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PURCHASING POWER PARITY TESTS IN COINTEGRATED PANELS: EVIDENCE FROM NEWLY INDUSTRIALIZED COUNTRIES

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This paper examines the long-run purchasing power parity (PPP) by testing for unit roots in real exchange rates of 10 newly industrialized countries (NICs) during the period 1980-2013. Alternatively, this paper examines the long-run PPP by evaluating the cointegration between nominal exchange rates and price ratios of the NICs. The Pesaran (2007) unit root test results support the evidence of long-run PPP during the period 1980-1990; however, during the other sub-periods, the results invalidate the long-run PPP. We find that the evidence against the unit root hypothesis is stronger for larger than small samples, for monthly than quarterly data. Moreover, the results suggest the mere evidence of strong PPP and also suggest that the speed at which the real exchange rates restore to equilibrium is relatively slow during the period 1991-2000.

Keywords: Purchasing Power Parity, Panel Cointegration, Unit Root Tests
JEL Classification: F31, C22, C23

1. INTRODUCTION

Purchasing power parity (PPP) is one of the most important conditions in international trade and finance because many models of the exchange rate determination are built on the assumption of PPP (Wu, 1996; Bilson, 1978; Dornbusch, 1976; Frankel, 1976). The long-run PPP or mean reversion in the real exchange rate is a standard but critical assumption of modern theories of the exchange rate in an open economy macro-models. It is also important to policymakers in considering the sizeable short-run deviations from PPP in recent years (Rogoff, 1996; Froot and Rogoff, 1995). The PPP principle is crucial in understanding because the natures of nominal as well as real disturbances in the macro-models are widely used in policy deliberations. The Large and relentless deviations from PPP over the last two decades, however, have raised a question and needs further research. In addition, it is well acknowledged that PPP, as an exact relationship, holds only under certain circumstances. Indeed, previous studies have reported evidence of significant short-run variations of the PPP doctrine (Adler and Lehmann, 1983; Frankel, 1981). The PPP performs weakly in the short-run, and many

economists still hold the view that over the long-run, relative price may move in proportion to the change in nominal exchange rate so that real exchange rate will revert to its parity. Therefore, the researchers are more interested to re-examine the issue of long-run PPP in recent times.

Early cointegration test such as augmented Dickey-Fuller cointegration regression and Johansen maximum likelihood (ML) procedures are tended to reject the null of long-run PPP, especially during the recent floating exchange rate period. The severe problems of the previous literature were based on the low power of tests, against the stationary alternatives. As a response researchers have used the recent development techniques in time series and panel data econometrics, such as panel unit root tests developed by Levin et al. (2002), Breitung (2000), Im et al. (2003), and Maddala and Wu (1999), and cointegration tests developed by Pedroni (2001), Kao (1999), Westerlund (2007), Abuaf and Jorion (1990), Diebold et al. (1991), Edison and Pauls (1993), and Mark (1990). Panel tests offer more powerful evidence than the conventional tests and their evidence support the mean reversion in real exchange rates and overturn previous findings during the current float.

The main shortcoming of the previous literature is that the tests for unit roots and cointegration have low power against the stationary alternatives in small samples. If one cannot reject the null hypothesis of a unit root in real exchange rates, or if no cointegration exists between the nominal exchange rate and relative price level, then PPP may not be inevitably rejected because of the low power of tests. The panel unit root tests impose the homogeneous unit value for the cointegrating vectors between the nominal exchange rates and aggregate price ratios. Previous studies have argued that there may be a tendency for these variables to move together in equilibrium in the long run, but this relationship need not be necessarily one-for-one under the more general weak form of PPP (Pedroni, 2001).[1] In certain circumstances, the weak form of PPP does not contradict the strong form of PPP. However, in certain cases of panel settings, the cointegrating vectors are homogeneous and equal to one for all countries are violated even if for a small subset of countries, because this mixes a few integrated series in which majority of the series are stationary, and this likely to lead an inability to reject the null of a unit root in the panel. This simply implies that data from some countries are consistent with PPP, but it does not necessarily imply that data from all sample countries are consistent with PPP, which would raise a question for further investigation after estimating the data.

