CAPITAL FLOWS AND EXCHANGE RATE DETERMINATION

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and

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ABSTRACT

This paper attempts to examine the effects of increased capital mobility on exchange rate determination in Australia. In particular, it examines the issue of whether increased capital mobility has made the exchange rate so responsive to short-term financial market considerations that it no longer responds to longer-term fundamentals.

The findings of the paper are consistent with the stylised facts of the international experience of floating exchange rates. The paper concludes that short-term capital flows are very interest sensitive but that the extent of this sensitivity is difficult to show empirically. Over the longer term, it appears that inflation differentials explain part of the movement of the nominal exchange rate. However, there have also been large movements of the real exchange rate. These fluctuations have been associated with shifts in Australia's terms of trade and commodity prices. The paper finds that commodity price shocks also explain some of the short-run volatility of the exchange rate. This long-run and short-run link between the exchange rate and commodity prices is one of the distinguishing features of the Australian dollar. Finally, it was difficult to find and quantify any systematic link between the current account and the exchange rate.

The paper concludes with a discussion of some of the policy implications of highly mobile capital. It is noted that in a country with a floating exchange rate and perfectly mobile capital, there is scope for a conflict between internal and external balance, particularly if there is high inflation and current account deficits. The paper notes that monetary policy should primarily be directed towards lowering the rate of inflation rather than achieving a particular exchange rate objective for current account purposes. This is particularly true when the currency is subject to export price shocks since exchange rate movements help to buffer the impact of those shocks.

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I. INTRODUCTION

The aim of this paper is to look at the effects of increased capital mobility on exchange rate determination. In particular, it attempts to address the question of whether exchange rates have become so responsive to financial market influences that they do not respond over the short and medium term to the needs of external balance of payments adjustment.

This subject has been discussed often over the last decade or so, but has attracted renewed interest lately. In large part, this is because of experience over the last 18 months where the exchange rates of the major surplus countries - Germany and Japan - have tended to fall, while that of the major deficit country - the United States - has risen. The discussion below attempts to review the Australian experience within this framework. Most of the paper concentrates on the period since the Australian dollar was floated in December 1983. It attempts to analyse the extent to which movements in the exchange rate can be explained by broad economic factors, such as relative inflation rates, the current account deficit and the terms of trade, and the extent to which they are due to financial variables, such as relative interest rates. Before doing this, however, it is necessary to fill in some of the institutional background.

II. CAPITAL MOVEMENTS

Pre-float

In nearly every year in the post-war period, Australia has run a deficit on its current account. Historically, this deficit has been viewed as part of the transfer of resources of the developed and older economies towards newer areas where rates of return are felt to be higher. Over the three decades from 1950 to 1980, the current account deficit averaged $2^1/_2$ per cent of GDP.

During this time, over 60 per cent of the external deficit was financed by inflows of equity capital. There were exchange controls operating over this period, which limited the extent to which Australian firms could rely on external debt raisings, and lending abroad by Australian institutions was prohibited for most of this period. With generally strong domestic growth and with international interest rates not high in real terms, Australia's external debt to GDP ratio remained low. To the extent that there was any public sensitivity to international capital flows, it was directed against highly visible foreign equity in domestic Australian businesses.

Over this period, the exchange rate regime changed a number of times, but all the variants could be classified as fixed or quasi-fixed. The Australian dollar was fixed against the pound sterling until 1967, against the U.S. dollar until 1974, and against a trade-weighted index until 1976. From 1976 to 1983, the Australian dollar was moved in an adjustable peg arrangement against a trade-weighted index.

Post-float

When the Australian dollar was floated in December 1983, the remaining exchange controls on capital movements were lifted. Apart from a minor restriction on movements in currency, Australia ended all controls on movements of capital. The Exchange Control Department of the Reserve Bank was abolished. Australia can now be classified, with only minor qualification, as a country with a freely floating exchange rate and perfect capital mobility.

The financing of the current account deficit has responded to changes in the institutional environment, particularly with the acceleration in financial deregulation. Paralleling the development of deeper and more sophisticated debt markets, there has been a marked shift in the source of financing towards debt. As is shown by Table 1, this was not a recent development. Even in the pre-float period, there was a tendency for debt flows to grow at the expense of equity flows, or at the expense of long-term borrowings between related institutions. In other words, the interest-sensitive component of international capital flows tended to grow towards the end of the fixed exchange rate era, to become the predominant form of capital inflow. It now accounts for over 100 per cent of net capital inflow compared with around 10 per cent for most of the 1960s and 1970s. In the 1960s, debt finance largely took the form of investment by foreign parents in their Australian subsidiaries. Today, over 90 per cent of debt funding is in the form of portfolio investment.

An important source of funds in recent years has been the Euro-Australian dollar bond market. The first Eurobond denominated in Australian dollars was issued in 1976, but raisings were negligible until 1983. Since that time, the raisings have increased rapidly (see Figure 1).[1] Issues rose strongly in

[1] The figure for 1989 is estimated by annualising raisings in the first nine months of the year.

Table 1

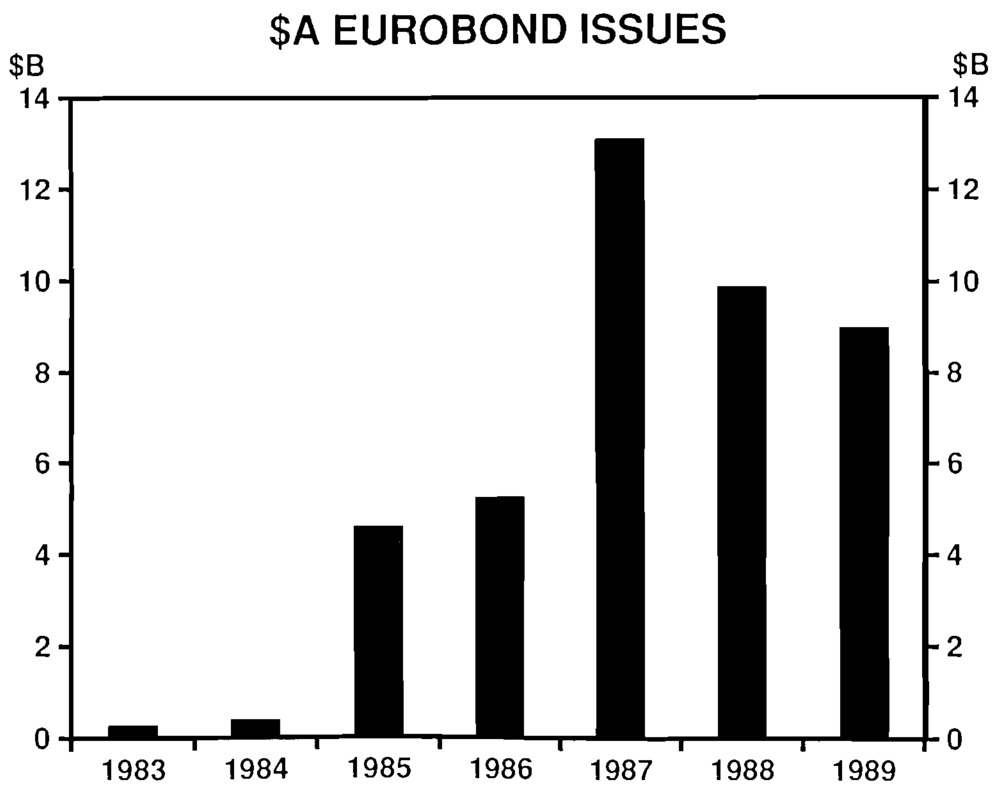
Percentage Share of Net Foreign Investment

	Direct Borrowing	Portfolio Borrowing	Equity & Other
Sep 59-Jun 77	23.9	12.7	63.4
Sep 78-Jun 83	8.7	80.4	10.9
Sep 83-Mar 89	13.1	116.9	-30.0

1985 and 1986 and peaked in 1987, before falling a little over the last two years. Outstandings in this market now amount to $37 billion (compared to $50 billion in the domestic government bond market and $66 billion in the bank bill market).

