International Financial Integration,  
Relations among Interest Rates and Exchange Rates,  
and Monetary Indicators

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This paper was written for a colloquium on International Financial Integration and the Conduct of U.S. Monetary Policy, held at the Federal Reserve Bank of New York, October 13, 1989. It is forthcoming in a N.Y. Fed volume, Spring 1990. I would like to thank Julia Lowell for research assistance. Some sections draw on joint work with Ken Froot and Cara Lown. I would also like to thank M. Akbar Akhtar, Peter Kenen, and Charles Pigott for comments.

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Conventional wisdom holds that international capital mobility is close to perfect. It is sometimes thought that perfect capital mobility implies that arbitrage equalizes interest rates across countries, either on a nominal or real basis. The equalization of interest rates, if valid, would have powerful implications. It would mean, for example, that the domestic interest rate would no longer be free to reflect expansionary monetary policy: In the Mundell-Fleming theory, the high degree of international financial integration implies that the role of the primary indicator of whether monetary policy is easy or tight should have passed from the interest rate to the exchange rate.

Perfect capital mobility, in the sense of low barriers to the movement of capital across national boundaries, does not imply the international equalization of nominal or real interest rates, however. The reason is high exchange rate variability under floating exchange rates (which may itself be in part a result of high capital mobility). Countries' interest rates are expressed in their own currencies, and thus may differ due to factors associated with the currencies in question rather than the national boundaries.

This paper begins by showing how the United Kingdom and Japan in 1979 removed capital controls to join the club of countries integrated into world financial markets, and how
liberalization has spread to more countries in the 1980s. It argues the possibility that covered interest differentials did not vary enough in the 1980s to be important sources of variation in international short-term interest differentials.

The paper then considers how liberalization affected the correlations of exchange rates with short- and long-term interest rates in the 1980s.

One might think, even if perfect capital mobility does not eliminate interest differentials completely, so that the domestic interest rate continues to be affected by monetary policy, that the exchange rate would nevertheless be a very good indicator of the stance of monetary policy. But the exchange rate sometimes fluctuates sharply for reasons that are apparently unrelated to macroeconomic fundamentals. The paper discusses an alternative possible indicator for monetary policy: the term structure of interest rates. It concludes with the obvious point that the monetary authorities would be well-advised to look at many available indicators simultaneously. However, it emphasizes the advantages of announcing a single intermediate target, as opposed to relying on a single indicator to attain the target. It concludes that, of the alternative possible intermediate nominal targets that have been proposed, nominal GNP may be the best. This is all the more true in the international context, where I have called the proposal INT, for International Nominal Targeting.
1. Recent Liberalizations: Diminishing "Country Barriers," as Indicated by Covered Interest Differentials

A number of different criteria for measuring the degree of international capital mobility have been proposed, and have been reviewed elsewhere. If the aim is to measure the extent of "country barriers" -- capital controls, transaction costs, and other barriers to the integration of national financial markets across political boundaries -- then the best measure is the covered, or "closed" interest differential, that is, the difference between offshore and onshore interest rates, hedged so as to eliminate exchange risk. The virtues of this measure are well-illustrated by three major liberalization episodes of the 1970s: Germany in 1973-74, the United Kingdom in 1979, and Japan in 1979-80.

In the early 1970s, Germany had stringent capital controls in place, designed to discourage the acquisition of German assets by foreign residents. The government

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1. The four principal measures of barriers to mobility are: saving-investment correlations (the Feldstein-Horioka definition), real interest differentials, uncovered interest differentials, and covered interest differentials. For an exposition of how the four criteria relate, tests on recent data, and extensive references, see Frankel (1989). Other guides to the literature on capital mobility include Caramazza, Clinton, Cote and Longworth (1986) and Akhtar and Weiller (1988).

7 Covered interest parity could hold perfectly, and yet many types of assets could be imperfectly substitutable across countries. For example, even if a yen bond in London is a perfect substitute for a yen bond in Tokyo, yen bonds may be imperfect substitutes for dollar or pound bonds because of exchange risk.
essentially prohibited the payment of interest to nonresidents on large bank deposits, taxed any new credits by nonresidents to German banks, and prohibited nonresidents from buying German bonds. Most of these controls were removed in late 1973 and 1974. Figure 1 illustrates the episode. The lower two lines are the Euromark interest rate and the covered Eurodollar interest rate in London, which are always virtually identical because covered interest parity always holds within the London Euromarket. During most of 1973, these Eurorates lay far below the German interbank rate, indicating that the controls were indeed effectively preventing foreign residents from obtaining assets within Germany. As the Figure shows, the gap narrowed at the end of 1973 and disappeared in the course of 1974, confirming the removal of controls. 8

Japan maintained stringent controls on capital inflows through most of the decade. Foreign residents were prohibited outright from holding many kinds of assets in Japan. [Until 1979, the Japanese, like the Germans earlier, were concerned about excessive capital inflows and appreciation of the yen.] The Ministry of Finance removed the prohibition against foreign investment in April 1979, and formalized the liberalization in December 1980. Further liberalization measures followed, relaxing controls against both inflows and outflows, notably the Yen/Dollar Agreement between the

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8 The German episode is analyzed by Dooley and Isard (1980).

Figure 2 illustrates the Japanese case. During the period January 1975 to April 1979, the differential between the Gensaki interest rate (a three-month rate) in Tokyo and the Euroyen interest rate in London averaged 1.84 per cent, showing the efficacy of the controls on capital inflow. During the period May 1979 to November 1983, the differential fell sharply, to negative 0.26 per cent. The fact that the differential was actually somewhat negative during this period is evidence that the controls that remained were working to discourage outflow more than inflow. In the period 1985-88, the differential was essentially zero, showing evidence of complete liberalization.⁹

A third liberalization took place in Britain in 1979. Legal restrictions had required British banks to keep their "offshore" accounts separate from their domestic accounts, until the incoming Thatcher government removed the restrictions. The onshore and covered offshore pound interest rates are shown in Figure 3. In 1978, the three-month Europound interest rate averaged 1.43 per cent per annum higher than the U.K. interbank interest rate, indicating effective controls against capital outflow. The differential fell to .29 per cent per annum in 1979, and to zero soon ahead.

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⁹ Frankel (1984) examines the Japanese episode and gives further references.
The liberalization trend spread more widely in the 1980s. Australia began to liberalize early in the decade, and New Zealand followed suit. France, which strengthened controls on outflow when the Socialists came to power in 1981, began to remove them in the late 1980s. France and Italy are both expected to meet a mid-1990 deadline for full liberalization among the EC Twelve. In the enlarged EC, only Spain, Portugal, Greece and Ireland are expected to need later deadlines.

Most tests of covered interest parity have somewhat artificially tested the hypothesis of "perfect" capital mobility, which can turn out awkwardly when non-zero covered interest differentials are in fact found. Furthermore most tests have been confined to small subsets of the G-10 countries, as theirs are the only currencies that have well-developed Euromarkets. However it has recently become possible to obtain London forward rate quotes for more countries, for the period since September 1982. These data are ideal for studying the extent of integration in the 1980s.