This paper is distinct from the previous studies in several aspects. First, it applies the recently developed panel unit-roots test to examine the validity of PPP, and alternatively, it applies the panel cointegration techniques to examine the long-run relationship between nominal exchange rates and price ratios of the NICs. Furthermore, this paper

[1] The weak form of PPP mechanism includes circumstances such as differences in the price indices between countries, measurement errors, transportation costs, and differential productivity shocks. In this case, it is natural to presume that heterogeneity could be raised in the panel cointegration method (Pedroni, 2001).

examines the intensity of cointegration between nominal exchange rates and price ratios, which is required for strong PPP to hold. Second, this paper attempts to examine the validity of PPP during the different sub-periods from 1980 to 2013 of the NICs. The classification of the NICs are defined by the group of social scientist and economist, include 10 emerging economies in the world, namely South Africa (Africa), Mexico (North America), Brazil (South America), China, India, Indonesia, Malaysia, Philippines, Thailand (Asia), and Turkey (Europe). The important aspect of taking the NICs is that since the 1980s these countries are passed through the different phases of financial sector reforms, trade reforms,[2] currency crises, and global financial crisis, which could provide an ideal testing ground to examine the PPP over the different sub-periods from 1980 to 2010.[3] Moreover, the NICs are inter-dependent in terms of their export-import trade share, financial transaction, and cross-country capital movements, etc. So, the possibility of cross-sectional dependence could not be avoided in the case of the NICs. However, none of the previous studies are properly addressing the question of cross-sectional dependence, while examining the PPP in the context of emerging and newly industrialized countries.[4] Therefore, keeping these factors into consideration, we examine the validity of long-run PPP for 10 NICs during the current float period 1980-2013 by employing the unit-roots tests that are more powerful than the usual tests in econometric applications. With this, the current research hopes to fill the existing gap in the literature. Furthermore, to the best our knowledge, this study is the first, to date, that utilizes the first and second-generation panel unit-root tests, especially Pesaran (2007) test to examine the long-run PPP in the 10 NICs.

We pool data on real exchange rates between the United States and 10 Newly Industrialized countries (NICs) in a panel set up and test the hypothesis that whether the real exchange rates follow the stationary process and facilitating to PPP. Precisely, Pesaran (2007) test results provide evidence against the unit root hypothesis for real exchange rates with monthly data during the period 1980-1990, but not with quarterly, data. With annual data, the unit root hypothesis for real exchange rates cannot be

[2] Many Asian countries started the trade liberalization policies and removed their capital controls in the 1980s.

[3] The NICs are usually characterized by some common features, i.e., (i) increased social freedoms and civil rights (ii) strong political leaders (iii) a switch from agricultural to industrial economies, especially in the manufacturing sectors (iv) an increasingly open-market economy (v) allowing free trade with other nations of the world (vi) large operating in several continents (vi) strong capital investment from foreign countries (vii) political leadership in their area of influence and (viii) rapid growth of urban centers and population. For further discussion of the NICs, see Bożyk (2006), Guillén (2003), and Waugh (2000).

[4] Chang and Tzeng (2013) have analyzed the issue of cross-sectional dependence, while examining the PPP in nine transition countries. By applying different sets of unit root tests, such as univariate tests, panel-based unit-roots tests, and panel SURKSS tests, they find different results related to PPP of the nine transition countries. However, their country-specific study is quite different from this study, which is an especially attempt to investigate the long-run PPP of the NICs during the period 1980-2013.

rejected at least at the 10% level for the period after the 1990s. Furthermore, with quarterly data, the unit root null cannot be rejected at the 10% level for any of the sub-periods of the NICs over the period from 1980 to 2013. Alternatively, our results indicate the presence of cointegration between the nominal exchange rates and price ratios during the period 1980-1990. Furthermore, our results also provide the weak evidence of strong PPP, and the results reveal that the speed of adjustment in real exchange rates revert to its parity is found to be low during the period 1991-2000.

The structure of this paper is organized as follows. Section 2 describes the panel-based econometrics procedures to test the long-run PPP, while Section 3 discusses the estimation results, and finally, concluding remarks are presented in Section 4.