Initially, Australian residents, particularly semi-government authorities, were the main issuers, but more recently banks have been the predominant Australian issuers. Issues by non-residents grew quickly and have accounted for more than half the volume of new issues since 1985.

Figure 1

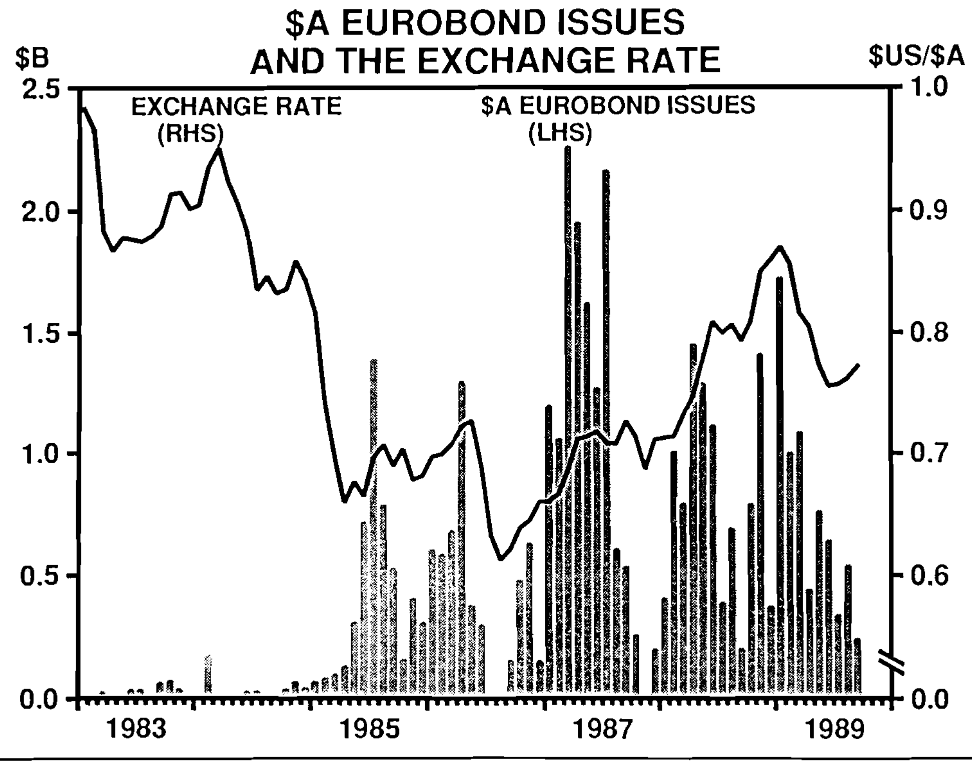


An important factor behind the growth of this market has been relatively high Australian interest rates which have encouraged a retail investor base in Europe. In addition, taxation and regulatory considerations have meant that Australian issuers have faced lower borrowing costs offshore. Funds raised offshore by Australian banks, for example, were not subject to the Statutory Reserve Deposit (SRD) requirement, which only applied to domestic deposits.[2] Also, Australian dollar Eurobonds issued by residents are usually structured so that they are exempt from interest withholding tax. The combined effect of these factors has been to encourage Australian companies to do their fixed interest borrowing offshore; the Euro-Australian dollar market is a replacement for a domestic corporate bond market.

The growth of non-resident issues has been encouraged by an active swap market in Australia. Non-Australian borrowers in the Euro-Australian dollar market typically swap the fixed rate Australian dollar proceeds to an Australian company, and in return receive, either directly or indirectly, a floating rate liability denominated in the currency of their preference.

Shorter term variations in the volume of issues can also be explained in terms of movements in Australian interest rates and in the Australian dollar. Apart

Figure 2



2 The SRD requirement was replaced in September 1988 by a new arrangement (non-callable deposits) which reduces the incentive to raise funds offshore.

from the initial fall in 1985, subsequent falls in the Australian dollar have tended to cause new issues to dry up. However, in periods when interest rates rose in response to the falling exchange rate (see Section III), new issues resumed. In particular, when Australian interest rates were high enough to steady the Australian dollar or cause it to rise, Euro-Australian dollar raisings picked up sharply. From Figure 2, it can be seen that this occurred in early 1986, in the first three quarters of 1987, and again through early 1988 and 1989.

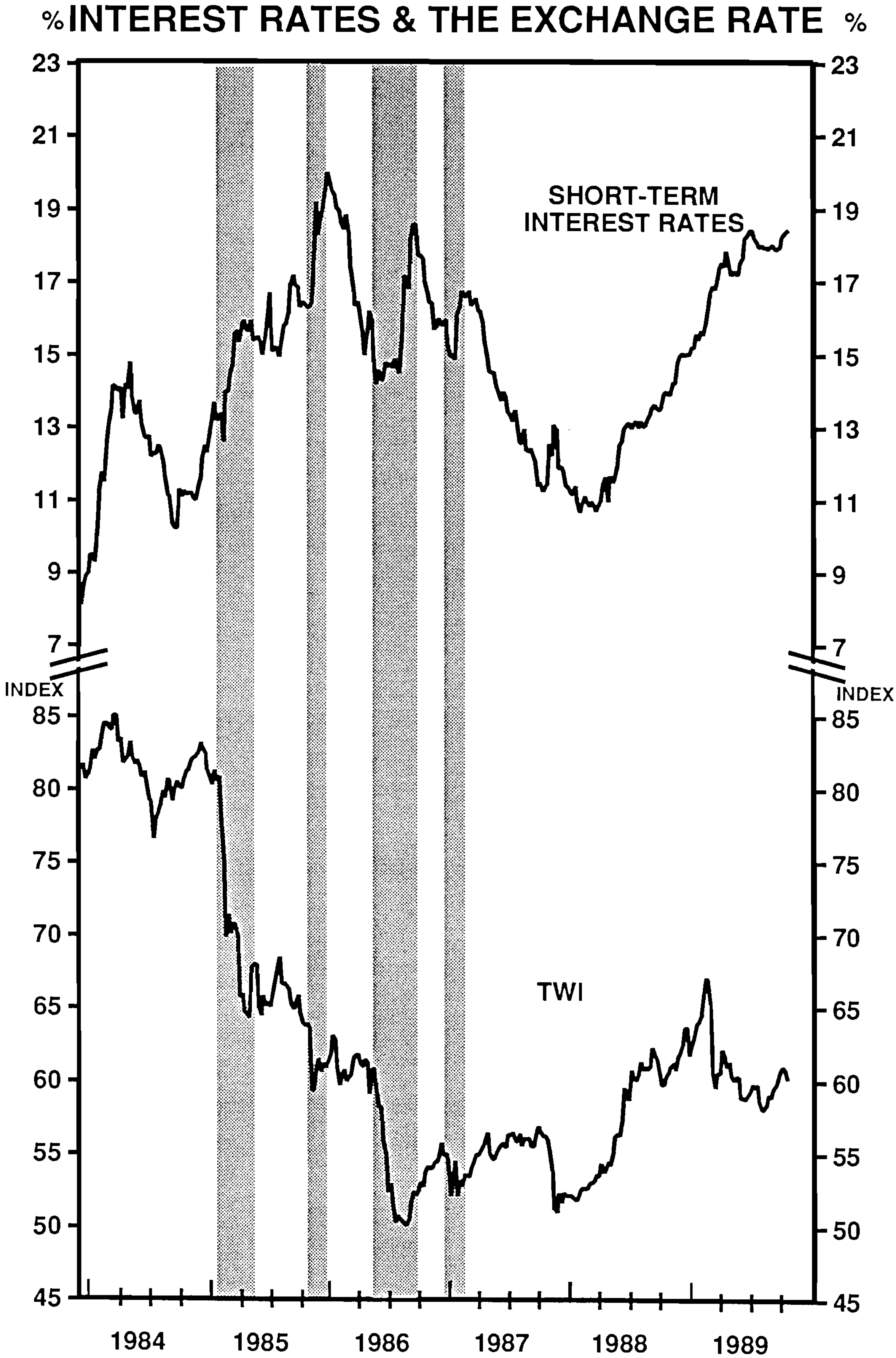
III. MONETARY MANAGEMENT IN THE POST-FLOAT PERIOD