The magnitude and variability of the covered interest

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11 For example, Frenkel and Levich (1975, 1977). Akhtar and Weiller (1988) point out the need for measuring changes in the degree of capital mobility, as opposed to the usual artificial tests of perfect capital mobility.
differentials were examined over the average of the period in Frankel (1989). Here we examine the trend, for each of 23 countries, to look for evidence of liberalization taking place within the sample period 1982-1988.12

Table 1 presents the results of regressions of the absolute covered interest differential against time. Twelve countries show statistically significant downward trends (at the 95 per cent level). The seven with the most rapid estimated trend, listed in descending order, are as follows: Portugal, Spain, France, New Zealand, Denmark, Australia, and Italy. This is precisely the list that one would have expected for countries liberalizing in the 1980s. The other five countries with significant downward trends are as follows: Germany, Switzerland, the Netherlands, Sweden, and Japan. This group already had small differentials at the beginning of the sample period anyway. The same is true of six of the ten countries with statistically insignificant trends in Table 1: Austria, Belgium, Canada, Hong Kong, Norway and Singapore. Only one country appears to have a statistically significant upward trend in the magnitude of its covered interest differentials during the sample period, namely the United Kingdom, which was starting from the third-

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12 Most of the forward rate data come from Barclay's Bank. We have eliminated Mexico from the earlier Sample, because no forward rate data has been available since early 1986, and have eliminated Ireland because, though rate data from early 1986, to early 1988 were quoted at one time, they appear to have been incorrect.
lowest level of any of the 23 [after Hong Kong and Canada]. The implication is that there are only four countries in the sample that still had made little effort toward liberalization by 1988: Greece, Bahrain, Malaysia, and South Africa. (Needless to say, most countries with large barriers are not in the sample, because their currencies do not have forward rates quoted offshore.)

The United States is not in the Table 1 sample, because the dollar is the currency relative to which the forward rates of the other currencies are measured. But for the United States as well, the closed differential between the offshore interest rate and the domestic rate has fallen over time, perhaps as the result of innovation in the Euromarkets. Reinhart and Weiller (1987, p. 16-18), find that the Eurodollar-U.S.CD differential had a statistically significant downward trend over the period 1971-1987, and that "the initial gap is all but eliminated by the end of the period." The differential was particularly smaller after 1983 than during the period 1978-82.\textsuperscript{13}

All the preceding results, and most of the tests of closed interest parity that others have done in the past, apply only to international arbitrage among short-term deposits. Feldstein and Horioka (1980) surmised that international arbitrage does not work as well for long-term

\textsuperscript{13} The statistics are in Frankel (1988, p.578-581). On the magnitude of the differential at the start of the 1980s, see also Kreicher (1982).
bonds. As Akhtar and Weiller (1987) point out, there is a need to test closed interest parity at the longer end of the maturity spectrum. Recently, however, a few studies have attempted to extend the tests to long-term bonds. The differential between long-term interest rates in the United States and in the Eurodollar bond market can be seen to have declined in the course of the 1980s.\textsuperscript{14} Popper (1988), using swap data, finds that the differential between swapped Japanese and U.S. government bonds by 1986 was as small as between short-term assets.\textsuperscript{15} The [tentative] conclusion is that bonds issued by different major industrialized countries, when otherwise similar in nature, have in fact become relatively close substitutes in the course of the 1980s.\textsuperscript{16}

2. "Currency Barriers:" Decomposition of the Forward Discount into the Exchange Risk Premium and Expected Depreciation

\textsuperscript{14} Frankel (1988). A contributing factor was a step taken by the U.S. Treasury to facilitate borrowing from abroad: the abolition of the withholding tax on interest paid to foreigners. On the proposition that U.S. corporations in the early 1980s could borrow more cheaply in the Eurobond market than domestically, see also Kim and Stulz (1988) and Marr and Trimble (1988).

\textsuperscript{15} Reinhart and Weiller (1987b, p.11 and Table 2) claim a similar finding for long-term government bonds (and also equities), using forward premia [apparently constructed from the three-month Eurocurrency interest rates in the Appendix] to cover the exchange risk in 3-month holding-period yields; however it is apparently not an arbitrage condition that is being tested, as the risk of capital gains and losses remains.

\textsuperscript{16} It no doubt remains true, however, that such assets as real estate and business plant and equipment are neither perfect substitutes across countries, nor perfect substitutes for bonds issued within their own countries.
The elimination of barriers to the movement of capital across national boundaries as reflected in covered interest differentials is not enough to equalize interest rates across countries, as is well known. Let $i$ be the U.S. interest rate, and $i^*$ be the foreign interest rate. The interest differential $i - i^*$ can be tautologically decomposed as follows:

$$i - i^* = (i - i^* - fd) + (fd - s^e) + s^e,$$

(1)

where $fd$ is the forward discount and $s^e$ is the expected rate of depreciation. The first term, the covered interest differential, is associated with the country or political jurisdiction in which an asset is issued, not with the currency in which it is dominated. We have already seen that liberalization sharply reduced the differential in 1979 for the cases of Japan and the United Kingdom, and gradually reduced it in the 1980s for the case of France and other countries. The second and third terms, which are the exchange risk premium and expected depreciation respectively, are associated with the currency of denomination, not with the political jurisdiction. Given the high volatility of floating exchange rates, it is quite possible that these latter terms have increased in size and variability in the 1980s, rather than decreased.\(^{17}\)

\(^{17}\) Papers that focus on the decomposition of interest
The conventional wisdom among economists is that the expected depreciation term is small in magnitude and variability, and the risk premium term larger in both magnitude and variability. This conventional wisdom emerges from the rational expectations methodology. The rational expectations methodology infers what investors must have expected ex ante from what actually happened ex post. The common application in international finance is the interpretation of findings of bias in the forward discount. The standard regression equation is:

\[ s_{t+1} = a + b \cdot fd_t + u_{t+1}. \]

The null hypothesis of unbiasedness is represented by \( b=1 \): all the variation in the forward discount would be explained as variation in expected depreciation, rather than as variation in the risk premium. (Sometimes the null hypothesis is also interpreted as implying \( a=0 \). But usually the focus is on the time-varying component of the bias, rather than on the constant term.\(^{18}\))

differentials into country components and currency components include Frankel (1989), Frankel and MacArthur (1988), and Kasman and Pigott (1988). The conclusion, that the currency component is now large even though the country component is by now small, could be interpreted as supporting the view of McKinnon (1987), who attributes the difference to the floating exchange rate regime.

\(^{18}\) One reason to allow for a constant term is to allow for the possible role of the convexity term that can emerge from Jensen's inequality.
The standard finding is that the coefficient \( b \) is in fact significantly less than one. Often it is close to zero (or even negative). Under the rational expectations methodology, this rejection of the null hypothesis is interpreted as evidence of an exchange risk premium that varies over time with the forward discount. When results show an estimate of \( b \) that is insignificantly different from zero -- an instance of the popular random-walk findings -- the rational expectations methodology interprets it as evidence that there is no variation in expected depreciation (the third term in equation (1)), and that all the variation in the forward discount represents variation in the exchange risk premium (the second term in the equation).\(^{19}\) Fama (1984) and Hodrick and Srivastava (1986) have argued that when \( b \) is found to be significantly less than \( 1/2 \), this is evidence that the variation in expected depreciation (even if not zero) is smaller than the variation in the risk premium.\(^{20}\)

The alternative interpretation is to argue that one cannot reliably infer \textit{ex ante} expectations from movements that are observed \textit{ex post}, even when the latter appear statistically significant by standard criteria. The rational

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\(^{19}\) Bilson (1985) in this context refers to the random-walk case as a "new empirical paradigm."

