International Finance Discussion Papers

Number 226

August 1983

WHAT'S WRONG WITH EMPIRICAL EXCHANGE RATE MODELS: SOME CRITICAL ISSUES AND NEW DIRECTIONS

by

Peter Isard

WHAT'S WRONG WITH EMPIRICAL EXCHANGE RATE MODELS: SOME CRITICAL ISSUES AND NEW DIRECTIONS

Peter Isard*/

August 1983

I. Introduction

A number of recent statistical studies have found that "representative" structural exchange rate models are no more accurate than forward rates or random walks in forecasting out-of-sample, even when purged of errors in forecasting explanatory variables.1/ This paper discusses some deficiencies in the specification and estimation of structural exchange rate models. The criticism is organized into three basic themes, which are developed in sections III-V after section II provides a brief review of some major issues and classes of models in the literature. Section III suggests that empirical exchange rate models have essentially put a lot of eggs into one basket in their attempts to capture the behavior of inflation expectations, and that new directions for modelling or measuring inflation expectations should be pursued. Section IV argues that portfolio balance models have been oversimplified: insufficient attention has been paid to microeconomic evidence on how large exchange market participants (banks and corporations) perceive their portfolio-management objectives and structure their portfolio-adjustment decision processes; and conceptual models have distinguished portfolio assets mainly by currency, without adequately linking the prospective yields on assets to country-specific variables such as stabilization policies and macroeconomic outlooks, taxes, capital controls, creditworthiness, etc. Section V argues, however, that despite the deficiencies in the specifications of structural exchange rate models, the poor empirical performance of these models may stem much less from structural short-comings than from deficiencies in quantifying ex ante expectations of explanatory variables, which are critical for testing structural models in a "news" framework.

II. An Overview of Models and Issues in the Literature

The exchange rate literature that has developed over the past decade has emphasized equilibrium conditions in asset markets as well as goods markets.[2/] The covered interest rate parity condition is generally assumed to hold continuously, such that[3/]

$$(1) \quad s = f + R_B - R_A$$

Here and below the notation is as follows:

s, f, s^e	denote the logrithms of the nominal values of spot, forward and expected future spot rates, in units of currency A per unit of currency B
p_A, p_B	denote lograrithms of the price levels in countries A and B
R_A, R_B	denote nominal own rates of interest on assets denominated in currencies A and B
e	denotes the expected future value of the variable to which it is superscripted

References are also made to the premium expected for bearing exchange risk and the real exchange rate, respectively defined as

$$(2) \quad risk^e = s^e - f$$

and

$$(3) \quad sreal = s + p_B - p_A$$

Definition (3) also applies to expected future values of the variables

$$(4) \quad sreal^e = s^e + p_B^e - p_A^e$$

Together, conditions (1), (2) and (4) imply

$$(5)\quad s = (R_B - R_A) - (p_B^e - p_A^e) + sreal^e - risk^e$$

In first-differenced form, condition (5) separates changes in the spot exchange rate into components reflecting changes in the nominal interest differential, revisions in expectations about future relative price levels (or the inflation differential), revisions in expectations about the future real exchange rate and changes in the risk premium. By adding and subtracting $p_A - p_B$ on the right-hand side, condition (5) can be converted into

$$(6)\quad s = (p_A - p_B) + (r_B^e - r_A^e) + sreal^e - risk^e$$

where r_B^e and r_A^e denote "expected real interest rates" defined as

$$(7)\quad r_B^e = R_B - (p_B^e - p_B)$$

$$(8)\quad r_A^e = R_A - (p_A^e - p_A)$$

Thus, from conditions (6) and (3)

$$(9)\quad sreal = (r_B^e - r_A^e) + sreal^e - risk^e$$

Conditions (5), (6) and (9) represent no more nor less than the covered interest rate parity condition manipulated into alternative forms through the use of definitions (2), (4),(7) and (8). Since covered interest parity is assumed by virtually all exchange rate models that have been proposed over the past decade, conditions (5), (6) and (9) provide a general framework for discussing some key issues that arise in modelling exchange rate behavior. The behavioral assumptions that have been embodied in exchange rate models can be divided into assumptions about parity conditions between variables that are generally regarded as endogenous, and additional assumptions to explain the behavior of endogenous variables other than the dependent exchange-rate variable. A nomenclature has developed which classifies exchange rate models on the basis of their assumptions about parity conditions.

The first basis on which exchange rate models have been classified is their assumption about whether the interest bearing assets denominated in the two currencies are perfect substitutes, such that portfolio arbitrage drives the nominal interest rate differential into equality with the expected rate of change in the exchange rate. This uncovered interest rate parity condition can be written as

$$(10) \quad R_A - R_B = s^e - s$$

It implies, from (1) and (2), that the forward rate equals the expected future spot rate, or that $risk^e = 0$. Models that adopt the assumption of uncovered interest parity or perfect asset substitutability have been labeled monetary models, while models that do not have been classified as portfolio balance models.[4/]

Monetary models have been subclassified on the basis of whether purchasing power parity (PPP) is assumed to hold continuously -- or more precisely, whether sreal is assumed to fluctuate unsystematically around a time-invariant PPP level. Monetary models that assume continuous PPP have been called flexible price monetary models.[5/] Monetary models that instead allow the real exchange rate to deviate systematically in the short run from its long run equilibrium level, equivalently allow real interest rates to differ across countries in the short run, with systematic differences between nominal interest differentials and expected inflation differentials.[6/] These models have generally imposed direct assumptions on the adjustment paths followed by price levels or the exchange rate in the short run, and have been classified as sticky price monetary models.[7/]

One issue that has been resolved convincingly in the literature is that the assumption of continuous PPP is not supported by the data; the flexible price monetary model can be rejected. Differences of opinion remain, however, on whether the data show evidence of a time varying risk premium, which would reject the sticky-price monetary model in favor of the portfolio balance model. A number of studies of the time series properties of exchange rates and interest differentials have been interpreted as rejecting the joint hypothesis that market participants form rational expectations and that the risk premium is zero (or constant).[8/] Many economists, however, remain skeptical of these results, and nobody has yet found significant evidence that the behavior of exchange rates lends support to a structural model of the risk premium.[9/] Section III presents some evidence that casts doubt on the sticky price monetary model, but that also suggests the portfolio balance model has been poorly specified.

The issues of modelling strategy that are discussed in sections III to V can be put into perspective by returning to condition (5). As noted above, this condition is merely a manipulated form of the covered interest rate parity assumption, and in general, the structural exchange rate models that have been tested empirically over the past decade can be derived by substituting behavioral models or assumed measures for the expectational terms in (5), or in some variant of (5). Sections III and IV respectively suggest directions for attempting to improve the way that price expectations are captured and the way that the portfolio balance framework and risk premium are formulated. Section V argues that regardless of whether the expectational terms in (5) are quantified directly or replaced by behavioral models together with assumed measures of the expected values of explanatory variables that enter those models, the poor forecasting performance of structural models may largely reflect inaccurate assumed measures of ex ante expectations and does not necessarily imply that the structural approach to modelling exchange rates should be abandoned.

