ALTERNATIVE CONCEPTS OF THE REAL EXCHANGE RATE: A RECONCILIATION

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ABSTRACT

Widespread reference to the real exchange rate stems from the belief that it is a useful summary indicator of key economic information. There exist, however, two forms of the real exchange rate: one form is based on deviations from purchasing power parity, while the other is based on the ratio of domestic prices of non-tradeables to tradeables. In this paper, an attempt is made to reconcile the two forms of the real exchange rate, both in theory and in practice. It is shown analytically that under certain restrictive conditions they will be equivalent. These conditions are, however, not always met so that in practice the two forms of the real exchange rate diverge. Changes in the productivity of the traded goods sector and the terms of trade are shown to be the principal sources of divergence. Identification of such economic fundamentals is central to the proper interpretation of movements in real exchange rates and, therefore, the efficacy of any attempt by policy makers to effect changes in them.

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1. INTRODUCTION

The real exchange rate has occupied a prominent place in both theoretical and policy debate during the last decade. The widespread reference to the real exchange rate stems, in large part, from the belief that it is a useful summary measure of key economic information. For instance, it is commonly used as a measure of competitiveness of the traded goods sector and even as a measure of the standard of living in one country relative to another. In addition, changes in the real exchange rate are seen as an important part of the adjustment process to real shocks. Given the importance of the real exchange rate, there is surprisingly little agreement concerning both how to measure and interpret movements in it. In large part, disagreement stems from the fact that the term "real exchange rate" has been applied to two different concepts.

The traditional form of the real exchange rate is that based on deviations from purchasing power parity (PPP). This measure came to prominence at the end of World War I with estimations by Cassel (1918) and has been used widely both in Australia and internationally. The other form of real exchange rate has evolved from the theoretical model of a dependent economy and is based on the ratio of domestic prices of non-tradeables to tradeables. It is most often associated with Salter (1959) and Swan (1960, 1963). Despite the equilibrating role afforded to domestic relative prices in theoretical models of open economies, practical difficulties associated with the estimation of such prices have resulted in widespread adoption of the PPP based measure of the real exchange rate. Typically, movements in it have been presumed to be indicative of changes in domestic relative prices (O'Mara, Carland and Campbell 1980).

However, over recent years, a variety of estimates of domestic relative prices have become available for Australia.[1] All relative domestic price series indicate that during the last five years the relative price of non-traded goods has risen. This finding is in contrast to the real depreciation suggested by deviations from PPP. The two forms of real exchange rate appear to give countervailing signals. How should such signals be interpreted? In this paper, an attempt is made to reconcile different measures and interpretations of the real exchange rate.

First, it is shown that the two forms of the real exchange rate will only generate similar results under extremely restrictive assumptions; most importantly, unchanging relative prices abroad. In most nations this condition is violated. Relative prices, both at home and abroad, may change for a variety of reasons. In this paper, two sources of change are considered: productivity growth in the traded goods sector, and movements in the terms of trade. Second, it is argued that proper interpretation of movements in real exchange rates requires consideration of the source and permanency of the change in relative prices both at home and abroad.

The paper is organised as follows. In Section 2, there is a brief theoretical exposition of the relationship between the two forms of the real exchange rate. In Section 3, sources of divergent movements in the two measures are identified. In particular, the implications of changes in the terms of trade and productivity for alternative measures of the real exchange rate are explored. In Section 4, different estimates of Australia's real exchange rate are presented. Disparate movements in various published estimates of the real exchange rate are appraised and shown to contain valuable information about developments in both the Australian and foreign economies. Finally, in Section 5, conclusions and policy implications are drawn.

2. THE THEORY OF REAL EXCHANGE RATES

The "conventional" real exchange rate is based on deviations from PPP and draws on an established body of empirical literature.[2] Proponents of PPP claim that, in the long run, nominal exchange rates should move in line with inflation differentials so

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1 See for example Shann (1982), Pitchford (1986), Dwyer (1991, 1992) and Lattimore (1988).

2 The concept of PPP has evolved over several centuries; for a review see Officer (1976) and Dornbusch (1987).

that their real values remain constant (Cassel 1918; Officer 1976). Deviations from PPP represent a change in the real value of the currency. A real exchange rate that measures such deviation can be expressed as:

$$R_p = \frac{EP}{P^*} \tag{1}$$

where: E is the nominal exchange rate index expressed in units of foreign currency per unit of domestic currency; P is the domestic price index; and P^* is the foreign price index. A fall in R_p represents a real depreciation.

In contrast, the relative domestic price form of the real exchange rate does not include a rate of exchange between currencies. Instead, it is the ratio of the domestic price indices for non-traded (P_n) and traded goods (P_t):

$$R_r = \frac{P_n}{P_t} \tag{2}$$

where P_t is the composite price of exports and imports.[3]

Again, a fall in R_r represents a real depreciation. This relative domestic price concept has evolved from the "Australian model" in which a unique relative price of traded and non-traded goods is required for the simultaneous attainment of internal and external balance (Salter 1959; Swan 1960, 1963).[4] While explicit reference to this domestic price ratio as a real exchange rate stems from Gregory (1976), the notion was popularised by Dornbusch (1980). Dornbusch demonstrated that if the domestic price of non-traded goods is given, attainment of the equilibrium relative price requires adjustment of the domestic price of traded goods. Given the law of one price, this requires an adjustment of the exchange rate. Thus, changes in R_r can

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[3] For the composite commodity theorem to be invoked, the relative price of exports and imports must remain stable (Green 1976). This implies a constant terms of trade assumption.

[4] In this model, the economy comprises a traded and non-traded goods sector in which the relative prices of these goods influence the allocation of resources and expenditure. The price of traded goods is determined on world markets in accordance with the law of one price, while the price of non-traded goods is determined by domestic demand. The economy has attained internal balance if there is equality of demand for and supply of non-traded goods. Similarly, external balance is represented by the equality of demand for and supply of traded goods. Equilibrium is defined by the simultaneous attainment of internal and external balance.

be associated with a rate of exchange between currencies.[5] The equilibrating role afforded to domestic relative prices in the Australian model has become central to the theory of open economy macroeconomics.

Clearly, the relative domestic price form of the real exchange rate and that based on deviations from PPP are fundamentally different in expression and have evolved from different streams of literature. However, they are related. In fact, under a special set of restrictive conditions, deviations from PPP will be *proportional* to changes in domestic relative prices.

In order to demonstrate this relationship, the general price levels used in R_p must be decomposed into their traded and non-traded goods components:

$$P = P_t^{1-a} P_n^a \tag{3}$$

$$P^* = P_t^{*1-b} P_n^{*b} \tag{4}$$

where: a star (*) denotes the foreign variable; α is the share of non-traded goods in domestic consumption; and β is the share of non-traded goods in foreign consumption.

Following Lowe (1992),[6] substituting these price terms into equation (1) and re-arranging gives:

$$R_p = \frac{\left[\frac{P_n}{P_t}\right]^a P_t E}{\left[\frac{P_n^*}{P_t^*}\right]^b P_t^*} \tag{5}$$

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[5] In turn, given prices of non-traded goods abroad, all movements in R_r can be associated with a change in the real value of the currency.

[6] See also expositions by Clements and Frenkel (1980), McKenzie (1986), Nguyen and Martin (1987) and Dwyer (1991).

Thus R_r (the relative price form of the real exchange rate) can be recognised as a term in the numerator of this expression for R_p (that real exchange rate which measures deviations from PPP).

From equation (5) it is apparent that movements in R_p will only be proportional to those in R_r if the following two conditions hold:

(i) the law of one price; and

(ii) relative internal prices abroad remain unchanged.

First, if the law of one price holds, the price index for traded goods, expressed in a common currency, will be the same in both the domestic and foreign countries (so that $P_t E = P_t^*$). In this case, equation (5) can be rewritten as:

$$R_p = \frac{[R_r]^a}{[R_r^*]^b} \tag{6}$$

Second, movements in R_p and R_r will only be proportional if R_r^* is constant.[7] In this case:

$$\dot{R}_p = a\dot{R}_r \tag{7}$$

where $\dot{\cdot}$ denotes proportional change. The important point to note is that even if both conditions are satisfied, movements in the two forms of the real exchange rate will not be the same; they will instead be proportional, governed by the factor of proportionality α.

In the limit, if α were unity so that all goods are non-traded, changes in R_p would be identical to changes in R_r. Thus the difference between the changes in the two forms of real exchange rate will be greater, the larger is the share of tradeables in

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[7] It should be noted that if R_r^* is not constant, differences between α and β will be a further source of divergence. Thus conceptually, differences in the degree of openness between nations will influence divergent movement between the two forms of real exchange rate. The extent to which this emerges as an important practical issue is, however, difficult to measure.

domestic consumption.[8] There is, however, a direct relationship between the two measures of the real exchange rate.

