their direction of movement apparently did also. See Krol (1986) and Swanson (1987) for further evidence in this regard.

15. Marianne Baxter and Alan Stockman (1987), also using multicountry data, find mostly lower correlations between foreign and U.S. quarterly indexes of industrial production during the floating rate period when the data are in the form of logarithmic first differences, but higher correlations in a number of instances when the data are in the form of deviations from semilogarithmic trends. Since the latter are apt to be smoother series and thus more akin to the annual (real income) data we use, we do not believe that there is any glaring contradiction between our results and theirs.

16. Canada, Germany, and Japan provide interesting examples of how the links between policies actually operated. For Canada, the Bank of Canada's attempts to stabilize spreads between Canadian and U.S. interest rates appears to have been the principal force. (See Bordo, Choudhri, and Schwartz 1987, and Gregory and Raynauld 1985.)

In Germany and Japan, in contrast, examination of data for the balance of payments and for high-powered money indicates that intervention in the foreign exchange market was the major infuence. In both countries, the official settlements balance went into substantial surplus, and growth rates of high-powered money increased considerably in 1978. The two were in line with the much increased balance-of-payments deficits in 1977 and 1978, and the roughly parallel acceleration in high-powered money in 1978 in the United States. The strong relationship of policies in both countries to policy in the United States in these years is further brought out in a series of contributions of Bundesbank and Bank of Japan officials in Meek (1983).

This correspondence between monetary conditions in Germany and Japan with those in the United States was more episodic in nature than continual and, as a result, weaker than for Canada versus the United States. As the annual regressions reported above indicate, the correlations of M1 growth in both countries with M1 growth in the United States were low for the floating period as a whole. Other regressions that we ran using annual growth rates of high-powered money tell a similar story: R^2's of 0.11 for both Germany and Japan vs. the United States.

Batten and Ott (1985) report results derived from an analysis of the relative effects of weekly U.S. M1 innovations on forward exchange rates and foreign interest rates consistent with this description of intercountry differences in the relationships with the United States.

References

Batten, Dallas S., and Mack Ott. 1985. The interrelationship of monetary policies under floating exchange rates. *Journal of Money, Credit and Banking* 17 (February): 103–10.

Baxter, Marianne, and Alan C. Stockman. 1987. For what does the exchange rate system matter? University of Rochester. Typescript.

Bordo, Michael D., Ehsan U. Choudhri, and Anna J. Schwartz. 1987. Money growth variability and money supply interdependence under interest rate control: Some evidence from Canada. *Journal of Money, Credit and Banking* 19 (May): 181–98.

Bordo, Michael D., and Lars Jonung. 1987. *The long run behavior of velocity: The international evidence.* Cambridge: Cambridge University Press.

Brittain, Bruce. 1981. International currency substitution and the apparent instability of velocity in some Western European economies and in the United States. *Journal of Money, Credit and Banking* 13 (May): 303–24.

Darby, Michael R. 1975. The financial and tax effects of monetary policy on interest rates. *Economic Inquiry* 13 (June): 266–76.

Darby, Michael R., and James R. Lothian. 1983. Conclusions on the international transmission of inflation. In *The international transmission of inflation,* Michael R. Darby, James R. Lothian, and Arthur E. Gandolfi, Anna J. Schwartz, and Alan C. Stockman. Chicago: University of Chicago Press.

Davutyan, Nurhan, and John Pippenger. 1985. Purchasing power parity did not collapse during the 1970s. *American Economic Review* 75 (December): 1151–58.

Friedman, Milton. 1953. The case for flexible exchange rates. In *Essays in positive economics,* ed. Milton Friedman. Chicago: University of Chicago Press.

______. 1971. Government revenue from inflation. *Journal of Political Economy* 79 (July/August): 846–56.

Friedman, Milton, and Anna J. Schwartz. 1982. *Monetary trends in the United States and the United Kingdom.* Chicago: University of Chicago Press.

Gregory, Allan W., and Jacques Raynauld. 1985. An econometric model of Canadian monetary policy over the 1970s. *Journal of Money, Credit and Banking* 17 (February): 826–35.

International Monetary Fund. *International financial statistics.* Various issues and companion computer tapes.

