DEFINITIONS AND CALCULATIONS OF REAL EXCHANGE RATES: AN APPLICATION TO SOUTH AFRICA

by

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GLOSSARY

CPI : CONSUMER PRICE INDEX

WPI : WHOLESALE PRICE INDEX

GDP : GROSS DOMESTIC PRODUCT

CONTENTS

In recent years economists have used several different definitions of the real exchange rate and, as a result of this proliferation, confusion has arisen in two areas. Depending on the definition used, so the real rate will either rise or fall in response to an exogenous shock and, given a particular definition, it has been shown that it has not been possible unambiguosly to predict how the real rate will change as a result of these shocks (Edwards 1987). The aim of this paper is to enumerate the different definitions of the real exchange rate, suggesting a possible reconciliation in terms of their usage and the ambiguities that have arisen. Measurement of the various concepts of the real exchange rate is then made for the South African economy. It is shown that, for a small open economy dominated by the production of a single commodity which is subject to price variability, the choice of real exchange rate to be used is critical when determining whether the rate is over- or undervalued.

Definitions of the Real Exchange Rate

1. **Purchasing Power Parity (PPP) Real Exchange Rate**

The earliest definition of the real exchange rate has been called the purchasing power parity real exchange rate where the nominal exchange rate (E) is multiplied by the ratio of the foreign price level (P^*) to the domestic price level (P). Therefore, letting e(ppp) be the real exchange rate, $e(ppp) = EP^*/P$. E is the price of a unit of foreign currency in terms of domestic currency. P and P^* have been measured as CPIs, WPIs, GDP deflators and unit labour costs. If CPIs are used, then in the case of bilateral rates this measure of the real exchange rate is the relative price of the baskets of consumption goods in the two countries.

When effective nominal exchanges rates are used, it is a weighted average consumption basket for all trading partners and the home country consumption basket which are compared. If WPIs or GDP deflators are used the baskets consist of production goods whereas if unit labour costs are used, relative labour costs in production are the focus of interest. In addition, if WPIs are used this is equivalent to measuring the real exchange rate as the terms of trade, given that wholesale prices exclude services and can thus be considered as proxies for the prices of traded goods (Katseli 1984).

2. The Ratio of the Price of Tradables to the Price of Nontradables

The real exchange rate has also been defined as the relative price of tradable to nontradable goods. This definition sprang from the dependent economy models (see Salter 1959, Corden 1985, Dornbusch 1974, Frenkel and Mussa 1984) which identified two sectors in an economy, namely, tradables and nontradables. Tradables consist of both exportables and importables where exportables consist of actual exports in addition to substitutes for exports which are sold on the domestic market and importables consist of imports as well as goods which are close substitutes for imports sold domestically. Nontradables are classified as those goods and services the prices of which are determined solely on the domestic market.

It should be borne in mind that in these models the aggregation of exportables and importables into a composite commodity such as tradables is dependent on the assumption that their relative prices do not change. If the terms of trade do not change, as is often assumed in the small country, case then this assumption is justified and, as will be seen later, gives generality to the use of this definition of the real exchange rate.

If the law of one price holds then the domestic price of tradables (P_t) and the foreign price of tradables (P_t^*) will be related via the nominal exchange rate E as follows: $P_t=P_t^*E$. The real exchange rate (e) for this definition is then $e = P_t/P_{nt}$ or $e = P_t^*E/P_{nt}$. Clearly, if the law of one price does not hold then there would be a divergence between the two.

The introduction of taxes on international trade raises the issue of whether to include or exclude them in the definition of the real exchange rate. If there is a uniform effective protective rate (t) on all tradables, and using $e = P_t^*E/P_{nt}$ as the real exchange rate, then the real rate incorporating the taxes (e_T) will be related to e as follows: $e_T = e(1+t)$. On the other hand, using $e = P_t/P_{nt}$ then the effects of taxes on the real rate are included and $e = e_T$. Once sector-specific rates change differentially, then although e and e_{Tj} move in the same direction the absolute changes will be different (1).

An instructive way of looking at this definition of the real exchange rate is to assume that the price of nontradables is given so that adjustments in the real exchange rate occur with a change in the nominal price of tradables. If in addition world prices are constant, then the nominal exchange rate would have to change in order to bring about the required change in relative prices. To illustrate, the price of tradables would rise with a nominal depreciation effecting a real depreciation, and the price of tradables would fall with a nominal appreciation implying a real appreciation.

3. The Relative Price of Importables to Nontradables

This definition attempts to come to terms with the problem of aggregation in the composite 'tradables'. It shows the relative price of importables to nontradables measuring the competitive position of importables as a group vis-a-vis nontradables. In

this case the real exchange rate e_{TM} is the domestic price of importables (P_m) divided by the price of nontradables so that $e_{TM} = P_m/P_{nt}$, or letting P^*_m be the foreign price EP^*_m/P_{nt}. Again, if the law of one price holds, these two expressions are equivalent.

4. The Relative Price of Exportables to Nontradables

This definition considers the competitive position of exportables in relation to nontradables. The aggregation problem raises its head yet again as it is the competitive position of exportables as a group which is examined. Let e_{TX} = the real exchange rate, P_X the domestic price of exportables, the foreign price P^*_X, then $e_{TX} = P_X/P_{nt}$ or EP^*_X/P_{nt}.

5. The Harberger Definition

A further variant of the real exchange rate was recently introduced by Harberger (1986). Letting P_g represent the general price level, then according to Harberger the real exchange rate is $e_H = E/P_g$. This definition of the real exchange rate can be interpreted as the relative price of the domestic basket of goods and services in terms of a unit of foreign currency, or what Harberger refers to as a 'dollar's worth'.

The Real Exchange Rate: A Comparison

The various concepts of the real exchange which are to be found in the literature all refer to the relative price of a particular basket of goods. There is no such thing as 'the' real exchange rate, and the definition which is adopted is dependent on the purpose for which the rate is intended.

The purchasing power parity concept of the real rate compares the price of a basket of foreign goods to a basket of domestic goods measured in the same currency. This enables us to draw conclusions as to whether the competitiveness of domestic goods vis-a-vis foreign goods has improved or deteriorated with its concomitant implications for the balance of trade. For example, an increase in the South African trade surplus requires a fall in expenditure in relation to output, and in addition a rise in other countries' expenditure relative to their output. Part of the fall in South African expenditure will lead to a decrease in demand for imports into South Africa, and part of the rise in spending abroad will be reflected in a higher demand for South African exports. If this redistribution of spending worldwide resulted in the demand for goods in South Africa being unchanged, then there would be no need for a change in exchange rates. However, as approximately 22 per cent of GDP is spent on imports in South Africa, and as the proportion of world income spent on South African goods is substantially lower, a redistribution of expenditure from South Africa to other countries will lower the demand for goods in South Africa in the aggregate. This means that the price of goods and services in South Africa relative to those in other countries would have to fall to increase the trade surplus in South Africa. In terms of the purchasing power parity concept of the real exchange rate this implies that the real exchange rate would have to depreciate. Similarly, a decrease in the size of the trade surplus would imply an appreciation of the real exchange rate.

The dependent economy concept of the real exchange rate, on the other hand, relates the price of tradables to the price of nontradables with a view to ascertaining the competitiveness of producing tradables as opposed to nontradables in the domestic economy and the resultant effects on the balance of trade and internal equilibrium.

A comparison of these two definitions yields interesting results. If the purchasing power parity rate is measured using CPIs and $P_t=EP_t^*$ with E fixed and equal to 1, let $P^*=P_N^{*b}P_T^{*(1-b)}$ and $P=P_N^{a}P_T^{1-a}$ where each price index is a geometric average of domestic nontradables and tradables prices. The superscripts represent each sector's domestic expenditure share. Then it can be shown that

$$e(ppp) = P_n^{*b}(P_T^{*(a-B)}/P_n)$$

Given that $e = EP_t^*/Pn$ then e(ppp) and e will only move in the same direction if the foreign price of nontradables does not change.

On the other hand, if the PPP rate e(ppp) is measured using WPIs, it becomes equivalent to a terms of trade measure and the relationship between changes in e(ppp) and e are as follows: $\hat{e}(ppp) = EP_t^*/P_t$ and $e = EP_t^*/P_{nt}$. Let E be fixed and equal to 1, then $\hat{e}(ppp) = \hat{P}_t^* - \hat{P}_t$, and $\hat{e} = \hat{P}_t^* - \hat{P}_{nt}$. Only if $\hat{P}_t = \hat{P}_{nt}$, will $\hat{e}(ppp) = \hat{e}$. Defining $e = P_t/P_{nt}$, then $\hat{e} = \hat{P}_t - \hat{P}_{nt}$ and once again there is no reason why the two should move in the same direction.

In addition, the PPP exchange rate measures the relative price of a basket of goods across countries and assumes that the composition of the basket is similar in all countries. For example, PPP is said to have been attained for the dollar when one dollar could buy the same basket of goods abroad as it could buy at home.

