Assessing the adequacy of measures of Australia's price competitiveness and structural change

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September 2001

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Abstract

There are a plethora of measures of Australia's international price competitiveness. This article provides a practitioners guide to those series. The currently available measures of international price competitiveness are found to be deficient. A theoretically sound measure is suggested and computer code is supplied to construct estimates.

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1. Introduction

The Reserve Bank of Australia (RBA) and the Treasury construct several measures of Australian price competitiveness.[1] The RBA real trade weighted index of exchange rates (RTWI) has not been made public but, Dungey and Joiner (2000) provide a spreadsheet that may be used to calculate a RTWI using the RBA methodology.[2] Given this plethora of measures of international price competitiveness there is scope for a guide for practitioners that reviews these indexes. In this paper I discuss the underlying economic concepts, assess how well these indexes approximate these economic concepts, assess the quality of the index construction and make available improved procedures for constructing these indexes.

A useful starting point is to note that one might convert foreign price indexes into Australia dollars and then take an average of these prices. Although there are many ways to make an average, the focus on interest is on relative prices and thus a trade weighted geometric average is a natural measure. Assume for the moment that all data is available continuously and let $w_i(t)$ represent country i's trade share, $e_i(t)$ and $p_i(t)$ represent the logarithm of it's bilateral exchange rate with the \$A and the logarithm of the relevant price index respectively. Consider the index $I_A(t)$ which is constructed as the logarithm of the relevant Australian prices p_A less the logarithm of the geometric mean of foreign prices converted to Australian dollars. Then $I_A(t)$ measures the ratio of Australian prices to a trade weighted index of foreign prices converted to \$A.

$$I_A(t) = p_A - \sum_{i=1}^{N} w_i(t)\left(p_i(t) + e_i(t)\right) \qquad (1)$$

Such an index is of some use for descriptive purposes but the main focus of interest is on why it changes over time. Differentiating equation (1) with respect to time yields the instantaneous change in the geometric mean of prices.

$$\frac{dI_A(t)}{dt} = \left\{\frac{dp_A(t)}{dt} - \sum_{i=1}^{N} w_i(t)\left[\frac{dp_i(t)}{dt} + \frac{de_i(t)}{dt}\right]\right\} - \sum_{i=1}^{N}\left[p_i(t) + e_i(t)\right]\frac{dw_i(t)}{dt} \qquad (2)$$

The first term in equation 2 measures the instantaneous change in Australia's price competitiveness, a rise in this component means that Australian goods have become more expensive relative to foreign goods indicating a decline in competitiveness. The second term measures how the change in the country structure of trade has affected the ratio of Australian prices to the average of foreign prices. Clearly, economic theory requires that we separate these two effects since otherwise we would confound price effects with quantity effects. Thus in assessing the various measures of competitiveness the main criteria will be minimizing the approximation errors made when trying to measure these two components. The relevant theory is discussed in section 2. The size of the approximation errors depends not only on the method of index construction but

[1] Treasury's real exchange rates are available from http://www.treasury.gov.au.

also on the pattern of movements in country trade shares, and exchange rates. Information on these is provided in section 3 of the paper. The RBA's nominal TWI is evaluated in section 4 and the several measures of international price competitiveness (real TWIs) are evaluated in section 5. Conclusions are presented in section 6.

2. Theoretical considerations in constructing indexes of price competitiveness and structural change

The approximation errors, alluded to in the introduction, arise because data on prices, exchange rates and trade shares are not available in a continuous record but instead are recorded at discrete (quarterly) intervals. Thus we need a link between the unobservable continuous time data in equation (2) and the observable discrete data on exchange rates prices and trade shares. This link is made via the two integral equations (3) and (4) that define the change from the beginning of the period (quarter) to the end of the period in the divisia index of price competitiveness($IC_t^{divisia}$) and structural change index $IS_t^{divisia}$.

$$\Delta IC_t^{divisia} = \sum_{k=1}^{K} \int_{t-1}^{t} \left[w_i(t) \left\{ \frac{de_i(t)}{dt} + \frac{dp_i(t)}{dt} \right\} \right] dt \qquad (3)$$

$$\Delta IS_t^{divisia} = \sum_{k=1}^{K} \int_{t-1}^{t} \left[\{ p_i(t) + e_i(t) \} \frac{dw_i(t)}{dt} \right] dt \qquad (4)$$

The index number problem then, is to obtain good approximations to these integrals above. In discussing these approximations it is useful to focus on the following discrete approximations made for various values of α in the interval 0 to 1.

$$\Delta \ln IC_t^{\alpha} = \sum_{k=1}^{K} [\alpha w_{kt-1} + (1-\alpha) w_{kt}] \{\Delta p_{it} + \Delta e_{it}\} \qquad (5)$$

$$\Delta IS_t^{\alpha} = \sum_{k=1}^{K} [\alpha \{p_{kt-1} + e_{kt-1}\} + (1-\alpha)\{p_{kt} + e_{kt}\}] \Delta w_{kt} \qquad (6)$$

Choice of the values 0, 0.5 and 1 for α yield a trinity of index numbers:

- $\alpha = 1$ yields Lasypeyres indexes of prices and structural change.
- $\alpha = 0$ yields Paasche indexes of prices and structural change.
- $\alpha = 0.5$ yields Törnqvist indexes of prices and structural change.

