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International Transmission Afloat

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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 view among economists and in a sizeable 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, short 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" (1983, p. 510).

Anna in her historical overview (1983, p. 25) of the period

pointed to the reason why:

> A variety of measures, adopted in countries with over- or under-valued 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, p. 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 at a conference in her honor. We examine the behavior of policy variables and other important economic variables across a sample

of 20 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 clearcut: Policymakers did gain a considerately greater degree of long-run independence under floating rates. The cross-country variability of nominal variables--average rates of inflation, average rates of monetary growth, and average rates 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 various countries' monetary authorities 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.

I. 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 also are 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:

$$e = m - L(y,i,u) - m' + L'(y',i',u'), \tag{5}$$

$$p = m - L(y,i,u), \tag{6}$$

$$p' = m' - L'(y,i,u). \tag{7}$$

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 with regard to how accurately equation (4) described the situation faced by a non-reserve country <u>in the short-run</u>. 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 with regard 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 with regard to the time dimension of the problem. The long run implicitly is 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 inter-country 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.[4]

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.[5] 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 of nominal cash balances supplied in different countries and under floating exchange rates little or no relationship. Correspondingly, under fixed rates we should observe no correlation between the quantity of real cash balances demanded and the price level and under

floating rates a zero or negative correlation.

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.

II. Empirical Results: Longer-Term Relationships

The data we use to compare the two regimes are for 20 OECD countries over the period 1956 to 1986. For all 20 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 14 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]

II. A. Cross-Country Variability

Evidence with regard to variability is contained in Charts 1 and 2. Chart 1 is for the entire 20 countries. Chart 2 is for the subsample of 14 countries. In both charts, we have plotted yearly cross-country standard deviations of rates of monetary growth and of inflation.[7] Chart 2 also includes a plot of the yearly cross-country standard deviations of bond yields.

Both measures of variability plotted in Chart 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 being particularly dramatic.[8] Chart 2 shows sizeable increases in inflation and in interest-rate variability at approximately the same time as the increases depicted in Chart 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 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 charts 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 1956-1973; the floating-rate period, the years 1974-1986. Table 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 charts -- 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; so 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 increases in excess M1 growth- - the difference between nominal M1 growth and our estimate of the growth of the real quantity of M1 demanded.

Another way to analyze it is in terms of the usual formula for the variance of an algebric 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 less twice their covariance. In the 14 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 20 country sample.

We interpret this as showing that 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 20 countries) is surprising since it suggests that foreign monetary authorities have selected nominal money targets with inflation a residual rather than selecting target trend inflation rates and choosing M1 growth trends which would achieve those targets. We turn next to further evidence in support of this interpretation.

II. B. Real Money Growth, Nominal Money Growth and Inflation

Table 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 .86 and .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 .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 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 towards 1.0. Measurement errors in prices will bias the coefficient in a regression of inflation on real money growth towards -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, that 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.

II. C. Bond Yields

In Table 3, we report estimates for each period separately 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, inter-country differences in rates of inflation will be transitory. Permanent differences require continuously changing

exchange rates. Under floating exchange rates inter-country 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 a higher correlations during that period. In practice, however, this cannot be the full explanation since variations in money growth across the 14 countries do not increase, yet the correlation of money growth and bond yields does.

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 on 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.

III. 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.

III. A. 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 alternately 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 4 through 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 rather than more, independence under floating. Consider the inflation-rate comparisons reported in Table 4.

Under floating rates,the correlation between U.S. and foreign inflation rates is actually higher: This is true on average and for a sizeable number of cases viewed individually. In going from fixed to floating, the median R^2 for these regressions rises from .21 to .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.

The inference, however, does not follow. Underlying it is a common 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 tell us very little when the size of the glass--the variability of the dependent variable and hence the total sum of squares of 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 -- 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 .025 under floating versus .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 both the median standard errors in going from fixed to floating (from .044 to .053 for money; from .005 to .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 the one period with the other, we see a largely similar pattern in the real money regressions to those described for the three nominal variables. Standard errors under floating generally are much higher than under fixed. Median figures are .047 and .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^2s 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 .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 Friedmen and Anna Schwartz (1982) for the United States and the United Kingdom has therefore continued to hold. Canada, evidently, also has become part of the process.

The real money regressions, thus, point to some continued non-monetary transmission from the United States to abroad 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 also 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 8 for real income growth. Standard errors of estimate on average decline under floating (from a median figure of .022 to one of .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 also is noticeably higher. In the other countries, no similar tendencies are apparent.

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 go full way in explaining 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 remained 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.

III. B. 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 II 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 pursing a clean float during 1974-1986 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 approach this question here, as in the International Transmission volume, 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 pursing these issues further.

