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Resource Dependency and the Empirical Validity of PPP: The Oil Exporter Countries

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Abstract: Notwithstanding the empirical validity of purchasing power parity hypothesis remains an open question, we investigate the hypothesis over the period 1974-2007 across a set of countries that the most important of their characteristic is to enjoy rich - resource especially crude-oil. We examine the purchasing power parity hypothesis by various conventional panel unit root tests and a novel test - panel Lagrange Multiplier unit root test with multiple structural breaks-that has been developed by Im *et al*. Findings of paper show that conventional panel unit root tests reject the unit root hypothesis but panel Lagrange Multiplier unit root test with one and two structural breaks don't reject it for oil exporting countries. Our finding complete the empirical relationship between country characteristics and the validity of purchasing power parity hypothesis.

JEL Classifications: F3 · C3

Key words: Purchasing power parity · Panel unit root test · Structural break · Oil exporter countries

INTRODUCTION

The purchasing power parity (PPP hereafter) is one of the puzzles on economic issues that are usually studied as an "all or nothing" proposition. PPP in its different version states a proportional relationship between nominal exchange rates between any two currencies and their relative national prices or that the real exchange rate is equal to constant. The absolute version of PPP doctrine that has based on the law of one price implies that by arbitrage in a wide range of goods, one should be able to buy the same basket of goods in any country for the same amount of a common currency. Its relative version stipulates that the nominal exchange rate will adjust to offset inflation differentials between countries. The underlying intuition is the arbitrage across time rather across space.

Despite a vast empirical literature and central role in many international finance models, the empirical validity of PPP remains as controversial issue yet. According to different version of PPP doctrine, it is interpreted in different way[1]. One of them that has been according to Cassel [2] point out that the exchange rate move toward PPP in the long-run, but it might transitorily diverge from PPP. This version of PPP is define as mean - reversion and has been criticized by Balassa [3] and Samuelson [4].

As has been mentioned by Narayan and Prasad [5] in empirical work, in order to examination of this definition of PPP, three different directions has been taken: unit root tests, cointegration tests, and nonlinear stationary tests. Rejection of the unit roots in real exchange rate and/ or acceptance of cointegration between various measure of domestic price and nominal exchange rate- adjusted foreign prices indicates real exchange rate move toward PPP in the long run.

During successive advances in the unit root and cointegration tests, the PPP hypothesis has had ebbs and flows over the years. For example, the earlier research on PPP used the conventional univariate unit root tests e.g. augmented Dickey and Fuller tests [6-8].

As has been mentioned by Zelhorst and Hasan [9], the power of unit root tests is largest when the span of the data is longest. Hence one should use longer time horizons. But using a long span of data entails some problems. Increase the possibility that the series of

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interest is affected by major structural change in Data Generating Process [9]. On the other hand, using long time horizon contains both fixed and flexible exchange rate regimes. Hence subsequent studies, in order to solve first problem, have used unit root test with structural break, and in order to overcome on second problem, have used special period e.g. post-1973 period that contains flexible regime [10-12]. Recently in empirical works, in order to increase degrees of freedom and the inclusion of heterogeneous cross-country information not available in univariate tests, various panel unit root tests have been applied to examine the stationary of real exchange rate series [1, 5, 10, 12-16]. One set of studies have used panel unit root tests of first generation including Im *et al.* [17], and Levin *et al.* [18]. These tests use widely in literature, but they don't consider cross-sectional dependence. In order to control cross- sectional dependence, all these tests use common time effects. As mentioned by Banerjee *et al.* [19], if panel members are cross-correlated, then these tests experience strong size distortion and limited power. Hence, the panel unit root tests of second generation, try that allow for more general format of cross-sectional dependence [20, 21].

It is important to bear in mind that when we apply panel unit root tests for PPP hypothesis, their results must be interpreted with some caution. As explained by Taylor and Samo [22], there is possibility that when the unit root null hypothesis in the panel is rejected, some of the numbers may be stationary while others may be non-stationary. In order to overcome on above shortcoming, we can use panel unit root tests that allow for structural breaks, as non-stationary in panel series or some of the members may be due to failure to allow for structural break.

Despite attempts to use different directions, but the evidence on PPP is mixed. In order to solve a part of PPP puzzle, some researchers have investigated the role of individual country characteristics on PPP [15,12]. These studies found stronger evidence of PPP in countries more open to trade, closer to the USA, with lower inflation and moderate nominal exchange rate volatility, low growth and low income.

