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The Determinants of Exchange Rate Movements

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No. 7: THE DETERMINANTS OF EXCHANGE RATE MOVEMENTS

by

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June 1983

THE DETERMINANTS OF EXCHANGE RATE MOVEMENTS

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A. Introduction

1. Exchange rates are relative prices of national currencies, and under a floating rate regime they may naturally be viewed as being determined by the interplay of supply and demand in foreign exchange markets. This proposition is uncontroversial, but it provides no more than a starting point for understanding exchange rate determination and its relationship to other macroeconomic variables and to policy. Supply and demand in currency markets are dependent on conditions in other markets, real and financial, which are affected in turn by exchange rates themselves. In fact any analysis which attempted to be general would describe exchange rates as being determined in a complex process of interaction simultaneously with all other variables in the international macro-economy. Such an approach would prove too cumbersome to be helpful empirically. Simplifying assumptions have therefore been used in most standard models to provide explanations which are in varying degrees partial. Each model has its own specific insights emphasising particular linkages, for example with trade and relative price developments, or with conditions in money and financial markets more generally.

2. The experience of floating exchange rates since 1971-73 has led to a radical reconsideration of how exchange rate determination may best be understood. The dust has yet to settle on many issues, but a broad consensus was reached at an early stage on the fundamental proposition that the determination of exchange rates is best viewed as being akin to the determination of the prices of financial assets. The basis and implications of this "asset-market" approach are discussed in Parts B.1 and B.2, where it is first compared with the earlier "balance of payments" view. A conceptual framework for the empirical analysis of exchange rate movements is then derived in Part B.3 which is a general implication of the asset-market view. The special assumptions which have been used to obtain some of the best-known theoretical and econometric results are described briefly in Part A.4; and the apparent failure of econometric exchange rate models to explain much of recent experience is discussed.

3. The subsequent analysis then considers how exchange rate movements in the floating rate period appear to have been related to the main suggested determining variables: relative price levels in Part C.1; interest rates in Part C.2; money supplies in Part C.3; portfolio preferences and asset supplies in Part C.4; and current account developments in Part C.5. With robust econometric evidence generally absent, much of the empirical discussion is necessarily speculative; it is based largely on the notes describing the experience of individual countries and currencies. A summary is provided in Part D. More technical aspects of the preceding discussion of exchange rate determination are presented in an Appendix to the Annex.

B. General Overview of Exchange Rate Determination

(1) Exchange rates determined by balance of payments flows

4. Early analyses of the impact of monetary and fiscal policy on exchange rates had been conditioned by the nature of the international financial system, and the policy pre-occupations of earlier post-war years(1). Under the Bretton Woods regime, exchange rates were viewed as "adjustable pegs", to be used for the correction of "fundamental disequilibria" in the balance of payments, which were usually to be identified by persistent imbalances on current account. The economic analysis of exchange rates correspondingly focused on their influence on current account flows, and on the mechanism which parity adjustment could thereby provide for the correction of payments imbalances.

5. The equilibrating role which might be played by transactions on capital account received less attention: apart from a structural element net capital flows were usually assumed to be dependent on the difference between domestic and foreign interest rates, but to be independent of the exchange rate because expectations of currency movements, which might otherwise have formed a link, were usually taken as fixed(2). When these assumptions about the balance of payments were appended to the conventional "Keynesian" analysis of the determination of output and interest rates in a closed economy, a framework was provided in which the impact of monetary and fiscal policy on a floating exchange rate could be examined. The main object of the exercise, however, was to examine the relative efficacy of fiscal and monetary stabilisation policies under fixed and floating exchange rate regimes. This, together with the usual adoption of an assumption of fixed domestic production costs, reflected the policy pre-occupations of the time.

6. Consider, for example, the implications of an increase in the domestic money supply. It is assumed that the economy is initially in internal and external equilibrium, but that output is not supply-constrained. The excess supply of money puts downward pressure on interest rates: this has internal and external effects. Internally, interest-sensitive expenditure increases, and output expands towards a new equilibrium where the increased money stock is willingly held, owing partly to higher incomes and partly to lower interest

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(1) The most influential work had been that of Fleming (1962) and Mundell (1963).

(2) It will be seen that this treatment of the capital account contrasts sharply with that associated with the asset-market approach, and that the differences may be considered partly a reflection of differing perceptions about the degree of capital mobility in the international financial system.

rates. Externally, lower domestic interest rates cause the capital account to deteriorate; and there is, in addition, a deterioration in the current account owing to an increase in imports stemming from the rise in income. Without official intervention in the foreign exchange market, this incipient deterioration in the overall balance of payments will cause the exchange rate to fall(3) to the point where the competitiveness of domestic goods and services, and hence the current account balance, are sufficiently improved for overall external balance to be restored in spite of the sustained deterioration on capital account. In the final equilibrium the current account balance must therefore be more favourable than in the initial position; and hence the expansionary effect on output of the increase in the money supply must be greater than if the authorities had intervened to prevent the depreciation.

7. The proposition that the effectiveness of monetary policy is enhanced by exchange rate flexibility, through the associated reponse of the current account, was one of the most significant implications of this analysis(4). From the viewpoint of the issue of exchange rate determination this proposition is less pertinent, and the import of the analysis may be summarised as follows. The exchange rate is viewed as being determined by the equilibration of balance of payments flows, with the responsiveness of the current account to variations in competitiveness providing the crucial mechanism. Domestic monetary expansion is predicted to lead to depreciation of the domestic currency in order to maintain, via the current account, external balance with whatever mix of lower interest rates and higher output is required to restore internal equilibrium.

(2) From flow-equilibrium to asset-market views of exchange rates

8. A number of features of the above analysis became increasingly inadequate in the light of more recent experience. One is the assumption of fixed domestic production costs, invariant in particular to both monetary conditions and the exchange rate. On this assumption, movements in the exchange rate entail equal changes in competitiveness (or the real exchange rate) which lead to the

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(3) Throughout this study, the "exchange rate" refers to the price of domestic in terms of foreign currency, so that a fall means depreciation of the domestic currency.

(4) Another was the converse proposition that the effectiveness of bond-financed fiscal policy is likely to be reduced by exchange rate flexibility. This will be the case if the upward pressure on interest rates which results from, say, a fiscal expansion attracts capital inflows which outweigh any deterioration in the current account, so that the exchange rate rises and net exports consequently fall.

effects described on the current account and output. The "purchasing power parity" (PPP) view of exchange rate determination (considered in Part C.2 below), which holds that exchange rate movements tend to offset changes in relative price levels so that real exchange rates tend to be stable, clearly has no role. This suggests that the analysis is concerned mainly with the short-term determination of exchange rates, and the short-term effects of monetary and fiscal policy in an open economy before prices have had time to adjust.

9. The second problem with the above analysis, however, contradicts this interpretation. This is that it is essentially static and ignores the lags with which output and trade volumes are likely to respond to exogenous disturbances. In reality, exchange rates and interest rates, being determined in "flexprice" markets, will tend to respond quickly to shocks which disturb supply and demand. On the other hand expenditures, income, output and trade (and also goods prices set in "sticky-price" markets) are likely to respond more slowly as plans are changed and contracts re-drawn. These observations carry two important implications:

- The changes in interest rates and exchange rates which may be required in the short run to maintain equilibrium in foreign exchange and other financial markets may exceed the changes required when sufficient time has elapsed for the more sluggish variables in the real economy to adapt and bear the burden of adjustment. This question of "overshooting" will be examined in the Appendix.

- Second, and more fundamentally, delays in the response of trade volumes to exchange rate changes mean that the current account cannot, in the short run, play the equilibrating role in the foreign exchange market described above.

10. Traded manufactured goods are usually invoiced in the currency of the exporter and primary products in dollars(5). Since the prices of the latter, in dollars, respond quickly to changes in that currency's exchange rate, it is a fair generalisation that when the currency of an industrialised country (including the U.S.) depreciates, the domestic-currency prices of its exports will (at least in the short run) remain unchanged, while those of its imports will rise. This deterioration in its terms of trade will cause the current account balance to worsen until export and import volumes have responded sufficiently to offset the unfavourable change in relative prices. The current balance will thus tend

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(5) See Grassman (1973), Carse and Wood (1979), Page (1981).

to follow a "J-curve" path, and may well not show an improvement from its initial position until a year or more has passed(6). This means that the role of equilibrator of the foreign exchange market in the short run must pass to the capital account, otherwise the market would be unstable. The capital account can take on this role if it is assumed that capital flows depend on the exchange rate (as well as the interest differential), which will be the case if they depend on expected exchange rate movements, provided the latter are not unstable. In the example considered above of an increase in the money supply, the implication is that the domestic currency must depreciate in the short run to the point where expectations of its future appreciation are sufficiently optimistic to generate a capital inflow large enough, despite the fall in the domestic interest rate, to offset the current account deterioration(7).

11. Finally, the assumption that capital flows are related to interest rate levels implies that a change in the differential between domestic and foreign interest rates will have a permanent effect on the capital account. This may be considered an apt description of a world where capital is relatively immobile internationally, and where it is mainly new wealth which is being allocated each period among assets denominated in different currencies. For the immediate post-war decade or so, when private capital flows were, to a large extent, discouraged by exchange controls, and international financial markets were relatively undeveloped, such a treatment may have been appropriate. But following the subsequent relaxations of capital controls, and the development of international capital markets encouraged by, in particular, the growth of multi-national corporations and the recycling of OPEC surpluses, it seems more reasonable to regard capital flows as adjustments of the composition of stocks of assets and liabilities, at least for the countries and currencies with which this study is primarily concerned.

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(6) This pattern of behaviour has been a typical empirical finding in large econometric models of major OECD countries.

(7) From the viewpoint of the question of the effectiveness of monetary policy under different exchange rate regimes, the argument of this paragraph raises doubts about the short-term validity of the proposition mentioned earlier, namely that it is greater with exchange rate flexibility. This point was made by Niehans (1975).

On this view, the effect of a change in interest differentials (or exchange rate expectations) will be to revise the preferred currency composition of portfolios(8).

12. The last two arguments - that transactions on capital account bear most of the burden of adjustment towards short-run equilibrium in the foreign exchange market, and that capital flows represent responses to imbalances between actual and desired portfolios - form the basis of the asset-market view of exchange rates which is represented in most of the recent theoretical and empirical work in this area. On this view, while it is acknowledged that exchange rates, in the absence of official intervention, maintain equilibrium between balance of payments flows, the nature of the process is considered to be such that they are better regarded as asset prices, as being determined by the willingness to hold available stocks. The relevant stocks in this case are those of financial assets denominated in different currencies; and the implication is that a freely determined exchange rate will tend in any period towards a value where the stocks of assets denominated in the two currencies concerned are willingly held. This view may provide useful insights because the behaviour of exchange rates typically resembles that of other asset prices in such respects as volatility (in relation to their presumed underlying determinants) and the absence or weakness of correlation between their changes in successive periods(9).

13. This equilibrium condition, common to all versions of the asset market approach, implies a direct influence of the current account through its effect on asset supplies. In the short run the exchange rate is likely to be dominated by factors affecting asset demands - simply because the potential scale of portfolio adjustments may exceed the relatively inert current balance. However, over longer horizons, once factors affecting demands have have time to adjust, the growth of asset supplies (and hence the current account) may dominate the broader swings of the exchange rate. Moreover, the current account itself can be expected to adjust to previous exchange rate movements over the medium-term. Finally, the current account may also play a significant role in the short run if it affects exchange rate expectations. These considerations will be expanded upon below, as the implications of asset market equilibrium are explored.

