

# **Purchasing power parity, nontraded prices and the terms of trade**

*by*

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## **ABSTRACT**

This paper argues that the essential problem underlying the failure of empirical tests of purchasing power parity may be the loss of information that arises from aggregation of prices. A disaggregated specification of purchasing power parity is proposed and a measure of nontraded goods prices based on a broad theoretical definition of prices and tradable goods is developed. This measure is tested empirically against other proxies found in the literature in the context of the purchasing power parity model of the bilateral Australian dollar/US dollar exchange rate. It is concluded that relative nontraded goods prices and the terms of trade play an important role in causing deviations away from purchasing power parity. Furthermore, the measure on nontraded prices proposed appears to provide more sensible estimates of the long run coefficients compared with other proxies used in the literature.

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**Key Words:** exchange rate, nontraded goods prices, purchasing power parity, terms of trade.

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## 1. Introduction

*“Under the skin of any international economist lies a deep-seated belief in some variant of the PPP theory of the exchange rate.” Dornbusch and Krugman (1976)*

Purchasing power parity (PPP) is a simple notion that exchange rates adjust to general price levels in domestic and overseas countries<sup>1</sup>. It forms the centrepiece of many theories of exchange rate determination. The theory was utilised in the Bretton Woods era as a guide for policy makers fixing exchange rates. Post-Bretton Woods it has been used to represent the external competitiveness of a country and as a benchmark against which floating exchange rates are judged to be ‘misaligned’.

The essential postulate of purchasing power parity is that the real exchange rate is a stationary (mean-reverting) variable. Recent empirical research, mostly based on time-series analysis of short spans of data for the floating rate era, has led many to conclude that PPP failed to hold and that the real exchange rate followed a random walk, with no mean reversion property. However, more recent studies have challenged this conventional wisdom, seeing it as a flawed result arising from lack of statistical power, a consequence not only of the small sample employed, but also of the inherent weaknesses of standard unit root tests.<sup>2</sup>

This paper argues that the essential problem underlying the failure of empirical tests of purchasing power parity may be the loss of information that arises from aggregation of prices. While some level of aggregation is required to make the problem manageable, it is clear that subsets of prices will have very different impacts on the real exchange rate. One such subset addressed in the literature is traded and nontraded goods prices, the importance of which stems from the Balassa (1964) productivity hypothesis. De Gregorio, Giovannini and Wolf (1994) and Dutton and Strauss (1997) address this issue and conclude that nontraded goods relative price movements are an important determinant of real exchange rate behaviour.

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<sup>1</sup> For an extensive discussion of the origins of PPP see Officer (1982); for a briefer survey see Rogoff (1996).

<sup>2</sup> Abauf and Jorion (1990) is a widely cited study of a long run data set (a century of dollar–franc–sterling exchange rate data) that found evidence of PPP. For a shorter data set post–Bretton Woods, Edison, Gagnon and Melick (1997) find evidence of PPP using improved estimation techniques. Another successful approach has been by increasing the number of observations using panel studies (such as Frankel and Rose (1996) and Lothian (1997)), although O’Connell (1998) questions the panel evidence.

However, a further disaggregation of traded prices may also be appropriate where changes in the terms of trade are a source of real shocks to an economy. In a small, open economy such as Australia there is much information contained in the aggregate ‘traded prices’ and there is a clear link between relative export and import prices (or the terms of trade) and the behaviour of the Australian real exchange rate<sup>3</sup>. Indeed, Backus and Crucini (2000) have found that a large part of the variability of the terms of trade is associated with extreme movements in oil prices for many industrial countries with the correlation depending on whether the country is a net importer or exporter of oil. In Australia's case, being both an importer and exporter of oil, Backus and Crucini find that Australia has the lowest absolute level of correlation between oil prices and the terms of trade. Nevertheless, accounting for oil shocks will be important from the United States point of view and should be part of the explanation for the behaviour of the bilateral Australian/US real exchange rate<sup>4</sup>.

This paper specifies the purchasing power parity relationship based on a disaggregation of general prices into traded/nontraded prices, and then traded prices into export/import prices<sup>5</sup>. The first difficulty encountered in attempting to test the disaggregated purchasing power parity relationship is the lack of data on nontraded prices. This paper develops a new approach to measuring nontraded prices that is easy to compute and able to make use of readily available, timely data. The proposed measure is tested in the framework of the purchasing power parity hypothesis and the model diagnostics are compared with alternative proxies for nontraded goods prices.

The format of the paper is as follows. The next section defines the model and outlines the empirical hypotheses to be tested. Section 3 considers different proxies for relative nontraded goods prices and proposes a new measure for relative prices based on the GDP implicit price deflator. Section 4 outlines the cointegration estimation procedure and presents the empirical results. Section 5 summarizes the paper's findings.

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<sup>3</sup> Gregory (1993:79) calls the strong relationship between the terms of trade and the real exchange rate the “Australian story”. Empirical evidence is given in Gruen and Wilkinson (1994) and Tarditi (1996).

<sup>4</sup> Juselius (1995) notes the importance of conditioning the purchasing power parity relationship with oil prices and Amano and van Norden (1998) find a stable link between oil price shocks and the US real effective exchange rate over the post-Bretton Woods period.

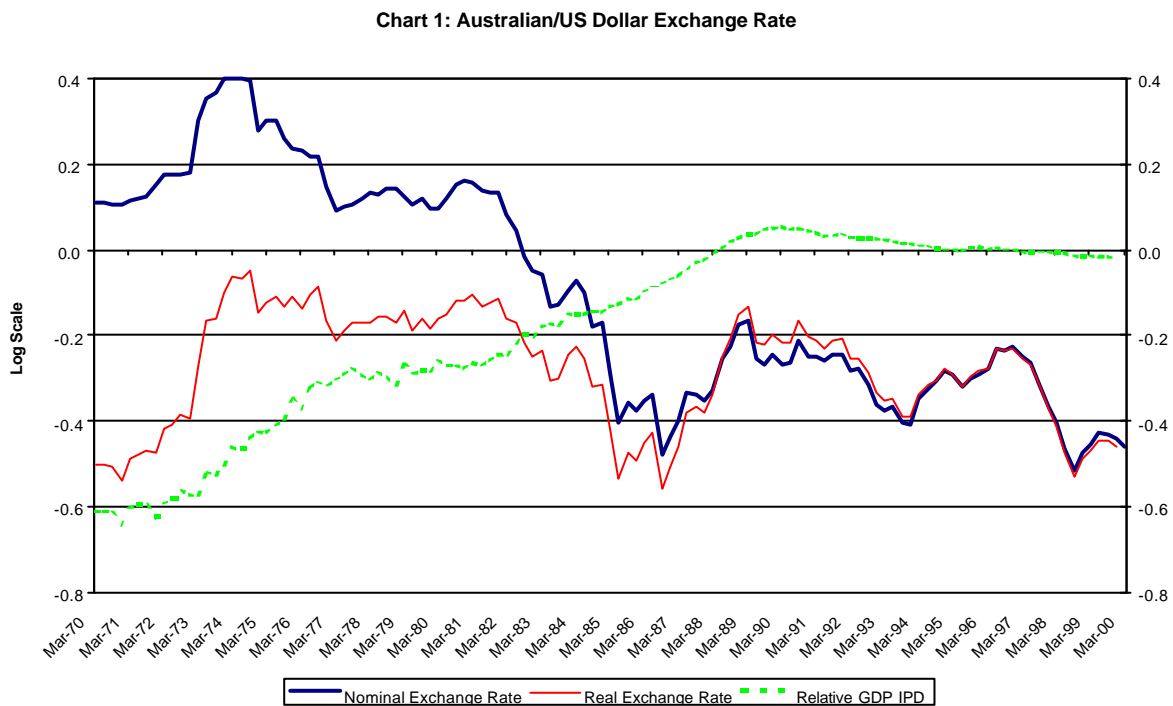
<sup>5</sup> By separating out traded prices into export and import prices, we can also avoid the problem of the inability to use the composite commodity assumption when relative prices are changing (Martin and Nguyen, 1989:2).