Some additional points about modelling strategy are evident from condition (9). Among the terms on the right side of (9), the expected real interest differential and the expected premium for bearing exchange risk are generally regarded to have small orders of magnitude, at least in comparison with the expected future real exchange rate. Thus, although changes in nominal interest rate differentials and expected inflation differentials may be regarded as largely accounting for changes in observed exchange rates, an explanation of the real or price-adjusted levels of observed exchange rates must be linked to an explanation of the level of the real exchange rate that is expected to prevail at some future horizon. In this context, the notion of long run equilibrium provides the most appealing foundation for anchoring expectations of future real exchange rates. Some empirical exchange rate models have assumed that the real exchange rate is expected to converge to a long-run purchasing power parity level that can be either measured as an historical average or treated as a constant parameter to be estimated in regression analysis. However, the strong assumption that expectations about the long-run purchasing power parity level are time invariant (or insensitive to "real shocks") has been challenged, and there is some evidence that it is rejected by data for the United Kingdom.[10/]

To deny the strong PPP assumption that the real exchange rate is always expected to converge to some exogenous time-invariant level is not to deny the weak PPP assumption that the real exchange rate may always be expected to converge to some endogenous equilibrium level, the perceived value of which may vary over time in response to "shocks" or new information. A key conceptual issue is how to model the long-run equilibrium level of the real exchange rate. In the Dornbusch (1976) model the long-run real exchange rate is constrained by a goods-market clearing condition, and it is a fairly short step from the Dornbusch specification to the popular notion that the real exchange rate must satisfy a balance-of-payments equilibrium condition in the long run. Rational expectations about the long run real exchange rate, accordingly, should be sensitive to changes in factors that influence production or absorption in the long run. Consistently, from a credit-market perspective, simple two-country comparative static analysis suggests that the expected long-run PPP level will be altered by any shocks that change the expected long-run stock of one country's (real) net claims on the other, assuming that the change in the debtor country's trade surplus consistent with meeting interest payments on the long-run stock of (real) debt requires a greater-than-infinitesimal adjustment of the real exchange rate.[11/]

The presumption that observed levels of real and nominal exchange rates are anchored by expectations about the long-run real exchange rate, however imprecisely defined, implies that observed nominal exchange rates discount nominal interest differentials and expected inflation differentials over long horizons. This is apparent from condition (6), in which fluctuations in nominal spot exchange rates relative to expected long-run real exchange rates reflect changes in expected long-term real interest differentials, appropriately compounded. In conditions (6) and (9) the expected real interest differential can be viewed as the integral over a long-term horizon of the expected instantaneous real interest differential (which must converge to the expected instantaneous premium for bearing exchange risk if the real exchange rate is expected to converge to a constant). Alternatively, the expected real interest differential can be viewed approximately as an expected long-term real interest differential, measured in percent per annum, multiplied by the number of years to maturity of the long-term assets to which the interest rates correspond. Moderate percentage-point per annum changes in expected long-term real interest differentials can thus give rise to much greater percentage changes in observed exchange rates, as discussions of exchange rate volatility have emphasized increasingly in recent years.[12/] Crude data on expected long-term inflation differentials suggest that more than half of the dollar's 40 percent appreciation against the mark between mid-1980 and mid-1982 was associated with observed changes in long-term nominal interest differentials relative to revisions in expectations about long-term inflation differentials (see Figure 2 in Section III below). These considerations suggest that models or measures of long-term inflation expectations are a critical ingredient for understanding the behavior of exchange rates.

III. Methods for Capturing Inflation Expectations

The argument that models or measures of inflation expectations are critical for "explaining" nominal exchange rates (given observations of nominal interest rates) need not be linked explicitly to conditions (5) or (6). A deeply-rooted notion in economic analysis is that general equilibrium models can be solved for relative price levels but typically not for absolute price levels. This suggests that real exchange rates may have equilibrium values, but that nominal exchange rates can only be explained relative to ratios of national price levels. Thus, changes in nominal exchange rates are critically linked to changes in the ratios of national price levels, or to relative inflation rates.

Reflecting this link, structural models of exchange rate determination have generally supplemented their assumptions about parity conditions with behavioral assumptions about price level determination. Many models, including each of the three structural models tested by Meese and Rogoff (1983a, 1983b), have assumed that price levels clear money markets in which money demand functions have the popular Cagan form

$$(11)\quad m_j = p_j + a_1 y_j - a_2 R_j \quad \text{for } j = A, B.$$

Here m_j and y_j denote the logrithms of the nominal money stock and real income in country j. Meese and Rogoff have conjectured that the instability of parameter estimates for this money demand specification may be a principal factor underlying the poor out-of-sample performance of the structural exchange rate models they tested. Hopes of using the money demand function to obtain a stable price equation are dimmed a priori by recognition that the set of close substitutes for money (however defined) is continuously changing, as are the "coefficients" that might best describe the extent to which central bankers attempt to adjust supplies of money in reaction to information about the economic variables and political developments that concern them. Hopes of combining a money demand function <u>and</u> the assumption of rational expectations to obtain a stable structural model of how market participants form expectations about future price levels, moreover, are dimmed further a priori by the fact that economists and other market participants disagree on the question of which model of prices is "rational". In practice, major econometric forecasting services rely on different classes of price equations, which in many cases do not appear to be closely linked to a simple form of the money demand function.[13/] These considerations raise questions about the prospective payoffs from incorporating structural models of inflation or price-level expectations into models of exchange rate determination. On the other hand, approaches to modelling exchange rates that do not require structural models of inflation expectations may also have serious limitations. In particular: autoregressive techniques seem poorly designed for capturing the important revisions in inflation expectations that may accompany elections or other changes in policy regimes (the Thatcher, Reagan and Mitterand effects); there is hardly any survey data available on long-term inflation expectations; and the use of long-term nominal interest rates as proxy measures for long-term inflation expectations (as in Frankel (1979) and Hooper and Morton (1982)) is incompatable with the widespread view that long-term dollar interest rates have not moved closely in parallel with U.S. inflation expectations during recent years. One response to this measurement dilemma has been the use of centered moving averages of actual inflation rates to proxy expected inflation rates, blending the assumptions of regressive expectations and accurate foresight.[14/] Potentially, the establishment of options markets in long-dated CPI futures might provide an ideal source of daily information on participants' long-term inflation expectations.

It is worth emphasizing, nevertheless, that conditions (5) and (6) provide a starting point for considering how empirical exchange rate modelling might proceed with direct or proxy data on long-term inflation expectations, however obtained. Given the endogeneity of interest rates and inflation expectations and the a-priori knowledge of the coefficients attached to them in condition

(5), it is appropriate to construct an index of the long term forward rate adjusted for expected future relative price levels

$$(12)\quad freal^e = s - (R_B - R_A) + (p^e_B - p^e_A)$$
$$= f + (p^e_B - p^e_A)$$

Condition (5) can then be transformed into

$$(13)\quad freal^e = sreal^e - risk^e$$

ignoring the potentially large measurement error in $(p^e_B - p^e_A)$ and hence $freal^e$. It is then straightforward to test the joint hypothesis that $sreal^e$ and $risk^e$ are constant (as implied by the sticky-price monetary model). In addition, structural models of the risk premium might be retested under the assumption of time-invariant expectations about the long-run real exchange rate.