\(^{20}\) Koedijk and Ott (1987) claim to weigh the two alternative interpretations of the standard forward bias regression. But, in fact, the article imposes the rational expectations methodology, thereby ruling out the alternative interpretation \textit{a priori}, just as Fama and Hodrick-Srivastava do.
expectations methodology could fail either because agents do not act rationally or because distributional difficulties associated with the "peso problem" invalidate the test statistics in conventional sample sizes. The proposition that observed patterns of movement in the exchange rate reflect investors' expectations is a proposition that one would like to be able to test rather than impose a priori.

In recent years, a number of researchers have begun to use survey data as an alternative method for measuring investors' expectations.\(^{21}\) A measure of expected depreciation based on survey data is exempt from some of the problems that plague conventional measures, and can be used to test propositions such as a constant risk premium and the validity of the rational-expectations methodology itself. Of course, the survey data undoubtedly have problems of their own; their measurement of market participants' expectations may be subject to error. Nevertheless, even allowing for the possibility of measurement error, there is much that one can learn from this approach.

Most of these papers so far have used data that only went up to 1985. One might wonder whether the results changed any in the late 1980s, as a result of either the continued process of financial integration documented in Section 1, a new era in the history of the dollar,\(^{22}\) or new forecasting techniques used

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\(^{22}\) The history of the early 1980s was dominated by the
by participants in the foreign exchange market. Furthermore, because these data sets are so new, three additional years of data are of interest in that they can increase the sample size by half.

Table 2 [taken from Frankel and Froot (1990)] reports an update of one of the earlier tests to include data through 1988. It is a regression of the expected depreciation of the currency against the forward discount. For two out of the three terms studied, the coefficients are even closer to 1 than they were in the 1981-1985 results. The results support the view that the variation in expected depreciation is large and the variation in the risk premium is small, precisely the reverse of the conventional wisdom, even more strongly than did the earlier results.

Three null hypothesis are relevant: $b=0$, $b=0.5$, and $b=1$. The first null hypothesis would represent the view that none of the variation in the forward discount represents variation in expected depreciation; it is easily rejected at the 99 percent level of significance. The second represents the middle-of-the-road case where the variance of expected depreciation is equal to the variance of the exchange risk premium; it is

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large appreciation of the dollar and characterized by a non-interventionist policy on the part of the U.S. government. Since 1985, the dollar has moved both down and up, and the United States has cooperated with other G-7 countries to intervene in the foreign exchange market. Only a few yearly observations are available for the period before 1980 (from a survey that used to be conducted by American Express Banking Corporation; Frankel and Froot, 1987.)

Froot and Frankel (1989).
also rejected at conventional significance levels, in favor of the hypothesis that expected depreciation is more variable than the risk premium. The third hypothesis represents the view that all the variation in the forward discount represents variation in expected depreciation, and none represents variation in the risk premium; the results by a wide margin do not reject this hypothesis.

These findings do not imply that the risk premium is zero. A majority of the t-ratios, when computed for the five individual currencies, show statistically significant constant terms, part of which could be due to constant risk premiums (as opposed to the convexity term).\textsuperscript{24} Nor do the results even imply that the risk premium is necessarily constant.\textsuperscript{25} However, the finding does suggest that variation in the forward discount does not reflect variation in the exchange risk premium as conventionally thought.

\textsuperscript{24} Kasman and Pigott (1988, p.37) use our survey data to compute average foreign exchange risk premia for the dollar against the mark, yen and pound, and find them in the range of 2.9 to 7.8 per cent. Such risk premia would be smaller and more plausible than the differences in \textit{ex post} rates of return across currencies; they point out that the latter typically exceed the differences between yields on very high risk junk bonds and AAA-rated bonds.

\textsuperscript{25} It is possible that part of the variation in the regression error term could be attributed to a (time-varying) risk premium. The preferred interpretation in Frankel and Froot (1989) is that the regression error represents (random) measurement error in the survey data. But results in Dominguez and Frankel (1989) suggest that the risk premium (as estimated by the survey data) \textit{does} vary significantly with Central Bank intervention in the foreign exchange market and with the variance of the exchange rate, in the way that the portfolio-balance model says it should.
The sum of the covered interest differential [the first term in equation (1)] and the exchange risk premium [the second term in equation (1)] is the uncovered interest differential, or the expected difference in rates of return across countries:

\[ i - i^* - _s^e = (i-i^*fd) + (fd-_s^e) \]

In view of the evidence that the magnitude and variability of the first term \((i-i^*-fd)\) has been small in the 1980s, and that the magnitude and variability of the second \((fd-_s^e)\) have also been small [relative at least to what is conventionally thought based on the rational expectations methodology], one might expect that the same is true of the uncovered interest differential. Reinhart and Weiller (1987, p.10-15), using the survey data to measure expected depreciation, find that this is indeed the case: For the sample period 1984:10 to 1986:6, the average uncovered interest differential between Japan and the United States is less than 1/20 the size in absolute magnitude, and opposite in sign, from what the rational expectations methodology would conclude from the difference in \textit{ex post} rates of return, even though the latter appears statistically significant at the 99 per cent level.

\footnote{An early and typical application of the rational expectations methodology to the measurement of the uncovered interest differential is Cumby and Obstfeld (1981).}
3. How Return-Correlations Across Germany, Japan, U.S. and U.K Have Changed in the 1980s

In this section, we look at how correlations across the four countries that are the most important financially changed in the 1980s. We start the sample in March 1973, with the beginning of generalized floating, and go up to February 1989. We divide the sample at 1979, the year of the initial Japanese and British liberalizations. We choose October 1979 as the precise breaking point, because we will need to take account of the fact that U.S. interest rate and exchange rate volatility increased in the 1980s, and the increase can be dated from the October change in operating procedures on the part of the Federal Reserve.

The variances reported in Table 3 show that short-term interest rates did indeed become more volatile in the 1980s in the United Kingdom and United States, and long-term interest rates did so in all four countries. The variability of the dollar/pound, dollar/mark, and dollar/yen exchange rates also increased in the 1980s. [In the case of the pound, the increase in variability only occurred in the early 1980s; during the four-year period beginning March 1985, the variance was much no higher than in the 1970s (not reported).] Stock markets also became more volatile in all four countries in the 1980s [though in the U.K. case, the stock market variance fell in the early 1980s (not shown)].
How would we expect the correlation of interest rates across countries to have changed in the 1980s? On the one hand, the results of Section 1 show that the covered interest differential, the first term in equation (1), virtually disappeared in the course of the 1980s. Thus one might guess that the variability of the interest differentials fell, and the correlation of interest rates across countries increased, in the 1980s.\textsuperscript{27}

On the other hand, the evidence from Section 2 suggests that -- although the variance of the exchange risk premium, the second term in the equation, may have been small in the 1980s -- the variance of expected depreciation, the third term, was large. This suggests that the correlation of interest rates across countries may have fallen, rather than risen. Indeed Kasman and Pigott (1988, p.33) find that the association among major countries' nominal interest rates became looser in the 1980s, than it had been in the 1960s or 1970s. Specifically, they find that the correlation of U.S. and foreign short-term interest rates fell, for Germany, Japan, the United Kingdom and Canada (though the correlations of long-term interest rates increased sharply); and the dispersion across five countries' interest rates also increased sharply after 1972 (mean absolute deviation of

\textsuperscript{27} Akhtar and Weiller (1988, pp.45-49) review several studies that generally find an increase in the correlation of interest rates among the United States and other countries since the 1970s.
countries' rates, whether short-term or long-term), and increased somewhat further after 1979, as German and Japanese interest rates failed to rise as much as the others'.

