Pakistan Economic and Social Review
Volume XLIII, No. 2 (Winter 2005), pp. 167-183

TEST OF PURCHASING POWER PARITY BASED ON COINTEGRATION TECHNIQUE
The Asian Evidence

FARZANA NAHEED KHAN and EATZAZ AHMAD*

Abstract. The paper tests purchasing power parity as a long-run equilibrium condition by investigating the short run behavior of exchange rate and relative prices for four Asian countries. The paper uses cointegration approach, looking at the data from 1976-2001 for three alternative price indices. The paper presents the empirical evidence that cointegrated relationship does not exist in the sampled data. The results of the study are not supportive of the purchasing power parity proposition in most of the cases.

I. INTRODUCTION

The concept of purchasing power parity proposition (PPP) is closely related to the behavior of real exchange rates, which are frequently used as a diagnostic tool to detect policy induced disequilibria in open economies. The purchasing power parity (PPP) theory of exchange, put forward by Cassel (1916), postulates that under ideal conditions of free trade the nominal exchange rate between two currencies is equal to the ratio of the two countries general price levels. Because of the importance of the PPP as a long run determinant of exchange rate in macroeconomic models, PPP has been subject to many interpretations and controversies.

The originators of PPP doctrine [Wheatley (1807) and Ricardo (1821)] have viewed it as an extension of quantity theory of money.[1] According to

---

*The authors are Lecturer and Professor at the Department of Economics, Quaid-i-Azam University, Islamabad (Pakistan).

[1]PPP is an extension of quantity theory of money in an open economy, implying that doubling of money supply doubles prices in home country, which in turn lead to a proportionate increase in exchange rate. See Cassel (1921).

the absolute version of purchasing power parity in each period t the nominal exchange rate must be equal to the ratio of domestic price level to the foreign price level. While the relative version of PPP requires that the nominal exchange rate must be proportional to the relative price.[2] It is worth noting that while relative PPP can be tested empirically, absolute PPP cannot be tested empirically due to the non-availability of comparable data, particularly on price level across countries.[3]

A sizable volume of theoretical and empirical models of exchange rate behavior has been built around purchasing power parity proposition. Officer (1978) studies the absolute and relative versions of PPP and concludes that there is strong evidence to support relative PPP hypothesis. Bhatti (1996) examines the long run PPP for Pakistan and its eight trading partner from the industrial world. The results of the study support the predictions of the PPP hypothesis that the nominal exchange rate tends to be equal to the ratio of domestic price index to the foreign price index. In a similar study Bhatti (2000) tests long run PPP for Pakistan Rupee exchange rate vis-à-vis eight Asian currencies. The results of the study are strongly supportive of the PPP proposition in five out of the eight cases.

While Officer (1980) showed that the deviations of purchasing power parity are explainable in terms of structural changes in the economies, Frankel (1981) showed the collapse of PPP during 1970s because of real shocks and structural changes in the economies of USA and its trading partners. Patel (1990) discussed that purchasing power parity does not hold for the floating exchange rate period. Similar results are given in Bayoumi and Macdonald (1999). Sjaastad (1998) investigates the properties of PPP real exchange rate as a proxy for the true real exchange rate and demonstrate that PPP real exchange rates are potentially highly defective.

Corbae and Ouliaris (1988) test PPP proposition for the USA with each of its trading partners in the G-7 group of countries. The study finds that the cointegrated relation does not exist in the sampled data. Eatzaz and Farzana (2002) examine the long run PPP for Pakistan and other Asian countries and

---

[2]A noteworthy implication of the both versions of PPP is that real exchange rates remain constant over time. The absolute version requires the RER to be one, while under the relative version the constant RER can be different from one.

[3]Even the use of comparable data on prices, if available across countries, is likely to produce results that may not differ significantly from those obtained by testing relative PPP using prices indices.

demonstrated the failure of the PPP theory. In a recent study Basher and Mohsin (2004) also test the relative version of PPP using panel co integration framework. The study uses aggregate CPI ratio for a set of ten Asian countries for the period 1980 to 1999. The results of the study rejects PPP hypothesis.

