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Testing the Law of One Price: A Comparison between Pakistan and Australia

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Abstract

The paper tests the validity of the Law of One Price (LOP) for Pakistan and Australia, where primary commodities constitute a substantial part of these countries' exports. This paper conducts co-integration analysis to determine the validity of the LOP in the long run. The study deals with the relative purchasing power parity approach to the analysis of exchange rate and relative prices, and covers the period from 1972-1997. The study documents the evidence generally supportive of the law.

I. Introduction

The law of one price (LOP) is one of the fundamental ideas in economics, particularly in international economics. Classical purchasing power parity (PPP) is based on the LOP. The law of one price states that in the absence of transportation and other transaction costs, competitive markets will equalize the price of an identical good between two trading countries when prices are expressed in the same currency.

The LOP is such a fundamental and intuitive proposition that Lamont and Thaler (2003) define it as the "Second law of economics". Cournot ([1838] 1927) seemingly was the first to assert that the same commodities command the same prices. He states, "The market is entire territory of which the parts are so united by relations of unrestricted commerce that prices take the same level throughout with ease and rapidity". The purchasing power parity is based on the extension and variation of the law of one price as applied to aggregate economy.[2]

There is a huge literature concerned with the testing of the LOP. Among the early studies to document the size and volatility of LOP deviations

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[2] *The validity of the LOP is essentially a sufficient condition for the PPP to hold, though PPP may hold by condition even if LOP is violated for a few goods.*

across seemingly highly traded goods are Isard (1977) and Richardson (1978). Giovannini (1988) concluded that LOP deviations are highly correlated with exchange rate movements. Rogoff (1996) found that for some highly traded commodities the law of one price holds very well.[3]

Pippenger (1993) examined the long run relationship between exchange rate and Wholesale price index (WPI) using co-integration analysis. The study found that for a majority of Swiss exchange rates examined, PPP holds as a long-run equilibrium condition.[4] Pedroni (2001) employed fully modified OLS and dynamic OLS for testing the hypothesis in co-integrated panels. The study found no support for the PPP hypothesis. Chen and Rogoff (2003) studied the effects of exogenous shocks on the PPP by focusing on three countries Australia, Canada and New Zealand where primary commodities constitute a substantial part of their exports. They concluded that for these economies PPP works well because now primary exports are generic, characterized by the ease of measuring them and the ability to transact them by contract.

Unfortunately, the empirical evidence regarding the law appears at best mixed. Previous work has not provided a satisfactory explanation for this situation. The researchers used various techniques to empirically test this theory and different results were obtained depending on the methodology applied. Some studies have produced evidence unsupportive of the hypothesis while other studies have indicated the validity of the hypothesis. These mixed results suggested that it is not easy to test the theory [see Sarno and Taylor (2002)]. The empirical inconclusiveness of the LOP and PPP, which is well known in the literature, to an extent that it has been regarded as the PPP Puzzle by Rogoff (1996), has motivated many researchers to return to the examination of the law of one price and the PPP.

It is worth noting that most of the studies investigated the empirical validity of the theory for major industrial countries vis–a-vis the US dollar, with some attention focused on the European countries vis–a-vis the German mark. However, only little work has been carried out in order to examine the validity of PPP for Pakistan and for Australia. The two countries have substantial trade with each other, especially from the point of view of

[3] *For a technical discussion of the literature on testing PPP, see Froot and Rogoff (1995).*
[4] *Sarno (2000) also indicates the validity of PPP in a different framework.*

Pakistan. While Pakistan is a poor country, Australia is a rich country and it is located close to Asia. The objective of the paper is to test the validity of the LOP for Pakistan and Australia where primary commodities constitute a substantial part of these countries' exports and their major trading partners are almost the same. The paper conducts a co-integration analysis of the PPP to determine the validity of the LOP in the long run. The study deals with the relative PPP approach to the analysis of exchange rate and relative prices and covers the period from 1972-1997.

The paper is organized as follow; Data are discussed in section II. Section III outlines the methodology adopted. The empirical analysis and discussion of the results are provided in section IV before concluding in section V.

