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by

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1. Introduction

This paper focuses on an accounting framework that is useful for distinguishing between the effects on exchange rates of four separate factors: relative price levels, balances of payments, interest rates and risk. The framework rests upon an approximate identity, developed in Section 2, which is transformed into a behavioral model of exchange rates in Sections 3-6. Section 7 reports the results of applying the model in an attempt to explain the month-to-month behaviour of the US dollar versus the Deutsche Mark during the 1975-79 period. Section 8 presents a summary and some conclusions.

It is widely accepted that an explanation of the observed behavior of exchange rates in terms of "fundamental factors" (such as relative price levels, balances of payments, interest rates and risk) requires an understanding of how changes in fundamental factors influence market psychology or expectations. As Keynes (1936, Chapter 12) put it: "the energies and skill of the professional investor and speculator are mainly occupied ... with what the market will value . . . [the investment] at, under the influence of mass psychology, three months or a year hence." Moreover, in seeking to understand how changes in fundamental factors are channelled, through their impacts on market expectations, to changes in observed exchange rates, an important piece of information is the fact that market expectations have foreseen only a minor portion of actual changes in exchange rates from the perspective of a month or a quarter in advance. Specifically, insofar as forward exchange rates can be taken to approximate the average of market expectations about future spot rates, it is a striking fact, according to Mussa (1979, page 21), that "over 90 percent of month-to-month or quarter-to-quarter changes in exchange rates are ... unexpected". Alternatively stated, over 90 percent of changes in exchange rates reflect revisions in expectations from what had been anticipated a month or a quarter earlier.

Although this fact has pessimistic implications for the accuracy of exchange rate forecasts, it does not preclude the usefulness of retrospective explanations of exchange rate behavior, which are important for casting light on how policy stances and the uncertainties surrounding them contribute both to cyclical swings and to longer term movements in currency values. An implication, however, is that retrospective attempts to explain the behavior of exchange rates should focus on changes in fundamental factors that had not been anticipated a month or a quarter in advance.[1]

In developing a model of exchange rates, this paper follows Genberg and Kierzkowsky (1979), Kouri (1976a), Dornbusch and Fischer (1980), Hooper and Morton (1980) and others in assuming that the long run real exchange rate is expected to be consistent with some notion of balance of payments equilibrium. The current real exchange rate is then linked to the expected long run real exchange rate by the real interest differential (i.e., the nominal interest differential minus the expected inflation differential) that is expected to accumulate after compounding over an interval that extends until the long run is reached. Conceptually, the long run is perceived to begin at the horizon at which foresight becomes too blurred to forecast more distant fluctuations in economic variables. It is assumed that the critical horizon is less than 5 years away and interest differentials on 5-year Eurocurrency deposits are used to link the current exchange rate to the expected long run real exchange rate. The use of long-term rather than short-term interest differentials to link the current and expected long run exchange rates, in contrast to Dornbusch (1976), Frankel (1979b) and Hooper and Morton (1980), avoids the necessity of making assumptions about the dynamics or term structures of interest rate and/or exchange rate expectations.

In the approximate accounting indentity that links the current exchange rate to the expected long run real exchange rate, the real interest differential has a coefficient of one. A purely arithmetic implication is that a change of one or two percentage points in long term nominal interest differentials or expected long term inflation differentials, as commonly expressed in percent per annum, can be associated with much larger percentage point changes in real interest differentials compounded over the time it takes to reach the long run, ceteris paribus, and hence with much larger percentage swings in observed exchange rates. Consistently, the regression results in section 7 suggest that changes in real interest differentials have explained much of the short term volatility of the dollar/Mark exchange rate since the mid-1970s. This is further illustrated in section 4, which focusses on the week-to-week movements in the dollar/mark rate during the spring of 1980, subtracts the component that is "explained" by changes in 5-year Eurocurrency interest differentials, and argues that the residual is a plausible estimate of how the expected inflation differential was revised in response to new information. The arithmetic also compounds the importance of the relative decline in U.S. real interest rates (the relative rise in U.S. inflation expectations) as a factor that contributed to the real depreciation of the dollar against the Mark during 1976-78, and the evidence is still inconclusive on how much of the dollar's depreciation was a response to shifts in the U.S. current account during that period.

To move from the arithmetic accounting framework to a behavioral model requires assumptions about inflation expectations, the expected long run real exchange rate and the risk premium. Inflation expectations are assumed to be revised simply on the basis of new information about the actual rate of inflation (as a nominal variable) and the unemployment rate (as a real variable); this ignores the fact that expectations about policy reactions have a major influence on how expectations about inflation are revised. Expectations about the long run real exchange rate are assumed to be revised, following the spirit (but not the detail) of Hooper and Morton (1980), in response to unexpected non-transitory shifts in balance of payments flows, where the latter, in this paper, are represented by the residuals from the regression of a crude measure of unexpected balance of trade flows on both domestic and foreign cyclical variables. A model of the exchange risk premium is adapted from Dornbusch (1980b), with strong links to the framework of Dooley and Isard (1979).

The estimation strategy that is employed imposes the theoretically-dictated values of one on the current relative price level and the compounded nominal interest differential. This involves transposing those terms to the left-hand-side of the regression equation and thereby defining the dependent variable to be a real 5-year forward exchange rate. One merit of this procedure is that it avoids the estimation bias that can arise from two-way causation between current exchange rates and current relative price levels and interest rates; neither price levels nor interest rates are assumed to be exogenous variables. A second merit is that it focusses strictly on explaining movements in real exchange rates, as Dornbusch (1978, 1980a) has urged, which can only be confused by attempting to explain nominal exchange rates solely, or predominantly, in terms of a theory of the relative price levels that can be observed at the outset.

2. An approximate accounting identity

This section focuses on an approximate accounting identity that relates changes in exchange rates to four separate and additive fundamental factors: (i) different rates of change in national price levels, or purchasing power parity factors; (ii) revisions in expectations about the "long run" real exchange rate, which can be viewed to reflect balance of payments factors; (iii) revisions in expectations about the compounded real interest differentials that would accumulate over the "long run" on assets denominated in different currencies; and (iv) changes in the premium for bearing exchange risk, which is a reflection of portfolio balance factors. The framework is similar to Hooper and Morton (1980), who have built upon Frankel (1979b), but here it is shown that the identities can be pushed further to lead to some arithmetic insights before any behavioral assumptions are imposed.

The starting point is the covered interest rate parity condition

(1) $S = F(1+R_B)/(1+R_A)$

along with a definition of the risk factor[1a]

(2) $RISK^e = S^e/F$

where

S, F	are current observations of the spot and forward exchange rates, in units of currency A per unit currency B
S^e	is the expectation held currently of the spot exchange rate that will prevail in the "long run"
R_A, R_B	are the compounded nominal rates of interest that investors could accumulate over the "long run" on assets denominated in currencies A and B. (The units here are percent per long run, not percent per year.)
$RISK^e$	reflects the premium that investors expect to earn by bearing exchange risk

Conditions (1) and (2) lead to

$$(3) \quad S = ((1+R_B)/(1+R_A)) \cdot S^e/RISK^e$$

which spells out the fact that an explanation of the joint behavior of the observed spot rate and interest rates requires models of the expected future spot rate and the risk factor.

As noted above, the literature on asset-equilibrium models of exchange rate determination has begun to reemphasize the role of balance of payments flows by making them the basis for forming and revising expectations about the long run real exchange rate. This paper takes the same approach, which motivates the separation of S^e into real and nominal components. Accordingly the traditional definition of the real exchange rate is adopted

$$(4) \quad SREAL \equiv S \cdot P_B/P_A$$

and it is also assumed that the expected nominal exchange rate can be written as the product of the expectations of the real exchange rate and the ratio of price levels

$$(5) \quad S^e = SREAL^e \cdot (P_A/P_B)^e$$

where the superscript e denotes an expected value. In addition, the expected ratio of future price levels is expressed as the product of the ratio of current price levels and the expected ratio of inflation factors.

$$(6) \quad (P_A/P_B)^e = (P_A/P_B) \cdot \left(\frac{1+\hat{P}_A}{1+\hat{P}_B}\right)^e$$

with $\hat{P}_A$ and $\hat{P}_B$ denoting inflation rates. Substitution of (5) and (6) into (3) then yields the multiplicative form of the desired accounting identity.

$$(7) \quad S = (P_A/P_B) \cdot SREAL^e \cdot \left(\frac{1+R_B}{1+R_A}\right) \cdot \left(\frac{1+\hat{P}_A}{1+\hat{P}_B}\right)^e /RISK^e$$

In terms of percentage changes, the identity can be separated into four additive factors

$$(8) \quad \%\Delta S = (\%\Delta P_A - \%\Delta P_B) + \%\Delta SREAL^e + \Delta(r_B^e - r_A^e) - \%\Delta RISK^e$$

purchasing power parity factor	balance of payments factor	real interest rate factor	risk or portfolio balance factor

under the approximations

$$(9) \quad \%\Delta\left(\frac{1+R_B}{1+R_A}\right) = \Delta\,(R_B - R_A)$$

$$(10) \quad \%\Delta\left(\frac{1+\hat{P}^e_A}{1+\hat{P}_B}\right) = \Delta\,(\hat{P}^e_A - \hat{P}^e_B)$$

along with the traditional definitions of expected real interest rates

$$(11) \quad r^e_A = R_A - \hat{P}^e_A$$

$$(12) \quad r^e_B = R_B - \hat{P}^e_B$$

The logrithmic form of the identity is also separably additive

$$(13) \quad s = (p_A - p_B) + sreal^e + (r^e_B - r^e_A) - risk^e$$

where lower case letters denote logrithms, with the exceptions of r^e_B, r^e_A.

By itself, the accounting identity -- whether expressed as (7), (8), or (13) -- provides no more than a conceptual framework. Alternatively stated, the identity amounts to no more than the interest rate parity condition, after manipulation to separate out the expected real exchange rate and to allow for exchange risk. Testable models of exchange rate behavior require that the identity be supplemented by theories or behavioral assumptions about how expectations are formed and/or revised, and about how the risk factor should be measured. Such behavioral assumptions will be discussed in sections 3-6. Although the horizon over which expectations are formed is left completely general in the accounting identities, the modelling strategy will interpret the expected real exchange rate as an expected long-run real exchange rate. Obversely, the modelling strategy will be based on behavioral assumptions that are plausible only in a long run context. For models that focus on the relationship of exchange rates to short term interest differentials, the above accounting identities must still hold but may not provide a helpful framework for organizing behavioral assumptions.[1b] The main advantage of the above accounting framework is that its focus on long-term interest differentials instead of short-term differentials avoids the necessity of making arbitrary assumptions about the shape of the path along which the exchange rate is expected to adjust to its long-run equilibrium level. The second important feature of the accounting framework is its explicit focus on the fact that exchange rates not only move gradually over time to reflect actual inflation differentials but also can jump unexpectedly and sharply to mirror fully the compounded long-run effects of revisions in expectations about long-term inflation differentials.

To emphasize the former advantage it is instructive to contrast the accounting framework with the models that have been tested empirically by Frankel (1979b) and Hooper and Morton (1980). Frankel's purpose, building on Dornbusch (1976), Frenkel (1976) and Bilson (1978), was to resolve the apparent conflict between the "Chicago" and "Keynesian" views of the relationship between changes in short-term interest differentials and changes in exchange rates. His starting point was the assumption of uncovered short-term interest rate parity, and in order to tie down expectations about the future spot rate in the short term he followed Dornbusch (1976) in spirit by introducing an assumption about the path of the expected adjustment to a long run equilibrium exchange rate. Hooper and Morton enriched the behavioral content of Frankel's model by treating the expected long-run real exchange rate as a variable and by allowing for exchange risk, thereby giving explicit empirical consideration to two channels through which current account imbalances might influence exchange rates. But Hooper and Morton basically retained Frankel's assumption about how the exchange rate is expected to adjust from the value expected a short-horizon into the future -- as reflected, apart from the risk premium, by a short-term interest differential -- to its expected long run value.

The difference here is the focus on modelling the current exchange rate in terms of interest rates that contain information about what the future exchange rate is expected to be after it has equilibrated in the the long run, rather than before it has equilibrated in the short run. More precisely, available data on 5-year interest differentials on Euro-currency deposits provide a time series on the 5-year forward rate,[2] which differs from the expected long run nominal exchange rate by a risk premium that can be modelled and estimated. In this context the term structure of exchange rate expectations (or the dynamics of expected exchange rate adjustment) is irrelevant, unless one challenges the assumption that the long run is expected to be reached in less than 5 years.

At a superficial level, the assumption that the long run is expected to be reached within 5 years can be justified by the notion of "long run imperfect foresight:" vision beyond a 5 year horizon is so poor that the best forecasts of economic variables are smooth "equilibrium" paths. Such justification, however, cannot deny the arbitrariness of focussing on 5-year interest differentials rather, say, than 10-year interest differentials. The implicit assertion is that the use of 10-year real interest differentials would generate the same empirical results. An empirical test of that assertion, unfortunately, requires a credible model of the inflation differential that is expected between the 5 and 10-year horizons.

