IV Variability of Exchange Rates

An assessment of exchange rate variability must be judgmental and is necessarily fraught with a variety of technical and conceptual difficulties. In this section, overall performance in terms of exchange rate variability is reviewed; the technical aspects are dealt with in a technical note at the end of this section. In order to assess the performance of the currencies participating in the EMS exchange rate mechanism, it would be desirable in principle to compare actual performance with estimated performance given the same exogenous world events, but in the absence of the EMS institutional apparatus. The requirements for constructing such a "counterfactual" experiment are, however, daunting. Therefore assessment has to be somewhat more limited and based on several elements: first, a comparison of exchange rate variability among the ERM currencies before and after the system's inception; second, a comparison of exchange rate variability between participating and nonparticipating currencies;[36] and third, an assessment of changes in exchange rate variability over time among the nonparticipating currencies. To the extent that a variety of different approaches all point in the same direction, some confidence can be placed in the results.

The broad conclusion of a previous analysis of exchange rate variability[37] was that ". . . it appears that the exchange rate variability of the EMS currencies has diminished since the introduction of the system . . . . In contrast, the exchange rate variability of the major currencies not tied to the EMS (the pound sterling, the U.S. dollar, and the Japanese yen) appears to have risen significantly." The present analysis differs from the former in four ways. First, the data used to perform the calculations have been extended by some three years. Second, the number of measures used to calculate variability has been increased (from one to three). Third, the changes in variability have been tested for statistical significance.[38] Fourth, several frequencies of exchange rate data (daily, weekly, and monthly) were examined to test the effect of data frequency on the measures of variability. This extended approach has broadly confirmed and strengthened the previous conclusions.

Conceptual Considerations

Interest in exchange rate variability arises from the belief that such variability imposes costs on economic agents. The nature of these costs is difficult to specify precisely, thus making agreement on an appropriate definition of variability also problematic. One argument is that exchange rate variations impose costs when they constitute variations away from equilibrium, in which case the variation around an equilibrium is the appropriate measure. There are, of course, great difficulties in attempting to define and measure equilibrium. It has been suggested that short-term swings of exchange rates around equilibrium are of minor importance, as the risks involved can be hedged, whereas medium- and long-term movements away from equilibrium may impose costly shifts in capital and labor resources between tradable and nontradable goods sectors, only for these shifts to be reversed as the exchange rate ultimately moves back. Indeed, such recent concern about exchange rate variability has, implicitly or explicitly, reflected a concern with the costs imposed by persistent and substantial deviations (overshooting or misalignments) of exchange rates from long-run equilibrium positions. Another argument is that unexpected exchange rate changes impose the most severe costs, in which case the relevant concept would be variation around an expected path, which also poses difficulties of measurement and interpretation. Measurement of the equilibrium exchange rate is beyond

[36] "Nonparticipating currencies" were selected on the basis of the importance of a currency in the international financial and trade system and the exchange rate regime of a country. The resulting group of eight currencies may, however, not be fully representative for all currencies outside the ERM of the EMS; this should be taken into account in the following comparison of exchange rate variability between the two groups. "Nonparticipating currencies" also refers to EC currencies not participating in the ERM, in particular the pound sterling (see also Section II).

[37] Ungerer (1983), p. 8–9.

[38] An alternative approach would be an analysis of variance. The F-test used here is intended to supplement the descriptive statistics on exchange rate variability provided in the Appendix Tables.

the scope of this study.[39] Instead, three different measures of exchange rate variability are employed, each with its own merits and drawbacks. The three measures are: the weighted average of the coefficient of variation[40] of bilateral exchange rates, the weighted average of the standard deviation of changes in the natural logarithm of bilateral exchange rates, and the standard deviation of changes in the natural logarithm of an effective exchange rate.[41] The properties of these measures are discussed further in the technical note at the end of this section.