Johnson, Harry G. 1969. The case for flexible exchange rates: 1969. *Federal Reserve Bank of St. Louis Review* 51 (June): 12–22.

Krol, Robert. 1986. The interdependence of the term structure of Eurocurrency interest rates. *Journal of International Money and Finance* 5 (June): 245–53.

Leamer, Edward E. 1978. *Specification searches: Ad hoc inferences with nonexperimental data.* New York: John Wiley and Sons.
Lothian, James R. 1976. The demand for high-powered money. *American Economic Review* 66 (March): 56–68.
———. 1985. Equilibrium relationships between money and other economic variables. *American Economic Review* 75 (September): 828–35.
———. 1986. Real dollar exchange rates under the Bretton Woods and floating-rate regimes. *Journal of International Money and Finance* 5 (December): 429–48.
Meek, Paul, ed. 1983. *Central bank views on monetary targeting.* New York: Federal Reserve Bank of New York.
Schwartz, Anna J. 1983. The postwar institutional evolution of the international monetary system. In *The international transmission of inflation,* eds. Michael R. Darby, James R. Lothian, and Arthur E. Gandolfi, Anna J. Schwartz, and Alan C. Stockman. Chicago: University of Chicago Press.
Swanson, Peggy E. 1987. Capital market integration over the past decade: The case of the U.S. dollar. *Journal of International Money and Finance* 6 (June): 215–26.
Swoboda, Alexander K. 1983. Exchange rate regimes and U.S.-European policy interdependence. *International Monetary Fund Staff Papers* (March): 75–102.
Williamson, John. 1985. On the system in Bretton Woods. *American Economic Review* 75 (May): 74–79.
———. 1983. *The exchange rate system.* Washington, D.C.: Institute for International Economics, September.

Comment Alan C. Stockman

Michael Darby and James Lothian have written a useful paper presenting evidence on the international transmission of inflation under alternative exchange rate systems. Their evidence is consistent with the hypothesis that policymakers gained independence for monetary policy under floating exchange rates in the long run. They also study the short-run links between inflation across countries, comparing statistical relations in pegged and floating exchange rate systems, which they associate with the time periods 1956–73 and 1974–86.

Darby and Lothian first discuss long-run relations in growth rates of prices, nominal money, and real money across countries. They argue that the adoption of floating exchange rates permitted a greater degree of monetary independence in the long run. Darby and Lothian present two types of evidence for this claim.

First, they look at the cross-country variances of average rates of growth of prices and money in the two periods. They find greater

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variance across countries of average inflation and bond yields (and, in their larger twenty-country sample, of average nominal money growth) in the floating period. They also find a smaller cross-country variance in average real income growth and real money growth in the floating period. The interpretation of these findings given in their paper is straightforward: nominal money and prices were constrained for each country in the long run under pegged exchange rates.

Second, Darby and Lothian show that the correlation across countries between average nominal money growth and average real money growth fell substantially from the pegged to the floating period. They argue that this is the expected result if pegged rates constrained monetary policy and prices in the long run, while floating exchange rates granted some monetary independence. Under pegged rates, an exogenous increase in the nominal money supply cannot be sustained in the long run (without a devaluation), while an increase in real money demand requires a higher nominal money supply because the domestic price level is constrained by the world price level. Given the world price level, then, real and nominal money move together in the long run. Under floating rates, on the other hand, an increase in the nominal money supply raises the price level and affects real money holdings only insofar as it raises expectations of inflation and nominal interest rates (and would be expected to reduce rather than raise real money demand); an exogenous increase in real money demand lowers the price level without necessarily affecting nominal money supply. So under floating rates, the correlation between real and nominal money growth could be smaller than under pegged rates.

This result does not follow unambiguously from theory. Changes in real money demand may be correlated across countries in the long run (just as seasonal changes in money demand are clearly correlated across countries). If so, the correlation between the growth rates of the real and nominal stocks of money could be arbitrarily small under pegged exchange rates (because the world price level would adjust as world money demand changes). Similarly, the correlation between real and nominal money growth could be high under floating rates if changes in the quantity of real money demanded are accommodated by monetary policy (as if, for example, the policymakers are targeting the price level or nominal interest rates with monetary policy).