Some survey data are now available on the 5-year U.S. inflation expectations of financial decision makers, sampled at 12 "points in time" since June 1980. These are shown in Table 1, along with some constructed measures of 5-year German inflation expectations (see the notes to Table 1). Figure 1 shows the week-to-week behavior of the spot (S) and 5-year forward (F) mark/dollar exchange rates since June 1980 (expressed as index levels, and not logrithmic), and Figure 2 compares movements in S and F with movements the 5-year forward real exchange rate ($FREAL^e$), as constructed from F and the data shown in Table 1.[15/]

The question of whether the long-term forward real exchange rate has been constant, as predicted by the sticky price monetary model under the strong form of the purchasing power parity assumption, can be considered visually with the help of Figure 2. The figure shows that the 5-year forward real DM/$ rate has varied over a 25 percent range, or by about 12-1/2 percent on each side of its sample mean. This could conceivably be explained by measurement errors of up to 2-1/2 percentage points per annum in the expected inflation differential.[16/]

Table 1

Survey Dates[a/]	Expected 5-year Inflation Rates		Consumer Price Indexes		5-year Eurocurrency Deposit Rates[c/]		Exchange Rates		
	United States[a/]	Germany[b/]	United States	Germany	Dollars	Marks	Spot nominal	5-year Forward nominal[d/]	5-year Forward "real"[e/]
	(percent per year)		(June 1980=100)		(percent per year)		marks/$	marks/$	(June 1980=100)
June 25, 1980	9.22	4.50	100	100	10.75	8.0	1.77	1.56	100
Oct. 7, 1980	9.38	4.40	103.3	100.4	12.75	8.375	1.80	1.48	98.9
Jan. 12, 1981	8.87	4.40	105.2	102.5	13.875	9.0	1.99	1.60	103.8
April 30, 1981	8.40	4.85	107.7	104.6	15.75	10.625	2.21	1.76	110.3
Sept. 4, 1981	7.80	4.05	112.5	106.8	17.00	11.875	2.41	1.93	124.6
Nov. 2, 1981	7.92	3.85	114.1	107.7	16.25	10.625	2.22	1.73	114.5
Jan. 27, 1982	7.36	4.25	114.9	108.9	16.00	9.75	2.32	1.76	110.6
April 9, 1982	6.75	4.60	116.9	110.0	15.625	9.06	2.42	1.81	109.4
June 30, 1982	6.81	4.60	118.2	111.7	15.875	9.5	2.46	1.85	112.0
Sept. 7, 1982	6.69	4.70	120.1	112.1	14.25	8.875	2.47	1.94	117.6
Jan. 4, 1983	6.34	3.75	121.9	113.2	11.625	7.625	2.37	1.97	123.5
March 10, 1983	6.05	3.50	122.6	113.2	11.25	7.25	2.39	1.99	125.3

Notes to Table 1

a/ The data on 5-year U.S. inflation expectations were collected by Richard B. Hoey, Vice President and Chief Economist at Warburg Paribus/A.G. Becker. Hoey surveyed the 5 and 10-year inflation expectations of several hundred financial decision makers at 12 "points in time" between June 1980 and March 1983. The polls were completed over periods of several days. The survey dates listed in the table are approximate midpoints of these periods.

b/ I have constructed 5-year German inflation expectations by taking Federal Reserve Board forecasts for horizons of 1-1/2 to 2 years and assuming that inflation beyond the Federal Reserve's forecast horizon was expected to continue at the rate forecast for the last 4 quarters of the horizon. The tabulated 5-year inflation expectations do not represent the forecasts of the Federal Reserve Board or anyone else on its staff.

c/ The data on Eurocurrency rates are brokers indications of bid rates for fixed-term 5-year Eurodollar and Euromark deposits, as collected by the Bank of America and made available through Data Resources Inc.

d/ The 5-year forward nominal exchange rates are constructed from spot exchange rates and Eurocurrency interest rates.

e/ The 5-year forward real exchange rates are constructed as the products of 5-year forward nominal exchange rates multiplied by the ratios of the U.S. and German price levels that are assumed to have been expected at 5-year horizons. The expected future price-level ratios have been constructed from current ratios of consumer price indexes and the expected 5-year inflation rates.

Figure 1

NOMINAL EXCHANGE RATES

(Weekly data)