The floating of the exchange rate provided the final pre-condition which enabled the Reserve Bank to conduct its monetary policy by orthodox open market operations. Monetary policy is now implemented by buying and selling government securities in a way which has its most immediate impact in a rise or fall in the rate of interest on overnight funds (equivalent to the Federal funds rate). While short-term interest rates are the instrument of monetary policy, its ultimate aim is to influence the movement in a nominal variable, such as inflation or nominal GDP. In this sense, therefore, it is directed primarily towards an internal objective rather than towards an external one, such as the exchange rate or current account.

That being said, there are times when movements in the exchange rate may be an important indicator of the need for monetary action, even within a framework where monetary policy is directed primarily towards an internal objective. For example, a falling exchange rate may provide additional evidence (to that already being provided by economic activity, money supply, etc.) of inflationary pressures, and hence the need for monetary tightening. There may also be other occasions where the exchange rate may fall (or be in danger of falling) so far that it puts unacceptable strains on the capacity of domestic prices and wages to adjust to its impact without generating excessive inflationary pressures. In both of these situations, one would expect to see a central bank responding to a falling exchange rate by raising short-term interest rates.

It is only necessary to point this out because for about half of the post-float period, i.e. between the beginning of 1985 and late 1987, monetary policy has been used in this way. During this period, there were some very large changes in the exchange rate - for example, between January 1985 and July 1986, it fell by 40 per cent on a trade-weighted basis. That is, during this period, the policy reaction function has been such that large falls in the exchange rate have quickly led to rises in short-term interest rates. At other times, for example from late 1987 to the present, monetary policy has generally been adjusted in response to domestic considerations and so rises in interest rates and rises in the exchange rate have tended to occur together.

Figure 3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INTEREST RATES & THE EXCHANGE RATE
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SHORT-TERM
INTEREST RATES
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1986
1987
1988
1989

The earlier period is highlighted in Figure 3, where the shaded bars show large falls in the exchange rate. On each occasion during the period, they were accompanied by rises in interest rates, but for different reasons:

- in the first half of 1985, when the Australian dollar fell sharply, monetary policy was tightened. The tightening was in response to the rapid growth in domestic demand and monetary aggregates during 1984. The fall in the exchange rate early in 1985 was further evidence that the setting of monetary policy had not been tight enough to contain domestic demand and inflationary pressures; it thus brought forward a tightening that was already imminent;

- from about January 1986, the previous year's high level of domestic interest rates slowed the economy and started to attract heavy inflows of capital. The monetary authorities took the opportunity during this period to move interest rates back to a level which was thought to be more appropriate for medium-term developments, given the reduced pressure of domestic demand; and

- this respite was short-lived, and a further sharp fall in the exchange rate starting in May 1986 brought the cumulative fall since the beginning of 1985 to nearly 40 per cent. Concern about the capacity of the economy to absorb a relative price change of this magnitude prompted another tightening of monetary policy at end July 1986. Again, with interest rates at very high levels, capital started to flow into Australia in large volume. Apart from a short-lived episode in January 1987, the exchange rate tended to rise through the remainder of 1987, and interest rates fell.

As a result of these episodes, movements in interest rates and the exchange rate were the mirror image of each other from early 1985 to late 1987.

By late 1987, the situation had changed and there was no longer any tendency for the exchange rate and the interest rate to move in this way. In October 1987, immediately following the share market crash, the Australian dollar fell sharply on market expectations of an impending world recession and a fall in commodity prices. No move was made to tighten monetary policy to resist this fall (although foreign exchange intervention was used). In the event, the exchange rate soon recovered and rose above its pre-October level. During 1988, it became apparent that the economy was growing quickly and progress in reducing inflation was threatened. Monetary policy was tightened on several occasions and the exchange rate rose. Thus, from late 1987 to early 1989, rises in interest rates tended to be accompanied by rises in the exchange rate.

Finally, in February and May 1989, the exchange rate fell again despite the fact that interest rates, which were already high, were raised again. On these occasions, the fall in the exchange rate seems to have been due to a reassessment by the market of the underlying balance of payments and inflation position (helped along by Ministerial statements and official sales of Australian dollars).

In summary, the period since the float has been characterised by diverse behaviour. For a large part of it, the relationship between interest rates and the exchange rate was dominated by an apparent policy reaction function from exchange rate to interest rates. On other occasions, interest rate differentials (with the expected positive sign) seem to have dominated. At other times, fundamental factors have had an influence on short-term adjustments of the exchange rate.

IV. EXCHANGE RATE DETERMINANTS

This section attempts to analyse the major determinants of movements in the Australian dollar. It does so in order to try to distinguish between determinants which are fundamental in nature - such as relative rates of inflation, current account imbalances and terms of trade movements - and those which are more related to short-term financial factors, particularly interest rate differentials. In the process, this discussion will implicitly also say something about that part of the movement in the exchange rate which is unexplainable by economic factors, and make some comments about the efficiency of the foreign exchange market.

Fundamental factors

The following discussion does not attempt to calculate equilibrium exchange rates on the basis of various models which relate the exchange rate to various economic fundamentals.[3] Instead, it looks at how well variations in the Australian dollar are correlated with variations in inflation differentials, the current account and movements in the terms of trade.