Pesaran *et al.* (2001) develop bound testing approach to cointegration. The study proposes various bond testing procedures and shows that the proposed tests are consistent. The empirical relevance of the bounds procedure is demonstrated by a re-examination of the earning equation included in the UK treasury macroeconomic model. Enormous empirical work has been conducted to examine the validity of purchasing power parity hypothesis for a large number of currencies. However traditional model of PPP do not adequately explore the relationship between exchange rates and prices, implied by PPP.

The objective of the paper is to re-examine PPP for four Asian countries by employing the Johansen's procedure. Bounds testing approach has not been used because it may not be suitable approach for the testing of PPP hypothesis for a country like Pakistan. Employing the time series concept of co integration, this paper empirically examines the validity of the PPP proposition by testing for the long run relationship between exchange rates and prices. The paper deals with relative PPP approach to the analysis of exchange rate.

The paper is planned as follows. Data are discussed in section II. Section III explains the procedure for testing the relative version of purchasing power parity and develops the method of analyzing short-term adjustment mechanism towards the equilibrium path. The results of this exercise are presented in section IV. Finally, section V consists of concluding remarks.

II. THE DATA

Our analysis is based on a sample of four Asian countries: the countries are Indonesia, Malaysia, Pakistan and Singapore. The analysis covers the period of 1976 to 2001. All the data are taken on annual basis. For each country on average 21 major trading partners are considered. To measure price in the home countries and trading partners, three different price indexes are used namely consumer price indices (CPI), which includes a large number of non traded goods; the whole sale price indices (WPI), which mainly contains tradable good; and the GDP deflator which is a genuine price index of aggregate production. The data on the trade of the sampled countries are

collected from International Trade Statistics. While the data on price indices and exchange rates are collected from International Financial Statistics. The bilateral exchange rates of home country with each of the trading partner are computed as $E_{ij} = E_{iu} / E_{ju}$, where E_{ij} is the exchange rate of home country i with trading partner j E_{iu} is the exchange rate of home country with US dollar and E_{ju} is the exchange rate of trading partner with US dollar.

III. MODELING PURCHASING POWER PARITY

The study uses the Johansen's procedure to test for cointegration.[4] In Johansen's procedure no variable is set exclusively as the dependent variable before hand. Instead exchange rate and relative price are assumed to follow the first order VEC (Vector Error Correction) system:

$$e_t = a_{ee}\, e_{t-1} + a_{er}\, r_{t-1} + \varepsilon_{et} \quad (1)$$

$$r_t = a_{re}\, e_{t-1} + a_{rr}\, r_{t-1} + \varepsilon_{rt} \quad (2)$$

Or subtracting lagged dependent variables from the respective equations, the system can be written in matrix notation as follows.

$$\begin{bmatrix} \Delta e_t \\ \Delta r_t \end{bmatrix} = \begin{bmatrix} \pi_{ee} & \pi_{er} \\ \pi_{re} & \pi_{rr} \end{bmatrix} \begin{bmatrix} e_{t-1} \\ r_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{et} \\ \varepsilon_{rt} \end{bmatrix} \quad (3)$$

where $\pi_{ee} = a_{ee} - 1$, $\pi_{rr} = a_{rr} - 1$, $\pi_{er} = a_{er}$ and $\pi_{re} = a_{re}$.

The existence of a cointegrating relationship depends on the rank of the matrix π. The necessary and sufficient condition for the existence of a cointegrating relationship is that the rank of the matrix π is equal to one. In this case, the two rows in the matrix π are linearly dependent on each other and, therefore, we can express the second row as a multiple of the first.

$$\Delta e_t = (\pi_{ee}\, e_{t-1} + \pi_{er}\, r_{t-1}) + \varepsilon_{et} \quad (4)$$

$$\Delta r_t = S_r\, (\pi_{ee}\, e_{t-1} + \pi_{er}\, r_{t-1}) + \varepsilon_{rt} \quad (5)$$

Now ECV AR (Error Correction Vector Autoregressive) model is formulated to test the existence of cointegrating relationship. We consider a generalized VEC model that combines the restricted VEC model with the conventional VAR model in first differences. Considering the error correction process by including an intercept and a trend term, and