The three measures are all calculated using nominal and real exchange rates (CPI based[42]), and variability of exchange rates is compared against ERM and non-ERM currencies. If bilateral rates move to offset relative inflation differentials, then variability of real exchange rates may capture more accurately the true risk to individuals than would variability of nominal rates. On the other hand, a major objective of the ERM has been to stabilize bilateral nominal exchange rates among participating currencies with the hope that the discipline of such a mechanism would lead to converging inflation rates and thus more stable real exchange rates as well. From this vantage point, the variability of actual nominal exchange rates is the more relevant approach in assessing the immediate success of the EMS. In a sense, the behavior of the real exchange rate over time provides a composite indicator of the behavior both of nominal exchange rates and relative inflation. Increased stability of real exchange rates could thus be an indication that nominal rate stability had been achieved and that there had been some convergence of inflation performance or that nominal exchange rate variations had closely matched divergence in inflation performance.

Patterns of Variability

The empirical results are presented in Tables 15–30, with Table 15 providing an overall summary. Tables 16–27 represent three versions of each of the three measures. Tables 28 and 29 are based on the Fund's multilateral exchange rate model's (MERM) effective exchange rates. For these tables, monthly data were used while Table 30 employs daily data. Overall the picture that emerges is one of a decline, since 1979, in variability among the ERM currencies, an increase in variability among the non-ERM currencies, and also an increase in variability between the ERM and non-ERM currencies. Of course, within this overall picture there are diverging patterns.

Nominal Exchange Rate Variability

In Tables 16–18, where nominal exchange rate variability against ERM currencies is calculated, intra-ERM variability (for all ERM currencies) declined between the pre-EMS and EMS periods.[43] The drop in variability is particularly pronounced in the years 1983–85, as would be expected because of the more than two years that passed without a realignment. The changes in variability were statistically significant[44] for all ERM currencies except the Belgian/Luxembourg franc. This is a strong result.

For those countries not participating in the ERM, the variability of nominal exchange rates generally went up between the pre-EMS and EMS periods. In Table 18, six of eight non-ERM currencies showed an increase in variability, which was statistically significant for Sweden, the United Kingdom, and the United States—the latter showing the most pronounced rise of all. The Austrian schilling and Swiss franc were the two European non-ERM currencies to exhibit significant declines in nominal exchange rate variability against ERM currencies. For Austria, this probably reflects the authorities' aim of maintaining a close link between the schilling and the deutsche mark. Although the Swiss authorities have not targeted the exchange rate, the Swiss franc has in practice closely followed the deutsche mark. The pound sterling, which is a freely floating currency not linked to any of the ERM currencies, showed significant increases in nominal exchange rate variability against the ERM currencies.

In terms of nominal variability versus non-ERM currencies, almost all ERM currencies showed an increase in the ERM period, regardless of the measure chosen (Tables 22–24). Five of seven changes in nominal variability were statistically significant (excluding only the Federal Republic of Germany and Italy). When non-ERM currencies were compared with other non-ERM currencies, the pattern was less definitive. The U.S., U.K., and Japanese currencies all showed increases in nominal variability, which were

[39] See, however, D. Gros, "On the Volatility of Exchange Rates," Unpublished manuscript, International Monetary Fund, October 1986, for an attempt to determine overshooting of exchange rates.

[40] Standard deviation divided by the mean.

[41] In the second measure, the weighting is over the standard deviations, whereas in the third, the overall standard deviation is taken of an (already weighted) effective exchange rate. These measures of exchange rate variability do not, however, indicate whether the variability is the result of a large number of smaller changes or of only a few larger changes.

[42] For Ireland, wholesale price data were used for lack of monthly consumer price data.

[43] The period average is calculated as the average of yearly measures of variability.

[44] The 5 percent confidence level is used, unless otherwise stated.

statistically significant in the first two cases. Tables 28 and 29 show the variability of effective exchange rates against a wider group of currencies (those included in the MERM, that is, the 15 countries already included in the earlier tables plus Australia, Finland, and Spain). When the exchange rate variability of non-ERM currencies was measured against this larger group, the number of currencies indicating an increase in variability fell somewhat; two exhibited a significant increase—the United States and the United Kingdom. Of the ERM currencies, only France and Denmark exhibited an increase in variability of nominal effective exchange rates. None of the ERM currencies experienced a significant increase in variability.

As mentioned earlier, data frequency was also considered a factor that might influence measured patterns of variability. Table 30 provides the same set of computations as Table 16, but relies on daily instead of monthly exchange rate data; comparison makes it clear that data frequency has very little effect on measures of variability. Weekly data were also checked; the results (not reported here) were essentially the same as when daily data were used.