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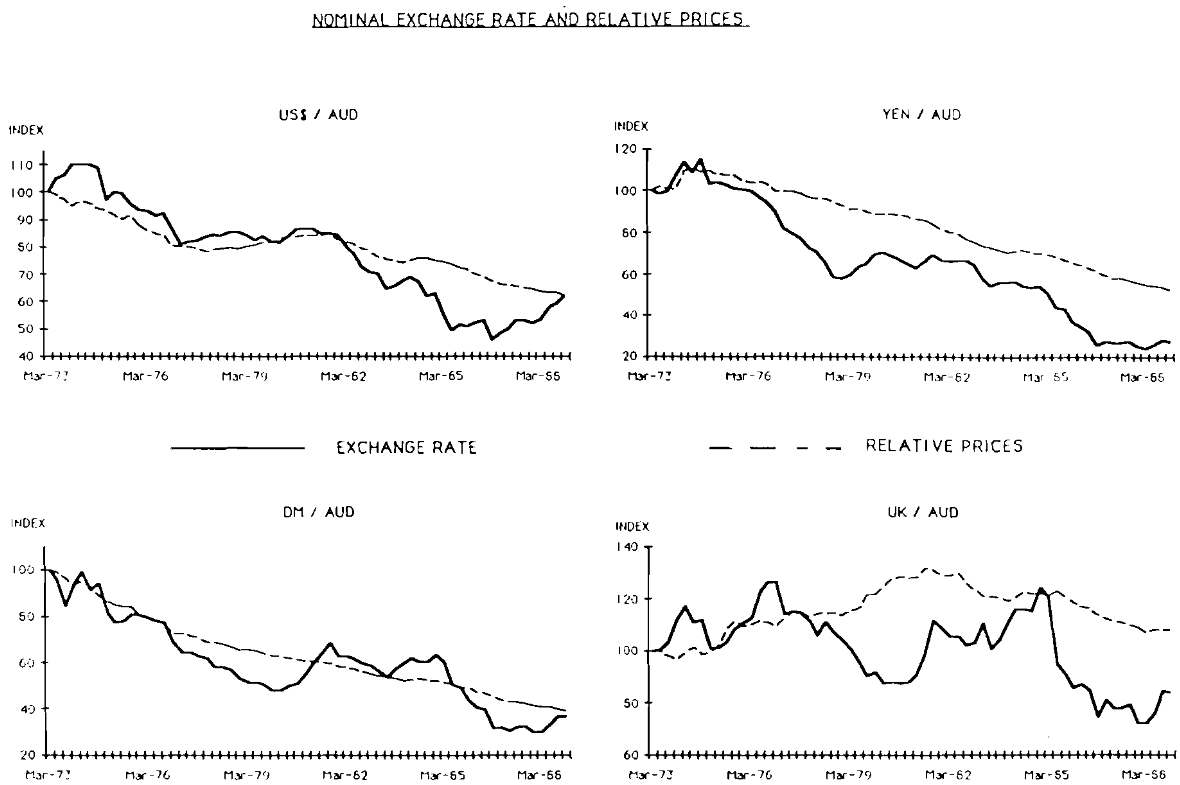
[3] We accept the empirical evidence that models of exchange rate determination are not well supported by the data, particularly when their out-of-sample forecasting performance is considered. See Meese and Rogoff (1983), Shafer and Loopesko (1983) and Dornbusch and Frankel (1987).

(a) Relative inflation rates

Relative inflation rates seem to be important in explaining movements in the Australian dollar over reasonable periods. Inflation in Australia has exceeded that of its major trading partners for most of the last two decades, and the Australian dollar has depreciated. Figure 4 shows four bilateral exchange rates of the Australian dollar and an index of relative price levels. (These are expressed as foreign CPIs over Australia's CPI.) They suggest some tendency for the exchange rate to adjust in a direction consistent with purchasing power parity (PPP), although the relationship is not close. The Australian dollar has depreciated against all three countries whose average inflation rate was well below Australia's (the United States, Germany and Japan).[4] The result is also consistent for the United Kingdom, which is the one country where the inflation differential with Australia has been variable. The Australian dollar rose against the pound sterling during the period of relatively high U.K. inflation (from the late 1960s to the late 1970s), and fell against the pound sterling during the period when U.K. inflation was lower than Australia's (for most of the 1980s).

Figure 4



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4 For Japan, however, the depreciation has been larger than suggested by PPP. There may be no tendency for this divergence to disappear if it reflects higher Japanese productivity. For the same observation between the yen and the U.S. dollar see Dornbusch (1989).

Even though the long-run tendency over a couple of decades is consistent with PPP, there have been extended periods where the exchange rate has moved in a different direction to that indicated by the inflation differential. In addition, it is apparent from these graphs that movements in the exchange rate have been much greater (in both directions) than that which would be indicated by the relatively smooth movements in inflation differentials. As a result, there have often been substantial movements in the real exchange rate, but these have tended to reverse themselves after an extended period. This suggests that other factors have been important in explaining exchange rate movements.

(b) Current account deficit

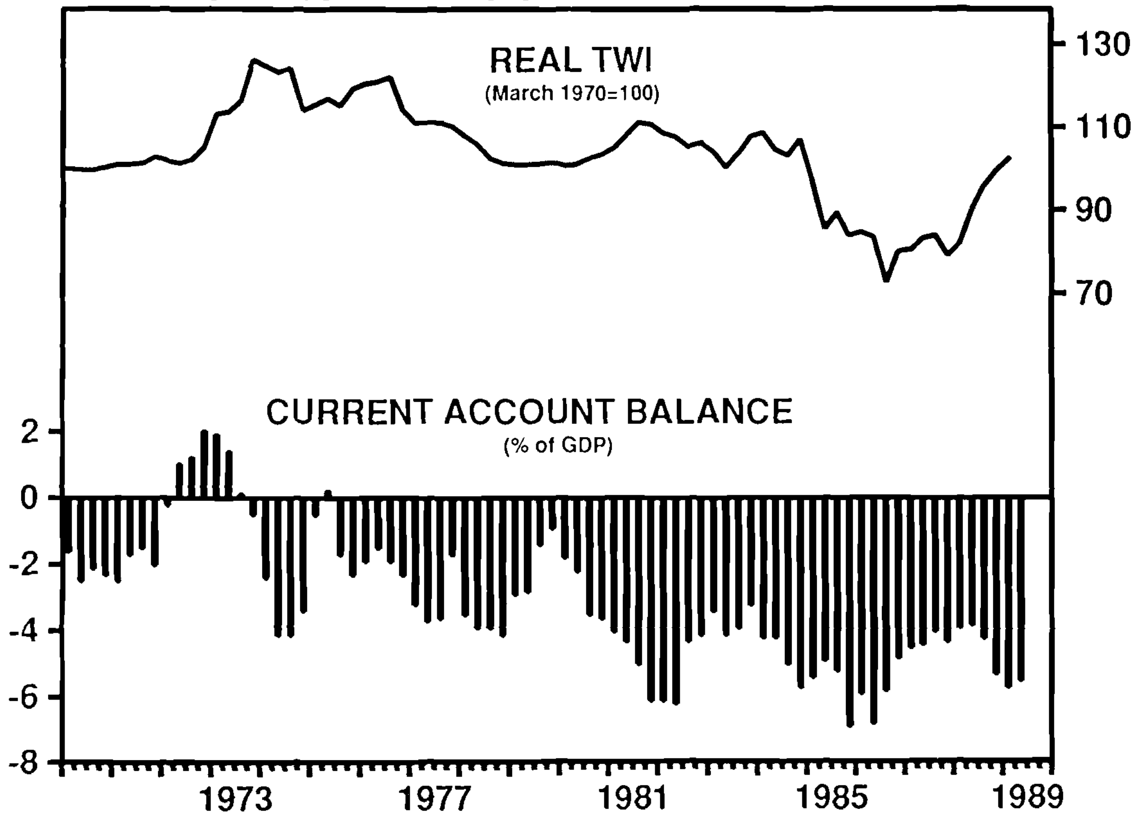
Most recent formal models do not give the current account a prominent role in explaining short-term movements of the exchange rate. In earlier models, it was assumed that the real exchange rate would adjust to ensure trade account balance. In more recent portfolio balance models, current account imbalances have their main influence on the exchange rate through their effect on the external debt position of an economy. Cumulative current account deficits, for instance, raise the level of net external debt and therefore raise the risk premium on a currency. This requires a depreciation of the currency and/or an increase in domestic interest rates to induce agents to hold the increased stock of debt. These adjustments, in turn, are necessary to bring about current account equilibrium. It should be noted that the dynamics of exchange rate and current account adjustment in these models are not well-defined as they depend upon assumptions about the degree of asset substitutability and the behaviour of the real economy.