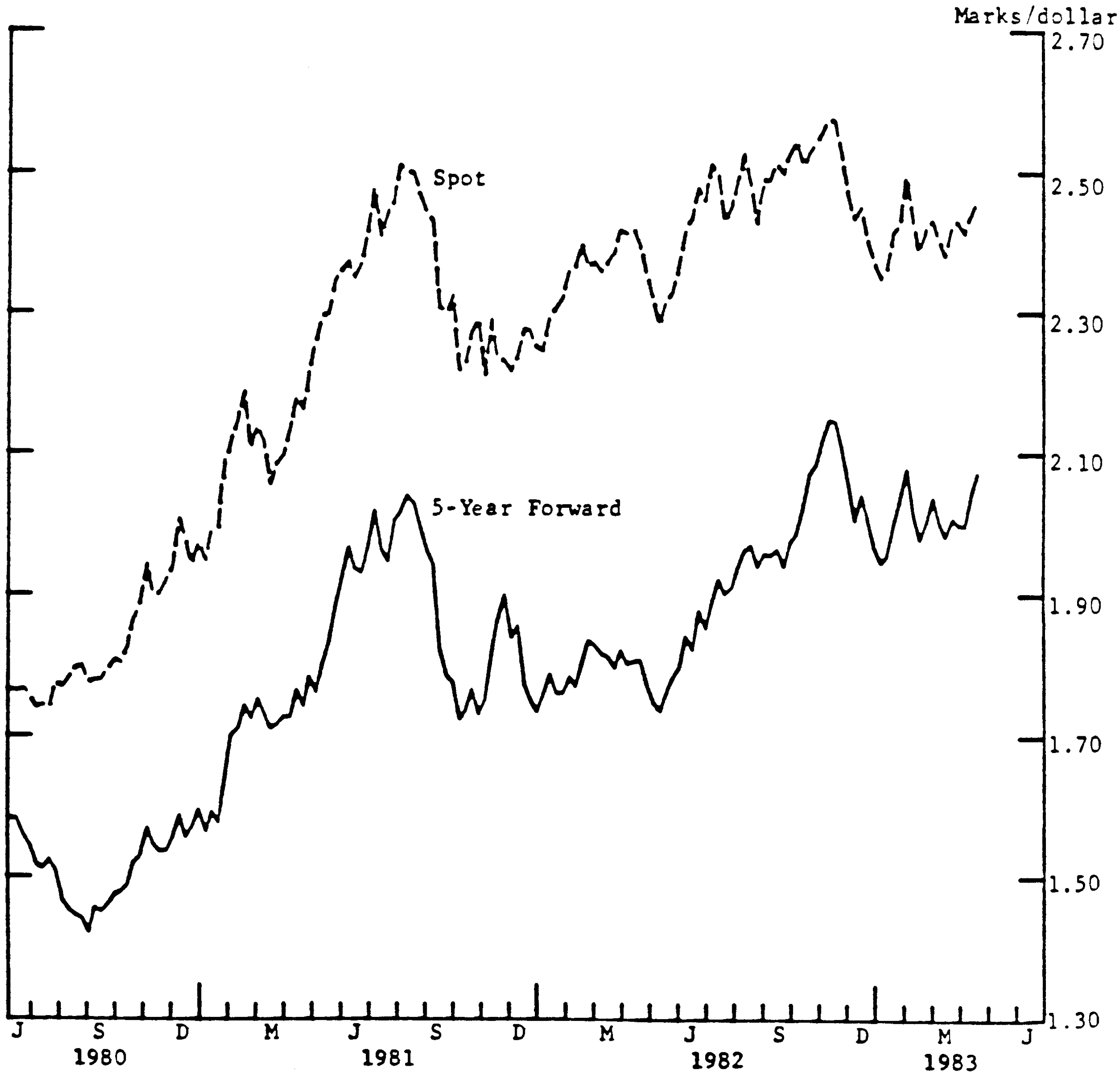
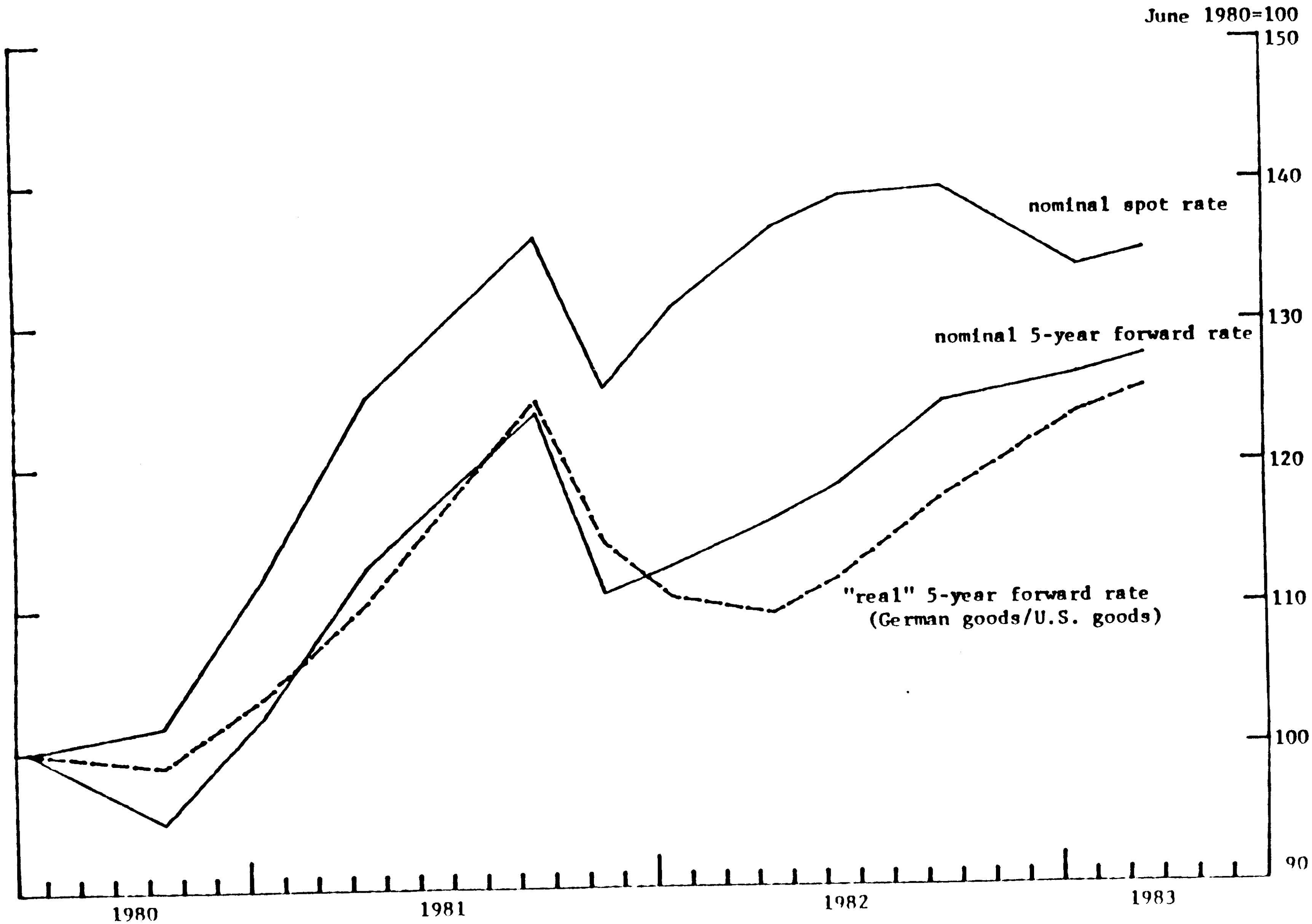


Figure 2: Mark/dollar Exchange Rate Indexes



It is also conceivable that the sticky price monetary model is correct but that it takes longer than 5 years for real exchange rates to adjust to their purchasing power parity levels. Consistently, the range of variation might be considerably narrower for the 10-year forward real DM/$ rate, which I have not attempted to construct.17/

The case against dismissing the visual impression of wide variation in the 5-year forward real DM/$ rate as measurement error or as uncharacteristic of movements in even longer-term forward real DM/$ rates is that the large changes shown in Figure 2 were contemporaneous with some informative market commentary. During the period from January through August 1981, financial portfolio managers commented frequently that they were impressed by the Reagan Administration's ability to formulate rapidly and then implement almost all of the economic programs it sought, in contrast with the situation in Germany, where the lack of a strong political consensus was paralyzing economic policy. According to the Bundesbank's analysis, the dollar "rose steeply on a strong wave of confidence ... [reflecting] the expectation that the new Administration would radically change the direction of economic policy in the United States."18/ A similar view was expressed by the Federal Reserve Bank of New York: "Market participants focussed on the policy challenges facing many governments abroad and were concerned that policies would not be adopted to deal with these problems effectively . . . Moreover, as the administration's economic proposals gained congressional approval, market participants compared the breadth of support for the new policy directions in the United States with the continuing debates on a full range of policies in many countries abroad."19/ Consistently, the decline in $FREAL^e$ between August and October 1981 coincided with perceptions that Congressional support for the Reagan Administration's programs was eroding, following the revelation in mid-August of new and larger official estimates of the prospective size of U.S. budget deficits, as well as public statements made by Congressional leaders upon returning from their Labor Day recess.

