SINGAPORE'S STRONG DOLLAR POLICY AND PURCHASING POWER PARITY

TILAK ABYESINGHE AND LEE KOK HONG

ABSTRACT

The policy of managing Singapore dollar to appreciate against other currencies may push Singapore dollar's exchange rate off its long-run equilibrium path. If purchasing power parity (PPP) is assumed to be the long-run equilibrium, then, based on a cointegration analysis, the results of this paper show that the Singapore-US exchange rate is in agreement with the PPP whereas some other rates are not. The error correction models constructed show that the movement towards PPP takes place more through the adjustment of prices as a result of the "strong dollar policy" adopted since 1981.

1. INTRODUCTION

Singapor e dollar was allowed to float in June, 1973. A further decision was made in September, 1975 to peg the dollar to an undiversified basket of currencies of her major trading partners. Since 1981, however, the exchange rate policy has been geared towards a "strong dollar policy". This policy has continued to this date (See Monetary Authority of Singapore (MAS) Annual Reports, 1981/82 and 1990/91). The aim of this policy has been to maintain stable prices to ensure sustainable economic growth. A question that arises is whether the strong dollar policy has pushed the Singapore dollar off its long-run equilibrium path. This paper attempts to answer this question by examining the relationship between Singapore dollar's exchange rate and purchasing power parity (PPP).

It should be acknowledged that there is no easy answer to the above question. The simple formulas offered by the PPP theory to calculate the equilibrium exchange rate is not universally accepted. However, no substitute theory has emerged to replace PPP successfully. Despite the shortcomings, the PPP theory has retained an undiminished popularity. (See Ollison, 1976 for a review of PPP).

There is a resurgence of work on PPP for two reasons. Firstly, the present era of floating—albeit managed—exchange rates provides useful data for testing PPP. If PPP holds, then under a floating exchange rate system the market exchange rate should be the same as the PPP rate at least in the long run. Secondly, the development of the theory of cointegrated processes (Engle and Granger, 1987) offers better techniques for empirical testing of economic theories. Empirical work on PPP conducted in the past have paid little attention to the time series properties of exchange rate and price data. These data series are unit-root nonstationary processes then the standard testing procedure are biased towards rejecting PPP even if it is true. (See Johnson, 1990 and references therein.)

These tests are predicated on the assumption that the observed nominal exchange rates are in fact the equilibrium rates. In a managed-float system, however, the official exchange rate could stay out of equilibrium for prolonged periods depending on its extent of intervention. Therefore, the divergence between the official exchange rate at the PPP does not necessarily mean that the PPP hypothesis is invalid. It may very well mean that the official exchange rate is out of equilibrium. Since a dual hypothesis involved here, the rejection of one is not possible without asserting that the other is true.

In this paper we draw on the methodology of cointegration to assess the agreement between PPP (the absolute version) and Singapore's official exchange rates during the floating period 1975-1990. Having found that the Singapore-US exchange rate is in line with PPP we proceed to construct error correction models. These models help evaluate how the exchange rate and prices adjust to maintain PPP under pre and post 1981 policy regimes. It should be reiterated that the other exchange rates, examined in the paper, deviate from PPP does not necessarily mean that PPP is wrong, nor does imply that the exchange rate is out of equilibrium. We draw attention to this point in the concluding section.

2. THEORY OF COINTEGRATION AND PPP

The absolute version of the PPP theory states that in the equilibrium

\[ E = P^* \]

where \( E \) = nominal exchange rate (domestic currency units per unit of foreign currency); \( P = \) domestic price level, and \( P^* = \) foreign price level.

If the PPP relationship (1) holds exactly then the real exchange rate \( R = E/P = P/P^* \)

equal to unity and

\[ \log R = \log E - \log P^* \]

is equal to zero. It is unrealistic to assume that the PPP relationship holds exactly in the short run. However, if \( \log R \) is a stationary series so that the mean of \( \log R \) is zero then the PPP relationship (1) holds in the long run. This is so because any short-run deviation from PPP is corrected in the long run and \( \log R \) reverts to its mean.

* National University of Singapore. We would like to thank Kenneth Chan, To Yiu Kwan and an anonymous referee for useful comments.