Table 4 shows cross-correlations among U.K., German, Japanese and U.S. money-market interest rates. All six correlations have increased in the period since October 1979.\(^{28}\) As Table 5 shows, all six cross-correlations among these countries' long-term interest rates also increased [and the same in terms of changes in interest rates]. Evidently, the high variability of expected depreciation in the 1980s was not enough to overcome the low variability in covered interest differentials and exchange risk premiums.

Table 6 reports statistics for stock prices as well (though the logic of the decomposition in equation (1) does not apply because stock prices are not the same thing as stock returns). Again, all six cross-correlations increased in the 1980s.\(^{29}\) [When changes in stock prices are computed however, 3 of the 6 correlations fall rather than rise in the second

\(^{28}\) I do not know how to reconcile these findings with the statistics reported by Kasman and Pigott (1988, p.34) showing that the correlations of U.S. short-term interest rates with those in Germany, Japan, and the U.K. decreased from the 1970s to 1980-1988II. [It might help that when the correlations of Table 4 are recomputed on changes, 2 of the 6 turn out to fall in the 1980s.] In any case, I agree with their central conclusion that, despite the fall in covered interest differentials, differences among interest rates remain large because of expected currency changes.

\(^{29}\) Of course, the correlation of world stock market prices was particularly high in the crash of October 1987. Bertero and Mayer (1989) and von Furstenberg (1988).
The correlations among the four long-term interest rates increase both in the 1979:10-1984:6 and 1984:7-1989:4 sub-periods. The same is true among the stock markets, except that the three correlations with the German stock market decline in the period 1984:7 to 1989:2. The pattern among the money-market rates is more varied. (To save space, the results for these sub-periods are not reported here.)

4. Indicators for Monetary Policy

The October 1979 change in Fed operating procedures represented an acknowledgement that nominal interest rates were not a useful indicator of whether monetary policy was tight or loose, in part because of the difficulty of distinguishing changes in the nominal interest rate from changes in the real interest rate. Since 1982, however, it has become widely acknowledged that M1 is also not a reliable indicator, because of large and lasting shifts in velocity. Thus there has been a search for new indicators.

One indicator/guide for monetary policy that has been suggested is the exchange rate.\textsuperscript{30} Theory tells us that when exchange rates are fixed and capital mobility is low, monetary policy is primarily reflected in interest rates, but that under modern conditions of floating exchange rates and high

\textsuperscript{30} See, for example, Williamson (1985) and McKinnon (1984).
capital mobility, changes in monetary policy should be reflected primarily in exchange rates.

There is evidence that exchange rates do indeed contain useful information as to market expectations regarding future monetary policy. One example comes from the period in the late 1970s and early 1980s when unexpectedly high weekly money announcements would regularly cause nominal interest rates to jump significantly upward. Clearly, during this period, market participants were using the news in the announcements to revise their expectations regarding the ease of future monetary policy. The question was whether an observed increase in the nominal interest rate was an increase in the real interest rate, signifying the expectation of tighter monetary policy in the future, or an increase in the expected inflation rate.

The foreign exchange market contains the answer. In the late 1970s, positive money surprises were associated with increases in the price of foreign exchange, indicating that the increases in the nominal interest rate were increases in expected inflation. In the period July 1980 to November 1982, the reverse was true. Positive money surprises were associated with decreases in the price of foreign exchange, indicating that the increases in the nominal interest rate were increases in the real interest rate (in anticipation that the Fed would act to bring the money supply back toward its
intended path).  

Another indicator/guide for monetary policy that has been suggested is the price of gold and other basic mineral and agricultural commodities. There is similar evidence that such prices also contain useful information as to market expectations regarding future monetary policy. In the period July 1980 to November 1982, positive money surprises were associated with decreases in the prices of commodities, indicating again that the increases in the nominal interest rate were increases in the real interest rate, and signs of a tighter rather than looser expected future monetary policy. 

Note, however, that the usefulness of the exchange rate or commodity prices as immediate indicators of the perceived stance of monetary policy does not mean that it would be wise for the authorities to pre-commit to targets for these prices, any more than to M1. There are large disturbances in each the demand for foreign exchange, the demand for gold, and the demand for M1; committing to a fixed number or target range for any of these three magnitudes would mean that the disturbances would be more fully transmitted to the level of real GNP and the general price level.

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31 Cornell (1982) and Engel and Frankel (1982). Further evidence that market participants regarded the M1 surprises as unintended deviations from Federal Reserve targets in the early 1980s lies in their quite different reactions to announcements of the monetary reserves; Hardouvelis (1984).

32 The commodities are corn, feeders, gold, live cattle, soybeans, wheat, cocoa, silver, and sugar. Frankel and Hardouvelis and Grubaugh and Sumner (1988).

33 The policy problem is considered further in the
Yet another possible indicator as to the expected future ease of monetary policy, which has received increased attention since a speech by Fed Vice-Chairman Manuel Johnson (1988), lies in the term structure of interest rates.\textsuperscript{34} The idea is that when the yield curve becomes steeper, this is a sign that the market expects inflation to increase in the future, and when its slope falls a sign that the market expects inflation to decrease. A simplistic interpretation of this idea would assume that the real interest rate is constant, from which it follows that the term spread is equal to the difference between the inflation rate expected in the long term and the inflation rate expected in the short term.\textsuperscript{35}

A more realistic model would allow for the fact that the short-term real interest rate is not constant in the short run, but would assume that there is a tendency for it to approach a constant gradually over time [as would be true in a model with goods prices that are sticky in the short run].

\footnote{Johnson suggested that the Fed might look at three indicators together, the term structure and the first two mentioned above: the price of foreign exchange and the price of gold and other commodities. See Lown (1989).}

\footnote{For example, Mishkin (1988, 1989), who finds that the spread between long-term and short-term interest rates does contain information useful at predicting future inflation rates. Unfortunately, his paper offers only a restrictive model that assumes the real interest rate is constant. [It is ironic that such a simplistic interpretation is being placed on the term-structure indicator after a decade in which the evidence of time-variation in the real interest rate has been overwhelming (much of the evidence having been presented by Mishkin (1984a,b) himself).]
Let us assume further the expectations hypothesis of the term structure: that the long-term interest rate is the average of the expected short-term interest rates over the relevant maturity, up to a possible (but constant) term premium. Then it is easy to show that the expected inflation rate can be expressed (up to a constant term) as a linear combination of the long-term and short-term interest rates [with weight greater than 1 on the former and negative weight on the latter, so that the linear combination is extrapolating out along the yield curve].\textsuperscript{36} It then follows that the difference between any expected long-term inflation rate and any expected short-term inflation rate is proportionate to the spread between any long-term interest rate and any short-term interest rate. But the constant of proportionality is not one as in the case of a constant real interest rate, and the investigator need not necessarily use interest-rate maturities that correspond to the horizon over which it is desired to forecast inflation.