[4]The construction is based on the Johansen's procedure explained in Enders (1995) with suitable changes in notations.

augmenting the VAR portion of the model by drift and linear trend variations, we can write the ECVAR model as follows:

$$\Delta e_t = [\pi_{ee}\, e_{t-1} + \pi_{eo} + \pi_{er}\, r_{t-1} + \pi_{et}\,(t-1)] + \sum_{j=1}^{p} \phi_{ee}\, \Delta e_{t-j} + \sum_{j=1}^{p} \phi_{er}\, \Delta r_{t-j} + \mu_e + \tau_e\, t + u_{et} \quad (6)$$

$$\Delta r_t = [\pi_{re}\, e_{t-1} + \pi_{ro} + \pi_{rr}\, r_{t-1} + \pi_{rt}\,(t-1)] + \sum_{j=1}^{p} \phi_{re}\, \Delta e_{t-j} + \sum_{j=1}^{p} \phi_{rr}\, \Delta r_{t-j} + \mu_r + \tau_r\, t + u_{rt} \quad (7)$$

The rank condition is tested by finding out the number of non-zero characteristic roots of the π matrix. The testable null hypothesis along with the alternative hypothesis and test statistic are given by:

H_0^A: $\lambda_1 = \lambda_2 = 0$ and H_1^A: $\lambda_i \neq 0$ for at least one i

Test statistic: $\lambda_{\text{trace}}(1) = -n\left[\ln\left(1-\hat{\lambda}_1\right) + \ln\left(1-\hat{\lambda}_2\right)\right]$

H_0^B: $\lambda_1 \neq 0$, $\lambda_2 = 0$ and H_1^B: $\lambda_i \neq 0$ for both i

Test statistics: $\lambda_{\text{trace}}(1, 2) = -n\left[\ln\left(1-\hat{\lambda}_2\right)\right]$

The existence of a cointegrating relationship requires that the first null hypothesis should be rejected while the second should be accepted.[5] The test will be applied under two alternative cases.

Case 1: Intercept but no trend in VEC and no drift or trend in VAR

Restriction: $\pi_{et} = \mu_e = \tau_e = 0$, $\pi_{rt} = \mu_r = \tau_r = 0$

Case 2: Intercept but no trend in VEC and drift but no trend in VAR

Restrictions: $\pi_{et} = \tau_e = 0$, $\pi_{rt} = \tau_r = 0$

Case 1 refers to the specification of ECVAR model wherein the error correction equation includes an intercept, while Vector Autoregressive (VAR) model does not have drift (or linear trend in level). In case 2, VAR part of the ECVAR model also includes drift. If cointegrating relationship exists, the ECVAR model is re-estimated for the error correction analysis by

[5] Johansen and Juselius (1990) have prepared critical values for the two statistics on the basis of simulation experiments.

imposing the restrictions on the π matrix implied by the rank condition. The parametric restrictions to satisfy the rank condition are:

$$\pi_{ro} = s_r\,\pi_{eo}, \quad \pi_{ro} = s_r\,\pi_{eo}, \quad \pi_{rr} = s_r\,\pi_{er} \text{ and } \pi_{rt} = s_r\,\pi_{et}$$

$$\Delta e_t = \pi_{ee}\,[e_{t-1} + \theta_{eo} + \theta_{er}\,r_{t-1} + \theta_{et}\,(t-1)] + \sum_{j=1}^{p} \phi_{ee}\,\Delta e_{t-j} + \sum_{j=1}^{p} \phi_{er}\,\Delta r_{t-j} + \mu_e + \tau_e\,t + u_{et} \tag{8}$$

$$\Delta r_t = \pi_{re}\,[e_{t-1} + \theta_{eo} + \theta_{er}\,r_{t-1} + \theta_{et}\,(t-1)] + \sum_{j=1}^{p} \phi_{re}\,\Delta e_{t-j} + \sum_{j=1}^{p} \phi_{rr}\,\Delta r_{t-j} + \mu_r + \tau_r\,t + u_{rt} \tag{9}$$

where $\theta_{eo} = \pi_{eo} / \pi_{ee}$, $\theta_{er} = \pi_{er} / \pi_{ee}$ and $\theta_{et} = \pi_{et} / \pi_{ee}$