The long-run relationships that Darby and Lothian seek from the data could perhaps be better investigated by testing for cointegration of nominal money and real money under pegged exchange rates, that is, for the existence of a common trend in both variables. Their argument implies that a common trend in nominal money and real money exists under pegged exchange rates because, under their hypothesis, these variables must move together in the long run. Their argument about the long run allows for any arbitrary short-run behavior of nominal and real money, and the tests for cointegration also permit arbitrary short-run behavior around the common trend. Their argument also implies that this common trend vanished under floating rates as nations took advantage of the long-run monetary independence that floating offered.

Overall, there is likely to be little controversy over the conclusions reached in the paper about long-run relationships. One important policy issue that the evidence presented in the paper is not capable of addressing involves the reasons for higher average inflation in the flexible exchange rate period. In particular, it is possible that the system of floating exchange rates eliminated a constraint on monetary policy that, other things being the same, would have kept money growth and inflation lower had pegged rates been maintained. If so, the benefits from lower money growth and inflation would have to be weighed against the costs due to losses from other policies, such as greater barriers to international trade and financial flows that might also be associated with pegged exchange rates.

The most controversial issues connected with this paper concern the short run. Darby and Lothian argue that there was some short-run independence of monetary policies under pegged exchange rates. They cite the following evidence. First, annual time-series regressions of inflation in each country on inflation in the U.S. have higher standard errors (as well as higher correlation coefficients) in the floating rate period than in the pegged rate period. Darby and Lothian interpret this as a measure of short-run "slack" in the relationships connecting national inflation rates. The same results are obtained from time-series regressions of nominal or real money growth in each country on the corresponding U.S. variable. Darby and Lothian also show that time-series regressions of the growth of real income in each country on U.S. real income growth typically yield lower standard errors and higher correlations in the floating rate period. They interpret this result as reflecting nonmonetary dependencies across countries that may have expanded with the increases in international trade and financial market liberalization that accompanied the floating rate period.

One interesting issue that arises here concerns the interpretation of the short-run and long-run results. Under one interpretation of the notion that countries had some degree of monetary independence in the short run under pegged exchange rates, a country with a pegged exchange rate could increase its nominal money supply and price level in the short run but not in the long run. In that case, we should see some intrinsic dynamics of the exchange-rate-adjusted ratio of price indexes. That is, when countries on pegged exchange rates experience high short-run money growth and inflation rates that exceed world inflation, those experiences should typically be followed by inflation rates that are lower than world inflation (or a devaluation). But there is evidence on exchange-rate-adjusted price ratios that suggests otherwise. There is some evidence that ratios of price indexes across countries, adjusted for exchange rates, are nonstationary random variables—close to random walks—under both exchange rate systems. This is consistent with temporary, serially-independent differences in inflation rates across countries under pegged exchange rates. It suggests that there may have been very little scope for independent monetary policies and inflation, even in the short run, under pegged exchange rates. Factors that caused divergence of relative price levels across countries (and of money stocks, given real money demand) were equally operative in the short run and long run. Highly persistent or permanent changes originating in the real sector of the economy could change equilibrium relative prices (including relative prices of nontraded goods, the terms of trade, and so on), and these changes would seem to be the most likely candidates to explain cross-country differences in the behavior of prices and nominal money.

Short-run effects of monetary policies are unlikely candidates to explain the short-run behavior of prices because one would then expect to see subsequent reversals in price behavior as the economy adjusted to the long run, and this is contrary to the random-walk evidence. It is true that the evidence that exchange-rate-adjusted price ratios are random walks is weak; they may be stationary autoregressive processes with a high degree of persistence, typically taking at least five to ten years to return halfway back to their mean values following a disturbance. But this very high degree of persistence reduces the plausibility of explanations for cross-country differences in price behavior (under pegged rates) that are based on short-run effects of money growth. There are many other plausible explanations. For example, some countries may have experienced greater increases in some years in relative prices of nontraded goods; given international arbitrage in prices of traded goods, this raises the domestic price level and (given real money demand) the nominal money stock. If changes such as these were highly persistent or permanent, then they could explain the evidence on the time-series behavior of relative international price levels.