Table 7, taken from Frankel and Lown (1990), reports some preliminary evidence on this topic. The first and third panels show regressions where the terms of the interest rates used in the forecast match the terms of the inflation rates to be forecast, as would be required under the theoretical framework that assumes the real interest rates constant. The estimates for the coefficient on the interest rate spread are

\textsuperscript{36} Frankel (1982).
greater than 0 and less than 1; this suggests that, on the one hand, there may indeed be forecasting power in the term structure, but that, on the other hand, the real interest rate does not appear to be constant. Thus far, these are the same results as those found by Mishkin (1988, 1989). But the practical advantage of the alternative theoretical framework that allows for short-term variation in the real interest rate is that it allows one to use a more reliable estimate of the slope of the yield curve, rather than being restricted to a narrow term spread that matches the inflation rates to be forecast. In the last panel of Table 7, we use the spread between the 5-year interest rate and the overnight federal funds rate, even though we wish to forecast the 1-year/3-month change in the inflation rate. The ability to predict changes in the inflation rate is greater than when the 1-year/3-month term spread was used, as indicated by $R^2$ or significance levels.\(^\text{37}\) The conclusion is that the alternative framework may be more useful for forecasting the future movement of inflation, aside from the theoretical desirability of allowing for variation in the real interest rate.

\(^{37}\) The reported standard error for the non-overlapping annual observations, .17, can be used as an upward-biased estimate of the correct standard error for .34, the coefficient estimated with the overlapping monthly observations. Planned future work will apply the method-of-moments correction to the standard errors, and also try to obtain better-still estimates of the slopes of the yield curves by OLS at each point in time.
5. The Relationship between the Exchange Rate and Short- and Long-Term Interest Rates

The Dornbusch (1976) model of overshooting when capital is perfectly mobile and goods prices are sticky, which entails a positive relationship between the real exchange rate and the real interest differential, is by now almost 15 years old. Some may regard it as old-fashioned [because investor behavior is not "rigorously derived from first principles of intertemporal optimization"]. Yet there is at least one sense in which the Dornbusch model arrived before its time. As we have seen, the assumption of perfectly integrated world financial markets was less true in the 1970s than in the 1980s. [Also, real interest differentials did not show as much variability in the 1970s as they did in the 1980s.] Thus, one might expect that the relationship between the real exchange rate and the real interest differential would have become stronger in the 1980s. This section presents some results on the changing relationship between the exchange rate and the interest differentials. They should perhaps be viewed more as descriptive correlation statistics than as estimates of any structural system. Nevertheless, it is appropriate to consider further what relationships between the exchange rate and interest rates would be expected under alternative possible models.

In the old-fashioned flow approach (with no role for
expectations), the short-term and long-term interest differentials each had positive effects on a country's balance of payments, via the short- and long-term capital accounts, respectively; thus under floating rates, each had a positive effect (along with determinants of the trade balance) on the demand for domestic currency and on the foreign exchange value of the currency. In the monetarist approach of the early 1970s, on the other hand, only the short-term interest differential mattered (assuming that the short-term interest rate was the rate of return relevant for money-demand), and it had a negative effect on the value of the currency. The reason was that a high nominal interest rate necessarily reflected a high expected inflation rate. Because the currency was expected to lose value in the future, investors had a low demand for it today.

For the overshotting model, let us combine the no-risk-premium assumption with a regressive model of exchange rate expectations:

\[
fd = _s^e - 0(s-s_) + (_p^e - _p^*)
\]

where \( s \) is the log of the spot exchange rate, \( s_\) is its value in long-run equilibrium, and \( _p^e \) and \( _p^* \) are the domestic and foreign expected inflation rates, respectively. Solving for the exchange rate,
\[ s = s^* - (1/0)[fd - (_p^*-p^*)]. \]  

(4)

Now, on the assumption of complete integration of financial markets, add the assumption of covered interest parity, \( fd=(i-i^*) \),

\[ s = s^* - (1/0)[i-i^* - (_p^*-p^*)]. \]  

(5)

An increase in the nominal interest rate has a positive effect when holding constant for expected inflation [as in the flow approach], while an increase in the expected inflation rate has a negative effect [as in the monetarist approach].

In the sticky-price model, the expected inflation rate should be proportionate to the difference between the long-term and short-term interest rates [as explained in the section on indicators for monetary policy]. There probably exist better predictors of inflation. Possible measures of expected inflation include distributed lags on past inflation, forecasts of larger econometric models, and surveys of expectations of market participants. But the subject at hand

\[ ^{38} \text{If the dependent variable is the real exchange rate, then the coefficient on the expected inflation differential should be the negative of the coefficient on the nominal interest differential (such as } 1/0 \text{ in the equation). If the dependent variable is the nominal exchange rate, then the absolute magnitude of the coefficient on the expected inflation differential should be larger (by an additive factor } \backslash, \text{ the semi-elasticity of money demand with respect to the interest rate), because of the effect on the equilibrium nominal exchange rate } s^*. \]
is the relationship among exchange rates, short-term interest rates, and long-term interest rates. The sticky-price model suggests that in a regression of the exchange value of domestic currency against the short-term nominal interest differential and the differential in term-spreads, we should look for a negative sign on the latter.\(^{39}\)

Some of our regressions include the covered interest differential as an additional explanatory variable, in order to embody a role for the degree of financial market integration. If the covered interest differential is thought to constitute a non-negligible gap between the interest differential and expected depreciation, then in place of covered interest parity, we substitute the covered interest differential, \(\text{cid} = i - i^* - \text{fd}\), into equation (4):

\[
s = s - \frac{1}{0} [i - i^* - \text{cid} - (_p - _p^*)].
\]

So we expect the covered interest differential to have a coefficient, \((1/00)\), that is opposite in sign to the nominal interest differential.

\(^{39}\) In Frankel (1979), the long-term interest differential was used as one of the proxies for the expected inflation differential in econometric estimation of the Dornbusch overshooting model. If the expected inflation rate is proxied by the term spread, then its coefficient will be altered because we saw in section 3 that the factor of proportionality is not one.
exchange rate, the model is supported. For all three currencies, pound, yen and mark, the coefficients on the three-month interest differential, the term premium, and covered interest differential are generally as hypothesized (positive, negative, and negative, when the dependent variable is the log of the value of the local currency in terms of dollars) and generally appear statistically significant. In addition, the logarithmic difference in stock market price indices, when included to try to capture "safe haven" shifts between countries in portfolio preferences, appears to have a positive, and highly significant, effect on the demand for and value of the local currency. However, low Durbin-Watson statistics indicate the presence of serial correlation.

When the regressions are run on first differences, statistical significance disappears. The exception is that, for the case of the dollar/pound exchange rate, an increase in the differential between the U.K. and U. S. short-term interest rates is associated with a statistically significant effect of the reverse sign. Such findings are an old problem in exchange rate regressions, generally attributed to simultaneity: when a disturbance causes the pound to depreciate, the Bank of England raises British interest rates in response. In the present instance, attempts to address the

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40 Bhandari and Genberg (1989) find that the correlation of stock prices and exchange rates changes sign over time, and in theory depends on the relative importance of real and monetary shocks.
simultaneity problem with instrumental variables were unsuccessful. Further details are given in an Appendix.