It is well known[3] that the Lasypeyres and Paasche indexes are first order approximations to the divisia price and structural change indexes. That is they produce second and higher order errors. That is the Lasyperes

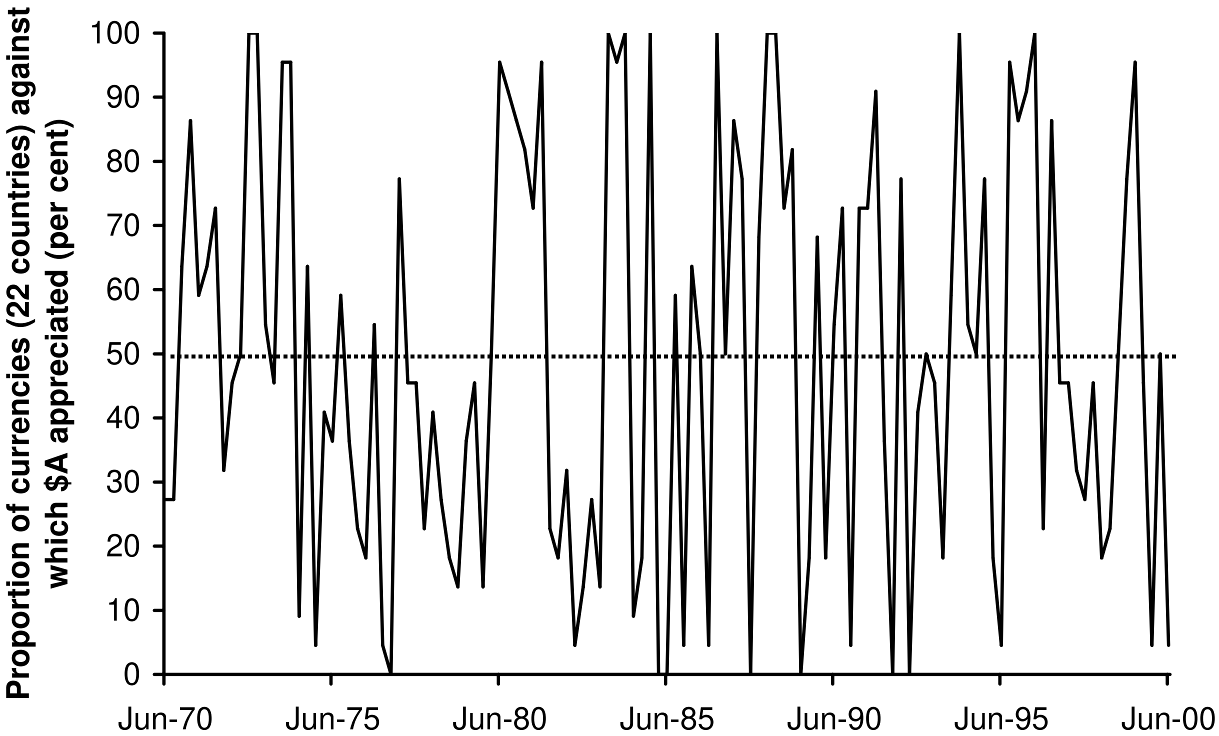
[2] The RBA also publishes a nominal trade weighted index of exchange rates.
[3] Diewert 1976 and 1981; Guerrieri and Milana 1995; Denny and Fuss (1983).

and Paasche indexes do a poor job of separating the price competitiveness and structural effects. The Törnqvist index in contrast is a second order approximation and thus produces third and higher order approximation errors. Thus it does a far better job at separating the price competitiveness and structural effects. Caves, Christensen and Diewert (1982a,b) show that the Törnqvist index maintains its high degree of approximation even if the underlying aggregation function is shifting in a non-homothetic way. Given that it is relatively straight forward to calculate, it seems that best practice is to compute Törnqvist indexes of price competitiveness.

3. Some features of bilateral exchange rates and country trade shares

Trade weighted exchange rates combine bilateral exchange rates and trade shares. Insight into the magnitude of the aggregation problem is obtained by examining these specific measures. For example, if bilateral exchange rates contain a significant common component then small aggregation errors will be incurred. However, as shown in Figure 1, in an average quarter, one half of currencies appreciate against the $A while the other half depreciate.[4] Moreover, the proportion of currencies that are appreciating against the $A varies considerably over time. The marked variation in the proportion of currencies against which the Australian dollar is appreciating also highlights the flaw in focusing on any single bilateral rate.