3. SOURCES OF DISPARITY

Given that deviations from PPP can only be identified with changes in domestic relative prices under a special set of conditions, it follows that disparate movements in R_p and R_r will reflect a violation of these conditions. Thus central to reconciliation of the two forms of real exchange rate is the relevance of the key assumptions of the law of one price and the stability of relative prices in foreign economies.

The law of one price is one of the oldest postulates of economics.[9] Typically, it is argued to hold in a relative sense so that, allowing for a "wedge factor" of transactions costs, the domestic and foreign prices of traded goods are equated by the exchange rate. Departures from the law are clearly evident in the short run and will detract from the equivalence of R_p and R_r temporarily.[10] However, there is a widespread acceptance that the law of one price is applicable in the long run.

The assumption that domestic relative prices remain stable in foreign economies is more contentious. Some authors have defended the assumption on the grounds that while relative prices will vary in an individual foreign economy, such variations can be expected to offset each other so that, in aggregate, foreign relative prices remain fairly stable (O'Mara *et al.* 1980; Nguyen and Martin 1987). However, the validity of this assumption has been challenged by empirical researchers (Shann 1982, 1986; Whitelaw and Howe 1992; Lowe 1992).

For the purpose of this paper it is assumed that the law of one price holds in the long run. This permits any *systematic* disparity between R_p and R_r to be explained in terms of the way in which the relative prices of non-traded goods changes at home

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[8] If α were zero so that all goods are traded, changes in R_p would also be zero so that no deviations from purchasing power parity would occur as long as the law of one price held.

[9] For an early discussion see Cairnes (1874).

[10] A prominent and comprehensive survey is that by Kravis and Lipsey (1978). For a recent review of the empirical literature see Menon (1992).

and abroad. Relative prices in the domestic economy may move differently to those abroad due to various shocks. In this paper, two main sources of shock are considered: productivity growth in the traded goods sector and changes in the terms of trade. It will be shown that the source of the shock is of primary importance to the interpretation of observed disparities between R_p and R_r.

Consider first, the effect on real exchange rates of a productivity shock.

3.1 Productivity Bias

International differences in rates of productivity are considered to be a key contributor to movements in relative prices at home and abroad and are, therefore, a potential source of divergence between R_p and R_r. The importance of productivity movements in driving relative prices was highlighted by Balassa (1964). In brief, he hypothesised that a country experiencing an increase in the productivity of its traded goods sector would also experience an increase in the relative domestic price of its *non*-traded goods. This change in relative prices is often referred to as "productivity bias". The term "bias" arises because the increase in the price of non-traded goods causes an appreciation of the real exchange rate which makes the domestic currency appear to be "overvalued".[11]

Balassa's arguments have been captured in the Dornbusch (1980) synthesis of the Australian model.[12] In this model, an increase in the productivity of the traded goods sector has the following effect. At the initial relative price, the productivity shock increases demand for labour in the traded goods sector. There is an attendant rise in wages in the traded goods sector which, with mobile labour, also results in an increase in wages in the non-traded goods sector. This generates excess demand for

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[11] Balassa made this observation with respect to deviations from PPP.

[12] Following Salter (1959), Dornbusch (1980) specifies that goods in the traded and non-traded goods sectors are produced using labour (which is mobile between sectors) and capital (which is sector specific). Diminishing returns to labour are assumed. Factor returns are flexible, ensuring continuous full employment.

non-traded goods.[13] Consequently, there is an increase in the relative price of non-tradeables.

Conversely, faster relative productivity growth in the non-traded goods sector will tend to exert downward pressure on the relative price of non-tradeables. However, evidence suggests that productivity growth is faster in the traded goods sector than in the non-traded goods sector. It also suggests that international differences in productivity are greatest in the traded goods sector.[14] The effect of this on relative prices is twofold. First, faster productivity growth in the traded goods sector will contribute to a secular increase in the relative price of non-tradeables. Second, relative prices at home and abroad will move in line with productivity differentials. This not only contributes to divergence between R_p and R_r, but has implications for the interpretation of movements in the respective real exchange rates.

Consider the case in which productivity growth occurs only in the traded goods sector and that this growth is faster in the domestic economy than it is abroad. In this case, R_r will be increasing at a faster rate than $\hat{R_r}$. From equation (6) it follows that the PPP based real exchange rate will also be increasing.

Can such an appreciation necessarily be interpreted as a loss of competitiveness? The answer is, no. Faster productivity growth in the domestic traded goods sector (relative to that abroad) with *no change* in the real exchange rate results in an increase in competitiveness - that is, the domestic traded goods sector is able to attract resources from the non-traded goods sector.[15] However, in equilibrium, it is not possible for the real exchange rate to remain unchanged. It must appreciate. Real appreciation means that the flow of resources into the traded goods sector is reduced relative to the case of no appreciation. Nonetheless, the resource flow is

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[13] At unchanged prices, labour flows out of the non-traded goods sector, reducing the supply of non-traded goods. At the same time, the increased income generated by higher productivity increases the demand for non-traded goods.

[14] Productivity differentials between the traded and non-traded goods sector are estimated by Goldstein and Officer (1979) and Lowe (1992). For an analysis of international differences in productivity and their effects on relative prices see Kravis and Lipsey (1988) and Mellis (1993).

[15] At unchanged relative prices, an increase in the productivity of the traded goods sector would increase the value of marginal product of factors used in the production of traded goods; thus resources would flow into that sector.

positive.[16] In this sense, the competitiveness of the traded goods sector has improved *despite* real appreciation of the currency.

Now suppose that the foreign country experiences faster productivity growth than the domestic economy. In this case, $\hat{R}_r$ will increase at a faster rate than R_r. From equation (6) it follows that R_p will fall. The important point to note is that the two forms of real exchange rate will move in *opposite* directions. However, in this example, the depreciation of R_p indicates that the productivity performance of the domestic traded goods sector is inferior to that of the foreign country.

Can such real depreciation necessarily be interpreted as an increase in competitiveness? Again, the answer is no. In this case, slower growth in productivity (relative to that abroad) with *no change* in the real exchange rate results in a decrease in competitiveness - that is, the traded goods sector is less able to attract resources from the non-traded goods sector. However, in equilibrium, it is not possible for the real exchange rate to remain unchanged. It must depreciate. Real depreciation means that the flow of resources into the traded goods sector is increased relative to the case of no depreciation. Nonetheless, the net flow of resources is away from the traded goods sector. In this sense, the competitiveness of the traded goods sector has decreased *despite* real depreciation of the currency.

In fact, the phenomenon of productivity bias has another implication for real exchange rates. To the extent that it generates secular movements in the relative price of non-traded goods, a sustained divergence between R_p and R_r can arise. In fact, even if rates of productivity growth converge,[17] and domestic relative prices move in exact proportion to those abroad, R_p will remain unchanged but R_r will increase: there will be *no automatic tendency* for these two forms of real exchange rate to move proportionally in the long run.

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[16] It might be otherwise if the income elasticity of demand for non-traded goods was significantly greater than that of traded goods. In this case, the additional income generated by the growth in productivity might cause excess demand for non-traded goods which, in turn, might increase their relative price and encourage resources to flow into the non-traded goods sector. However, in the absence of such evidence, it is assumed that income elasticities are comparable for both classes of good.

[17] Between nations (or groups of nations with similar resource endowments) there tends to be catchup and convergence in patterns of productivity growth in the long run. See Dowrick and Nguyen (1989) for a detailed discussion.

We now turn to an examination of the effect on real exchange rates of a change in the terms of trade.

3.2 Terms of Trade

The potential for movements in the terms of trade to impact differently on relative prices at home and abroad creates another source of divergence between R_p and R_r.

Traditionally, it has been assumed that there is a direct relationship between movements in the terms of trade and both forms of real exchange rate. This assumption has been popularised by Dornbusch (1980). He demonstrated that for a small open economy to attain equilibrium, adjustment to a rise in the terms of trade requires a rise in the relative domestic price of non-traded goods (effected by appreciation of the currency), whilst adjustment to a fall in the terms of trade requires a fall in the relative domestic price of non-traded goods (effected by depreciation of the currency). Consequently, R_p and R_r move in line with each other. This view has been prominent in thinking about open economy macroeconomics.

Certainly, it has been observed that empirical estimates of R_p have a general direct relationship with movements in the terms of trade (Blundell-Wignall and Thomas 1987; Blundell-Wignall and Gregory 1989; Gruen and Wilkinson 1991). However, with respect to R_r, Edwards and van Wijbergen (1987) have established that the impact of a change in the terms of trade on the relative price of non-traded goods is inherently ambiguous. It is governed by the nature of the income and substitution effects arising from terms of trade shocks.[18] Furthermore, Martin and Nguyen (1989) demonstrate that the source of the change in the terms of trade also matters.[19] Thus the impact of a terms of trade shock cannot readily be generalised.

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[18] They demonstrate that the conventional proposition of a direct relationship between movements in the terms of trade and the relative price of non-traded goods is dependent upon the dominance of income effects. They argue that if the dominance of income effects over substitution effects is generally considered an anomaly, then so too should be the existence of a direct relationship between the movements in the terms of trade and R_r.