6. Chartists, Fundamentalists and Trading in the Foreign Exchange Market

The conclusion from the preceding section is that, even though the standard macroeconomic theories of exchange rate determination draw some empirical support from observed reactions to news (such as the money announcements discussed in section 4), and even though real interest differentials appear to have explanatory power for exchange rates on levels, the ability to predict changes in the exchange rate is close to nil.

Figure 4 illustrates the problem. During most of the period since 1973, the real value of the dollar has been highly correlated with the differential in real interest rates between the United States and trading partners, as Equation (5) says it should be. At times however, the dollar departs from the path dictated by macroeconomic fundamentals. The most notable episode is the period from mid-1984 to February 1985, when the dollar continue to appreciate at an accelerated speed, despite the fact that the real interest differential -- and virtually all other measures of macroeconomic fundamentals as well -- were moving in the opposite direction. Some have
suggested that the appreciation of the dollar in 1988-1989 may be of a similar nature. Ken Froot and I have suggested that such episodes may be examples of speculative bubbles, and that they are best described by models in which market participants are not necessarily assumed to agree on the correct model for forecasting the exchange rate [Frankel and Froot (1988)].

Begin with the tremendous volume of foreign exchange trading. The Federal Reserve Bank of New York (1989) has just released its three-yearly count of transactions in the U.S. foreign exchange market. It showed that in April 1989, foreign exchange trading (adjusted for double-counting) totaled $110.5 billion among banks, an increase of 121 per cent from March 1986, and $18.4 billion among nonbank financial institutions, an increase of 116 per cent; plus $56.9 billion among foreign exchange brokers, a 120 per cent increase.

What is the importance of trading volume? There are three possible hypotheses. (1) The higher the liquidity of the markets, the more efficiently is news regarding economic fundamentals processed and the smaller is "unnecessary volatility" in the exchange rate. (2) The foreign exchange market is already perfectly efficient, so that trading volume is irrelevant and uninteresting. (3) Much trading is based on "noise" rather than "news," and leads to excessive volatility. Choosing convincingly among these three hypotheses is far too
large a task to accomplish here.

There is evidence that trading volume, exchange rate volatility, and the dispersion of expectations forecasters (as reflected in the survey data) are all positively correlated. The direction of causality has not yet been definitively established. But Granger-causality tests show that the degree of dispersion has strong effects on the market. Dispersion Granger-causes volume at the 90 per cent level in three currencies out of four. Dispersion also Granger-causes volatility. We also find that the contemporaneous correlation between volume and volatility is high. One interpretation of these results is that the existence of conflicting forecasts leads to noise-trading -- the causation runs from dispersion to the volume of trading, and then from trading to volatility -- though there probably exist other interpretations as well.

In a study of minute-by-minute foreign exchange market data, Goodhart and Figlioli (1989, 31) find "no signs at all of sudden major jumps on the receipt of 'news'." For the most part, foreign exchange markets in a given country are open during exactly the same hours that news is released, so that it is difficult to do a study of noise trading and volatility such as that carried out by French and Roll for the stock market. However, Goodhart and Giugale (1988) find some evidence in hourly data that could be interpreted as supporting the view that spot rate movements occur in response

\[\text{Frankel and Froot (1990) or Ito (1989).}\]
to trading volume, and not just to news. The variance of changes over the weekend is small, even though a lot of news relevant to the foreign exchange market comes out over the weekend, and each Monday morning the volatility for each European currency is high in the first hour of trading in the geographical market where that particular currency has the highest trading volume, even when other markets open earlier in the day and could in theory have been just as able to process any weekend news. [Also, trading volume in London and volatility both reach daily low points during the lunch hour, even though news is still coming out then.]

Interestingly, the banks in the 1989 New York survey reported that only 4.9 per cent of their trading was with a nonfinancial firm, and the nonbanks only 4.4 per cent; in other words, 95 per cent of the trading takes place among the banks and other financial firms, rather than with customers such as importers and exporters. If the 1986 data are a guide, similar proportions apply in London (still the world's largest foreign exchange market). Clearly, trading among themselves is a major economic activity for banks. Schulmeister (1987, p.24) has found that in 1985, twelve large U.S. banks earned a foreign exchange trading income of $1.165 billion. Every single bank reported a profit from its foreign exchange business in every year that he examined.

Goodhart (1988, p.25 and Appendix D) has surveyed banks
that specialize in the London foreign exchange market: "Traders, so it is claimed, consistently make profits from their position-taking (and those who do not get fired), over and above their return from straight dealing, owing to the bid/ask spread" (p.59). Apparently they consider the taking of long-term positions based on fundamentals, or of any sort of position in the forward exchange market, as too "speculative" and risky. Bankers recall the Franklin National crisis and other bank failures caused by open foreign positions that were held too long. But the banks are willing to trust their spot exchange traders to take large open positions, provided they close most of them out by the end of the day, because these operations are profitable in the aggregate. In the description of Goodhart, and others as well, a typical spot trader does not buy and sell on the basis of any fundamentals model, but rather trades on the basis of knowledge as to which other traders are offering what deals at a given time, and a feel for what their behavior is likely to be later in the day.

The theory of speculative bubbles developed in Frankel and Froot (1988) says that over the period 1981-85, the market shifted weight away from the fundamentalists, and toward the technical analysts or "chartists," this shift being a natural response to the inferior forecasting record of the former group; the change in the weighted-average forecast of future changes in the value of the dollar in turn changed the demand
for dollars and therefore its price in the foreign exchange market.

Is there any sort of evidence for such a theory? *Euromoney* magazine runs a yearly August review of between 10 and 27 foreign exchange forecasting services. Summary statistics are reported in Table 8. The trend is very clear.

In 1978, 18 forecasting firms described themselves as relying exclusively on economic fundamentals, and only 2 on technical analysis. By 1985, the positions had been reversed: only 1 firm reported relying exclusively on fundamentals, and 12 on technical analysis. [There are no signs of a "fundamentalist revival" in more recent years.]

As the table indicates, a number of firms combine the two approaches, or else offer a separate service of each kind. In this case, usually technical analysis is used for short-term forecasting and fundamentals for long-term forecasting.42 This pattern matches up well with the results from surveys of market participants regarding exchange rate expectations, in Frankel and Froot (1988, 1990): at horizons of one week and one month, respondents tend to forecast by extrapolating

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42 A recent study by Allen and Taylor (1989, p.4-5) confirms that chartism is most widely used at short horizons. Out of 200-plus questionnaires received back from chief foreign exchange dealers in the London market, 60% judged charts to be at least as important as fundamentals in their forecasts at horizons of one week or less, while 85% judged fundamentals to be more important than charts at horizons of one year or longer. 74% of the respondents reported that the source of their chartist input was on-line commercial services.
recent trends, while at horizons of 3, 6, and 12 months they tend to forecast a return to a long-run equilibrium such as PPP.\textsuperscript{43}

In short, it may indeed be the case that shifts over time in the weight that is given to different forecasting techniques are a source of changes in the demand for dollars, and that large exchange rate movements may take place with little basis in macroeconomic fundamentals.