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(8) McKinnon and Oates (1966), McKinnon (1969), and Branson (1969) were among the first to reject the Mundell-Fleming formulation and assume stock-adjustment responses in the capital account. The assumption that capital flows depend on interest rate levels continued, however, to be used by some writers, e.g. Niehans (1975).

(9) The serial correlation question is examined in Part C.4.

(3) Asset-market equilibrium: a general interpretation

14. The stocks of assets denominated in two currencies will be willingly held if their expected yields give wealth-holders no incentive to switch out of one currency into the other. This will be the case when the expected nominal interest differential in favour of any foreign asset in relation to a comparable domestic asset, net of any risk premium which wealth-holders may require to persuade them to hold the outstanding stock of foreign-currency assets, is equal to the market's expected rate of appreciation of the domestic currency over a time-horizon which matches the term of the interest-bearing assets(10). This is to say that expected yields on domestic and foreign assets, when expressed in terms of a common currency, must be equalised apart from a risk premium. The latter measures the differential preference of wealth-holders for one currency or the other relative to the respective supplies of assets denominated in each, and which reflects the risks of capital gains and losses arising from uncertainty about the future course of the exchange rate(11).

15. This statement about relative asset yields may now be re-interpreted as a condition which the current exchange rate must satisfy in asset-market equilibrium. Since the expected appreciation of the domestic currency is the proportional difference between the expected future exchange rate and its current value, the statement implies that the current exchange rate must be related in a particular way to its expected value, the interest differential, and the risk premium. More specifically, the domestic currency will tend to appreciate from one period to the next if its expected future value increases; if domestic interest rates rise in relation to foreign rates; or if the risk premium on foreign currency rises owing to a change in preferences in favour of the domestic currency or a relative increase in the supply of foreign currency assets. Now the expected future nominal exchange rate may be regarded as comprising an expected future real exchange rate and the expected future relationship between foreign and domestic price levels; and the latter expected price ratio may be further decomposed into the corresponding current price ratio and the difference between expected foreign and domestic inflation rates.

16. This leads to an interpretation of the asset-market equilibrium condition which identifies five components of, or contributors to, exchange rate movements: it indicates that the value of a currency will tend to rise in any period if:

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(10) For convenience of exposition it is assumed that expectations are uniform throughout the market.

(11) The meaning of the risk premium is defined more precisely in Part C.5 and the Appendix.

(i) foreign prices are currently rising faster than domestic prices;

(ii) expectations of domestic interest rates are being revised upwards in relation to expectations of foreign interest rates;

(iii) expectations of domestic inflation are being revised downwards in relation to expectations of foreign inflation;

(iv) expectations of the future real exchange rate are being revised upwards; and

(v) there is an increase in the risk premium on foreign currency.

This decomposition is a general implication of the asset-market approach: it assumes nothing more than the equilibrium condition posited above (12). It retains what may be regarded as the central insight of the asset-market approach, that exchange rates, like the prices of all durable (or financial) assets which are purchased and held with a view to resale, are crucially dependent on expectations, so that changes in them may be very largely a reflection of revisions to expectations resulting from "news" or "surprises"(13). The difficulty of formally describing or modelling the formation of expectations must, to some extent, explain the widespread failure of econometric work in this area which will be referred to below. The inherent unpredictability of new information explains much of the difficulty of forecasting exchange rate changes.

17. The decomposition may also be regarded as helpful in providing a general accounting framework for the analysis of observed exchange rate movements(14). But its use as such is fraught with difficulties, not only because of the general problem of identifying expectations, but also because the component influences will tend to be interrelated. Thus faster domestic growth may raise expectations of domestic inflation (iii), but this effect may be outweighed by expectations that domestic interest rates will be raised as a policy response (ii). Furthermore, any change in relative interest rates which is not matched by a change in the expected movement of the exchange rate must imply a change in the risk premium (v). The latter will also tend to vary with

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(12) The formal definition of the risk premium is such that the assumption of covered parity of interest rates is in fact also required: See Parts C.5 and Appendix.

(13) Evidence that observed exchange rate changes are almost entirely unanticipated is referred to below in Part C.5.

(14) See in particular Isard (1980, 1981).

shocks to the current account, because these affect the rate of accumulation of foreign assets which may, in turn, also bring about revisions to expectations about the real exchange rate (iv). These possibilities illustrate the fact that the general framework provided by the above classification acquires operational significance only when special assumptions are adopted which endow it with more precise structural content.

(4) Exchange rate models and econometric evidence

18. Three models comprising different special assumptions within the asset-market framework may be distinguished(15):

(i) The flexible-price monetary (or "monetarist") model;

(ii) The sticky-price monetary (or "Dornbusch") model;

(iii) The portfolio-balance model with static or stable exchange rate expectations.

These may be regarded as representative of most models which have been applied in econometric work on the determinants of exchange rate movements in the period of floating. The list is in increasing order of generality of the assumptions adopted. Models (i) and (ii) are called "monetary" because money is the only asset whose supply and demand play any role. Other assets denominated in different currencies are assumed to be perfect substitutes in demand: there are assumed to be no risk premia or portfolio preferences, and expected returns are always equalised irrespective of asset supplies.

19. Model (i) also assumes that PPP rules: the real exchange rate is constant and expected to remain so. This, together with the assumption of no risk premium, carries the further implication that the differential between domestic and foreign interest rates is given by the difference between expected rates of inflation. Model (i) thus eliminates influences (ii)-(v) of the above framework and concentrates on the influence of relative price levels via PPP. The model assumes finally that prices are sufficiently flexible to hold the supply and demand for money in equilibrium. The relationship between the supplies of domestic and foreign money, relative to the demands for them, therefore determines the exchange rate.

20. Model (ii) resembles model (i) in its description of how exchange rates are determined in the long run. But its predictions about short-run behaviour are significantly different because of its assumption that prices are sticky, responding only gradually to excess demand and supply in the

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(15) These models and econometric results are summarized in the Appendix.

goods market. It is interest rates which maintain money-market equilibrium in the short-run. The differential between domestic and foreign interest rates may in the short run deviate from the differential between expected inflation rates; and such deviations are mirrored in expected and actual movements in the real exchange rate. Models (i) and (ii) thus carry starkly contrasting predictions about the influence of interest rates and interest differentials on exchange rates. Given the supply of money, the flexible-price model predicts that a relative increase in domestic interest rates will be associated with a depreciation of the domestic currency on the grounds that it signifies a relative increase in expected domestic inflation and implies a relative contraction in the demand for money(16). The sticky-price version predicts the opposite, on the grounds that an increase in domestic interest rates (which arises from an excess demand for money) must be offset, for equilibrium in international capital markets, by a lower expected rate of appreciation, which will be brought about by a rise in the current exchange rate in relation to its long-run equilibrium. Because both models assume no risk premium, the interest differential in favour of domestic assets is in both cases always matched by expected depreciation. But whereas in model (i) the latter is given by the difference between expected inflation rates at home and abroad (because PPP is assumed), in model (ii) it depends on the gap between the current exchange rate and its long-run equilibrium. A further characteristic of model (ii), which is particularly well-known, is that when responding to monetary disturbances, the exchange rate will in the short run "overshoot" its new long-run equilibrium.

21. Model (iii) differs from (i) and (ii) in assuming that assets other than moneys denominated in different currencies are imperfect substitutes. Thus a role in exchange rate determination is attributed to changes in non-monetary asset supplies such as those arising from bond-financed fiscal deficits, sterilised intervention in the foreign exchange market, and current account imbalances. Changes in portfolio preferences also have a potential role, although this has been neglected in most econometric applications. Drastically simplifying assumptions have also usually been adopted about exchange rate expectations: in fact the assumption most commonly adopted is the static one that the exchange rate is not expected to change. Recent work in which this assumption has been modified will be referred to below.

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(16) The interest rate elasticity of the supply of money may outweigh this effect so that in a larger simultaneous model the exchange rate may appreciate.

22. The monetary models have been more widely estimated than the portfolio balance model, partly because of the ready availability of the required data (for money stocks, real incomes, and interest rates), and partly because of the apparent success with which model (i), in particular, was applied in early investigations. The portfolio balance model, which is more general but which correspondingly carries less straightforward prior implications for the parameters to be estimated, and whose requirements are more problematical because of the paucity of data for asset stocks in the form needed, has been less commonly applied.

23. The Appendix describes how, following initial results for all three models which seemed favourable, all three broke down under later scrutiny - in particular when they were confronted with the task of explaining important exchange rate developments after 1976. Most prominently, they failed to explain the depreciation of the U.S.$ in 1977-78. More recent research has failed to resurrect them. Tables 1 and 2 of the Appendix, which summarise the econometric results, tell similar stories of unfulfilled promise. It would be an overstatement to say that the models described have been shown to be devoid of any empirical explanatory power: some studies of the monetary models have shown certain exchange rate movements to have been closely related to relative movements in money stocks and interest rates, while some estimates of the portfolio balance model have appeared to confirm the influence of current account developments. But such relationships have been shown to be unreliable - in the case of relative interest rates even the direction of their influence has been shown to be uncertain - and there have been important developments which none of the above models have succeeded in explaining.

24. There are a number of possible explanations for the empirical failure of these asset-market models. The possibility which has received most attention in recent research is that the role played in the determination of exchange rates by expectations is inadequately accounted for in all the econometric work which has been referred to. This may be considered a deficiency stemming from the failure of theoretical models to convey what are the clear implications of the asset-market approach set out in the general framework of Part B.3. There have, in particular, been a number of attempts to take fuller account of the role of changes in expectations about real exchange rates - item (iv) of that framework - and of the way in which such changes may occur in response to fresh information or "news" about the current account. This recent work has been partly a response to the observation that certain notable exchange rate movements have been closely associated with current account developments in a way which cannot be explained by the portfolio balance model considered earlier. This applies most notably to the problematical case of the weakness of the U.S. dollar through 1977-78 and its subsequent recovery.

25. Encouraging econometric results have been obtained along these lines (for example, Hooper and Morton (1982)), and are discussed in the Appendix. They suggest that the behaviour of exchange rates in the last decade can be understood only in terms of an approach which is more general than the models described earlier and which, in particular, takes seriously the question of how expectations are formed about inflation and real exchange rates, and which does not neglect the current account - a factor which the earlier flow approach had of course emphasised. These new results have, however, been put in some perspective by Meese and Rogoff (1981), who re-estimated the new model constructed by Hooper and Morton, together with the flexible-price and sticky-price monetary models for four dollar exchange rates (against the Deutschemark, sterling, yen, and a trade-weighted average index) over two periods, March 1973-November 1976 and March 1973-November 1978, and examined their subsequent out-of-sample forecasting performance, using actual data for the explanatory variables. They found that although the Hooper-Morton model out-performed the forecasts of the other two structural models over the longer forecast period - the sticky-price monetary model did better over the shorter period - the forecasts of each of the structural models were consistently less accurate than those provided by a random walk model, i.e. a model which simply takes the current exchange rate to be the best predictor of its future value.

26. Meese and Rogoff interpret the apparent failure of what may be regarded as the current "best-practice" economic models to provide exchange rate forecasts superior to - or even as good as - the simplest univariate time-series model as evidence of serious instability in the economic structure. They mention, in particular, the two oil shocks, changes in policy rules, and technological change. Such instabilities may obviously be important; but a greater part of the explanation may still well lie in the problem of expectations. The econometric models may well have failed to identify the determinants of exchange rate expectations, and to distinguish between anticipated and unanticipated movements of the explanatory variables. This may also be true of the Hooper-Morton model, even though it does attempt more seriously to address the issue.

C. Major Sources of Exchange Rate Pressure

(1) Relative price levels, real exchange rates and purchasing power parity.