[19] They show how changes in *export* prices can generate an *inverse* relationship between movements in the terms of trade and R_r. Conversely, changes in *import* prices can generate a *direct* relationship between movements in the terms of trade and R_r.

Nonetheless, the potential for terms of trade shocks to effect divergent movements in R_p and R_r can be shown by simple example. If we abstract from departures from the law of one price and assume that both countries have the same share of non-tradeables in their consumption, then equation (6) can be rewritten:

$$R_p \equiv \frac{\left[\frac{P_n}{P_t}\right]^a}{\left[\frac{P_n^*}{P_t^*}\right]^a} \equiv \left[\frac{R_r}{R_r^*}\right]^a \tag{8}$$

Now assume that the domestic economy experiences an improvement in its terms of trade generated by an *increase in the price of its exports*. Both P_t and $P_t^{\wedge}$ will increase. However, the terms of trade shock will affect R_r and $R_r^{\wedge}$ differently. Domestically, higher income generated through higher export prices will increase the demand for non-traded goods.[20] Similarly, the increase in the relative price of exports will induce substitution in consumption towards non-tradeables (and substitution in production away from them). These positive income and substitution effects will place upward pressure on P_n. In general, these effects will not lead to an increase in P_n of the same magnitude as the increase in P_t. As a consequence, R_r will actually fall.[21]

In the foreign country, the same substitution effects are at work. However, for the foreign economy, imports are now more expensive. This has a negative income effect that partially offsets any rise in $P_n^{\wedge}$ associated with the substitution effects. Hence, $R_r^{\wedge}$ is likely to fall by *more* than the fall in R_r, so that R_p increases. In other words, following an increase in the price of home country exports, the relative price of non-tradeables will fall, but the PPP based measure of the real exchange rate will

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[20] Assuming that they are normal goods.

[21] This is consistent with Edwards and van Wijbergen (1987). However, intuitively, following a commodity price boom, the combined income and substitution effects are seldom observed to be so great that P_n increases by proportionately more than P_t. In even simpler terms, a wool price boom will not generate an increase in the price of haircuts of the same order of magnitude.

appreciate. Contrary to convention, R_r varies inversely with the terms of trade, while R_p varies directly with it.[22]

In contrast, if the improvement in the terms of trade is generated by a *fall in the price of imports* the conventional relationship holds. In this case, both P_t and P_t^* will fall. Domestically, the positive income effect generated by lower import prices acts to force up the price of non-tradeables while the substitution effects exert downward pressure. The net effect on the price of non-traded goods is ambiguous. However, even if the substitution effects are extremely strong, it is unlikely that the price of non-tradeables would fall by as much as that of tradeables. For the foreign economy, the price of its exportables has now fallen, generating negative income and substitution effects such that R_r^* can be expected to rise by *less* than R_r, so that R_p also increases. In other words, following a fall in the domestic price of importables, both R_r and R_p can appreciate and thus vary directly with the terms of trade.

In summary, only when changes in a nation's terms of trade are caused by changes in import prices, are R_p and R_r likely to move in the same direction. Conversely, when changes in a nation's terms of trade are sourced to export prices, movements in R_p and R_r are likely to be of opposite sign. Furthermore, if there is a secular deterioration in the terms of trade caused by falling export prices, a sustained divergence between R_p and R_r will arise, just as in the case of productivity bias. If, however, movements in the terms of trade are purely cyclical then there may be a periodic divergence between R_p and R_r which is subsequently reversed.

In the following section, estimates of R_p and R_r are presented for Australia and a range of other countries. We use the framework established in Section 3 to help interpret both the broad trends in the two measures of the real exchange rate and the periodic sharp divergence between them. We rely on graphical analysis. Unlike the use of econometrics, this approach lacks the discipline of reporting significance levels. However, the results of graphical analysis lend support to our theoretical propositions about the impact of both terms of trade shocks and productivity bias on the movement of the two measures of the real exchange rate.

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[22] Similarly, an inverse relationship between R_r and the terms of trade is found for the case of a fall in export prices.

4. EVIDENCE OF A DISPARITY

4.1 Measuring Real Exchange Rates

Estimates of the PPP based real exchange rate, R_p, are obtained by adjusting a weighted nominal exchange rate index for differential movements in prices between the domestic economy and foreign economies. Institutions such as the International Monetary Fund, the OECD and Morgan Guaranty publish a variety of real exchange rate indices for various countries. In this paper we use the Morgan Guaranty series for our international comparisons as they are published for a broader range of countries and for a longer time period that are the other series.[23] For Australia, we use the Reserve Bank's estimate of the real trade weighted index (TWI), as this measure of the real exchange rate is very similar to the Morgan Guaranty series. Data are described in the Appendix.

As discussed by Dwyer (1992), estimates of the domestic relative price form of the real exchange rate, R_r, can be obtained in two main ways:

- the "direct" approach, in which the price of output from broad industry divisions nominated as representative of the non-traded goods sector is compared with the price of output of industries representing the traded goods sector; and

- the "indirect" approach, in which the relevant output prices are not known. The relative price of non-traded goods is measured indirectly by dividing an index of the general price level by the price of traded goods, with the latter proxied by an average of export and import prices.

The direct approach relies on the availability of implicit price deflators or price indices for specific classes of goods. Whilst most examples of this approach use highly aggregated data and generate crude proxies of relative prices, an exception is that by Dwyer (1992) in which a sophisticated estimate of relative prices for Australia is presented. The results of Dwyer (1992) have been updated and will be

[23] In the Morgan Guaranty series, weights are proportional to the absolute value of trade between the domestic economy and its trading partners. In adjusting for differences in inflation across countries, the price of non-food manufactures is used.

used here to represent relative domestic prices in Australia.[24] Unfortunately, however, equivalent measures are not available for other countries. In consequence, to obtain a proxy for relative prices abroad, the indirect approach was employed as it does not require sectoral price indices. Following Pitchford (1986), the general price level is measured by the CPI and divided by a simple average of the implicit price deflators for exports and imports.[25]

4.2 Australia's Real Exchange Rate

The real TWI (R_p^{twi}) and an index of domestic relative prices (R_r^{cpi}) are illustrated in Figure 1. A fall in either index implies real depreciation. It is apparent that the two measures behave quite differently. Of the two indices, R_p^{twi} has been considerably more volatile, with episodes of sharp depreciation in the mid 1980s and again more recently. In contrast, R_r^{cpi}, after moving in a relatively narrow band in the 1970s, has exhibited a pronounced upwards trend over the 1980s.

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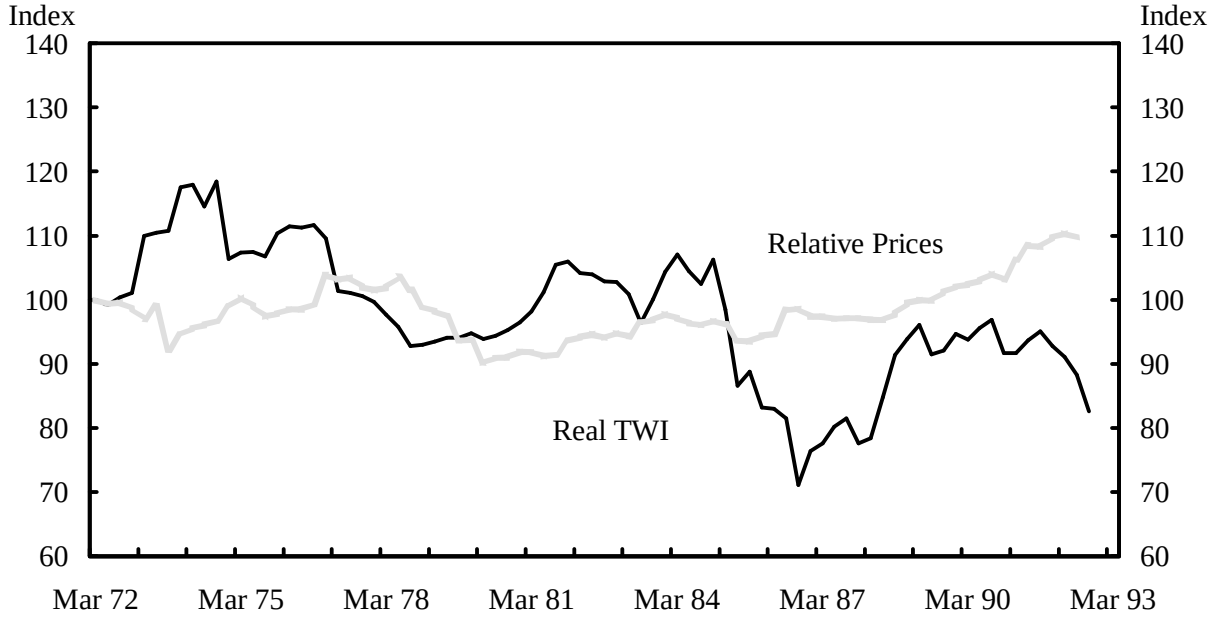
[24] Dwyer (1992) uses input-output tables to classify each of the 108 industries in the commodity details of the national accounts as either tradeable or non-tradeable and then constructs the relevant price indices using these classifications. The measure draws on an unpublished ABS data set that covers the period from the March quarter 1970 until the March quarter 1990. However, the series has since been updated to the June quarter 1992. In the international literature, see also Mellis (1993) for a sophisticated direct estimate of relative prices in for a number of European countries. Mellis uses detailed consumer price data to construct a relative price series for goods (tradeables) and services (non-tradeables).