The object of present paper is to investigate the empirical validity of the PPP hypothesis for the flexible regime period (1974-2004) in oil exporting countries (OEC hereafter). The study differs from an earlier study[23] in an important way. Mehrara used various panel unit root tests and cointegration tests and found that PPP hypothesis is hardly acceptable for OPEC. Chang and Su [24] examined validity of the PPP hypothesis for seven major OPEC countries using nonlinear panel unit root test over the period 1995-2008. He found that the PPP hold true for four countries namely Angola, Indonesia, Iran, and Saudi Arabia. In present study, we have used the panel Lagrange Multiplier (LM hereafter) test proposed by Im *et al* [20] that allows for multiple structural breaks in the panel data series in order to avoid spurious results and add to Chang and Su [24] results. Hence, we have found new results that are in sharp contrast to the finding of Mehrara. Our finding show, however it may that Dutch disease, with the continuous volatility of oil prices transmitted to the real exchange rate and leading to deviations from PPP, but these deviations will be temporary.

The remainder of paper is organized as follow. Section 2 describes data and the econometric methodology used. The empirical results are discussed in the next section. Conclusion is presented in final section.

Data and Econometric Methodology

Data: We used quarterly CPIs and end-of-period nominal exchange rates in dollars, from 1974, first quarter to 2007, fourth quarter. All data are extracted from the International Financial Statistic (IFS-CD, 2008), for 11 oil exporter countries: Colombia, Ecuador, Gabon, Indonesia, Iran, Mexico, Nigeria, Norway, Saudi Arabia, Trinidad and Tobago, and Venezuela.

Econometric Methodology: Using Lm panel unit root test. The panel LM unit root test statistic is computed by averaging the optimal univariate LM unit root *t*-test statistics estimated for each country. The univariate LM test, following the work of Lee and Strazicich [25, 26], is based on the following model:

$$Exit = \gamma' i\, \Psi it + \partial it \qquad I=1,...,N \quad and \quad t=1,...,T \tag{1}$$

$$\partial It = \eta i \partial it-1+\varepsilon it \tag{2}$$

Where Ex is real exchange rate in country i and year t. Ψ and γ are a vector of exogenous variables that takes the form (1, t) and the corresponding parameter vector respectively. ∂ Is the disturbance error component and ε is a zero-mean error term that allows for heterogeneous variance structure across cross-section units, but assumes no cross-correlations. Parameter η is used to test

the unit root null hypothesis and allows for heterogeneous measures of persistence. As mentioned by Jewell *et al.* [27], "when the data generating process follows Eq. (1), the resulting critical values of the panel unit root test will be invariant to γit. In order to allow for two structural breaks in level and slope of the i-*th* series, we define the vector of deterministic terms as:

Ψit= [1, t, D (TB_1),$D(TB_2)$,$DT(TB_1)DT(TB_2)$] where $D(TB_k)$ = 1if $t \geq TB_k + 1$ for $k \in \{1,2\}$and 0 otherwise. $DT(TB_k) = t - TB_k$ if $t \geq TB_k + 1$ for $k \in \{1,2\}$ and 0 otherwise.

The unit root test is based upon:

$$\Delta Ex_{it} = \gamma_i' \Delta\Psi_{it} + \phi_i S_{it-1} + \sum_{j=1}^{p} \theta_{ij} \Delta S_{it-j} + \vartheta_{it}$$

Where $S_{it-1} = (Ex_{it} - Ex_{i1}) - \gamma' i\ (\Psi_{it} - \Psi_{i1})$, with γi the estimated least square parameters vector in a regression of $\Delta Exit$ on $\Delta\Psi xit$. The unit root null hypothesis corresponds to

$H_0: \phi < 0$ Versus $H_1: \phi = 0$ (implying no unit root and stationary) for each country.

The panel LM test statistic is derived from Eq. (3) and is defined as:

$$\overline{LM}_{NT} = \frac{1}{N} \sum_{i=1}^{N} LM_{iT} \quad (4)$$

Where LM_{it} is the individual t-statistic associated to ϕ_i with expected value $E(L_T)$ and variance $V(L)_T$ A standardized panel LM test statistic is constructed by $E(L_T)$ and $V(L_T)$ as follow [20]:

$$\Gamma_{LM} = \frac{\sqrt{N}[\overline{LM}_{NT} - E(L_T)]}{\sqrt{V(L_T)}} \quad (5)$$

Im *et al.* [20] provide numerical values for $E(L_T)$ and $V(L_T)$ for various combinations of T and p, via stochastic simulations using 500,000 replications.

As mentioned by Jewell *et al.* [28], distribution of the panel LM unit root test depends on N and T but is unaffected by any other parameters e.g. the presence of break(s) under the null hypothesis and its asymptotic distribution is standard normal.