Given these observations, it is not surprising that there does not appear to be a close relationship between the real exchange rate and the current account deficit in Australia. For example, the current account deficit widened from an annual average of 2 per cent of GDP in the 1970s to around $4^3/_4$ per cent of GDP in the 1980s and the stock of net external debt rose from around 7 per cent of GDP in 1970 to nearly 35 per cent of GDP by mid 1989. Despite this, the real exchange rate in 1989 was much the same as it was a decade earlier (although it had been significantly lower in the 1985-1987 period). This relative stability occurred despite a nominal exchange rate depreciation of about 40 per cent over the period. Figure 5 shows a comparison of the real exchange rate and the current account balance.

Some recent work by Smith and Gruen (1989) is, however, suggestive of a link between the external imbalance and the exchange rate. They find that in recent years investors have required an excess return for holding Australian dollar assets. Their results show that this excess return is higher than conventional estimates of the risk premium. They suggest that it is required because investors expect a major depreciation of the currency at some point as part of the adjustment toward external balance.

Figure 5

THE EXCHANGE RATE AND CURRENT ACCOUNT BALANCE



(c) Terms of trade

Developments in the Australian dollar during the 1980s seem to confirm that currency movements are, in part, dependent on movements in commodity prices (or the terms of trade).[5] This can be seen in Figure 6. On the two occasions when there was a large lift in Australia's terms of trade (1972 to 1973 and from mid 1986 to 1989), the real exchange rate appreciated sharply. On the two occasions when the terms of trade fell (1974 to 1978 and 1985 to 1986), there were large depreciations.

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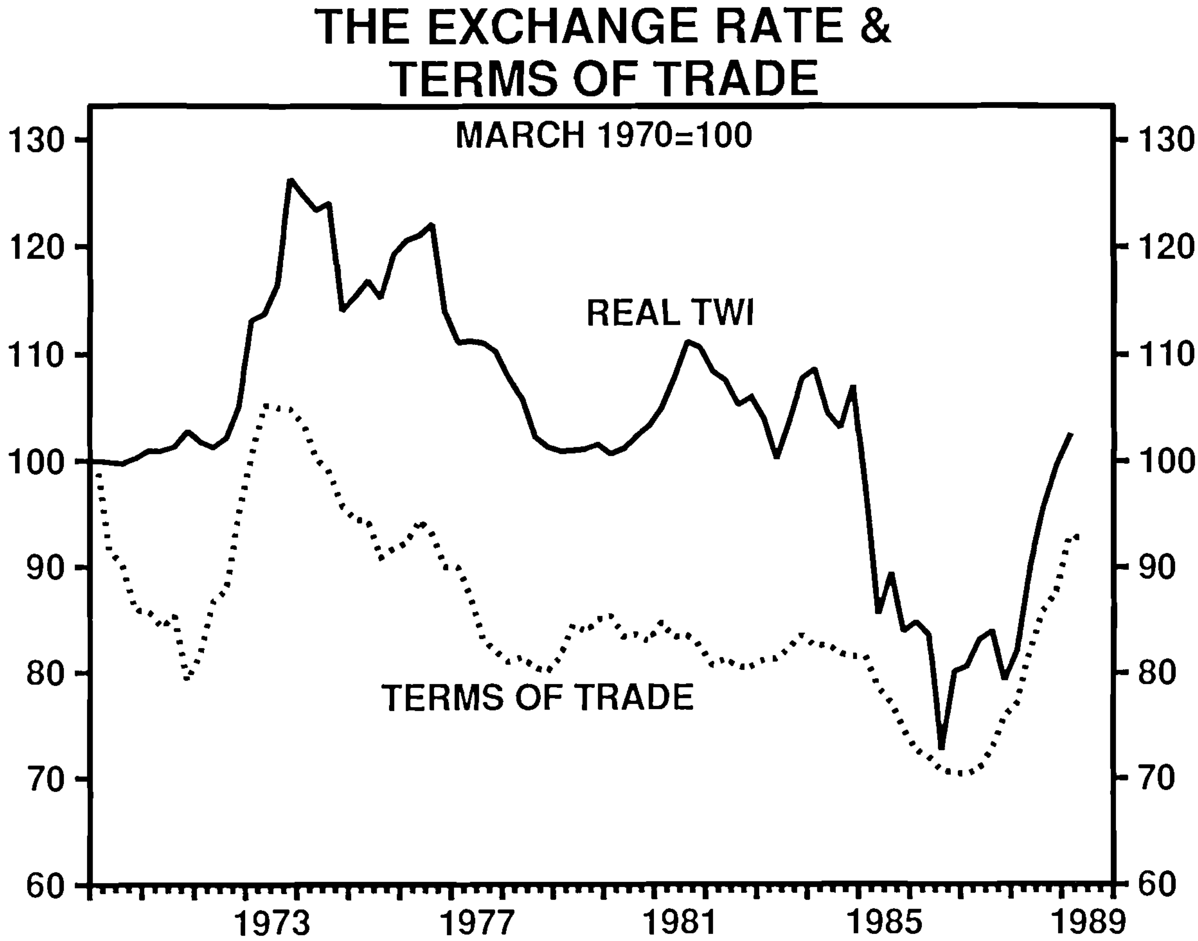
5 It can be shown (see Blundell-Wignall and Gregory (1989)) that the extent to which the exchange rate adjusts to the terms of trade depends on the elasticities of demand and supply for importables and exportables and on the degree of openness of the economy. Ostry (1988) has shown that the response also depends on whether changes in the terms of trade are expected to be temporary or permanent.

Figure 6



This link from the terms of trade to the exchange rate, as well as being evident from long-run graphical comparison, seems plausible in terms of the way markets behave. Two recent studies, Blundell-Wignall and Thomas (1987) and Blundell-Wignall and Gregory (1989), have explored this link further. They find evidence of a long-run relationship linking the real exchange rate to the terms of trade, and that the strength of this relationship has increased since the floating of the Australian dollar. By some estimates, the effect doubles in the post-float period (see later for some estimates of short-term linkages between commodity prices and the exchange rate).

Interest rate differentials

Our understanding of how markets work, and particularly of episodes where investors have been attracted to Australian dollar-denominated securities by high Australian interest rates, suggest a large role for relative interest rates in explaining movements in the exchange rate (see Section 1).

One way that nominal interest rates and exchange rates are linked is the medium-term linkage through the rate of inflation. High relative inflation is usually associated with high nominal interest rates and a depreciating currency. While there is no doubt that this sort of relationship operates in the medium-term, it is the inflation rate which is the driving force behind this mechanism; the interest rate differentials simply reflect the inflation differential. Indeed, high relative interest rates are associated with a depreciating currency in this medium-term context.[6]

The more interesting link for our purposes is the shorter-run relationship between interest rates and the exchange rate. An unanticipated rise in the domestic interest rate due to tighter monetary policy should cause an immediate appreciation of the currency. If domestic prices are sticky, then the exchange rate may overshoot its equilibrium value.[7] It is not a straight-forward matter to estimate the short-term link between interest rates and exchange rates. In common with other overseas efforts to measure interest sensitivity, our results do not capture a significant interest rate effect, either over the post-float period or when longer estimation periods are used. We used a number of tests to examine this relationship. In one set (using equations 1 and 2 below) the exchange rate is regressed on lags of itself and lags of domestic and foreign interest rates or interest rate differentials.

$$\Delta S_t = \alpha + ß\,(L)\,\Delta S_t + \gamma\,(L)\,\Delta i_t + \delta\,(L)\Delta i^*_t + \varepsilon_t \qquad (1)$$

or

$$\Delta S_t = \alpha + ß\,(L)\,\Delta S_t + \gamma\,(L)\,\Delta\,(i_t - i^*_t) + \varepsilon_t \qquad (2)$$

where,

L = number of lags. Current values and four lags of the interest rate terms appear in the equation, while the first four lags of the exchange rate are included;
S = log of the spot exchange rate;
i = 90-day Australian bank-bill rate; and
i^* = 90-day foreign Euro-rate.