## 2. Purchasing power parity

We start by defining the real exchange rate consistent with the traditional PPP model:

$$(1.) \text{ RER} = EP/P^*$$

where E is the nominal bilateral exchange rate expressed in units of foreign currency per unit of domestic currency (i.e. US cents per 1\$A), P is general domestic prices<sup>6</sup>, an asterisk indicates the foreign country variable, and RER is the real exchange rate. Chart 1 shows the movements of these variables for the AUD/USD exchange rate over the past 30 years. Clearly there is more to the real exchange rate than simply relative aggregate prices.



Unlike Dutton and Strauss (1997), the model is not based on the assumption of the law of one price for traded goods<sup>7</sup>. The possibility of impediments to trade (including transportation costs, local market pricing, trade barriers, etc) are modeled explicitly so that equation 1 becomes:

$$(2.) \text{ RER} = EP^k/P^{*w}$$

<sup>6</sup> For reasons discussed in the next section, the measure of prices used in this paper is the implicit price deflator (IPD) for GDP, which covers domestic production but excludes imported goods prices.

<sup>7</sup> For a review of the evidence against the law of one price see Rogoff (1996) and Goldberg and Knetter (1997).

where  $k$  and  $w$  represent institutional/physical impediments to the law of one price (or a wedge factor) in Australia and the United States respectively<sup>8</sup>.

But we note that the general level of prices will contain a subset of traded/nontraded prices and these prices are assumed to be multiplicative.

$$(3.) \quad P = P_T^\alpha P_N^{(1-\alpha)}; \text{and}$$

$$(4.) \quad P^* = P_T^{*\beta} P_N^{*(1-\beta)}$$

where  $P_T$  is the price level of the tradable sector and  $P_N$  is the price of the nontradable sector and  $\alpha$  and  $\beta$  represent the weight of the traded sector in the domestic and foreign countries respectively.

Breaking traded prices down further, the tradable sector consists of three components:

$$(5.) \quad P_T = P_X^{\lambda_1} P_{XH}^{\lambda_2} P_{MH}^{\lambda_3}; \text{and}$$

$$(6.) \quad P_T^* = P_X^{*\delta_1} P_{XH}^{*\delta_2} P_{MH}^{*\delta_3}$$

where  $P_X$  is a price index of actual exports (X),  $P_{XH}$  a price index of those goods that could have been exported but were consumed at home (XH) and  $P_{MH}$  is a price index of import replacements produced and consumed at home (MH). Similarly, the foreign price index can be broken down (equation 6)<sup>9</sup>. Because we are using the GDP deflator, import prices do not directly influence traded goods prices<sup>10</sup>.

Taking natural logarithms of 2 and substituting in the logs of equations 3 and 4 we get:

$$(7.) \quad \ln RER = \ln E + \alpha k \ln P_T - \beta w \ln P_T^* + (k - \alpha k) \ln P_N - (w - \beta w) \ln P_N^*$$

<sup>8</sup> For simplicity  $k$  and  $w$  are assumed to be constants, although it could be argued that these parameters would be falling over time as tariffs have been reduced during the period considered.

<sup>9</sup> Note that  $\lambda_1 + \lambda_2 + \lambda_3 = 1$  so that  $\lambda_1 + \lambda_2 = 1 - \lambda_3$ ; and  $\delta_1 + \delta_2 + \delta_3 = 1$  so that  $\delta_1 + \delta_2 = 1 - \delta_3$ .

<sup>10</sup> Although they will indirectly affect both the traded and nontraded prices where they are used as inputs into production.

Substituting equations 5 and 6 into equation 7 we obtain:

$$(8.) \quad \ln RER = \ln E + \alpha k [ \lambda_1 \ln P_X + \lambda_2 \ln P_{XH} + \lambda_3 \ln P_{MH} ] \\ - \beta w [ \delta_1 \ln P_X^* + \delta_2 \ln P_{XH}^* + \delta_3 \ln P_{MH}^* ] + (k - \alpha k) \ln P_N - (w - \beta w) \ln P_N^*$$

Assuming that potential export prices and import replacements prices would have prices equal to actual exports and imports<sup>11</sup>, so that  $\ln P_{XH} = \ln P_X$  and  $\ln P_{MH} = \ln P_M$  (and the same for the United States), then equation 8 becomes:

$$(9.) \quad \ln RER = \ln E + \alpha k [ (\lambda_1 + \lambda_2) \ln P_X + \lambda_3 \ln P_M ] \\ - \beta w [ (\delta_1 + \delta_2) \ln P_X^* + \delta_3 \ln P_M^* ] + (k - \alpha k) \ln P_N - (w - \beta w) \ln P_N^*$$

Rearranging equation 9 we obtain:

$$(10.) \quad \ln RER = \ln E + \alpha k \ln (P_X / P_N) - \alpha k \lambda_3 \ln (P_X / P_M) \\ - \beta w \ln (P_X^* / P_N^*) + \beta w \delta_3 \ln (P_X^* / P_M^*) + k \ln P_N - w \ln P_N^*$$

Notice that the domestic and foreign coefficients will be equal only under the following conditions: the wedge factors or institutional barriers to trade are the same in both countries; the share of traded and nontraded sectors in the domestic and foreign economy are the same; and the  $\lambda$ 's and the  $\delta$ 's are equal. If  $k$  and  $w$  are equal to 1 then the model collapses to the traditional definition of the real exchange rate. The higher the share of the nontraded sector in the economy, the lower will be the coefficients on the export and import price series.

Equation 10 forms the basis for our empirical hypothesis. The next section describes the measure of nontraded prices used and section 4 presents the empirical results.

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<sup>11</sup> The implicit assumption behind these proxies is that commodity arbitrage and substitution possibilities in consumption and production are sufficiently powerful to ensure that export and domestic prices of the same product are closely aligned.

### 3. Relative tradable/nontradable prices

The importance of the distinction between the tradable and nontradable sectors of the economy has long been recognised in the Australian theoretical literature. Nguyen and Martin (1987:3) note that the ratio of nontradable prices to tradable prices is a key variable in the dependent economy model, sometimes also called the Australian model because of the contributions by Swan (1960) and Salter (1959). The role of the relative price in the dependent economy model is to direct productive resources between the tradable and nontradable sectors, and to allocate domestic expenditure between tradable and nontradable goods. With prices and wages assumed to be flexible, adjustments in relative prices and aggregate expenditure ensure that both internal balance (equilibrium in the nontraded goods market) and external balance (zero trade surplus) are attained<sup>12</sup>.

Despite the importance of the tradable/nontradable dichotomy in theory, there is considerable difficulty in getting reasonable and timely data<sup>13</sup>. In the literature, the usual approach is to use a proxy that takes the ratio of the CPI to a wholesale or producer price index (Goldstein and Officer 1979 and Faruqee 1995). This is a fairly crude proxy that assumes the CPI will contain more nontraded goods than the wholesale price index and hence the ratio will act similarly to nontraded/traded prices. Dutton and Strauss (1997) construct two different series define manufactured goods as traded and all other items except food as nontraded<sup>14</sup>.

Pitchford (1986) proposed a direct measure of a relative nontraded price form of real effective exchange rates<sup>15</sup>. It is constructed as

$$(11.) RER_P = CPI / (0.5P_X + 0.5P_M)$$

Pitchford justifies the use of CPI in place of nontraded goods as a means of overcoming the difficulty of measuring the latter directly. The CPI includes the prices of both traded and nontraded goods and can therefore be decomposed as follows:

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<sup>12</sup> These relative prices are directly related to the traditional definition of the real exchange rate used in this paper. Dwyer and Lowe (1993) reconcile the two definitions of the real exchange rate.

<sup>13</sup> In the Australian case, the Australian Bureau of Statistics has investigated nontraded/traded price indexes (in Knight and Johnson (1997)). However, the data only run from March 1977 to June 1995. Earlier data are not easily attainable given substantial changes to ASIC in 1978 which means there are problems linking the 1974–75 class definitions to the 1977–78 class. More importantly perhaps, the data has not been updated since the study was undertaken and there are no plans to do so at this stage.

<sup>14</sup> Refer to Dutton (1993) for methodology.