If the value of error term is greater than zero it means that the exchange rate is greater (less) than the level that should prevail along the equilibrium path and/or relative price level is less (greater) than the equilibrium level. If such an error occurs in a period then under any version of PPP one would expect that in the next period the adjustments in exchange rate and price level are such that they produce tendency towards restoring equilibrium. This can happen if and only if the error correcting process satisfy the conditions:

$$\pi_{ee}\,D_{t-1} < \pi_{re}\,D_{t-1} \text{ whenever } D_{t-1} > 0 \tag{10}$$

$$\pi_{ee}\,D_{t-1} > \pi_{re}\,D_{t-1} \text{ whenever } D_{t-1} < 0 \tag{11}$$

where $D_{t-1} = e_{t-1} + \theta_{eo} + \theta_{er}\,r_{t-1} + \theta_{et}\,(t-1)$

denotes the deviation from equilibrium. The above conditions simplify to $\pi_{ee} < \pi_{re}$. Three possible patterns that are consistent with this requirement are $\pi_{ee} < 0$, $\pi_{re} > 0$ or $\pi_{ee} > \pi_{re} > 0$ and $\pi_{ee} < \pi_{re} < 0$.

This completes the procedure for cointegration analysis. We must now spell-out in what sequence will various tests be applied. The first step is to determine if the cointegrating relationship exists. While at the second stage the parameters of the error correcting equation are studied to determine whether or not the PPP proposition holds.

IV. THE RESULTS

We now analyze PPP proposition by testing the existence of cointegrating relationships. The information that comes out of this exercise is about the number of characteristic roots that are significantly different from zero. The results in Table 1 show that the nominal exchange rate and relative price do not cointegrate for most of the trade partners. The table presents the

TABLE 1

The Results of Johansen's Test for Significant Characteristic Roots in ECVAR Model

Countries	WPI								CPI								GDP Deflator							
	Indonesia		Malaysia		Pakistan		Singapore		Indonesia		Malaysia		Pakistan		Singapore		Indonesia		Malaysia		Pakistan		Singapore	
	CEC 1	CEC 2	CEC 1	CEC 2	CEC 1	CEC 2	CEC 1	CEC 2	CEC 1	CEC 2	CEC 1	CEC 2	CEC 1	CEC 2	CEC 1	CEC 2	CEC 1	CEC 2	CEC 1	CEC 2	CEC 1	CEC 2	CEC 1	CEC 2
Australia			*	*	*	*					*	*	*	*	*	*					*	*		
Belgium				*			N	N							N	N					*	*	N	N
Canada		*			*	*									*		*		*		*	*		
China	*				*		*	*					*		*	*								
France					*	*											*							
Germany	*				*				*				*		*		*	*			*	*		
India	*				*				*		*		*		*		*		*	*			*	
Indonesia	N	N			*		N	N	N	N	*				N	N	N	N			*	*	N	N
Italy			*		*	*								*	*				*				*	
Japan	*							*									*							
Korea	*	*			*	*										*	*	*	*					
Malaysia	*		N	N					*		N	N		*	*	*	*		N	N		*		
Netherlands	*												*	*	*		*					*		
New Zealand					N	N					*	*	N	N	*	*			*	*	N	N		
Pakistan	*				N	N	N	N				*	N	N	N	N	*	*		*	N	N	N	N	N
Philippines					N	N							N	N							N	N		
Saudi Arabia					*	*			*					*	*		*					*		
Singapore		*			*	*	N	N	*		*			*	N	N					*	*	N	N
South Africa	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sri Lanka	N	N	N	N	*	*	N	N	N	N	N	N	*	*	N	N	N	N	N	N	*	*	N	N
Sweden	*		*		*	*																		
Switzerland	*					*							*				*					*		
Thailand			*	*		*	*			*	*		*									*	*	
UK															*								*	
USA						*	*					*						*	*					

Note: The trading partners with cointegrating relationship between the nominal exchange rate and relative price are shown by *, while an empty cell indicates the absence of cointegrating relationship. The cases, for which the test is not applied, either because the corresponding countries are not among the selected trade partners or because the same country appears on both sides, are identified by the letter N.

summary of the results on Johansen's test for the number of significant characteristic roots in ECVAR model for each bilateral exchange rate and the relative price.