27. There are essentially two ways in which exchange rates may be affected by relative price developments in domestic and foreign economies. First, an autonomous increase in domestic costs and prices which is not accommodated by monetary policy may cause the domestic currency to appreciate because it will tend to tighten domestic monetary conditions and put upward pressure on interest rates while expectations of future

inflation may be unaffected and even reduced. Thus some have suggested that increases in indirect taxes and wages in the U.K. in 1979, while the declared stance of monetary policy was being tightened, contributed to the appreciation of sterling. But this is essentially a short-term phenomenon.

28. Over longer periods, and when price movements are accommodated by monetary policy, inflation in one economy in relation to the rest of the world may be expected to cause a compensating depreciation, for competitiveness to be maintained at a level consistent with a sustainable current balance and an acceptable rate of domestic economic activity. The remainder of this section is essentially concerned to examine the basis and empirical validity of the theory or "Law" of Purchasing Power Parity (PPP), which is usually interpreted as stating that competition in trade will tend to ensure that movements in exchange rates will be such as to compensate for differences in national inflation rates. The relative price competitiveness of any country's goods - or international differences in the price of any bundle of goods when expressed in a common currency - will then be constant: in other words exchange rates will be constant in real terms(17).

29. There are a number of reasons why the rigid formulation of PPP may fail to hold, both in the short run and over longer periods. Some have already been referred to in the discussion of the asset-market approach. The movements of exchange rates over short periods are unlikely to be dictated by current trade flows or the balancing of the current account; and furthermore, the consequences for the current balance of substitution in response to relative price disparities are unlikely to materialise without long lags. More fundamentally, exchange rates and goods prices are determined in different kinds of markets. The prices of most goods and services, apart from primary commodities, are determined in "sticky-price" markets where demand usually exerts a weaker influence in the short run and expectations play a much smaller role than in "flexprice" foreign exchange markets.

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(17) It was seen in Part B.4 that this proposition is a distinctive component of the monetary model of the exchange rate. There are other interpretations of PPP in the literature, of which one may be noted. This is the weaker proposition that real exchange rates are in the long run invariant to changes in money supplies, or that in the long run "the money supply affects the price of foreign exchange in the same way as other prices" (Niehans, 1980, p.256). Recall that this holds in the Dornbusch model of Part B.4, as well as in the monetary model, but is not usually imposed in this form in the portfolio balance model.

This implies first, that even if real exchange rates tend not to change in the long run in response to some kinds of disturbance, they will change in the short run simply because exchange rates respond faster than prices. A second implication is that since changes in expectations will tend to affect exchange rates but not prices, "...in periods which are dominated by 'news' which alters expectations, exchange rates are likely to be more volatile, and departures from purchasing power parity are likely to be the rule rather than the exception" (Frenkel, 1981a, p.667).

30. Even over longer periods, when current account considerations may indeed dominate, there are a number of reasons why PPP may not hold in a rigid sense. It was already noted in the main text on policy issues that real exchange rates are difficult to define. There may be significant swings or trends in the relative non-price advantages offered by different countries' traded goods; there may be changes in administered trade barriers; and observed changes in real exchange rates will depend upon the price indices used, and problems such as productivity bias may be important(18). Another obstacle to PPP in the long run is that the restoration of current account balance following any disturbance to it is unlikely to require the exact restoration of the original real exchange rate, because the change in net investment income arising from the intervening current account imbalances will imply a different long-run imbalance on the trade account(19). This third objection (Isard 1978) is the single argument which has been raised against the proposition that real exchange rates will tend to remain constant in the long run in the wake of purely monetary disturbances.

31. Three kinds of evidence may be referred to. First, a number of studies of the "Law of One Price" - the micro analogue of PPP - have shown significant and persistent disparities between countries in the common-currency prices of individual goods other than primary commodities. For example, Isard (1977, p.942), in a study of U.S., German, Canadian, and Japanese industrial prices, found that "exchange rate changes substantially alter the relative dollar-equivalent prices of the most narrowly defined domestic and foreign manufactured goods for which prices can readily be matched. Moreover, these relative price effects seem to persist for at least several years and cannot be shrugged off as transitory." A number of studies by Kravis and Lipsey (e.g. 1978) have also cast serious doubt on the validity of any assumption that competition in trade is such that PPP will be maintained.

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(18) The "productivity bias" problem is associated with Balassa (1964).

(19) See the discussion of the portfolio balance model in the Appendix.

Secondly, there have been a number of econometric studies of PPP. The results, summarised in the Appendix, are mixed, finding support for the proposition in data for the hyper-inflations of the 1920s but persistent deviations from PPP in the 1970s. The third set of evidence is provided by the data on real exchange rates and relative unit labour costs shown in Chart 1.

32. This, it will be recalled, shows the quarterly movements of the real effective exchange rate and relative unit labour costs for the 11 countries covered in the survey over the period 1973-1982(20). A number of features stand out. Firstly, there have been significant short-run divergences from PPP in all countries, reflected in year to year fluctuations of the real exchange rate. Secondly, the secular trends in these variables suggest mixed evidence on any long-run tendency towards PPP.

- In France and Italy there has been a secular deterioration in relative unit labour costs, and the nominal exchange rate has by and large depreciated to maintain the real rate constant, as would be predicted by PPP. In Germany, Japan and Switzerland the secular decline in relative unit labour costs has largely been offset by appreciations of their respective nominal exchange rates. In Switzerland and Japan there have, nevertheless, been some very large year to year swings in the real exchange rate.

- In the United Kingdom PPP held reasonably well until 1978, but subsequently the real appreciation of sterling has been particularly marked.

- In the United States relative unit labour costs and the real exchange rate declined around 1975, while in Canada they increased. Subsequently, there have been no secular movements in either country. In Canada a sustained period of depreciation from 1976 to 1978 has led to a prolonged departure from PPP. In the United States the depreciation of 1978 actually exacerbated the earlier divergence from PPP. However, it is of some interest to note that the marked appreciation of the dollar during the 1980s has almost exactly restored the real exchange rate to its 1973 level.

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(20) Domestic unit labour costs relative to a trade weighted average of foreign unit labour costs.

CHART 1

REAL EXCHANGE RATES AND RELATIVE UNIT LABOUR COSTS

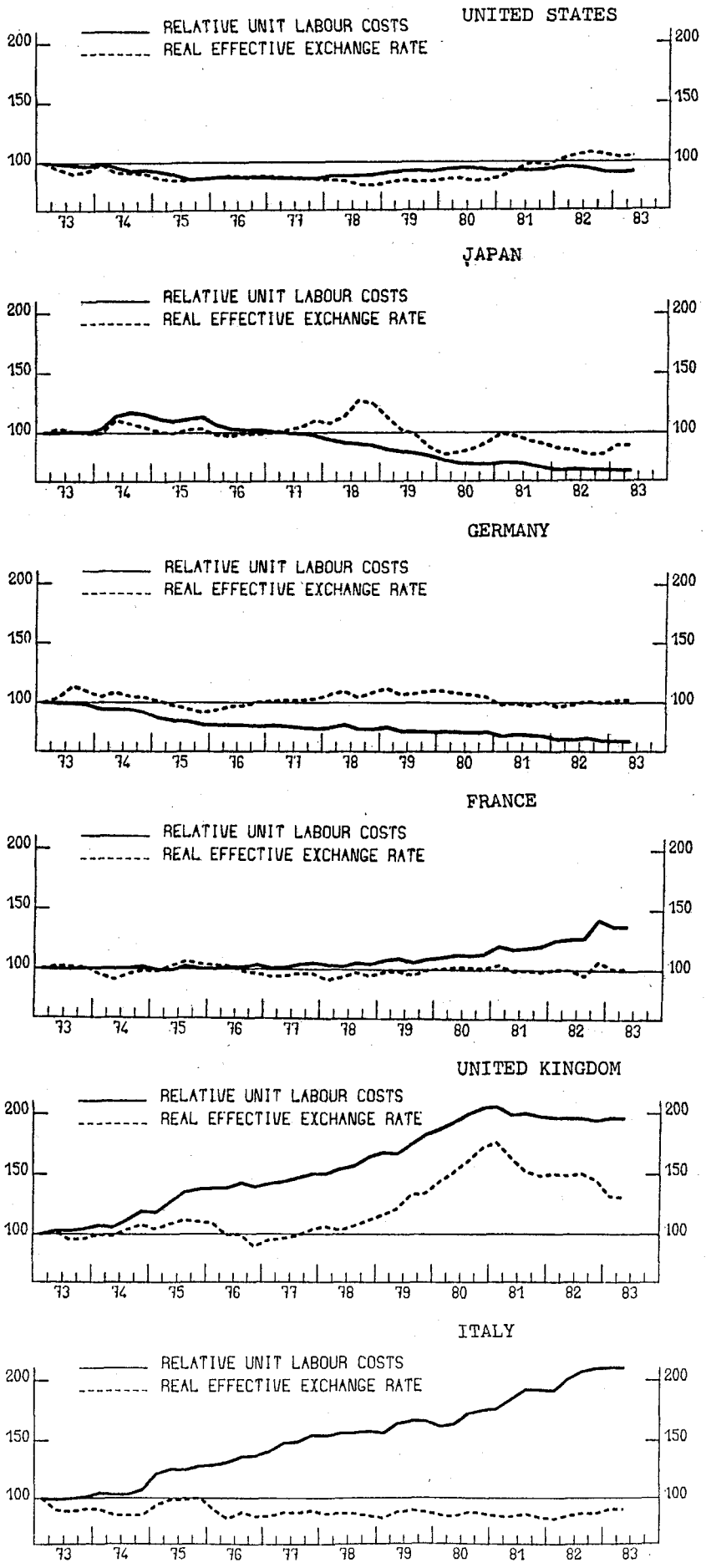
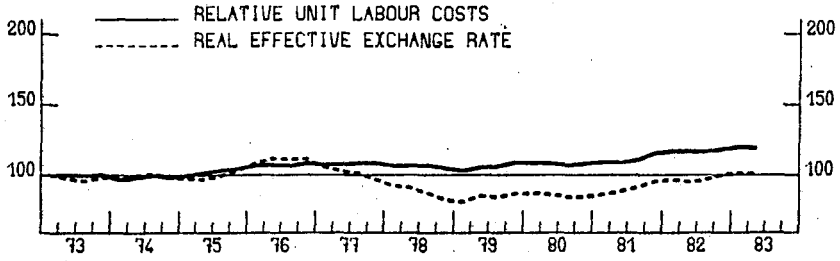
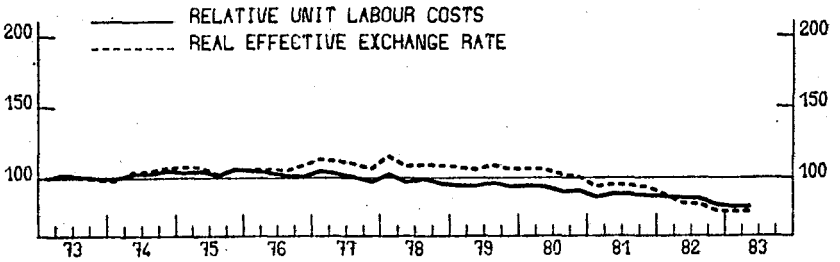