II. The Data and Methodology

The paper conducts a co-integration analysis of the relative PPP to test the validity of the LOP for Pakistan and for Australia. The study examines the long run relationship between exchange rate and price indexes and covers the period of 1972 to 1997. All the data are taken on annual basis.[5]

To measure price in the home countries and trading partners three different price indices are used, namely consumer price indices (CPI), whole sale price indices (WPI), and GDP deflator. There are two main advantages to this choice. First, all the three indexes are considered to be comprehensive measures of general price level. Second, data on these price indexes are easily available for both Pakistan and Australia, and their trading partners.

The sample of trading partners is fairly comprehensive and it covers most of the international trade of the two countries under focus. The number of trading partner is 21 for Pakistan and 22 for Australia, while the average share of trading partners in total trade of each country is more than 70%. We have collected the data on the trade of the sampled countries from different volumes of International Trade Statistics. The data on price indices and exchange rates are collected from different volumes of International Financial Statistics.

The law of one price states that for any good i $P_i = E P_f$, where P_i is the domestic currency price of good i, P_f is the foreign currency price and E is the

[5] *If monthly or quarterly data were available, we could be able to trace short-term fluctuations in the real exchange rates as well.*

exchange rate defined as the home currency price of foreign currency. Simply put LOP states that once prices are converted to a common currency, the same good should sell for the same price in different countries.

The study considers the relative version of PPP.[6] It employs the Johansen's procedure to test for co-integration.[7] The following construction is based on Johansen's procedure explained in Enders (2006). The time path of exchange rate and relative price are assumed to be characterized by the following first order VEC (Vector Error Correction) system e_t denotes natural logs of nominal exchange rate measuring the price of currency j in units of currency i and r_t denotes natural logs of relative price between countries i and j.

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

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

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

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

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

The existence of a co-integrating relationship depends on the rank of the matrix π. The necessary and sufficient condition for the existence of a co-integrating relationship is that the rank of the matrix π is equal to one. In this case, we can express the second row as a multiple of the first.

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

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

Now the study considers 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 augmenting the VAR portion of the model by drift and linear trend

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[6] *The evidence supporting PPP proposition is always based on the validity o f LOP.*

[7] *Larsson and Lyhagen (2007) introduced a likelihood based framework for testing and estimation in co- integrated panels-vector-error correction models setting that can be seen as a generalization of the Johansen procedure.*

variations, we can write the ECVAR model as follows

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

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

The rank condition is tested by finding out the number of non-zero characteristic roots of the π matrix. Enders (2006) provides a general procedure to test the following two null hypotheses. 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 leat one i*

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

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

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

The existence of a co-integrating relationship requires that the first null hypothesis should be rejected while the second should be accepted. Following the standard convention the test will be applied under five alternative cases, which are listed below along with the implied restrictions on parameters in the ECVAR system.

Case 1: No intercept or trend in VEC and no drift or trend in VAR

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

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

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

Case 3: Intercept but no trend in VEC and drift but no trend in VAR

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

Case 4: Intercept and trend in VEC and drift but no trend in VAR

Restrictions: $\tau_e = 0, \quad \tau_r = 0$

Case 5: No drift or trend in VEC or VAR

Restrictions: None

Although the test will be applied under all the above five options, we shall concentrate only on case 2 and case 3 for detailed analysis. For example case 1 does not have much relevance in the light of the fact that absolute version of PPP cannot be tested. Case 4 and case 5 are also not very suitable for testing relative PPP. The reason is that de-trending takes much of the long-term variations from the series and as a result the power of test to reject the null hypothesis of stationary in data is unnecessarily reduced.

When a co-integrating (or 'equilibrium') relationship between exchange rate and relative price exists, the next natural step is to study dynamic response in the two variables to deviations. In that case the ECVAR model is re-estimated for the error correction analysis by imposing the restrictions on the π matrix implied by the rank condition. The parametric restrictions to satisfy the rank condition are:

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

The resulting ECVAR model (equation 6 & 7) can now be written as:

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

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

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 (less) than 0, 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 satisfies the conditions:

$$\pi_{ee} D_{t-1} < \pi_{re} D_{t-1} \quad whnever\ D_{t-1} > 0 \qquad (10)$$

$$\pi_{ee} D_{t-1} > \pi_{re} D_{t-1} \quad whnever\ D_{t-1} < 0 \qquad (11)$$

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 co-integration analysis. Now the first step is to determine the existence of co-integrating relationship and at the second stage the parameters of the error correcting equation are studied to determine whether or not the PPP proposition holds.