The Harberger definition of the real exchange rate, where $e_H = E/P_g$, is much closer to the PPP parity exchange rate. In the Harberger model the preferred real exchange rate is defined as Ep^*/P_g, where p^* is the foreign price index, an index of the "dollar prices of goods somewhere on the high seas" (Harberger 1986). P_g represents the general price level as in the CPI, and p^* the foreign price of tradables only. Therefore, the

denominator includes all goods while the numerator excludes nontradables. Harberger's idea of the real exchange rate is therefore an amalgamation of the PPP exchange rate. Kahn, in his comment on Harberger's paper, reconciles this definition with the dependent economy definition as does Edwards (1987). This requires making the assumption that the domestic price index Pg is highly correlated with the price of nontradables so that $Ep^*P_g = P_t/P_{nt}$.

The Dependent Economy Model

The dependent economy definition of the real exchange rate has been increasingly used in theoretical analyses, and despite Harberger's reservations (Harberger 1986) has been a useful concept. However, its use is limited to examining the effect on the real exchange rate of capital inflows and outflows, demand shifts between traded and nontraded goods, and productivity improvements which impinge equally across the traded or the nontraded goods sector. Once different price effects within tradables are introduced then it is no longer possible to treat them as a composite and it becomes difficult to predict whether the real exchange rate will rise or fall when defined as the price of tradables to nontradables.

To illustrate the derivation of this definition and its use, consider the following model. Assume that

(i) the terms of trade are exogenously determined so that exportables and importables can be aggregated into a composite 'tradables';
(ii) wages and prices are flexible; and
(iii) capital is specific to each of the sectors, tradables and nontradables.

With a fixed capital stock there are diminishing returns to labour in the labour market so that the demand for labour in each sector is a decreasing function of the real wage (W/P_i). Equilibrium in the labour market occurs where the real wage in each sector is equalised and the entire labour force is employed. At this equilibrium the wage is a function of the prices of nontradables (P_n) and tradables (P_t) as well as the capital (K_i) employed in each sector, so that

$L_t(W/P_t, K_t) + L_n(W/P_n, K_n) = L$ .....(1)

$W = W(P_n, P_t; K_i)$....(2)

W is a linear homogeneous function of P_n and P_t so that

$\hat{W} = a\,\hat{P}_n + (1 - a)\hat{P}_t = \hat{P}_t - a(\hat{P}_t - \hat{P}_n)$ .....(3)

and

$\hat{W} - \hat{P}_t = -a(\hat{P}_t - \hat{P}_n)$ .....(4)

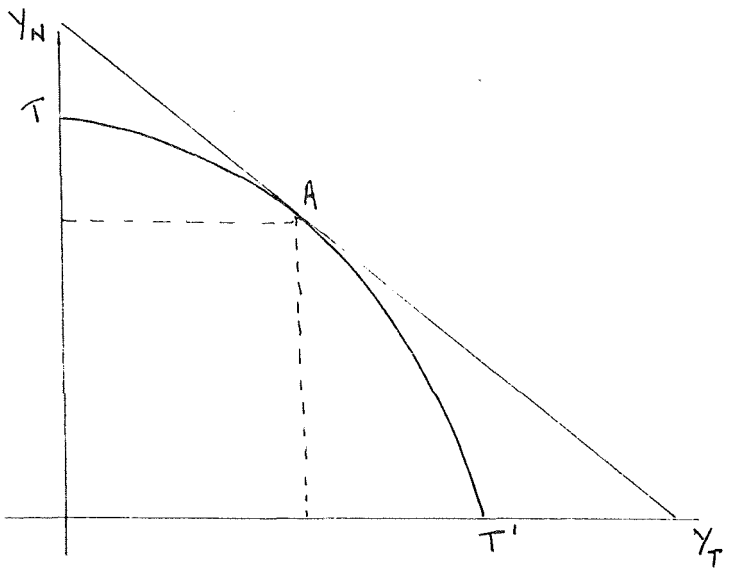
$\hat{W} - \hat{P}_n = (1 - a)(\hat{P}_t - \hat{P}_n)$.....(5)

Using (1),(2),(4) and (5) it is clear that output in each sector will be a function of relative prices P_t/P_n:

$Y_t = Y_t(P_t/P_n)$ and $Y_n = Y_n(P_t/P_n)$.....(6)

The output of tradables rises as the relative price of traded goods rises and the output of nontradables falls. Bearing in mind that the supply of both tradables and nontradables are derived from labour markets in full employment equilibrium, then the effect on the outputs of tradables and nontradables of changing relative prices can be traced out by a production possibility curve TT' in Figure 1.

Figure 1



The demand side of the model is quite straightforward where the demand for the output of each sector is a function of relative prices (P_t/P_n) and real expenditure (E) defined in terms of nontradables. Hence nominal expenditure (NE) divided by P_n is equated to real expenditure (E), and the demand functions can be written as follows:

$D_t = D_t(P_t/P_n, E)$ and $D_n = D_n(P_t/P_n, E)$.....(7)

Furthermore, nominal expenditure can be written as

$NE = D_nP_n + D_tP_t$

and

$E = D_n + (P_t/P_n)D_t$.....(8)

Total nominal output in the economy is then the sum of tradables and nontradables nominal output.

$NY = P_t Y_t + P_n Y_n$, and total output in terms of nontradables

$Y = (P_t/P_n)Y_t + Y_n$.....(9)

Subtracting (8) from (9) yields

$Y - E = (P_t/P_n)(Y_t - D_t) + (Y_n - D_n)$.....(10)

Equation (10) can also be written as

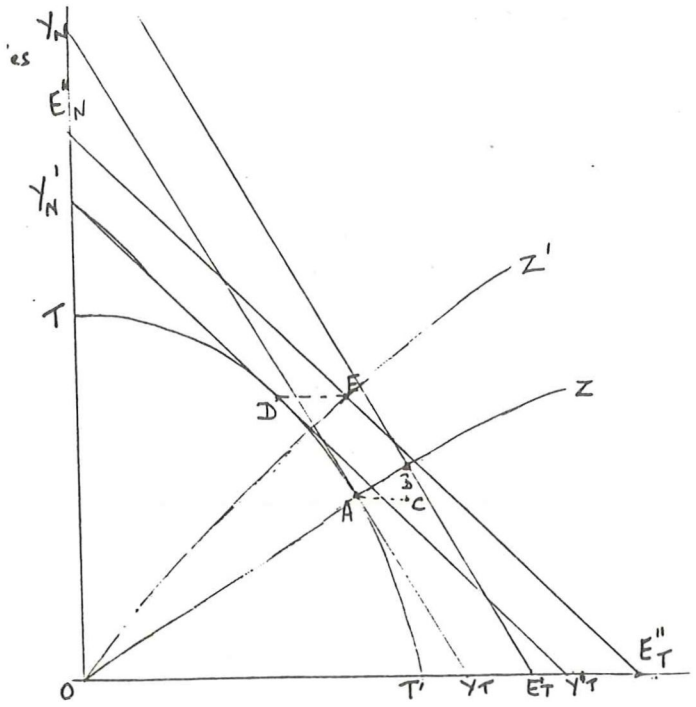
$(P_t/P_n)(Y_t - D_t) = (Y - E) + (D_n - Y_n)$.....(11)

Equation (10) tells us that, if expenditure is greater than income, this would be reflected in an imbalance on the trade account and/or an imbalance in the market for nontradables. Equation (11) shows that, if the nontradables market is in equilibrium, then a trade deficit would be reflected in an excess of expenditure over income. This result was first recognised in Alexander's absorption approach to the balance of payments (Alexander 1952).

This model can be used to analyse the effect of capital flows on the composition of output, the level of expenditure and the real exchange rate. Assume that the country experiences a net inflow of capital which is not sterilised by the Central Bank and hence allows expenditure to rise above the full employment level of output and income. Let dNE represent the increase in nominal expenditure which is equivalent to the net capital inflow. Figure 2 shows the economy at equilibrium before the capital inflow where both the trade account is in balance and the market for nontradables clears at the point A.

Income in terms of tradables is Y_t and in terms of nontradables is Y_n. Expenditure is equal to output at A as well. The real exchange rate is given by the slope of the expenditure line $Y_n Y_t$. Capital flows in, permitting expenditure to increase to E'_t in terms of tradables and to E'_n in terms of nontradables. This shifts the expenditure line out beyond the original budget constraint $Y_n Y_t$. If the real exchange rate remains constant, then