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6 The average short-term interest differential (Australia minus overseas) and average annual nominal depreciations between 1973 and 1989 were:

Australia vis-a-vis	**Average Interest Differential**	**Average Depreciation**
United States	4.2	2.4
Japan	5.5	4.6
West Germany	5.6	4.0
United Kingdom	1.6	1.0

7 See Dornbusch (1976).

These equations were estimated on the basis of weekly and monthly data between 1983 and 1989. The results of the test are reported in the Appendix. In no case was the short-term movement in the exchange rate significantly related to the domestic interest rate. In general, this was also true for foreign rates. There was some evidence that weekly movements in Japanese and U.K. interest rates were significantly related to the exchange rate. However, this was not the case in the monthly equations.[8]

One explanation for this result lies in the two-way relationship between interest rates and the exchange rate. While an unanticipated rise in the domestic interest rate may cause the exchange rate to rise, monetary policy may sometimes respond to a changing exchange rate. If such periods have a high weight in the estimation period, it may appear that the exchange rate and the interest rate differential are related inversely rather than positively. As explained in Section II, this type of behaviour was predominant in the period between early 1985 and late 1987.

An alternative way of addressing this issue is to examine the relationship between changes in the exchange rate and unanticipated movements in interest rates (and other determinants). Asset market models suggest that short-run volatility in the exchange rate should be related to "news" about its determinants. In the model below, the unanticipated movements in each variable are generated from forecasting equations estimated for each variable. The Appendix describes in more detail how the forecast is constructed. The model is summarised by equation 3.

$$\Delta\hat{S}_t = \alpha + \beta\Delta\hat{Z}_t + \varepsilon_t \quad (3)$$

where,

$\Delta\hat{S}_t$ = unanticipated change in the exchange rate; and

$\Delta\hat{Z}_t$ = unanticipated change in a vector of determinants.

The variables chosen as determinants are:

- domestic and overseas short-term interest rates;

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8 In a multi-country study of the relationship between the real exchange rate and real interest differentials, Coe and Golub (1986) find that in many instances the coefficient on the interest rate term is insignificant and/or of the wrong sign. This was true in the Australian case.

- the current account; and
- commodity prices.[9]

The equation was estimated using monthly observations between January 1984 and April 1989. The equation was estimated for four bilateral exchange rates of the Australian dollar (US$/AUD, YEN/AUD, DM/AUD and £/AUD) and a trade-weighted index.

A number of interesting results emerge from these estimates. Unanticipated movements in the chosen determinants only account for a small part of the volatility in the unanticipated exchange rate. The equations only explain 10 to 20 per cent of the variance in the unanticipated exchange rate.

However, the results suggest that there was a significant and positive relationship between unanticipated rises in commodity prices and the exchange rate. That is, an unanticipated rise in commodity prices causes an appreciation of the currency. This suggests that not only do commodity prices explain long-term movements in the exchange rate, they also account for some of its short-run volatility.

In all cases, the coefficient on the unanticipated change in the domestic interest rate was negative (and significant in the US$/AUD, YEN/AUD, £/AUD and TWI equations). There are a number of possible interpretations of this result, but again we think the most plausible one is that the estimation period is dominated by the policy reaction function from the exchange rate to interest rates.

Foreign exchange market efficiency

An alternative approach to measuring whether capital is fully mobile and responsive to interest rate differentials is to test for foreign exchange market efficiency, i.e. to see whether expected returns are equalised across countries. The standard test of this is to see whether uncovered interest parity (UIP)

9 It would also be desirable to include some measure of inflation and the money supply in this equation. Unfortunately, a monthly CPI series is not available in Australia. Also, structural changes in the financial system have distorted the monetary aggregates in Australia. To the extent that monetary policy in Australia is implemented through short-term interest rates, then the domestic interest rate term should capture information on the stance of monetary policy.

holds.[10] If it does, we can conclude with confidence that capital is mobile and that it is interest sensitive. To test uncovered interest parity, we estimate:

$$\Delta S_{t+k} = \alpha + ß\,(i_t^* - i_t) + \varepsilon_{t,k} \qquad (4)$$

If uncovered interest parity holds, then $\alpha = 0$, $ß = 1$ and $\varepsilon_{t,k}$ is a white noise process. (More detail is provided in the Appendix.)

Previous tests in Australia, for example, those by Tease (1988) and Smith and Gruen (1989), have rejected uncovered parity. Tests of equation (4), presented in the Appendix, also confirm this result. This is not surprising in view of the international literature which overwhelmingly comes to the same conclusion.[11]

This rejection of uncovered interest parity does not, however, indicate that capital is immobile. Acceptance of CIP clearly shows that it is. Rather, it suggests that some of the auxiliary assumptions underlying UIP (rational expectations and risk neutrality) can be rejected. For instance, it is conceivable that capital is mobile and interest sensitive, but that people are bad at forecasting the exchange rate. In fact, they have to be not only bad, but systematically biased in their forecast of the exchange rate. There is a fair amount of evidence to suggest that this is the case.

What most tests in Australia over recent years discover is that people are being over-compensated for holding the Australian dollar. Over long periods, what they gain from high interest rates in Australia vis-a-vis the rest of the world, they do not lose fully in terms of depreciation of the Australian dollar against other currencies. The ex-post return for holding Australian dollars has thus been higher than for holding other currencies.

An explanation of this apparent anomaly is that people believe that eventually there will be a major downward correction as part of the adjustment to external balance. They, therefore, require an "excess" return for holding Australian assets. Smith and Gruen show that market participants have consistently predicted a depreciation of the currency over a period in which the currency has, on average, appreciated.

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10 Tests of covered interest parity (CIP) have also been used to examine the degree of capital mobility. The empirical evidence clearly supports CIP, so we do not attempt to test it here.

11 See Hansen and Hodrick (1980) and Cumby and Obstfeld (1984) for examples.

Some tentative conclusions

A number of tentative conclusions can be drawn about the behaviour of the Australian dollar. With one exception, these conclusions are consistent with those drawn about other major currencies in the recent empirical literature on exchange rates. The conclusions are as follows:

1. Inflation differentials are an important long run determinant of movements in the nominal exchange rate.

2. This means that the real exchange rate has a tendency for mean reversion.[12]

3. Even so, the real exchange rate can move in one direction for extended periods before reverting.

4. These movements cannot be systematically related to changes in the current account of the balance of payments, although there certainly are occasions where this occurs.

5. Similarly, these movements cannot be systematically related to interest differentials, although everyday observation demonstrates that capital is mobile and that it responds to higher interest rates.

6. The foreign exchange market fails tests of efficiency in that expected returns do not appear to be equalised across countries.

The one conclusion which is not common to most other currencies[13].

7. Long-run movements in the real exchange rate of the Australian dollar are related to movements in commodity prices, and there is also a tendency for some of the short-run movements to be related in this way also.

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[12] See Frankel and Meese (1987).

[13] There is evidence that commodity prices influence the real exchange rate of other commodity exporting countries such as New Zealand and Canada; see Blundell-Wignall and Gregory (1989) and Longworth and Murray (1987).