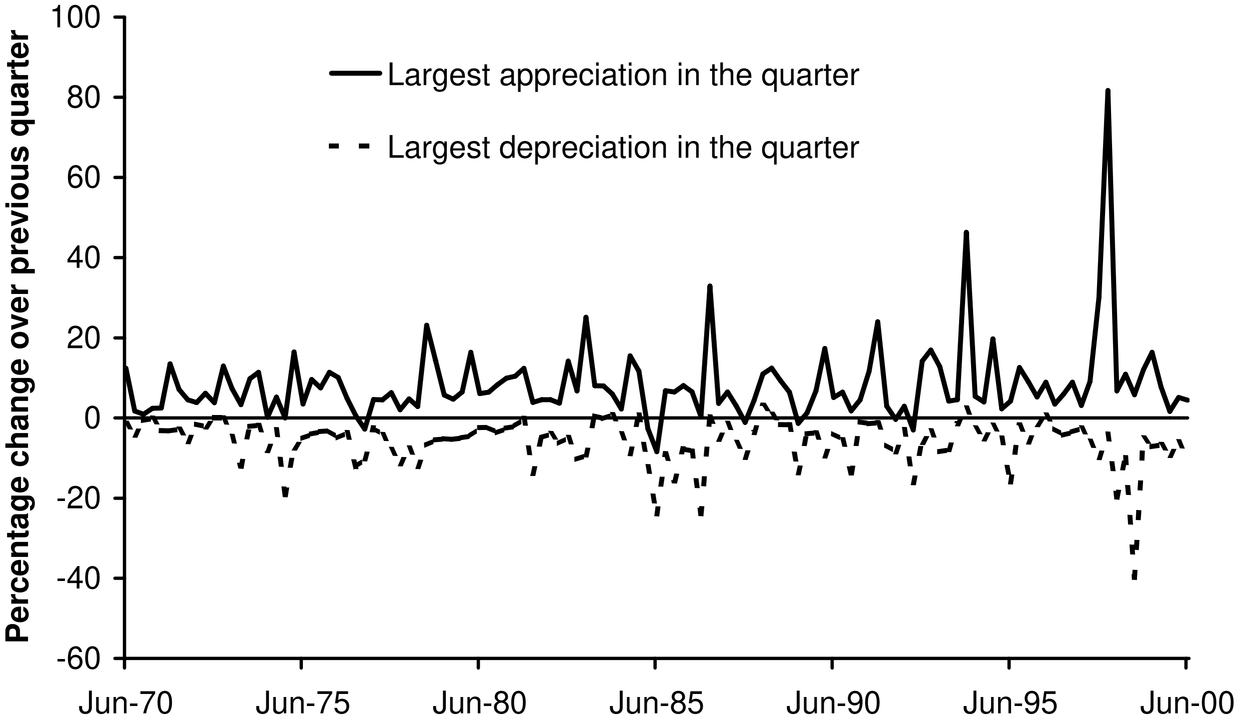
Figure 1. Proportion of currencies against which $A appreciated in the quarter, June 1970 to June 2000



4 Based on the 22 countries that comprise Australia's largest trading partners. These comprise, United States, United Kingdom, Belgium, France, Germany, Italy, Netherlands, Sweden, Switzerland, Canada, Japan, New Zealand, Saudi Arabia, Taiwan, Hong Kong, India, Indonesia, South Korea, Malaysia, Singapore, Papua New Guinea, China.

Even with the directional pattern of bilateral exchange rate fluctuations shown in Figure 1, construction of a trade-weighted index of exchange rates would be relatively straightforward if the magnitude of the fluctuations were small. However, the largest bilateral appreciation of the $A in a quarter averages 8.3 per cent while the largest bilateral depreciation averages 5.9 per cent. Moreover as is shown in Figure 2 there are substantial fluctuations around these averages. Indeed, the largest appreciation of the $A was 82 per cent against the Indonesian Rupiah in March 1998 while the largest bilateral depreciation was 40 percent against the Indonesian Rupiah in December 1998. Moreover as is shown in Figure 3 the standard deviation of bilateral exchange rates varies considerably and has been as high as 19 per cent during the Asian crisis.

Figure 2. Maximum, minimum and arithmetic average of the change in bilateral $A exchange rates for Australia's 22 largest trading partners, June 1970 to June 2000



When constructing trade weighted exchange rates the objective is to separate the movement in exchange rates from the change in the country structure of trade. If country trade shares are constant this problem does not arise. Unfortunately construction of TWIs for Australia is complicated because its trade shares are changing over time. Specifically, there is a change away from trade with the countries that represented Australia's big four trading partners in 1970 and towards increased trade with Asia (See Figure 4).

Figure 3: Standard deviation of percentage changes in Australian bilateral exchange rates with 22 countries