Chart 1 continued

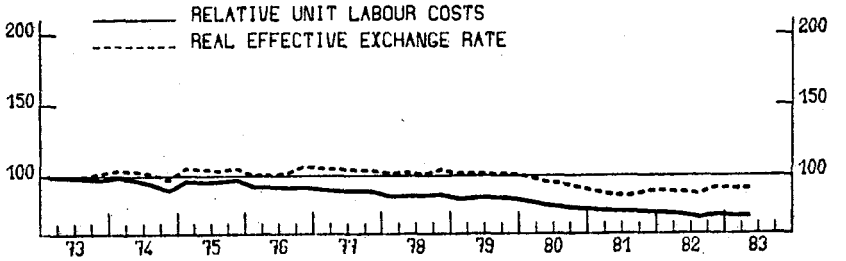
CANADA



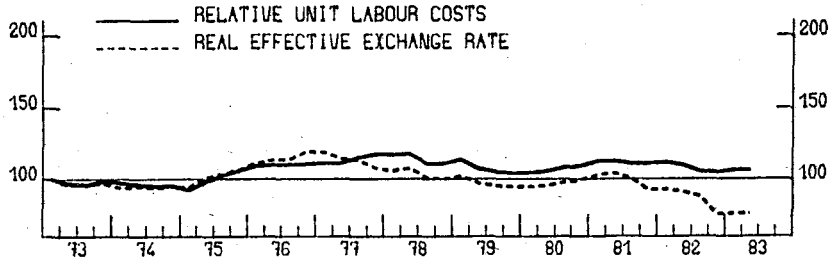
BELGIUM



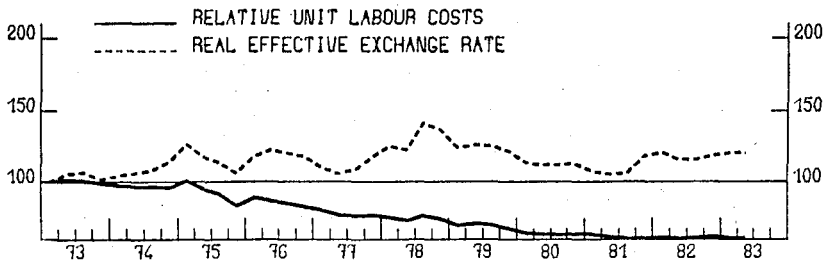
NETHERLANDS



SWEDEN



SWITZERLAND



Note: The real effective exchange rates shown in this Chart are calculated as the nominal effective rates deflated by relative unit labour costs for the countries covered by the survey. Relative unit labour costs are also presented in the chart. The difference between the two series then reflects the movement of the nominal effective exchange rate.

Source: OECD Secretariat.

- Amongst the smaller economies relative unit labour costs have declined in Belgium and the Netherlands for most of the period. Until the end of the 1970s, consistent with PPP, their real exchange rates remained fairly constant. Subsequently, however, fixed nominal exchange rates and/or their depreciation, has led to a declining real exchange rate in both countries. In Sweden the real exchange rate has by and large followed relative unit labour costs and, if anything, movements in the nominal rate have acted to exacerbate divergences from PPP.

33. To summarize, since PPP hypothesizes a relationship between two variables which are endogenous it cannot even in principle provide a complete understanding of exchange rate determination. It has been used, rather, as a component of some exchange rate theories - most notably the monetary model. There are good reasons why PPP should not be expected to hold in the short run; and all the evidence is that it does not. PPP is more likely to be valid over longer periods, but real exchange rates are still unlikely to be stable in the presence of such disturbances as changes in trade barriers and structural changes in the real economy. There is evidence that there was a tendency towards PPP in the 1920s,possibly owing in part to the dominance of monetary disturbances. The current period of floating has exhibited mixed evidence on PPP as a long-run tendency. There have been large and persistent swings in the real exchange rate, which indicate that PPP is an unreliable "law". In looser terms, however, there may be real competitive forces which assert themselves in determining relative prices across national borders over longer periods. Moreover, the insight that real exchange rates will be largely independent of nominal magnitudes in the long run may have some implications for the conduct of monetary policy.

(2) Relative interest rates

34. It has already been indicated that there is a crucial distinction to be drawn between changes in relative (nominal) interest rates which directly represent changes in the relative yields on assets denominated in different currencies, and changes which merely reflect and offset changes in expectations about future exchange rate movements. In the former case, domestic interest rates may rise with a tightening of domestic monetary policy, and the exchange rate may be expected to appreciate owing simply to the increased attractiveness of domestic currency assets. Secondary supporting effects may also flow from expectations of slower domestic inflation (owing to slower prospective monetary growth) or an improved current account (due to lower domestic activity)(21). In the latter case, however, domestic interest rates may be pushed upwards by higher inflation expectations (perhaps on account of faster monetary growth), and since

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(21) A lower expected rate of return on real assets on account of lower activity levels may provide an offset.

these should be associated with correspondingly more pessimistic exchange rate expectations, there is no direct inference to be drawn about the relative attractivenes of domestic and foreign assets. The domestic demand for money may, however, be reduced; and this could cause the exchange rate to fall, not rise. The former positive direction of association between movements in the interest differential in favour of the domestic currency and the exchange rate may be expected to apply in the short run, and where interest rates are dominated by domestically-oriented monetary policy; the latter negative association may be expected to be more prevalent over longer periods, and where interest rates are determined primarily by the external policy objective of exchange rate stability.

35. Econometric evidence summarized in the Appendix shows that both correlations have been in evidence, and that the positive association - which is the more pertinent to many policy considerations - has been difficult to disentangle and quantify. In fact it is fair to say that the negative association has been more in evidence in econometric results, particularly (as would be expected) when long-term interest rates have been used. But this may well be because inflation or exchange rate expectations have not been separately identified in an adequate way, or because the simultaneous dependence of domestic interest rate policy on exchange rate pressure has not been adequately taken into account.

(3) Money supplies

36. It is a unanimous prediction of all exchange rate theories that relative expansion of the domestic money supply will cause the domestic currency to depreciate; only transmission mechanisms differ. On some views the link is provided by the response of prices and then PPP. Other views would emphasise the mechanism provided by the response of interest rates, as described in Part C.3. A third possible link is provided by the response of price expectations to monetary shocks, or of inflation expectations to monetary shocks, or of inflation expectations to changes in monetary growth. It is of course possible to combine all three linkages; and the Dornbusch model does so in a particularly vivid way (see Appendix), obtaining the prediction of overshooting; i.e. that on account of the stickiness of goods prices, the response of exchange rates to monetary shocks will be greater in the short run than in the long run.

37. In contrast with the unanimity of theory, the econometric evidence of money supply effects on exchange rates is mixed, problematical, and inconclusive, as is shown in the Appendix. One problem which may be worth mentioning here is the simultaneous dependence of the external counterpart of monetary expansion on the exchange rate itself. If there is official intervention in the foreign exchange market seeking to stabilise the exchange rate, then the external counterpart will tend on this account to be positively correlated with the

value of the domestic currency. If this intervention is not then sterilised, any negative impact of monetary expansion on the exchange rate may be difficult to discern. The same simultaneity problem has also hampered all attempts to quantify the exchange rate effects of intervention.

38. This simultaneity problem stands out from country experiences. For example, exchange rates have often weakened during periods of excessively permissive monetary growth. This was the case in the United Kingdom, Italy and France on a number of occasions during the 1970s. Loose monetary policy was also associated with the weakness of the Canadian dollar from 1976 to 1978, as it was with the U.S. dollar in 1978. However, there have also been periods when the attempt to stabilize a previously strong currency has led to faster than desired monetary growth. This was the case, for instance, in Germany and Japan in 1973 and in Germany and Switzerland during 1978.

(4) Portfolio preferences and asset supplies

39. Any difference there may be between the interest differential in favour of foreign currency and the expected rate of appreciation of the domestic currency was referred to in Part B.3 as the risk premium on foreign currency. It is the premium required by wealth-holders for assets in both currencies to be willingly held, given the supplies of assets denominated in the two currencies and the preferences of wealth-holders. In Part B.4 models were described where the risk premium was assumed to be zero - where assets were assumed to be perfect substitutes - so that preferences and the supplies of interest-bearing assets play no role. But a portfolio balance model was also discussed where a risk premium was assumed to exist, and where the effects of changes in asset supplies - arising from current account imbalances, bond-financed fiscal deficits, and sterilised intervention - can be traced. The mixed econometric success of this approach was also referred to.

40. This section is concerned mainly with an examination of further evidence on the issue of the risk premium: are assets denominated in different currencies perfect substitutes, or, owing to exchange rate uncertainty, do risk premia exist which may provide a role in exchange rate determination for asset supplies and portfolio preferences? The potential influences of asset supplies have already been alluded to. Two examples of the potential influence of portfolio preferences are worth mentioning. First, Dornbusch (1980) has argued that the real appreciation of the DM in relation to the dollar in the 1970s may have been partly the result of portfolio diversification by dollar holders as they became increasingly aware, while gaining experience of floating exchange rates, of the different characteristics of the returns on assets denominated in different currencies. Secondly, Hacche and Townend (1981b), on the basis of some evidence that the currency preferences of OPEC countries differ from those of industrial

and non-oil LDCs, have drawn attention to the possible implications for currency values of the large shifts in wealth entailed in OPEC current account surpluses. The problem with the empirical verification of such arguments, of course, is that neither expected yields nor preferences are directly observable: actual yields and currency shares in portfolios are measurable (the latter with some difficulty), but are not necessarily any indication of expected or preferred values.

41. For similar reasons - more specifically, because the expected exchange rate and its expected movements are not directly observable - tests of the existence of a risk premium require assumptions to be made about how expectations are formed. As a result, they become tests of a joint hypothesis concerning both the characteristics of equilibrium expected returns (the risk premium question), and the nature of the expectations formation process. Most of these have in fact been joint tests of the existence of a risk premium and the efficiency of the foreign exchange market.

42. An asset market is said to be efficient if the prices formed in it fully reflect available information, so that systematic profit opportunities are unavailable to investors. An implication of efficiency in the foreign exchange market is that since covered interest arbitrage is necessarily free of exchange risk, covered returns on assets denominated in different currencies will be equalised, apart from a margin of indeterminacy dependent on transactions costs, unless there are exchange controls or non-exchange ("political") risks. Aside from these qualifications, the nominal or uncovered interest differential in favour of foreign currency assets should be matched by the forward premium on domestic currency, or the proportional difference between the forward and spot exchange rates. The covered interest differential will then be zero: domestic and foreign interest rates will be in covered parity. The empirical evidence, summarised in the Appendix, overwhelmingly supports the view that efficiency in this sense holds in international capital markets. With covered parity holding, a rather more convenient definition for the risk premium suggests itself: it may be regarded as the difference between the forward premium on domestic currency and its expected rate of appreciation which, in logarithmic terms, is simply the difference between the forward exchange rate and the expected future spot rate(22).

43. A second implication of efficiency relates to speculative rather than covered arbitrage activity. This is that in an efficient foreign exchange market forecasting errors should be serially uncorrelated, or "white noise". Otherwise, if successive differences between the actual spot rate and its previously expected value were serially correlated, then investors would be forming their forecasts irrationally and there would be information in the time-series

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(22) See Appendix.

of the exchange rate which could be exploited for profit(23). Now speculative efficiency and the absence of a risk premium together form a joint hypothesis which is testable against the data: if there is no risk premium, the forward rate measures the expected future spot rate, so that efficiency then implies that successive differences between the logarithmic values of the actual spot rate and its corresponding previous forward value should be serially uncorrelated(24). In other words, the forward rate should be an unbiased predictor of the future spot rate. If there is a risk premium, however, this implication does not follow from the efficiency hypothesis, since the risk premium may well, in particular, be serially correlated.

44. It is therefore clear that the numerous studies which have been made of the forecasting performance of the forward rate form tests of the joint hypothesis that the exchange market is efficient and that there is no risk premium. Most writers have in fact, however, preferred to relate their results to one hypothesis or the other. The results are mixed and ambiguous; but they seem to be tending towards rejection of the joint hypothesis and hence on one interpretation, towards acknowledgement of the existence of risk premia(25).