7. Conclusions

This paper has touched on many disparate points. It is now necessary to draw the unifying conclusions, and in particular to draw the implications for the making of monetary policy.

In section 1 we saw tangible evidence of how low transactions costs and low government controls have brought about a highly integrated world financial market, and in section 6 we saw that the volume of transactions in the foreign exchange market is indeed tremendous. In theory, a world of floating exchange rates and high capital mobility should be a world in which the exchange rate is a very good indicator of whether monetary policy is loose or tight. In practice, although the exchange rate does often contain

\textsuperscript{43} Notice in the table that between 1978 and 1985 [as the relative weight of technical analysis rises], the horizon of the forecasts offered by the services grows shorter.
valuable information on the perceived stance of monetary policy, at other times it undergoes large movements for reasons that appear to have no connection with macroeconomic fundamentals, but rather to come from the internal dynamics of foreign exchange market trading.

A number of implications follow regarding exchange rate volatility. First, because expectations of exchange rate changes can be large, there is no reason to expect real interest rates to be equalized across countries, even when arbitrage does equalize interest rates expressed in a common currency. Second, speculative bubbles may mean that exchange rate volatility is "excessive." Several further points on the idea of "excess" volatility should be noted. On the one hand, speculative bubbles need not be "irrational" on the part of market participants in order to constitute an additional source of variation in the exchange rate. On the other hand, if the bubble component of the exchange rate happened to be negatively correlated with the fundamentals component, it is conceivable that total variability could be smaller with the bubbles than without them. More generally, it is difficult to make firm statements regarding the implications for economic welfare. Using monetary policy to suppress variability in the exchange rate may mean creating more variability elsewhere in the economy. Even if it can be established that exchange rate volatility is needlessly large, it is not clear that the monetary authorities can do anything to eliminate speculative
bubbles. The Williamson-Miller proposal assumes that speculative bubbles would disappear if the government announced target zones, but this is only a hope and assertion.

Another relevant implication to follow from the possibility of exchange rate movement unrelated to macroeconomic fundamentals is that exchange rates are not by themselves reliable indicators of monetary policy. Indeed, no single monetary indicator is sufficient in itself. Exchange rates, commodity prices, and the term structure of interest rates all contain useful information, but they should be used in conjunction with each other (as Manuel Johnson suggested) and with other indicators as well. This conclusion is a familiar principle. But it should not be confused with the claim that the monetary authorities can always do better by simultaneously pursuing multiple targets (the goals like output, inflation and the trade balance that the country cares about), than it can by publicly announcing a single (intermediate) target variable. There are important reasons, which are by now well-known, why it is optimal for the authorities to have at least some degree of pre-commitment to a nominal target. To try to obtain the advantages of reduced expectations of inflation in the wage-setting process,

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44 The presumption that the government is in practice capable of "beating the market at its own game" should be no more automatic when it comes to foreign exchange than in many aspects of the real economy.
monetary authorities often declare a commitment to refrain from overexpansion; for such declarations to be credible, it helps for the authorities to announce a specific nominal intermediate target by which the public can evaluate the genuineness of the commitment. Similarly, to try to obtain the advantages of international coordination, the G-7 holds regular meetings; for substantive coordination agreements to be abided by, it would help for the governments to set specific intermediate targets by which they could evaluate the genuineness of each others' commitment.

What variable should be the intermediate targets to which authorities express some degree of commitment? Three candidates that have been proposed are the exchange rate, the price of gold and other commodities, and the money supply. While these three variables do contain useful information as indicators of the stance of monetary policy, they are not good candidates for intermediate targets because they are only distantly related to ultimate objectives like output and inflation. Failure to accommodate disturbances to the demand for money, the demand for gold, or the demand for foreign exchange would needlessly transmit these disturbances to the rest of the economy.

It has been argued by many that the optimal candidate for the intermediate target to which the monetary authorities

45 The formalization of the argument for rules rather than pure discretion has been made by Kydland and Prescott, Barro and Gordon, and Rogoff.
should publicly declare a degree of commitment is nominal GNP.

Under a nominal GNP target, demand disturbances such as shifts in velocity are completely offset, while little is given up in the case of supply disturbances.\textsuperscript{46} It can be shown that a nominal GNP target is in general better than an exchange rate or M1 target at minimizing a quadratic loss function in output, inflation, and the exchange rate. The only exceptions arise if (1) an unexpected ten per cent fluctuation in the exchange rate is considered much worse than an unexpected ten per cent fluctuation in the price level, or (2) under a floating exchange rate regime, there are large disturbances in the demand for domestic currency that would disappear under an exchange-rate target regime. Frankel (1989b) contains a proof, gives further references, and further develops the argument for nominal GNP targeting in the specific context of international coordination of monetary policy.\textsuperscript{47}

\textsuperscript{46} Supply disturbances are taken half as changes in output and half as changes in inflation. While this outcome will not correspond perfectly to the split that would be chosen under full discretion (unless the objective function happens to put equal weight on each), full discretion gives up the benefits of reducing inflation expectations through pre-commitment to a nominal target.

\textsuperscript{47} The argument for nominal GNP targeting in the context of international coordination includes, in addition to uncertainty regarding future disturbances, uncertainty regarding the proper model. One of the obstacles to coordination as conventionally conceived, where policy-makers bargain over M1 money supplies, is that the existing models are in complete disagreement as to whether a monetary expansion in one country has a positive or negative effect on its trading partners' economies. But if Ministers in G-7 meetings commit to joint expansion (or joint contraction, as
the case may be) in terms of nominal GNP rather than M1, the presence of exchange rate stability as a goal will encourage each country to fulfill its nominal GNP commitment in part through fiscal policy or other instruments, and not solely through monetary policy. As a result, there may be less uncertainty that transmission from each country to the next will be positive. For more on the implications of uncertainty for coordination, see Frankel (1989), Ghosh and Masson (1988), Kenen (1988) and Holtham and Hughes-Hallett.
Appendix: Exchange rate regressions for the 1970s and 1980s compared (using money market interest rates)

In this appendix, we consider how exchange rate regression results differ between the 1970s and the 1980s.

Even in the golden days of exchange-rate regressions (1976-1980), the endogeneity of the interest rates (and money supplies) was a serious problem, in practice as well as in theory. Central banks often reduce the money supply or raise interest rates in response to a depreciation in their currencies. It was difficult to control for this source of simultaneity. As a result, the money supply and interest rate often showed up with the wrong sign in an exchange-rate regression.

Econometrics has grown more cynical during the ten years since the days when we merrily ran exchange-rate regressions. The error term, which we used to think of as a small residual that is left over after the equation's macroeconomic fundamentals have explained most of the variation in the exchange rate, has grown in importance far beyond its traditional bounds. Today it is considered noteworthy if the fundamentals explain any part of the movement in the exchange rate; the error term has taken over virtually everything.\(^48\)

Regardless how one chooses to think of the origins of the error term (the two leading candidates at this point are unidentified mysterious shifts in the equilibrium real exchange rate, and speculative bubbles or fads), it has major implications for the statistics. If one accepts that the increased variability of the exchange rate in the 1980s is in part due to an increase in the variability of the error term, and one accepts that the reaction function of the monetary authorities is a prime channel of endogeneity of the interest rate, then one might be less hopeful of finding a positive relationship between the exchange value of the currency and the interest differential in the 1980s, rather than more hopeful.