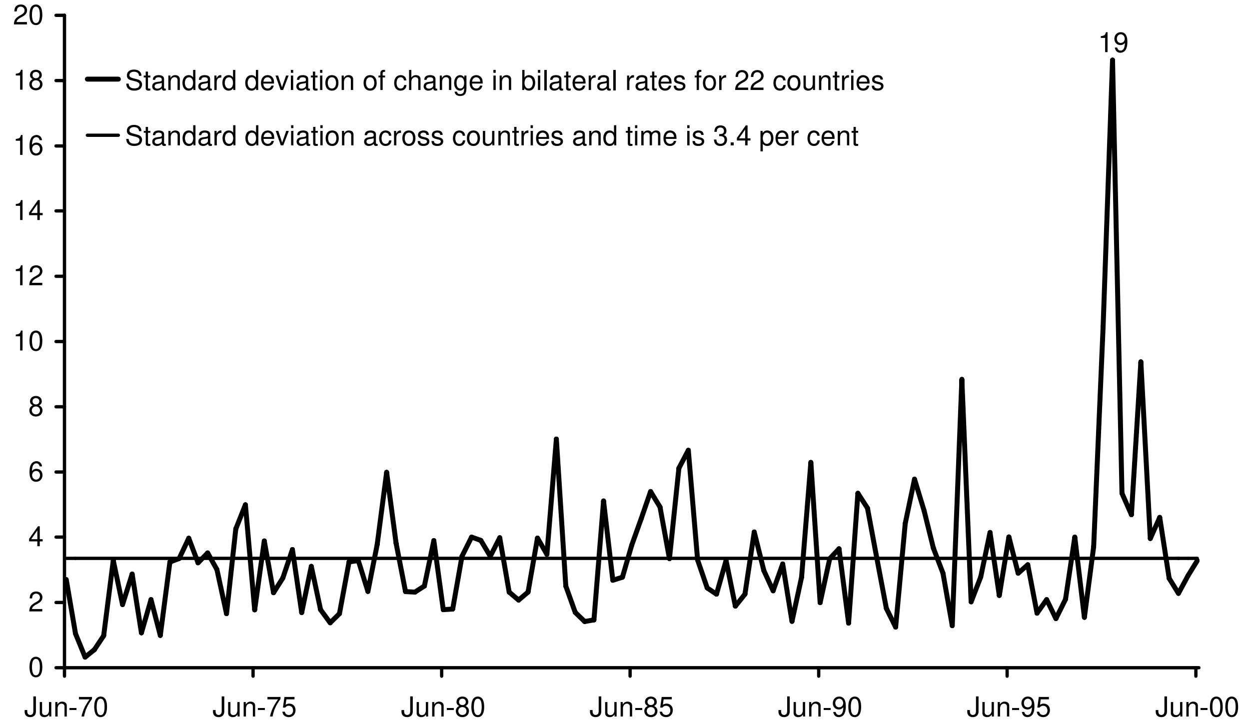
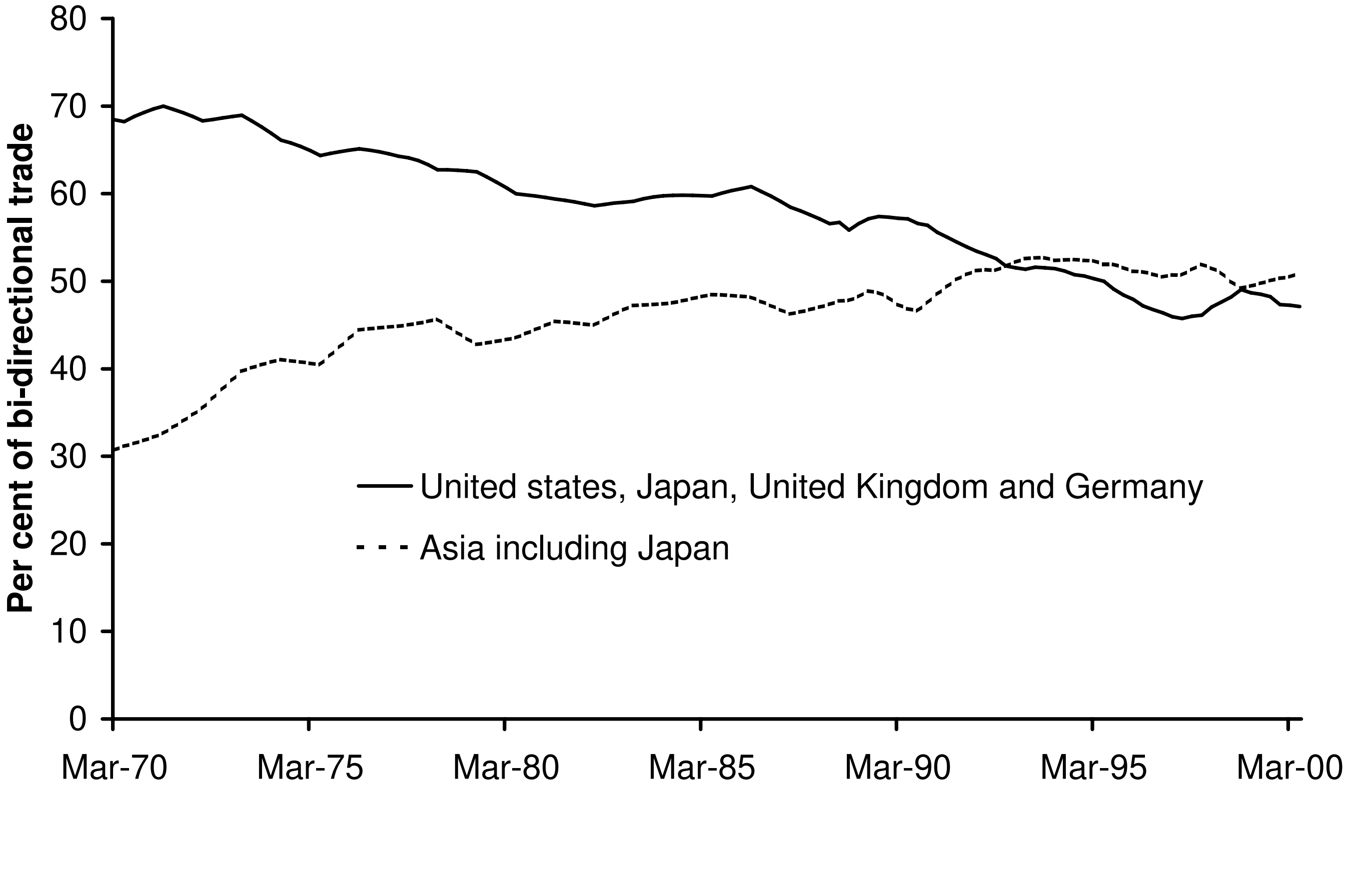


Figure 4. The changing regional pattern of Australia's trade, March 1970 to June 2000