<sup>15</sup> He assumed additive prices as opposed to the multiplicative assumption used in this paper.

$$(12.) \text{CPI} = cP_T + (1-c)P_{NT}$$

Substituting (12) into (11):

$$(13.) \text{RER}_P = c + (1+c)(P_{NT}/P_T)$$

where the domestic price index for traded goods ( $P_T$ ) is represented as an average of the domestic export price index and the domestic import price deflator. Thus, Pitchford argues, movements in  $\text{CPI}/P_T$  will be proportional to movements in  $(P_{NT}/P_T)$  and the former can be used in its place.

Dwyer (1987,1991) modifies Pitchford's measure by using implicit price deflators for both exports and imports, and combining the two as a weighted rather than a simple average. Further, Dwyer argues that Pitchford's use of the CPI does not completely isolate the price on nontraded goods and it does not take into account the differential effects of movements of the terms of trade on the prices of export goods and import substitutes. Dwyer attempts to directly measure  $P_{NT}$  by subtraction of import replacement goods from the CPI. If it is assumed that movements in the prices of import replacements follow those of imports, and that all imports are replaceable, import prices can be used as a proxy for the prices of import replacements. Thus when the import price deflator is deducted from the CPI the residual should be the price index of non-tradables<sup>16</sup>.

Dwyer then goes on to construct a measure which isolates the terms of trade effects<sup>17</sup>. If  $P_X$  is the implicit price deflator for exports, then assuming that the terms of trade remain unchanged  $P_X = P_M$ .

If the price of traded goods is a weighted average of export and import prices, then:

$$(14.) P_T = fP_X + (1-f)P_M \quad 0 < f < 1$$

<sup>16</sup> Dwyer assumes  $\text{CPI} = dP_M + (1-d)P_{NT}$ ; so that  $P_{NT} = (\text{CPI} - dP_M)/(1-d)$ . The parameter  $d$  is estimated to lie between 0.1 and 0.4 and represents the share of imports in the CPI. Dwyer plots this against Pitchford but finds that there is not much difference between the two measures and concludes that the anomalous real appreciation evident since early 1985 in Pitchford's index is not explained by the method of measuring nontraded goods prices, and therefore may be attributable to a terms of trade distortion which affects the measurement of traded goods prices.

<sup>17</sup> Martin and Nguyen (1989:2) note that with a change in the terms of trade the prices of tradable goods themselves would change in terms of each other and you cannot invoke the composite commodity assumption. The use of the traded/nontraded price ratio under such circumstances would therefore suffer from a number of conceptual and practical problems. They suggest using separate real exchange rate indexes formed with import price indexes and export price indexes. The former index was found to behave consistently with the conventional wisdom – appreciating in response to a terms of trade deterioration. By contrast, the real exchange rate index formed by using the price of exports is most likely to behave in the opposite direction – appreciation in response to a terms of trade deterioration and depreciation in response to an improvement. The behaviour of the real exchange rate index formed with a composite traded goods price index is largely ambiguous. This is hardly surprising as the composite traded goods is essentially a weighted average of the component indices, and these two component indexes are likely to move in diametrically opposite directions.

Hence if terms of trade are constant then  $P_T = P_X = P_M$ . If one assumes that the price of traded goods changes at the same rate as the price of imports and that movements in  $P_X$  follow  $P_M$  the real effective exchange rate can be expressed as<sup>18</sup>:

$$(15.) \text{RER}_D = P_{NT}/P_M$$

The proposed new proxy for relative nontraded prices incorporates three modifications to the Dwyer (1987,1991) measure already outlined above. First of all, the proposed measure uses a broader definition of prices than the CPI, namely the GDP deflator. Since the purpose in this paper is to derive a better test of PPP, the broader definition of prices is favoured on theoretical grounds<sup>19</sup>. The argument for the use of the traditional proxy of CPI/WPI is less convincing for an open economy like Australia where the CPI would contain a larger proportion of potentially tradable commodities. Note that while the CPI focuses on domestic consumption (it includes import prices but excludes export prices), the GDP deflator focuses on domestic production (it includes export prices but does not include import prices).

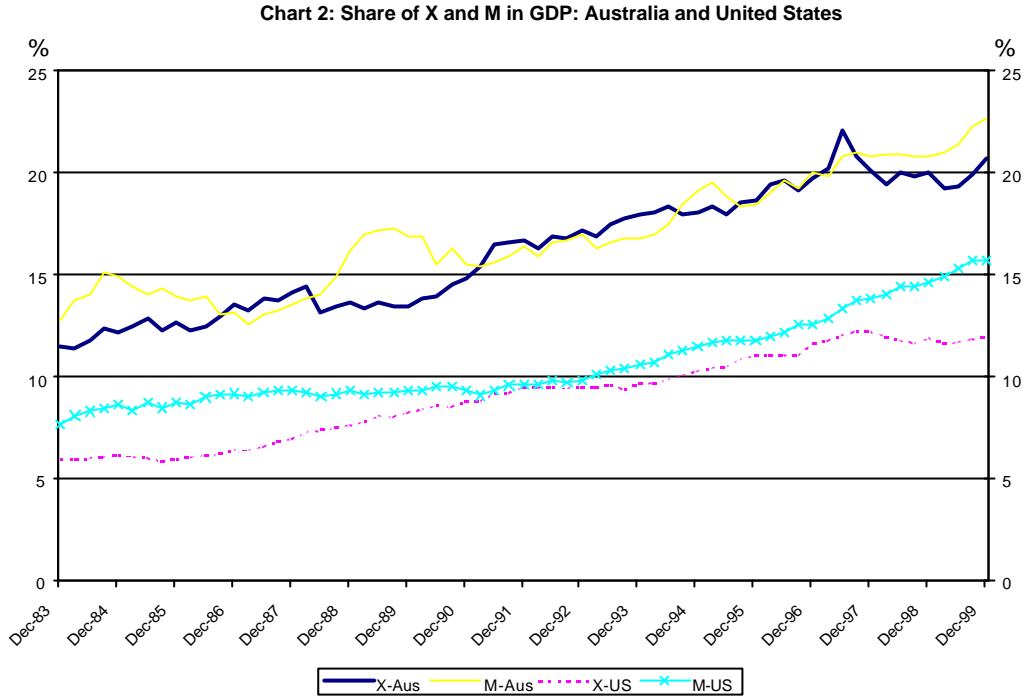
Secondly, the measure used by Dwyer does not fully take into account the tradable sector in the CPI when deducting import prices. Using the broad definition of traded goods<sup>20</sup>, the tradable sector includes those goods that could be exported but were consumed at home. The proposed measure explicitly takes those prices out of the nontraded goods component. Thirdly, while the Dwyer measure uses a fixed weight price index and assumes that the ratio of imports in the CPI was a constant (e.g. 0.1), when deducting export prices from the current weight GDP deflator the weight must be time varying since the share of exports (and import replacements) in production has been increasing over time (Chart 2).

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<sup>18</sup> Dwyer notes that alternatively one could assume that  $P_M$  follows  $P_E$  and construct a real effective exchange rate expressed as  $P_{NT}/P_E$  but argues that the use of import prices is preferred as a better proxy for the world price of traded goods.

<sup>19</sup> Officer (1982) clearly notes the preference for a broad measure of prices, namely GDP measures, since it is production that we are interested in not consumption.

<sup>20</sup> Salter (1959:226) defines traded goods as those with prices determined on world markets and consist of exportables, of which the surplus over home consumption is exported; and importables, of which the deficiency between consumption and home production is imported. Nontraded goods are those which do not enter into world trade; their prices are determined solely by internal costs and demand.