Figure 1 may help to clarify the assumption. There the accounting identity is being considered in logrithmic form with the nominal exchange rate and relative price levels consolidated as the real exchange rate, thereby transforming (13) into

$$(14) \qquad sreal^{e} = sreal + (r_{A}^{e} - r_{B}^{e}) + risk^{e}$$

The term structure of real exchange rate expectations held at time t_o can be generated by using (14) to plot $sreal^e$ as a function of the expectations horizon. That term structure is depicted by the solid line in Figure 1. (More general shapes of the term structure are conceivable, but the arguments of section 3 suggest that expectations of a moving equilibrium real exchange rate may not be rational.) The explicit form of the assumption adopted below is that at a given point in time t_o, only surprises about the balance of payments can shift the segment of the path extending to the right of t_o+5 years. Consistently, if at some time t_1 later than t_o the term structure path had shifted to the dashed line and the spot exchange rate was observed at $sreal_1$, then ignoring any changes in the risk premium, the change in the cumulative real interest differential would be $\Delta(r_A^e - r_B^e)$, whether measured between t_1 and t_1+5 years or between t_1 and t_1+10 years. Accordingly, the change in the 5-year interest

Figure 1

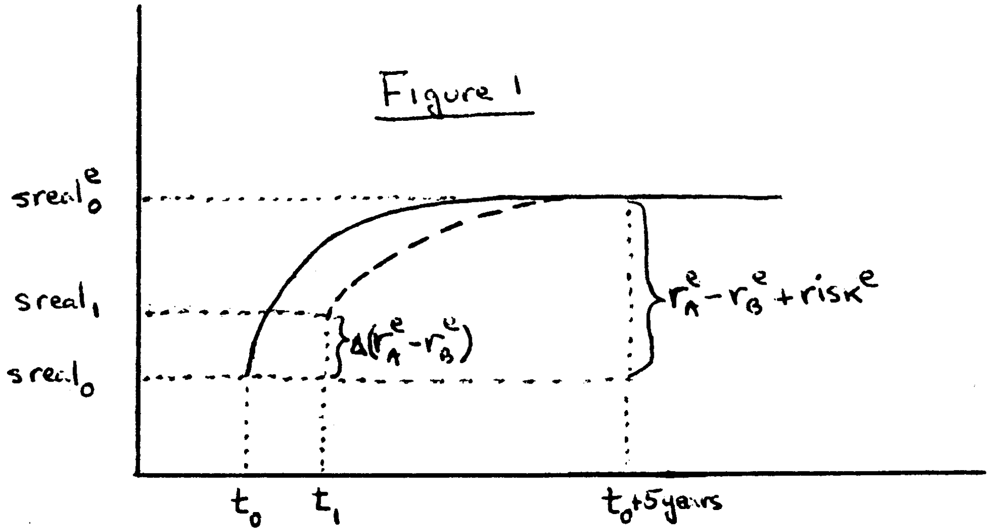
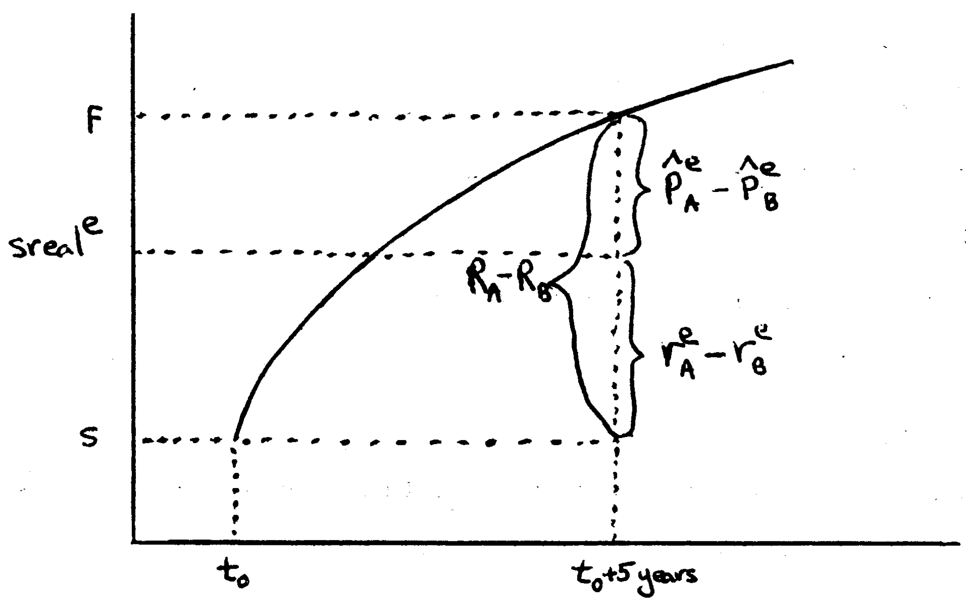


Figure 2*/



*/ Assumes $risk^e = 0$ and sets $P_A = P_B = 1$.

differential, as measured per annum, would be roughly one-fifth of the amount $\Delta(r_A^e - r_B^e)$, while the change in the 10-year interest differential per annum would be roughly one-tenth of $\Delta(r_A^e - r_B^e)$. Or to state the point still another way, the incremental expected real interest differential per increment in maturity is assumed to be zero for maturities longer than 5 years (or to be exogenously fixed under more general shapes of the term structure path).

Figure 2 shows the relationships between nominal spot and forward exchange rates and the expected long run real exchange rate, neglecting the risk factor and setting initial price levels equal to one. The expectations path now represents the term structure of nominal exchange rate expectations or forward exchange rates. To the extent that the expected real exchange rate is constant, the variability of the spot rate reflects the variability of the long term real interest differential, whereas the variability of the long-term forward rate reflects the variability of the long term expected inflation differential.

It is worth emphasizing again that the real interest differential and expected inflation rates have units of percentage points per 5 year horizon, reflecting the arithmetic of the accounting identity. Thus a one percentage point widening of the 5 year real interest differential, as commonly expressed at an annual rate, can generate a 5 percent change in the spot exchange rate, *ceteris paribus*. Few models of exchange rate determination, with the exception of Fellner (1979), have focussed explicitly on the arithmetic of compounding interest rates and expected inflation rates over a horizon that extends until the long run is reached.

3. The expected long-run real exchange rate: how important are balance-of-payments factors?

Balance-of-payments views of exchange rate determination predate Adam Smith by at least a century[3] and occupy a dominant position in most textbooks on international economics. This dominant position has been strongly challenged over the past two decades, as focus has shifted towards viewing exchange rates and interest rates as variables that equilibrate the demands for and supplies of stocks of financial assets, rather than balance-of-payments flows. But recent years have brought a resurgence of sentiment for balance-of-payments factors, particularly after witnessing the behaviour of exchange rates that accompanied the emergence of surprisingly large current-account deficits for the United States during 1977-78.

The result is that models of asset stock equilibrium have now been combined with the assumption that wealth variables are expected to converge in the long run to a stationary level, with current accounts, consistently, expected to balance in the long run.[4] Thus, unexpected shifts in current-account flows in the short run create expectations that the real exchange rate will adjust in the long run by whatever amount is necessary to reestablish the current account on a path that converges to equilibrium.[5]

The stationary long-run wealth assumption is a model-building convenience. Its further justification or rationalization can be attempted by combining two arguments: (i) there cannot be persistant current account imbalances in either direction, since this would eventually lead to an infinite transfer of wealth, and (ii) long run foresight is too imperfect to place faith in any particular forecast of current account fluctuations around the required average flow of zero.

The assumption of long run current account balance leads naturally to the assumption that there is a well-defined equilibrium level of the expected long run real exchange rate. In the empirical arena, the task is to estimate how extensively expectations about the long-run real exchange rate are revised in response to the unexpected components of balance of payments flows. Two set of estimates have now been provided by Hooper and Morton (1980) and Dornbusch (1980). This new empirical approach confronts three major difficulties, however. The first difficulty is to separate out the unexpected component of balance of payments flows, which requires measures (forecasts) and/or models of what was expected ex ante. The second difficulty is to further separate the unexpected flow into transitory and the nontransitory components -- or, more generally, to separate out the component that, once recorded, is expected to be "corrected" via adjustment in the long run real exchange rate.

The third difficulty is to put plausibility bounds on the magnitude of the change in the long run real exchange rate that is required to "correct" an unexpected nontransitory payments imbalance. If the exports of different countries were perceived from the demand side to be near perfect substitutes in the long run, large deviations from purchasing power parity could not persist in the long run, and expectations about the long run real exchange rate, if rational, would not be revised significantly in response to unexpected nontransitory shifts in balance of payments flows. More realistically, if exports of different countries are perceived to be vastly different in commodity composition but potentially highly competitive in the long run through the potential mobility of new additions to physical capital stocks on the supply side, then it is the mobility of physical capital that will insure long run current account equilibrium.

Purchasing power parity will prevail in the long run, with the real exchange rate fixed (or constrained to vary only narrowly) by the potential for producing goods that are near perfect substitutes to consumers.

The latter argument would suggest throwing the current account back out in the context of a long run in which physical capital was indeed highly mobile. For purposes of this paper, however, the long run is defined to be only 5 years away, and the role of the current account is not dismissed a priori. Moreover, the observable response of exchange rates to revisions in expectations about future oil prices, with the yen and pound consistently moving in opposite directions against other currencies, suggests that the outlook for current account balances is indeed relevant to the market's expectations about future exchange rates.

In section 6 below, revisions in expectations about the long-run real exchange rate are modelled in terms of errors in forecasts of balance-of-trade flows that cannot be attributed to unforeseen cyclical movements in explanatory variables. Because monthly data on errors from sophisticated balance-of-trade models are not readily available, an over-simplified measure of the unexpected component of the balance of trade is adopted: namely, the reported balance of trade minus the average of the trade balances reported for the previous three months. The cyclical component that is subtracted from the unexpected trade balance is then defined as the component that is explained by regression on both domestic and foreign cyclical indicators, and the residual or non-cyclical component, viewed ex post, is adopted as a measure of the trade imbalance that was "expected to be corrected" via movements in the real exchange rate over a 5-year horizon. One obvious limitation of this measure is the lack of any attempt to subtract out the change in the trade balance (relative to its average level for the previous three months) that represents an expected adjustment to past movements in the exchange rate.

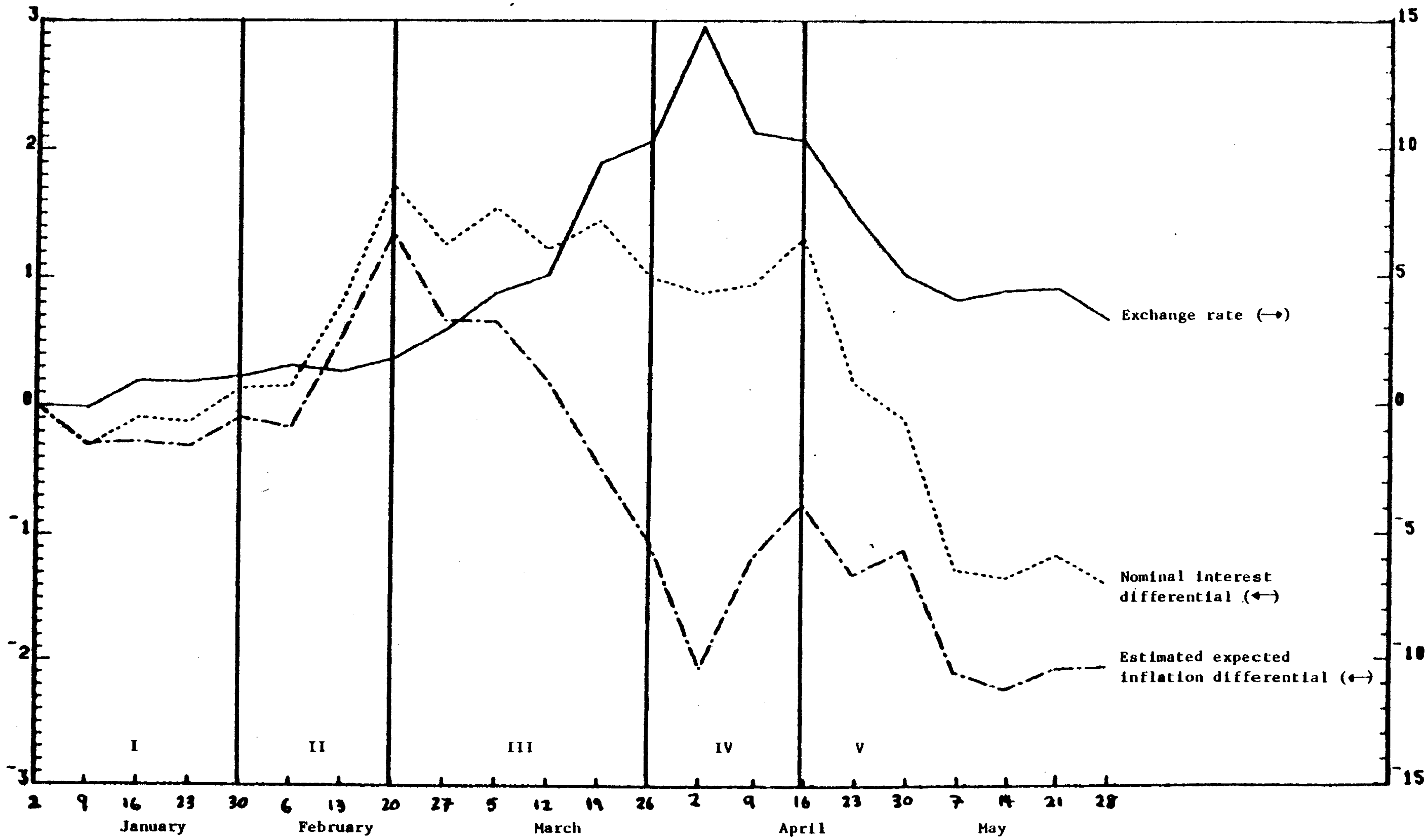
4. Changes in expected real interest differentials: explaining the the short-run volatility of exchange rates

Given expectations about what the real exchange rate will be in the "long run", exchange rates in the short run will be observed to fluctuate in real terms (i.e. relative to purchasing power parity levels) with any revision in expectations about the compounded real interest differentials that can be earned over a period that extends until the "long run" is reached. Moreover, expectations about real interest differentials compounded over periods as long as five years, for example, can be quite volatile and would appear capable of explaining most of the short-run instability of exchange rates. As represented by the third term in accounting identity (8), such expectations are continuously revised in response to updated information on economic statistics, statements by policy authorities and/or market rumours. The revision of expectations is a psychological process in which rational responses to incomplete and gradually emerging information can easily give rise to volatile shifts and reversals in exchange rates.