Real Exchange Rate Variability

Real exchange rate variability against ERM currencies is displayed in Tables 19–21. For the ERM currencies, real exchange rate variability against their own group fell for all currencies by all three measures, which is a strikingly uniform result. Only that for the Belgian/Luxembourg franc was not statistically significant, as had been the case for nominal exchange rate variability as well. A particularly noteworthy feature is the more clearly pronounced decline in intra-ERM real variability, compared with Ungerer (1983), which reflects the addition of the 1983–85 period, when there was greater convergence of inflation rates (see Section V).

For those countries not participating in the ERM, the variability of real exchange rates against ERM currencies went up between the pre-EMS and EMS periods. The same six countries that exhibited a rise in nominal exchange rate variability also saw real variability increase, especially that of the U.S. dollar. As with nominal variability, the Austrian schilling and the Swiss franc were the two European non-ERM currencies to exhibit significant declines in real exchange rate variability.

ERM currencies all showed an increase in variability of real exchange rates against non-ERM currencies between the pre- and post-1979 periods, irrespective of the measure used (Tables 25–27). The changes were, however, statistically significant only for Belgium, France, and the Netherlands. Virtually all non-ERM currencies (excepting only Canada) showed an increase in real variability against their own group, with changes for Austria, Japan, United Kingdom, and United States statistically significant.

Conclusions

The aim of this analysis was to examine whether or not the establishment of the EMS coincided with a reduction in variability of exchange rates amongst ERM currencies. This question was assessed by an examination of several measures of variability before and after the establishment of the system for currencies inside and outside the exchange rate mechanism, and for both nominal and real exchange rates.

The strongest conclusion to be drawn from the study is that variability of bilateral exchange rates among ERM currencies has fallen since 1979, regardless of the measure chosen and irrespective of whether nominal or real rates were used in the calculations. In six of seven cases, the decline in measured variability was significant at the 1 percent confidence level (Tables 18 and 21).[45] This means that not only has the EMS succeeded in generating greater stability of nominal exchange rates, but also that to an increasing extent cost and price developments have converged (see also Section V).

Predictably the pattern was less striking with respect to the non-ERM currencies, both against ERM and against other non-ERM currencies. While intra-ERM variability appears to have decreased, the same cannot be said for intra-non-ERM variability. This result is not all that surprising because of the relative lack of homogeneity among the non-ERM countries as against the ERM countries. In Table 27, half the non-ERM currencies showed a statistically significant increase in variability against other non-ERM currencies.

The existence of the EMS since 1979 has coincided with a marked reduction in the variability of nominal and real exchange rates within the ERM. This was one major goal of the system, and for this purpose the intervention arrangements and other elements of the exchange rate mechanism were established. This trend toward greater stability, already evident in the earlier study undertaken in late 1982, has been substantially reinforced in the last three years, as there has been relative calm in the EMS exchange markets, as well

[45] This conclusion is all the more striking since some of the ERM currencies were participating in the European Common Margins Arrangement before 1979, which should also have had a constraining effect on variability in the earlier period.

as significant progress toward the goal of convergence of inflation rates.

By contrast, the variability of nominal and real exchange rates of participating versus nonparticipating currencies, and vice versa, has by and large stayed constant or risen. The nominal and real exchange rate variability of nonparticipating currencies against one another has shown no pronounced overall trend since 1979. Thus it does not seem that events exogenous to the EMS have led to the decline in exchange rate variability among participating currencies, since no such trend is evident elsewhere.[46] The clear diminution of exchange rate variability within the system, together with the absence of such a trend elsewhere, is certainly consistent with the view that the system has been successful in contributing to exchange rate stability among participating countries.

Technical Note: Measuring Exchange Rate Variability

This note presents the details of the measures of variability employed, as well as other aspects of the empirical work. One approach used is to examine stability around the average, that is, with no trend, which may be appropriate since a major aim of the system is to stabilize bilateral nominal rates. Another approach used is to assume that economic agents expect an underlying trend to continue in the near future. This allows the use of the variability of changes in the natural logarithm of the spot rate to be a proxy for "unexpected" changes.

Three measures of variability are employed: The weighted average of the coefficient of variation[47] of bilateral exchange rates, the weighted average of the standard deviation of changes in the natural logarithm of bilateral exchange rates, and the standard deviation of changes in the natural logarithm of an effective exchange rate. These three measures will be discussed in more detail below.