1 A review of the evolution of Singapore's exchange rate policy is given in Lee Chong Yee and Associates (1988), Chapter 5.
If $Z_i$ is stationary then Granger Representation Theorem (Engle and Granger, 1987) shows that an error correction model (ECM) can be constructed as $\Delta L = \gamma' \Delta Z_i + d(L) \epsilon_i$, where $\Delta L$ and $d(L)$ are polynomials in the lag operator $L$. As it is assumed that $X_i$ is a unit root process, $\Delta L$ is a stationary process. Further, if $X_i$ is cointegrated then $Z_i$ is stationary too. Engle and Granger (1987) have shown that the moving average process $d(L) \epsilon_i$ can be approximated by an autoregressive appropriate lag length for $\Delta L$ such that $d(L) \epsilon_i$. Given these results and by setting $A^*(0)$-identity matrix (5) turns out to be a vector autoregressive process augmented by the error correction (EC) term $\gamma' \Delta Z_i$. The EC term measures the equilibrium error made in the previous period. Originally developed by Davidson et al. (1978) the ECM (5) captures the short run dynamics and the long run equilibrium relationship postulated by economic theory.

Under managed float system the adjustment towards PPP is possible through both prices and exchange rate. It is possible, therefore, to construct two ECM's, one for the exchange rate and the other for the price level. They take the form

\[ \Delta \log E_t = \sum_{i=1}^{4} \alpha_i \Delta \log E_{t-i} + \sum_{i=1}^{2} \beta_i \Delta \log P_{t-i} - \gamma_1 \log R_{t-1} + \epsilon_t \] (6)

\[ \Delta \log P_t = \sum_{i=1}^{2} \beta_i \Delta \log P_{t-i} + \sum_{i=1}^{2} \beta_i \Delta \log E_{P_{t-i}} - \gamma_2 \log R_{t-1} + \epsilon_t \] (7)

where the log real exchange rate ($\log R_t$) is derived from (2) and included in both (6) and (7) and the ECM should have opposite signs in the two models. This is indicated by the signs attached to $\gamma_1$ and $\gamma_2$. Consider, for example, an increase in the foreign price $P_t$. This will lead to depreciation of Singapore's real exchange rate, that is an increase in $R$. This will set in the disequilibrium E-E(P) or R-E. The correction towards equilibrates in a managed float system, therefore, requires $P$ to increase and $E$ to decrease (i.e., nominal exchange rate to appreciate). This explains the opposite signs of the EC term in (6) and (7).

**DATA**

Quarterly data from 1975:1 to 1990:3 are utilized to the analysis. Bilateral nominal exchange rates of Singapore with five of her main trading partners, namely Malaysia, U.S., U.K., Japan and West Germany are examined. These rates were obtained from the MAS Monthly Statistical Bulletin, Quarterly Bulletin, and Economic Survey of Singapore (Quarterly). All these rates are either weekly or monthly averages except those repaid in the Economic Survey of Singapore. Quarterly transformations merely take the form of averaging the weekly or monthly averages.

It should be noted that, besides the Singapore-US exchange rate, all other published rates are cross rates derived on the basis of the rates for various currencies against the US dollar. The divergence between the cross rates and direct rates can be expected to be
TABLE 1
UNIT ROOT TEST FOR PRICE AND NOMINAL EXCHANGE RATE SERIES (LOG)

<table>
<thead>
<tr>
<th>STORE</th>
<th>US</th>
<th>JAPAN</th>
<th>M'SIA</th>
<th>UK</th>
<th>GERMANY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>t-ratio</td>
<td>-0.42</td>
<td>-1.36</td>
<td>-7.08*</td>
<td>-1.47</td>
<td>-3.31</td>
</tr>
<tr>
<td>WPI</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>t-ratio</td>
<td>-1.61</td>
<td>-1.13</td>
<td>-1.41</td>
<td>-2.32</td>
<td>-1.29</td>
</tr>
<tr>
<td>Exchange Rate</td>
<td>100yen</td>
<td>Ringgit</td>
<td>Pound</td>
<td>Mark</td>
<td></td>
</tr>
<tr>
<td>S'PORE per k</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>t-ratio</td>
<td>-0.31</td>
<td>-0.98</td>
<td>2.36</td>
<td>1.29</td>
<td>-1.13</td>
</tr>
</tbody>
</table>

* Significant at the 5% level.

k = All lags used in equation (3).