An illustration is provided by the experience from January through May of 1980, when movements of the US dollar vis-à-vis the Continental European currencies were both volatile and dominated by differential movements in interest rates and expected inflation rates. Figure 3 shows the cumulative week-to-week movements in the Deutsche Mark price of the dollar compared with cumulative changes in the difference between interest rates on 5-year Euro-dollar and Euro-Mark deposits.[6] The associated values of the exchange rate and interest rates are shown in Table 1. Rather than plotting cumulative changes in the interest differential compounded over the 5-year maturity of the Euro-deposits, the graph uses two different vertical scales in order to compare cumulative changes in the 5-year interest differential, measured as a rate per annum, with one-fifth of the cumulative percentage changes in the exchange rate. Ignoring changes in the expected long run real exchange rate and the risk premium, the residual or discrepancy between the scaled-down percentage change in the exchange rate and the change in the interest differential can be regarded as an estimate of the revision in expectations about the differential rate of inflation, measures at an average annual rate over a 5-year horizon.

Figure 3

<u>Changes in the exchange rate, nominal interest differential and estimated expected inflation differential</u>*



* Cumulative changes since the beginning of 1980 based on Wednesday data. The exchange rate curve shows the percentage change in the Deutsche Mark price of the dollar. The interest differential is the Euro-dollar rate minus the Euro-Mark rate on 5-year deposits, in percentage points per annum. The third curve is the difference between the first two, which represents an estimate of the expected difference between US and German inflation rates, in percentage points per annum.

Table 1

Exchange Rates and Interest Rates on 5-year Euro-deposits[1]					
		DM/$	Euro-dollar rate	Euro-Mark rate[2]	Differential[2]
January	2	1.7145	11.75	7.85	3.90
	9	1.7127	11.81	8.23	3.58
	16	1.7306	11.88	8.08	3.80
	23	1.7303	12.00	8.23	3.77
	30	1.7340	12.50	8.46	4.04
February	6	1.7414	12.63	8.58	4.05
	13	1.7374	13.25	8.54	4.71
	20	1.7460	14.50	8.89	5.61
	27	1.7649	14.75	9.60	5.15
March	5	1.7897	15.00	9.57	5.43
	12	1.8017	14.88	9.77	5.11
	19	1.8760	15.25	9.92	5.33
	26	1.8902	15.00	10.11	4.89
April	2	1.9664	15.13	10.35	4.78
	9	1.8960	15.00	10.16	4.84
	16	1.8908	14.63	9.43	5.20
	23	1.8420	12.63	8.56	4.07
	30	1.8015	12.13	8.33	3.80
May	7	1.7850	11.38	8.75	2.63
	14	1.7914	11.25	8.69	2.56
	21	1.7926	11.38	8.64	2.74
	28	1.7717	10.88	8.37	2.51

1 Data are taken from various issues of The Money Manager. Interest rates and differentials are expressed in percentage points per annum.

2 Constructed; see footnote 6 of the text.

The estimated time path of the expected inflation differential seems quite plausible and, accordingly, it seems quite plausible that the volatility of the exchange rate during the first five months of 1980 predominantly reflected revisions in expectations about the real interest differential. During January there was little movement in the three curves shown in Figure 3. Sub-period II on the graph began right after the US budget proposals and the Economic Report of the President were released on January 28th and 30th, respectively. The subsequent three weeks brought an upward revision in the expected pace of US inflation: by February 6th it had been discovered that the US Budget had substantially underestimated the costs of military outlays for fuel; by February 13th new data showed a strong acceleration in US retail sales during January; by February 20th it had been revealed that US wholesale prices had jumped 1.6 per cent. during January, a sharp acceleration from December; and on February 22nd it was reported that US consumer prices had also accelerated sharply in January. Nevertheless, the exchange rate remained relatively stable throughout those weeks as the Euro-dollar rate increased by 2 percentage points, and by 1½ percentage points more than the Euro-Mark rate.

The news of the January rise in US consumer prices ushered in sub-period III on the graph as financial markets, according to Reuters, reacted "perversely". The consumer price data strengthened expectations of further anti-inflationary policy measures by the US authorities - expectations that were confirmed by the new budget proposals and monetary and credit actions of March 14th. According to the estimates shown on the graph, the expected US inflation rate, looking out over a 5-year horizon, was revised downwards over the course of a month by roughly 2 percentage points per annum relative to the expected German inflation rate, and the dollar appreciated strongly against the Mark even though nominal Euro-Mark rates moved up somewhat faster than Euro-dollar rates.

Sub-period IV on the graph began on March 27th with the decision, announced following the fortnightly meeting of the Bundesbank Central Council, that German credit policies would be left unchanged. The apparent upward revision in expectations about the pace of German inflation, relative to US inflation, was supported on April 2nd by the report of a full half percentage point drop in the German unemployment rate during March. Additional support may have been provided by major new banking legislation, passed by the US Congress on March 28th, which strengthened the Federal Reserve's control over money and credit growth. During the first four trading days of April, spanning the long Easter weekend, the dollar wavered around a level 4 per cent. higher than where it had closed on March 26th. Then it dropped the full 4 per cent. on April 9th. Among the news that may have led to the reassessment was the announcement late on April 8th that the German Government had arranged to borrow one billion Marks from the US Government, the release of data on April 9th indicating no change in German industrial production during February, and the prediction by a respected US banker that dollar interest rates would soon begin to tumble. The first and second items suggested less pressure on the German money supply, given the authorities' reluctance to push interest rates higher, while the third item may have provided a revised impression of how contractionary a stance the Federal Reserve had taken. In any case, the residual moved to offset some of the earlier estimated narrowing of the expected difference between US and German inflation rates.

Sub-period V started on April 16th, the day that US prime rates began the rapid descent from their peak. By the end of May the 5-year Eurodollar rate had fallen by more than 4 percentage points per annum, and by roughly 2-1/2 percentage points relative to the 5-year Euro-Mark rate. Meanwhile the expected pace of US inflation was revised downwards, responding in particular to the May 2nd announcement that US unemployment had skyrocketed from 6.2 percent in March to 7.0 percent in April.

The story can be complicated by trying to make sense of fluctuations over even shorter sub-periods, drawing on countless secondary news items. The basic test of the story, however, centres on the plausibility of the residual curve as the estimated time path of changes in the expected inflation differential - in particular, on the plausibility of the magnitudes of these estimated changes. Given the focus on 5-year interest differentials, the residuals are estimated changes in the expected inflation differential per annum averaged over a 5-year horizon.[7] Is it plausible that the expected inflation differential over that horizon could have first increased (during sub-period II) by more than 1 percentage point per annum and then declined (through the end of May) to roughly 2 percentage points per annum less than what had been expected during January? The casual answer is yes: changes of such magnitude in the US inflation outlook were widely discussed by the financial press, although without explicitly looking much further into the future than the end of 1981.[8] A more convincing answer seems precluded by the absence of published and frequently revised inflation forecasts that extend as far as 5 years into the future.

Such arguments and evidence relating the short-run volatility of exchange rates to unexpected news can be both helpful and frustrating in efforts to explain exchange rates with formal statistical techniques. Changes in nominal interest differentials can be observed, but changes in the compounded inflation differentials expected over a 5-year horizon can neither be observed nor modelled in a fully satisfactory manner. The stories above are helpful in drawing attention to evidence that unexpected changes in observed inflation rates and unemployment rates (or in other related statistics) can lead to revisions in expectations about future inflation rates. But the stories are frustrating in focussing on the major revisions in long-run inflation expectations that have followed or anticipated such policy measures as the US money and credit actions and revised budget proposals of March 14th. Such policy measures are difficult to summarize in quantitative terms, and both their magnitude and their timing are difficult to relate systematically to observable economic variables. Thus, the large random element in policy reaction functions implies some large error terms in formal econometric models of exchange rate behavior.

5. The portfolio balance effect: is there a premium for bearing exchange risk?

The debate between the monetarist and portfolio balance views of exchange rate determination centres on the significance of the risk premium.[9] By definition, the risk premium is zero if and only if the forward exchange rate corresponds to the expected future spot rate. Under that condition, there would never be any change in the risk factor, as defined by equation (2) of Section 2, and the risk term would vanish from the accounting identity (8).

Monetarist models[10] assume, explicitly or implicitly, that the risk premium is negligible. Under the interest rate parity condition, interest-bearing bonds denominated in different currencies are then always expected to offer identical returns to investors: by neglecting risk, bonds can thus be treated as perfect substitutes, regardless of currency denomination. Accordingly, in viewing exchange rates to be completely determined by the conditions necessary to maintain equilibrium in money markets, monetarist models are consistent with Walras' Law, under which it is valid to ignore what is essentially assumed to be a single market for bonds.

Portfolio balance models,[11] in contrast, treat risk factors as important and variable, although in some cases the focus on risk is only implicit in the assumption that exchange rates depend on the supplies of and demands for bonds denominated in different currencies, as well as on the supplies of and demands for money. Since bonds, unlike money, cannot be assumed to be demanded for transactions purposes alone, a further implication is that exchange rates are sensitive to changes in wealth variables. Thus, the presumption of a risk premium provides or expands the rôles in the process of exchange rate determination (i) for sterilised foreign exchange interventions, which do not affect money stocks but do change the privately-held stocks of bonds denominated in different currencies, (ii) for public budget deficits, which affect both stocks of bonds and private wealth variables, and (iii) for current-account balances, which shift the international residence of wealth between countries that may have different portfolio preferences.

At the microeconomic level, there is clear evidence that risk premiums are not always zero. Market participants have different expectations that cannot all be simultaneously equal to the same market-clearing forward rate. Moreover, considerable resources are spent on forecasting or formulating expectations about future exchange rates, which is prima facie evidence that expectations are not simply equated to forward rates.

At the macroeconomic level, however, there is still the possibility that risk premiums average out to zero - or that they are sufficiently small to justify neglecting them as a convenient simplification. Focussing on behavioral models of the risk premium, Dooley and Isard (1978, 1979) present statistically weak evidence that risk premiums do not vanish at the macoreconomic level, whereas Frankel (1979c) presents regression evidence that fails to reject the hypothesis of a zero risk premium. Focussing as an alternative on the time series properties of spot and forward exchange rates, Cumby and Obstfeld (1979) and Meese and Singleton (1980) reject the hypothesis of a zero risk premium but do not provide evidence that risk premiums are large.

In theory, there are two cases in which the risk premium would always be zero. The first, by definition, is the case of the risk neutral world in which infinitely-elastic speculation bids forward rates into equality with expected future spot rates. The second is the case of a risk averse (or risk loving) world in which private holdings of public debt are viewed to be matched by future tax liabilities, thereby adding nothing to private wealth; see Frankel (1979a). By contrast, in the presence of risk aversion and public debts that are viewed to add to private wealth, a gap can open up between the forward rate and the expected future spot rate.