A second major swing in $FREAL^e$ (as shown in Figure 2) has occurred since the middle of 1982, coinciding with the intensification of concerns over international debt problems and the emerging indications of a U.S. economic recovery. In analyzing exchange market behavior during that period, the Council of Economic Advisers reported: "Many observers believe that other factors besides real interest rates help explain the dollar's strength. In particular, the unsettled state of the world economy ... may have created a desire on the part of investors for a safe haven for their funds. The United States, according to this argument, is still regarded as the most politically and economically stable of the market economies and has become a financial refuge in troubled times."[20/] In addition, since mid-1982 most forecasts of U.S. real activity growth have been raised relative to forecasts of German activity growth: the U.S. economic outlook has improved and perhaps become less uncertain relative to the economic outlook for Germany.

The official explanations of the behavior of dollar exchange rates during the first eight months of 1981 and since the middle of 1982 closely reflect the market commentary of financial portfolio managers. The explanations suggest that alternative portfolio assets are not perfect substitutes, but emphasize substitutability considerations that are not stressed by portfolio balance models as they have traditionally been formulated and estimated. The next section discusses ways that portfolio balance models might be reformulated to capture better the messages of market commentary.

IV. Some Shortcomings of Portfolio Balance Models

Traditionally, portfolio balance models have distinguished between stocks of outside assets denominated in different currencies, and attempts to test the empirical validity of these models have looked for significant correlations between the relative stocks of these assets and the relative yields they were expected to offer, taking account of expected exchange rate movements. Several shortcomings in the formulation and estimation of such models seem particularly severe: (1) the degree of uncertainty about exchange rates has generally been treated empirically as an exogenous parameter rather than an endogenous variable; (2) portfolio assets have been distinguished mainly by currency and not adequately by the countries on whose macroeconomic policies, productivity performances, creditworthiness, taxes and capital controls their yields depend; and (3) the microeconomic foundations of the literature do not adequately reflect the way that major exchange market participants perceive their portfolio-management objectives and structure their portfolio-adjustment decisions.

With regard to point 1, the degree of uncertainty about future exchange rates has been linked in conceptual models of the exchange risk premium to perceived degrees of uncertainty about relative inflation rates, output levels, etc., which in turn reflect uncertainties about macroeconomic policies.[21/] Although it seems difficult to construct quantitative time series data on the degrees of uncertainty attached to exogenous variables, it can also be argued that the attempts that have been made to verify the portfolio balance approach by seeking structural evidence of asset substitutability or exchange risk premiums have been primitive in their treatment of the degree of exchange risk as a constant parameter or matrix of parameters.[22/]

With regard to point 2, it is interesting to consider a portfolio balance model that explicitly includes opportunities to invest in individual economies through purchases of equities. Such a model could potentially be developed to describe the effects of a change in the attractiveness of one country's equities (perhaps reflecting an election outcome or policy change) on the spectrum of market clearing asset prices and exchange rates. To the extent that equities in U.S. firms are denominated in dollars, the expected real return on U.S. equities might be held roughly in line with the expected real return on dollar-denominated bonds, recognizing that actual returns on stocks and bonds could diverge in different states of the world. The extent to which the mark value of the dollar should appreciate in response to revisions in expectations about relative returns on U.S. and German equities might still be judged roughly on the basis of changes in expected real interest differentials on dollar and mark-denominated bonds. The interesting consequence of introducing equities, however, is that it allows the risk premium to be formulated by modelling the link between the perceived variance of real returns on equities and perceptions about the effectiveness of macroeconomic policies in particular, or country-specific exogenous variables in general.[23/]

With regard to the third shortcoming of portfolio balance models, the limited attention to microeconomic foundations is particularly striking when contrasted with the numerous and careful econometric studies of whether time series data on exchange rates and interest rates support the joint hypothesis of market efficiency and risk neutrality (recall footnote 8). It seems difficult to avoid concluding that the microeconomic evidence challenges both parts of the joint hypothesis.

With regard to efficiency in the use of information, some exchange rate forecasters will admit to biasing their forecasts toward the forward rate. These forecasters perceive that the major element in their payoff or loss function is whether they have correctly advised their clients that covering exposures in the forward market will prove profitable or unprofitable, and not how accurately they have predicted how much the future spot rate will differ from the forward rate. Although this perception alone does not make it rational to bias their forecasts, it is apparently also perceived that clients are suspicious of predictions that differ considerably from what other forecasters are predicting. There seems to be a cost attached to being too extreme, or perhaps a risk-averse response by the forecaster to the prospect that an extreme prediction may reflect an incorrect forecasting model.

A second anecdotal fact that bears on market efficiency is that neither forecasters nor their clients review their full information sets every day. A typical multinational corporation may undertake an extensive review of its foreign currency exposure once a month, and relatively few exchange rate forecasters revise their predictions more frequently than once-a-month or once-a-week. This suggests a lagged response to new information on the part of many large market participants. Of course, it may only take a "margin" of fully-informed quickly-responding market participants to make market-clearing exchange rates efficient. Perhaps the tail can wag the dog. But it seems constructive to address the efficiency question by posing it with a time dimension. How many minutes, hours or days does it take for markets to respond fully to new information — or as a weak-form definition of market efficiency, for exchange rates to respond fully to the information content of their own history? The

Dooley-Shafer (1983) findings and some evaluations of the profitability of technical forecasting services[24/] suggest that there is money to be made (on average over time) by taking positions in exchange markets on the basis of filter rules or various turning-point indicators. There is additional anecdotal evidence, however, that a large part of the profits from following technical rules is obtained during the few days following the signals to change positions; those who do not act fairly quickly may not profit. Thus, the suggestion may be that markets take up to several days to adjust fully to new information, which is consistent with contentions that sterilized intervention or large "exogenous" private foreign exchange flows can sometimes influence exchange rates for a few hours or days.[25/]

To be respectable, such a view requires that market participants are risk averse and/or find it costly to re-evaluate their currency positions continuously. The proposition that it is difficult to find large market participants who are not risk averse was advanced early in the floating-rate period by McKinnon (1976) and has not been seriously disputed. Both banks and nonbank corporations generally instruct their foreign exchange managers to avoid exposing the value of their firms to large risks through open foreign currency positions.

Apart from the conclusion that foreign exchange managers are not delegated the authority to take large foreign exchange risks, however, it is difficult to know what to infer from the literature on corporate foreign exchange practices.[26/] There is an important distinction between the overall objectives of the firm and the objectives that foreign exchange managers are given instructions or incentives to pursue. The fact that foreign exchange managers may act to limit the foreign currency exposure that results from the projected operations of the corporation reveals little about how top corporate management choses the currency composition of the firm's net financial assets.[27/] What is presumably true, however, is that upper-level decisions about portfolio stocks are normally reviewed only periodically, reflecting the costs of top management's time, so that the stock-adjustment response to new information may be gradual. In addition, to the extent that the discretionary authority of corporate foreign exchange managers is essentially restricted to deciding how extensively to hedge the transactions exposures associated with the payables and receivables that can be projected over near-term horizons, corporate hedging operations may put pressures on exchange rates that are directly related to prospective near-term balances of international trade flows, other things equal. In any case, these considerations suggest that many of the large participants in foreign exchange markets (banks and corporations) consider it rational to structure their internal decision processes and authority in a way that is inconsistent at the microeconomic level with the traditional instantaneous-adjustment paradigm of portfolio balance models.[28/]

V. Interpreting the Poor Forecasting Performance of Structural Models

Meese and Rogoff (1983a, 1983b) and others have searched extensively and unsuccessfully for evidence that structural exchange rate models can outperform the forward rate or a random walk in forecasting post sample. The structural models don't even outperform the random walk when purged of all errors in forecasting the explanatory variables.[29/] One interpretation is that the structural models are not "fit to survive."