Figure 2



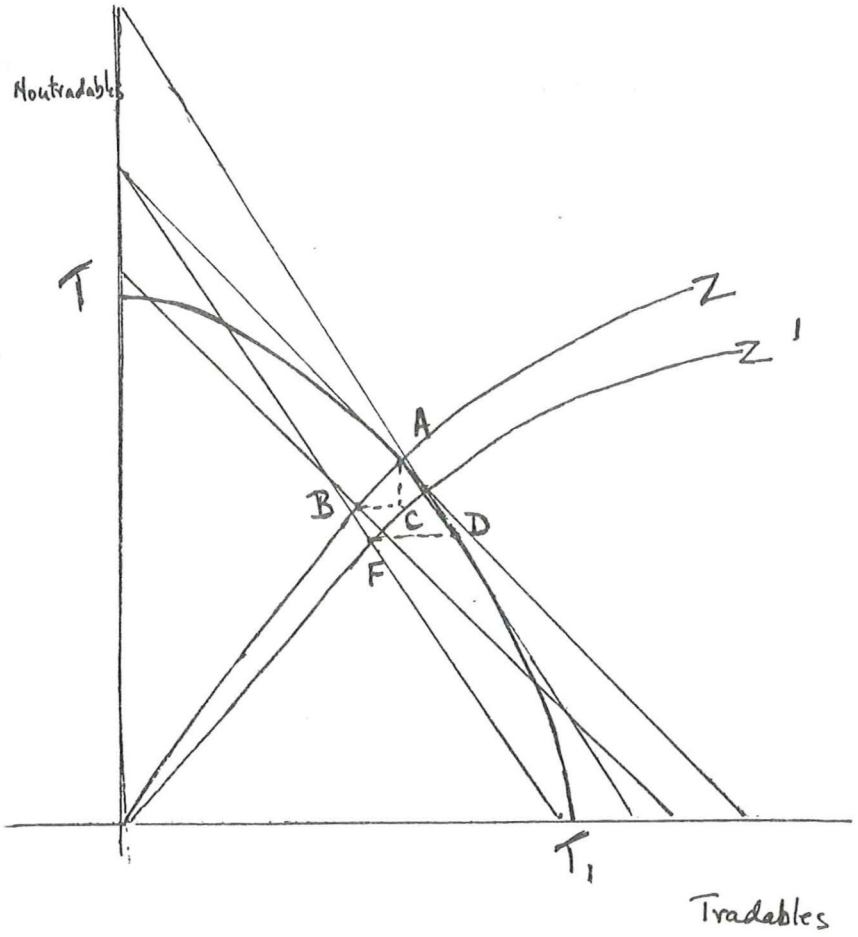
the economy moves to a point such as B where there is a trade deficit of AC and an excess demand for nontradables of BC. The trade deficit of AC is less than the capital inflow measured in terms of tradables, namely, $Y_tE'_t$, implying that full transfer in real terms of the capital inflow has not occurred and that on the balance of payments as a whole there is a surplus. In addition, the nontradables market is not in equilibrium. At this point either the nominal exchange rate could appreciate, lowering the domestic price level of tradables, or the price of nontradables could rise. In either case the real exchange rate, measured as the price of tradables to nontradables, will fall, signifying a real appreciation.

In Figure 2 the change in the real exchange rate is shown by the production price ratio shifting to $Y'_nY'_t$ and the expenditure budget line moving to $E"_nE"t$. Consumption now occurs at F and production at D. The market for nontradables clears and the trade deficit of DF is exactly equal to the capital inflow in terms of traded goods of $Y_tE'_T$ which is equal to $Y'_tE"_t$. In this analysis an important aspect was the extent to which the spending on tradables was increased by the capital inflow. The greater the amount spent on nontradables, the larger the required real appreciation to achieve equilibrium. If the increased spending had fallen entirely on tradables the financial transfer would have been completely effected without a real appreciation of the exchange rate.

A capital inflow will also result in a real appreciation of the exchange rate if it is defined as the purchasing power parity rate. Letting $e(ppp) = EP_t{}^{*a}P_{nt}{}^{*1-a}/P_t{}^bP_{nt}{}^{1-b}$, then as was described in the dependent economy model, to achieve transfer the price of nontradables can rise and/or a nominal appreciation of the exchange rate could occur. In either case the real exchange rate e(ppp) will appreciate.

A capital outflow can be analysed in a similar fashion. Assuming that the Central Bank does not sterilise the effects of the outflow, then expenditure will decrease as is shown in Figure 3 by an inward shift of the expenditure constraint to E'nE't. Reference to equation (10) shows that, if income is greater than expenditure this could be reflected in a trade surplus and/or an excess supply of nontradables. Figure 3 shows a trade surplus equal to BC and an excess supply of nontradables of AC. To complete the financial transfer, once again the real exchange rate should change.

Figure 3



This could be achieved by either the nominal exchange rate depreciating, which would raise the domestic prices of tradables relative to nontradables, or the price of nontradables falling. As the model assumed wage and price flexibility, either would change the real exchange rate. In any event a real depreciation would be required for equilibrium to be attained. As in the case of the capital inflow, the extent to which decreased spending falls on tradables will determine the degree to which the real exchange rate will have to depreciate.

If the purchasing power parity definition of the real exchange is used a capital outflow will have the same effect on the real exchange rate in order to effect the transfer of real resources. Whether the price of nontradables falls or whether the nominal exchange rate depreciates, e(ppp) will also depreciate. We can therefore conclude that, in the case of capital flows, both definitions of the real exchange rate will move in the same direction. Harberger (1986), using a different model, arrives at the same conclusion as to the effect of capital flows on the real exchange rate.

When the prices of importables or exportables change at a different rate, then the dependent economy model in its two-sector tradables and nontradables form is not adequate when analysing the effect of a change in the world prices of either exports or imports.

Following Dornbusch (1974), it is necessary to distinguish importables from exportables as well as nontradables. It is no longer possible to aggregate exportables and importables into a composite and it becomes difficult to define the real exchange rate as the price of tradables to nontradables. It is here that confusion has arisen in the assessment of the effect of a change in tariffs and the terms of trade on the real exchange rate (defined as the price of tradables as a whole to the price of nontradables) (See van Wijnbergen and Edwards (1987).

Using similar notation as above, the demand for nontradables (Dn) is now a function of the relative prices of exportables, importables, and real income. Let $p_x=P_x/P_n$ and $p_m = P_m/P_n$. Then

$D_n = D_n(p_x, p_m, Y)$

and

nominal income $NY = P_nY_n + P_xY_x + P_mY_m$

$Y = NY/P_n = Y_n + p_xY_x + p_mY_m$

Output in the nontradables market (Y_n) is also a function of relative prices such that

$Y_n = Y_n(p_x, p_m)$

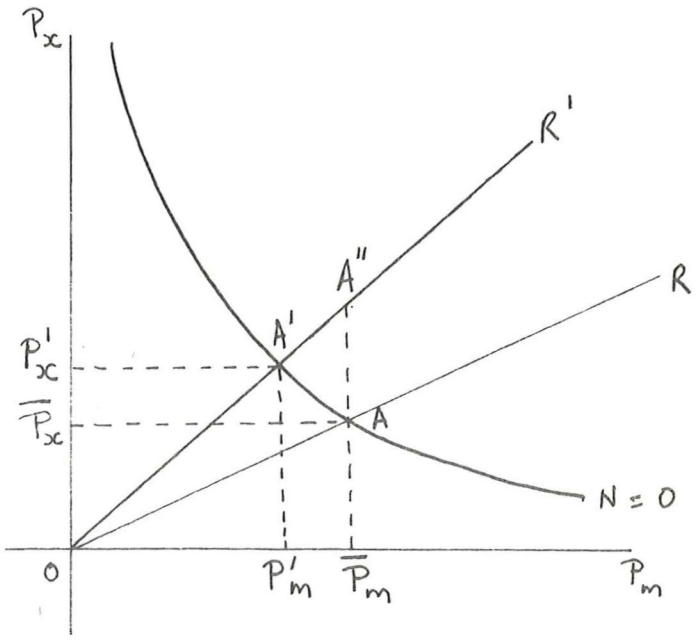
Equilibrium in the nontradables market occurs when demand and supply are equated where

$Y_n(p_x, p_m) = D_n(p_x, p_m, Y)$

The supply of nontradables will always increase if the price of nontradables rises relative to the prices of importables and exportables. However, on the demand side, if the price of exportables rises in relation to nontradables then the demand for nontradables will rise. The substitution effect ensures that relatively lower-priced nontradables are substituted for exportables and the higher real income arising from the higher price of exportables on the world market will also increase the demand for nontradables. If the price of importables rises, on the other hand, the substitution effect still works in the same direction. Nontradables are substituted for the higher priced importables but the real income effect is such that the lower purchasing power will decrease the demand for nontradables. If we assume that substitution effects dominate, then we demonstrate the nontradables market equilibrium in Figure 4.

The nontradables market equilibrium curve therefore slopes downward. To the right of the curve there is an excess demand for nontradables while to the left there is an excess supply.

Figure 4



Let D_x and D_m represent the consumption of both exportables and importables in the country while assuming that the terms of trade are exogenously determined. Then total real expenditure is as follows:

$$E = D_n + p_x Y_x + p_m Y_m$$

Then

$$Y - E = (Y_n - D_n) + p_x(Y_x - D_x) + p_m(Y_m - D_m)$$

Letting

$M = D_m - Y_m$,

$X = Y_x - D_x$, and

$N = D_n - Y_n$, then

$(p_x X - p_m M) - N = 0$,.....(6)

when expenditure E and income Y are equal.

In Figure 4 OR represents the given terms of trade between exports and imports. When the demand and supply for nontradables are equal, then equilibrium occurs at A.

Up to now changes in the terms of trade could not be analysed within the two-sector dependent economy model, whereas this model does permit an analysis of an increase in the price of exportables or the effect of an increase in import tariffs on the real exchange rate.