[25] Estimates of relative prices based on this method need to be interpreted with some caution. Recalling that α is the share of non-traded goods in the CPI, this measure can be expressed as:

$$R_r = \left(\frac{P_t}{P_t^*}\right)^{a} \qquad (2')$$

If α is different in each economy, movements in this proxy of relative prices are not directly comparable across counties. In addition, abstracting from other measurement problems, movements in this index will underestimate movements in actual relative prices as α is less than one. (This underestimation is greater the smaller is α.)

Figure 1: Measures of Australia's Real Exchange Rate
March 1972 = 100



Ultimately, in the absence of measurement problems, disproportionate movements between R_p^{twi} and R_r^{cpi} must reflect a violation of the conditions which relate the two forms of the real exchange rate - that is, the law of one price and unchanging relative prices abroad.

Whilst it is assumed that the law of one price holds in the long run, short-run departures from the law of one price are self evident and will contribute to disparities between R_p^{twi} and R_r^{cpi}. This is so because whilst changes in the nominal exchange rate impact immediately on R_p^{twi}, this need not be the case for R_r^{cpi}. Unless exchange rate pass-through is both complete and instantaneous, movements in domestic relative prices will both lag those of R_p^{twi} and exhibit smaller oscillations. However, other things being constant, when the process of pass-through is complete, the two forms of real exchange rate should move similarly.[26]

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[26] As discussed in Dwyer, Kent and Pease (1993), the bulk of exchange rate pass-through to free on board import prices occurs in the first two quarters and is complete after one year. A similar rate of pass-through is found for commodity exports (Heath 1991). Thus to the extent that departures from the law of one price drive disparate movements in the two forms of real exchange rate, this is likely to be significant for only two or three quarters.

Instead, the focus of this paper is on situations in which there may *not* be an automatic tendency for R_p^{twi} and R_r^{cpi} to move similarly. These situations emerge when relative prices at home and abroad move differently, reflecting real factors such as changes in productivity and terms of trade shocks.

First, the secular increase in the relative domestic price index is suggestive of trend growth in the productivity of the tradeables sector exceeding that of the non-tradeables sector. As shown analytically, if the increase in the relative price of non-tradeables abroad is greater than that at home, the PPP based real exchange rate will depreciate even though the domestic relative price of non-tradeables is increasing. This appears to have happened over the 1980s: R_r^{cpi} has increased whilst R_p^{twi} has fallen.

Second, the two forms of real exchange rate appear to respond differently to movements in the terms of trade. As noted in the theoretical discussion, the terms of trade should be *positively* correlated with R_p^{twi}. The strength of this direct relationship is illustrated in Figure 2.[27] It is most evident during the major swings in the terms of trade during the early 1970s and mid 1980s.

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[27] The implicit price deflators used in the calculation of the terms of trade exclude computers. This is so for two main reasons. One, their prices have fallen rapidly in recent years, significantly affecting the aggregate deflator for imports. Two, the method employed by the Australian Bureau of Statistics to estimate computer prices differs to that adopted by other agencies and detracts from the comparability of domestic and foreign prices of traded goods.

Figure 2: PPP Deviations and the Terms of Trade
March 1972 = 100

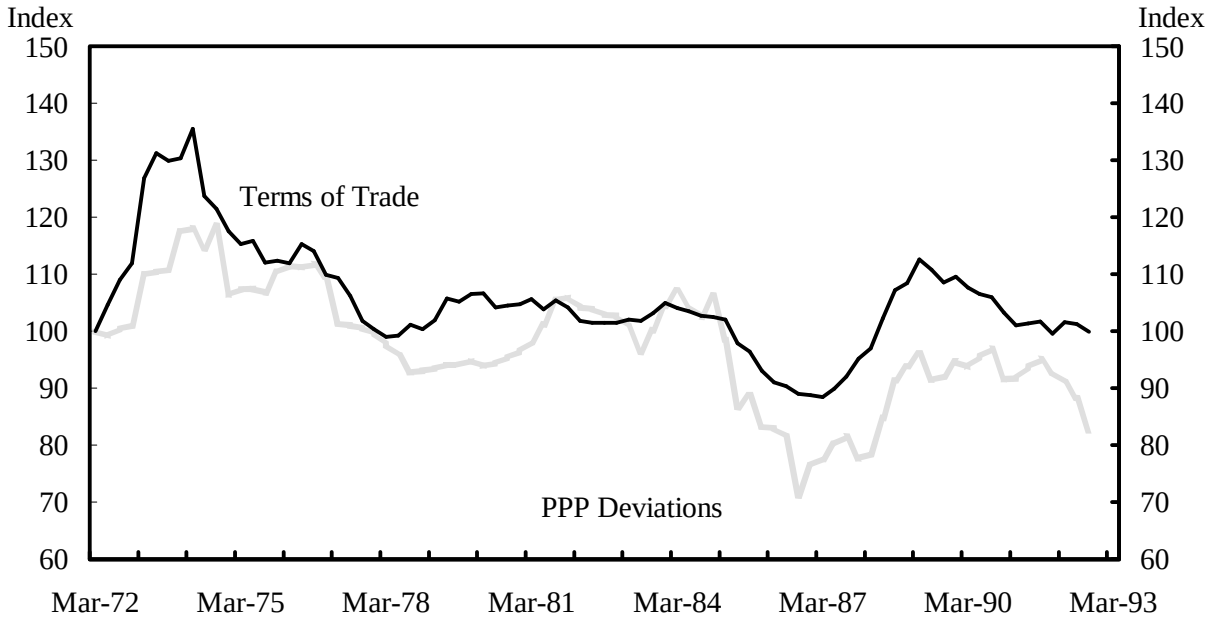
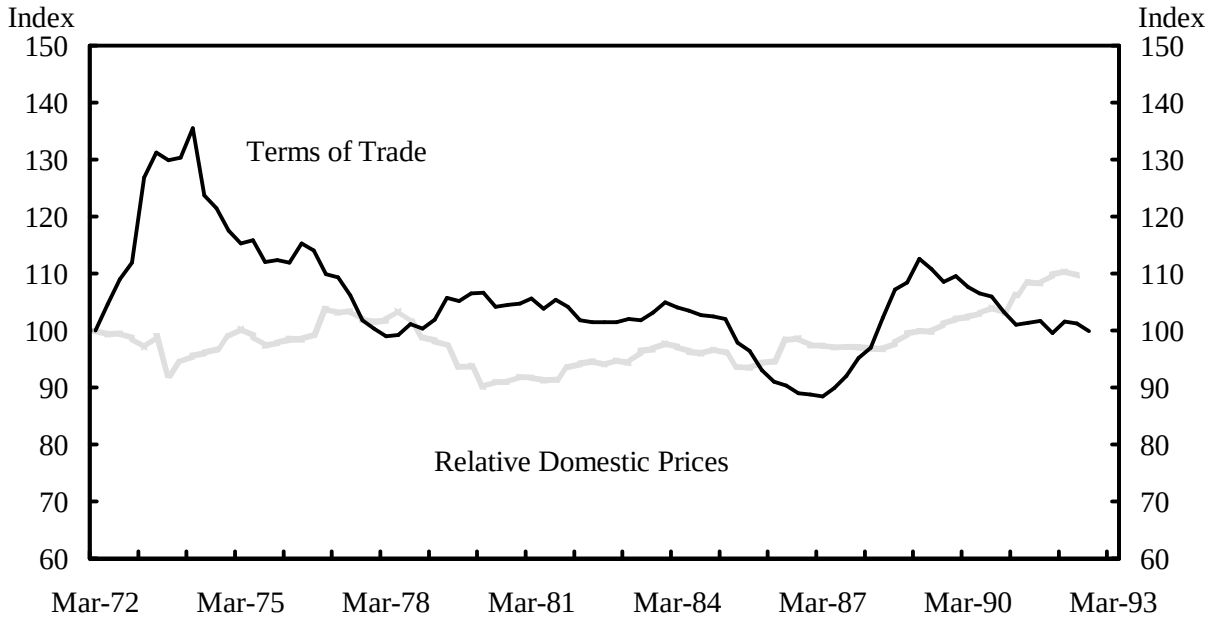


Figure 3: Relative Domestic Prices and the Terms of Trade
March 1972 = 100



Conversely, it was noted in the theoretical discussion that R_r^{cpi} should be *negatively* correlated with the terms of trade when export prices change. A general inverse (although not tight) relationship between the terms of trade and R_r^{cpi} is suggested in Figure 3. This result is consistent with observations that Australia's terms of trade shocks are most often generated by changes in export prices. For instance, in the early 1970s, the price index for non-tradeables increased more slowly than that for tradeables so that the relative price index fell. This occurred at a time when the terms of trade improved due to a rise in export prices. The same inverse relationship is apparent during the major changes in the terms of trade in the late 1970s and the mid 1980s. Thus changes in export prices are likely to produce pronounced differences between the two forms of real exchange rate, whilst differences in trend productivity growth will contribute to an increase in the underlying divergence between them.