An alternative interpretation is that the structural models have not been tested properly in a "news" framework with sufficiently accurate measures of the news. The Meese-Rogoff results may basically reflect a lack of attention to, or success at, capturing the difference between ex ante expectations about explanatory variables and their actual realizations (or capturing changes in expectations between successive points in time). Consistently, the basic structural features of exchange rate models — namely, the covered interest rate parity condition and the notion that movements in nominal exchange rates are correlated with revisions in expectations about inflation differentials, other things equal — may provide an extremely profitable forecasting framework for anyone who is relatively accurate in predicting changes in nominal interest rates and (expected) inflation rates. Foreign exchange markets are analagous to stock markets in offering profit opportunities to forecasters who can accurately predict the directions in which investors as a group will revise their expectations about interest rates, inflation rates and other market "fundamentals."

The view that "news" explains a major portion of exchange rate variation has now become widely accepted.[30/] Most of the initial efforts to isolate the effects of news have quantified the news either as differences between ex post realizations and autoregressive measures of ex ante expectations, or as first differences of autoregressive measures of ex ante expectations.[31/] The definition of "news" as revisions in expectations is appropriate for a risk-neutral world. A broader definition of news would be more appropriate in principle to the extent that investors are concerned with more than just the means of the probability distributions that describe the future values of explanatory variables. In a risk averse world, the realization of an expected outcome can be "news" in the sense that it can influence the exchange rate by resolving uncertainty.

The view that exchange rate movements predominantly reflect responses to news has different implications for forecasting ex ante than for explaining exchange rates ex post. Economists without accurate foresight of the news can test structural models in a news framework if they have accurate ex post measures of what market participants expected ex ante. A notable feature and criticism of the strategies that have been used to date for quantifying expectations in exchange rate models is that they have pursued unbiasedness with little concern for efficiency. This limitation deserves considerable attention, particularly if one accepts the view that the mileage in making structural exchange rate models more useful lies in constructing more accurate measures of expectations.

Two directions for increasing the efficiency of expectations measures can be suggested. One suggestion is to impose the hypothesized structure of the exchange rate equation completely in order to construct measures of exchange rate expectations "rationally" from (or simultaneously with) constructed measures of the expected values of the explanatory variables that enter the exchange rate equation.[32/] On efficiency grounds such an approach would generally dominate regressing the realized (perfect foresight) value of the exchange rate on a set of relevant variables, since the former approach would generally exploit more information on the relevant set of variables and how they fit together. Similarly, structural information should be exploited as much as possible in constructing measures of the expected values of the explanatory variables that enter the exchange rate equation. A second suggestion, which is particularly relevant for constructing efficient measures of the expected values of those explanatory variables that are treated as exogenous, is to pool data on different indicators within each class of variable. Market participants in fact revise their expectations continuously in response to data announcements for many different types of price indexes, activity indicators, monetary variables, etc. Observing pools of indicators enables them both to filter out noise and to obtain more frequent observations, and econometric techniques that did likewise might generate more accurate measures of market expectations.

VI. Conclusions

This paper has listed a number of criticisms of empirical exchange rate models, with the intent of suggesting directions for improvement, and without regard for the obvious difficulties of pursuing many of these directions. After characterizing the literature in section II, the paper has argued three broad themes in sections III-V. The theme of section III is that models of nominal exchange rates are bound to be at least as poor as models or measures of expected inflation differentials, and that the literature should diversify away from imposing a simple money demand structure to capture inflation or price-level expectations. The theme of section IV is that the portfolio-balance framework needs renovation: (a) to describe more adequately the link between prospective yields on assets and country-specific variables such as macroeconomic policies and outlooks, taxes, capital controls, etc.; and (b) to draw on microeconomic evidence on how large exchange market participants (banks and corporations) perceive their portfolio-management objectives and structure their portfolio-adjustment decision processes. Section V ends, however, on an upbeat theme for structural exchange rate models: their poor forecasting performance to date cannot unsettle the major structural foundations provided by the covered interest parity condition and the notion that movements in nominal exchange rates are correlated with revisions in expectations about inflation differentials, other things equal. Instead, the poor forecasting performance can be interpreted as indicating the importance of estimating structural models in a "news" framework, and of developing more accurate (efficient) measures or models of expectations.

References

Adler, Michael and Bernard Dumas, "Should Exposure Management Depend on Translation Accounting Methods," Euromoney, June 1981.

__________, "International Portfolio Choice and Corporation Finance: A Survey," manuscript, November 1982.

Artus, Jacques R. "Exchange Rate Stability and Managed Floating: The Experience of the Federal Republic of Germany", IMF Staff Papers 23, 1976: 312-33.

Bilson, John F.O. "The Monetary Approach to the Exchange Rate: Some Empirical Evidence", IMF Staff Papers 25, 1978: 48-75.

Branson, William H. "Asset Markets and Relative Prices in Exchange Rate Determination" Sozialwissenschaftliche Annalen 1, 1977: 69-89.

Branson, William H., Hanna Halttunen and Paul Masson. "Exchange Rates in the Short Run: The Dollar Deutschemark Rate", European Economic Review 10, 1977: 303-24.

__________, "Exchange Rates in the Short Run: Some Further Evidence", European Economic Review 12, 1979: 395-402.

Cumby, Robert E. and Maurice Obstfeld, "A Note on Exchange-Rate Expectations and Nominal Interest Differentials: A Test of the Fisher Hypothesis", Journal of Finance 36, 1981: 697-704.

Danker, Deborah, Richard Haas, Steven Symansky and Ralph Tryon, "Small Empricial Models of Exchange Market Intervention: Applications to Canada, Germany and Japan," Federal Reserve Board Staff Study, forthcoming, 1983.

Dooley, Michael P. and Peter Isard, "A Portfolio Balance Rational-Expectations Model of the Dollar-Mark Rate", Journal of International Economics 12, 1982:257-76.

__________ "The Portfolio-Balance Model of Exchange Rates and Some Structural Estimates of the Risk Premium", manuscript (IMF DM/83/20), 1983a.

__________ "Country Risk, International Lending and Exchange Rate Determination", International Finance Discussion Paper No. 221, Federal Reserve Board, 1983b.