III. Empirical Results

We now analyze Purchasing Power Parity (PPP) proposition by testing the existence of co-integrating relationships between bilateral nominal exchange rates of Pakistan and Australia with each of their trading partners and the corresponding relative price. Johansen's test is applied on the null hypothesis H_0^A and H_0^B to determine the number of co-integrating vectors with $\lambda_{trace}(1)$ and $\lambda_{\max}(1, 2)$ statistics.

The crucial information that comes out of this exercise is about the number of characteristic roots that are significantly different from zero (equal to the number of co-integrating vectors), which in the present context can vary from zero to two. This information is given by table 1 and table 2 focusing mainly on case 2 and 3 and considering three price indices utilized. There are 132 potential co-integrating relationships for Australia with its 22 trading partners and 126 such relationships for Pakistan with 21 trading partners. Since not all these co-integrating relationships are established, we end up with the estimates of 94 ECVAR models shown in table 3. The results show that the numbers of co-integrating relationships with WPI, CPI and GDP deflator are respectively 41.49%, 25.5% and 32.97% of the number of estimated models. Thus, the possibility of a long-run relationship between nominal exchange rate and relative price at the retail level (CPI) is lower than at the

wholesale level (WPI and GDP deflator).

Table 3 presents the 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. Case 2 refers to the specification of ECVAR model wherein the error correcting equation includes an intercept, while VAR model does not have drift (or linear trend in level). In case 3 VAR part of the ECVAR model also includes drift. For both Pakistan and Australia the results are supportive of the PPP proposition. An obvious implication is that the exchange rate policies in the two countries have been closely linked with domestic inflation rate relative to the inflation rate in their trade partners.

The next step of our analysis is to study the error correction dynamics for all those cases where a co-integrating relationship has been established. Since the error correcting equations vary across pairs of country both in terms of specification of the model (that is case 2 or case 3) and the specification of relative price, therefore the results are discussed separately for each country.

1. Pakistan

Details of the adjustment process for the trading partners of Pakistan are given in table 1, the error correction process in exchange rate and relative price between Pakistan and most of its trading partners shows the expected pattern of changes in exchange rate and/or relative price in response to dis-equilibrium forces. The results for Pakistan and Belgium show that, as required for error correction, the coefficient of exchange rate is negative and that of relative price is positive. Furthermore the adjustment process is statically significant both for exchange rate and relative price. This implies that both the exchange rate and price level have been adjusting in the right direction to offset the effects of overshooting in nominal exchange rate beyond the equilibrium level, as defined by the co-integrating relationship. The same pattern is exhibited by the exchange rate and relative price for 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. 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 (for Germany and Thailand) that are unacceptable on theoretical grounds. On the whole the error correcting process seems to work well for Pakistan.

Table 1: Rank of the Matrix π for Pakistan

	Relative Price Based on Wholesale Price Index					Relative Price Based on Consumer Price Index					Relative Price Based on GDP Price Deflator				
Trading partner	case 1	case 2	case 3	case 4	case 5	case 1	case 2	case 3	case 4	case 5	case 1	case 2	case 3	case 4	case 5
Australia	0	1	1	1	1	0	1	1	1	1	0	1	1	1	1
Belgium	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0
Canada	0	1	1	1	1	0	0	0	1	1	0	1	1	0	1
China	1	1	2	2	2	1	1	2	2	2	1	2	2	2	2
France	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Germany	1	1	0	0	2	1	1	0	0	2	1	1	1	1	2
India	2	1	2	1	2	2	1	2	1	2	2	2	2	2	2
Indonesia	0	1	2	0	0	1	2	2	2	0	0	1	1	0	0
Italy	0	1	1	1	0	0	0	1	0	1	0	0	0	0	1
Japan	1	2	2	1	1	1	2	2	2	2	1	2	2	1	1
Korea	0	1	1	2	1	0	0	0	0	0	0	0	0	1	1
Malaysia	1	2	2	2	2	1	2	1	1	2	1	2	1	1	2
Netherlands	1	2	0	0	0	1	1	1	0	0	1	2	1	0	1
Saudi Arabia	0	1	1	2	2	1	2	1	1	2	1	2	1	1	2
Singapore	0	1	1	0	2	0	2	1	1	1	0	2	1	1	2
Sri Lanka	0	1	1	2	2	0	1	1	2	2	0	1	1	1	2
Sweden	2	1	1	1	1	1	0	2	0	2	0	0	0	0	2
Switzerland	1	2	1	1	2	1	1	0	1	2	1	2	1	1	2
Thailand	1	2	1	2	2	1	1	0	1	2	1	2	1	2	2
U. K.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U. S. A.	0	2	1	1	2	0	0	0	1	2	0	0	0	1	2

Rank equal to zero means that the two variables do not co-integrate.
Rank equal to one means that the two variables are integrated and they do co-integrate.
Rank equal to two means that the two variables are stationary but they do not co-integrate.