An increase in the price of exportables would have the effect of shifting the terms of trade line OR to OR' in Figure 4. If the price of nontradables remains the same, then at A" there is an excess demand for nontradables and a trade surplus. This result follows from equation (6). The adjustment to A', where equilibrium would be reestablished could occur in two ways. Firstly, the currency could appreciate in nominal terms, reducing the domestic prices of both exportables and importables in relation to nontradables until A' is reached. The adjustment from A" to A' involves a real appreciation in terms of both exportables and importables. If the real exchange is defined as the price of tradables to nontradables, and the price of tradables is the following composite $P_t = P_e^a P_m^{(1-a)}$, then P_t/P_{nt} falls. Alternatively, in order to move the economy from A" to A' the price of nontradables could rise, achieving the same switching of expenditure and eliminating both the excess demand for nontradables and the trade surplus. Once again the real exchange rate P_t/P_{nt} would appreciate.

There is no ambiguity in the appreciation of the real exchange rate from A" to A' - in terms of both exportables and importables there is a real appreciation. The problem arises when comparing the relative price of importables and exportables at A prior to the improvement in the terms of trade with the position at A'. It can be shown that the relative price of importables falls to P_m'

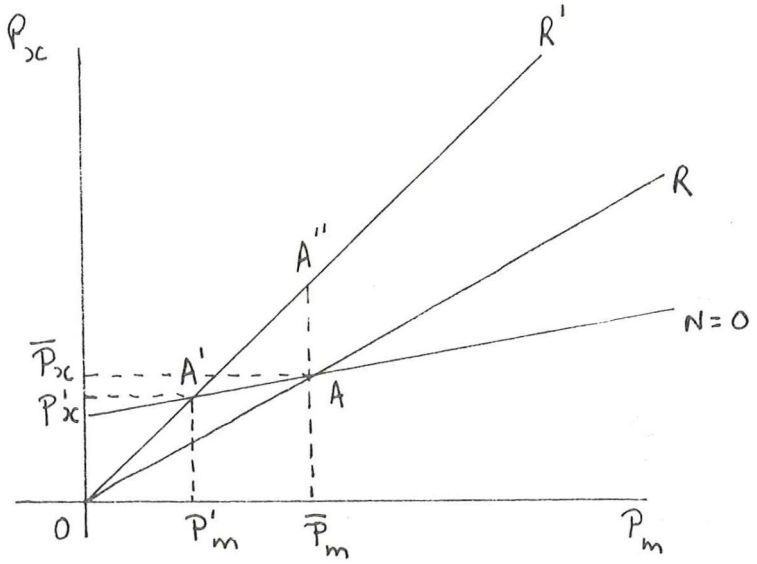
while that of exportables rises to P_x'. Therefore, if the real exchange rate is defined as the price of exportables relative to nontradables it depreciates, and if it is defined as the price of importables relative to nontradables it appreciates. On the other hand, if the real exchange rate is defined as the price of tradables to nontradables, it may appreciate or depreciate depending on the weighting of importables and exportables in the composite price index for tradables.

Harberger (1986), has pointed out that this ambiguity places the dependent economy definition of the real exchange rate in jeopardy. Kahn and Zahler (1985), simulating the effects of trade liberalisation on key economic variables, found that despite these ambiguities the assumed parameter values and the initial shares of exportables, importables and nontradables generated a real appreciation of the exchange rate when defined as the price of tradables relative to nontradables. Kahn and Montiel (1987), in an analysis of the effects of shocks on the real exchange rate, show that a terms of trade improvement will in general appreciate the real exchange rate when defined as the price of importables to nontradables, and depreciate it when defined as the price of exportables to nontradables. Within their model they also show that if the income effect arising from the terms of trade improvement is sufficiently large, causing the price of nontradables to increase more than the price of exportables, then the exchange rate will appreciate under both definitions, eliminating any ambiguity.

There are two other instances in which this ambiguity does not arise: (1) where nontradables and importables are complements, and (2) where nontradables and exportables are complements.

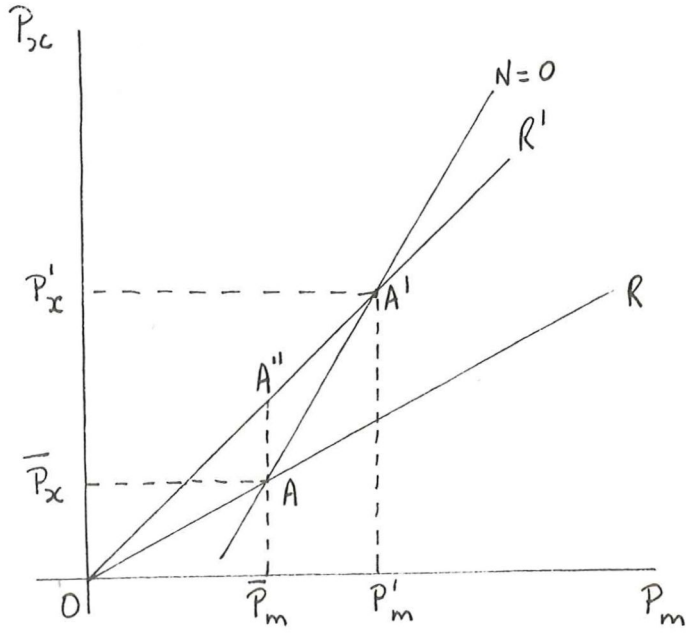
For the cases of complementarity, the nontradables market equilibrium curve is no longer downward sloping but is positively sloped. Figure 5 shows the complementarity between nontradables and importables with the NN curve cutting the ray OR from above. (See Dornbusch 1974) This means that when the price of exportables increases, initially there is a trade surplus at A" concomitant with the excess demand for nontradables. To arrive at the equilibrium A', the price of nontradables rises and the prices of both exportables and importables decline.

Figure 5



When nontradables and exportables are complements, the nontradables market equilibrium curve cuts the ray OR from below as is shown in Figure 6. At A" there is now a trade deficit with the excess supply of nontradables, and the price of nontradables falls, depreciating the real exchange rate in terms of both importables and exportables.

Figure 6



This graphical two-sector model can be used to incorporate a change in the price of a particular exportable. In this case the model would include this exportable, while importables and those exportables which have not experienced a price change can be treated as a composite. The results which were arrived at above can now be translated into a 'Dutch disease' effect. For example, in South Africa gold is an important export and its price fluctuates daily. According to this model, when the price of gold rises, if gold and other tradables (importables and other exportables) are substitutes for nontradables, then the price of gold relative to nontradables rises while the price of other tradables falls relative to nontradables. Therefore the real exchange rate, defined as the relative price of gold depreciates. On the other hand, the real exchange rate, defined as the price

of other tradables to nontradables, appreciates. On the production side gold is stimulated, while other tradables are penalised. The contractionary effects of this real appreciation has been termed the 'Dutch disease'.

A change in the terms of trade could also occur if the price of importables were to alter. Notable changes which have been analysed in the literature have been changes in tariff structure and increases or decreases in the world price of a principal import such as oil. The graphical model analysing the effects of an increase or decrease in the terms of trade arising from changes in the world price of exportables can also be used here. The results are similar to those arrived at for changes in the price of exportables. The ambiguities which arise are largely a result of the relative prices of exportables and importables moving in opposite directions, giving rise to the ratio of the price of tradables to the price of nontradables either rising or falling depending on the weights of tradables in the composite price index Recently, Edwards and van Wijnbergen (1987), arrived at a similar conclusion. However, Edwards (1987), goes even further and shows that, within two simple general equilibrium models of a small open economy, irrespective of the definition of the real exchange rate used the effects of a change in the terms of trade or a tariff reduction will be ambiguous. Neary (1988), in a recent note proves that if every traded good is a substitute for every nontraded good in his model, a terms of trade improvement will tend to appreciate the exchange rate defined as the price of tradables relative to nontradables.

In summary, it is apparent that in order to ascertain the implications of an improvement in the terms of trade for a particular sector it is not sufficient to examine the price of tradables to nontradables. In addition, an examination of the price of exportables to nontradables or the price of importables to nontradables may also give the 'wrong' answer. What is

required is the calculation of the real exchange rate for that particular sector. Micro studies of the effects of trade policy have used this approach (see Krueger 1978), in order to determine empirically the extent of incentives and disincentives. It has been within the macro models that the dependent economy definition of the real exchange rate has been used most frequently, and for many of the problems studied this definition has been adequate in terms of giving the 'right' answer.

Calculations of Real Exchange Rates for South Africa since 1973

1. PPP Exchange Rates

PPP exchange rates were calculated on a monthly basis for the period January 1973 to September 1987. Five trade-weighted real exchange rate series using consumer price indices were computed as described in Holden and Holden (1985). The formula used to calculate the rates was:

$e(ppp) = A_j D_j . P_{sa}/P^*$

where A_j = trade weight (as defined below) of South Africa with country j.

D_j = $E_j . 100/E$
E_j = units of foreign currency per rand at time t.
E = average nominal exchange rate for 1980.
P_{sa} = Consumer Price Index for South Africa.
P^* = trade weighted consumer price index for South Africa's trading partners.

The five series which were calculated used the following trade weights:

(1) REER1 was the real exchange rate calculated using import weights.

(2) REER2 was the real exchange rate calculated using import plus export weights excluding gold.

(3) REER3 was the real exchange rate calculated using import and export weights including gold.