Dooley, Michael P. and Jeffrey R. Shafer, "Analysis of Short-Run Exchange Rate Behavior: March 1973 to November 1981", in David Bigman and Teizo Taya, eds., Exchange Rate and Trade Instability (Ballinger: Cambridge, Mass.), forthcoming 1983.

Dornbusch, Rudiger, "Expectations and Exchange Rate Dynamics, Journal of Political Economy 84, 1976: 1161-76.

__________ "Exchange Rate Economics: Where Do We Stand?" Brookings Papers on Economic Activity 10, 1980: 143-85.

__________ "Exchange Risk and the Macroeconomics of Exchange Rate Determination", in R. Hawkins, R. Levich and C. Wihlborg, eds., The Internationalization of Financial Markets and National Economic Policy, (JAI Press: Greenwich, Conn.), 1982.

Eckstein, Otto, ed., The Econometrics of Price Determination (Board of Governors of the Federal Reserve System: Washington, D.C.) 1972.

Edison, Hali, "The Rise and Fall of Sterling: Testing Alternative Models of Exchange Rate Determination," manuscript, 1983.

Edwards, Sebastian, "Exchange Rates and 'News': A Multi-Currency Approach", Journal of International Money and Finance 1, 1982: 211-24.

Fellner, William, "The Bearing of Rise Aversion on Movements of Spot and Forward Exchange Relative to the Dollar." In John R. Chipman and Charles P. Kindleberger, eds., Flexible Exchange Rates and the Balance of Payments, (Amsterdam: North Holland) 1979.

Frankel, Jeffrey A. "On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials", American Economic Review 69, 1979: 610-22.

__________, "Monetary and Portfolio-Balance Models of Exchange Rate Determination", in J. Bhandari, ed., Economic Interdependence and Flexible Exchange Rates (MIT Press: Cambridge, Mass.), 1982a.

__________, "A Test of Perfect Substitutability in the Foreign Exchange Market", Southern Economic Journal 48, 1982b: 406-16.

__________, "In Search of the Exchange Risk Premium: A Six-Currency Test Assuming Mean-Variance Optimization", Journal of International Money and Finance 1, 1982c: 255-74.

Frenkel, Jacob A. "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence", Scandinavian Journal of Economics 78, 1976: 200-24.

__________,"Flexible Exchange Rates, Prices and the Role of 'News': Lessons from the 1970s", Journal of Political Economy 89, 1981: 665-705.

Geweke, John F. and Edgar L. Feige, "Some Joint Tests of the Efficiency of Markets for Forward Foreign Exchange", Review of Economics and Statistics 61, 1979: 334-41.

Goodman, Stephen, "Technical Analysis Still Beats Econometrics," Euromoney, August 1981.

__________, "Two Technical Analysts Are Even Better Than One," Euromoney, August 1982.

Haas, Richard and William Alexander, "A Model of Exchange Rates and Capital Flows," Journal of Money and Credit and Banking 11, 1979: 467-82.

Haakio, Craig S. "Expectations and the Forward Exchange Rate," International Economic Review 22, 1981: 663-78.

Hanson, Lars Peter and Robert J. Hodrick, "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis", Journal of Political Economy 88, 1980: 829-53.

__________, "Risk Averse Speculation in the Forward Foreign Exchange Market: An Econometric Analysis", in J.A. Frenkel, ed., Exchange Rates and International Macroeconomics (U. of Chicago Press: Chicago, Ill.) forthcoming 1983.

Herring, Richard J. and Richard C. Marston, "The Forward Market and Interest Rates in the Eurocurrency and National Money Markets", in C.H. Stem, J.H. Makin and D.E. Logue, eds., Eurocurrencies and the International Monetary System (American Enterprise Institute: Washington, D.C.) 1976.

Hoffman, Dennis L. and Don E. Schlagenhauf, "Rational Expectations, the Role of 'News,' and Exchange Market Efficiency," manuscript, 1982.

Hooper, Peter, "Movements in the Dollar's Real Exchange Rate over the Ten Years of Floating: A Structural Analysis," manuscript, 1983.

Hooper, Peter and John Morton, "Fluctuations in the Dollar: A Model of Nominal and Real Exchange Rate Determination", Journal of International Money and Finance 1, 1982: 39-56.

Isard, Peter, "Factors Determining Exchange Rates: The Roles of Relative Price Levels, Balances of Payments, Interest Rates and Risk", International Finance Discussion Paper No 171, Federal Reserve Board, 1980.

__________________, "An Accounting Framework and Some Issues for Modelling How Exchange Rates Respond to the News", in J.A. Frenkel, ed., Exchange Rates and International Macroeconomics (U. of Chicago Press: Chicago, Ill.) forthcoming 1983.

Kouri, Pentti J.K. "The Exchange Rate and the Balance of Payments in the Short Run and in the Long Run", Scandinavian Journal of Economics 78, 1976: 280-304.

Levich, Richard M., "How to Compare Chance With Forecasting Expertise," Euromoney, August 1981.

__________________, "How the Rise of the Dollar Took Forecasters by Surprise," Euromoney, August 1982.

Longworth, David, "An Empirical Efficient-Markets Model of Exchange Rate Determination," manuscript, 1980.

__________________, "Testing the Efficiency of the Canadian-U.S. Exchange Market Under the Assumption of No Risk Premium," Journal of Finance 36, 1981: 43-9.

Loopesko, Bonnie, "A Time Series Study of the Relationship Between Exchange Rates, Intervention and Other Variables: Empirical Evidence From Daily Data," Federal Reserve Board Staff Study, forthcoming, 1983.

McKinnon, Ronald I., "Floating Exchange Rates 1973-74: The Emperor's New Clothes," in K. Brunner and A. Meltzer, eds., Institutional Arrangements in the Inflation Problem (North Holland: Amsterdam) 1976.

Meese, Richard M. and Kenneth S. Rogoff, "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?", Journal of International Economics 14, 1983a: 3-24.

______________, "The Out-Of-Sample Failure of Empirical Exchange Rate Models: Sampling Error or Misspecification?", in J. A. Frenkel, ed., Exchange Rates and International Macroeconomics (U. of Chicago Press: Chicago, Ill.) forthcoming 1983b.

Meese, Richard and Kenneth Singleton, "On Unit Roots and the Empirical Modelling of Exchange Rates" Journal of Finance, 37, 1982: 1029-36.

Mussa, Michael, "Empirical Regularities in the Behavior of Exchange Rates and Theories of the Foreign Exchange Market", in K. Brunner and A.H. Meltzer, eds., Policies for Employment Prices and Exchange Rates, Carnegie-Rochester Conference Series on Public Policy, Vol. 11, Supplementary series to Journal of Monetary Economics, 1979.

Obstfeld, Maurice, "Exchange Rates, Inflation and the Sterilization Problem: Germany, 1975-1981," manuscript, 1982.

Rodriguez, Rita M., Foreign-Exchange Management in U.S. Multinationals, (Lexington, Mass.: Lexington Books) 1980.

Rogoff, Kenneth, "On the Effects of Sterilized Intervention: An Analysis of Weekly Data," manuscript, 1983.