In developing an operational measure a number of assumptions must be made. Firstly, we assume that  $P_X$  and  $P_{XH}$  are both represented by the implicit price deflator for exports and assume that the implicit price deflator for imports represents  $P_{MH}$ <sup>21</sup>. Secondly, the proportion of exports and imports in total trade are used as proxies for the weight of  $P_X$  and  $P_{MH}$  in the traded sector ( $\lambda_1$  and  $\lambda_3$  for Australia,  $\delta_1$  and  $\delta_3$  for the US). Thirdly, it is assumed that the proportion of potential exports in total trade ( $\lambda_2$  and  $\delta_2$ ) is equal to zero. Other proxies for these parameters were tried but as they were fairly arbitrary and did not have a major impact on the final results the zero assumption was adopted. Finally, the proportion of traded goods in total domestic production in Australia and the United States ( $\alpha$  and  $\beta$  respectively) are assumed to be equivalent to the proportion of total exports and imports relative to GDP.

Putting this together we get

$$(16.) P = (P_X^{\lambda_1} P_{XH}^{\lambda_2} P_{MH}^{\lambda_3})^\alpha P_{NT}^{1-\alpha}; \text{ and}$$

$$(17.) P^* = (P_X^{*\delta_1} P_{XH}^{*\delta_2} P_{MH}^{*\delta_3})^\beta P_{NT}^{1-\beta}.$$

Assuming  $P_X$  corresponds to  $P_{XH}$  and  $P_{MH}$  corresponds to  $P_M$ , then we can define  $P_{NT}$  as:

$$(18.) P_{NT} = (P - \alpha(1-\lambda_3)P_X - \alpha\lambda_3P_M)/(1-\alpha); \text{ and,}$$

<sup>21</sup> See footnote 11.

(19.)  $P_{NT}^* = (P^* - \beta(1-\delta_3)P_X^* - \beta\delta_3P_M^*)/(1-\beta)$  for the United States.

In Charts 3 and 4, this GDP based measure of nontraded prices is compared with the consumer price proxy and the Dwyer measure. The various measures of relative nontraded/traded prices and their underlying assumptions are summarised in Appendix 1. Chart 3 shows the three proxies of nontraded prices in levels and Chart 4 shows the same proxies in first differences. The levels data are virtually indistinguishable from one another. The differenced data, however, show that while the Dwyer and CPI measure are almost identical, the GDP based measure has much greater volatility.

Chart 3: Nontraded prices: measures compared (levels)

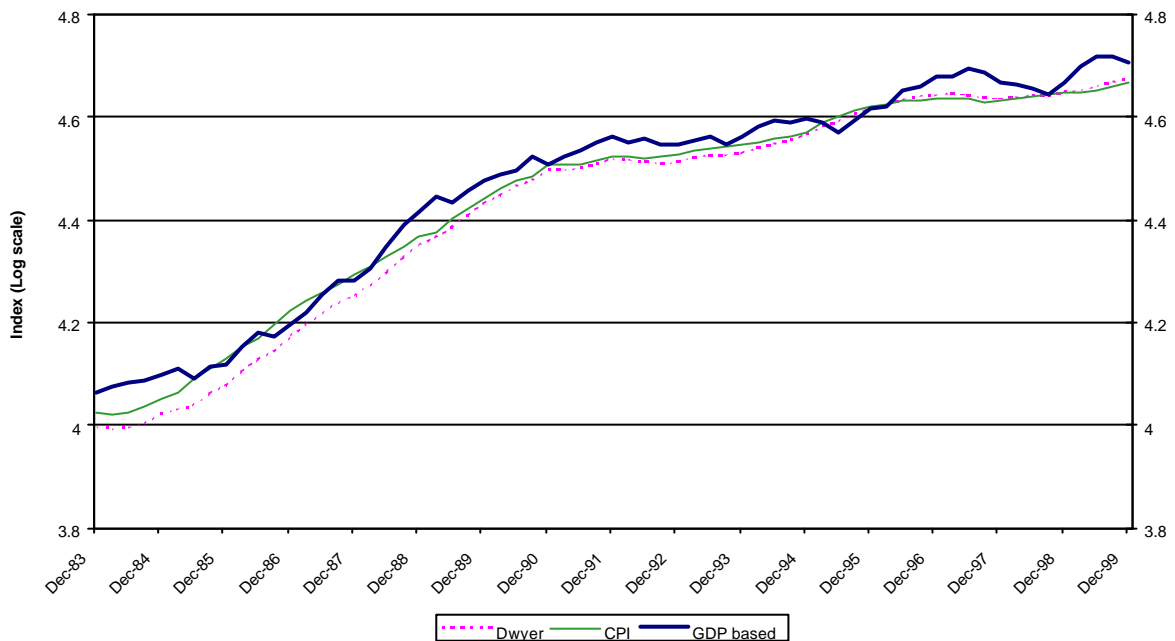


Chart 4: Nontraded prices: measures compared (changes)

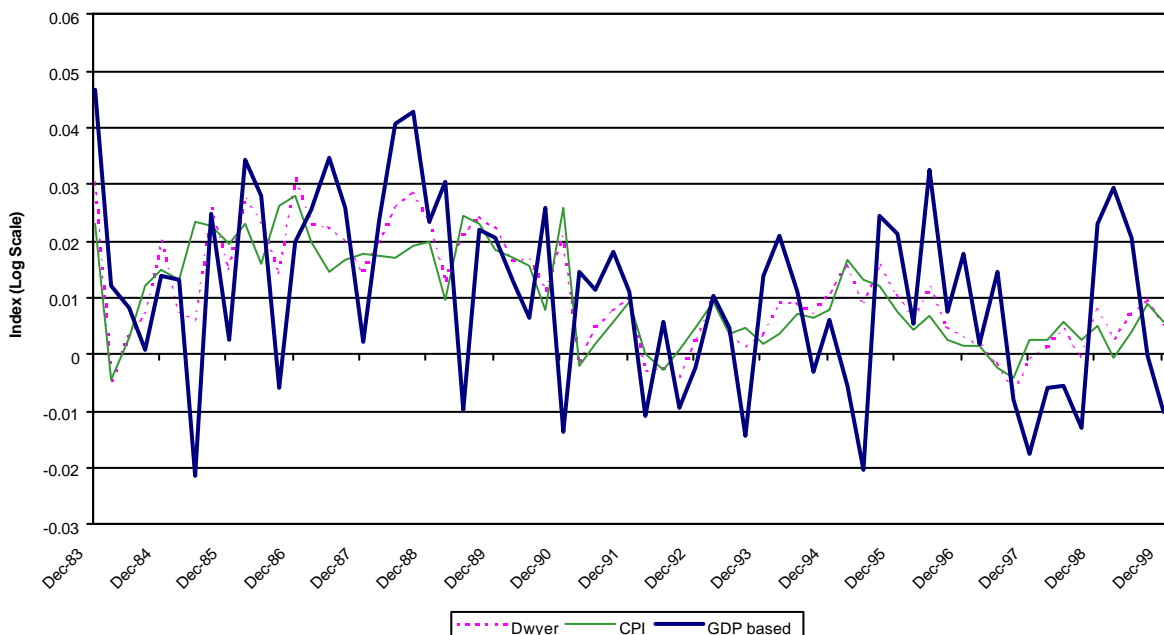
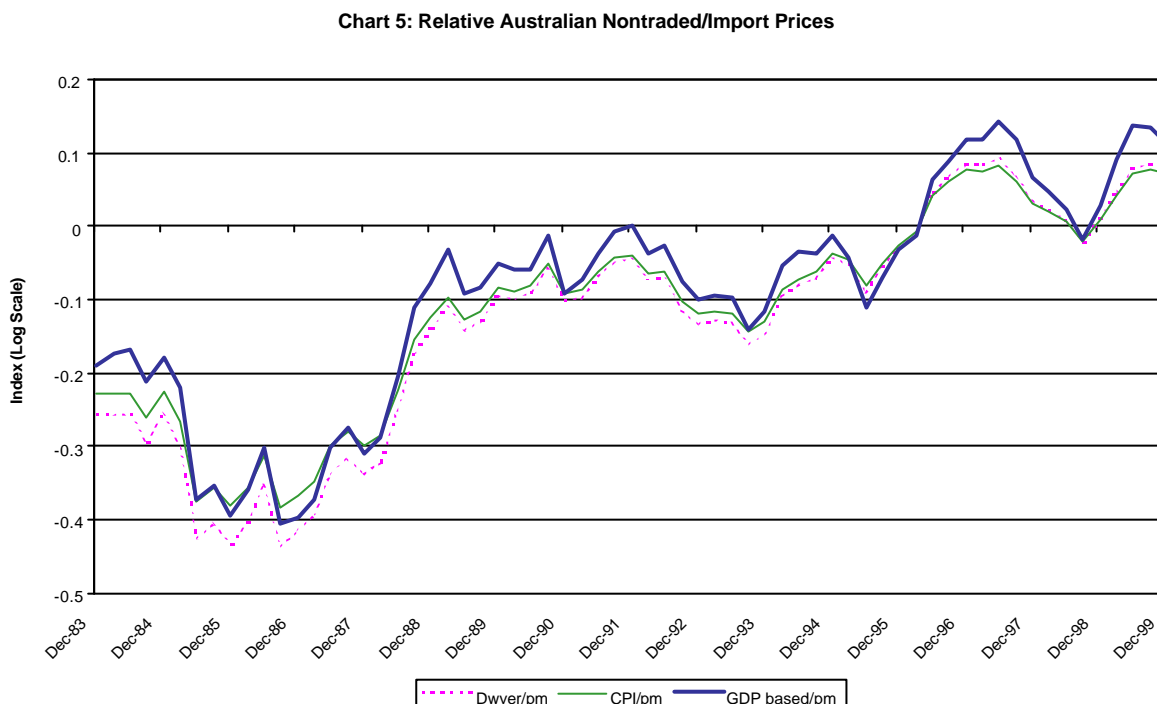