2. ECONOMETRIC METHODOLOGY

The real exchange rate for a country (considering the United States (US) dollar as the numeraire currency) could be defined as follows:

$$Q_{it} = S_{it}\frac{P_t^*}{P_{it}}, \tag{1}$$

where S_{it} is the nominal exchange rate, P_t^* is the US consumer price index (CPI) and P_{it} is the CPI for country i. Denoting logarithms in lower case letters, we therefore have

$$q_{it} = s_{it} + p_t^* - p_{it}. \tag{2}$$

In this case, for strong PPP to hold, we require to test the null hypothesis of a unit root in the q_{it} series, either individually (i.e., country by country) or by using panel methods. Previous researchers have taken two approaches to examine the long-run PPP. The first approach is to examine whether the real exchange rate series itself is stationary (Adler and Lehmann, 1983; Dieblod et al., 1991; Roll, 1979). The second approach is to examine the cointegration between the nominal exchange rate and price ratios. To do the robustness checking in the strong and weak form of PPP, this paper uses the two approaches of PPP. Initially, it examines the validity of long-run PPP under the current float by employing the unit root tests in the real exchange rates and secondly, it examines the cointegration between nominal exchange rates and price ratios. Furthermore, in order to check the intensity of cointegration between exchange rates and price ratios, let us consider the following regression:

$$s_{it} = \alpha_i + \beta_i pr_{it} + u_{it}. \tag{3}$$

The long-run PPP hold, when s_{it} and pr_{it} are cointegrated with slopes β_i, which may or may not be homogeneous across i (Pedronoi, 2001). The pr is considered as

aggregate price ratio in terms of the CPI between the two countries. Wu (1996) further explains that the symmetry between domestic and foreign countries and the proportionality between the nominal exchange rate and price levels require the cointegrating vector to satisfy $\beta_1 = -\beta_2 = 1$.[5] However, while examining the validity of PPP, the weak power of standard unit roots and cointegration tests render the empirical results become inconclusive.[6] In addition, from Eq. (3), for strong PPP to be hold, we require under the null hypothesis that $H_0: \beta_i = 1, \ \forall i$.

The panel-based procedure pools cross-section and time series data, and evaluates the null hypothesis that the real exchange rate in a panel contains a unit root against the alternative that the series become stationary. In addition, the panel based procedure allows using a large number of data points and exploiting cross-section variation in data to improve the efficiency in estimation. The null hypothesis imposes the cross-equation restrictions on the first-order autoregressive coefficients. Furthermore, the panel test can yield higher power than the standard tests of each individual time series exchange rates. The main purpose of this paper is to implement this procedure to examine the stationarity of the real exchange rate and compare the new results with the well-known univariate test between the exchange rate and price levels.

To examine the long-run PPP in panel data, and to evaluating the stationarity in the real exchange rate, let us consider estimating the following regressions, which include the country-specific and time-specific effects,

$$\Delta q_{jt} = \eta_j + v_t + \rho q_{jt-1} + \sum_{i=1}^{k} c_{ji} \Delta q_{jt-i} + \varepsilon_{jt}, \tag{4}$$

in which the subscript $j = 1, 2, \ldots, 10$ indexes the countries. Whereas, η_j represent the country-specific effect, v_t represent the time-specific aggregate effect, and ε_{jt} represent the idiosyncratic disturbance factors. These three are assumed to be mutually independent random variables with zero means. In this case, the null hypothesis implies that the real exchange rate contains a unit root, i.e. $\rho = 1$. Furthermore, to conduct the panel unit root test, we assume that the disturbance term follows the i.i.d. assumption with $E(\varepsilon_{it}) = 0$, $E(\varepsilon_{it}^2) = \sigma^2$ and $E|\varepsilon_{it}|^{2+\lambda} < \infty$ for some $\lambda > 0$. Levin and Lin (1992) provide the asymptotic results for the ordinary least squares estimators; and the t-statistic as both the time periods and a number of individuals in the panel go to infinity

[5] The cointegration between the nominal exchange rate and price levels could be examined by estimating the following regression models, as $s_{it} = \alpha_i + \beta_1 p_{it} + \beta_2 p_t^* + \varepsilon_{it}$. Whereas p_t^* and p_{it} are the CPI of US and CPI for country $i (i = 1, 2, \cdots, N)$. Furthermore, if long-run PPP holds, then s_{it} would be cointegrated with p_t^* and p_{it}, while $\beta_1 = -\beta_2 = 1$. For detailed discussion, see Wu (1996, p. 56).