To develop a better sense for the factors that influence the risk premium, as well as a sense for how the risk premium serves to quantify the degree of exchange risk, imagine a two-currency world in which governments and central banks create non-interest-bearing base money and interest-bearing public debt, pushing these "outside" assets into private portfolios and allowing interest rates and exchange rates to adjust to a configuration at which private portfolio managers are willing to hold the stocks of outside assets denominated in each currency. Given other factors relevant to private portfolio decisions, an increase in the stock of outside assets denominated in currency B must presumably lead to an increase in the expected relative rate of return on those assets to induce private sectors to absorb the additional assets into their portfolios. Thus, at given interest rates, an increase in the stock of outside assets denominated in currency B will require an increase in the expected rate of appreciation of currency B - presumably associated with an immediate depreciation of currency B that exceeds any downward revision in expectations about future values of currency B. This has the result of reducing the forward currency-A price of currency B relative to the expected future spot price and can thus be viewed to increase the risk premium (which condition (3) has implicitly defined as the risk premium for holding assets denominated in currency B).

In the same sense that the risk premium may be viewed to increase with an increase in the stock of outside assets denominated in currency B - or conversely, with a decline in the stock of outside assets denominated in currency A - risk premiums may also be viewed to increase with shifts in portfolio preferences away from assets denominated in currency B, or with current-account imbalances that shift the international residence of private wealth towards countries with relatively weak preferences for assets denominated in currency B.

Three aspects of this viewpoint deserve emphasis. First, the riskiness of assets is characterised in terms of fundamental supply and demand factors. Assets are perceived to become more risky with increases in their excess supply - as a function of given expected relative yields; and consistently, assets could be judged to have become more risky, other things equal, if their expected relative yields could be observed to have increased in order to maintain market equilibrium.

A second point is that an increase in excess supply at any given expected relative yield can arise without any increase in global supply and without any shift in the asset demand functions of individual behavioural units. Rather, changes in risk premiums may reflect a redistribution of global wealth, through current-account imbalances, between countries with different portfolio preferences.

As a third point, accordingly, recognition of the rôles of wealth variables and risk in portfolio decisions provides an additional place for balance-of-payments flows in asset-equilibrium models of exchange rate determination.

The remainder of this section develops a simple model of the risk premium that will be used in transforming the basic accounting identity into an empirically testable model of exchange rate determination. As suggested by the discussion above and shown formally by Dooley and Isard (1979) and Dornbusch (1980b), among others, the risk premium depends on three classes of variables: the stocks of public debts (or outside moneys and bonds) denominated in different currencies; the global distribution of private financial wealth; and certain parameters that describe the proportions in which private investors desire to divide their financial wealth holdings between assets denominated in different currencies. For these three classes of underlying variables, acceptable data can be assembled on stocks of public debts denominated in different currencies.

It is more difficult, however, to construct data on private financial wealths broken down by countries or other groupings within which wealth holders might be assumed to have similar portfolio preferences. As first approximations, the private financial wealths of different countries can be constructed from cumulative data on public budget deficits, current-account imbalances, changes in money stocks and official foreign exchange interventions; but the first approximations may be poor ones in the absence of data on the currency compositions of wealth portfolios, without which it is difficult to assess the capital gains and losses that have resulted from exchange rate movements. For this reason, the attention given to wealth variables in this paper is limited to an attempt to estimate the influence of the substantial shift in the distribution of world financial wealth towards the OPEC countries.

The third class of variables on which risk premiums depend are the parameters that describe the proportions in which investors desire to divide their financial wealth holdings between assets denominated in different currencies. Intuition suggests that two types of parameters are relevant here: parameters that express the degree to which investors are risk averse and parameters that describe the magnitude of the risk that investors perceive.

Appendix A draws extensively from Dornbusch (1980b) in applying the theory of portfolio selection to suggest formally that the risk factor can be viewed to depend on the types of variables and parameters just discussed in the following nonlinear form:[12]

$$(15)\quad RISK^{e} = 1 + \frac{u_N . v . ASSETRATIO}{1 + \frac{(u_N - u_0)}{u_0} . WEALTHRATIO}$$

where

u_N, u_O are the coefficients of risk aversion that characterise non-OPEC and OPEC portfolio preferences

v is the subjectively perceived variance of the ratio of the future spot rate to the forward rate

ASSETRATIO is the share of assets denominated in currency B in the global private portfolio of outside assets denominated in either currencies A or B

and

WEALTHRATIO is the share of global private financial wealth that is owned by the OPEC countries (treated as part of the global private sector)

Several points can be noted about equation (15). In the limiting risk-neutral case in which bonds offering the same expected yields are regarded as perfect substitutes independent of currency denomination, u_N is zero and $\%\Delta RISK^e$ vanishes from the accounting identity (8). In the general case, the risk premium (defined as $(S^e-F)/F = RISK^e-1$) is proportionate to both the degree of risk aversion (u_N) and the perceived degree of exchange rate variability (v). The distribution of world wealth affects the exchange rate via the risk premium only if different countries have different preferences for assets denominated in different currencies - or equivalently, only if different countries have different coefficients of risk aversion with respect to the currency A valuations of their wealths. As shown in Appendix A, the proportionate difference between the OPEC and non-OPEC coefficients of risk aversion ($(u_N-u_O)/u_O$) is equal to the proportionate difference between the shares of OPEC and non-OPEC portfolios that are held in assets denominated in currency B.

Under the assumption that $RISK^e$ does not differ greatly from one, the transformation of equation (15) into percentage changes can be approximated as

$$(16) \quad \%\Delta RISK^e = \Delta \frac{u_N \cdot v \cdot ASSETRATIO}{1 + \frac{(u_N - u_0)}{u_0} WEALTHRATIO}$$

Substitution of (16) into the accounting identity (8) then suggests a non-linear exchange rate equation, however, which would greatly complicate the estimation problem. In order to avoid this complication, u_N and v are treated as constant time-invariant parameters in the estimation below,[13] and a prior value is assigned to $(u_N - u_0)/u_0$ based on ordinary least squares estimates of the currency compositions of non-OPEC and OPEC wealth holdings that satisfy the market-clearing condition for assets denominated in currency B (i.e. that staisfy condition A7 of Appendix A). These estimates are that x_0=32 percent of OPEC's financial wealth and x_N=11 percent of non-OPEC financial wealth were held in Deutschemarks, implying $(u_N - u_0)/u_0$ = $(x_0 - x_N)/x_N$ = 1.91. This leads to the construction of a composite variable

$$(17) \quad AW = \frac{ASSETRATIO}{1 + 1.91 \cdot WEALTHRATIO}$$

and to the simplified expression

$$(18) \quad \%\Delta RISK^e = a_7 \Delta AW$$

where a_7 is the constant $u_N v$.

6. Behavioral assumptions about revisions in expectations

By substituting equation (18) along with the definitions of real interest rates, the accounting identity (8) can be transformed into

$$(19) \quad \%\Delta S = (\%\Delta P_A - \%\Delta P_B) + \Delta(R_B - R_A) + \Delta(\hat{P}^e_A - \hat{P}^e_B) + \%\Delta SREAL^e - a_7\Delta\Delta W$$

To procede from equation (19) to regression analysis requires behavioral assumptions that model the expected inflation differential and changes in the expected long-run real exchange rate in terms of variables that can be observed. An explanation of month-to-month changes in exchange rates requires behavioral assumptions that can pinpoint the timing as well as the magnitudes of shifts in these expectationsl variables. Much less sophistication is required to explain the level of the exchange rate, and indeed the empirical literature on exchange rate determination, with few exceptions, is directed at explaining levels rather than changes. This paper also winds up presenting the results of estimating a log-linear level equation.

Regarding behavioral assumptions about the expected compounded 5-year inflation differential -- the third term on the right-hand side of equation (19) -- it is assumed that expectations are formed by looking at the most recent inflation rates along with prevailing rates of unemployment. More specifically, the tests assume that

$$(20) \quad (\hat{P}^e_A - \hat{P}^e_B) = c + a_1\hat{P}_A - a_2\hat{P}_B - a_3U_A + a_4U_B$$

where

$\hat{P}_A$, $\hat{P}_B$ are the most recent available monthly observations of percentage changes in price levels (measured over 12 months)

and

U_A, U_B are the most recent available monthly observations of unemployment rates

Such a formulation is oversimplified in three important ways: it does not make a serious attempt to incorporate perceptions of policy reaction functions into the expectations formation process; it does not link expectations rationally to a sophisticated structural model of inflation; and, relatedly, it does not recognize that inflation expectations adapt gradually and depend not only on the most recently observed states of the two economies but also on how the economies have evolved to those states. Nevertheless, as an intentionally simple framework, assumption (20) emphasizes that inflation expectations are linked to both nominal and real variables. The inclusion of unemployment rates or other real variables is essential if one believes that inflation is negatively related to the degree of macroeconomic slack -- whether by a stable negatively-sloped Phillips curve or through disequilibrium short-run adjustment to a natural rate of unemployment. The crucial factor underlying the divergence of U.S. and German inflation experiences following the world recession of 1974-75 was a divergence of basic policy attitudes and strategies, and changes in unemployment rates provide broad indicators of the basic policy decisions that govern the outlook for inflation over the long run.

Regarding behavioral assumptions about the fourth right-hand-side term in equation (19) -- changes in the expected long-run real exchange rate -- a major difficulty, as discussed in Section 3, is to quantify the unexpected changes in balance-of-payments flows that, once recoreded, are "expected to be corrected" via movements in the real exchange rate. The results reported below rely on the oversimplified assumption that the unexpected trade balance in any month can be measured as the recorded trade balance for that month minus the average trade balance for the previous three months.[14] Since propensities to trade as shares of income or output are generally conceived to be a more stable concept than levels of trade, and since trade elasticities are normally conceived to be volume concepts, the focus here is on volume trade balances as a proportion of industrial production levels (which are reported monthly and also are volume concepts). Import volumes are measured in terms of the export quantities that would be required to purchase them -- that is, the same export price index is used to deflate both exports and imports.[15] The unexpected changes in volume trade balances, as shares of industrial production, are denoted TBU_A and TBU_B. Because unexpected changes in trade propensities that are viewed as transitory -- e.g. due to cyclical factors -- are unlikely to influence expectations regarding the long-run real exchange rate, TBU_A and TBU_B are purged of their cyclical components by regressing them on both a domestic cyclical variable and a foreign cyclical variable; see appendix B for details. The residuals from these regressions, denoted $TBUN_A$ and $TBUN_B$, represent estimates of the unexpected changes in trade propensities that can be attributed to non-cyclical factors. It is assumed that expectations regarding the long-run real exchange rate are revised in response to unexpected non-cyclical changes in trade propensities according to the simple relationship[16]

$$(21) \quad \% \Delta SREAL^e = a_5 TBUN_B - a_6 TBUN_A$$

where the right-hand-side variables are lagged by two months to correspond to the most recent observations available at the time that the dependent variable is observed.

7. Empirical results

Substitution of (20) and (21) into (19) yields

$$(22) \quad \%\Delta S = (\%\Delta P_A - \%\Delta P_B) + \Delta(R_B - R_A) + a_1 \Delta\hat{P}_A - a_2 \Delta\hat{P}_B - a_3 \Delta U_A + a_4 \Delta U_B + a_5 TBUN_B - a_6 TBUN_A - a_7 \Delta AW$$

The first and second terms on the right-hand side of (22) can be directly observed and have unit coefficients that require no estimation. The first right-hand-side term is the purchasing-power parity factor, and Figure 4 shows that it "explains" almost two-thirds of the appreciation of the Mark against the dollar between January 1975 and December 1979, whether measured in terms of export prices or consumer prices.