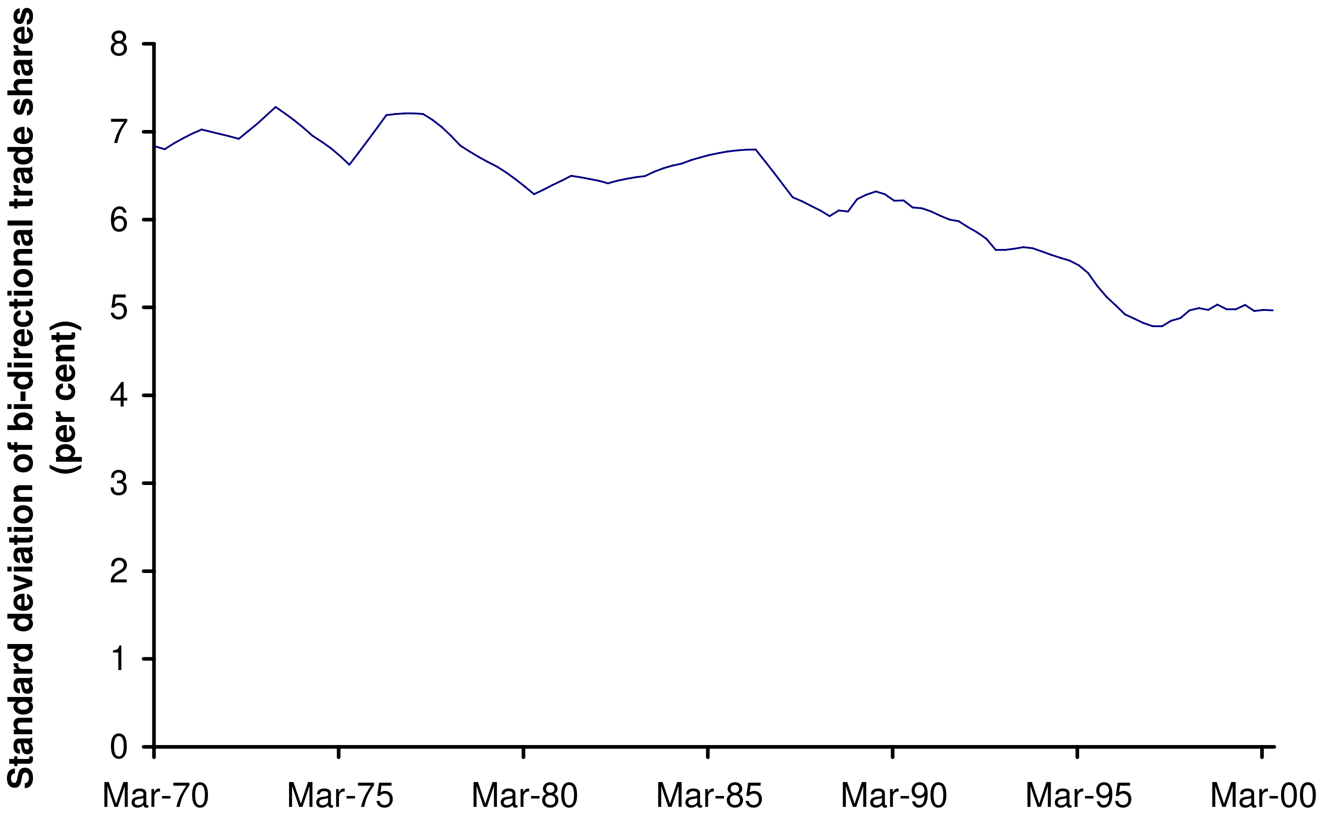


It is also instructive to examine movements in the standard deviation of country trade shares shown in Figure 5. To interpret that figure, notice that if N represents the number of countries then (since trade shares add to 100) the average trade share is 100/N. Thus, the standard deviation of trade shares is

$$\sigma_t = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(S_{it} - \frac{100}{N}\right)^2}\ .$$

Note that σ_t is minimized with value zero when all the trade shares are equal to 100/N. Thus from Figure 5 we can conclude that Australia's trade is concentrated with some large trading partners but, the fall in the standard deviation since the mid 1980s signals increased dispersion of trade. That is, Australian trade has been shifting from a few countries with large trade shares to many countries with smaller trade shares.

Figure 5. Standard deviation of Australia's trade shares, March 1970 to June 2000



In summary, the preceding discussion suggests that the pattern of movements in Australia's bilateral exchange rates and trade shares is such that construction of both nominal and real TWI's needs to be undertaken with considerable care so as to avoid making large approximation errors. These considerations strengthen the case for using the Törnqvist index to construct real and nominal TWIs.

4. The RBA's measure of the nominal and real trade-weighted exchange rates

The RBA publishes a nominal trade-weighted index of exchange rates that is reported in the financial media and is widely used in financial markets and in econometric models of the Australian economy. This measure was initially constructed as an arithmetic mean of exchange rates. In October 1988 the Bank followed international practice and moved to calculating the TWI as geometric mean of exchange rates. Rather than recalculating the TWI on the new method the Bank chose to splice the new geometric mean series onto the old arithmetic mean series at 30 September 1988. Thus, it is very difficult to know how to interpret the TWI as produced by the Bank. It is not suitable for use in econometric work as the time series properties of the arithmetic and geometric means are quite different.

Each year since 1988 the Reserve Bank has updated the weights used to calculate the TWI. However, it follows a practice of calculating the TWI for the smallest number of countries that cover 90 per cent of Australia's trade in the year for which the weights were calculated. Each year the TWI so calculated is spliced to the previous year's TWI. What this means is that the countries on which the TWI is based change over time. Again this limits the usefulness of the RBA measure of the TWI.