Table 2: Rank of the Matrix π for Australia

	Relative Price Based on Wholesale Price Index					Relative Price Based on Consumer Price Index					Relative Price Based on GDP Price Deflator				
Trading Partner	case 1	case 2	case 3	case 4	case 5	case 1	case 2	case 3	case 4	case 5	case 1	case 2	case 3	case 4	case 5
Belgium	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0
Canada	0	0	0	0	2	1	0	0	0	0	2	1	1	1	1
China	0	0	0	1	1	0	1	1	1	1	2	1	1	0	0
France	0	1	1	1	2	0	0	0	0	2	0	0	0	0	0
Germany	0	1	0	0	1	2	0	0	0	0	1	1	2	1	0
India	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0
Indonesia	0	0	0	0	2	0	0	0	1	2	0	0	0	0	2
Italy	0	1	2	0	0	0	0	0	1	2	0	0	0	0	1
Japan	0	1	1	1	2	0	1	0	0	2	0	0	0	0	0
Korea	0	1	2	1	2	0	0	1	1	2	0	1	1	1	2
Malaysia	0	1	2	0	0	0	1	2	0	1	0	0	0	0	0
Netherlands	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0
New Zealand	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2
Philippines	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
Saudi Arabia	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1
Singapore	0	0	0	0	1	2	1	1	2	2	2	0	0	1	1
South Africa	0	0	0	1	1	0	0	0	0	2	0	1	1	1	1
Sweden	0	1	2	1	2	0	0	0	0	0	0	0	0	0	0
Switzerland	0	1	1	0	1	2	0	0	0	0	2	0	0	0	0
Thailand	0	1	1	1	1	0	1	2	1	2	1	2	2	1	1
U. K.	0	0	0	1	2	0	0	0	0	1	0	0	0	0	1
U. S. A.	0	0	0	0	2	0	0	0	0	0	0	1	2	1	2

Rank equal to zero means that the two variables do not co-integrate. Rank equal to one means that the two variables are integrated and they do co-integrate. Rank equal to two means that the two variables are stationary but they do not co-integrate.

Table 3: Results for the Significant Characteristic Roots in ECVAR Model

Country	WPI				CPI				GDP Deflator			
	Pakistan		**Australia**		**Pakistan**		**Australia**		**Pakistan**		**Australia**	
	Case		Case		Case		Case		Case		Case	
	2	3	2	3	2	3	2	3	2	3	2	3
Australia	*	*	n	n	*	*	n	n	*	*	n	n
Belgium									*			
Canada	*	*							*	*	*	*
China	*				*		*	*			*	*
France	*	*	*	*								
Germany	*		*		*				*	*	*	
India	*				*						*	*
Indonesia	*								*	*		
Italy	*	*	*			*						
Japan			*	*			*					
Korea	*	*	*					*			*	*
Malaysia			*			*	*			*		
Netherlands					*	*				*		
New Zealand	n	n		*	n	n			n	n		
Pakistan	n	n	n	n	n	n	n	n	n	n	n	n
Philippines	n	n			n	n			n	n		
Saudi Arabia	*	*				*	*			*	*	*
Singapore	*	*				*	*	*		*		
South Africa	n	n			n	n			n	n	*	*
Sri Lanka	*	*	n	n	*	*	n	n	*	*	n	n
Sweden	*	*	*									
Switzerland		*	*	*	*					*		
Thailand		*	*	*	*		*			*		
U. K.												
U. S. A.		*									*	

The trading partners with co-integrating relationship between the nominal exchange rate and relative price are shown by *, while an empty cell indicates the absence of co-integrating 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.