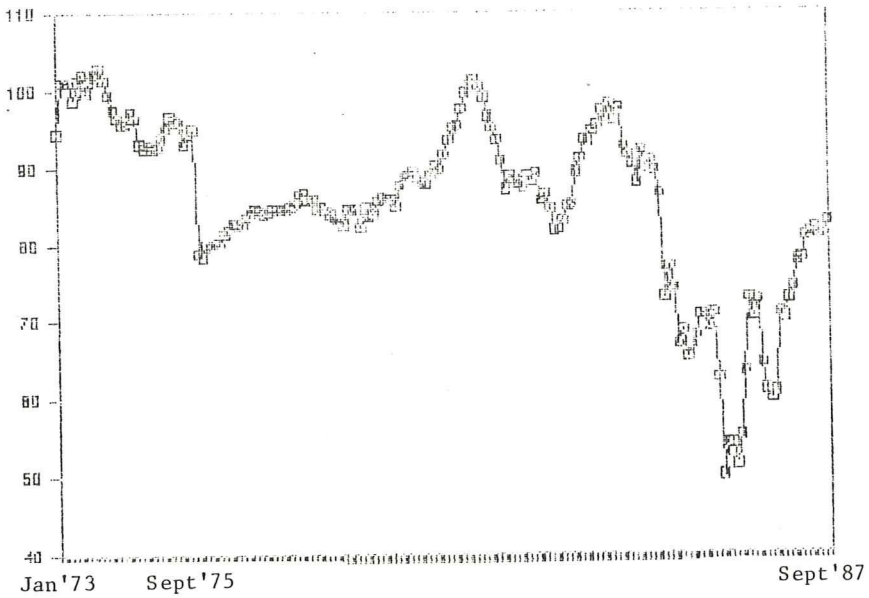
(4) REER4 was the real exchange rate calculated using export weights including gold.

(5) REER5 was the real exchange rate calculated using export weights excluding gold.

Movements in the series are shown in Diagrams 1 to 5. All five purchasing power parity real exchange rates show great variability over the period. All five peaked at the end of 1973, declined sharply in 1975 with the nominal devaluation of the rand in September of that year. Real rates remained relatively constant until 1979 when nominal appreciations in response to the rising price of gold led to real appreciations peaking at the end of 1980. The declining gold price then led to nominal depreciations which were also reflected in real depreciations until the end of 1982 when the rising price of gold led to the exchange rate appreciating in both nominal and real terms until the end of 1983. The declining price of gold coupled with large capital outflows in 1984 and 1985 precipitated severe nominal and real depreciations of the rand through 1985. Towards the end of 1985 the rate appreciated in both real and nominal terms, depreciated later in 1986, but recovered sharply in the last few months of 1986 appreciating gradually in real terms as the gold price rose through 1987.

Table 1 shows the London dollar price of gold on an annual basis and short-term capital movements on the part of the private sector, including errors and omissions.

REER 3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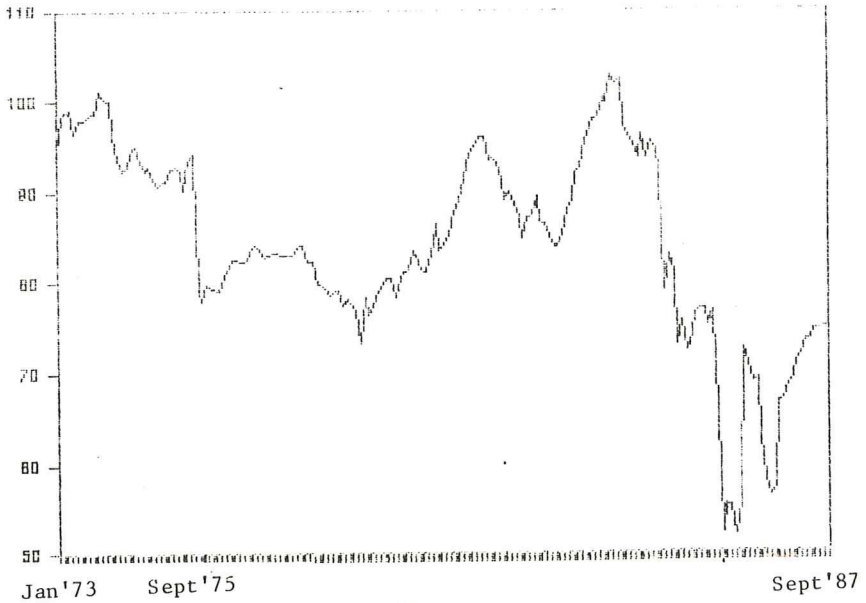
Sept'75
Sept'87

REER 4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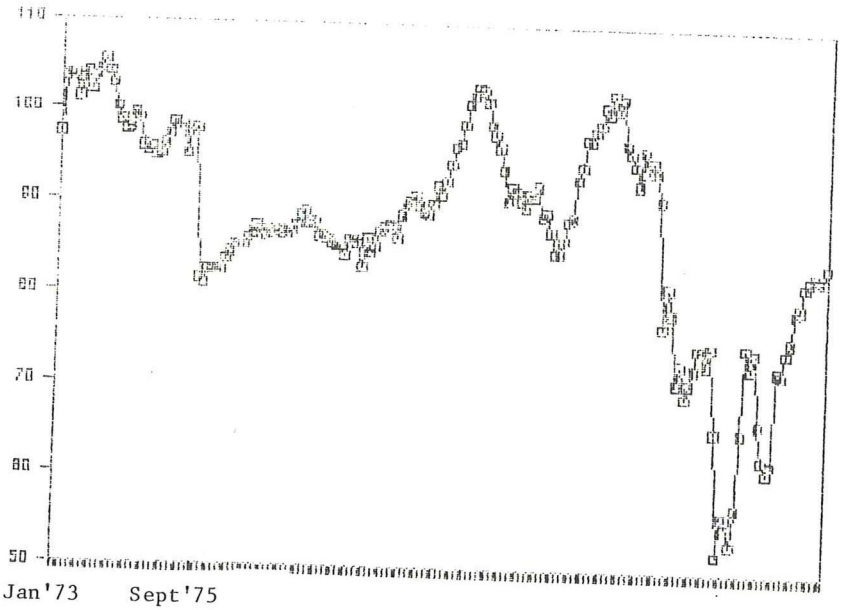
REER 1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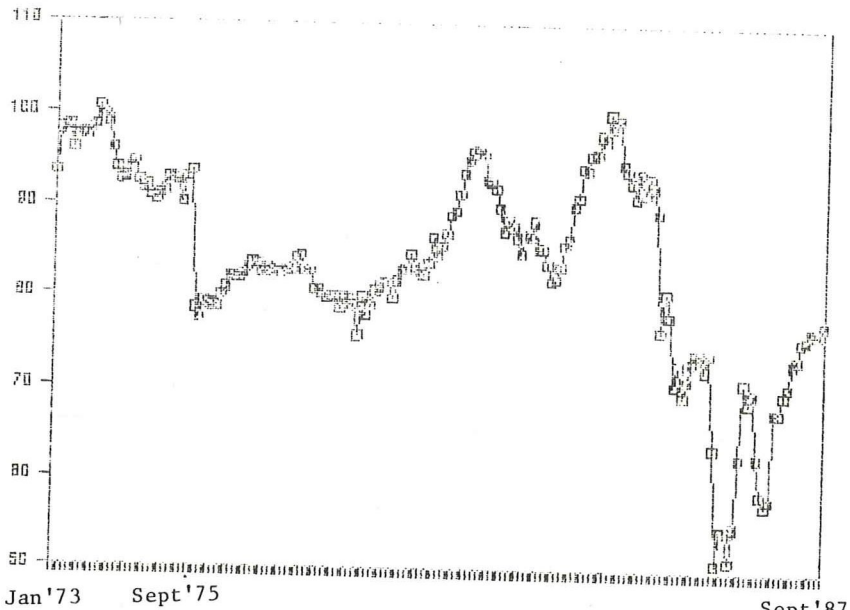
REER 2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REER 5

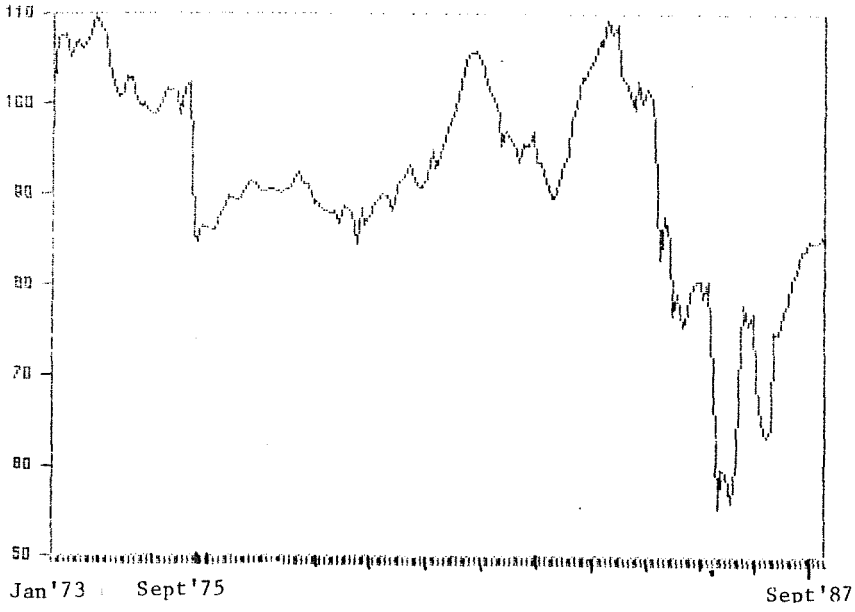


Table 1 London Gold Price and Short-term Capital Movements

	$ per ounce	Rm
1973	97.24	-195
1974	159.18	97
1975	161.05	-362
1976	124.83	-543
1977	147.71	-964
1978	193.26	-1017
1979	307.01	-1723
1980	613.07	-1815
1981	459.69	734
1982	375.79	806
1983	424.31	199
1984	360.45	-1757
1985	317.29	-8704
1986	367.59	-2742
1987	446.60	-1339

A regression analysis of the determinants of the purchasing power parity real exchange rate by Gerson and Kahn (1987) showed that, for this period, the terms of trade and capital flows were significant determinants of the real rate in South Africa.