The data on 3-month interest differentials and covered interest differentials that we used for the period 1982-1988 is not available before then. We use money market interest rates instead of the regular 3-month rates. Some of the

\(^{48}\) In recent years, the error term has not even been content with its traditional role of reminding us of the extent of our ignorance. Rather, it now masquerades as a "theory" of its own, under the name of the "random walk model." [Proud claims to have found that a particular variable follows a random walk are what I have in mind by the "cynicism of modern econometrics." They are in truth a statement by the investigator that he has found nothing to say about what causes the variable to change.]
results are shown in Table A1, for nominal exchange rates. When the regressions are run on levels, passing from the time period 1973-79 to the time period 1979-1989 changes the coefficient from negative to positive for each of the three currencies, and it appears significantly positive in the case of the mark and pound. But one cannot claim much evidence in favor of the overshooting model, because the Durbin-Watson statistics indicate high serial correlation. When the regressions are run on first differences, all statistical significance is lost. The results are not any better when the real exchange rate is used for the dependent variable, or when instrumental variables are used.

*   *   *

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Table 2: Test for time-varying risk premium

OLS regression of \( s^p \) on \( f_d \)

<table>
<thead>
<tr>
<th>Term (k)</th>
<th>3 month</th>
<th>6 month</th>
<th>12 month</th>
</tr>
</thead>
<tbody>
<tr>
<td>( b ) estimate</td>
<td>1.123</td>
<td>1.113</td>
<td></td>
</tr>
<tr>
<td>standard error</td>
<td>0.143</td>
<td>0.096</td>
<td></td>
</tr>
<tr>
<td>GMM standard</td>
<td>0.196</td>
<td>0.146</td>
<td></td>
</tr>
<tr>
<td>error (homos.)</td>
<td>0.169</td>
<td>0.198</td>
<td>0.122</td>
</tr>
<tr>
<td>GMM s.e. (correcting for heteros.)</td>
<td>0.198</td>
<td>0.122</td>
<td></td>
</tr>
<tr>
<td>( t: b=0 )</td>
<td>5.73*</td>
<td>7.61*</td>
<td></td>
</tr>
<tr>
<td>( t: b=0.5 )</td>
<td>3.18*</td>
<td>4.20*</td>
<td></td>
</tr>
<tr>
<td>( t: b=1 )</td>
<td>0.63</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>( F: a=0,b=1 )</td>
<td>20.9*</td>
<td>41.8*</td>
<td>x</td>
</tr>
</tbody>
</table>

DF: 308

\( R^2 \): .36 .58 .53

DW (lower bound): 1.60 1.29 0.90

Source: Frankel and Froot (1990)

Notes: GMM standard errors are calculated using the Generalized Method of Moments; although overlapping observations are not an issue because ex post spot rate changes do not enter in, pooling across currencies creates a correlation across exchange rates. Correcting for possible heteroskedasticity makes little difference; the reported test statistics assume homoskedasticity. Separate constant terms were estimated for each currency, but are not reported, to save space. The five currencies are the pound, mark, Swiss franc, yen and French franc.
x: F stat not reported, because GMM covariance matrix not positive definite

* significant at 95 per cent level
### TABLE 3: INCREASED VARIANCES IN THE 1980s

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample</th>
<th>US</th>
<th>UK</th>
<th>Ger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rates</td>
<td>1973:3-1974:4</td>
<td>5.49</td>
<td>4.88</td>
<td>9.17</td>
</tr>
<tr>
<td>(overnight)</td>
<td>1979:10-1989:4</td>
<td>12.03</td>
<td>8.50</td>
<td>6.26</td>
</tr>
<tr>
<td>Bond yields</td>
<td>1973:3-1979:9</td>
<td>0.47</td>
<td>2.42</td>
<td>2.68</td>
</tr>
<tr>
<td>(long term)</td>
<td>1979:10-1989:4</td>
<td>4.66</td>
<td>4.03</td>
<td>2.20</td>
</tr>
<tr>
<td>Stock market</td>
<td>1973:3-1979:9</td>
<td>.01</td>
<td>.11</td>
<td>.01</td>
</tr>
<tr>
<td>(price indices)</td>
<td>1979:10-1989:2</td>
<td>.11</td>
<td>.25</td>
<td>.14</td>
</tr>
<tr>
<td>Exchange rates</td>
<td>1973:1-1979:10</td>
<td>.02</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td>(log $/local)</td>
<td>1979:11-1989:2</td>
<td>.04</td>
<td>.04</td>
<td></td>
</tr>
</tbody>
</table>
## INCREASED CROSS-COUNTRY CORRELATIONS IN THE 1980s

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sample</th>
<th>US-UK</th>
<th>US-Ger</th>
<th>US-Ja</th>
<th>Ja-UK</th>
<th>Ja-Ger</th>
<th>Ger-UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.Interest rates (overnight mkt)</td>
<td>1973:3- 1979:9</td>
<td>.03</td>
<td>.54</td>
<td>.22</td>
<td>.16</td>
<td>.44</td>
<td>-.35</td>
</tr>
<tr>
<td></td>
<td>1979:10-</td>
<td>.36</td>
<td>.87</td>
<td>.60</td>
<td>.48</td>
<td>.71</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1989:4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.Long-term interest rates</td>
<td>1973:3- 1979:9</td>
<td>.07</td>
<td>-.37</td>
<td>-.25</td>
<td>.69</td>
<td>.72</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1979:10-</td>
<td>.76</td>
<td>.91</td>
<td>.79</td>
<td>.86</td>
<td>.87</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1989:4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.Stock market</td>
<td>1973:3- 1979:9</td>
<td>.73</td>
<td>.67</td>
<td>.66</td>
<td>.91</td>
<td>.70</td>
<td>.81</td>
</tr>
<tr>
<td></td>
<td>1979:10- 1989:2</td>
<td>.98</td>
<td>.93</td>
<td>.97</td>
<td>.9</td>
<td>.89</td>
<td>.94</td>
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</tbody>
</table>
Table 7: Regression of Inflation Spread Against Term Spread

************

Inflation Rates: long-term - 24 months; short-term - 3 months

<table>
<thead>
<tr>
<th>Const.</th>
<th>Coeff.</th>
<th>$R^2$</th>
<th>$R^{-2}$</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>$i_{2yr} - i_{3mo}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>estimate</td>
<td>-.80</td>
<td>.28</td>
<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td>OLS s.e.</td>
<td></td>
<td>(.27)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>-2.95</td>
<td></td>
<td>1.81</td>
<td></td>
</tr>
<tr>
<td>corrected s.e.</td>
<td></td>
<td>(7.83)</td>
<td></td>
<td>(3.60)</td>
</tr>
<tr>
<td>T</td>
<td>-0.09</td>
<td></td>
<td>+0.08</td>
<td></td>
</tr>
</tbody>
</table>

| $i_{5yr} - i_{ff}$ |  |  |  |
| estimate | - .92 | .78 | .31 | .30 |
| OLS s.e. |  | (.20) |  | (.10) |
| corrected T | -0.19 |  | 0.32 |

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