45. It is worth referring finally to an implication of exchange rate data, following from the hypothesis that currencies are perfect substitutes, which has been noted by many writers. This is that expected exchange rate changes, which on the hypothesis of no risk premium are measured by

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(23) It may be noted that speculative efficiency and rationality of expectations are almost synonymous: in the absence of transactions costs, rational expectations imply speculative efficiency.

(24) There is no implication, it should be noted, that successive differences between the current and previous logarithmic values of the spot rate itself should be serially uncorrelated. The frequently reported finding that the rate of change of the exchange rate is white noise - or that the exchange rate follows a random walk e.g. Mussa (1979), Frenkel (1981) - strictly speaking carries no efficiency implications. Even with efficiency and no risk premium the rate of change of the exchange rate may be serially correlated if interest differentials are serially correlated.

(25) The efficiency of the foreign exchange market has also been tested by examination of the profitability of trading strategies based on the mechanical application of simple rules of thumb. The results usually suggest ex post that there were strategies which would have been profitable; but their implications for efficiency are again ambiguous.

forward premia or interest rate differentials, invariably account for a minor proportion of subsequent actual changes. In other words, the greater proportion of exchange rate movements are unexpected, representing responses to unforeseen shocks. Mussa (1979) suggests the "general empirical regularity" that "over 90 per cent of month-to-month or quarter-to-quarter changes in exchange rates are attributable to unexpected exchange rate changes". Hacche and Townend (1981b), in their study of quarterly movements in eight effective exchange rates between 1972 and 1980 calculated that this proportion, on average, ranged from 48 per cent in the case of the dollar to 177 per cent for the DM. Dooley and Isard (1979) arrived at similar conclusions for the DM-dollar rate over the period 1973-78, after attempting to take account of variations in the risk premium.

(5) Current account developments

46. Even in the asset-market approach, current account developments can affect exchange rates through a number of mechanisms. First, current account imbalances may impact on domestic demands for goods and assets by affecting domestic income and wealth. Second, a deficit in a country's current account implies a shift in private sector wealth from domestic to overseas residents; and since the desired proportion of domestic currency assets in portfolios is likely to be larger for domestic than for foreign residents, this is likely to cause a depreciation of the domestic currency. Third, the value of a currency may be affected by the current account imbalances of other countries between which wealth is thereby being redistributed if agents have different preferences for the currency concerned. Fourth, shifts in current accounts may be interpreted as signifying the need for changes in real exchange rates, if market participants expect the latter to move in a way which prevents indefinite transfers of wealth through current account imbalances.

47. Hooper and Morton have made the most serious attempt thus far to provide an econometric model which explicitly identifies a role for the current account through:

- unanticipated developments affecting expectations of the real exchange rate; and

- the cumulated current account plus intervention affecting asset supplies and the exchange rate through the risk premium.

In none of the equations did the risk premium coefficients have either the expected sign or a value significantly different from zero. However, in their preferred results (which excluded the risk premium variable) they found that a $1 billion increase in the cumulative U.S. current account (proxying an increase in the stock of net foreign currency assets) would lead to a 0.4 per cent appreciation of the weighted average dollar rate, via the expectations mechanism.

Dornbusch (1980) adopted a different approach, by assuming that contemporary forecasts published by the OECD were representative of market expectations, so that deviations of the outturn from them could be used to measure unanticipated current account "shocks". He found that these deviations contributed significantly to an explanation of movements in the dollar effective rate and the $-yen rate, but not to the $-DM rate, between 1973 and 1979.

D. Summary

48. The points which stand out would seem to include the following:

(a) There are strong links from monetary policy to exchange rates in any theoretical framework. The main transmission mechanisms were seen to be:

(i) interest rate differentials;

(ii) relative prices and inflation expectations;

(iii) domestic demand and the current account.

(b) It was also noted that there are strong theoretical arguments that exchange rates may overshoot in response to monetary policy. Expansionary monetary policy will tend to improve competitiveness in the short run (and vice versa) but not necessarily the current account.

(c) The empirical evidence on PPP indicates that changes in nominal exchange rates are associated with relatively long-lived changes in real exchange rates, and that there are large variations in the latter, even over periods of a number of years, which have to be explained.

(d) There are important theoretical reasons (but less evidence) which suggest that shifts in portfolio preferences, and shifts in wealth between countries with different preferences, may play a role in affecting exchange rates.

(e) Econometric work has been hampered by the problem of non-observable variables, such as exchange rate expectations, risk premia and the like. More successful results may have to await accumulation of sufficient data for a long enough period to be examined for expectations to "wash out".

(f) The importance (at least in the short term) of expectations implies that the stability of exchange rates (if an objective) may also require the stability of expectations. This may have particular relevance for the way in which monetary policy is conducted with respect to domestic and external objectives.

APPENDIX

TECHNICAL ASPECTS OF MODELS AND ECONOMETRIC EVIDENCE

(a) The Asset-Market Approach: Three Special Cases

1. At least until relatively recently, most econometric work on the determinants of exchange rate movements in the period of floating has been based on one or other of three theoretical models. These may be regarded as representative of an extensive and rather more diverse literature. They are summarised here in increasing order of generality.

(i) The flexible-price monetary model

2. In what is also sometimes referred to simply as the 'monetary' or 'monetarist' model, three radically simplifying assumptions are adopted(1). First, there is assumed to be no risk premium. This requires either that wealth-holders are indifferent to exchange risk or, if they are risk averse, that exchange risks faced by creditors and debtors are usually offsetting and diversified away. Then, irrespective of relative asset supplies, the interest differential between foreign and domestic assets always equals the expected rate of appreciation of the domestic currency: uncovered interest parity holds. Comparable interest-bearing assets denominated in different currencies are thus perfect substitutes, and both portfolio preferences and such influences on the supplies of interest-bearing assets as bond-financed fiscal policy, sterilised intervention in the foreign exchange market, and current account imbalances lose an influence they might otherwise exert. The fifth of the components listed in B.3 is therefore eliminated. Three of the four components remaining are then eliminated by the second assumption that purchasing power parity (PPP) holds and is expected to continue to do so. This means that the real exchange rate is expected to remain unchanged - so that component (iv) of the sources of exchange rate variation is eliminated - and this in turn implies that the interest differential between foreign and domestic assets must equal the difference between expected foreign and domestic inflation rates, so that components (ii) and (iii) eliminate each other. What then remains is the PPP condition that the exchange rate, apart from a constant, is equal to the ratio of foreign to domestic price levels. The third assumption is that prices are flexible, sufficiently so as to ensure the maintenance of money-market equilibrium. The ratio between foreign and domestic price levels, and hence the exchange rate, may then be expressed in terms of foreign and domestic money supplies and the variables (other than prices) and parameters which enter the respective demand functions for

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(1) See, for example Frenkel (1976), Bilson (1978, 1979).

foreign and domestic money. Interest rates then reappear as determinants of the exchange rate; but the direction of their influence is different, as will be seen.

3. In this model, any money-market disequilibrium is eliminated by an adjustment of demand in response to a movement in prices. The other determinants of the demand for money are determined outside the model - real income implicitly by the productive technology, and interest rates by inflation expectations(2). Any such movement in prices then requires a compensating movement in the exchange rate for the real exchange rate to be held constant and PPP to be maintained. For given values of the foreign variables, the exchange rate is therefore in effect the variable which 'clears' the domestic money market via the domestic price level: this may be seen as the analogue for a small open economy of the closed-economy quantity theory of money.

4. If, then, starting from equilibrium there is an increase in the domestic money supply, this model implies, assuming that the price-elasticity of demand for money is unity, that the price level must rise and the exchange rate depreciate in the same proportion. If there is an increase in domestic interest rates, the domestic currency must again depreciate, because higher interest rates imply a lower demand for, and an excess supply of money: for equilibrium to be restored, prices must rise, and this requires the exchange rate to fall. This Unequivocal implication that the value of the domestic currency will be negatively associated with the interest differential in its favour is a distinctive feature of the monetary model. Its sense is clear when it is recalled that changes in interest rates in this model do not represent changes in relative yields: by the assumption of no risk premia, yields are always equalised, and changes in the interest differential occur in order to offset changes in inflation and exchange rate expectations which would otherwise give rise to disparities in expected yields. Interest rates then affect exchange rates only indirectly, via the demand for money. Finally, an increase in domestic real income (perhaps owing to a resource discovery or a more favourable current account balance) should cause the exchange rate to appreciate through an increase in the demand for money.

5. The implications for the exchange rate of changes in the corresponding foreign variables follow in the same way from the assumed maintenance of equilibrium in the foreign money market by the foreign price level. In sum, exchange rates in the flexible-price monetary model are determined by domestic

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(2) It is perhaps surprising that inflation expectations, which are assumed to be represented by interest rates, are not assumed to be dependent on money supplies. This is, nevertheless, the case in most empirical applications of this model.

and foreign monetary conditions: factors which do not affect the supply or demand for money at home or abroad do not affect the external value of the domestic currency.

(ii) The sticky-price monetary model

6. The second set of special assumptions to be considered is based on the model developed by Dornbusch (1976), by whose name it is sometimes known; it has subsequently been extended by many authors(3). It shares with the first model the assumption of no risk premium (or perfect asset substitutability) but it does not assume for the short run either than prices are sufficiently flexible to maintain money-market equilibrium or that the exchange rate is tethered by PPP.

7. The domestic interest rate takes on the role of equilibrator of the domestic money market; and the exchange rate maintains equilibrium in the currency market by always moving instantaneously to the point at which, for given expectations of its future level, the uncovered interest parity condition is satisfied. With prices given in the short run, the exchange rate determined in this way in turn determines competiveness; and competiveness, together with the interest rate which clears the money market, helps to determine the demand for domestically produced goods. In the version of the model which assumed fixed output, domestic prices then respond to the excess demand or supply of goods; and this movement in prices feeds back to competitiveness, and also to the interest rate via the demand for money. The economy thus moves towards a long-run equilibrium where the supply and demand for goods are in balance and the real exchange rate is not expected to change. The latter condition means that, in the long run, the domestic interest rate is fixed by the foreign rate and the differential between domestic and foreign inflation rates: as in the previous model, the domestic price level must then be the variable which ensures equilibrium in the money market. The former condition determines the long-run equilibrium real exchange rate as that which, at the given rate of interest, generates a demand for goods equal to supply. This real exchange rate, which will clear the goods market in the long run, provides the anchor for expectatins at each point in time: exchange rate expectations are thus assumed to be "rational" or consistent with the model.

8. With this new set of assumptions, a once-for-all increase in the domestic money supply will, in the long run, have consequences similar to those predicted by the flexible-price model: domestic prices will be proportionately higher, because this is the only way the demand for money can expand to match the new supply, and the exchange rate must be proportionately lower so that the real exchange rate is restored to the level at which net exports are consistent with

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(3) E.g. Buiter and Miller (1981), Eastwood and Venables (1980).

goods-market equilibrium. The short-run implications, however, are significantly different. Expectations of the long-run price level and exchange rate immediately adjust to their actual future values; but because prices are sticky, the domestic interest rate has to fall for the larger money stock to be willingly held. For the foreign exchange market to be held in equilibrium, the expected rate of appreciation of the domestic currency therefore has to rise; hence the exchange rate has to fall by more than its expected future (and long-run equilibrium) level. This is the well-known result that with sticky prices the exchange rate will need to overshoot its lower long-run equilibrium for asset-market equilibrium to be continuously maintained in the wake of a monetary expansion.