The Table 2 shows that the nominal exchange rate and relative price do not cointegrate for most of the trade partners. Out of 504 ECVAR models estimated only 144, or about 28.5% form a cointegrating relationships. 168 models are then estimated each using WPI, CPI and GDP deflator as the price index. The results show that the numbers of cointegrating relationships with WPI, CPI and GDP deflator are respectively 29.76, 27.97 and 29.97 percentage of the number of estimated models. It means that the possibility of a long-run relationship between nominal exchange rate and relative rice at the retail level (CPI) is lower than at the wholesale level (WPI) and GDP deflator.

TABLE 2

Percentage of Cases in which Cointegration Relationship Exists

Countries	No. of cointegrating relationships For Case 1, 2			All Cases
	WPI	CPI	GDP	
Indonesia	13	6	15	25.75
Malaysia	7	10	10	20.45
Pakistan	25	15	17	45.23
Singapore	5	16	5	22.80
%age	29.76	27.97	27.97	28.5

The country-wise position is as follows. The percentage of cointegrating relationships between nominal exchange rate and relative price is minimum (20.45%) for Malaysia followed by Singapore (22.80%) and Indonesia (25.75%). On the other hand the maximum number of cointegrating relationships is found for Pakistan (45.27%). The results for Pakistan stand out as exception to the norm. An obvious implication is that the exchange rate policies in Pakistan have been closely linked with domestic inflation rate relative to the inflation rate in its trade partners.

The pairs of countries for which cointegrating relationship is established are further analyzed for error correction. The existence of a cointegrating relationship only establishes that there is a long run relationship between exchange rate and relative price. It does not guarantee, however, that the relationship is consistent with the PPP proposition. The next step of our analysis is to study the error correction dynamics for all those cases where a

cointegrating relationship has been established. The results are discussed separately for each country.

INDONESIA

The results for Indonesia, presented in Table 3, shows that with most of the trading partners of Indonesia the changes in exchange rates are such that they tend to counter balance the dis-equilibrium forces. The changes in relative price, on the other hand, are mostly destabilizing. This pattern holds for the trading partners Japan, Malaysia, Netherlands, Switzerland and Saudi Arabia. For Pakistan as a trading partner also the exchange rate plays more significant role than the relative price.

The case of India is quite unacceptable as exchange rate is changing in the right direction but the error correcting parameter is statistically insignificant while the relative price is changing in the wrong direction and it is statistically significant. The relative price is changing in the wrong direction for Japan, Malaysia. Netherlands. Saudi Arabia and Singapore while the exchange rate is changing in the wrong direction for China, Germany and Sweden.

MALAYSIA

The results for Malaysia presented in Table 4, show that the nominal exchange rate in most of the trading partners of Malaysia adjusts in the right direction although it does not playa significant role in adjustment process, On the other hand relative price not only adjust in the right direction but also plays a significant role in the error correction process, This pattern is true, for example, in case of Australia, New Zealand and Singapore.

The error correction mechanism for the nominal exchange rate and relative price between Malaysia and Pakistan works through both the variables and both the error correcting parameters are highly significant. There are few unacceptable case in which the changes in relative price or exchange rate have destabilizing effect. Such pattern holds for Belgium, Canada, India, Indonesia, Italy, Sweden, Thailand and USA.

PAKISTAN

The results of error correction for Pakistan, presented in Table 5, show that the nominal exchange rate and relative price adjust in the right direction and plays significant role for most of the trading partners. Examples of such cases are Belgium, Canada, Malaysia and USA. The role of exchange rate remains the same but adjustment due to relative price become insignificant for the countries France, Korea and Sweden.