The result that real income growth is more highly related to U.S. real income growth in the recent floating rate system deserves further study. In recent work, Marianne Baxter and I have studied the behavior of some main macroeconomic and international trade variables under alternative exchange rate systems. We found little evidence that the exchange rate system is connected with the behavior of most of these variables, including real income growth. However, we uncovered some (weak) evidence that output fluctuations became more country-specific and less worldwide in the post-1973 period.

One major problem faced by economists studying the effects of alternative exchange rate systems involves distinguishing effects of the exchange rate system per se from the effects of different time periods under study. This problem can be solved by using cross-sectional information from countries that floated prior to 1973 (such as Canada) and from countries that maintained pegged rates after 1973 (which includes many countries, mainly LDCs) and from mixed arrangements such as the EMS. My casual observations suggest that further study of the long-run relations will support the conclusions reached by Darby and Lothian. The short-run problems are more difficult, as usual.

General Discussion

BRUNNER said that Alan Stockman's remarks reminded him of a study prepared by his group at the University of Bern. They investigated the response of the Swiss National Bank to changes in the Deutschemark–Swiss franc exchange rate, finding a systematically asymmetric response pattern centered around a critical benchmark of 80 francs to DM100. Whenever the Deutschemark rate approached the benchmark and threatened to move lower, the National Bank raised the growth rate of the monetary base. Improvements of the Deutschemark rate did not systematically induce a retardation of the Swiss monetary base.

Brunner also commented on the concept of the reaction function. Its formulation usually involves a relation between money stock (or bank credit) and a selection of economic determinants presumed to guide policy action. This relationship, however, meshes the structure of the money supply process with the response of policy variables to the state of the economy. It is not an informative formulation and may lead to false inferences. A long lag of the dependent variables behind the selected guide variables has generally been attributed to a recognition lag, when it actually results from a misinterpretation by the authorities of their own actions. But the notion of a reaction function suffers from an even more fundamental flaw, at least for the U.S. A detailed study of Federal Reserve policymaking reveals that there is no such thing as a stable reaction function. Policymakers find it politically inadvisable to tie themselves to a regular pattern. Their responses to various conditions change over time and the weights attached to specific aspects of the state of the economy shift. He concluded that the search for a stable reaction function is futile and yields little insight into our policymaking procedures.

DARBY responded that reaction functions do play a role in describing the average behavior of policymakers but not as a guide or a reference point. In response to a point raised in Stockman's comment, Darby attributed the fact that the standard deviation of industrial production sometimes rose in the floating rate period—whereas he and Lothian found that the standard deviation of GNP tended to fall in the same period—to the greater short-run variability of the relative prices of tradables versus nontradables. Because industrial production is largely the production of tradables, more variability in shifts between the tradable and nontradable sectors is observed despite the fact that at the same time—because there is less variation in money and output—less variability occurs in real GNP.

MCCALLUM made the point that Brunner's view of reaction functions does not imply that policymakers do not have stable preferences, rather, it implies that they will not tell us what they are.

BRUNNER agreed that he does not deny stable preferences, but suggests that we need to be careful in understanding to what the preferences apply. In his judgment they do not apply to the usual variables selected (inflation, unemployment, etc.) but to more fundamental political objectives (e.g., the range of admissible actions and the level of public criticism or approbation). These objectives, expressed by a utility function, yield, together with some political constraints, a shifting and unpredictable response to the usually emphasized variables. According to him, the work by Alex Cukierman and Allan H. Meltzer gets closest to the reality of the problem.

LOTHIAN, MELTZER, and MCCALLUM made the point with respect to the Federal Reserve's reaction function that although the Fed has always tried to peg the federal funds rate, it has varied its target rate in different periods in response to different conditions. Thus, according to Meltzer, they responded differently when they wanted to disinflate in 1979 than when they wanted to expand in 1976, or in 1986 when they wanted to drive down the nominal exchange rate.

O'DRISCOLL argued that it is not clear that there is not a set of stable constraints. Particularly in a fiat money regime, it is not clear that the central bank can resist shifting political forces.

LAIDLER expanded on Stockman's point about the importance of distinguishing between a break in the time series and a break in the exchange rate regime in evaluating the correlations between nominal and real money balances in table 5.2. According to him, the period 1956 to 1973 was characterized by relatively low money growth, low inflation and interest rates, and stable real growth, in contrast to the subsequent period characterized by high inflation and interest rates, and wide swings in real output.