Figures 5 focusses on the relationship between movements in the real exchange rate -- i.e., movements in the nominal exchange rate that are not explained by the purchasing power parity factor -- and changes in the nominal interest differential. As discussed in Section 2, the nominal interest differential and expected inflation differential are

Figure 4

The nominal exchange rate versus relative price levels

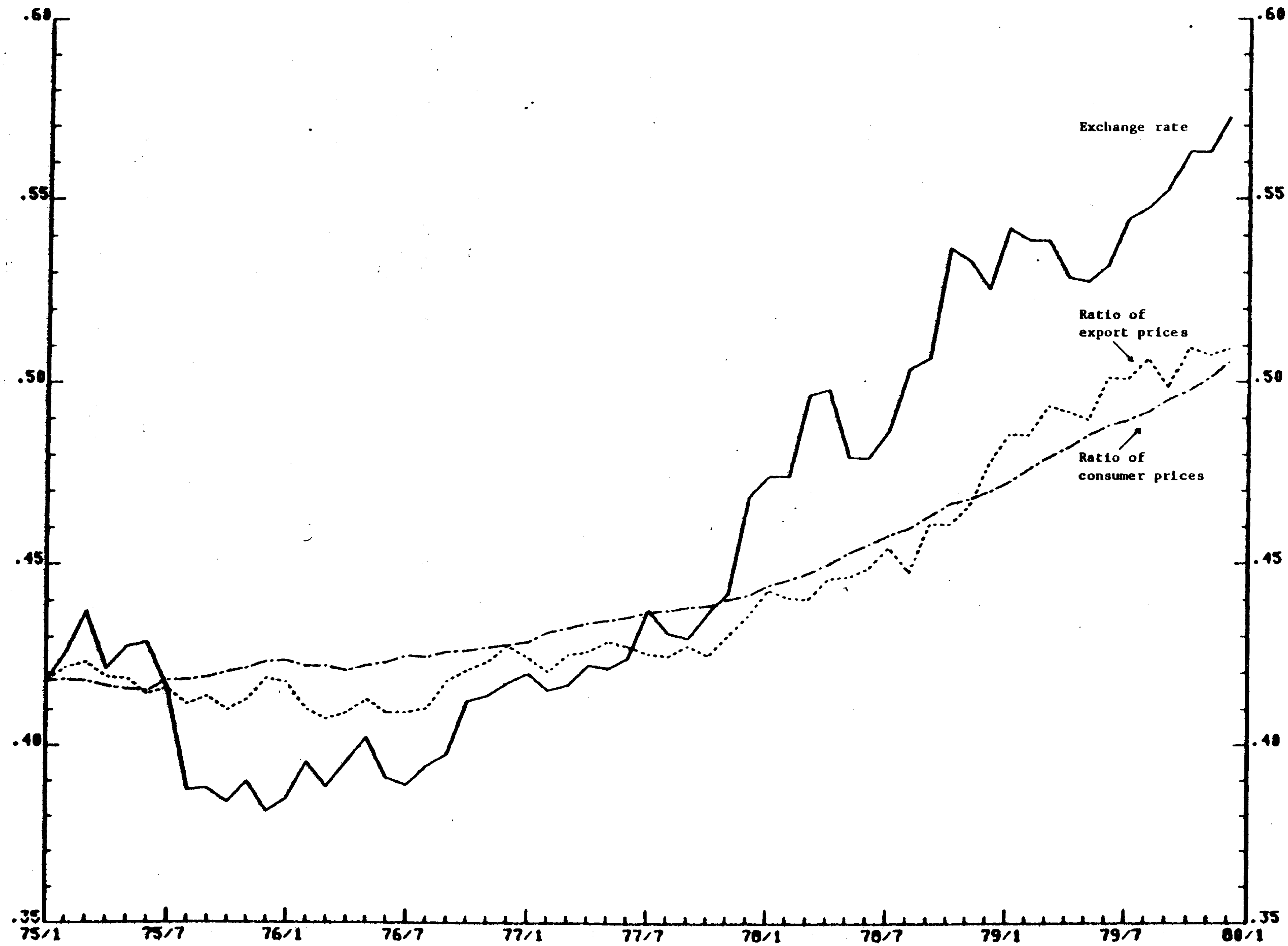
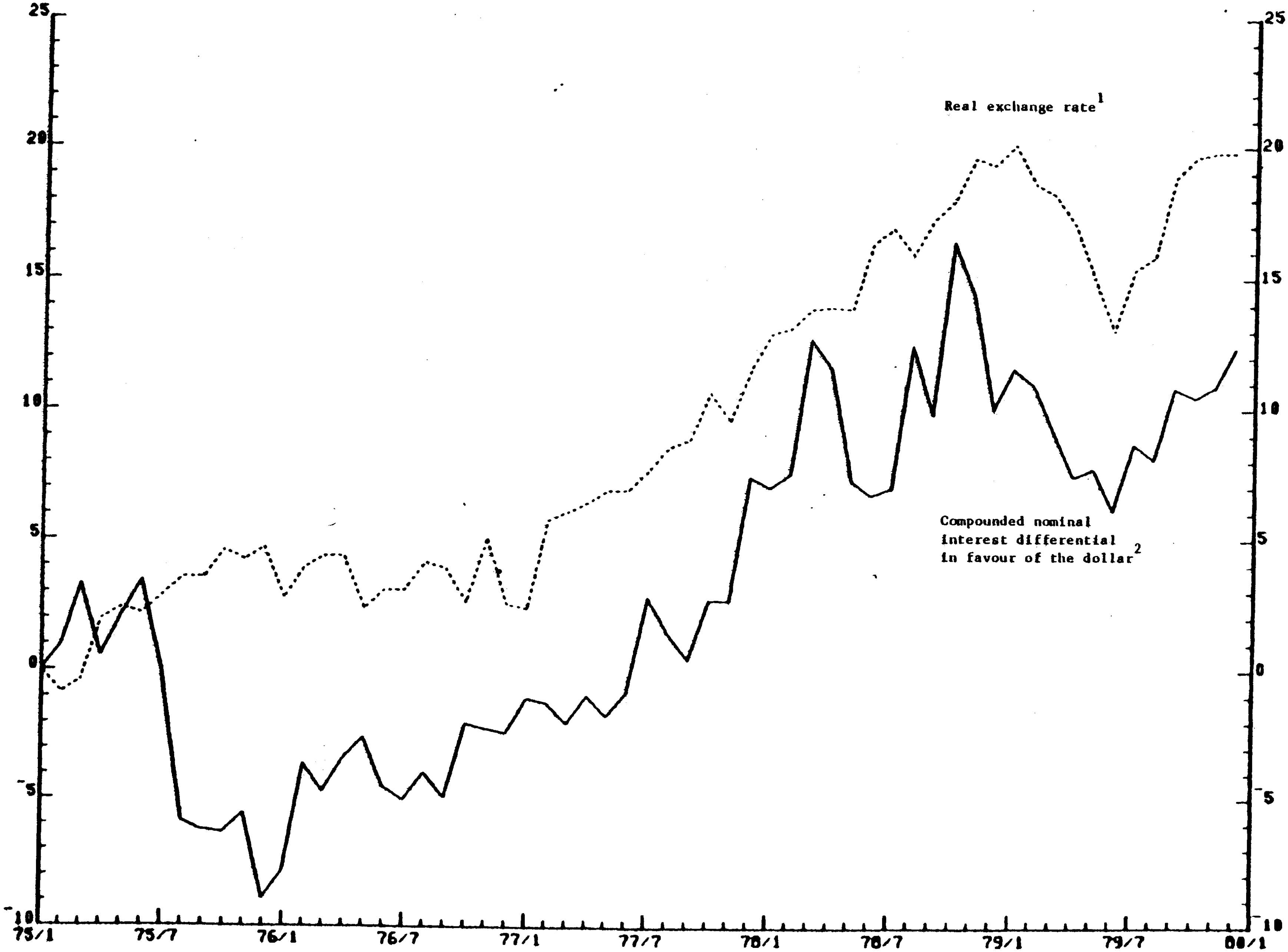


Figure 5

The real exchange rate versus the compounded nominal interest differential



1 Cumulative percentage change since January 1975, based on export price indexes.
2 Cumulative change since January 1975, in percentage points.

compounded over a 5-year horizon. The striking points about Figure 5 are the degree of parallel between the two curves and the fact that the correlation is inverse: appreciations of the Mark are associated with increases in the nominal interest differential in favor of the dollar. The suggested explanation of the inverse correlation, which is supported by regression results reported below, is that despite their pursuit of monetary growth targets, central-bank authorities resisted letting the nominal interest differential move as widely as would have been necessary to offset changes in expected inflation differentials, thereby generating a strong negative correlation between the nominal interest differential and the estimated real interest differential.

In order to impose the unit coefficients on the observable price and nominal interest rate terms in (22), it is useful to define

$$(23) \qquad SREALADJ = SREAL\left(\frac{1+R_A}{1+R_B}\right)$$

such that

$$(24) \qquad \%\Delta SREALADJ = \%\Delta S - (\%\Delta P_A - \%\Delta P_B) - \Delta(R_B - R_A)$$

Accordingly (22) transforms into

$$(25) \qquad \%\Delta SREALADJ = a_1\Delta\hat{P}_A - a_2\Delta\hat{P}_B - a_3\Delta U_A + a_4\Delta U_B + a_5 TBUN_B - a_6 TBUN_A - a_7\Delta AW$$

Note by comparison of (23) and (1) that SREALADJ is the forward exchange rate analog of SREAL, but note also by comparing (4) and (5) that this concept of the forward rate cannot be considered as a close approximation (up to a risk premium) to the expected future real spot rate since the former is constructed from the ratio of current price levels while the latter depends on the expected ratio of future price levels. Thus, SREALADJ varies relative to $SREAL^e$ with revisions in the expected inflation differential, and in this sense it may be confusing to refer to SREALADJ as a real forward rate.

It is worth emphasizing two advantages of using SREALADJ as a dependent variable. The first advantage is that of avoiding the estimation bias that can arise from two-way causation between current exchange rates on the one hand and current relative price levels, interest rates or their hypothesized determinants (e.g. money supplies) on the other hand; see Caves and Feige (1980). The second advantage is the focus on explaining movements in exchange rates that are not due to movements in relative price levels. Relative price levels can be observed to begin with, and the monetarist approach of replacing them in the exchange rate equation with money-market clearing conditions risks the introduction of specification error that can only confuse the explanation of why real exchange rates move.

As suggested above, equation (25) yields poor estimates of month-to-month changes in exchange rates. A strong presumption is that the right-hand-side variables -- as behavioral models of changes in expectational variables -- do a poor job of pinning down the timing of expectational changes month by month.

More sense can be made out of esimates of the integral or log-linear transformation

$$(26)\quad \log(\text{SREALADJ}) = a_0 + a_1\hat{P}_A - a_2\hat{P}_B - a_3U_A + a_4U_B + a_5\Sigma \text{TBUN}_B - a_6\Sigma \text{TBUN}_A - a_7\text{AW}$$

These estimates are reported in Table 2. Details of data sources and construction are presented in Appendix B. Basic points about the data are that exchange rates and interest rates are measured on the second Wednesday of each month and that right-hand-side variables are lagged by one or two months to correspond to the most recent monthly data available at the times that the exchange rate was observed. For the regressions reported in Table 2, price and inflation variables are based on export prices in view of the focus of the accounting framework on a notion of the real exchange rate that is consistent with balance of payments equilibrium; and $\hat{P}_A$, $\hat{P}_B$ are measured as percentage changes over 12 months. Countries A and B correspond to the United States (US) and Germany (G), with the exchange rate measured in dollars per Mark.

In the case 0 estimates of equation (26), AW is constructed as discussed in connection with definition (17) of Section 5. The construction uses condition (All) of Appendix A and regression estimates, on a least-squares basis (and corrected for first-order serial correlation), that 32 percent of OPEC financial wealth and 11 percent of non-OPEC financial wealth were denominated in Marks during the sample period. As

Table 2

Regression results[a]

	Constant	$\hat{P}_{US}$	$\hat{P}_G$	U_{US}	U_G	$\Sigma TBUN_{US}$	$\Sigma TBUN_G$	AW	$\bar{R}^2$	D.W. (RHO)	R.M.S.E.[b]
Expected sign ...	?	+	-	-	+	-	+	-			
Case 0[c]...	- 1.59 (-8.74)	.315 (2.48)	-.594 (-1.47)	- 3.77 (-2.43)	2.93 (.758)	-.0314 (-3.85)	-.0178 (-2.98)	4.89 (7.07)	.950	1.60	2.39%
								AWFIT			
Case 1[c]...	- .539 (-3.03)	.867 (6.16)	-.893 (-1.44)	-11.5 (-6.26)	4.83 (.884)	-.00711 (-.684)	.00041 (.0487)	-.437 (-.541)	.901	.947	3.35%
Case 2[d]...	- .466 (-2.67)	.696 (3.96)	-1.01 (-1.44)	- 9.93 (-4.67)	.0920 (.0160)	-.00584 (-.433)	-.00274 (-.306)	-.282 (-.416)	.997	1.72 (.450)	3.15%
Case 3[c]...	- .583 (-3.69)	.866 (6.19)	-1.04 (-1.86)	-11.1 (-6.82)	4.45 (.827)	-.00717 (-.695)	-.00148 (-.192)	-	.902	.942	3.36%
Case 4[d]...	- .485 (-2.93)	.693 (3.96)	-1.18 (-2.07)	- 9.45 (-5.09)	- .671 (-.122)	-.00617 (-.458)	-.00411 (-.489)	-	.997	1.74 (.461)	3.17%

a Numbers in parentheses are t-values. Coefficients on the $\hat{P}$ and U variables can be interpreted as the estimated percentage effects on the exchange rate of one percentage point changes in inflation rates and in unemployment rates.

b The root mean squared error as a percentage of the mean of the dependent variable.

c Ordinary least squares estimates.

d Estimates corrected for first-order serial correlation.

the first row of Table 2 reveals, this leads to an implausible positive estimate of the coefficient on AW.

Case 1 reflects an attempt to adjust for the fact that AW, particularly insofar as it reflects cumulative official exchange-market interventions, is not independent of the exchange rate. An instrumental variables procedure, designed to avoid this source of simultaneity bias, simply replaces AW with the fitted values (AWFIT) from a regression (corrected for first-order serial correlation) of AW on all the other right-hand-side variables of equation (26) along with an index of time. With this modification, the case 1 regression correctly estimates the expected signs on all coefficients. When the case 1 results are corrected for first-order serial correlation in case 2, the coefficients on the cumulative German expected non-cyclical trade balance loses its correct sign but remains insignificant. Cases 3 and 4 confirm, in comparison with cases 1 and 2, that the inclusion of the AWFIT variable has little influence on estimates of the coefficients attached to other variables.