TABLE 3

Error Correction Parameters for Indonesia

Country	Wholesale Price Index				Consumer Price Index				GDP Deflator			
	Case 2		Case 3		Case 2		Case 3		Case 2		Case 3	
	π_{ex}	π_{sr}	π_{ex}	π_{sr}	π_{ex}	π_{sr}	π_{ex}	π_{sr}	π_{ex}	π_{sr}	π_{ex}	π_{sr}
Canada	–0.052	0.104*							0.046*	–0.028*		
China	0.0127	0.251*										
Germany	0.026**	0.021*			0.037**	0.018*			0.026**	0.021*	0.002	0.05*
India	–0.006	–0.046*			0.114	0.169*			0.025	0.075*		
Japan	–0.135*	–0.085*							–0.144*	–0.036*		
Korea	–0.202	0.169	–0.294	0.102					–0.153	0.149*	–0.15	0.15*
Malaysia	0.158*	0.121*			0.069*	0.025*			0.024*	0.011*		
Netherlands	–0.016*	–0.013*							–0.054*	–0.023*		
Pakistan	–0.542*	0.066							–0.47*	0.116	–0.512*	0.083
Saudi Arabia					0.066*	0.035*			0.174*	0.162*		
Singapore			–0.04	0.115*	–0.222*	–0.034*						
Sweden	0.046**	0.044*										
Switzerland	–0.097*	–0.054*							0.076*	0.027*		
Thailand							–0.11	0.079*				
USA											–0.099**	0.11*

Note: The parameters π_{ex} and π_{sr} denote the error correction parameters for nominal exchange rate and the relative price. The parameters significantly different from zero at 5% and 10% two tailed levels of significance are marked by * and ** respectively.

TABLE 4

Error Correction Parameters for Malaysia

Country	Wholesale Price Index				Consumer Price Index				GDP Deflator			
	Case 2		Case 3		Case 2		Case 3		Case 2		Case 3	
	π_{ee}	π_{er}	π_{ee}	π_{er}	π_{ee}	π_{er}	π_{ee}	π_{er}	π_{ee}	π_{er}	π_{ee}	π_{er}
Australia	0.328	0.214*	–0.533	0.181*	0.061	0.296*	0.352	0.273*				
Belgium	0.02	0.19*										
Canada									0.036	0.064*		
India					–0.393*	–0.111			0.33*	–0.041	–0.321*	0.066
Indonesia					–0.106*	–0.042*						
Italy	0.049*	0.043*							0.063	0.246*		
Korea									–.003**	0.004*		
New Zealand					0.024	0.383*	–0.116	0.345*	0.009	0.38*	0.083	0.368*
Pakistan							–0.802*	0.203*			–0.814*	0.174*
Singapore					0.039	0.184*						
Sweden	0.073	0.089*										
Thailand	–0.305*	0.008	–0.326*	0.052	–0.489*	–0.144			–0.405*	–0.009		
USA							–0.385*	0.204	–0.392*	–0.072		

Note: The parameters π_{ee} and π_{er} denote the error correction parameters for nominal exchange rate and the relative price. The parameters significantly different from zero at 5% and 10% two tailed levels of significance are marked by * and ** respectively