[6] Patel (1990) argues that since different countries use different weights to construct price indices, the constraint that the coefficients on the price indices are equal to unity may not be always satisfied, even if PPP holds.

under the null hypothesis of $\rho = 1$ (Wu, 1996).[7] We estimate Eq. (4) by applying the several panel unit root tests, with coefficients ρ equated across countries and appropriate lag length (k) would be selected by the Schwartz-Bayesian criterion (SBC). The detail discussions of the empirical results are given in the next section.

3. EMPIRICAL RESULTS

All data are taken from the Economic Research Federal Reserve Bank of St. Louis. To examine the robustness in empirical results, the study implements the unit root tests with data sample at monthly, quarterly, and annual frequencies, respectively. For the CPI real exchange rates, ten newly industrialized countries are selected. For the monthly data, the sample covers the period from January 1980 through December 2013, with 3672 observations. For the quarterly data, the period covers between the first quarters of 1980 to the fourth quarter of 2013, with 1224 observations. We do not have monthly and quarterly information on the real exchange rate for the Philippines, so, we interpret the panel estimation of unit roots and cointegration tests for nine newly industrialized countries in the case of monthly and quarterly data. In addition, the annual data are covered from 1980 to 2013 period including ten NICs with 340 observations.

Figure 1 display the trends of real exchange rates with annual data of the ten sampled NICs. The figure reflects that except the Philippines, the remaining nine sampled countries real exchange rates do not exhibit large deviations from their sample mean over the past 4 decades. It is also observed that the Philippines exhibit huge deviation in the real exchange rate with the US dollar being taken as the numeraire country. Furthermore, the Asian industrialized countries like Indonesia, Malaysia, Philippines, and Thailand have already gone through the different phase of the financial crisis and almost all Asian emerging economies are affected by the East Asian crisis in 1997-98. The NICs are also affected by the more recent global financial crisis in 2007-08, Latin American Debt crisis during the period of the 1980s, and country-specific balance of payment crisis, etc. The cross-country heterogeneity is so inter-dependent that macroeconomic financial shock of any country could affect the other industrialized countries. Therefore, taking into the consideration of different financial crisis, macroeconomic shocks, and cross-country dependence in the NICs, and to examine the

[7] The commonly used unit root tests like the Dickey-Fuller (DF), augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests have lack of power in distinguishing the unit root null from stationary alternatives, and using panel unit root tests are one way of increasing the power of tests than the single time series tests (Wu, 1996; Oh, 1996; Macdonald, 1996). Note that there is statistical power problem in standard unit root tests. However, to overcome the power problem, it is also obvious that more powerful tests are available even in the single equation context (Elliott et al., 1996; Perrron and Ng, 1996). The IPS test is claimed to be a generalization of the Levin and Lin (1992, 1993) tests. However, it is better viewed that IPS test is more powerful than the Levin and Lin test.

long-run PPP of the NICs over the different time period from 1980 to 2013, the entire sample period is divided into three sub-periods.[8]

The NICs are inter-dependent through the different macroeconomic aspects, so the possibility of cross-sectional dependence could not be avoided while examining the PPP doctrine. Therefore, to handle the problem of cross-sectional dependence, it is instructive to apply the panel unit root test proposed by Pesaran (2007).[9] Furthermore, in order to get more robust empirical findings, the study has used the Pesaran unit root test along with the other first generation panel unit root tests. The study has applied first-generation four different approaches of panel unit root tests namely, Levin, Lin, and Chu (LLC); Im, Pesaran, Shin (IPS); ADF Fisher Chi-square, and Philips-Perron Fisher Chi-square. The unit root test results of real exchange rates are reported in Tables 1 and 2. With the monthly data, the reported results suggest that the presence of unit root null can be rejected at a conventional significance level during the different sub-periods under study from 1980 to 2013, which certainly suggest to holding the long-run PPP during these sub-periods.[10]

With quarterly data, the results suggest that the unit root null cannot be rejected at a conventional significance level during the different sub-periods under study. Similarly, for the annual data, the unit root null can be rejected for the first sub-periods, and during the other two sub-periods, the unit root null cannot be rejected. This further indicates that in the case of quarterly data, the empirical results are not in favor of the long-run PPP. However, with monthly and annual data, we find different evidence of long-run PPP over the different sub-periods.