Because the appropriateness of using mechanical techniques to correct for serial correlation is a controversial issue, cases 1 and 2 will be considered jointly. Except for the estimated coefficient attached to the German unemployment rate, the two euqations are broadly similar. Changes of one percentage point in either the US or the German rate of export price inflation, as measured over 12 months, are estimated to have an effect of only about one percentage point on the expected compounded 5-year inflation differential. By contrast, a one percentage point decline in the US unemployment rate revises US inflation expectations upwards by estimates of 9.9 or 11.5 percentage points over a 5-year horizon, while a one percentage point decline in the German unemployment rate revises

German inflation expectations upwards by a compounded 4.8 percent according to the case 1 estimates. Such estimated unemployment effects are striking. To the extent that changes in policy attitudes were reflected much more quickly and/or clearly by unemployment rates than by inflation rates during the 1975-79 period, it is not surprising that expectations regarding compounded rates of inflation over a 5-year horizon appear to have been more sensitive to unemployment rates than to recent rates of inflation. Contrary to this view, however, it might be argued that the unemployment effects are overestimated in association with underestimates of the balance-of-payments effect and the portfolio balance effect, which will be discussed in connection with Table 3 below.

Although Table 2 reports overall goodness-of-fit statistics that are impressive by conventional standards, it should be noted that a root-mean-squared error of 3.3 per cent. amounts to an error of about 1½ cents per Mark, and in the presence of positive serial correlation - which is not completely eliminated by the autoregressive corrections - the series of monthly residuals may during some periods dominate the explained change in the exchange rate. It should also be noted that the high $\bar{R}^2$ statistics may largely reflect the correlation between the nominal interest differential, as absorbed into the dependent variable, and the estimated expected inflation differential.

Table 3 translates the regression results into estimates of the contributions of various factors to movements in the nominal value of the spot dollar/Mark exchange rate between several selected points in time. Except for the first and last months in the sample, the selected dates correspond, loosely speaking, to turning points in either the exchange rate or its explanatory factors.[17] December 1975 corresponds to the

Table 3

Components of exchange rate changes

(in percentages)

	February 1975 to December 1975		December 1975 to July 1977		July 1977 to September 1978		September 1978 to December 1979		February 1975 to December 1979	
Observed change in the exchange rate ..	- 11.1		13.7		14.6		12.3		29.5	
- Change in relative price level	- 0.7		1.6		8.0		9.9		18.8	
= Change in real exchange rate	- 10.4		12.1		6.6		2.4		10.7	
- Change in compounded nominal interest differential	- 5.5		- 3.1		- 10.6		- 3.1		- 22.2	
= Change in adjusted exchange rate ...	- 4.9		15.2		17.2		5.5		32.9	
of which, estimated change due to	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
Revisions in inflation expectations	- 6.5	- 8.1	14.9	9.7	15.4	10.4	1.4	3.6	25.2	15.6
Balance-of-payments factors	- 0.9	0.2	1.3	0.7	0.3	0.4	- 0.2	0.5	0.4	1.8
Portfolio-balance or risk factors ..	0.5	0.3	- 0.5	- 0.3	- 0.3	- 0.2	- 0.1	- 0.1	- 0.4	- 0.3
Unexplained factors	2.0	2.7	- 0.5	5.1	1.8	6.6	4.4	1.5	7.7	15.8
Memorandum item :										
Change in compounded real interest differential (line 4 plus line 6)	- 12.0	- 13.6	11.8	6.6	4.8	- 0.2	- 1.7	0.5	3.0	- 6.6

lowest value of the Mark during the sample period, preceding a shift of the US trade balance into deficit in early 1976 and a sharp increase in the US trade deficit in early 1977. July 1977 was the month before talk emerged about measures to stimulate the German economy. September 1978 preceded a month of heavy speculation that catalysed the US anti-inflation actions during October and on November 1st, and also represents the last month before the German unemployment rate was revealed (with a lag) to have finally moved below the 3.8 to 4 percent range in which it had been stuck since mid-1976.

Focussing first on the size of the unexplained factors (next to bottom row), it can be noted for the sample period as a whole that the case 1 results leave unexplained roughly one-fourth of both the observed change in the exchange rate (top row) and the change in the adjusted exchange rate (the dependent variable, shown in the fifth row). The case 2 results fail to explain roughly half of the changes for the sample period as a whole. It is noteworthy that the unexplained factors are proportionately smaller for the case 2 results in all four sub-periods and for the case 1 results in all but the final sub-period. The reason is that the results for both cases repeatedly err in the direction of underexplaining the appreciations and overexplaining the depreciation of the Mark (with the minor exception of the case 1 results for the second sub-period), and the failure of the Mark to appreciate in all four sub-periods then makes the cumulative error look proportionately larger.

Turning to the explanatory factors, it can be noted first that the change in relative price levels or purchasing power parity factor "explains" roughly two-thirds of the overall movement of the exchange rate during the sample period as a whole (i.e. 18.8 out of 29.5 per cent.). By comparing the third line with the bottom line for the individual subperiods, it can also be noted that most of the volatility of the exchange rate (after subtracting the purchasing power parity factor) is apparently explained by changes in the compounded real interest differential.

The results show only weak evidence of the balance-of-payments factor and the portfolio balance or risk factor. The surprisingly sharp swing of the US trade balance into deficit during 1976-78, in particular, is estimated to have weakened the dollar by only 1 to 2 per cent. against the Mark between December 1975 and September 1978. Such results cannot be accepted as conclusive, however, partly because of the oversimplified behavioural assumptions that have been adopted about the expectations and risk variables, and partly because the repeated underestimates of the appreciation of the Mark are consistent with both a strong balance-of-payments effect and with the conjecture that the risk factor became increasingly more favourable to the Mark during the sample period.

Nevertheless, the regression estimates as they stand can be given a three-part interpretation. First, inflation expectations, particularly in the United States, appear strongly attuned to changes in unemployment rates as indicators of policy commitments and the likely course of prices over a long 5-year horizon. Second, unexpected payments imbalances, to the extent that they are accurately captured by the oversimplified measures, may have been largely viewed as transitory and may, therefore, have had little impact on expectations regarding the long-run real exchange rate. Thus, the estimates suggest that despite the strong correlation between the depreciation of the dollar and the emergence of a surprisingly large U.S. trade deficit during 1976-78, the depreciation of the dollar may have largely reflected the shift in expected inflation rates and real interest differentials that accompanied, but were not caused by, the growing trade deficit. Third, the estimates do not reject the view that Euro-Mark and

Euro-dollar deposits are near perfect substitutes, which would imply that -- except insofar as nominal interest rates or inflation expectations are affected -- exchange rates are influenced only negligibly by sterilized exchange-market interventions, public-budget deficits and shifts in the global distribution of private wealth.

8. Summary and conclusions

This paper has developed a model that views changes in exchange rates to predominantly reflect unexpected changes in "fundamental factors." It begins by using the interest rate parity condition to link current exchange rates to expectations about future exchange rates. A basic conceptual difficulty is to model how expectations about future exchange rates are revised in response to new information about fundamental factors. The strategy adopted here reflects the view that it is most plausible to explain revisions in exchange rate expectations in terms of a model of the real exchange rate that is consistent with balance of payments equilibrium in the long run. The model that has been adopted allows a test of the hypothesis that the long run real exchange rate is constant, which is the case of long-run purchasing power parity.

By combining the covered interest rate parity condition with conventional definitions of the risk premium (reflecting the difference between forward exchange rates and expected future spot rates) and "real" exchange rates and interest rates, the link between the current nominal spot rate and the expected long run real spot rate can be expressed as an approximate accounting identity that involves the current ratio of price levels, the risk premium, and the real interest differential <u>compounded</u> over a horizon that extends until the long run is reached. As an operational definition that reflects the maturities for which interest rate data are available (for Euro-currency deposits), the long run has been assumed to be reached in 5 years. With respect to model design, the use of 5-year interest differentials that provide information about what the future exchange rate is expected to be (up to a risk premium) after it reaches equilibrium in the long run, rather than before it has equilibrated in the short run, avoids arbitrary assumptions about the expected dynamic adjustment of the exchange rate -- in contrast, for example, with Dornbusch (1976), Bilson (1978, Part IV), Frankel (1979b), and Hooper and Morton (1980). With respect to empirical insights, the accounting framework emphasizes that a unit change in the nominal interest differential or expected inflation differential, as commonly expressed in percentage points per annum, can be associated with a much larger change in the real interest differential over an horizon that extends until the long run is reached and should, accordingly, be viewed as typically contributing to (or associated with) a much larger percentage change in the spot exchange rate. Section 4 has illustrated this point in terms of a graphical history of week-to-week movements in the dollar/mark rate during the first 5 months of 1980, arguing that what is not "explained" by changes in 5-year Eurocurrency differentials can be viewed to represent a plausible estimate of how the expected inflation differential was revised in response to new information.

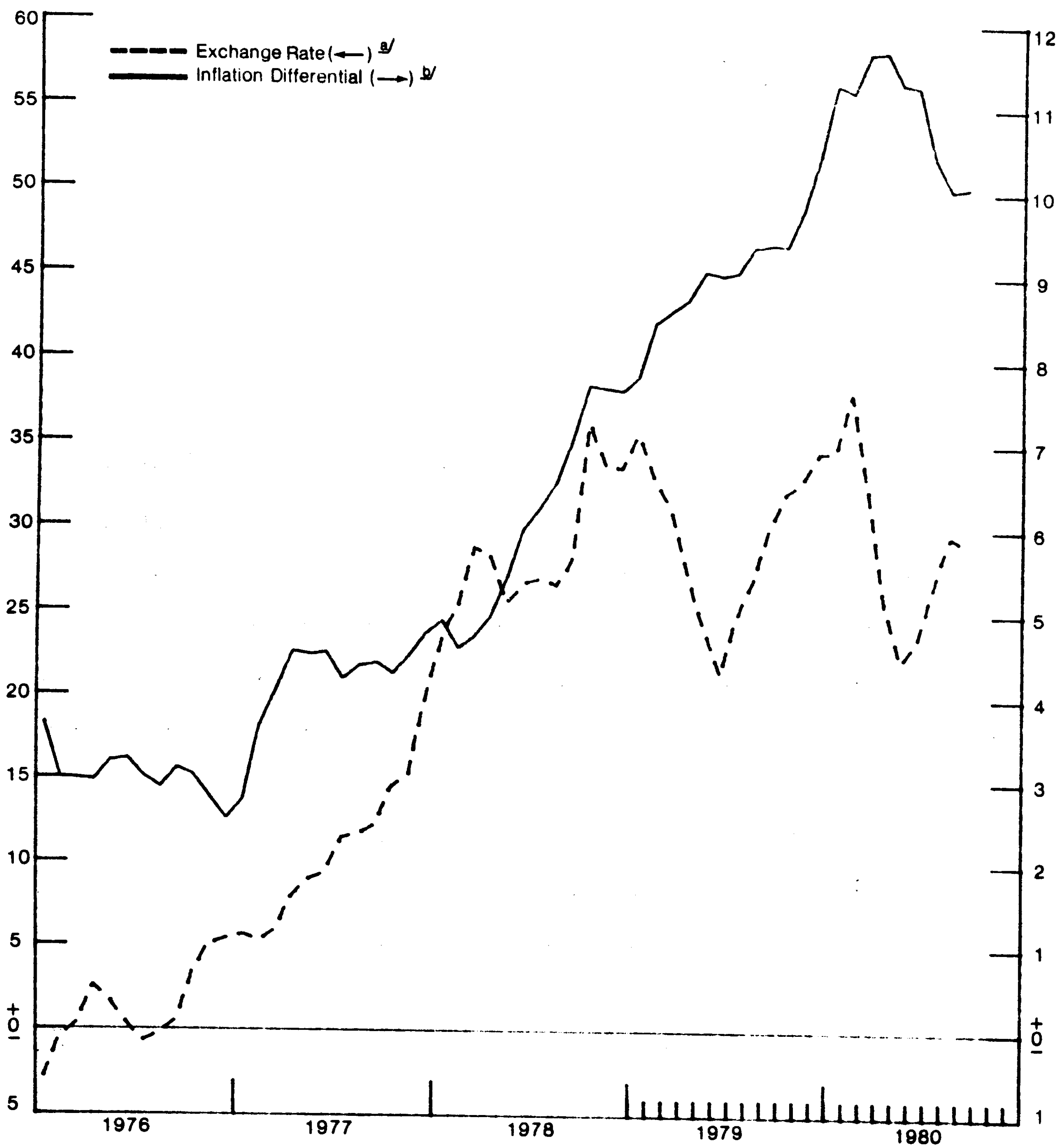
Besides emphasizing the role of new information, the regression analysis has imposed theoretically-dictated coefficients of unity on the observed price ratio and the nominal interest differential. More precisely, spot exchange rates, current price levels and nominal interest rates are viewed to be jointly endogenous and have been combined into a real 5-year forward exchange rate, which has been used as the dependent variable in the regression analysis. In addition to avoiding estimation bias that can arise from two-way causation between exchange rates and current price levels (or money supplies), the procedure has the merit of isolating the "real" component of exchange rate movements, about which present empirical understanding is particularly weak.