Chart 5 shows nontraded prices relative to export prices. The various measures produce similar results. It could be expected that the long run relationship estimated by the different measures of nontraded prices relative to export prices would produce similar results. This expectation is tested in the next section. The empirical work in this paper will be based on the GDP based measures for nontraded prices developed and illustrated above. The GDP based measure is more readily calculated with published data, comparatively timely and is theoretically more attuned to the ultimate purpose of this paper which is testing for PPP.



#### 4. Empirical results

We can examine the impact of relative nontraded/traded prices and the terms of trade on the real exchange rate using the now well-known Johansen (1988) multivariate cointegration methodology. This methodology involves finding a stationary, linear combination of a set of variables which are themselves non-stationary. The concept of cointegration provides a useful statistical definition of long run equilibrium existing between two or more integrated economic time series. In the current context, the augmented PPP model we have outlined above requires a long run equilibrium to exist between the nominal exchange rate, relative nontraded prices and the terms of trade, both in Australia and the U.S.

In order to utilise this methodology we first have to establish whether the variables identified in equation 10 are integrated. The results of the augmented Dickey-Fuller and Phillips–Perron (1988) tests (results not presented) indicate that all variables have a unit root for the post-float period except the Australian terms of trade<sup>22</sup>. Given the theoretical and empirical importance of the terms of trade in the real exchange rate in Australia, the model is estimated including the stationary Australian terms of trade. As noted by Harris (1995:80), “stationary I(0) variables might play a key role in establishing a sensible long-run relationship between non-stationary variables, especially if theory *a priori* suggests that such variables should be included”. He also notes that the practical implication of including I(0) variables is that cointegration rank will increase.

Consider the general specification of a structural vector autoregressive model with Gaussian errors:

$$(20.) \quad Az_t = A_1 z_{t-1} + \dots + A_k z_{t-k} + \mu + \psi D_t + v_t$$

where  $z_t$  is an  $n \times 1$  vector of variables,  $v_t \sim \text{NIID}(0, I)$  and  $D_t$  is a vector of deterministic variables (seasonal dummies, intervention dummies, etc...). The reduced form of the structural model (20.) is:

$$(21.) \quad z_t = A_1^* z_{t-1} + \dots + A_k^* z_{t-k} + \mu^* + \psi^* D_t + \varepsilon_t$$

where  $A_i^* = A^{-1} A_i$ ,  $\mu^* = A^{-1} \mu$ ,  $\psi^* = A^{-1} \psi$ ,  $\varepsilon_t = A^{-1} v_t$ , and  $\text{cov}(\varepsilon_t) = A^{-1} (A^{-1})' = \Sigma$ .

Equation (21.) can be reparameterized in the error-correction form:

$$(22.) \quad \Delta z_t = \Gamma_1 \Delta z_{t-1} + \dots + \Gamma_{k-1} \Delta z_{t-k+1} + \Pi z_{t-1} + \mu^* + \psi^* D_t + \varepsilon_t$$

where  $\Pi = (A_1^* + \dots + A_k^* - I)$  and  $\Gamma_i = -(A_{i+1}^* + \dots + A_k^*)$ .

Equation (22.) will be referred to as the Vector Error Correction Model (VECM). If  $z_t$  is I(1), this model contains a combination of I(1) and I(0) components. Given the conditions imposed on  $\varepsilon_t$  this is only possible if:

- (i)  $\text{rank}(\Pi) = 0$ , i.e.  $\Pi$  is the null matrix and (20.) is a traditional differenced vector time series model; or
- (ii)  $0 < \text{rank}(\Pi) = r < n$  implying that there are  $n \times r$  matrices  $\alpha$  and  $\beta$  such that  $\Pi = \alpha \beta'$ . The matrix  $\alpha$  can be interpreted as a measure of the speed by which the system corrects last period's equilibrium error.  $\beta$  is the matrix of cointegrating vectors.

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<sup>22</sup> The unit root properties of the Australian dollar are well established in the literature e.g. Gruen and Wilkinson (1994). They also report mixed evidence for the terms of trade but assume one unit root.

The rank  $r$  determines the number of linearly independent stationary relations between the levels of the variables. Johansen (1988) develops the maximum likelihood estimators of (22). Johansen (1991) and Johansen and Juselius (1990) present likelihood ratio tests for the rank of  $\Pi$ , the maximum eigenvalue test and the trace test, which can be used to establish whether the elements of  $z_t$  are cointegrated.

The vector error-correction model (22.) is estimated in logarithms using the nominal exchange rate defined as foreign currency per unit of domestic currency, relative nontraded prices ( $P_X/P_N$ ) and terms of trade ( $P_X/P_M$ ) and nontraded prices, both in Australia and the United States. The data are quarterly and the period is from December 1983 to December 1999 (64 observations) covering the floating period for the Australian dollar. A longer time frame was not considered because of I(2) properties of the full sample (especially US prices). The data are from the DX database and Appendix 2 lists the variable names used in the paper, as well as data identifiers, and descriptions.

Two intervention dummies (elements of  $D_t$ ) are included:

- $dumban = 1$  in June–September 1986, 0 otherwise;
- $dpoil$  which is the change in oil prices which is assumed to be both weakly exogenous for  $\alpha$  and  $\beta$ , and does not enter the cointegration space.

The first dummy variable (**dumban**) represents important short run effects arising from the impact of the banana republic statement in May 1996. The change in the price of oil (**dpoil**) acts like a dummy variable due to the two extreme changes in the oil price (see Juselius (1995)) and it is important as a conditioning variable for the US variables in the model.

The number of lags is set to  $k = 2$ . It is chosen such that the residuals of model fulfil the required assumptions, but is also suggested from the results of the Dickey Fuller and Philips-Perron unit root tests. The constant is restricted to the cointegrating space (such a choice was confirmed by testing the joint hypothesis of both the rank order and the deterministic components). Residual diagnostics statistics for the VAR model in levels are given in Table 1. The program Cats in Rats was used for the estimation (Hansen and Juselius, 1995).

**Table 1<sup>23</sup>**  
**December 1983 - December 1999**  
**Model Evaluation Diagnostics (Full rank)**

Statistics	LER	LPXPNA	LPXPNU	LTOT A	LTOT U	LPNA	LPNU
<b>Univariate statistics</b>							
ARCH(2)	7.30	4.24	1.97	2.00	2.38	1.01	0.92
$\chi_{nd}^2(2)$ normality test	0.54	1.78	2.62	4.36	1.20	5.90	3.98
$R^2$	0.49	0.42	0.70	0.40	0.65	0.40	0.58
<b>Multivariate statistics</b>							
LM(1) autocorr. test	58.4	p = 0.17					
LM(4) autocorr. test	34.0	p = 0.95					
$\chi_{nd}^2(8)$ normality test	16.6	p = 0.28					

\*\* Rejects the null hypothesis at 1% level, \* rejects the null hypothesis at 5%.  $\chi_{nd}^2$  is the Doornik and Hansen (1993) test for normality. ARCH(4) is an LM test for 4th order ARCH and has a  $\chi^2(4)$  distribution. LM(1) and LM(4) are multivariate tests for first and fourth order autocorrelation. They are both  $\chi^2(9)$ .