As discussed before, to handle the problem of cross-sectional dependence, we apply the Pesaran (2007) test. The Pesaran test results are reported in Table 3. With monthly data, the results suggest that the real exchange rates of the NICs follow the stationary process during the sub-periods 1980-1990. This supports the evidence of long-run PPP holding during the period 1980-1990. Similarly, with quarterly data, we do not find any evidence of long-run PPP. This indicates that the Pesaran (2007) test is more or less support the evidence of first-generation panel unit roots test. Furthermore, with annual data, the unit root null cannot be rejected for the sub-periods 1991-2000, and 2001-2013. This suggests that the NICs do not exhibit the long-run PPP after the 1990s. One possible explanation plausible is that the Asian countries that suffered most in the East Asian crisis of 1998 such as Indonesia, Malaysia, Philippines, and Thailand are in the group of NICs. After the 1990s, many newly emerging markets face the challenges of

[8] Taking into the consideration of different macroeconomics shocks, financial bubbles and crisis, and capital controls, the total sample period is divided into three sub-periods: 1980-1990, 1991-2000, and 2001-2013.

[9] See Maddala and Wu (1999) and Pesaran (2007).

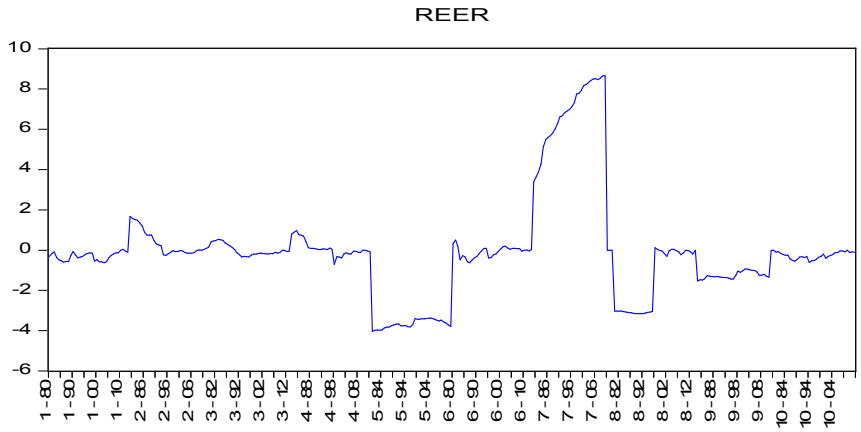
[10] Note that during the different sub-periods from 1980 to 2013, out of four-unit root tests, majority of the tests are in favour of the rejection of the null hypothesis of unit root presence. This infers that real exchange rates are stationary during these sub-periods, which certainly indicate the validity of PPP.

the balance of payment crisis, financial crisis, and debt crisis. For instance, India has faced serious trade and balance of payment crisis during the period of 1980 and 1990s. Similarly, Latin American countries like Mexico has faced serious debt and financial crisis during the period of 1980 and 1990s. Furthermore, on the onset of the East Asian financial crisis in 1998, the impact might have centered in the East Asia, but it contagion spreads over to other European and Asian emerging economies.

The impacts of this shock that have hit the economy in the past during the period of the 1990s, but it impacts prolonged to the period of 2000s. In addition to that the substantial effect of the global financial crisis emerging from the subprime mortgage market in the United States, has blown into the international banking crisis, which spreads over to the entire world and emerging markets. Furthermore, during the period of the 1990s and 2000s, most of the emerging economies face the challenges to maintain their current account sustainability. According to Kim et al. (2009), current account sustainability refers to whether an economy is capable of meetings its intertemporal budget constraint in the long-run. In addition, during the second and third sub-periods, these industrialized countries have pass through the phase of current account deficits and huge cross-border capital mobility due to saving-investment disturbance. Therefore, recognizing these facts, it is hard to sustain the long-run PPP during the second and third sub-periods of the NICs.