The regression analysis has focussed on the monthly behavior of the dollar/mark rate during the 1975-79 period and represents a test of specific behavioral assumptions about three unobservable explanatory factors: the expected long run real exchange rate, the expected inflation differential over a 5-year horizon, and the risk premium. The assumptions that have been adopted can be summarized as follows: (1) Only unexpected and non-cyclical balance-of-payments flows are assumed to cause revisions in expectations about the real exchange rate in the long run; unexpected balance-of-payments flows are measured in an oversimplified manner as changes in balances of trade from recent average levels; and the cyclical components that are subtracted from these unexpected trade balances are the components that can be explained econometrically using both domestic and foreign cyclical indicators. (2) The expected inflation rates that affect the real interest rate factor are assumed to depend in an oversimplified manner on the most recently reported values of observed inflation rates and unemployment rates. And (3) the risk premium -- which can be viewed as a change in currency values that is required to compensate private investors in the aggregate for dividing their global portfolio into the currency composition that is imposed by the available stocks and currency denominations of public debts -- is assumed to depend on (a) the relative stocks of public debts denominated in Marks and dollars, and (b) the distribution of global private wealth between OPEC and non-OPEC countries, which may have different preferences for assets denominated in Marks and dollars.

Several empirical "conclusions" have emerged after transforming the regression results into an explanation of the spot exchange rate. For the 1975-79 period as a whole, roughly two-thirds of the appreciation of the Deutschemark against the dollar was "explained" by relative price movements or the purchasing power parity factor. By contrast the shorter-term volatility of the exchange rate is estimated to have primarily reflected the widening and narrowing of real interest differentials.

The empirical findings are inconclusive in assessing the importance of balance-of-payments and risk or portfolio balance factors. Under the behavioral assumptions that were tested these factors were not found to be significant, but the behavioral assumptions are oversimplified and the results underexplain the appreciation of the mark over the sample period as a whole, consistent with the hypothesis that either the large shifts in balance-of-payments flows were indeed important or risk considerations become substantially more favorable to the mark during the 1975-79 period. Support for this hypothesis is also provided by Figure 6, independently of the particular behavioral assumptions that were tested in the regression analysis. The figure compares the cumulative appreciation of the mark against the dollar -- in terms of the 5 year "real" forward rate -- with the difference between the recorded <u>annual</u> rates of U.S. and German consumer price inflation. The real forward rate remained fairly constant from August 1975 through September 1976 and then appreciated by 25 to 30 percent to a new range within which it fluctuated

Figure 6



a/ Percentage appreciation of the (real forward) mark from its average level for the period August 1975 through September 1976.

b/ Difference between percentage rates of change over 12 months in the U.S. consumer price index and the German cost of living index.

with no trend from March 1978 through September 1980. By comparison, the annual inflation differential moved from a range of about 3 percent per annum during 1976 to about 5 percent in early 1978, nearly 8 percent by the end of 1978, and in excess of 10 percent beginning in November 1979. Abstracting from differences in the timing of the appreciation and the divergence of inflation rates, it might be argued that the 7 percent widening of the annual inflation differential was associated with up to a 35 percent widening of the inflation differential expected over 5 years -- enough to explain the entire appreciation of the mark. Recognizing the differences in timing, however, suggests that balance of payments and/or risk considerations must in fact have played an important role as well. For although there was some foresight of the U.S. price acceleration, the 25 to 30 percent appreciation coincided with a major shift of the U.S. current account into deficit and had essentially ended by March 1978, when the annual inflation differential had only moved from 3 to 5 percent, and when most if not all forecasts underpredicted the far greater extent to which U.S. and German inflation rates would diverge over the next year and a half.[18]

This chain of argument emphasizes the general point that to unravel the roles of inflation expectations, balance of payments factors and risk or portfolio balance considerations is likely to require sophisticated behavioral models of all three. There is considerable scope for moving beyond the "first attempts" that this paper has tested, particularly in the direction of relating the expectations variables more "rationally" to simple structural models of inflation rates and balance of payments flows. In addition, a sophisticated model of how inflation expectations are revised in response to new information requires a simultaneous model of how policy is expected to react to the new information as well, which is an important challenge.

As a final point, the accounting framework reinforces arguments by Mussa (1976) and others by emphasizing that unexpected policy actions, or revisions in expectations about prospective policy actions, can lead to large revisions in compounded real interest differentials and to equally large movements in exchange rates. Accordingly, by directing policies along well-defined and easily anticipated courses, and by holding to such courses, policy authorities, if they so desired, might substantially reduce the volatility of exchange rates.

Appendix A

This appendix applies the theory of portfolio selection to a slight variation of the model developed lucidly by Dornbusch (1980b), who provides references to earlier groundwork by Solnik (1973), Kouri (1976b), Kouri and de Macedo (1978) and others. The investor starts with initial wealth W, as measured in units of currency A. Exchange rates are given spot (S) and forward (F) in units of currency A per unit currency B. Also given are the respective own nominal rates of interest (R_A, R_B) on assets denominated in currencies A and B. Uncertainty attaches only to the future spot rate ($\tilde{S}$), and the investor's only decision variable is the share (x) of his wealth that he chooses to hold in assets denominated in currency B. The currency-A value of the investor's terminal wealth ($\tilde{W}$) can thus be described as

$$\text{(A1)} \qquad \tilde{W} = (1-x).W.(1+R_A) + \frac{xW}{S}.(1+R_B)\tilde{S}$$

Equivalently, for simplification, focus on the ratio of the present discounted value of terminal wealth to the value of initial wealth

$$\text{(A2)} \qquad \tilde{w} = \frac{\tilde{W}/(1+R_A)}{W} = 1 - x + \frac{x\tilde{S}}{F}$$

where the forward exchange rate F has been introduced by substituting from the interest rate parity condition (i.e. equation 1 of Section 2).

The traditional portfolio-choice framework views the investor to choose x by maximzing a utility function that depends on the mean and variance of a wealth variable, which here is conveniently taken to be $\tilde{w}$. The mean and variance in question can be represented as

$$\text{(A3)} \qquad \text{MEAN}(\tilde{w}) = 1 - x + \frac{xS^e}{F}$$

and

$$\text{(A4)} \qquad \text{VAR}(\tilde{w}) = x^2 . \text{VAR}(\tilde{S}/F)$$

where S^e is the mean or expected value of the future spot rate. Thus, the utility-maximizing solution is

$$\text{(A5)} \qquad x = \frac{-U_1}{2U_2} \frac{(S^e/F)-1}{\text{VAR}(S/F)}$$

where U_1 and U_2, respectively, are the positive and negative derivatives of the utility function with respect to the mean and the variance of $\tilde{w}$. It is notationally convenient to define

$$\text{(A6)} \qquad u = \frac{-2U_2}{U_1}$$

which is conventionally called the coefficient of risk aversion.

Now distinguish two wealth holders with subscripts 0 (for OPEC) and N (for non-OPEC). Q_B denotes the global stock of currency-B denominated assets (valued in units of currency B) that are available for 0 and N to hold, and the market clearing condition is thus

$$\text{(A7)} \qquad x_0 W_0 + x_N W_N = SQ_B$$

Accordingly, using (A5) and (A6) to substitute for x_0 and x_N,

$$\text{(A8)} \qquad S^e/F = 1 + \frac{VAR(\tilde{S}/F).SQ_B}{(W_0/u_0) + (W_N/u_N)}$$

Equivalently, denoting global wealth by

$$\text{(A9)} \qquad W = W_0 + W_N$$

and using the defintion $RISK^e = S^e/F$ (equation 2 of Section 2),

$$\text{(A10)} \qquad RISK^e = 1 + \frac{u_N.VAR(\tilde{S}/F).\ (SQ_B/W)}{1 + \frac{(u_N - u_0)}{u_0}\ (W_0/W)}$$

Thus the risk factor depends on (i) the non-OPEC coefficient of risk aversion, which equals zero in the limiting case of risk neutrality; (ii) the subjectively-perceived variance of the ratio of the future spot rate to the forward rate; (iii) the share of currency-B assets that must be held in the combined global portfolio; and (iv) the share of OPEC wealth in global wealth multiplied by the proportionate difference between OPEC and non-OPEC coefficients of risk aversion. The latter proportionate difference between coefficients of risk aversion is equivalent, from (A5) and (A6), to the proportionate difference between the portfolio shares that are allocated to currency B:

$$\text{(A11)} \quad \frac{u_N - u_O}{u_O} = \frac{x_O - x_N}{x_N}$$

Appendix B

The exchange rate and Euro-dollar rate on 5-year deposits (as bid in London) are measured on the second Wednesday of each month (or the previous trading day when the second Wednesday is a holiday) as taken from issues of The Money Manager. The second Wednesday of the month conveniently follows the release of data on unemployment rates for the previous month and price levels and trade balances for the month before last. These lags are incorporated into the regression equations. Although data on 5-year Euro-Mark rates are available, they were not conveniently accessable when the regression analysis was undertaken; consequently the regression results are based on a monthly series, published by the Bundesbank, on market yields on DM-bonds of foreign issuers. The yields pertain to fully taxed fixed-interest bearer bonds with original terms of issue exceeding four years and remaining period to maturity exceeding three years. See Statistical Supplements to the Monthly Reports of the Deutsche Bundesbank, Series 2, Securities Statistics, Table 8b.

Data on prices, unemployment rates and trade balances are seasonally adjusted from national sources. In most of the empirical analysis the price variables are represented by the German export price index paired with the US export unit value index; in Figure 4 the consumer price ratio is constructed from the German cost-of-living index and the US consumer price index. Data on volume trade balances are constructed by deflating value trade balances with export price indexes; normalised volume trade balances, or propensities to trade, are constructed as volume trade balances divided by industrial production indexes; and the expected component of each of the normalized volume trade balances is defined, for each month, as the total normalized volume trade balance for the previous three months. For each country the non-cyclical component of the unexpected normalized volume trade balance ($TBUN_G$ or $TBUN_{US}$) is taken to be the residual component that is not explained by regressing the total unexpected normalized volume trade balance (TBU_G and TBU_{US}) on both the change in a domestic cyclical indicator and the change in a foreign cyclical indicator. To be consistent with the construction of TBU_G and TBU_{US}, changes in cyclical indicators are measured as changes from average levels for the previous three months. For Germany, the domestic cyclical indicator is constructed as the ratio of the number of workers unemployed to the number of job vacancies, each seasonally adjusted, from Statistical Supplements to the Monthly Reports of the Deutsche Bundesbank, Series 4. For the United States, the domestic cyclical indicator is the Federal Reserve Board's capacity utilization index for manufacturing, seasonally adjusted. For both countries the external cyclical indicator is the deviation from trend of the OECD's index of total OECD industrial production.

In constructing the portfolio-balance variables ASSETRATIO and WEALTHRATIO, the stock of privately-held outside assets denominated in Marks is constructed as total German Federal Government debt plus Bundesbank holdings of US-dollar investments, as taken from Tables VII.10 and IX.6 of the Monthly Report of the Deutsche Bundesbank. The stock of privately-held outside assets denominated in dollars is constructed as gross US Federal Government debt held by the public minus US liabilities to foreign official institutions; the former measure is taken from the Commerce Department's Business Statistics and Survey of Current Business, while the latter is taken from the Annual Statistical Digest of the Federal Reserve Board and from Treasury Bulletins. The stock of global private financial wealth is constructed as the dollar value of the combined constructed stock of outside assets denominated in Marks and dollars, implicitly defining the global private sector to include the public sectors of all countries other than Germany and the United States. The stock of

OPEC financial wealth is constructed as the cumulative dollar value of the current-account surplus of the OPEC countries, beginning in March 1973, based on estimates provided in the IMF's World Financial Outlook. For each of the years 1975-79 the construction equates monthly OPEC current-account surpluses to one-twelfth of the annual estimates. All portfolio variables are measured end-of-month and the exchange rate on the second Wednesday of the month is regressed on the value of the composite portfolio variable at the end of the previous month.

Footnotes

* An earlier version of this paper was written at the Bank for International Settlements and issued as BIS Working Paper No. 4. Although this new draft presents the same empirical results, the discussion of the conceptual framework and its relationship to the literature has been extensively revised. The views presented herein are not necessarily shared by either the Federal Reserve Board or the Bank for International Settlements. I gratefully acknowledge comments from many colleagues at both institutions, especially William Allen, Matt Canzoneri, Robert Flood, Dale Henderson, Karen Johnson, Masahiro Kawai, Richard Meese, John Morton, Kenneth Rogoff, Jeffrey Shafer, and Ralph Smith. I am also indebted for views that were shaped during past collaboration with Michael Dooley. None of the above should be implicated for the paper's shortcomings.