RESULTS

In order to investigate PPP hypothesis between OEC, first we apply the panel unit root tests proposed by Levine, Lin and Chu [18], LLC hereafter, Im, Pesaran, and Shin [17], IPS hereafter, and Hadri [29]. LLC and IPS tests have a null hypothesis unit root in any of series while Hadri has null hypothesis of no unit root in any of series. Hadri and LLC tests assume common unit root process across cross-section but IPS assumes individual unit root process. Following several recent studies [5, 30], we include heterogeneous trend in unit root tests. Results of above panel unit root tests are presented in table (1). P-values of LLL, IPS and Hadri tests show that none of them can not reject the unit root hypothesis at the 10% for OEC. Notwithstanding, Mehrara used black market real exchange rate and yearly data, but our results is similar to his results. As explained earlier, OEC have experienced several shocks due to oil price volatility. Hence, it is possible that previous finding of non-stationary in real exchange rate may be due to failure to allow for structural breaks. In order to avoid spurious results, we apply the panel LM unit root tests with multiple structural breaks that recently developed by Im *et al* and were described in previous section. The results of LM panel unit root without structural break, and with one and two structural break are presented in table (2). As see in table (2), according to LM panel unit root test statistic (without structural break), we cannot reject unit root hypothesis for OEC. The results are as previous. But, according to this test, we can reject unit root test for Indonesia in 10% level. When, we apply LM panel unit root test with one and two structural break, we can reject unit root hypothesis for OEC. Results of univariate LM unit root test with one structural break test show that we can reject the null hypothesis for eight of the 11 countries. Results of univariate LM unit root test with two structural breaks in table (2) show that considering two structural break in real exchange rate series, we can reject the unit root test hypothesis for all of OEC.

Table 1: Panel unit root tests for real exchange rate

Method	Statistic	P-value	Null hypothesis
Levine, Lin, and Chu (2002)	0.42	0.66	Null: unit root
Im, pesaran, and Shin (2003)	-0.97	0.17	Null: unit root
Hadri-Z stat (1999)	7.37	0.000	Null: no unit root

1) Unit root test include individual effects and heterogeneous trend in data.
2) All tests assume asymptotic normality.
3) We use Schwarz criterion for the lag differences and Newey-West bandwidth selection method using Bartlett kernel.

Table 2: univariate and panel LM unit root tests for real exchange rate

	LM unit root test without structural break		LM unit root test with one structural breaks			LM unit root test with two structural break		
Country	Univariate LM test statistic	Optimal lag length (p)	Univariate LM test statistic	Optimal lag length (p)	Break location	Univariate LM test statistic	Optimal lag length (p)	Break locations
Colombia	-2.174	9	-3.376**	9	1992Q2	-4.718*	9	1992Q2 1998Q3
Ecuador	-2.684	8	-3.965**	8	1987Q1	-4.591*	8	1992Q2 1998Q1
Gabon	-2.153	12	-3.505***	12	1995Q1	-3.942**	12	1985Q1 1995Q1
Indonesia	-2.879*	4	-4.164**	2	2000Q4	-5.765*	3	1992Q3 1997Q3
Iran	-2.1	0	-2.934	0	1986Q3	-4.649*	12	1992Q3 1996Q1
Mexico	-2.303	3	-4.153**	3	1988Q1	-4.959*	4	1987Q3 1996Q1
Nigeria	-2.077	1	-3.132	8	2000Q4	-4.806*	9	1989Q2 1998Q3
Norway	-2.015	0	-2.689	11	1988Q3	-4.45**	0	1985Q3 1996Q3
Saudi Arabia	-2.581	4	-3.447***	4	1981Q3	-5.373*	4	1979Q1 1992Q1
Trinidad and Tobago	-2.733	0	-3.555***	0	1983Q1	-4.642*	0	1982Q3 1996Q4
Venezuela	-1.597	9	-4.018**	12	1996Q1	-5.618*	12	1986Q3 1997Q2
Panel LM test statistic	-2.174		-9.116[*]			-16.582[*]		
1) All tests allow for time fixed effects and all regressions include an intercept and time trend. The critical values for: 1% [*] 5% [**] 10% [***]								
2) Lm unit root without structural break:			-3.63			-3.06		-2.77
3) Lm unit root with one structural break:			-4.239			-3.566		-3.211
4) Lm unit root with two structural breaks:			-4.545			-3.842		-3.504

CONCLUSION

This paper examined the empirical validity of PPP hypothesis across oil exporting countries over 1974-2004 by quarterly data and using various panel unit root tests and LM panel unit root test with multiple structural breaks. Later method eliminates spurious results in conventional panel unit root tests e.g. Im, Pesaran, and Shin (2003) and Levine, Lin and Chu (2002) due to structural breaks in data.

Results of paper show notwithstanding conventional panel unit root tests reject PPP hypothesis across oil exporting countries, but results of univariate and panel LM unit root tests with one and two structural breaks show that we can reject unit root in quarterly real exchange rate series for oil exporting countries. Therefore, we conclude that PPP hypothesis do not reject for oil exporting countries.

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