4.3 International Comparisons

We now turn to a number of international comparisons, paying particular attention to two issues:

(i) Is the Australian experience of an increase in the relative price of non-tradeables common to other countries?

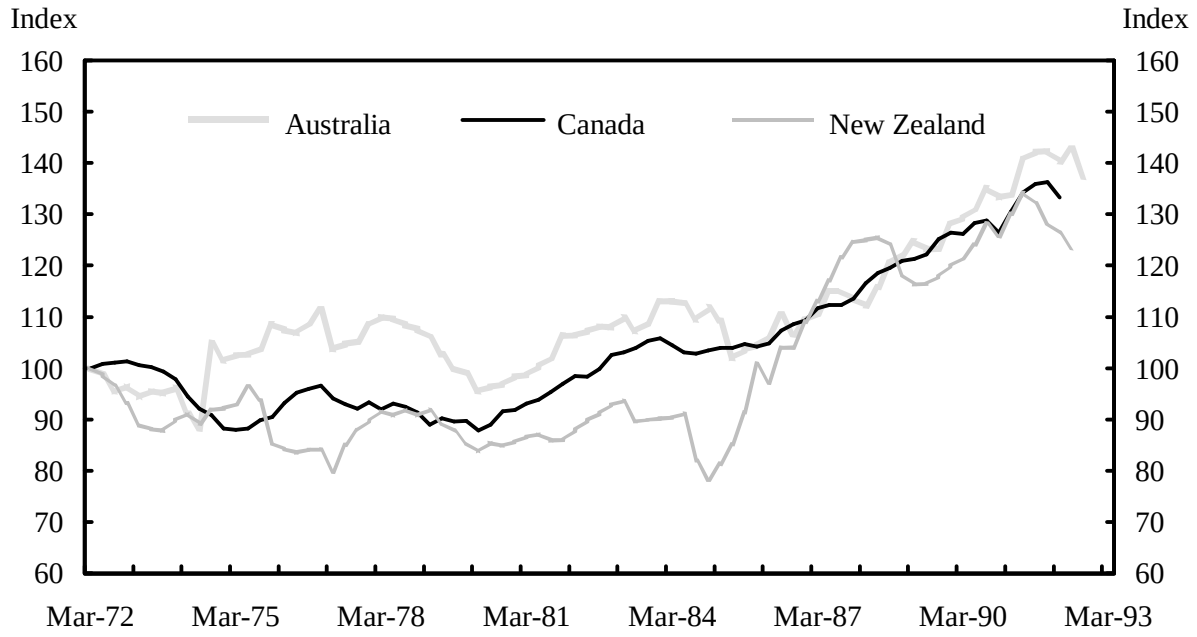
(ii) What relationship exists between movements in the terms of trade and the real exchange rate in other countries?

4.3.1 Secular Movements in Domestic Relative Prices

In this section we present estimates of domestic relative prices (R_r^{cpi}) for a range of countries. Figure 4 presents R_r^{cpi} for Australia, New Zealand and Canada. Each of these countries is a small open economy that is subject to large relatively swings in its terms of trade. Figure 5 presents R_r^{cpi} for four European countries: France, Germany, Italy and the United Kingdom. Figure 6 presents this domestic relative price index for the United States, Japan and South Korea. Figure 7 shows the index for Norway, the Philippines and Pakistan. These figures show that over the 1980s, in all countries (except for Pakistan), the price of non-traded goods has increased at a faster rate than the price of traded goods. Clearly, the Australian experience of a secular rise in the relative price of non-tradeables is not unique.

Simple proxies of domestic relative prices must be interpreted with caution. In particular, it is difficult to relate directly movements in such prices to differential rates of growth in productivity in the traded and non-traded goods sector, where similarly crude proxies are used.[28] Furthermore, it is difficult to separate the effect of productivity bias from other effects, especially when countries are characterised by different degrees of stability in their general price level or in their terms of trade. Such an exercise in beyond the scope of this paper. Nonetheless, for those countries with unambiguously high rates of productivity growth in the traded goods sector (such as Korea and Japan) the rise in the relative price of non-tradeables has been greater than elsewhere. Conversely, in those countries where productivity growth in the traded goods sector is unambiguously low (such as Pakistan and the Philippines), the rise in the relative price of non-tradeables has been less than elsewhere.

Figure 4: Relative Prices: CPI Divided by Price Index for Tradeables
March 1972 = 100



[28] The essential problem is accurately identifying what constitutes the traded and non-traded goods sector in each country. Sectors are most often defined as traded or non-traded *a priori* rather than according to a formal classification system. Whether or not prices, output or productivity rates are representative of a given sector is rarely tested.

Figure 5: Relative Prices: CPI Divided by Price Index for Tradeables
March 1972 = 100

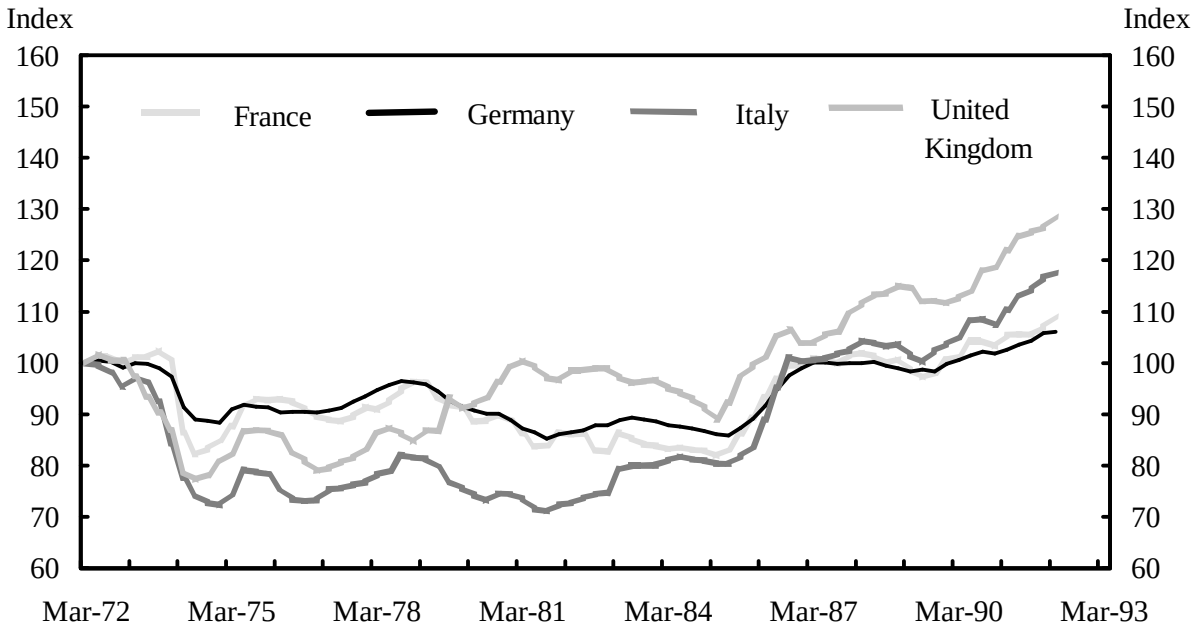


Figure 6: Relative Prices: CPI Divided by Price Index for Tradeables
March 1972 = 100