As shown in Figure 6 there are significant differences between the published RBA measure of the TWI and the preferred Törnqvist measure of the TWI.[5] For example, At June 2000 the deviation between the two indexes was about 10 percentage points. Moreover, the unusual weighting pattern and year to year variation in country coverage of the RBA measure introduces significant quarter to quarter variation in the difference between the two indexes.

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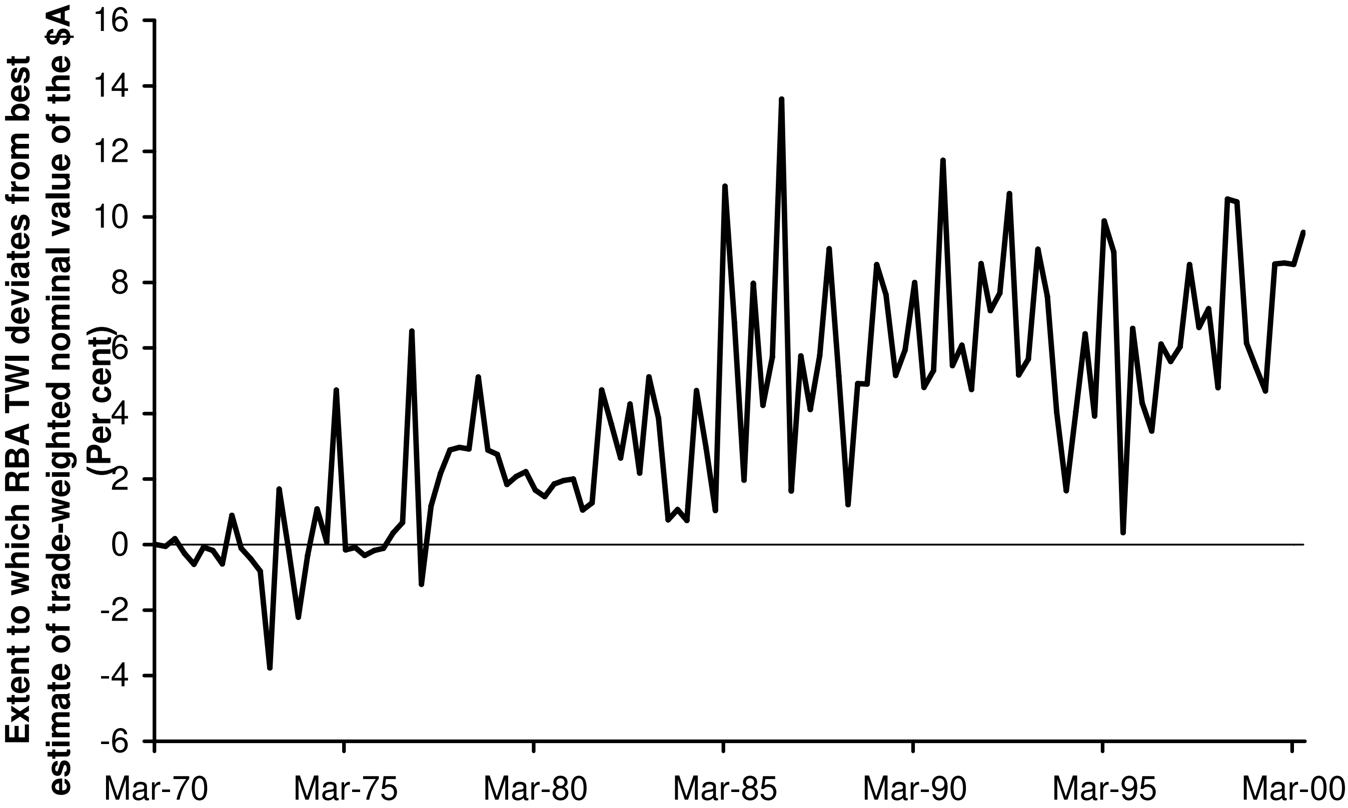
5 Gauss code for constructing Törnqvist indexes is available from the author on request.

Figure 6. Deviation between the RBA measure of the nominal TWI and the preferred Törnqvist index based measure, March 1970 to June 2000 (per cent)