1 This point has been emphasized by Mussa (1976, 1979), Barro (1978), Dornbusch (1978, 1980a), and Dooley and Isard (1979), among others.

1a Throughout this paper, interest rates refer to yields on Euro-currency deposits or other assets that are known to satisfy the covered interest rate parity condition, and risk refers to exchange risk. For a distinction between exchange risk and political risk see Aliber (1973) and Dooley and Isard (1980).

1b It may be helpful to confirm that selected exchange-rate models obey the accounting identities. The monetary approach models of Frenkel (1976) and Bilson (1978, Parts I and II) assume that $S = P_A/P_B$ -- for "true" price levels or appropriately scaled price indexes -- and also that nominal interest differentials reflect expected inflation differentials such that real interest differentials never change. The former assumption of purchasing power parity implies that the expected long run real exchange rate is constant, and the risk premium is assumed to be zero. Thus, all but the purchasing power parity factor are assumed to vanish from the accounting identity, which is then transformed into a testable behavioral model by replacing the purchasing power parity term with a theory of the price levels that equilibrate money markets. In contrast, Dornbusch (1976) does not hypothesize purchasing power parity or constant real interest differentials but instead develops a model with goods and money markets in which it is assumed that the exchange rate is expected to move at a constant rate towards its long run equilibrium level. The risk premium is assumed to be zero, the long-run nominal interest differential is thus in parity with the gap between the logrithms of current and long-run equilibrium nominal exchange rates, and it can be shown that the long-run accounting identity (condition 13) is satisfied by noting that the logrithm of the expected long-run real exchange rate is the difference between (the logrithms of) the equilibrum nominal exchange rate and the long-run equilibrum price ratio, while the expected long-run inflation differential is the difference between (the logrithms of) the long-run equilibrium price ratio and the current price ratio. As a final example, Kouri (1976a) also takes the approach of modeling exchange rates to simultaneously satisfy both a stock and a flow equilibrium condition. Kouri differs substantially from Dornbusch, however, in emphasizing the influence of wealth on asset stock demands and in viewing exchange rate movements to influence current account flows primarily through their valuation effects on wealth, which in turn influence desired savings flows, rather than through terms-of-trade effects. Kouri's model can be seen to satisfy the accounting identity by noting that (i) purchasing power parity is assumed, (ii) the expected rate of change in the nominal exchange rate is equated to the expected inflation differential such that the expected real exchange rate is constant, (iii) nominal interest rates are set equal to zero such that the real interest differential is the expected inflation differential, and (iv) with no nominal interest differential, spot and forward rates are equal and the risk term (the logrithm of S^e/F) equals the expected rate of change of the spot rate, which also equals the expected inflation differential.

2 Interest rates on fixed-term 5-year Euro-deposits are collected by the Bank of America for 5 major currencies: the U.S. dollar, the Deutschemark, the Dutch guilder, and the Swiss and French francs. One limitation of the data is that markets are thin: on many days transactions do not occur in each currency. In using the data to construct 5-year forward exchange rates, a second limitation is that the interest differential represents a weighted sum of 1, 2, 3, 4 and 5 year forward rates, since interest on the deposits is paid at the end of each year.

3 See Einzig (1970).

4 Genberg and Kierzkowski (1979), in an earlier draft dated 1975, may have presented the first model of exchange rate determination that embodied this assumption -- or that kidnapped it from the literature on portfolio and monetary approaches to the balance of payments. Kouri (1976a) made a major contribution in using the assumption to tie the short run behavior of the exchange rate to an expected long run equilibrium. See also Dornbusch (1976) and Dornbusch and Fischer (1980).

5 A second notion focusses on policy reactions in linking the long run real exchange rate to unexpected balance-of-payments flows: the anticipation that policy authorities will act to reduce payments imbalances can lead to a revision of exchange rate expectations in response to surprises about the balance of payments. Such expectations of policy reactions were clearly in evidence during the Bretton Woods regime of adjustable pegs, when official international permission or pressure to adjust exchange rates was based on the concept of "fundamental disequilibrium", which in practice became generally viewed as a state of persistent current-account imbalances. The validity of the argument is limited, however, to expectations of policy reactions that are likely to have a permanent influence on

the exchange rate. The notion is not valid when the expected policy actions are cyclical stabilization measures, although expectations of such measures may result in revisions in expected real interest rates and affect the exchange rate through the third component of the accounting identity.

6 Wednesday data are used to minimize any distorting effects of the weekend bookkeeping transactions that are made to reduce the burden of U.S. reserve requirements. The source for all data is The Money Manager. Data on 5-year Euro-Mark rates are constructed estimates based on 3-month and 1-year rates under the assumption of a smooth interest rate term structure in which the difference between the 3-month and 5-year rates is taken to be four times the difference between the 1-year and 5-year rates. Because the Euro-Mark term structure remained fairly flat during January-May 1980, the analysis is not very sensitive to this assumption.

7 To the extent that nominal interest differentials on 10-year maturities are much the same as those on 5-year maturities, the story told graphically in terms of 10-year interest differentials would halve the size of the estimated revisions in expected inflation differentials per annum as averaged over a 10-year horizon. Recall the discussion in Section 2.

8 Judging from movements in the 1-year forward rate, the inflation differential expected over a 1 year horizon was 4 percent per year lower at the end of May than at the beginning of the year.

9 See Frankel (1980) for a more extensive taxonomy and description of the various classes of "asset-market" views of exchange rate determination.

10 See Frenkel (1976, 1980), Bilson (1978), and references cited therein.

11 See Branson (1976), Branson, Halttunen, and Masson (1977, 1979), Dooley and Isard (1979), Porter (1977, 1979), Frankel (1980) and references cited therein. See also Allen and Kenen (1980) or the preview by Kenen (1978) for a portfolio balance framework embedded in a 2-country, 3-good macro-model that is used to analyze the comparative statistics and dynamics of the joint determination of exchange rates, interest rates, goods prices, incomes and wealths.

12 Dooley and Isard (1979) provide a similar formulation that begins from portfolio demand functions, rather than from a utility-maximizing framework.

13 Anecdotal evidence suggests that these factors, in fact, may have changed over time as investors became more risk averse or more perceptive of risk following repeated experiences of getting "burned" by holding dollar-denominated assets. Such changes could be systematically modelled and estimated using non-linear procedures.

14 As indicated in Section 3, a major limitation of this treatment is the lack of any attempt to capture the changes in trade flows that represent expected lagged responses to changes in real exchange rates.

15 This choice reflects a concern to avoid deflating away the substantial increases in the price of oil imports.

16 An alternative procedure would be to estimate a model of balance of payments flows, which could then be used to generate the change in the real exchange rate that was required in the long run to offset current changes in exogenous variables -- i.e., which could be used to generate "rational" revisions in expectations about the long run real exchange rate. Major drawbacks of such an approach, however, would be (i) the difficulties of estimating significant exchange rate elasticities, (ii) the degrees of freedom that would have to be sacrificed to account for long lags in the response of balance of payments flows to changes in exchange rates; and (iii) the difficulty of jumping from observed current changes in exogenous variables to forecasts of long run changes.

17 The January 1975 observation was sacrificed inadvertently in the process of lagging explanatory variables rather than discarded as a misfit.

18 There is also clear evidence from daily or hourly data that announcements of unexpected news about balance-of-payments flows are followed by immediate jumps in exchange rates, which suggests either that investors are irrational or that balance-of-payments surprises have some permanent effects.

References

Aliber, Robert Z., "The Interest Rate Parity Theorem: A Reinterpretation" Journal of Political Economy, November/December 1973.

Allen, Polly R. and Peter B. Kenen, Asset Markets, Exchange Rates, and Economic Integration: A Synthesis. New York: Cambridge University Press, 1980.

Barro, Robert J., "A Stochastic Equilibrium Model of an Open Economy Under Flexible Exchange Rates." Quarterly Journal of Economics, Vol. XCII (no. 1), February 1978.

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

Branson, William H., "Asset Markets and Relative Prices in Exchange Rate Determination," Seminar Paper No. 66, Institute for International Economic Studies, Stockholm, 1976.

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

________________, "Exchange Rates in the Short Run: Some Further Results," European Economic Review, October 1979.

Caves, Douglas W. and Edgar L. Feige, "Efficient Foreign Exchange Markets and the Monetary Approach to Exchange-Rate Determination." American Economic Review, March 1980.

Cumby, Robert and Maurice Obstfeld, "Exchange-Rate Expectations and Nominal Interest Differentials: A Test of the Fisher Hypothesis" Discussion Paper No. 34, Columbia University, July 1979.

Dooley, Michael P. and Peter Isard, "A Portfolio-Balance Rational-Expectations Model of the Dollar-Mark Rate: May 1973 - June 1977." Federal Reserve Board, International Finance Discussion Paper No. 123, 1978.

________________, "The Portfolio Balance Model of Exchange Rates," Federal Reserve Board, International Finance Discussion Paper No. 141, May 1979.

________________, "Capital Controls, Political Risk, and Deviations from Interest-Rate Parity." Journal of Political Economy, April 1980.

Dornbusch, Rudiger, "Expectations and Exchange Rate Dynamics." Journal of Political Economy. December 1976.

________________, "Monetary Policy Under Exchange Rate Flexibility." In Managed Exchange Rate Flexibility: The Recent Experience, Federal Reserve Bank of Boston Conference Series, No. 20, 1978.

________________, "Exchange Rate Economics: Where Do We Stand?", Brookings Papers on Economic Activity, 1:1980a.

________________, "Exchange Risk and the Macroeconomics of Exchange Rate Determination," M.I.T., revised manuscript, April 1980b.

________________ and Stanley Fischer, "Exchange Rates and the Current Account." American Economic Review, forthcoming, December 1980.

Einzig, Paul, The History of Foreign Exchange. London, MacMillan, 1970.

Fellner, William, "The Bearing of Risk Aversion on Movements of Spot and Forward Exchange Relative to the Dollar: in John S. Chipman and Charles P. Kindleberger, eds., Flexible Exchange Rates and the Balance of Payments: Essays in Memory of Egon Sohmen, Amsterdam: North Holland, forthcoming (1979 manuscript).

Frankel, Jeffrey A., "The Diversifiability of Exchange Risk." Journal of International Economics, August 1979a.

________________, "On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials." American Economic Review, September 1979b.

________________, "A Test of the Existence of the Risk Premium in the Foreign Exchange Market vs. the Hypothesis of Perfect Substitutability." Federal Reserve Board, International Finance Discussion Paper No. 149, August 1979c.

________________, "Monetary and Portfolio-Balance Models of Exchange Rate Determination," in J. Bhandari and B. Putnam, eds., The International Transmission of Economic Disturbances under Flexible Exchange Rates, forthcoming (July 1980 manuscript).

Frenkel, Jacob A., "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence." Scandinavian Journal of Economics 2, 1976.

________________, "Flexible Exchange Rates in the 1970's." Revised manuscript, January 1980.

Genberg, Hans and Henryk Kierzkowski, "Impact and Long-Run Effects of Economic Disturbances in a Dynamic Model of Exchange Rate Determination," Weltwirtschaftliches Archiv, 1979.

Hooper, Peter and John Morton, "Fluctuations in the Dollar: A Model of Nominal and Real Exchange Rate Determination," Federal Reserve Board, International Finance Discussion Paper No. 168, October 1980.

Kenen, Peter B., "New Views of Exchange Rates and Old Views of Policy", American Economic Review, May 1978.

Keynes, John Maynard, The General Theory of Employment, Interest, and Money. London, MacMillan, 1936.

Kouri, Pentti J. K., "The Exchange Rate and the Balance of Payments in the Short Run and in the Long Run: A Monetary Approach." Scandinavian Journal of Economics, 1976a.

_______________, "The Determinants of the Forward Premium," Institute for International Economic Studies Seminar Paper No. 62, Stockholm, August 1976b.

_______________ and Braga de Macedo, "Exchange Rates and the International Adjustment Process." Brookings Papers on Economic Activity, 1978.

Martin, John P. and Paul R. Masson, "Exchange Rates and Portfolio Balance," NBER Working Paper No. 377, August 1979.

Meese, Richard A. and Kenneth J. Singleton, "Rational Expectations, Risk Premia, and the Market for Spot and Forward Exchange." Federal Reserve Board, International Finance Discussion Paper No. 165, July 1980.

Mussa, Michael, "The Exchange Rate, the Balance of Payments, and Monetary and Fiscal Policy Under a Regime of Controlled Floating." Scandinavian Journal of Economics 2, 1976.

_______________, "Empirical Regularities in the Behavior of Exchange Rates and Theories of the Foreign Exchange Market." Volume 11 of the Carnegie-Rochester Conference Series on Public Policy, a supplementary series to the Journal of Monetary Economics, 1979.

Porter, Michael G., "The Exchange Rate and Portfolio Equilibrium," manuscript, 1977.

_______________, "A Portfolio Model of Exchange Rate Behavior - Results for Eight Currencies," manuscript, 1979.

Solnik, Bruno H., European Capital Markets: Towards a General Theory of International Investment. Lexington Books, 1973.