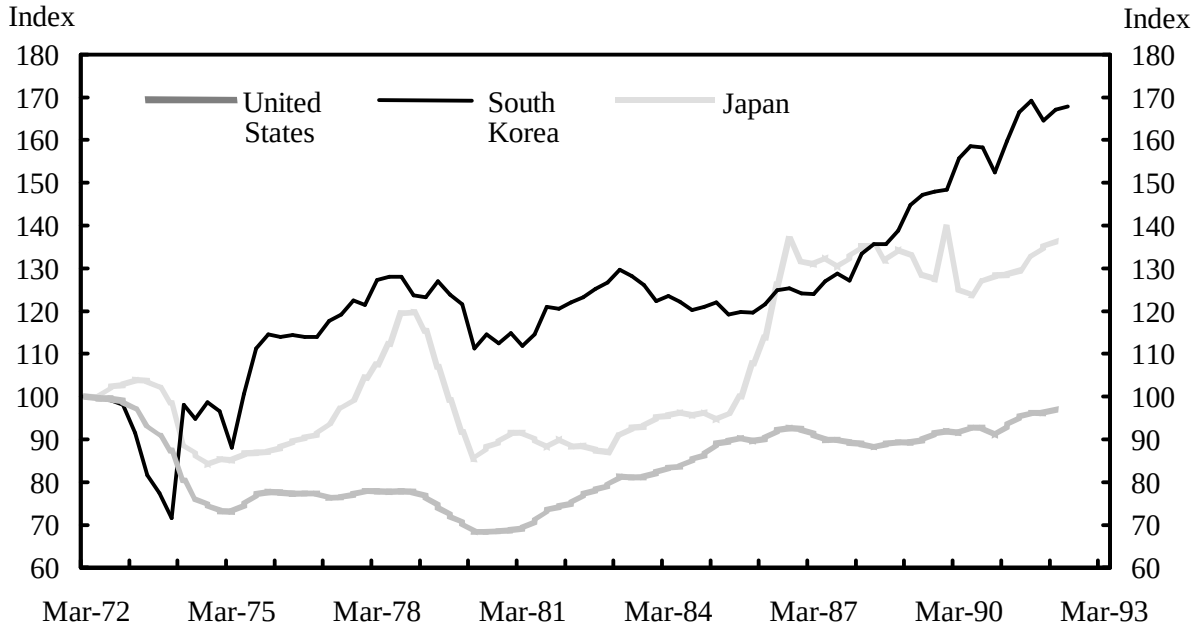
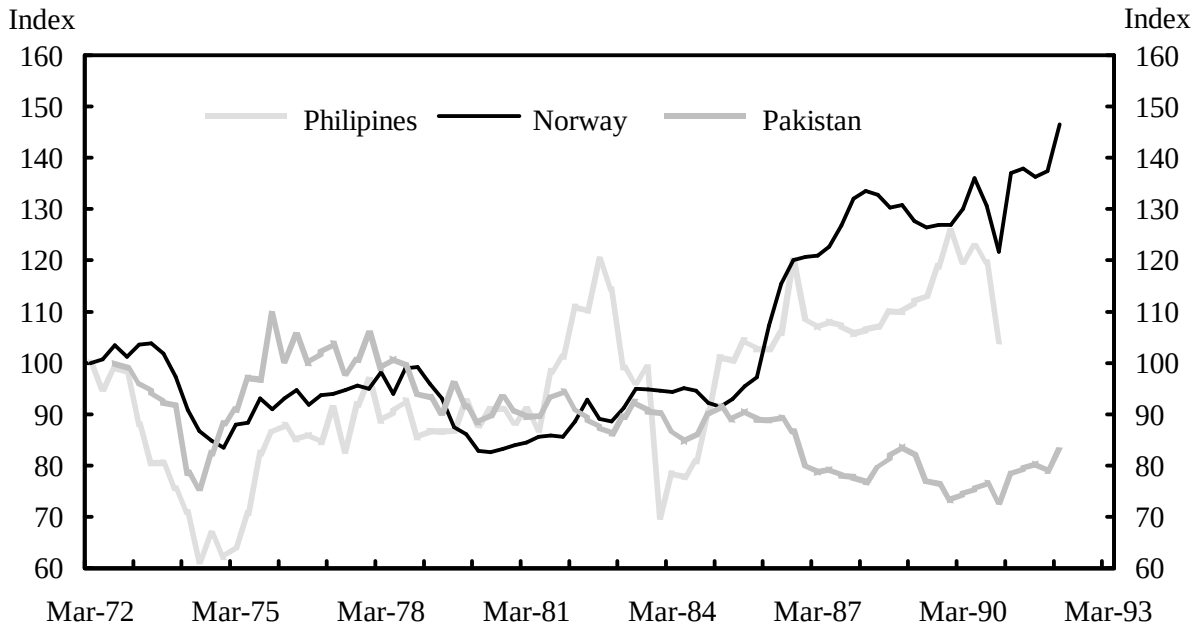


Figure 7: Relative Prices: CPI Divided by Price Index for Tradeables
March 1972 = 100



The figures reveal another important aspect of trend movements in domestic relative prices. In almost every country, the general increase in the relative price of non-traded goods was restricted to the 1980s. Of the 13 countries examined, only one experienced a net increase in the relative price of non-tradeables between 1972 and 1980. This raises the question of why the experience of the 1980s is so different to that of the 1970s? To a large extent, the answer lies in the substantial increase in oil prices in 1974 and 1979. These increases represented a direct increase in the relative price of traded goods. In addition, in oil importing countries, higher oil prices represented a sizeable shock to real income. This income shock placed further downward pressure on the relative price of non-tradeables. The reverse process occurred in 1986 when oil prices fell substantially. Lower oil prices meant lower traded goods prices. Further, in oil-importing countries the lower prices generated positive income effects and upward pressure on non-traded goods prices. Since 1986, most countries have experienced further upward pressure on the relative price of non-tradeables. The influence of the oil price shocks invites further consideration of the relationship between real exchange rates and the terms of trade.

4.3.2 Real Exchange Rates and the Terms of Trade

In the case of Australia it was argued that increases in the terms of trade are likely to lead to an appreciation of the PPP based real exchange rate, but to a decrease in the relative price of non-tradeables. This inverse relationship between the terms of trade and the relative price of non-tradeables reflects the fact that, in general, changes in export prices, rather than import prices drive the terms of trade. In contrast, in countries for which import prices are more volatile than export prices, a positive relationship between relative prices and the terms of trade should be the result. This point can be seen in the following figures. These graphs show the terms of trade, domestic relative prices and PPP based measures of the real exchange rate for four countries: Japan, Korea, the United States and Norway. For the first three of these countries, import prices are more volatile than export prices. In contrast, Norway, like Australia, experiences greater volatility in its export prices than in its import prices.

The PPP based real exchange rate presented in these graphs is the Morgan Guaranty measure (R_p^{MG}). Recall that this measure uses the wholesale price of non-food manufactures to deflate the nominal effective exchange rate index. This price series comprises a disproportionate share of traded goods and may not be a good measure of the general price level in all countries, especially those with a high share of non-tradeables in their consumption bundle or those in which relative price changes have been pronounced. Unfortunately, PPP based real exchange rates that include general consumer prices are not readily available back to 1972 for the countries under review. In consequence, a real exchange rate that incorporates a general consumer price index was also constructed.[29] The result was little different for all countries for which it could be calculated, with the exception of Japan. For Japan, the two measures are quite different and thus both are shown.[30]

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[29] Given that a consistent published series of PPP real exchange rates based on consumer prices is not available back to 1972, a simple proxy was calculated. The Morgan Guaranty *nominal* trade weighted index (against industrial countries) was multiplied by the home country CPI and then divided by the IMF's estimate of an aggregate industrial country CPI.

[30] Similar differences might be expected for Korea. However, this cannot be tested readily as Morgan Guaranty do not estimate a nominal effective exchange rate for Korea which can be adjusted for differences in consumer prices domestically and abroad.

Figure 8: The Real Exchange Rate, Relative Prices and the Terms of Trade: Japan
March 1972 = 100

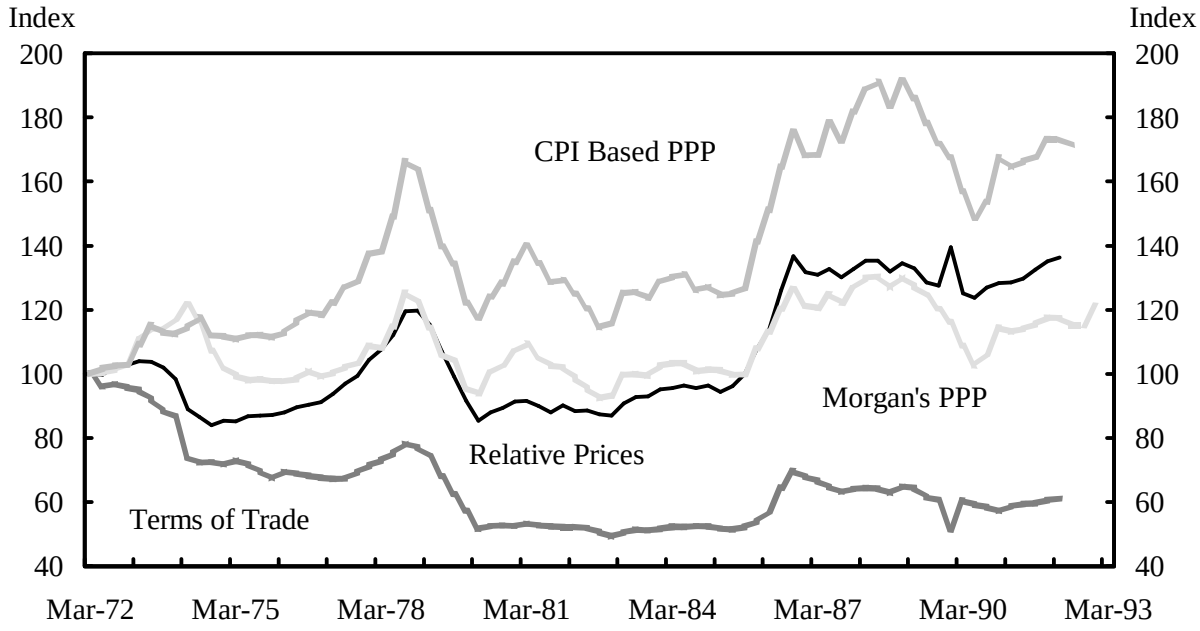


Figure 9: The Real Exchange Rate, Relative Prices and the Terms of Trade: Korea
March 1972 = 100