2. Dependent Economy Real Exchange Rates

Most empirical studies of the real exchange rate have computed the purchasing power parity concept of the rate despite the increasingly theoretical use of the dependent economy definition. The major reason for this lag in the empirical work has been the difficulty in obtaining reliable time series data on the prices of tradables and nontradables. Goldstein and Officer (1979), suggest that, for many countries where there are data on GDP by industry of origin, it is possible to construct these price indices using the GDP by industry in current and constant prices.

In South Africa the GDP is published quarterly by industry in current and constant prices. The industry categories are as follows:

Agriculture, Forestry and Fishing
Mining and Quarrying
Manufacturing
Electricity, Gas and Water
Construction
Commerce, Catering and Accommodation Services
Transport, Storage and Communication
Finance, Real Estate and Business Services
Community, Social and Personal Services
General Government
Other Producers

The first three categories listed above were grouped as tradables. The remaining ones were treated as nontradables. Very generally, this approach assumes that tradables encompass not only those goods which are actually traded but also those which are potentially tradable. One could argue that this criterion is far too broad. However, when comparing the tradables with the nontradables group, it is clear that the tradables group has a much higher proportion of foreign trade, and that its prices are related to a greater degree to prices in other countries, and are closer substitutes for goods imported from abroad, than are nontradables. Nevertheless, it should be recognised that this classification suffers from the problem that, within the tradables category, there will be some goods which will never move in international trade, and within the nontradables category some services that are actively involved in international trade.

To construct the price indices for tradables and nontradables the following approach was used:

(1) Gross Domestic Product in tradables (as defined)at current prices from the first quarter of 1970 to the first quarter of 1987 was tabulated.

(2) Gross Domestic Product in tradables in constant prices on a quarterly basis for the same period was tabulated.

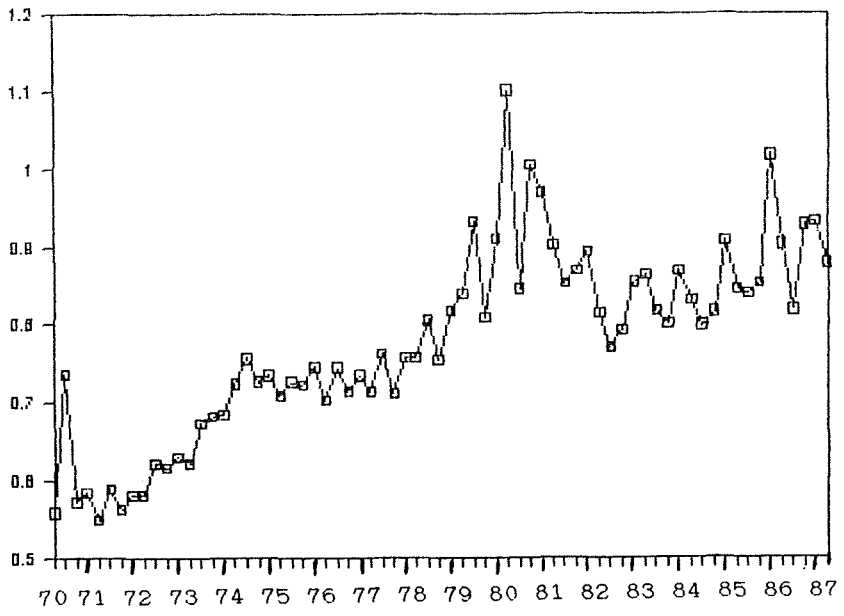
Let Gross Domestic Product in tradables at current prices = GDPTC, and Gross Domestic Product at constant prices = GDPT. If we then divide GDPTC by GDPT we arrive at an implicit price deflator Pt, a proxy for the price of tradables.

In similar fashion let the Gross Domestic Product in nontradables at current prices = GDPNC, and Gross Domestic Product in nontradables at constant prices = GDPN. Then GDPNC/GDPN = P_{nt}, an implicit price deflator, a proxy for the price of nontradables.

Having arrived at two series for the prices of tradables and nontradables, we may now compute P_t/P_{nt}. Diagrams 6-8 show the movements in the real exchange rate from 1970 to the first quarter in 1987 under a number of different assumptions.

In Diagram 6 the real exchange rate was calculated so that all tradables in the economy were included in the numerator. Bear in mind that an increase in the index represents a depreciation, and a decrease an appreciation. The rate depreciates steadily from 1971 through to 1974, remaining relatively stable from the second quarter of 1974 until the first quarter of 1978. Thereafter the real rate depreciates through to the end of 1980 if a trend is assumed. After 1980 there appears to be a real appreciation, followed by a depreciation in the third quarter of 1982. It then continues to depreciate through to the end of 1985, then appreciating in 1986.

DIAGRAM 6



It could be hypothesised that, when gold is included in the tradables sector, movements in its price overwhelm movements in the price of other tradables. To test this hypothesis the price of tradables was computed excluding the sector 'Mining and Quarrying'. The results of this calculation are shown in Diagram 7. The appreciations in the rate shown in Diagram 6 no longer occur, and from 1971 to 1987 the trend in the real exchange rate is upward, showing an overall depreciation and indicating that, tradables other than mining and quarrying improved their competitive position relative to nontradables.

DIAGRAM 7

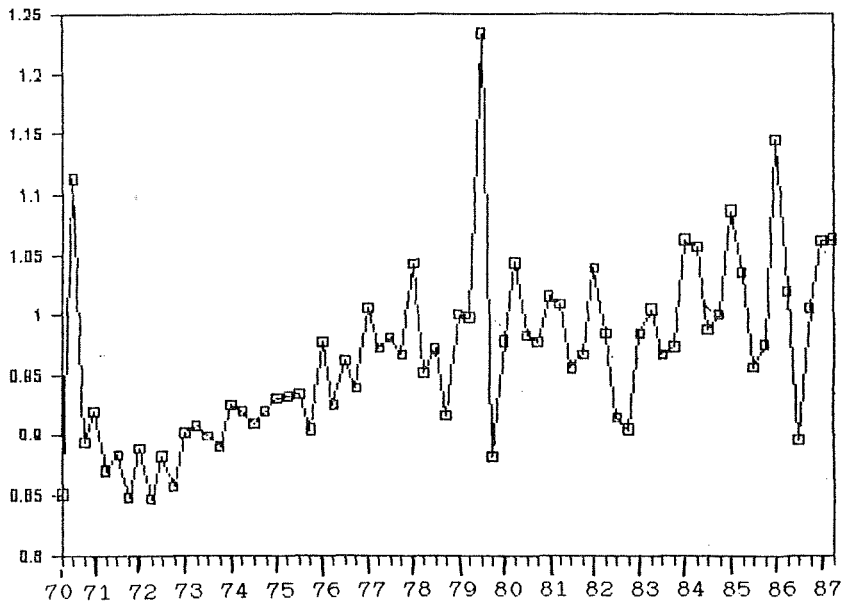
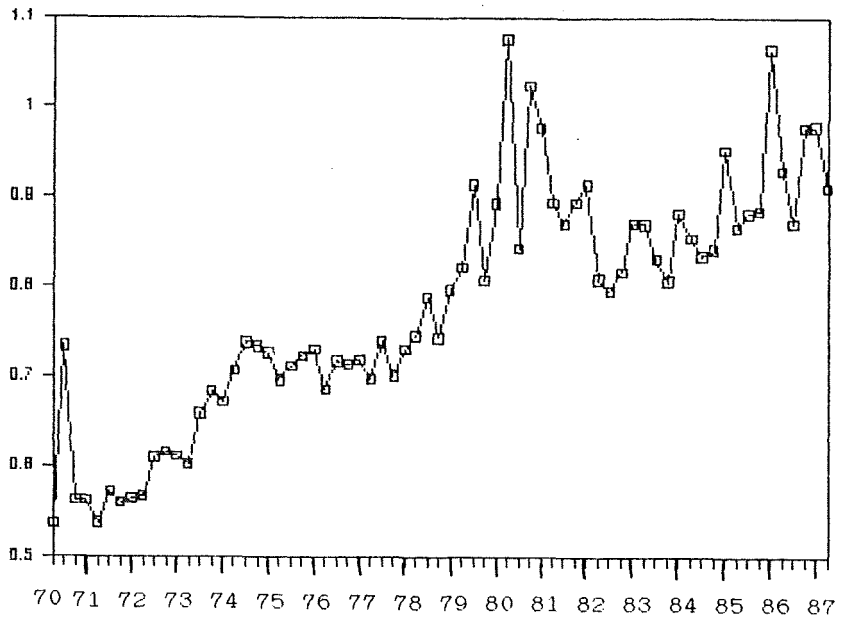


Diagram 8 excludes government from the calculation of the price of nontradables on the premise that the computation of an implicit price deflator for government may be unreliable, and not all of government expenditure can be considered nontradable.