In Table 2 the trace and maximum eigenvalue statistics are presented. It should be noted that including intervention type dummy variables will affect the underlying distribution of the test statistics and the published critical values are thus only indicative. For small samples such as this one, Reimers (1992) suggests adjusting for degrees of freedom by dividing the maximum eigenvalue and trace statistics by  $\frac{T}{T - nk}$  (which in this case equals 1.286, where  $T (= 63)$  is the number of observations,  $n (= 7)$  is the number of variables and  $k (= 2)$  the lag-length when estimating (22)). In Table 2 we have included the statistics corrected for degrees of freedom. On the basis of the Trace test it is possible to accept that there are at most two cointegrating vectors, while the eigenvalue test suggests three. We assume that there are two cointegrating vectors, although it is only the first cointegrating relation that we are interested in. The diagnostic tests for the restricted model (rank = 2) are presented in Table 3. The estimated cointegrating vector  $\beta$  and the adjustment matrix  $\alpha$  are given in Table 4.

<sup>23</sup> Variable names are defined in Appendix 2.

Table 2

**December 1983 - December 1999**  
**Test for the Cointegration Rank**

$H_0: r =$	$n-r$	$\hat{\lambda}_i$	$\lambda_{\text{trace}}$	Corrected $\lambda_{\text{trace}}$	$\lambda_{\text{trace}}$ (0.90)	$\lambda_{\text{max}}$	Corrected $\lambda_{\text{max}}$	$\lambda_{\text{max}}$ (0.90)
0	7	0.761	216.48	168.34	126.71	90.07	70.04	29.54
1	6	0.510	126.41	98.30	97.71	44.93	34.94	25.51
2	5	0.404	81.48	63.36	71.66	32.63	25.37	21.74
3	4	0.344	48.85	37.99	49.92	26.58	20.67	18.03
4	3	0.179	22.27	17.32	31.88	12.47	9.70	14.09
5	2	0.094	9.81	7.63	17.79	6.20	4.82	10.29
6	1	0.056	3.61	2.81	7.50	3.61	2.81	7.50

Critical values from Osterwald-Lenum (1992) are denoted by  $\lambda_{\text{trace}}(0.90)$  and  $\lambda_{\text{max}}(0.90)$

Table 3

**December 1983 - December 1999**  
**Model Evaluation Diagnostics for the VECM with  $r = 2$**

Statistics	LER	LPXPNA	LPXPNU	LTOTA	LTOT U	LPNA	LPNU
<b>Univariate statistics</b>							
ARCH(4)	0.898	0.784	4.031	0.537	3.792	2.564	2.111
$\chi_{\text{nd}}^2(2)$ normality test	1.986	2.252	0.998	8.190	0.236	2.502	1.032
$R^2$	0.318	0.270	0.575	0.331	0.616	0.316	0.492
<b>Multivariate statistics</b>							
LM(1) autocorr. test	48.36 p = 0.50						
LM(4) autocorr. test	32.77 p = 0.96						
$\chi_{\text{nd}}^2(8)$ normality test	14.24 p = 0.43						

\*\* Rejects the null hypothesis at 1% level, \* rejects the null hypothesis at 5%.  $\chi_{\text{nd}}^2$  is the Doornik and Hansen (1994) test for normality. ARCH(4) is an LM test for 4th order ARCH and has a  $\chi^2(4)$  distribution. LM(1) and LM(4) are multivariate tests for first and fourth order autocorrelation. They are both  $\chi^2(9)$ .

Table 4

**December 1983 - December 1999**  
**Estimates of the first Cointegrating Vector and the Adjustment Matrix**  
**Normalised on LER**

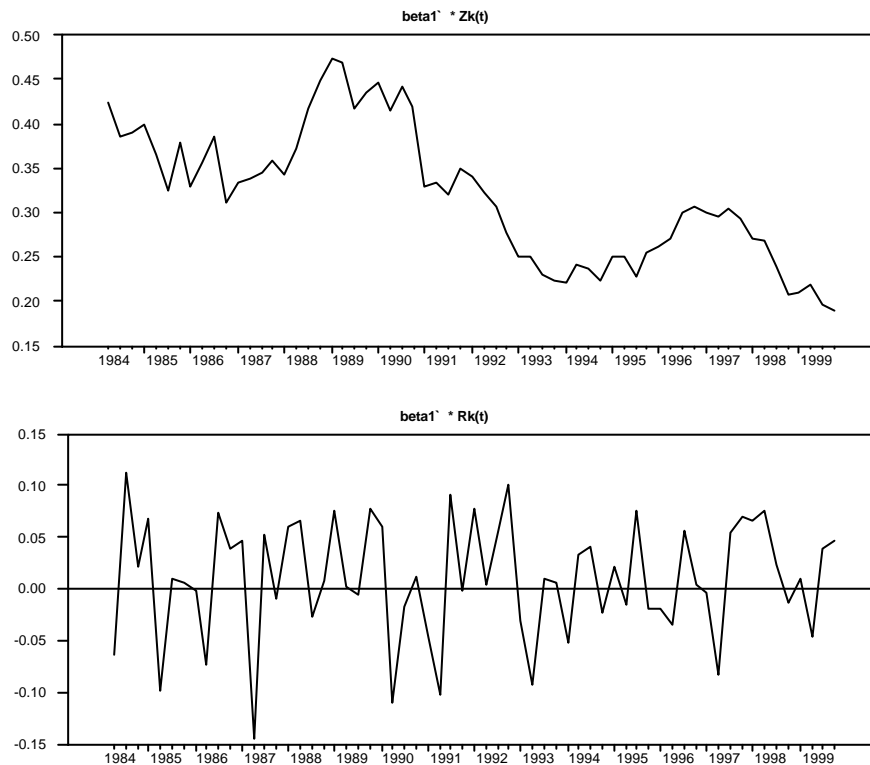
	LER	LPXPNA	LPXPNU	LTOT A	LTOTU	LPNA	LPNU
<b>b'</b>	<b>1</b>	<b>1.123</b>	<b>-2.071</b>	<b>-0.163</b>	<b>1.346</b>	<b>1.320</b>	<b>-2.517</b>
	(2.334)	(1.542)	(-2.333)	(-1.079)	(2.056)	(2.484)	(-2.582)
<b>a'</b>	<b>-0.204</b>	<b>0.194</b>	<b>-0.041</b>	<b>0.054</b>	<b>-0.046</b>	<b>-0.015</b>	<b>0.020</b>
	(-2.585)	(2.951)	(-3.278)	(1.384)	(-2.708)	(-0.506)	3.947

The numbers in parenthesis are the t-ratios on the corresponding elements of  $\Pi$  and  $\alpha$ .

Constant not reported.

The first cointegrating relationship is plotted in Chart 6. The upper graph shows the actual disequilibrium as a function of all the short-run dynamics including dummies. The bottom graph shows the disequilibrium corrected for short-run effects and pictures the ‘clean’ disequilibrium. It is the series in the lower graph that is actually tested for stationarity and thus determines the rank in the maximum likelihood procedure. Thus the bottom series shows the behaviour of the real exchange rate after nontraded prices and terms of trade are taken into account and provides evidence in support of the purchasing power parity hypothesis.