TABLE 2
UNIT ROOT TEST FOR REAL EXCHANGE RATE SERIES (LOG)

Between STORE and US JAPAN M'SIA UK GERMANY

Using CPI
<table>
<thead>
<tr>
<th>k</th>
<th>0</th>
<th>2</th>
<th>0</th>
<th>3</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-ratio</td>
<td>-3.37*</td>
<td>-1.54</td>
<td>2.50</td>
<td>-0.98</td>
<td>-0.44</td>
</tr>
</tbody>
</table>

Using WPI
<table>
<thead>
<tr>
<th>k</th>
<th>1</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>t-ratio</td>
<td>-1.26</td>
<td>-1.29</td>
</tr>
</tbody>
</table>

k = All lags used in equation (3).

* Significant at the 5% level.

3. RESULTS

All variables analyzed here are expressed in natural logarithm. The first set of unit root test results are given in Table 1. The t-ratios shown in the table test the null hypothesis of a unit root process against the alternative of a stationary process. Further, k is the maximum lag length used in regression (3) to ensure that the residuals are white noise. The results in Table 1 indicate that, except for the Japanese CPI, all other series short lived since such divergences lead to profit making in the foreign exchange market.

The price series are proxied by CPI and WPI. The choice of these indices was governed by the availability of data. The WPI series is available over the entire sample period for Singapore, US, and Japan only. All data pertaining to CPI and WPI are collected from the International Financial Statistics. All the indices were then converted to a common base year using 1980 prices. The choice of 1980 was arbitrary.

The second set of unit root tests are on the log real exchange rates which test for cointegration of the nominal exchange rates and price series. The presence of a unit root in a log real exchange rate series is evidence against the PPP equilibrium. These results are given in Table 2. It can be seen from the table that none of the t-ratios, except one, are significant even at the 10% level. The exception is the Singapore-US real exchange rate calculated using CPI data. This t-ratio is significant at the 5% level indicating that the Singapore-US nominal exchange rate is in line with PPP.

The divergence of the other exchange rates from PPP calls for deeper analysis. Nevertheless, the alignment of the Singapore-US rate with PPP reveals the close link between the Singapore dollar and the US dollar. Despite the undisclosed nature of the trade weighted basket used in fixing the Singapore exchange rate, it is quite a well known fact that the Singapore dollar is more closely linked to the US dollar than to any other currency. Moreover, the US dollar is used in the foreign exchange policy as a means of maintaining the Singapore exchange rate within the undisclosed target band. In the words of MAS:

"...The Authority manages the floor within the band mainly through its foreign exchange operations. The intervention process is done by buying or selling United States (US) dollar. There is persistent pressure on the Singapore dollar to appreciate...the Authority tends to buy US dollars and sell Singapore dollars to lower the value of the latter currency, thus maintain it within the target band. (MAS Annual Report, 1984, p.3)

When the Singapore dollar is appreciating the relative price of Singapore to that of US will increase. The selling of Singapore dollar and the buying of US dollar actually reverse the effect. Therefore, the exchange rate moves towards the equilibrium path as specified by the PPP relationship. A closer examination of these relationships will be facilitated by the error correction model presented later.

Figure 1 shows the movements of the Singapore-US exchange rate and the price ratio (S$ CPI/US CPI) over the sample period. Both the series move in the same direction as they should be. However, the exchange rate fluctuates much more than the price ratio.

The log real exchange rate is graphed in Figure 2. There are two salient features of this graph. Firstly, the series are all above 1.0 for all time. All data pertaining to CPI and WPI are collected from the International Financial Statistics. All the indices were then converted to a common base year using 1980 prices. The choice of 1980 was arbitrary.

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derivative $\Delta \log R_{US}$. This procedure ensures that $\Delta \log R_{US}$ contain the most
important short run effects. If other lags of $\Delta \log R_{US}$ are thought to be important
they can be included in the above regression tree. Figure 2 shows the Adjusted $\log R_{US}$ using $\Delta \Delta \log R_{US}$. It
is seen in the figure that the adjustments for short run effects has changed the
movements of the real exchange rate substantially. The path of the adjusted series
skews the long run path of the real exchange rate. Figure 3 shows that the real exchange rate
has appreciated initially then stabilised and then started to appreciate again.

We now move on to the error correction models. Table 3 shows the error correction models
constructed on the basis of the models given by (6) and (7). These models are
only for the Singapore-US exchange rate and the CPI series. Each model is
estimated separately for the sub-periods and there is no cointegration among the
companion series (see results in Table 2).

As 1981 marks the switch of the policy towards a strong dollar, the EC models are
constructed for the sub-periods 1975-1980 and 1981-1990 separately. In each sub-
period there are two error correcting processes, one is through the exchange rate and the
other is through the price level. The lagged variables, except the EC term, in each model
were chosen on the basis that they are statistically significant, interpretably, compatible
over the sub-periods and yield empirically white noise residuals. The whiteness of the
residuals is well confirmed by the Q statistics shown in Table 3.