V. IMPLICATIONS FOR MONETARY POLICY

If we accept the common-sense proposition that the exchange rate is sensitive to domestic and foreign interest rates, and put aside the fact that this relationship cannot be established econometrically, the above conclusions are reasonably standard for a country with a floating exchange rate. The only distinguishing feature of the Australian exchange rate is its apparent long-run and short-run sensitivity to commodity prices or the terms of trade.

In a country with a floating exchange rate and interest sensitive capital movements, there is scope for a conflict between internal and external balance. In Australia's case, this usually takes place against a background of relatively high domestic inflation and a large current account deficit. The tight monetary policy likely to be required to help achieve the domestic anti-inflationary objective may push the exchange rate up and, therefore, slow down the balance of payments adjustment. However, in a world of flexible exchange rates and perfect capital mobility, there is a respectable body of opinion that says this should be the primary objective of monetary policy.[14] By and large, we accept the proposition that monetary policy should be directed primarily towards lowering the rate of inflation. The use of monetary policy to improve the current account deficit in the circumstances postulated is likely to be counter-productive. Attempts to hold down the nominal exchange rate are not likely to succeed in holding down the real exchange rate in the medium term; increases in the real exchange rate would simply be achieved through higher inflation. At the same time, fiscal and other policies (including wages policy) can contribute to the anti-inflation objective, as well as focussing on savings and investment incentives directed towards achieving external balance.[15]

If we add in the special feature of the sensitivity of the exchange rate to commodity prices, the basic proposition mentioned in the previous paragraph is strengthened. For example, Blundell-Wignall and Gregory have shown that a country that seeks to maintain price stability in the face of shocks to export prices should have a relatively flexible exchange rate (where price stability is defined as the minimisation of the variance of inflation from an

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14 This point was demonstrated by Mundell (1968); a more recent exposition is by Genberg and Swoboda (1987). They have shown that in such a world monetary policy should be assigned to an internal objective, while fiscal policy should be assigned to an external objective.

15 If the authorities feel that there is strong evidence of overshooting of the exchange rate, there may also be a case for foreign exchange market intervention (sterilised), as in February 1989 in Australia.

inflation target). This result is derived from a model which they use to consider the optimal degree of exchange market intervention in a small commodity-exporting country. The model is specified to reflect some of the characteristics of the Australian economy.

The model result obtains because movements in the nominal exchange rate (in response to a commodity price shock) help to cushion some of the inflationary consequences of the change in commodity prices. For instance, a rise in commodity prices will boost domestic income and expenditure, raise the domestic price of exportables and tend to divert resources into the traded -goods sector and away from satisfying domestic demand. With a floating rate, the exchange rate will appreciate, which will act in the opposite direction to each of the three inflationary effects identified above. Similarly, a fall in commodity prices will dampen demand, reduce the domestic price of exportables and re-direct resources into satisfying domestic demand. A fall in the exchange rate would offset some of these deflationary effects.

APPENDIX

TESTS OF THE RELATIONSHIP BETWEEN NOMINAL INTEREST RATES AND THE EXCHANGE RATE

1. Direct Tests of Exchange Rate Sensitivity to Relative Interest Rates

The following equations were estimated to examine the sensitivity of exchange rates to short-term interest rates (equations 1 and 2 in the text).

$$\Delta S_t = \alpha + \beta\,(L)\,\Delta S_t + \gamma\,(L)\,\Delta i_t + \delta\,(L)\Delta i_t^* + \varepsilon_t \qquad (1)$$

$$\Delta S_t = \alpha + \beta\,(L)\,\Delta S_t + \gamma\,(L)\,\Delta\,(i_t - i_t^*) + \varepsilon_t \qquad (2)$$

where,

S = log of the spot exchange rate;

i = 90-day Australian bank-bill rate; and

i* = 90-day foreign Euro-rate.

These equations were estimated on the basis of both weekly and monthly data between 1983 and 1989. The data were obtained from the International Department of the Reserve Bank. All data were sampled on Wednesdays.

Earlier tests revealed that most of the series had at least one unit root, indicating the need for first differencing in estimation.[16] Equations which use levels rather than first differences of the interest rate terms were also estimated to see if the results were sensitive to differencing. This was not the case.

Some summary statistics from estimating equations 1 and 2 are presented in Tables 2 and 4. The equations which use levels rather than first differences of the interest rate terms are presented in Tables 3 and 5. The statistics reported in the Tables are F-tests of the exclusion of the lags of the relevant

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[16] Tests were also conducted to see if the exchange rate and the relevant interest rate variables were cointegrated. The tests did not find any evidence of cointegration. Attempts to estimate (1) and (2) as error correction models were therefore not conducted.

interest rate variable. A significant value of the statistic indicates that the hypothesis that the coefficients on the lagged interest rates are zero can be rejected. Two sets of results are reported; one for equations estimated for weekly changes and one for monthly changes.

The results, in general, indicate that the null hypothesis cannot be rejected. Weekly or monthly changes in domestic interest rates are not significantly related to weekly or monthly changes in the exchange rate. In general, this was also true of foreign rates, although there was some evidence of a relationship between weekly movements in Japanese and U.K. rates and the exchange rate. This was not the case in the monthly equations.

Test for Significance of Interest Rates
Table 2

$$\Delta S_t = \alpha + \beta (L)\, \Delta S_t + \gamma (L)\, \Delta i_t + \delta (L) \Delta i_t^* + \varepsilon_t$$

Sample: January 1984 - May 1989

Exchange Rate	Δi_t Weekly	Δi_t Monthly	Δi_t^* Weekly	Δi_t^* Monthly
US$/AUD	0.81	1.27	0.83	1.00
YEN/AUD	1.60	1.41	2.53*	0.26
DM/AUD	2.09	0.53	1.76	0.73
£/AUD	1.04	0.51	3.64**	1.41

*(**) Significantly different from zero at the 5(1) per cent level.

Table 3

$$\Delta S_t = \alpha + \beta (L)\, \Delta S_t + \gamma (L)\, i_t + \delta (L) i_t^* + \varepsilon_t$$

Exchange Rate	i_t Weekly	i_t Monthly	i^*_t Weekly	i^*_t Monthly
US$/AUD	1.09	1.35	0.86	1.03
YEN/AUD	1.46	0.95	2.78*	0.32
DM/AUD	1.77	0.53	2.01	0.56
£/AUD	0.68	0.58	3.64**	1.52

See footnotes Table 2.

Table 4

$$\Delta S_t = \alpha + ß\,(L)\,\Delta S_t + \gamma\,(L)\,\Delta\,(i_t - i_t^*) + \varepsilon_t$$

Exchange Rate	$\Delta\,(i_t - i_t^*)$ Weekly	Monthly
US$/AUD	1.02	1.68
YEN/AUD	3.09*	1.52
DM/AUD	2.30	1.35
£/AUD	3.53**	2.27

See footnotes Table 2.

Table 5

$$\Delta S_t = \alpha + ß\,(L)\,\Delta S_t + \gamma\,(L)(i_t - i_t^*) + \varepsilon_t$$

Exchange Rate	$(i_t - i_t^*)$ Weekly	Monthly
US$/AUD	0.43	1.70
YEN/AUD	3.52**	1.47
DM/AUD	2.59*	1.63
£/AUD	3.37**	2.32

See footnotes Table 2.

2. Unanticipated Exchange Rate Movements in Response to "News"

It is well known that interest differentials (or forward premia) do not forecast short-term movements in the exchange rate with any degree of accuracy. The tests of uncovered interest parity reported later illustrate this point. Furthermore, the forecasting performance of structural and time series exchange rate models is not generally superior to a random walk model. This poor forecasting performance is not surprising since unanticipated movements in the exchange rate account for most of its short-run volatilty (see Mussa (1979)). In an asset market model, these unexpected movements are due to unanticipated changes in its determinants.