**Chart 6: The first cointegrating relationship**



Moreover, the estimated coefficients have the expected signs. From the model presented in equation 10, the economic interpretation of these estimated long run coefficients ( $\beta$ 's) can be derived and checked for consistency. The coefficients for nontraded prices ( $k$  and  $w$ ) represent a measure of trade barriers (or openness) in Australia (1.320) and the United States (2.517) and could

arguably suggest a higher level of barriers in the latter<sup>24</sup>. The coefficients on relative traded to nontraded prices ( $\alpha k$  and  $\beta w$ ) suggest that the proportion of traded goods ( $\alpha$  and  $\beta$ ) in Australia and the United States is around 85 % and 83 % respectively. The coefficients on the terms of trade ( $\alpha k \lambda_3$  and  $\beta w \delta_3$ ) suggest that the proportion of import competing goods ( $\lambda_3$  and  $\delta_3$ ) in Australia and the United States is 14% and 65% respectively. These parameters are not inconsistent with expectations, although they differ from the assumptions used to calculate nontraded prices which, apart from the constants  $k$  and  $w$ , are based on the proportions changing over time. The model estimates can be perhaps best be viewed as an average over the estimation period.

The same process was repeated with other proxies for nontraded prices used in the literature: the Dwyer and CPI measure described in Section 3. The estimated coefficients for the first cointegrating relationship are reported in Table 5 along with the implied parameters in equation 10. The diagnostics are not reported but the results are similar to those given above in that there are at most 2 cointegrating relationships in the model and the properties are well behaved. While both proxies still suggest that nontraded prices and the terms of trade are significant in explaining movements in the real exchange rate, not all coefficients are of the expected sign (marked with an asterisk). Furthermore, some of the implied parameters are not within the bounds of prior expectations. In the context of this model, this is taken as evidence that the GDP based measure of nontraded prices used in this paper is to be preferred to other proxies used in the literature.

**Table 5**  
**December 1983 - December 1999**  
**Estimates of the first Cointegrating Vector and the Adjustment Matrix**  
**Normalised on LER**

	LER	LPXPNA	LPXPNU	LTOT A	LTOT U	LPNA	LPNU
<b>Dwyer <math>\mathbf{b}'</math></b>	<b>1</b>	<b>0.267</b>	<b>-0.278</b>	<b>-3.101</b>	<b>3.542</b>	<b>0.204</b>	<b>1.016*</b>
	(2.86)	(1.91)	(-2.74)	(-3.27)	(3.36)	(1.98)	(1.67)
<b>CPI <math>\mathbf{b}'</math></b>	<b>1</b>	<b>-0.717*</b>	<b>1.644**</b>	<b>-6.377</b>	<b>7.030</b>	<b>-1.008**</b>	<b>4.848*</b>
	(1.96)	(0.47)	(3.32)	(-3.07)	(3.11)	(-3.17)	(1.51)

	<b>k</b>	<b>w</b>	<b>a</b>	<b>b</b>	<b><math>\mathbf{l}_3</math></b>	<b><math>\mathbf{d}_3</math></b>
<b>Dwyer</b>	0.204	1.016	1.31	0.27	11.61	12.74
<b>CPI</b>	1.008	4.848	0.71	0.34	8.89	4.28

<sup>24</sup> A likelihood ratio test of the null hypothesis that  $k = w$  was rejected at the 1% significance level, supporting the conclusion that  $w$  is statistically significantly greater than  $k$ .

The numbers in parenthesis are the t-ratios on the corresponding elements of  $\Pi$  and  $\alpha$ .

Constant not reported.

\* indicates wrong sign and insignificant

\*\* indicates wrong sign and significant

## 5. Conclusion

This paper argues that the essential problem underlying the failure of empirical tests of purchasing power parity may be the loss of information that arises from aggregation of prices. This paper specifies the purchasing power parity relationship based on a disaggregation of general prices into traded/nontraded prices, and then traded prices into export/import prices. Furthermore, it is recognised that oil prices are a subset of export/import prices and that these prices will also play a role. The significance of that role will depend on the country involved and whether it is primarily an oil importer or exporter (or both as is the case for Australia).

In order to test this argument empirically, a measure of nontraded goods prices based on a broad theoretical definition of prices and tradable goods is developed. This measure is tested against other proxies found in the literature in the context of the purchasing power parity model of the bilateral Australian dollar/US dollar exchange rate. It is concluded that relative nontraded goods prices and the terms of trade play an important role in causing deviations away from purchasing power parity. Furthermore, the measure on nontraded prices proposed appears to provide more sensible estimates of the long run coefficients compared with other proxies used in the literature.

## Appendix 1

### Summary of different measures of nontraded/traded relative prices

Source	Measure	Assumptions
Faruqee (1995)	CPI/WPI	<ul style="list-style-type: none"> <li>• CPI = nontraded</li> <li>• WPI = traded</li> </ul>
Dutton and Strauss (1997)	Services/Manufactured goods	<ul style="list-style-type: none"> <li>• Services = nontraded</li> <li>• Manufacturing = traded</li> <li>• (excludes food)</li> </ul>
Pitchford (1986)	$CPI/P_T$ $P_T = 0.5P_X + 0.5P_M$	<ul style="list-style-type: none"> <li>• CPI = nontraded</li> <li>• <math>P_X</math> = domestic export price index</li> <li>• <math>P_M</math> = domestic import price deflator used as a proxy for import replacements</li> </ul>
Dwyer (1987,1991)	$P_{NT}/P_T$ $P_{NT} = (CPI - dP_M)/(1-d)$ $P_T = P_M$	<ul style="list-style-type: none"> <li>• Assumes that the nontraded sector is estimated by removing import prices from the CPI.</li> <li>• <math>P_M</math> = domestic import price deflator used as a proxy for import replacements</li> <li>• <math>d</math> = share of imports in the CPI (assumed constant = 0.1).</li> <li>• Given problems aggregating <math>P_X</math> and <math>P_M</math> when terms of trade change, assumes that <math>P_M</math> is the best approximation to world traded goods prices.</li> </ul>
GDP based measure Australia and U.S.	Refer to Section 3	<ul style="list-style-type: none"> <li>• Assumes that the nontraded sector is estimated by removing the price of exports, exportables and import replacements, from the GDP implicit price deflator.</li> <li>• <math>\lambda_1 + \lambda_2 = X/GDP</math></li> <li>• <math>\lambda_3 = M/GDP</math></li> </ul>

## **Appendix 2: Data**

Data used in the paper are derived from the primary series described below.

The following nomenclature is applied throughout the paper:

**l** prefix represents natural logarithms; **er** is the nominal exchange rate; **'a'** suffix represents Australia,

**'u'** suffix represents United States; **pxpn** is relative exports/nontraded prices; **tot** is terms of trade;

**pn** is nontraded prices .

<b>Name</b>	<b>Description</b>	<b>Identifier</b>	<b>Units</b>	<b>From</b>
er	US Dollar exchange rate: Monthly average: Australia	AUS.CCUSMA02.ST	AUD/USD	mei_sub3
pgdpu	United States: GDP: (sa): Implicit price level	USA.NAGITT01.IXOBSA	1995=100	mei-usa
pgdpa	GDP: Implicit price level: Australia: (sa)	AUS.NAGITT01.IXOBSA	1995=100	mei_nac
gdpu	GDP: Constant prices: United States: (sa)	USA.NAGVTT01.NCALSA	bln 96 USD	mei_nac
gdpa	GDP: Constant prices: Australia: (sa)	AUS.NAGVTT01.NCALSA	bln 97-98 AUD	mei_nac
xu	Expenditure on GDP: Exports of goods & services: United States: (sa)	USA.NAGVEX01.NCALSA	bln 96 USD	mei_nac
xa	Expenditure on GDP: Exports of goods & services: Australia: (sa)	AUS.NAGVEX01.NCALSA	bln 97-98 AUD	mei_nac
mu	Expenditure on GDP: Imports of goods & services: United States: (sa)	USA.NAGVIM01.NCALSA	bln 96 USD	mei_nac
ma	Expenditure on GDP: Imports of goods & services: Australia: (sa)	AUS.NAGVIM01.NCALSA	bln 97-98 AUD	mei_nac
cpiu	Consumer prices: All items: United States	USA.CPALTT01.IXOB	1995=100	mei_sub
cpia	Consumer prices: All items: Australia	AUS.CPALTT01.IXOB	1995=100	mei_sub
ppiu	Producer prices: Manufacturing: United States	USA.PPIAMP01.IXOB	1995=100	mei_sub
ppia	Producer prices: Manufacturing: Australia	AUS.PPIAMP01.IXOB	1995=100	mei_sub
poil	United States: Prices: PPI: Refined petroleum products	USA.PPOGRP01.IXOB	1995=100	mei-usa
pxu	United States: Implicit price index: Exports of goods & services	USA.EXPEXP.DNBSA	1996=100	qna-usa
pmu	United States: Implicit price index: Imports of goods & services	USA.EXPIMP.DNBSA	1996=100	qna-usa
pxa	Australia: Implicit price index: Exports of goods & services	AUS.EXPEXP.DNBSA	1997/98=100	qna-aus
pma	Australia: Implicit price index: Imports of goods & services	AUS.EXPIMP.DNBSA	1997/98=100	qna-aus