DIAGRAM 8



Bearing in mind that mining and quarrying are included as tradables, a comparison of Diagrams 6 and 8 shows that government makes little difference to movements in the real exchange rate.

There are some notable differences in movements in the purchasing power parity definition of the real exchange rate e(ppp) as shown in Diagrams 1-5 and the dependent economy definition (e). In particular, during the period 1979-80, e(ppp) as shown in Diagram 1 strongly appreciates while e as shown in Diagram 6 depreciates. If mining and quarrying are excluded from the calculations then most of the depreciation of e is eliminated. This shows that the increase in the price of gold and other extractive products during this period was largely responsible for the rise in the price of tradables generally. The nominal appreciation in the exchange rate which occurred and is reflected in e(ppp)

appreciating was not reflected in lower prices of tradables, nor did the spending effect of the increase in the price of gold spill over increasing the price of nontradables relative to tradables. The fact that the price of nontradables did not rise as much as that of tradables could also be explained if the supply response to the spending boom had been sufficient to nullify the increase in the demand for nontradables (see Neary 1988). The appreciation in e(ppp), on the other hand, can be explained as a nominal appreciation which was not countered by a concomitant fall in the CPI, or alternatively foreign price levels had risen faster then the CPI in South Africa. In terms of purchasing power the rand could purchase more abroad in real terms in 1979-80, and in this sense could be considered overvalued. Whereas during this period tradables as a group were better off competitively, non-gold tradables merely maintained their position vis-a-vis nontradables.

The decline in the price of gold in 1981 also led to a similar divergence in e and e(ppp), with e appreciating and e(ppp) depreciating. In Diagram 6 it is the decline in the price of gold which leads to a paradoxical appreciation of the rate. When gold is excluded as in Diagram 7, e remains relatively constant. It is interesting that the nominal depreciation of the exchange rate did not raise the price of non-gold tradables sufficiently to depreciate the rate. In all probability the delayed effect of the rise in the price of gold was now being felt in the economy, and the price of nontradables had increased as a result of the boom. It is also likely that the effect of the earlier improvement in the terms of trade on the real exchange rate was being felt with a lag. Unfortunately this point cannot be generalised as the real depreciation in e during 1978-80 did not follow a fall in the price of gold or a deterioration in the terms of trade. The depreciation in e(ppp) in 1981 occurred as a result of the nominal depreciation of the rand, and once again the CPI failed to rise sufficiently in relation to foreign price levels to

offset this. Once again e and e(ppp) move in opposite directions. The purchasing power of the rand declined abroad and the competitive position of tradables as a group deteriorated, while that of non-gold tradables remained constant.

In 1983 the rising price of gold caused e(ppp) to appreciate as the nominal exchange rate rose. Yet in this case e remains relatively constant. This means that although the price of gold had risen increasing the price of tradables, the mini-boom experienced at that time raised the price of nontradables proportionately. If mining is omitted from the calculation, e shows a depreciation over the year implying that the price of non-gold tradables rose at a faster rate than did the price of nontradables. During 1983, therefore, the rand became overvalued through an increase in its foreign purchasing power while the competitive position of tradables as a whole remained the same and the scarcity of non-gold tradables rose.

During 1984 and 1985 both e(ppp) and e, including and excluding mining, depreciated. Even though the price of gold fell in those two years, the outflow of capital from the country was of such a magnitude as to ensure that the severe nominal depreciation of the rand increased the domestic prices of tradables more than proportionately to the increase in the price of nontradables so that e depreciated. The nominal depreciation of the rand also ensured that e(ppp) depreciated as the inflation differential between South Africa and its trading partners was of a smaller magnitude. In this period, therefore, the rand was undervalued in the sense that it failed to purchase the same quantity of goods as it had in 1983. In addition, the competitive position of tradables vis-a-vis nontradables improved.

In summary, these calculations confirm the theoretical supposition that the purchasing power parity concept of the real exchange rate and the dependent economy definition may not move

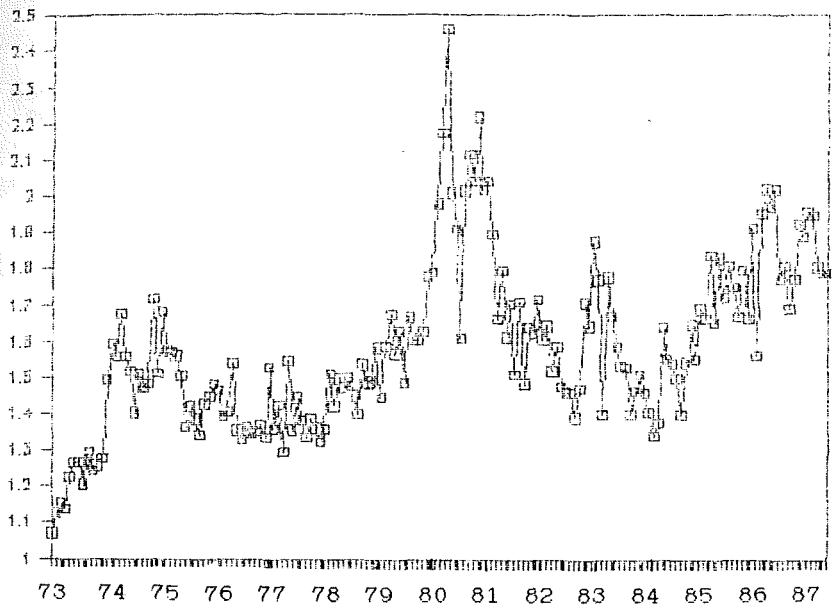
in the same direction, particularly when an economy such as South Africa's is dominated by a single commodity the price of which is subject to great variability .

3. Relative Prices of Exportables and Importables as the Real Exchange Rate

The calculation of the price of tradables relied on quarterly national accounts data. As these data included all tradables both exportable and importable, it was not possible to calculate a price series showing movements in the price of exportables relative to the price of other goods nor a series showing the price of importables relative to other goods. However, the Quarterly Bulletin of Statistics does publish a monthly series of unit value indices for exports and imports. It was not possible to match these data with a monthly price index for nontradables, yet theory has indicated that using nontradables as the numeraire may not give the only measure of the relative competitiveness of exports and imports. It was therefore decided to use the Consumer Price Index as the numeraire.

Diagram 9 shows the movement in monthly terms of the price of exports in total divided by the CPI for the period 1973 to 1987. From 1973 to 1975 exports improved their competitive position. The next three years saw little change, to be followed in 1978 with a sharp real depreciation through to 1981. Thereafter competitiveness declined, reviving somewhat in 1983, declining in 1984 and improving thereafter. This pattern follows that shown in Diagram 6 which tracked the price of tradables relative to nontradables.

DIAGRAM 9



Price of Exports/ CPI

Excluding mining exports from the unit value index, the price of manufactured exports relative to the CPI is shown in Diagram 10.

It is clear that from 1974 to 1983 manufactured exports suffered from declining competitiveness, which was only reversed over the period 1984 to 1987. This result partly conforms with the hypothesised Dutch Disease effects of the change in the price of gold. Over the period 1974 to 1980 the price of gold rose by 285 per cent in dollar terms. However, except for the increase in 1983, the early 1980s saw the dollar price declining, to be followed by increases in 1986 and 1987.