9. Although the instantaneous responses of the interest rate and exchange rate hold the money market and foreign exchange markets in balance, they disturb equilibrium in the goods market by raising aggregate demand through a reduction in the cost of finance and an improvement in competitiveness. It is this excess demand which sets off the rise in the price level towards its new long-run equilibrium. As the inflation proceeds, the transactions demand for money expands, putting upward pressure on the interest rate which thus begins to return to its original level; and as the interest rate increases, the exchange rate rises towards its long-run equilibrium. The exchange rate and domestic interest rate, it will be noted, are positively associated throughout. In contrast with the monetary model, interest rates are determined independently of exchange rate expectations, and changes in them imply incipient changes in relative yields on different currencies which have to be offset, for uncovered parity to be maintained, by movements in currency values.

(iii) The portfolio balance model with static or stable exchange rate expectations

10. The third example of the asset-market approach is the portfolio balance model exemplified by Branson (1977, 1979). Unlike the two previous models, this does not assume that currencies are perfect substitutes: it assumes rather than in response to exchange risk wealth-holders seek to diversify their portfolios, being prepared to hold interest-bearing assets in different currencies in non-zero amounts which depend on the configuration of their relative yields. Asset-market equilibrium does not then require the equalisation of expected yields (uncovered parity); and risk premia provide a conceptual measure of divergences among them arising from different asset supply and demand conditions. The supplies of interest-bearing assets, as well as domestic and foreign money, therefore have to be brought into the analysis. Thus suppose there are four assets - domestic and foreign (non-interest-bearing) money, and domestic and foreign bonds. Neither of the two moneys is held by residents of the other country, so that domestic residents hold domestic money and domestic bonds, both of which are public sector

liabilities (and therefore 'outside assets' of the private sector), and foreign bonds. It is also assumed that foreign bonds are the only tradeable asset: foreign residents do not hold domestic bonds, and any increase in domestic liabilities to overseas residents arising from a current account deficit will entail a fall in domestic holdings of foreign bonds, which are denominated in the foreign currency. This assumption facilitates the analysis of exchange rate dynamics(4); domestic holdings of foreign bonds represent net foreign assets, and they are assumed to be positive.

11. The proportion of their wealth which domestic residents wish to hold in each asset then depends on their relative expected common-currency yields, and hence on the interest rates on domestic and foreign bonds and the expected movement of the exchange rate. The current exchange rate impinges on these demands in two ways. First, movements in the exchange rate will tend to affect expectations about its future rate of change; and the assumption is adopted here that expectations of its future level are relatively stable, so that actual appreciation tends to reduce expected future appreciation and hence the relative expected yield on domestic assets(5). Secondly, exchange rate changes entail revaluation, in terms of domestic currency, of foreign assets which are denominated in foreign currency; and, since domestic residents are assumed to be in a net credit position abroad, domestic wealth will fall when the exchange rate rises, but by a smaller proportion than its foreign-assets components. Each of these influences implies that a rise in the exchange rate will switch demand from domestic to foreign assets, owing first to a change in relative expected yields and second to the involuntary reduction in the proportion of domestic wealth held in foreign assets which appreciation entails.

12. The exchange rate is then viewed as being determined in the short run (when asset supplies are given) simultaneously with the two interest rates by the equilibration of asset markets. But the exchange rate which thus emerges may go on to disturb asset supplies, because it will affect the current balance and hence (assuming no official intervention) the net acquisition of foreign assets by domestic residents. As in the flow model of B.1, the current account is assumed to respond favourably to depreciation and unfavourably to appreciation: a rise in the exchange rate thus reduces the supply of foreign assets to the domestic economy. In contrast with the flow model, however, the portfolio balance model - like the Dornbusch model - draws an explicit distinction between the flexibility of interest rates and exchange rates

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(4) Its relaxation in discussed in Part B.

(5) The assumption more usually adopted is that exchange rate expectations are static, i.e. that the exchange rate is not expected to change from its current level.

on the one hand and the stickiness of real variables on the other, and between the short-run responses of exchange rates as they help to equilibrate asset markets and their longer-run responses after the adjustments of real variables - including asset supplies - have run their course. The long run is therefore in this context defined naturally as the period in which asset supplies again become stationary; and this requires, as a condition of long-run equilibrium, that the current account should be in balance(6).

13. Now consider the implications of the disturbance of such an equilibrium by an increase in the domestic money supply. This may be due to a money-financed fiscal deficit (in which case there is an increase in private sector wealth), domestic open-market operations (where there is also a reduction in the supply of domestic bonds), or non-sterilized intervention in the foreign exchange market (where there is also a reduction in the supply of foreign bonds). These distinctions were irrelevant in models (i) and (ii) because neither wealth nor bond supplies played any role. In fact, however, the three possibilities have consequences which are qualitatively similar, although quantitatively different. In each case, an excess supply of money and an excess demand for both domestic and foreign bonds emerge at the original interest and exchange rate; and both a decline in the domestic interest rate (which switches demand from domestic bonds to money and foreign bonds) and a depreciation of the domestic currency (which switches demand from foreign bonds to money and domestic bonds) are required to restore asset equilibrium. As in the Dornbusch model, the exchange rate and domestic interest rate are positively associated, although there is now no clear chain of causation from the latter to the former.

14. In the new asset equilibrium, with goods prices unchanged, the domestic currency has depreciated in real terms: by assumption the current account will now move into surplus and foreign assets begin to grow. There thus develops an excess supply of foreign bonds which requires the exchange rate to rise for portfolio balance to be maintained. One consequence of the improvement in the current account is therefore a partial reversal of the original depreciation; and this, by reducing net exports, will tend to bring the growth in foreign assets to a halt. Meanwhile, however, the increase in foreign assets will also have been raising investment income from abroad, thereby tending to push the current account further into surplus. For stability, it has to be assumed that trade elasticities are sufficiently large for the latter effect to be outweighed by the former, so that the current account surplus resulting from the initial depreciation is eventually eliminated and full equilibirum restored.

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(6) This condition has in subsequent portfolio balance models provided an anchor for exchange rate expectations.

15. The exchange rate in this final long-run equilibrium will clearly be higher than in the temporary asset equilibrium - another case of overshooting, accounted for now by lags in the response of trade to the exchange rate, rather than lags in the response of prices to money. Moreover, the real exchange rate in the final equilibrium should be higher than it was initially, because, although the current account is in balance in both positions, investment income must be higher after the effects of the monetary expansion have worked through, so that the trade balance must have deteriorated. This implies, unless there have been effects on activity, that competitiveness has deteriorated: if the domestic price level has risen in proportion to the money supply, the proportionate depreciation must have been smaller. In the portfolio balance model, therefore, PPP need not hold even in the weak sense in which it held in model (ii): purely monetary disturbances may change real exchange rates, even in the long run.

16. Three further disturbances may now be considered more briefly with attention restricted to short-term effects. An exogenous improvement in the current acount will cause an immediate appreciation as portfolios are rebalanced in the face of an increased supply of foreign currency assets; no change in interest rates is required. A bond-financed fiscal deficit will entail an excess supply of domestic bonds and excess demands for money and foreign bonds. A rise in the domestic interest rate is unambiguously required for asset equilibrium, but the exchange rate may rise or fall depending on the substitutability of assets in demand: if foreign bonds are a closer substitute than money for domestic bonds, the exchange rate will tend to rise, and conversely. Finally, sterilised intervention in support of the domestic currency will entail an increase in the supply of foreign assets and an equal reduction in the supply of domestic bonds. Again the consequences are ambiguous, depending upon substitutability conditions: substitution between domestic bonds and money should lead to a lower interest rate, and this may offset the appreciation implied by substitution between domestic and foreign bonds. In the last two cases considered, it will be noted that the exchange rate may be either positively or negatively associated with the domestic interest rate.

(b) Survey of Econometric Evidence

(i) The flexible and sticky price monetary models

17. Some representative results for both the flexible-price and sticky-price monetary models are summarised in Table 1. Some relatively successful results were obtained for the former model by Frenkel for the 1920s, and by Bilson for the period 1970 to 1977. However, the early optmism about the explanatory power of the flexible-price model has been tempered by the observation (by e.g. Frankel, and Hacche and Townend) of data which contradict its distinctive prediction about the relationship between exchange rates and interest rates. Moreover, there may be an inherent mis-specification

TABLE 1 ECONOMETRIC RESULTS FOR THE MONETARY MODELS(a)

Authors	Currencies and Period	Special Features	Summary of Results
1 Frenkel 1976	DM : $ Feb 1920-Nov 1923	Interest differential represented by forward premium. Real income variables and US money omitted, on grounds that German hyper-inflation the dominant factor.	'Fully consistent with prior expectations': ln S = -5.135 + 0.975 lnM + 0.591 lnr (0.731) (0.050) (0.073) where S is DM per $, and r is forward premium on $. (Standard errors in brackets) R^2 = .994; Sœ = .241; DW = 1.91
2 Bilson 1978	DM : £ Apr 1970-May 1977	Interest differential represented by forward premium; lagged adjustment to equilibrium exchange rate; mixed estimation procedure allowing imposition of priors; inclusion of time trend.	Consistent with monetary model. In dynamic simulation, superior to a simple PPP model but inferior to a 'sophisticated' PPP model including prices and interest rates but not money supplies or real incomes. 'Rational expectations' version of the monetary model superior to an RE version of PPP.
3 Bilson 1979 (a)	DM : $ 1963 Q1-1978 Q3	Interest differential measured by forward premium; polynomial lags on exogenous variables; inclusion of time trend.	'Provide strong support for the monetary theory'. The model 'captures all of the major turning points'; but most significant variable a quadratic time trend. Inclusion of prices 'did not offer any support for the Dornbusch model'.
4 Bilson 1979 (b)	33 currencies against $ 1954-74	Interest differntials proxied by inflation differentials; generalised least squares estimation.	'Provide convincing evidence that the monetary approach leads to predictions of the actual exchange rate which are, on average, both less biased and less disperse than those based on' PPP.
5 Girton and Roper 1977	Canadian $: US $ 1952-74	Dependent variable is 'exchange market pressure' = sum of exchange rate change, and intervention/money ratio. Interest rates excluded.	Coefficients right-signed and significant; high explanatory power.
6 Frankel 1979	DM : $, July 1974- Feb 1978	Short and long interest differentials included; instrumental variable estimation to correct for shortcomings of long rates as proxies for expected inflation.	Coefficients right-signed; in particular, different signs on long and short interest differentials. But significance levels weak after allowance for auto-correlation, until IV estimation used.

(a) Abbreviations used include: OLS; Ordinary least squares; IV: instrumental variables; RE: rational expectations; 2SLS: two stage least squares.

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TABLE 1 (continued)

7	Driskill 1981	SF:$, Mar 1973 - Nov 1977	Estimates reduced-form of Dornbusch model - interest rates absent - and compares this with the reduced-form of an amended model which allows for under-shooting and non-monotonic exchange response paths.	After exclusion of real income variables, and addition of a dummy for the 1973-4 oil price shock, results for both models satisfactory, but more supportive of amended model. Results support long-run validity of PPP, overshooting, and non-monotonic exchange rate responses.
8	Dornbusch 1978	DM : $ Mar 1974-May 1978	Allows for partial adjustment in demand for money; short and long interest differentials included; coefficient of unity imposed on relative money supplies.	Results improved by partial adjustment formulation which includes lagged dependent variable; but real incomes and short interest differential not significant. 'I take the evidence, theoretical and empirical, to reject the monetary approach'.
9	Dornbusch 1980	DM : $ 1973 Q2 - 1979 Q4	As for (8)	Coefficients of relative money supplies (when freely estimated) and relative real incomes not significant. When coefficient of unity imposed on relative money supplies and lagged dependent variable included, the latter was the only significant determinant. '... little doubt that the monetary approach is an unsatisfactory theory.'
10	Hacche and Townend 1981	£ effective rate, Feb 1972 - Feb 1980	Partial adjustment allowed for in demand for money and exchange rate; instrumental variable estimation to allow for endogeneity of domestic interest rate and intervention.	In OLS estimates, no variables significant apart from domestic interest rate and intervention counterpart of change in money supply, the latter wrong-signed. In IV estimates, no determinants significant.
11	Frankel 1981	DM, £, FF, Y and Can $ against US $, 1974-81, various monthly periods.	Frankel 1979 re-estimated on more recent data, but with inflation expectations measured by actual inflation rather than long interest rates.	'Results discouraging' for the monetary models; some evidence suggested that the problems may lie in drifts in real exchange rates and demand for money functions.

in the usual assumption that the money supply (particularly its external counterpart) and interest rates are exogenous to the exchange rate. Frankel similarly found some early support for the sticky price monetary model over the period 1974-78, but subsequent econometric support for this model has also been relatively scarce.