## References

- Abauf, N., and P. Jorion (1990), "Purchasing Power Parity in the Long Run", *The Journal of Finance*, Vol. XLV, No. 1, March, pp. 157-174.
- Amano, R. and S. van Norden, (1998), "Oil prices and the rise and fall of the US real exchange rate", *Journal of International Money and Finance*, Vol. 17, pp. 299-316.
- Backus, D. and M. Crucini (2000), "Oil prices and the terms of trade", *Journal of International Economics*, Vol. 50, pp. 185-213.
- Balassa, B. (1964), "The purchasing power parity doctrine: a reappraisal", *Journal of Political Economy*, Vol. 6, pp. 584-596.
- De Gregorio, J., A. Giovannini, and H. Wolf (1994), "International evidence on tradables and nontradables inflation", *European Economic Review*, Vol. 38, pp. 1225-1244.
- Doornik and Hansen (1993), *A practical test of multivariate normality*, Nuffield college, University of Oxford.
- Dornbusch, R., and P. Krugman (1976), "Flexible Exchange Rates in the Short Run", *Brookings Papers on Economic Activity*, 1976:3, pp. 537-575.
- Dutton, M. (1993), "Real interest rate parity new measures and tests", *Journal of International Money and Finance*, Vol. 12, pp. 62-77.
- Dutton, M. and J. Strauss (1997), "Cointegration tests of purchasing power parity: the impact of non-traded goods", *Journal of International Money and Finance*, Vol. 16, No. 3, pp. 433-444.
- Dwyer, J. (1987), "Real Effective Exchange Rates as indicators of Competitiveness", Paper presented at the *16<sup>th</sup> Conference of Economists*, Surfers Paradise, 23-27 August.
- Dwyer, J. (1991), "Issues in the Measurement of Australia's Competitiveness", in K.W. Clements, R. G. Gregory and T. Takayama (eds.), *International Economics Postgraduate Research Conference Volume*, supplement to the Economic Record, pp. 53-59.
- Dwyer, J., and P. Lowe (1993), "Alternative concepts of the real exchange rate: a reconciliation", *Reserve Bank of Australia*, Research Discussion Paper, RDP 9309.
- Edison, H., J. Gagnon, and W. Melick (1997), "Understanding the empirical literature on purchasing power parity: the post-Bretton Woods era", *Journal of International Money and Finance*, Vol. 16, No. 1, pp. 1-17.
- Faruqee, H. (1995), "Long-Run Determinants of the Real Exchange Rate: A Stock-Flow Perspective", *IMF Staff Papers*, Vol. 42, No. 1, March, pp. 80-107.

Frankel, J., and A. Rose (1996), "A panel project on purchasing power parity: Mean reversion within and between countries", *Journal of International Economics*, Vol. 40, pp. 209-224.

Goldberg, P. and M. Knetter (1997), "Goods Prices and Exchange Rates: What Have We Learned?", The *Journal of Economic Literature*, Vol. 35, September, pp. 1243-1272.

Goldstein, M. and L. Officer (1979), "New measures of prices and productivity for tradable and nontradable goods", *Review of Income and Wealth*, Vol. 25, December, pp. 413-427.

Gregory, R. (1993), Discussion, pp. 79-82, on Blundell-Wignall A., et al, "Major influences on the Australian dollar exchange rate", in A. Blundell-Wignall (1993) (ed.) *The Exchange Rate, International trade and the Balance of Payments*, Proceedings of a Conference, Reserve Bank of Australia, July.

Gruen, D., and J. Wilkinson (1994), "Australia's Real Exchange Rate - Is it explained by the Terms of Trade or by Real Interest Differentials?", *The Economic Record*, Vol. 70, No. 209, June, pp. 204-219.

Hansen, H. and Juselius, K. (1995), *CATS in RATS: Cointegration Analysis of Time Series*, Estima: Evanston, Illinois, USA.

Harris, R. (1995), *Using cointegration analysis in econometric modelling*, Hemel Hempstead, England : Harvester Wheatsheaf, Prentice Hall.

Isard, P. (1977), "How far can we push the law of one price?", *American Economic Review*, Vol. 67, No. 5, pp. 942-948.

Johansen, S. (1988), "Statistical analysis of cointegration vectors", *Journal of Economic Dynamics and Control*, Vol. 12, pp. 231-54.

Johansen, S. (1991), "Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models", *Econometrica*, Vol. 59, No. 6, November, pp. 1551-1580.

Johansen, S., and K. Juselius (1990), "The full information maximum likelihood procedure for inference on cointegration – with applications to the demand for money", *Oxford Bulletin of Economics and Statistics*, 52, pp. 169-210.

Juselius, K. (1995), "Do purchasing power parity and uncovered interest rate parity hold in the long run? An example of likelihood inference in a multivariate time-series model", *Journal of Econometrics*, Vol. 69, pp. 211-240.

Knight, G. and L. Johnson (1997), "Tradables: Developing Output and Price Measures for Australia's Tradable and Non-Tradable Sectors", *Australian Bureau of Statistics Working Papers in Econometrics and Applied Statistics*, Working Paper No. 97/1, ABS Catalogue No. 1351.0, December.

Lothian, J. (1997), "Multi-country evidence on the behaviour of purchasing power parity under the current float", *Journal of International Money and Finance*, Vol. 16, No. 1, pp. 19-35.

Martin, W., and D. Nguyen (1989), "The terms of trade and real exchange rates", Paper prepared for presentation to the *Conference of Economists*, Adelaide, July 10-13.

Nguyen, D. and W. Martin (1987), "When is the real exchange rate a useful concept", Contributed paper for presentation to the *31<sup>st</sup> Annual Conference of the Australian Agricultural Economics Society*, Adelaide, February 9–12.

O'Connell, P. (1998), "The overvaluation of purchasing power parity", *Journal of International Economics*, Vol. 44, pp. 1-19.

Officer, L. H. (1982), *Purchasing Power Parity and Exchange Rates: Theory, Evidence and Relevance*, JAI Press Inc., Greenwich, Connecticut.

Osterwald-Lenum, M. (1992), "A note with quantiles of the asymptotic distribution of the ML cointegration rank test statistics", *Oxford Bulletin of Economics and Statistics*, 54, pp. 461–72.

Phillips, P. and P. Perron (1988), "Testing for a unit root in time series regression", *Biometrika*, 75, pp. 335–46.

Pitchford, J. (1986), "The Australian Economy: 1985 and Prospects for 1986", *The Economic Record*, Vol. 62, No. 176, pp. 1-21.

Reimers, H. (1992), "Comparison of tests for multivariate cointegration", *Statistical Papers*, 33, pp. 335–59.

Rogoff, K. (1996), "The Purchasing Power Parity Puzzle", *The Journal of Economic Literature*, Vol. 34, June, pp. 647-668.

Swan, T. W. (1960), "Economic control in a dependent economy", *The Economic Record*, Vol. 36, pp. 51-66.

Salter, W. E. G. (1959), "Internal and External Balance: The role of Price and Expenditure Effects", *The Economic Record*, Vol. 35, pp. 226-238.

Tarditi, A. (1996), "Modelling the Australian Exchange Rate, Long Bond Yield and Inflationary Expectations", *Reserve Bank of Australia*, Research Discussion Paper, No. 9608.