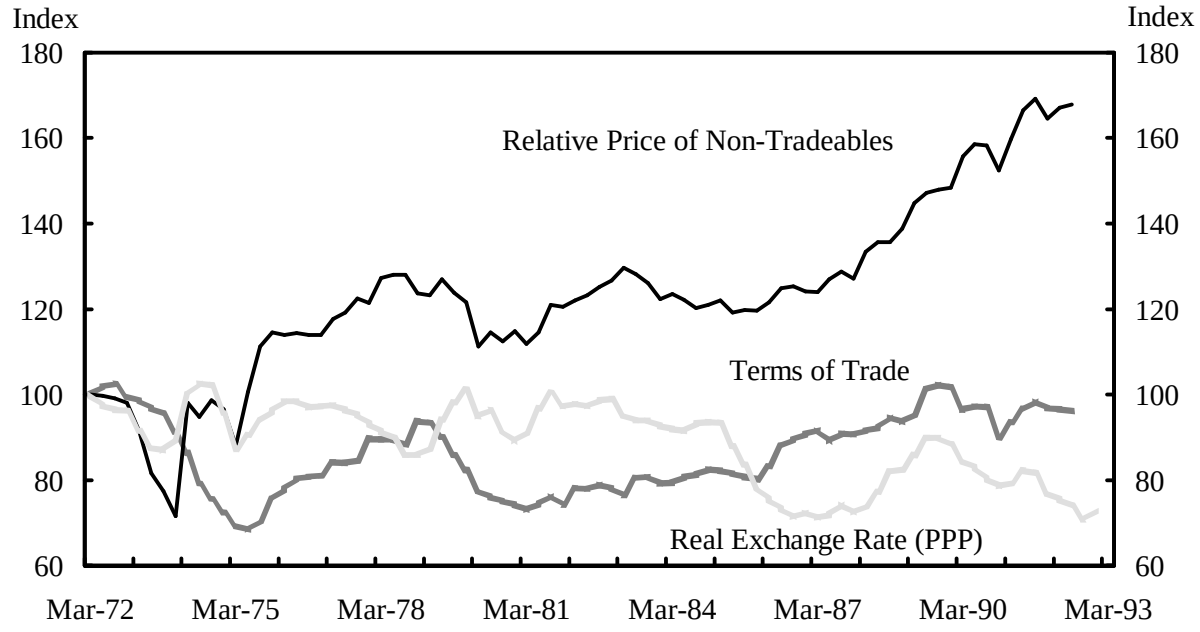


Figure 10: The Real Exchange Rate, Relative Prices and the Terms of Trade: USA
March 1972 = 100

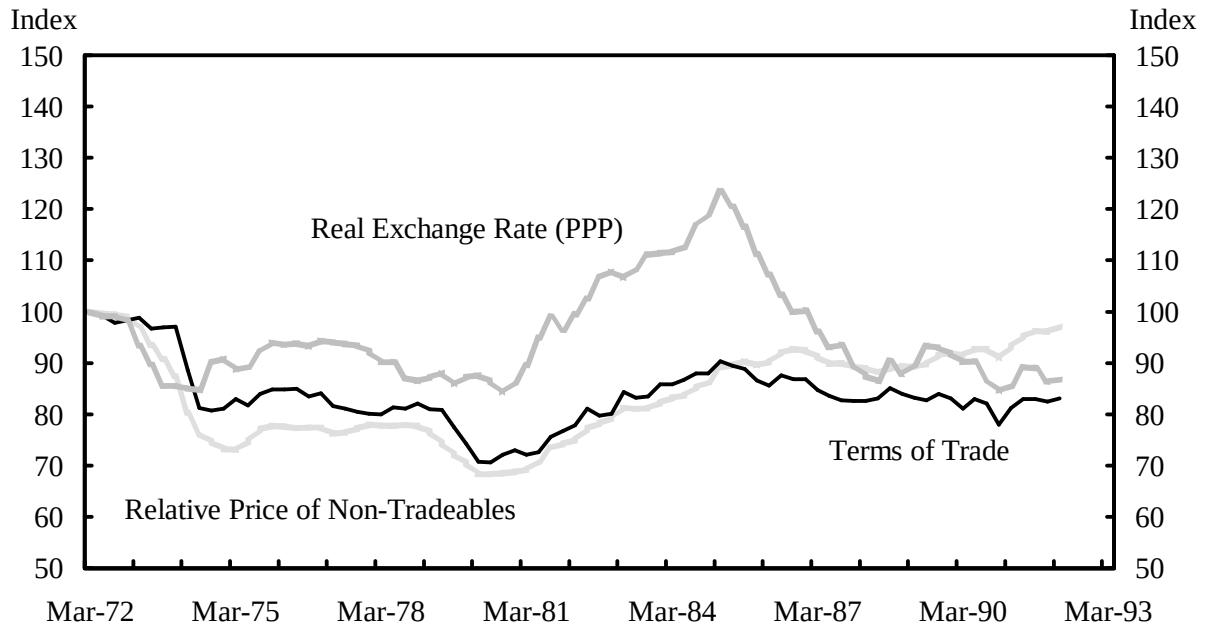
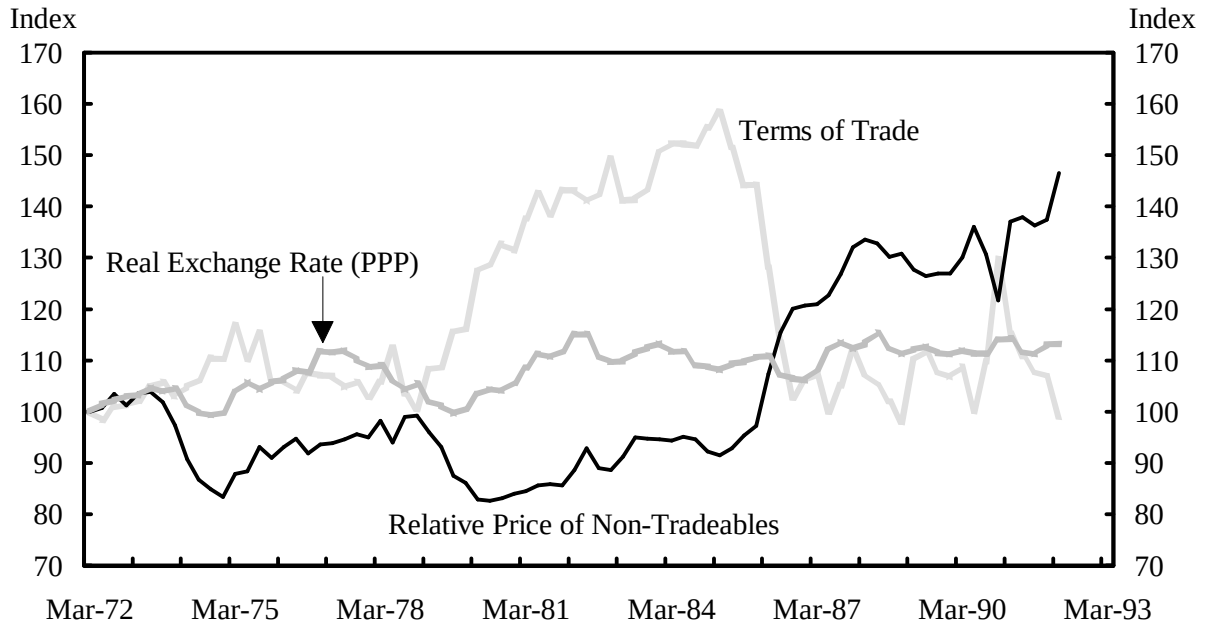


Figure 11: The Real Exchange Rate, Relative Prices and the Terms of Trade: Norway
March 1972 = 100



We begin by examining the Japanese case. Figure 8 shows the Japanese terms of trade, relative domestic prices and the two measures of the PPP based real exchange rate. Japan appears to be the classic textbook case. Large improvements in its terms of trade lead to an appreciation of both PPP based measures of the real exchange rate and also to an increase in the relative price of non-traded goods, as is the traditional view.