TABLE 5

Error Correction Parameters for Pakistan

Country	Wholesale Price Index				Consumer Price Index				GDP Deflator			
	Case 2		Case 3		Case 2		Case 3		Case 2		Case 3	
	π_{ex}	π_{er}	π_{ex}	π_{er}	π_{ex}	π_{er}	π_{ex}	π_{er}	π_{ex}	π_{er}	π_{ex}	π_{er}
Australia	–0.902*	0.077	–0.863*	0.088	–0.727*	0.066**	–0.689*	0.076*	–0.837*	0.097*	–0.794*	0.105*
Belgium									–0.745*	0.063**		
Canada	–0.686*	0.131**	–0.703*	0.125*					–0.246*	0.212*	–0.368*	0.189*
China	–0.012*	0.003			–0.091*	0.029**						
France	–0.439*	0.029	–0.403*	0.103								
Germany	0.02	0.151*			0.234	0.161*			0.275*	0.093*	0.058	0.121*
India	0.438	0.155*			–0.66*	–0.111						
Indonesia	–0.375*	0.065							–0.297*	0.121*	–0.35*	0.092
Italy	–0.241	0.138*	–0.234	0.141*			–0.459*	0.084				
Korea	0.509*	0.094	–0.484*	0.115								
Malaysia							0.917*	0.162*			0.897*	0.147*
Netherlands					0.839*	0.015	–0.763*	0.086**			0.679*	0.096*
Saudi Arabia	–0.967*	0.144**	0.913*	0.223*			–0.772*	0.151			–0.717*	–0.117
Singapore	0.853*	0.051	–0.808*	0.023			–0.598*	0.174*			–0.355*	0.258*
Sri Lanka	0.083	0.304*	0.082	0.304*	0.07	0.227*	0.068	0.227*	–.324**	0.22*	–.343**	0.217*
Sweden	–0.499*	0.075*	–0.504*	0.073								
Switzerland			–0.601*	0.124*	–0.392*	0.007					–.336**	0.166**
Thailand			–.356**	0.197*	0.508*	0.07*					0.059	0.178*
USA			–.374**	0.603*								

Note: The parameters π_{ex} and π_{er} denote the error correction parameters for nominal exchange rate and the relative price. The parameters significantly different fhm1 zero at 5% and 10% two tailed levels of significance are marked by * and ** respectively.

TABLE 6

Error Correction Parameters for Singapore

Country	Wholesale Price Index				Consumer Price Index				GDP Deflator			
	Case 2		Case 3		Case 2		Case 3		Case 2		Case 3	
	π_{oe}	π_{er}	π_{oe}	π_{er}	π_{oe}	π_{er}	π_{oe}	π_{er}	π_{oe}	π_{er}	π_{oe}	π_{er}
Australia					−0.154	0.336*	0.199	0.33*				
Canada					0.085	0.185*						
China	−0.141	0.688*	−0.208	0.666*	0.189*	0.198*	0.136	0.224*				
Germany					−0.043	0.036*						
India					−0.225*	−0.101			−0.194*	0.115*		
Italy					−0.129	0.26*			0.15	0.211*		
Japan			−0.01	−0.011*								
Korea							−0.631*	0.065				
Malaysia					0.055	0.272*	0.081	0.28*				
Netherlands					0.005	0.021*						
New Zealand					−0.317	0.184	−0.249	0.228**				
Saudi Arabia					0.058**	−0.095*			0.093*	0.065		
Thailand	0.016*	0.008							−0.014*	−0.001		
UK					−0.345*	0.202**			0.049*	0.04*		
USA	−0.273*	−0.26*										

Note: The parameters π_{oe} and π_{er} denote the error correction parameters for nominal exchange rate and the relative price. The parameters significantly different from zero at 5% and 10% two tailed levels of significance are marked by * and ** respectively.

The case of China is different because the relative price changes in wrong direction and plays a significant role. However, the error correcting adjustments in nominal exchange rate are large enough to remove the instability caused by changes in relative price. There are two cases (Germany and Thailand) for which the results are unacceptable on theoretical grounds. In these particular cases although the exchange rate and relative price form a cointegrating relationship, but there is no evidence of error correction.

SINGAPORE

Table 6 shows that the error correction process in exchange rate and relative prices between Singapore and UK follows the expected pattern of adjustment in response to dis-equilibrium forces and both the error correcting parameters are statistically significant. It further shows that the effects of perverse movement in nominal exchange rate with the trading partners Canada and Malaysia are offset by the adjustment in relative price, with the net result that the deviations from the equilibrium path are gradually diminished.

There are quite a few cases of destabilizing dynamics. In case of Japan, for example, the adjustment in relative price is in the wrong direction and it is not fully offset by the error correcting changes in the nominal exchange rate. For New Zealand, although both the exchange rate and relative price adjust towards the equilibrium but these adjustments are statistically insignificant. For USA the adjustment in relative price is in the wrong direction and it is significant.