Table 9 summarizes the results of what Leamer (1978) has termed specification searches for the 13 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 evidently is due to our inclusion here of data for the latter part of the 1970s and 1980. One of the major factors -- perhaps the major factor--influencing Federal Reserve policy then was the combination of a falling dollar, a balance of payments deficit and resultant pressures from policymakers abroad. When the impact of 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 9 for the United States are 1.29 with a t value of 2.99 for scaled reserves during the intervention period and .18 with a t value of .59 for the same variable during the remainder of the period.

IV. 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 20 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 necessarily was a hallmark of the fixed-rate system became weak or virtually non-existent.

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, therefore, much more attenuated than under fixed exchange rates.[15] 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 20 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 were ignored by policymakers as being of secondary importance.

NOTES

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The views expressed in the paper are those of the authors and should not be construed as necessarily representative of the institutional positions of either the United States Department of the Treasury or Citicorp.

1 The most often cited statements on the subject are Milton

Friedman's classic article "The Case for Flexible Exchange Rates" 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 or 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 and 1985) and the list of references cited in the concluding chapter of the former.

[4] Nurhan Davutyan and John Pippenger (1985) and Lothian (1986) present evidence on purchasing power parity consistent with this argument.

[5] 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 in the behavior of the promanteau variable. Friedman (1971), Lothian (1976), and Michael Bordo and Lars Jonung (forthcoming) all contain discussions of differing demand for money behavior among countries.

[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 1956, the first year within the fixed-rate period, for example, a standard deviation like the ones plotted in the charts is computed as

where x_{ijt} is variable x in country i (i=1,...,n), in period j (j=1,2) in year t (t=1,..., Tj)and $x._{11}$ 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 charts 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, morever, 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 footnote 7 we can, for example, write the standard deviation for the first (the fixed-rate) period as

where $x_{i1.}$ is the mean of all of the yearly observations for country i in period 1 and $x_{.1}$. 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 a measure of the change in the cost of holding money -- the change in the government bond yield for the 14 countries and the average acceleration in inflation for the 20.

[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

where as 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

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

substituting from (c) into (d) we have

can rewrite this in turn as

where w =

and

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 .017 in the fixed-rate period to .033 in the floating-rate period. Those figures translated into sums of squared deviations from the period means of .0048 and .0169, respectively.

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 .50 -- roughly the median for the period -- the corresponding figure under floating rates turns out to be .67. This is almost 35% 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 .15 in the floating-rate case and .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] 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 Raynaud, 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 influence.

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 paralleled acceleration in high-powered money in 1978

in the United States. The strong relationship of policies in both countries to policy in the United Stated in these years is brought out further 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 Untied 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^2s of .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 inter-country differences in the relationships with the United States.

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Table 1

Economic Variability under Fixed and
Floating Exchange Rates
1956 to 1986

	20 Countries		14 Countries	
Standard Deviation of:	Fixed	Floating	Fixed	Floating
M1 growth	.038	.060	.036	.031
Inflation	.014	.067	.008	.028
Bond yields	N.A.	N.A.	.010	.027
Excess M1 growth	.022	.065	.019	.035
Real income growth	.014	.009	.015	.010
Real M1 growth	.032	.022	.033	.017
Correlation of				
M1, real M1 growth	.929	.142	.978	.469

Source: See text

Note: Standard deviations are of country averages of annual data for the periods 1956-1973 and 1974-1986, respectively. Rates of growth are computed as changes in the logarithms of the series. Bond yields are in decimal form

Table 2

Regressions of Money Growth and Inflation
on Real Money Growth
Country-Average Data

Dep. Variable	Period	Constant	m-p	R^2	SEE
20 Countries					
m	1956-73	.037	1.102	.856	.014
		(6.315)	10.658		
p	1956-73	.037	.102	.001	.014
		(6.315)	.989		
m	1974-86	.110	-.381	.034	.061
		(7.956)	(.607)		
p	1974-86	.110	-1.381	.168	061
		(7.956)	(-2.200)		
14 Countries					
m	1956-73	.035	1.067	.953	.008
		(10.191)	(16.239)		
p	1956-73	.035	.067	.003	.008
		(10.191)	(1.018)		
m	1974-86	.081	.832	.155	.028
		(9.039)	(1.838)		
p	1974-86	.081	-.168	-.071	.028
		(9.039)	(.371)		

Source: See text.

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

Table 3

Regressions of Bond Yields and
Inflation and Money Growth
Country Average Data

Period	Constant	m	p	R^2	SEE
1956-73	.050	.130		.155	.010
	(8.025)	(1.842)			
1956-73	.041		.506	.087	.010
	(3.105)		(1.496)		
1974-86	.037	.772		.770	.013
	(3.250)	(6.665)			
1974-86	.037		.854	.742	.014
	(3.240)		(6.190)		

Source: See test

Note: The level of government bond yields (expressed as a decimal) is the dependent variable; absolute values of t statistics are in parentheses beneath the coefficients.