Laidler also suggested that an application of Hayek's model of competing monies to central bank behavior in a flexible exchange rate regime leads to the implication that market mechanisms such as currency substitution would, over time, discipline central banks to produce greater exchange rate stability. He asked whether Darby and Lothian observed such a tendency in their data.

LOTHIAN responded that their data showed no evidence of currency substitution in the form of a negative correlation between real cash balances in one country and in another. He agreed with Laidler that central banks learn over time, but doubted if this was by the Hayekian mechanism. Instead he stressed the importance of political forces, giving as an example the disinflation of 1980. In response to Laidler's comment on the break point of the data, Lothian argued that the demarcation between periods chosen may have biased the case somewhat against their findings.

DARBY pointed out that much of the increase in trade volume and integration of capital markets that has occurred since 1973 is regime related. Since the advent of floating rates, governments no longer have the excuse of pressure on international reserves to maintain exchange and capital controls.

MELTZER addressed the question of whether the Hume mechanism or some other adjustment mechanism is dominant. He argued that, in retrospect, both are dominant depending on the period and the nature of the shocks in that period. For example, the response to real shocks, if they were dominant, may induce an increase in productivity in country A which sends capital flowing to it from country B. Eventually country B's income will increase in the form of repatriated return on investment, but that may take a very long time. In this particular example, most of the adjustment is in the capital market, but for another kind of shock, the adjustment may occur mainly in some other market. Both adjustments operate in different proportions under different regimes.

LOTHIAN agreed with Meltzer. According to him, the story that emerges from both the tests and the more descriptive part of their paper is that the Humean mechanism continued to be of considerable importance under floating rates.

M. FRIEDMAN distinguished two different meanings of fixed exchange rates. Fixed rates resulting from unified currencies, in which case central banks have no role. And fixed rates that are pegged rates, in which case central bankers are very important. Under pegged rates, he stated, exchange rate problems always come up and central bankers are the ones to turn to when you run into exchange rate problems. Moreover, he felt that the self-interest of central bankers would be better served by a fixed exchange rate regime than by a floating rate regime, because a fixed rate regime gives them greater independence from domestic political forces. Central bankers can always point to external pressures to explain why they cannot accommodate the politicians.

Friedman then amplified Laidler's point that central banks have been going through a very important learning process about how to live in a world of floating exchange rates. According to him, although there is evidence of learning by central banks, this does not mean that they do not make mistakes. Nineteen seventy-one marked the introduction of an historically unprecedented monetary system in the world. It was the first time that all countries were on a pure fiat currency standard, hence it is not surprising to him that it took them some time to settle down and figure out how to handle it. In the process, they produced a worldwide inflation in the 1970s. Friedman stated that his belief that the central banks have settled down is shown by the widespread disinflation policies in 1979, and by the reluctance that Japan and Germany have recently demonstrated to yield to pressures coming from the United States to inflate.

Bordo pointed out that central banks are opposed to actually creating unified currency areas, but at the same time they frequently engage in working out exchange rate arrangements—for example, recent initiatives at policy coordination—which will preserve their important role.

Stein characterized a fixed exchange rate regime as one where, for a period of time, the exchange rate does not change, but then when it changes, it does so by a discrete amount. In other words, he characterized the fixed exchange rate period as a series of step functions. Under fixed rates, inflation rates can frequently diverge among countries while exchange rates are held fixed, but then when countries find that their price levels are way out of line, there will be a discrete adjustment in exchange rates. The process will then repeat itself. Stein asked whether continuity was better than discontinuity.

Darby agreed with Stein's characterization of the fixed rate regime. This was the view expressed by him, Lothian, Gandolfi, Schwartz, and Stockman in the *International Transmission of Inflation* volume. In his paper with Lothian, he viewed the key question as whether or not the fixed rate system was fundamentally different from the flexible rate period in terms of variability of inflation. That is, were the pegs more binding than the current transient goals, such as they are. He viewed their evidence as saying that in the recent period the transient goals were much less binding than the pegs were previously. Although they did find large changes under Bretton Woods, the variance in the average rate of change was less. There was in fact more harmonization under the Bretton Wood system for nominal variables than under floating rates.

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