V. CONCLUDING REMARKS

The paper presents empirical evidence on the long run purchasing power parity by examining the relationship between exchange rate and relative prices. The study applies cointegration test for a sample of four Asian countries and their respective major trading partners for the period 1976-2001. The analysis of bilateral exchange rates reveals that in most of the cases the nominal exchange rate and price levels have a weak relationship that does not persist in the long run. The results of the study are not supportive of purchasing power parity in most of the cases.

Deviations from PPP for these countries also reflect that the economies experienced real shocks, which required adjustment of relative prices. The real shocks include oil price shocks, supply shocks, commodity booms and shortages, shifts in demand for money and differential productivity growth. PPP theory requires completely flexible exchange rate determined by market

forces while in practice the exchange rate markets have been subject to frequent interventions.

One possible explanation for the deviations from the PPP proposition may be the weaknesses in financial sectors. These deviations may further be explained in these countries by examining the impact of the 1997 Asian financial crisis. The financial crisis should have changed the behavior of the real exchange rates in the crisis countries and caused structural shocks. Thus, while the exchange rate provides useful information, one needs to exercise great caution in interpreting the observed changes in exchange rate.

REFERENCES

Basher, A. and M. Mohsin (2004), PPP tests in cointegrated panels: Evidence from Asian developing countries. *Applied Economics Letters*, Volume 11, pp. 163-166.

Bayoumi, T. and Macdonald (1999), Deviations of exchange rates from purchasing power parity: A story featuring two monetary unions. *IMF Staff Papers*, Volume 46, pp. 89-102.

Bhatti, R. (1996), A correct test of purchasing power parity: The case of Pak-Rupee exchange rates. *The Pakistan Development Review*, Volume 35(4), pp. 671-682.

Bhatti, R. (2000), On purchasing power parity between Pakistan and other Asia countries. *Pakistan Economic and Social Review*, Volume 38(1), pp. 1-15.

Cassel, G. (1916), The present situation of foreign exchange. *Economic Journal*, Volume 26, pp. 62-65.

Cassel, G. (1921), *The World's Monetary Problem*. Constable and Co. Limited, London.

Corbae, D. and Ouliaris, S. (1988), Cointegration and test of purchasing power parity. *Review of Economics and Statistics*, Volume 70, pp. 508-511.

Eatzaz, A. and Farzana, K. (2002), Short run dynamics in purchasing power parity: A case of selected Asian countries. *The Middle East Business and Economic Review*, Volume 1(2), pp. 28-40.

Enders, W. (1995), *Applied Time Series Econometrics*. John Wiley & Sons Inc., New York.

Frankel, Jacob (1981), The collapse of purchasing power parity during the 1970s. *European Economic Review*, Volume 16, pp. 145-165.

International Monetary Fund (1972, 1997), *International Financial Statistics Yearbook*. Washington, D.C.

International Monetary Fund (1972-1997), *International Trade Statistics*. Washington, D. C.

Johansen, S. and K. Juselius (1990), Maximum likelihood estimation and inference on cointegration with application to the demand for money. *Oxford Bulletin of Economics and Statistics*, Volume 52, pp. 169-209.

Officer, L. H. (1978), The relationship between absolute and relative purchasing power parity. *Review of Economics and Statistics*, Volume 60, pp. 562-568.

Officer, L. H. (1980), Effective exchange rates and price ratios over the long-run: A test of the purchasing power parity theory. *Canadian Journal of Economics*, Volume 13, pp. 206-230.

Patel, J. (1990), Purchasing power parity as a long-run relation. *Journal of Applied Econometrics*, Volume 5, pp. 367-379.

Pesaran, M. H., Y. Shin and R. Smith (2001), Bounds testing approaches to the analysis of level relationship. *Journal of Applied Econometrics*, Volume 16, pp. 289-326.

Ricardo, D. (1821), *Principles of Political Economy and Taxation*. G. Bell and Sons, London.

Sjaastad, L. (1998), Why PPP real exchange rate mislead. *Journal of Applied Economics*, Volume 1, pp. 179-207.

Wheatley, J. (1807), *An Essay on the Theory of Money and Principles of Commerce* (London).