Table 4: Error Correction Parameters for Pakistan

	Wholesale Price Index				**Consumer Price Index**				**GDP Deflator**			
Country	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	-0.902*	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*	.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*	-0.324**	0.22*	-0.34**	0.217*
Sweden	-0.499*	0.075*	-0.504*	0.073								
Switzerland			-0.601*	0.124*	-0.392*	0.007					-0.34**	0.166*
Thailand			-0.36**	0.197*	0.508*	0.07*					0.059	0.178*
U. S. A.			-0.34**	0.603*								

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 Australia

	Wholesale Price Index				Consumer Price Index				GDP Deflator			
Country	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}
Canada									-0.736*	0.183*	-0.985*	0.088
China					0.049	0.218*	0.129	0.219*	-0.233**	0.085*	-0.08	0.114*
France	-0.16	0.399*	-0.16	0.397*								
Germany	-0.36	0.116**							-0.01	-0.021*		
India									-0.15	0.268*		
Italy	-0.17	0.233*										
Japan	-0.36	0.256*	-0.5**	0.216*	-0.3	0.107*						
Korea	-0.3	0.107*					-0.768*	-0.204*	0.594*	-0.15*	-0.617*	-0.148*
Malaysia	-0.28	0.221*			-0.07	0.29*						
New Zealand			-1.218*	-0.09								
Saudi Arabia					-0.18	0.289*			-0.13	0.397*	-0.351**	0.392*
Singapore					-0.23	0.316*	-0.29	0.313*				
South Africa									-0.968*	-0.197**	-1.094*	-0.11
Sweden	-0.23	0.214*										
Switzerland	-0.33	0.234*	-0.54	0.201*								
Thailand	-0.78	0.388*	-0.983*	0.333*	-0.813*	0.09						
USA									-0.434*	0.072*		

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.

2. Australia

The results of error correction for Australia are presented in the above table 5. The results show that the nominal exchange rate and relative price adjust in the right direction and plays significant role for most of the trading partners. The error correction process in exchange rate and relative price between Australia and most of its trading partners shows the expected pattern of changes in exchange rate and/or relative price in response to dis-equilibrium forces. The results for USA show that, as required for error

correction, the coefficient of exchange rate is negative and that of relative price is positive. This implies that both the exchange rate and price level have been adjusting in the right direction to offset the effects of overshooting in nominal exchange rate beyond the equilibrium level, as defined by the co-integrating relationship. The same pattern is exhibited by the exchange rate and relative price between Australia and Canada.

In case of France, India, Italy, Japan, Malaysia, Sweden, Switzerland and Singapore, however, relative price plays a more active role in offsetting the deviations of nominal exchange rate and/or relative price from the equilibrium path. In case of China the error correcting adjustment in exchange rate, though not in the right direction, is statistically insignificant. However the relative price adjusts in the right direction to offset the deviations in exchange rate and relative price from the equilibrium path.

There is only one wrong case for Australia that is for Germany. It shows that although exchange rate is working in the right direction to remove the dis-equilibrium, but the adjustment parameter is statistically insignificant while relative price is changing in the wrong direction and the corresponding error correcting parameter is also significantly different from zero. In this particular case though the exchange rate and relative price form a co-integrating relationship, there is no evidence of error correction.

IV. Conclusions

The study tests the law of one price for Pakistan and Australia over the period 1972-1997. The analysis is conduced by examining long-run relationship and short-run dynamics between each of the bilateral exchange rates and the relative price levels considering each trading partner of the two countries one by one. Both in Pakistan and Australia primary commodities constitute a substantial part of their exports. The study documents the evidence that is generally supportive of the law.

An interesting outcome of our exercise is that the evidence to accept the purchasing power parity proposition is stronger when it is applied on the wholesale index as compared to the case when it is applied on the consumer price index. In other words, the purchasing power parity is more likely to hold for the wholesale prices than for the retail prices. The model developed here receives indirect but strong support from Chen and Rogoff (2003). They find that the PPP works well for the countries where primary commodities constitute a substantial part of these countries' exports.

The real world is characterized by a number of complications such as differentiated product, taste and wide range of costs, which create considerable problems for economists testing the theory empirically. Since co-integration tests of PPP are unlikely to be robust in the presence of these problems, rejection of the hypothesis of co- integration between exchange rate and prices does not provide very strong support for the rejection of PPP and thus the LOP. However since the evidence is found supporting co- integration between two variables in spite of these problems, the results lend strong support to the proposition that PPP holds as a long-run relationship. The results found here could be considered as adding strong support to the conclusion of Bhatti (2000) and Ahmad (2002), who have found evidence that PPP, holds as a long-run relationship.

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