18. Furthermore, the empirical validity of both versions of the monetary approach has been questioned more radically as a result of increasing doubts about the reliability of PPP, even in the long run, and also because of their failure, in econometric investigations, to explain some of the most important exchange rate developments of recent years (see Table 1). Thus Dornbusch (1978) found that the depreciation of the dollar in 1977-78 could not be explained in terms of Frankel's monetary model and that it had occurred in spite of relatively slow monetary growth in the United States. Dornbusch (1980) found that the same model did not fit the data for the DM-$ rate, 1973-79, at all well. Similarly poor results were obtained by Hacche and Townend (1981) when they attempted to explain the movements in sterling, 1972-80, in terms of a number of variants of the monetary model; and Beenstock, Budd, and Warburton (1981) also failed, using the monetary approach, to quantify the influences which had resulted in sterling's appreciation between 1976 and 1980. Frankel (1981) describes the failure of his model to fit 1974-81 data for most of the major currencies.

(ii) The portfolio balance model

19. Some results obtained for the portfolio balance model described in the previous section of this Appendix are summarised in Table 2. These econometric applications have neglected the feedback mechanism entailed in the dependence on the exchange rate of the current account and the accumulation of foreign-currency assets, and have been more concerned to investigate the short-run dependence of exchange rates on asset supplies. The explanatory variables are then, in principle, the supplies of domestic and foreign money, the supplies of domestic and foreign government interesting-bearing debt, and the net supply of foreign assets to the domestic private sector. The two studies by Branson and others ommitted the supplies of interest-bearing assets and proxied the net bi-lateral supplies of foreign assets by the cumulated aggregate current-account surpluses (from some bench-mark) of the two countries concerned in each case. Martin and Masson, more correctly, included variables representing bond stocks, and used bi-lateral current account data for their proxies for net foreign asset supplies. Both Branson, Halttunen and Masson, and Martin and Masson adjusted the cumulated current account surpluses for cumulated official intervention, and in estimation attempted to allow for simultaneous determination of intervention policy.

TABLE 2 ECONOMETRIC RESULTS FOR THE PORTFOLIO BALANCE MODEL

Authors	Currencies and Period	Special Features	Summary of Results
1 Branson and Halttunen (1979)	DM and Yen against $; FF, IL, SF, and £ against DM; July 1971-June-1976 and April 1973-June 1976	For each exchange rate, explanatory variables are domestic and foreign money stocks, and domestic and foreign cumulated current account surpluses. NB. (i) supplies of interest-bearing assets omitted; (ii) because of lack of bilateral data, domestic net claims on the foreign country represented by the two countries' respective net foreign assets, proxied by cumulated current account surpluses.	'As a whole', the results seem 'mildly encouraging': after taking account of serial correlation of residuals, the following variables were right-signed and significant: $:DM - over full period, both German variables only; over short period, no variables; $:Yen - In both periods, the Jap. cum. current account only; DM:FF - Over full period, both money stocks only; in short period French cum. current account also; DM:IL - Money stocks only; DM:SF - German money stock only; DM:£ - In full period, UK money stock and German cum. current account; in short period, UK money stock only.
2 Branson, Halttunen, and Masson (1977)	$: DM, Aug 1971-Dec 1976	As for (1), except that (i) cumulated intervention netted from cumulated current account surpluses; (ii) exchange rate equation estimated simultaneously with policy reaction functions for intervention and DCE, by 2-stage least squares.	'The estimates look reasonable and support the asset-market model.' In OLS estimates, after allowing for auto-correlation all coefficients right-signed, but US money the only significant determinant. In 2SLS estimates, each coefficient significant and right-signed; $\bar{R}^2 = 0.94$. (Policy reaction functions indicate a sterilisation coefficient not significantly different from unity, and intervention aimed at smoothing).
3 Martin and Masson (1979)	Can.$, Yen, and basket of 8 W.European currencies against $, Apr. 1973-Apr. 1978	For each exchange rate, explanatory variables are domestic and US money and bond stocks and the bi-lateral net foreign asset position with the US. NB.(i) bond stocks proxied by public debt; (ii) bi-lateral net foreign asset stocks calculated from bi-lateral current account data (vis-a-vis US); (iii) bi-lateral net foreign asset stocks defined in some variants as excluding direct investment flows; (iv) exchange rate equation estimated simultaneously with reaction function for intervention by two-stage least squares;	Results 'very mediocre'. In 2SLS estimates, the following variables were significant: Can.$:US$ - dummy for Quebec election of 1976; cumulated intervention (with perverse + sign); US money (with perverse - sign). Yen :US$ - US money (with perverse - sign); cumulated intervention (with perverse + sign). W.Eur.:US$ - cumulated intervention (with + sign). Thus 'the empirical verdict on the utility of the portfolio balance model ... must be judged unfavourable'.

20. The initial results obtained by Branson and Halttunen may be seen to have been mixed, but they were regarded as 'mildly encouraging'. Those subsequently obtained by Branson, Halttunen and Masson for the Dm-$ rate appeared more satisfactory: after allowance for the simultaneous determination of intervention, the coefficients estimates were in all cases right-signed and significant, and the model seemed to fit the data well. The later results of Martin and Masson were, however, much worse: the only consistently significant influence on the three exchange rates examined was found to be cumulated official intervention, and this with a perverse sign. Thus, as in the case of the monetary models, the optimism which had been encouraged by the early econometric applications of the portfolio balance model was soon disappointed.

(iii) Expectations and the current account

21. Recent work has interpreted the failure of econometric attempts to identify exchange rate models as being a result of an inadequate treatment of expectations, and more particularly a result of the neglect of the influence of the current account on expectations about the real exchange rate. This orientation of recent work has partly been a response to the observation that exchange rate movements have, in some important cases, been closely associated with current account developments - most notably the dollar's weakness through 1977-78 and its subsequent recovery. The current account has a specific role in the portfolio balance model. Its assumptions entail that the transfer of wealth from the foreign to the domestic private sector implied by a current account surplus takes the particular form, in the absence of intervention, of an increase in privately-held foreign government debt, denominated in foreign currency. For this to be willingly held, the exchange rate must rise. The domestic-currency value of the foreign bonds is thereby reduced, and their relative rate of return raised on account of more pessimistic expectations about the future movements of the domestic currency.

22. A number of doubts arise, however, as to whether the apparent influence of current account developments can be explained by portfolio re-balancing. First, the quantitative importance of such wealth effects is unlikely to be large in the short term because the current account imbalances of the industrialised countries are generally small, over short periods, in relation to the stocks of internationally mobile assets denominated in their currencies. Secondly, portfolio re-balancing cannot explain cases where intervention was sufficient to offset any effect which the transfer of wealth may have had on asset demands. In particular, Hooper and Morton (1980) note that while the cumulated US current deficit during 1977-78 was $28 billion, purchases of dollar assets by foreign central banks were more than double that amount in the same period. Even on the extreme assumption that the entire transfer of wealth from US to foreign residents was switched

out of dollars into other currencies, portfolio re-balancing should have caused the dollar to appreciate rather than depreciate; and this is the effect which model (iii) would have predicted.

23. The current account acquires a role of its own, however, independent of intervention, if it is assumed to affect exchange rate expectations. The long-run equilibrium real exchange rate in model (iii) is determined by the condition that the current account be balanced. If expectations are assumed to be 'rational' or consistent with the model, the expected future real exchange rate must then be determined by this condition and will respond to shocks which disturb current account conditions and prospects. This approach has been adopted in recent papers(7) which have argued that this injection of 'rationality' into the expectations assumptions of the portfolio balance model provides a transmission mechanism for the current account which may be more important than its wealth effects. In reality, of course, current accounts need not balance even over long periods if there are persistent structural capital flows in one direction. But even for a country where this is the case(8), it is still true that there are limits outside which current account imbalances are unsustainable, and that non-transitory disturbances to the current account (and to structural capital flows) will usually imply a need for corrective real exchange rate adjustments which is likely to affect expectations.

24. An example of the application of this idea is provided by Hooper and Morton's attempt to explain the movements in a trade-weighted index of the dollar's value against ten other currencies between 1973 and 1978. They found that after elimination of the risk-premium variable, whose coefficient was persistently wrong-signed but insignificant, their model explained 80 per cent of the quarterly variations in the value of the dollar over the estimation period. All remaining coefficients were right-signed (the interest coefficients being signed as in the Frenkel model) and only that on the short interest differential was not significant. Their results imply that although the dollar's fluctuations over the period as a whole were caused in about equal part by monetary and real factors, about 4/5 of its depreciation through 1977 and 1978 had been due to a revision of expectations about the equilibrium real exchange rate caused by the current account deficit.

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(7) E.g. Dooley and Isard 1980, 1981), Hooper and Morton (1980), Dornbusch (1980).

(8) Canada has been an example of a country with a persistent current account deficit, while Switzerland has normally had a surplus.

25. Hooper and Morton's representation of the formation of real exchange rate expectations is however simpliste, and it may be argued that their results merely re-state the known correlation between the value of the $ and the US current account. Dornbusch (1980) adopted a different approach, by assuming that contemporary forecasts published by the OECD were representative of market expectations, so that deviations of the outturn from them could be used to measure unanticipated current account 'shocks'. He found that these deviations contributed significantly to an explanation of movements in the $ effective rate and the $-Yen rate, but not the $-DM rate, between 1973 and 1979.

26. The above account of the way in which the econometric modelling of exchange rates has evolved suggests that the exchange rate movements of the last decade cannot, in general, be satisfactorily explained on the basis of the special assumptions adopted in any of the three models described above. The relative generality of Hooper and Morton's model - especially its acknowledgement of the active role of exchange-rate expectations and their dependence on the information transmitted by the current account - may be considered a necessary advance; but it is possible to question both its particular assumptions about expectations formation (as seen above) and the significance of its apparently successful results (as Meese and Rogoff (1981) have shown).