5. Assessment of official measures of Australia's external price competitiveness

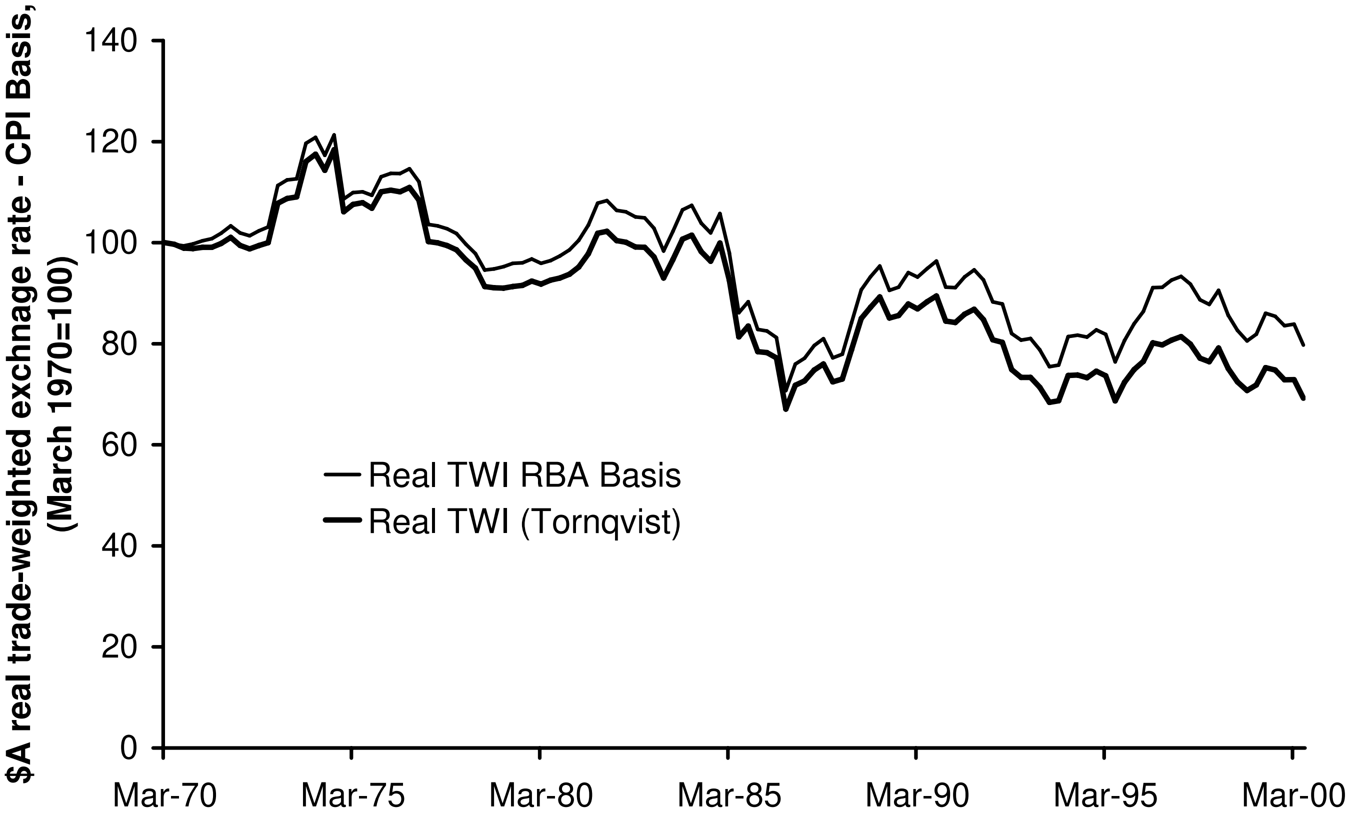
5.1. The RBA real TWI

The RBA's Real TWI (like its nominal TWI) is based on a Laspeyres-type index except that annual trade weights from the previous financial year are used rather than the weights from the previous quarter. Thus for the year 1999/00 the RBA uses the trade weights from 1998/99. In principle the RBA published nominal TWI and its unpublished real TWI can be decomposed as follows. [6]

TWI^{RBA}= Törnqvist index measuring price competitiveness effect + Törnqvist index of structural change in trade patterns + measurement error from use of Lasyperes index + measurement error from using out-of-date trade shares.

As shown in Figure 7 these measurement problems mean that there are significant differences between (my estimate of) the RBA's unpublished real TWI and the preferred Törnqvist index measure of the real TWI. At June 2000 the RBA measure of the real TWI is too high by about 14 percentage points when compared to the Tornqvist index measure.

Figure 7. Alternative measures of the $A real trade-weighted exchange rate, March 1970 to June 2000



5.2. The Treasury's three measures of the real exchange rate

The Treasury publishes three measures of the real trade-weighted exchange rates that compare domestic and foreign consumer prices, implicit price deflators and real unit labour costs respectively. The Treasury indexes share the same problem as the RBA's measure in that they are based on Paasche index numbers. However, the Treasury's measures cover only 4 of Australia's largest trading partners the United Kingdom, the United States of America, Germany and Japan. In 1970 these trading partners accounted for 68 per cent of Australia's external trade. But this share has declined over time; by 1997 those countries accounted for only 46 per cent of Australia's external trade. Thus the Treasury measures are becoming obsolete and potentially misleading.

Inspection of Figure 8 shows The Treasury measure of the real exchange rate differs significantly from the preferred Törnqvist index and significantly overstates the real exchange in the 1970s. More recently the Treasury's measure of the real TWI overstates the improvement in Australia's external price competitiveness by about seven percentage points. Thus the Treasury series moves from a 5 per cent overestimate in 1996 to a seven per cent underestimate currently. This is a total shift in measurement error of 12 percentage points in four years.