DIAGRAM 10

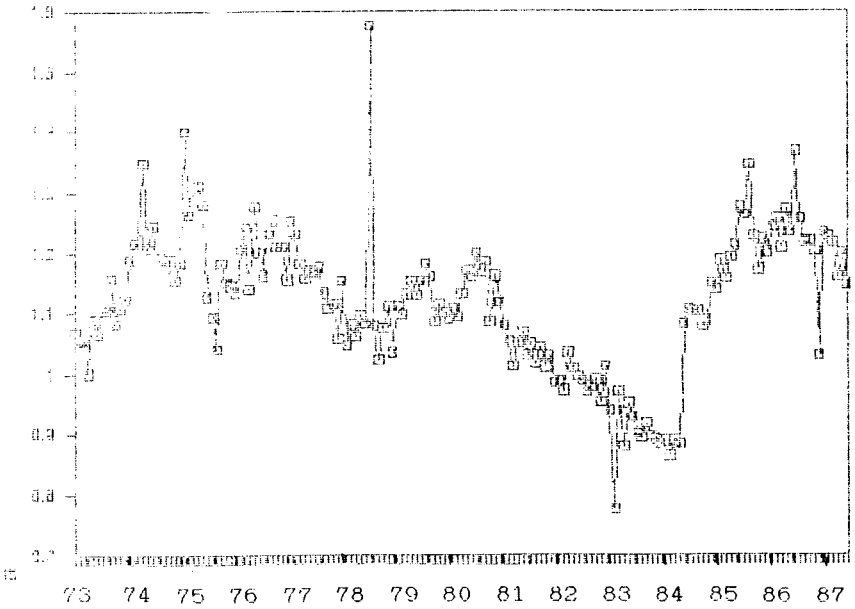
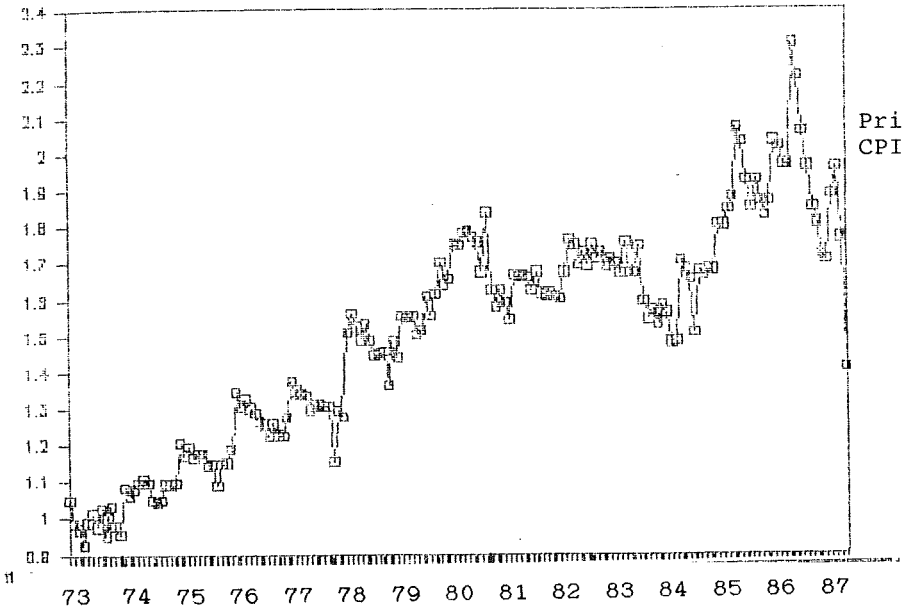


Diagram 11 shows the movement in the unit value of imports in total relative to the CPI. In general the trend for the entire period shows improving competitiveness in the production of importables in South Africa. It is clear that import substitution was favoured by changes either in the nominal exchange rate or in the world prices of imports.

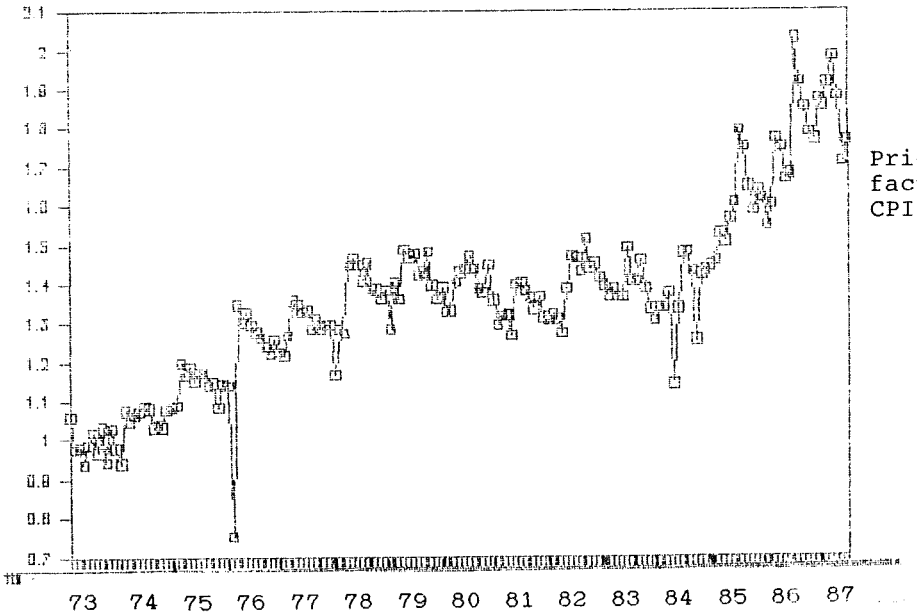
In order to remove the effects of the changing international price of oil, the price ratio of manufactured imports to the CPI was computed. The results are shown in Diagram 12, indicating that the same trend of rising profitability was observed for manufactured importables as well.

DIAGRAM 11



Price of Imports/ CPI

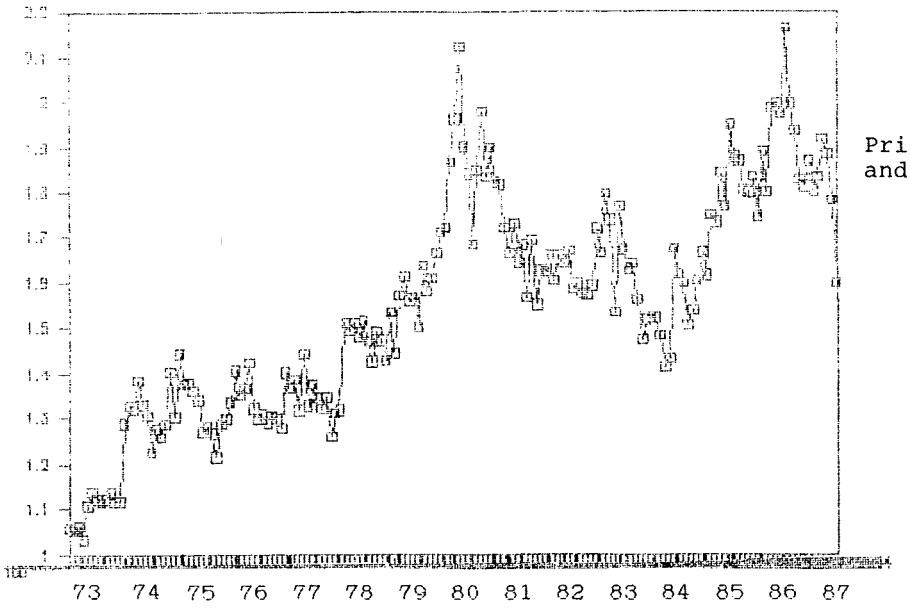
DIAGRAM 12



Price of Manu-factured Imports/ CPI

Finally, using the same data source, a weighted price index of exports and imports in total was computed and plotted against the CPI, and is shown in Diagram 13. This series should be compared with that plotted in Diagram 6 which was computed using the national accounts data to compute the prices of tradables and nontradables. Bearing in mind that the national accounts series starts in 1971 and ends with the first quarter of 1987, and uses quarterly as opposed to monthly data, it appears that the two series approximate each other well.

DIAGRAM 13



This gives one a measure of confidence in the method suggested by Goldstein and Officer for arriving at a composite price index for tradables and nontradables.

Conclusion

The definition of the real exchange rate which is adopted is dependent on the use for which the exchange rate is intended. The purchasing power parity rate is useful when drawing conclusions as to the competitiveness of domestic and foreign goods and the implications for the trade balance. The dependent economy definition enables the economist to judge the relative strength of the incentives to produce and consume tradables or nontradables. Theoretically it was shown that there is no reason why these two definitions will move in the same direction, and the calculations of the two real exchange rates for South Africa also showed that they have not moved in the same direction.

In addition, when examining the implications of an improvement in the terms of trade for different sectors in the economy, it was shown that it was insufficient merely to examine the change in the price of tradables to nontradables. If exportables and importables are the focus of interest, it is the prices of exportables to nontradables and the prices of importables to nontradables which should be calculated. The computations of these definitions for the South African economy showed very different patterns of competitiveness for exportables and importables.

The question of overvaluation or undervaluation of the exchange rate can only be decided by examining the fluctuations in the real exchange rate. Purchasing power parity theory suggests, that if the real exchange rate remains constant, then purchasing power parity has been attained and the exchange rate is in equilibrium. This rate would also in all probability be one where the current account would be in balance.

A constant price of tradables to nontradables would also be indicative of equilibrium in the economy in the sense that

resources would not be moving between tradables and nontradables. Similarly, constant prices of exportables to nontradables and of importables to nontradables would signal little change in resource allocation.

However, the calculations of the various definitions of the real rate for South Africa show little constancy, indicating that for all definitions there has been overvaluation and undervaluation for the period studied. The thorny question of the appropriate `equilibrium' or `constant' real rate has not been addressed in this paper, providing fertile ground for further research.

Footnote

1. $e_{Tj} = EP_j^*(1 + t_j)/P_n$

$e = EP_T^*/P_n$

where $P_T^* = P_j^* P^{i*b}$

Introduce t_j = tariff on P_j

then $P_T^* = P_j^{*a}(1+t_j)^{a}pi^{*b}$

and $e = [EP_j^{*a}(1+t_j)^{a}P_i^{*b}]/P_n$

$\hat{e}_{Tj}/1+\hat{t}_j = EP_j^*/P_n$

$\hat{e}/1+\hat{t}_j = [aEP_j^{*a}P_i^{*b}(1+t_j)^{a-1}]/P_n$

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