The first panel of the table presents the exchange rate equations and the second panel
the price equations. The EC term ($\Delta \Delta \log R_{US}$) in all equations is statistically significant
and correctly signed. Also noticeable is the changes in the magnitude of the coefficient
of the EC term over the sub-periods. This coefficient becomes slightly smaller in
magnitude in the exchange rate equations as we move from 1975-80 to 1981-90 while
that of the price equations shows a noticeable increase in the magnitude. This appears to
reflect the effect of the policy switch since 1981. During this period the adjustment
towards PPP equilibrium takes place mostly through price adjustment since exchange
rate movements are closely controlled.

Table 3 brings out some interesting observations too. The exchange rate equations do not
show an uncorrelated AR lag structure. However, the price ratios (P/P') enter the
equation with a negative sign. We expect the exchange rate to appreciate (i.e. E to fall) when P/P'
falls as observed in Figure 1. The negative sign seems to indicate that in the short run policy interventions have been to curtail the excessive
appreciation of the Singapore dollar.

Unlike the exchange rate, the inflation rate (the price equations) shows a strong
AR lag structure. Further, the magnitude of the AR coefficients increase in the second
sub-period. On the other hand, the lags of $\Delta \log P_{US}$ (see eq. (7)) do not appear to play
an important role in determining inflation. This can be explained since foreign inflation is
offset by the appreciating dollar. The AR structure of inflation reflects the presence of
domestic causes of inflation not explained by the lags of $\Delta \log P_{US}$.
TABLE 3

ERROR CORRECTION MODELS

<table>
<thead>
<tr>
<th>Exchange Rate Equations</th>
<th>1975:1 - 1980:4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \ln \left( \frac{F}{P} \right) = 0.06 \times \Delta \ln \left( F_{P} \right) + 0.02 \times \Delta \ln \left( \frac{P}{P_{S}} \right) + \epsilon_{t}$</td>
<td>[1.64]</td>
</tr>
<tr>
<td>$\delta = 0.12 \times Q(10) = 16.18, P-value = 0.581$</td>
<td>$[1.97]$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1981:1 - 1990:2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \ln \left( \frac{P}{P_{S}} \right) = 1.02 \times \Delta \ln \left( F_{P} \right) + 0.013 \times \Delta \ln \left( \frac{P}{P_{S}} \right) + \epsilon_{t}$</td>
</tr>
<tr>
<td>$\delta = 0.02 \times Q(24) = 28.77, P-value = 0.229$</td>
</tr>
</tbody>
</table>

PRICE EQUATIONS

<table>
<thead>
<tr>
<th>1975:1 - 1990:4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \ln P = 0.12 \times \Delta \ln F_P + 0.38 \times \Delta \ln P_{S} + 0.014 \times \Delta \ln P_{S} + \epsilon_{t}$</td>
</tr>
<tr>
<td>$\delta = 0.013 \times Q(18) = 19.93, P-value = 0.272$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1981:1 - 1990:2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \ln P = 0.56 \times \Delta \ln F_P + 0.43 \times \Delta \ln P_{S} + 0.05 \times \Delta \ln P_{S} + \epsilon_{t}$</td>
</tr>
<tr>
<td>$\delta = 0.019 \times Q(18) = 11.88, P-value = 0.906$</td>
</tr>
</tbody>
</table>

4 CONCLUSION

Out of the five bi-lateral nominal exchange rates of Singapore dollar examined in this paper only the Singapore-US rate is in agreement with PPP. Even in this case it is the CPI ratio, not the WPI ratio, which is in agreement with the exchange rate. This shows that the policy makers keep at CPI in targeting the exchange rate movements.

If we concentrate only on the Singapore-US exchange rate and assume that the PPP at the long run equilibrium, then the results of this exercise show that Singapore’s strong dollar policy has not created a disequilibrium exchange rate. Under this policy, however, the adjustment towards PPP takes place more through the adjustment of prices than through the change in the exchange rate.

Again on the basis of PPP the other four exchange rates appear to be out of equilibrium. This analysis, however, has ignored the effect of the asset markets acting from the interest rate differential between Singapore and other countries. In other words, for PPP relationship should be examined after controlling for the effects of interest rate.

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REFERENCES