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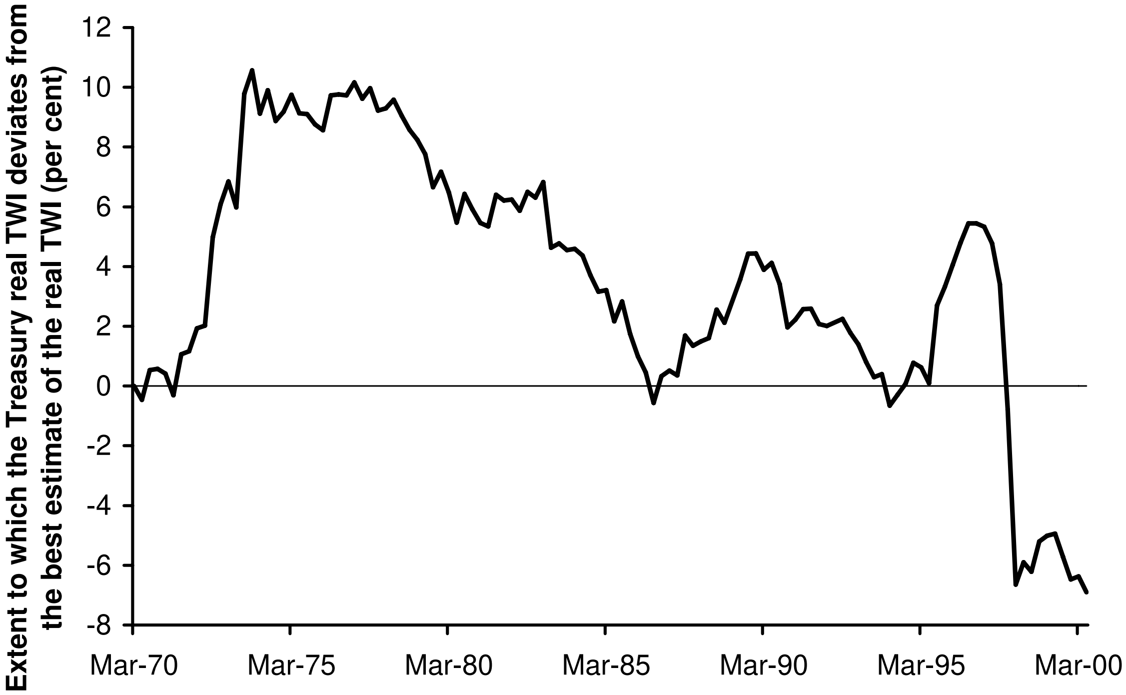
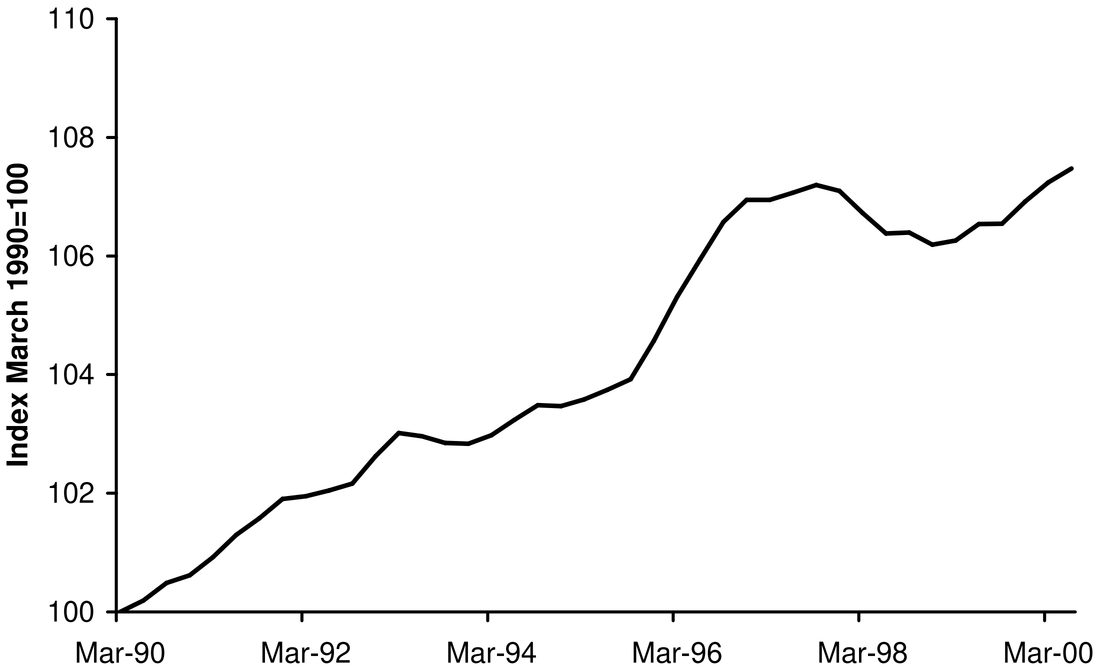
[6] This decomposition is only achievable in principle because of the other two problems with the RBA measures, namely the changing country composition and the splicing of the arithmetic mean index to the geometric mean index.

Figure 8. Deviation between the Treasury measure of the real TWI and the preferred Törnqvist index based meaure, March 1970 to June 2000



It is also of some interest to examine the effect of structural change in Australia's trading patterns. As is shown in Figure 9, over the 1990's Australia's trade has moved towards countries against which the real $A is appreciating. This shift in trade patterns counteracts to some extent the stimulus that comes from improved price competitiveness over the same period.

Figure 9. Effect of the changed country structure of trade on the Australian real TWI, March 1990 to June 2000



6. Conclusions

The RBA and Treasury produce several nominal and real TWIs. However, I have shown that these measures are poor approximations to the economic concepts of interest. I have provide a formula and computer code to construct more accurate approximations. When properly measured, the real trade weighted exchange rate is between 7 and 14 per cent below official estimates. This suggests that Australia is significantly more price competitive than suggested by official estimates. I have also constructed a index that measures the structural effect that arises because of changes in the pattern of Australia's trade. It turns out that this shift in the pattern of Australian trade is towards countries against which the bilateral $A real exchange rate is appreciating. This structural effect then works against the price improved price competitiveness of Australia.

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