(iv) Purchasing power parity

27. Some representative results of econometric studies of the relationship between exchange rates and relative price levels are summarised in Table 3. The usual procedure has been to regress either the exchange rate on domestic and foreign price levels, or the rate of change of the exchange rate on domestic and foreign inflation rates, and to examine whether the estimated parameters support the hypothesis that the exchange rate responds proportionately to price disturbances, perhaps after allowance for lagged adjustment. A problem with this procedure is that since prices cannot generally be assumed to be exogenous to the exchange rate, coefficients obtained by OLS must be expected to provide biased estimates of the exchange rate's responses to price movements. Frenkel (1978), having obtained OLS estimates for three exchange rates in the 1920s which appeared to confirm long-run PPP, recognised the difficulty, and on the basis of 'causality' tests which showed that exchange rate changes usually led rather than lagged behind price changes, inferred that it would be more proper to estimate the inverted regression, with relative price levels 'explained' by exchange rates. These results again appeared to support the long-run validity of PPP. But Frenkel's alternative specification of course assumed that exchange rates had been exogenous to relative price levels, whereas both exchange rates and prices should in general be regarded as endogenous: exchange rates are likely to lead prices not because the former are exogenous to the latter, but because foreign exchange markets tend to

.E 3 ECONOMETRIC RESULTS FOR PURCHASING POWER PARITY

ıors	Currencies and Period	Special Feature	Summary of Results
?renkel 1978	$:£, FF:$, FF:£, Feb 1921-May 1925	(i) 3 sets of price indices: wholesale, raw material, food; (ii) Sims causality test used to test for exogeneity of prices.	(i) Hypothesis that elasticities of rate of change of exchange rate with respect to domestic and foreign inflation rates are equal not rejected in each case; (ii) After allowing for lags in adjustment, elasticity with respect to differential inflation rate close to unity in long run, except in case of £:$. Speeds of adjustment vary among price indices; (iii) Causality tests indicated that exchange rates 'caused' prices rather than vice-versa. Equations therefore re-estimated with ratio of price levels the dependent variable. Long-run homogeneity not rejected in most cases.
Krugman 1978	(i) DM:$, Feb 1920-Dec 1923, £:$, Feb 1920-Dec 1925, FF:$, Feb 1920-Dec 1926 (ii) DM:$, IL:$, SF:$, £:$, July 1973-Dec 1976	(i) No allowance for lagged adjustment; (ii) Instrumental variable estimation used to take account of endogeneity of prices; (iii) Wholesale prices only	(i) In OLS estimates, after allowing for auto-correlation, only 2 of the 7 sets of data do not reject the hypothesis that the elasticity of the exchange rate with respect to relative price levels is unity in the short run, viz. IL:$ and £:$ in 1970's; (ii) IV estimates more favourable: elasticity not significantly different from unity in any case; but for DM:$ in 1970's, not significantly different from zero either; (iii) But variations in real exchange rates generally large, and substantially serially correlated in all cases.
Dornbusch 1978	DM:$, Mar 1974-May 1978	Regression of real exchange rate (defined using CPI's) on previous value.	'The real exchange rate depends to the extent of one third on its long-run value and two-thirds on its recent history' indicating 'substantial and persistent deviations from PPP'.
Frenkel 1981	(i) DM:£, Feb 1921-Aug 1923; FF:£, $:£, FF:$, Feb 1921-May 1925; (ii) $:£, $:FF, $:DM, June 1973-July 1979; then £:DM and FF:DM over same period	(i) Wholesale prices and CPI's; (ii) Instrumental variable estimation.	For the 1920's, the results support PPP; but for the 1970's 'the results (for all $ exchange rates) are extremely poor and the estimates are extremely imprecise': coefficients on relative inflation rates all insignificant, and sometimes wrong-signed. But results better for £:DM and FF:DM.

respond faster to disturbances than goods markets. This implies that a simultaneous-equations estimation technique is more appropriate.

28. This was recognised by Krugman (1978) and Frenkel (1981) when they used instrumental variables to estimate equations for a number of exchange rates in the 1920s and 1970s. The results were mixed. For the 1920s they were consistent in both studies with long-run PPP. Krugman's estimates for 1973-6 also failed to reject PPP, although they were not less well-determined, markedly so in the case of the DM:$ rate. Frenkel's results for 1973-9 were much poorer for the exchange rates involving the dollar - with coefficients usually insignificant and sometimes even wrong-signed - but they were still reasonably satisfactory for the £-DM and FF-DM rates. Krugman qualified his relatively favourable results by observing that although the real exchange rates examined had, as predicted by PPP, usually been more stable than the corresponding nominal rates - with the notable exception of the DM-$ rate in the 1970s - there appeared to have been substantial serial correlation in the deviations of real exchange rates from their mean values. In other words, there appeared not to have been any strong tendency for purchasing power disparities to correct themselves. Dornbusch (1978) drew a similar inference from his own econometric investigation.

(v) Covered interest parity

29. Table 4 summarises evidence on this question, referred to in C.5. It overwhelmingly supports the view that efficiency in this sense holds in international financial markets. In the Euro-markets, where exchange controls and political risk are absent, any apparent covered disparities may be accounted for entirely by transactions costs; disparities in onshore markets appear to be explicable usually by exchange controls.

(vi) Efficiency and the risk premium: forward exchange rates as predictors of spot rates

30. Part C.5 refers to the implication of the joint hypothesis of speculative efficiency and the absence of a risk premium that the forward exchange rate will be an unbiased predictor of the future spot. Evidence on this issue is summarised in Table 5. On the joint hypothesis, if the spot rate is regressed on the lagged forward rate, then the constant should be zero, the coefficient should be unity, and there should be no serial correlation in the errors. If there is a risk premium, however, these implications do not follow from the efficiency hypothesis, since the risk premium may well, in particular, have a constant component and be serially correlated. Moreover, if there is a risk premium which is a component of the error term in the regression, the lagged forward rate will be correlated with the error term, so that OLS will not provide a consistent estimation procedure; the equation may, however, be estimated by instrumental variables.

TABLE 4 EVIDENCE ON COVERED INTEREST PARITY

	AUTHORS	INTEREST RATES AND PERIOD	SPECIAL FEATURES	SUMMARY OF RESULTS
1	Frenkel and Levich, 1975	(i) US and UK Treasury Bills (ii) US and Canadian TBs (iii) Euro-$ and Euro-£ deposits Jan 1962 - Nov 1967, weekly.	Estimation of transactions costs for calculation of 'neutral band'.	Very high proportion of observed disparities lie within the neutral band defined by transactions costs - 85% for TBs, 99-100% for euro-deposits.
2	Frenkel and Levich, 1977	As in (1), but 3 periods: (i) Jan 1962-Nov 1967, the 'tranquil peg' (ii) Jan 1968-Dec 1969, the 'turbulent peg' (iii) July 1973-May 1975, the 'managed float'	As in (1)	(i) Transactions costs much higher in floating period, owing to wider bid-ask spreads; (ii) For 1962-7 and 1973-5, results as in (1); but proportion of disparities explained by transactions costs much lower in the 'turbulent peg' period in the TB comparison - only 30-40%. Proportion still high, however, in the euro-deposit comparison. Results for 1968-9 explained by 'political risk' (more specifically financial uncertainty and reduced co-operation among central banks) rather than market inefficiency.
3	McCormick, 1979	(i) US and UK TBs (ii) euro-$ and euro-£ deposits April-Oct 1976, weekly	An in (1), but based on refined (more closely aligned) data	(i) Transactions costs estimated to be much lower than data comparable to those used in (1) and (2) would suggest; (ii) Newly calculated neutral bands explain 100% of disparities for euro-deposits, but only 20-30% for TBs. Explained by UK exchange controls.
4	Dooley and Isard, 1980	Euro-DM deposits and DM inter-bank deposits, Jan 1970-Dec 1974 monthly	A portfolio balance model used to explain the differential between euro-DM and internal DM interest rates in the presence of controls on capital inflows.	Most of the change in the differential, from near zero in 1970 to 10% in April 1973 then back to zero, explained by the effective tax imposed by actual controls, rather than by the risk of prospective controls.

TABLE 5 | EVIDENCE ON FORWARD RATE AS PREDICTOR OF SPOT RATE*

Authors	Currencies and Period	Horizon	Techniques and Special Features	Summary of Results
1 Frenkel 1976	DM:£, Feb 1921-Aug 1923, monthly	1 month	OLS regression of S on F1 and F2	Constant and coefficient of F2 not significant; coefficient of F1 not significantly different from unity; DW indicates absence of serial correlation. Efficiency inferred.
2 Cornell 1977	$ against FF, July 1974-Jan 1977; $ against £, Can $, DM, SF, DG and Yen, April 1973-Jan 77; monthly	1 month	Examination of forecasting errors of lagged forward rate; comparison with lagged spot (random walk)	Mean forecasting errors of lagged forward rate statistically insignificant in each case. Zero average risk premium inferred. But errors significantly auto-correlated in some cases, raising questions about efficiency. Results barely distinguishable from those for random walk.
3 Frenkel 1978	DM:£, FF:£, FF:$, Feb 1921-May 1925, monthly	1 month	As in (1)	As in (1)
4 Levich 1978	$ against Can $, £, BF, FF, DM, IL, DG, SF, and Y, Jan 1967-May 1975, weekly	1, 3, and 6 months	Examination of forecasting errors of lagged forward rate; also tests of profitability of simple forecasting rules	Mean forecasting errors of lagged forward rate statistically significant in most cases. Non-zero risk premia inferred. But errors not serially correlated; efficiency inferred, and confirmed by unprofitability of forecasting rules.
5 Frenkel 1979 (b)	$ against DM, FF, £, IL, SF, DG, Jan 1973-Apr 1978, weekly	1 month	Regressions: (i) (S-FI) against constant (ii) S on FI and constant, with instrumental variables (iii) S on FI and (SI-F2)	(i) Constant not significant: ie mean forecast errors (ii) Apart from £ and SF, constants differ significantly from zero, and coefficient of F1 differs significantly from unity. But results more consistent with efficiency and zero-risk premium when Jan 73-June 74 excluded. (iii) Results mixed. In sum, results ambiguous except that DM:$ rate passes all tests for the period July 74-Apr 78.
6 Cumby and Obstfeld 1980	$ against SF, DM, Can $, FF, DG, £, July 1974-June 1980, weekly	1 week	Tests for serial correlation in differences between (S-SI) and lagged interest differentials	Apart from £, all currencies showed significant serial correlation. Risk premium inferred.
7 Frenkel 1981 (a)	$ against £, FF, DM, June 1973-July 1979, monthly	1 month	OLS and IV estimates of regression of S on F1 and F2	In all cases F2 not significant, and DW indicates absence of serial correlation. Joint hypothesis of zero constant and unit coefficient not rejected.

* In this table S and F refer to the logarithmic values of spot and forward rates; F1 is the one-period lag of F, etc.

31. Although Table 5 refers to tests of a joint hypothesis, Frenkel (1976, 1978) drew a strong inference about efficiency from his OLS regressions; these included the second lag of the forward rate as an additional explanatory variable to provide a more powerful test of the hypothesis that the first lag embodies all the relevant information for the systematic prediction of the spot. While Frenkel interpreted his results as evidence in favour of efficiency, the recent study by Cumby and Obstfeld (1980) preferred to assume efficiency and to conclude from their finding of significant serial correlation in the difference between the rate of change of the spot rate and the lagged interest differential (which is the same, under covered parity, as the logarithmic difference between spot and the lagged forward rate) that most exchange rates against the dollar displayed a risk premium. Frenkel (1979a), in a study of the DM-$ rate not included in Table 5 used the same dependent variable as Cumby and Obstfeld, but in a different way and with different results. Assuming efficiency, Frenkel interpreted the difference between actual appreciation and the lagged forward premium as being the same, apart from white noise, as the previous period's risk premium. He then investigated whether this ex post risk premium was correlated with relative asset supplies, as portfolio balance theory suggests for the ex ante premium. In over a hundred attempts using quarterly data, he failed to find a single specification where a significant asset-supply influence appeared. He concluded that 'The evidence points in the direction of perfect substitutability of assets'. But the difficulties involved in constructing asset stock data - to say nothing of the dubiousness of the necessary assumption that actual asset stocks measure asset preferences - together with the absence of clear confirmation in the other studies referred to, suggests that the evidence on this issue is more ambiguous.

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