Rosenberg, Michael R., "Is Technical Analysis Right For Currency Forecasting?", Euromoney, June 1981.

Shafer, Jeffrey R. and Bonnie E. Loopesko, "Floating Exchange Rates After Ten Years", Brookings Papers on Economic Activity, 1983: forthcoming.

Tryon, Ralph, "Testing for Rational Expectations in Foreign Exchange Markets", International Finance Discussion Paper No. 139, Federal Reserve Board, 1979.

______________________, "Small Empirical Models of Exchange Market Intervention: A Review of the Literature," Federal Reserve Board Staff Study, forthcoming, 1983.

Wihlborg, Clas, "Currency Risks in International Financial Markets," Princeton Studies in International Finance No. 44, 1978.

Footnotes

* This paper represents the views of the author and should not be interpreted as reflecting the views of the Board of Governors of the Federal Reserve System or other members of its staff. I am particularly grateful to Michael P. Dooley and Ralph W. Smith for discussions of some of the issues addressed in this paper.

1/ The careful and extensive studies by Meese and Rogoff (1983a, 1983b) are pathbreaking examples.

2/ See Frankel (1982a) for a recent review of the literature of empirical exchange rate models and Rogoff (1983) and Tryon (1983) for reviews of portfolio balance models. See Shafer and Loopesko (1983) for a perspective of the history and policy issues that have influenced how the exchange rate literature has developed over the past decade.

3/ In reality the covered parity condition holds closely when R_B and R_A are represented by Eurocurrency deposit rates; see Herring and Marston (1976, footnote 3). Reserve requirements and other taxes or capital controls can lead to significant covered disparities between the domestic deposit rates of different countries.

4/ Examples of the wide variety of different specifications of small-scale empirical portfolio balance models include Artus (1976), Branson, Haltunnen and Masson (1977, 1979), Dooley and Isard (1982, 1983a), Haas and Alexander (1979), Hooper and Morton (1982) and Obstfeld (1982). See Rogoff (1983) and Tryon (1983) for recent surveys. For the traditional simple two-country portfolio balance model with two moneys and two bonds, the assumption that the bonds are perfect substitutes makes it sufficient via Walras' Law to restrict the set of asset-market clearing conditions to those for the two moneys: hence, the term "monetary model".

5/ Examples include Frenkel (1976) and Bilson (1978).

6/ This is readily seen from condition (9) under the monetary model assumption that $risk^e = 0$.

7/ Examples include Dornbusch (1976) and Frankel (1979).

8/ The large and growing "market efficiency literature" includes Geweke and Feige (1979), Tryon (1979), Hansen and Hodrick (1980, 1983), Haakio (1981), Longworth (1981), Cumby and Obstfeld (1981), Meese and Singleton (1982), Dooley and Shafer (1983) and Loopesko (1983).

9/ See Rogoff (1983) and Tryon (1983). Attempts to estimate structural models of the risk premium include Dooley and Isard (1982, 1983a), Frankel (1982b, 1982c), Rogoff (1983) and Danker, Haas, Symansky and Tryon (1983).

10/ See Edison (1983).

11/ This argument is spelled out in Dooley and Isard (1983b). The notion that the long-run PPP level should solve a goods-market or balance-of-payments equilibrium condition can also be found in the important contributions by Kouri (1976) and Branson (1977).

12/ See Fellner (1979), Isard (1980, 1983), Shafer and Loopesko (1983), Hooper (1983) and the 1983 Economic Report of the President.

13/ For a somewhat dated reference see Eckstein (1972).

14/ See Shafer and Loopesko (1983) and Hooper (1983).

15/ The behavior of mark/dollar exchange rates during 1980-81 has been considered at greater length in Isard (1983).

16/ One possible source of measurement error in survey or forecast data on inflation expectations is that some respondents or forecasters may report modes rather than means when their subjective probability distributions are not symmetric.

17/ 10-year U.S. inflation expectations are available from the same source as the 5-year expectations (see Table 1). 10-year Eurodollar and Euromark interest rates, however, are not available for constructing 10-year nominal forward exchange rates, and the construction of 10-year German inflation expectations would require extrapolating 2-year inflation forecasts over 8 years rather than 3. It thus seems evident, a priori, that constructed data on 10-year forward real DM/$ rates would be subject to considerably greater measurement error than the data on the 5-year forward real DM/$ rates.

18/ From the 1982 Annual Report of the Bundesbank, p. 68.

19/ From "Treasury and Federal Reserve Foreign Exchange Operations", Federal Reserve Bulletin, September 1981, pp. 697-8.

20/ The Economic Report of the President, February 1983, p. 64.

21/ See Wihlborg (1978) or Dornbusch (1982) for relatively simple expositions.

22/ Frankel (1982c) estimates a variance-covariance matrix of nominal rates of return, treating the elements of this matrix as parameters that are constant throughout his sample period. Dooley and Isard (1982, 1983a), Frankel (1982b) and Rogoff (1983) essentially absorb the variance of the exchange rate into the parameters of asset demand functions.

23/ Dooley and Isard (1983b) take a similar approach in modelling international lending and exchange rate determination in the context of default risk.

24/ Goodman (1981, 1982), Levich (1981, 1982) and Rosenberg (1981) provide interesting evaluations.

25/ The latter is a suggestion that it may take several hours or days for markets to readjust to old information following a large "exogenous" currency flow.

26/ Rodriguez (1980) presents data from surveys of corporate foreign exchange management practices in 1974 and 1977, although her analysis of corporate behavior leans heavily on a questionable classification of particular currencies into those that were expected to appreciate and those that were expected to depreciate. Adler and Dumas (1981, 1982) provide more recent perspectives.

27/ The choice of the currency composition of a multinational corporation's net financial assets may take the form of a choice of how much net worth to allow each overseas facility to hold in local-currency assets and how much to convert back into home-currency denominated investments.

28/ Such "inefficiency" at the microeconomic level has presumably been reduced over time as experience has made firms more sophisticated at integrating the objective of responding quickly to new information with the objective of using top management's time in a cost-effective manner.

29/ Meese and Rogoff do find that the superiority of the random walk over the structural models diminishes as the forecast horizon is extended. A search over grids of theoretically-plausible coefficient values discovers coefficients with which structural models can sometimes out perform the random walk at forecast horizons longer than 12 months, but in an unstable fashion that is not consistent across different forecast horizons.

30/ See Mussa (1979) for striking evidence of how little of the variation of spot exchange rates is predicted ex ante by forward premiums.

31/ Efforts to model the news explicitly include Dornbusch (1980), Isard (1980), Longworth (1980), Frenkel (1981), Edwards (1982) and Hoffman and Schlagenhauf (1982). Dornbusch (1980) relies on OECD current account forecasts rather than autoregressive measures of ex ante expectations.

32/ To my knowledge only Dooley and Isard (1982) have attempted to incorporate the structure of the exchange rate equation into the process that is assumed to generate exchange rate expectations. They did not, however, attempt to exploit much information in generating expectations of asset stocks and other exogenous variables, for which they relied on simple autoregressions.