This section of the appendix explores the extent to which short-run volatility of the exchange rate can be explained by unanticipated changes in its determinants. To do this we estimate (equation (3) in the text):

$$\Delta\hat{S}_t = \alpha + ß\Delta\hat{Z}_t + \varepsilon_t \qquad (3)$$

where,

$\Delta\hat{S}_t$ = unanticipated change in the exchange rate;

$\Delta\hat{Z}_t$ = unanticipated change in a vector of determinants.

We assume that the relevant determinants are domestic and foreign interest rates, the current account and commodity prices. It would also be desirable to include some measure of inflation and the money supply as determinants. (However, see footnote 9 for the problems in doing so.)

To construct estimates of the unanticipated changes, we estimate the following forecasting equations:

$$\Delta x_{t+1} = \alpha + ß\Delta y_t + u_{t+1} \qquad (5)$$

where,

x = variable being forecast;

y = vector of variables in the information set; and

u = forecast error.

This equation is estimated for the exchange rate and each of its determinants.

The estimated forecast errors $\hat{u}_{t+1}$ are then extracted from the various equations and used as proxies for the unanticipated change in the variables. The following equation was then estimated:

$$\Delta S^u_t = \alpha + ß_1 \Delta i^u_t + ß_2 \Delta i^{*u}_t + ß_3 \Delta CA^u_t + ß_4 \Delta CP^u_t + \varepsilon_t \qquad (6)$$

where,

S = nominal exchange rate;

i = domestic 90-day bill rate;

i^* = overseas 90-day Eurorate;

CA = current account deficit; and

CP = commodity prices.

Unanticipated changes are denoted by the superscript u.

OLS estimation of equation (6) will yield consistent estimates of the ß's (see Pagan (1984)). The results of estimating equation (6) for four bilateral exchange rates of the Australian dollar and a trade-weighted index are reported in Table 7.

Table 7

Unanticipated Disturbances and the Exchange Rate

Exchange Rate	α	Δi_t^u	Δi_t^{*u}	ΔCA_t^u	ΔCP_t^u	$\bar{R}^2$	DW
US$/AUD^u	0.00	-0.97*	0.18	-0.00	0.32	0.07	2.03
	(0.00)	(0.49)	(1.26)	(0.00)	(0.21)		
DM/AUD^u	0.00	-0.84	1.84	0.01	0.96**	0.22	1.88
	(0.00)	(0.56)	(1.90)	(0.01)	(0.24)		
YEN/AUD^u	0.00	-1.24*	-0.59	0.01	0.67*	0.13	1.95
	(0.00)	(0.60)	(1.92)	(0.01)	(0.27)		
£/AUD^u	0.00	-1.06*	0.89	0.00	0.50*	0.10	2.07
	(0.00)	(0.52)	(0.68)	(0.01)	(0.24)		
TWI^u	0.00	-0.87	0.83	0.01	0.76**	0.22	1.95
	(0.00)	(0.50)	(1.26)	(0.01)	(0.20)		

Standard errors are in brackets.

*(**) Significantly different from zero at the five (one) per cent level.

The foreign interest rate term reported in the TWI equation in the table is 90-day US Eurorate. Other foreign rates were tried in the equation and they were also insignificant.
Sample: January 1984 - April 1989.

Three points emerge from these results. First, unanticipated changes in the exchange rate are significantly related to unanticipated changes in commodity prices. An unanticipated rise in commodity prices leads to anappreciation of the currency in four of the five Australian dollar exchange rates tested. This suggests that not only do commodity prices explain part of the longer-run movement in the exchange rate, they also account for some of its short-run volatility. It is interesting (and somewhat surprising) to note that the US$/AUD exchange rate is the only one not significantly related to commodity prices. Its importance, however, is not large enough to detract from the significant relationship found for the (more important) trade-weighted index.

Second, there is a negative correlation between unexpected changes in the exchange rate and the domestic interest rate. In three cases, the coefficient is significant at the 5 per cent level. The negative relationship is consistent with the observation in the text that the results are dominated by the policy reaction function that operated for much of the sample period. That is, unanticipated shocks to the exchange rate led the Reserve Bank on a number of occasions to alter domestic interest rates.

Finally, unanticipated movements in the determinants only account for a small part of the volatility of exchange rate.

3. Uncovered Interest Parity

When capital is perfectly mobile, and agents are risk neutral and rational, then capital flows should ensure that expected returns are equal across countries. That is, uncovered interest parity should hold. The uncovered interest parity hypothesis states that nominal interest differentials between similar assets denominated in different currencies equal (in the absence of a risk premium) the expected change in the exchange rate. Thus,

$$E(S_{t+k} | \phi_t) - S_t = i^*_t - i_t \qquad (7)$$

where,

S_t = logarithm of the spot exchange rate in period t;

E( ) = expectational operator;

ϕ_t = information set in period t;

i_t = k-period domestic nominal interest rate in period t; and

i^*_t = k-period foreign interest rate in period t.

Equation (7) states that the differential between k-period nominal interest rates equals the expected change in the exchange rate over the next k periods.

Assuming that agents expectations are formed rationally[17] allows us to derive an estimable form of equation (7) (this is equation (4) in the text):

$$\Delta S_{t+k} = \alpha + ß(i_t^* - i_t) + \varepsilon_{t,k} \qquad (4)$$

If expected returns are equalised across countries then α=0, ß=1 and $\varepsilon_{t,k}$ is a white noise process. One of the stylised facts of the international experience with floating exchange rates is that uncovered interest parity does not hold. Furthermore, to the extent that nominal interest differentials (or forward premia) provide any information on short-run changes in the exchange rate, this is dominated by movements in $\varepsilon_{t,k}$.

Estimates of equation (4) for a number of bilateral rates are reported in Table 8. The data are weekly observations on 90-day Australian interest rates and 90-day Eurorates for the foreign currencies. The sample period is January 1984 to May 1989.

Table 8

$$\Delta S_{t+k} = \alpha + ß(i_t^* - i_t) + \varepsilon_{t,k}$$

Sample: 4 January 1984 - 10 May 1989
Number of Observations: 280

Exchange rate	$\hat{\alpha}$	$\hat{ß}$	$\bar{R}^2$
US$/AUD	-0.26	0.359	
	(-0.26)	(0.317)	0.026
DM/AUD	0.027	-0.534	0.022
	(0.050)	(0.453)	
£/AUD	-0.024	0.317	0.002
	(0.043)	(0.807)	
YEN/AUD	-0.01	-0.255	
	(0.02)	(0.604)	0.002

Hansen-Hodrick standard errors are in brackets.

[17] That is, agents expectations are, on average, realised so that $E(S_{t+k} | \phi_t) = S_{t+k} + \varepsilon_{t,k}$. Where $\varepsilon_{t,k}$ is a white noise process orthogonal to elements of ϕ_t.

Uncovered interest parity is resoundingly rejected in most cases. In the £/AUD equation, $\hat{\beta}$ is within two standard errors of one. However, the confidence interval is so large that the hypothesis $\hat{\beta}$=0 also cannot be rejected. The nominal interest differential is found to have no explanatory power in predicting future movements in the nominal exchange rate. These results are consistent with earlier Australian evidence examining the behaviour of the US$/AUD exchange rate reported in Tease (1988) and Smith and Gruen (1989) and with other international evidence; see Hansen and Hodrick (1980) and Cumby and Obstfeld (1984) for examples.

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