Any measure or definition of variability involves implicit assumptions that may be reasonable in some circumstances and not so reasonable in others. The choice is necessarily a matter of judgment and will, of course, depend on the notion of uncertainty that one has in mind. The three measures all have advantages and disadvantages, so that no single construct was relied upon. To the extent that several different measures indicate similar broad conclusions, it should be reasonable to judge that the conclusions have at least some robustness and validity. A serious attempt was also made to assess the statistical significance of changes in exchange rate variability.[48]

Weighted Average of the Coefficients of Variation (CV) of the Bilateral Exchange Rates

If the bilateral exchange rate varies around a constant level, the coefficient of variation may be an appropriate measure of predictability, as it represents a measure of dispersion around the mean. In the ERM of the EMS, one of the goals is to keep relative nominal bilateral rates broadly constant, so that in this context also the CV may be appropriate as it measures the degree of success in achieving this goal.

Weighted Average of the Standard Deviation of Changes in the Natural Logarithm of the Exchange Rate (SD1)

If the exchange rate contains a trend, the SD1 measure may be more appropriate. This could happen when, for example, a currency continuously depreciates to offset an inflation differential. If market participants expect the exchange rate to follow a trend, variability around the expected trend captures best the risk to these traders. Clearly, variability around the mean, in this case, would be an inappropriate measure of risk.[49]

Standard Deviation of Changes in the Natural Logarithm of a Weighted Average of Bilateral Rates (SD2)

The SD2 measure differs from the SD1 measure in that it takes account of the covariance of bilateral

[46] This conclusion depends, however, on the assumption that the introduction of the EMS has not significantly affected exchange rate variations among nonparticipating countries.

[47] Standard deviation divided by the mean.

[48] Several earlier studies had shown exchange rate distributions to be leptokurtic—that is, more massive tails and a sharper peak than the normal distribution, which tends to invalidate many statistical procedures. However, K. Rogoff ("Can Exchange Rate Predictability be Achieved Without Monetary Convergence? Evidence from the EMS," *European Economic Review* (Amsterdam), Vol. 28 (1985), pp. 93–115) has indicated that "when mean absolute deviations rather than variances are used as a measure of variability, the comparisons across subperiods are qualitatively unaffected." Rogoff uses an F-statistic to test differences in conditional variances between subperiods. The same approach is employed here.

[49] It is possible, however, for an exchange rate to follow a medium-term trend away from the equilibrium or expected path, in which case the SD1 measure would be inappropriate. It is also possible for the determinants of the equilibrium to change quickly—for example, if there is an oil price shock—a case not allowed for by use of a smooth trend.

rates.[50] Inclusion of the covariance of bilateral rates can increase or decrease the measure of variability. For example, if two variables are positively (negatively) correlated, the variance of the sum of those two variables will be greater (less) than the sum of the variances of the two individual variables. Lanyi and Suss (1982) noted that in trying to capture changes in competitiveness a trade weighted VEER (variability of effective exchange rate) index is probably better than an EV (effective variability) index, since it takes into account the correlations in competitiveness among trading partners.[51] Since emphasis is placed on predictability and the cost of unexpected changes, if economic agents are aware of the covariances of bilateral exchange rates (as portfolio theory would suggest), this information should be taken into account in defining a measure of variability.

[50] The covariance is a measure of the extent to which two time series move together. The role of the covariance in the SD2 measure can be illustrated as follows:

$$\mathrm{VAR}(\Sigma_j W_{ij}\mathrm{LN}(S_{ij})) = \Sigma_j W_{ij}^2 \mathrm{VAR}[\mathrm{LN}(S_{ij})] + 2\Sigma_j\Sigma_k W_{ij}W_{ik}\mathrm{COV}[\mathrm{LN}(S_{ij}),(S_{ik})]$$

where VAR = variance, COV = covariance, LN = natural logarithm, W_{ij} is the weight of currency $_j$ in the index of currency $_i$, and S_{ij} is the bilateral rate between countries $_i$ and $_j$.

[51] See A. Lanyi and E. Suss, "Exchange Rate Variability: Alternative Measures and Interpretation," *Staff Papers,* International Monetary Fund (Washington), Vol. 29 (December 1982), pp. 527–60.