This outcome for Japan reflects several key points outlined in the theoretical discussion. First, the trend increase in the relative price of non-tradeables is consistent with faster productivity growth in Japan's traded goods than in its non-traded sector. Second, the appreciation of the PPP based real exchange rate is consistent with faster productivity in Japan's traded goods sector relative to those abroad. (In fact, in this regard, it is not surprising that the PPP based measure which uses consumer prices has appreciated considerably more than the Morgan Guaranty index as the former will include a greater share of prices of non-tradeables.) Third, the positive correlation between both forms of real exchange rate and the terms of trade arises from the fact that shocks to the Japanese terms of trade come primarily through shocks to import prices, in particular oil.[31]

The Korean case is a little more difficult to interpret (see Figure 9). It might be expected that a faster rate of growth in productivity of Korea's traded goods sector would drive up the relative price of non-traded goods by more than in its trading partners so that *both* forms of real exchange rate would appreciate. Instead, only the domestic relative price index increased. Domestic relative prices are, in general, positively correlated with the terms of trade. However, there has been a slight downward trend in the conventional real exchange rate. In fact, movements in the real value of the currency appear, to a significant extent, to be detached from the terms of trade.

In the United States, movements in relative prices have been much less pronounced than in either Korea of Japan (see Figure 10). However, just as in Korea and Japan,

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[31] A qualification is required here. The Japanese terms of trade is, to some extent, endogenous: by improving productivity in its traded goods sector, it reduces the relative price that it receives for its exports, leading to upward pressure on its real exchange rate. However, *major* swings in the terms of trade are exogenous and tend to come about through increases in the world price of its inputs. In this case, both forms of the real exchange rate are positively correlated with the terms of trade, in accordance with conventional wisdom.

the relative price of non-tradeables has been positively correlated with the terms of trade. So too has the PPP based measure of the real exchange rate, suggesting that terms of trade shocks in the United States are typically caused by changes in import prices.[32]

Finally, the Norwegian experience shown in Figure 11 is similar to that of Australia: the terms of trade is negatively correlated with the relative price of non-tradeables. Norway is, however, an oil exporting nation. Thus the improvement in Norway's terms of trade following the oil price increase in 1979 was associated with a fall in the relative price of non-tradeables. Conversely, the fall in its terms of trade following the collapse of oil prices in 1986 saw the relative price of non-tradeables increase. These changes in relative prices associated with the terms of trade have occurred against the background of a general secular increase in the relative price of non-tradeables.

5. SUMMARY AND CONCLUSIONS

In this paper an attempt has been made to reconcile two alternative forms of the real exchange rate: that based on domestic relative prices and that based on deviations from purchasing power parity. It was shown analytically that the two forms of the real exchange rate will only move similarly under restrictive conditions - namely, that the law of one price holds and relative prices are constant in foreign economies. It was argued that, in the short run, departures from the law of one price would contribute to differential movement between the two forms of real exchange rate. More importantly, it was shown that changes in the terms of trade or sectoral differences in productivity growth are likely to cause a systematic divergence between the two forms of the real exchange rate.

Estimates of domestic relative prices and deviations from PPP were presented for Australia and a number of foreign economies. Propositions regarding the

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[32] In the United States, the terms of trade are, to a significant extent, endogenous. For this reason, one might expect positive correlation between the PPP based real exchange rate and the terms of trade. However, the US is subject to some exogenous shifts in its terms of trade, in particular due to oil price shocks. Of interest is the fact that, at these times, the relative price of non-tradeables *also* exhibits positive correlation with the terms of trade, consistent with the proposition that terms of trade shocks are sourced to import prices.

relationship between them were, in general, supported by the data. Relative prices were shown to vary abroad, contributing to divergence between the two forms of real exchange rate. In fact, a tendency for a secular rise in the relative price of non-tradeables was evident in most countries, consistent with the hypothesis of faster productivity growth in the traded goods sector than in the non-traded goods sector. However, when large movements in both forms of the real exchange rate occurred within a short period of time, the driving force was the terms of trade. Furthermore, for countries whose terms of trade are driven by changes in import prices, it was found that both measures of the real exchange rate moved in the same direction: they were positively correlated with the terms of trade. In contrast, for countries whose terms of trade are driven by export prices, it was found that the two measures of the real exchange rate moved in different directions: relative prices were negatively correlated with the terms of trade whilst the real value of the currency was positively so. Certainly, for Australia, as a commodity exporting nation, divergent movements of the two measures of the real exchange rate were greatest at the time of major changes in the nation's export prices.

These findings raise several issues relevant to the policy maker. These issues centre on the proper interpretation of relative price movements and the efficacy of seeking to alter them.

For some time in public debate, it has been argued that the rise in the relative price of non-tradeables in Australia warrants nominal depreciation of the currency. The argument is along the lines that the trend rise in the relative price of non-tradeables has reduced the competitiveness of the traded goods sector and, hence, led to a larger current account deficit. While the argument that, if all else remains the same, high relative prices of non-traded goods reduce the competitiveness of the traded goods sector is true, all else has not remained the same. In Australia, as elsewhere, the relative price of non-tradeables has shown a secular increase reflecting faster productivity growth in the traded goods sector than in the non-traded goods sector. In fact, the faster is such productivity growth, the faster is the increase in the relative price of non-tradeables likely to be. It is, therefore, incorrect to conclude, simply on the basis of an observed rise in the relative price of non-tradeables, that the Australian dollar is overvalued.

In the short run, however, relative prices can be altered by monetary policy. For instance, an unexpected easing of monetary policy is likely to result in depreciation

of the nominal exchange rate. Assuming some (if not instantaneous) exchange rate pass-through, this will lower the relative price of non-tradeables. With sticky prices, it will also depreciate the PPP based real exchange rate. These falls in the measures of the real exchange rate will generate improvements in competitiveness. Indeed, this improvement in competitiveness is an important part of the monetary transmission mechanism. But, the important point to stress is that this improvement in competitiveness will be only *temporary*, dissipating as the price of non-traded goods rises and relative prices are restored. In some cases, policy makers may wish to engineer such temporary changes in competitiveness. Repeated attempts will, however, result in a sustained increase in inflation and no improvement in competitiveness.

In the longer run, changes in the real exchange rate measures are driven by fundamentals such as shifts in productivity and the terms of trade: they are endogenous and independent of monetary policy. This does not mean that government policy cannot indirectly influence the real exchange rate. However, only actions of government directed at altering the *real* economy will influence the real exchange rate in a sustainable way. Ultimately, efficiency gains that increase the ability of the traded goods sector to attract resources from competing sectors (both domestic and foreign) will induce appreciation of the real exchange rate, however defined.

APPENDIX: DATA

All data series are quarterly and period averages where relevant. For most countries, data range from 1972:1 to 1992:3.

(a) Domestic Relative Prices

For Australia, the domestic relative price indices are calculated as in Dwyer (1992). Industries are classified as traded if at least 10 per cent of their total supply (total usage) is of exports (competing imports), as represented in the absorption matrix where competing imports are allocated to industries indirectly. The income based measure of GDP is then estimated for each industry and the traded and non-traded goods sectors as a whole. Weights (proportional to each industry's share of sectoral GDP) are applied to disaggregated price data to form price indices for traded and non-traded goods.

For the United States, Japan and Norway, the domestic relative price indices are calculated as the CPI divided by the simple average of the implicit price deflators for exports and imports.

For the Philippines, Pakistan and Korea, indices of unit values of exports and imports are used in place of implicit price deflators.

Source: ABS, Catalogue No. 5209.0, 5206.0, 5302.0 and 5211.0; ABS, unpublished producer prices and expenditure classes of the CPI; OECD, *Main Economic Indicators*; IMF, *International Financial Statistics*; Datastream, Country Sources.

(b) Deviations from PPP

For Australia, this is the Reserve Bank's real trade weighted index. Weights are proportional to the absolute value of trade between Australia and its 22 largest trading partners. The CPI is the measure of price.

For all other countries, the Morgan Guaranty real effective exchange rate is used. This is calculated similarly to the Reserve Bank measure for Australia. It is a real trade weighted exchange rate index with weights proportional to the absolute value of total trade between the domestic economy and a common group of 40 countries (18 industrialised and 22 developing). The wholesale price index of non-food manufactures is the measure of price.

Source: Reserve Bank of Australia; Morgan Guaranty, *World Financial Markets*.

(c) Terms of Trade

For Australia, the terms of trade is defined as the ratio of the implicit price deflators for exports and imports of goods and services, adjusted to exclude the prices of computers. For computer imports, the Standard Industrial Trade Classification categories 752 and 75997 are used. For computer exports, only the more general SITC division 75 was available and only from 1978:3.

For the United States, Japan and Norway, the terms of trade is measured as the ratio of the implicit price deflators for exports and imports of goods and services, but without adjustment for computers.

For the Philippines, Pakistan and Korea, indices of unit values of exports and imports are used in place of implicit price deflators.

Source: ABS Catalogue No. 5206.0 and 5302.0; Datastream, Country Sources.

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