Consider now the speed at which the real exchange rate reverts to its parity following a one-time shock. The half-life measurement contains the long-run information of adjustment to the equilibrium, i.e. it measures the deviation of a variable from its equilibrium path. Moreover, in this empirical exercise, we want to measure the speed of adjustment at which the real exchange rates revert to its long-run equilibrium path following a one-time shock. Table 4 reports the half-life adjustment to long-run equilibrium in the real exchange rate using the panel of ten NICs. Following Holmes (2001, 2002), and Wu (1996) the measurement of the half-life is based on the t-bar test calculated as $ln(0.5)/ln[average(\beta_i)]$, where β_i is the average values of β for all the countries across the individual groupings (Lau and Baharumshah, 2006). With monthly data, the estimated values of ρ are 0.991, 0.986, and 0.995, respectively over the different sub-periods from 1980 to 2013. Similarly, the estimated values of ρ are varied with quarterly and annual data.[11] The calculated value of half-life measures is varied over the different sub-periods in different-level sampled data. With monthly data, the calculated value of half-life during the period 2001-2013 is less than the other two sub-periods.

[11] The ρ values are estimated by simply regressing the real exchange rates following an AR (1) process.



Note: REER represents the real exchange rates of the NICs.

Figure 1. Trends of CPI Real Exchange Rates of Ten NICs

Table 1. Panel Unit Root Tests for Real Exchange Rates (Variable in levels)

	Sub -periods	Without trend				With trend			
		LLC	IPS	ADF-Fisher Chi-square	PP-Fisher Chi-square	LLC	IPS	ADF-Fisher Chi-square	PP-Fisher Chi-square
Monthly	1980-1990	0.223	-1.366	40.284	55.152	-0.328	-1.386	32.774	42.911
		(0.588)	(0.085)	(0.001)	(0.000)	(0.371)	(0.082)	(0.017)	(0.000)
	1991-2000	-1.051	-3.152	46.198	46.105	-0.516	-2.045	37.305	35.775
		(0.146)	(0.000)	(0.000)	(0.000)	(0.302)	(0.020)	(0.004)	(0.007)
	2001-2013	-0.895	-3.991	62.026	58.166	0.170	-3.093	42.485	45.214
		(0.185)	(0.000)	(0.000)	(0.000)	(0.567)	(0.001)	(0.000)	(0.000)
	1980-2013	-4.983	-7.921	148.646	157.399	-2.459	-5.660	117.717	125.585
		(0.000)	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	(0.000)
Quarterly	1980-1990	-0.511	-0.131	18.235	23.726	0.205	-0.289	15.902	16.491
		(0.304)	(0.447)	(0.440)	(0.164)	(0.581)	(0.386)	(0.599)	(0.558)
	1991-2000	0.137	-0.571	15.780	16.335	0.378	-0.810	21.138	10.748
		(0.554)	(0.284)	(0.607)	(0.569)	(0.647)	(0.209)	(0.272)	(0.904)
	2001-2013	0.032	-1.132	24.731	20.997	1.081	-0.874	19.129	18.881
		(0.513)	(0.128)	(0.132)	(0.279)	(0.860)	(0.190)	(0.383)	(0.399)
	1980-2013	-5.947	-4.954	78.130	73.435	-1.298	-1.564	40.192	43.243
		(0.000)	(0.000)	(0.000)	(0.000)	(0.097)	(0.058)	(0.002)	(0.000)
Annual	1980-1990	-3.720	-0.437	30.828	29.310	-9.049	-1.494	35.314	26.048
		(0.000)	(0.331)	(0.057)	(0.081)	(0.000)	(0.067)	(0.018)	(0.164)
	1991-2000	0.554	1.215	12.107	12.799	-3.949	0.813	10.148	18.955
		(0.710)	(0.887)	(0.912)	(0.885)	(0.000)	(0.792)	(0.965)	(0.524)
	2001-2013	-1.459	-0.240	27.766	23.941	-3.225	-0.075	24.549	22.572
		(0.072)	(0.404)	(0.115)	(0.245)	(0.000)	(0.469)	(0.219)	(0.310)
	1980-2013	-3.666	-4.098	56.895	50.741	-1.570	-1.603	46.117	32.951
		(0.000)	(0.000)	(0.000)	(0.000)	(0.058)	(0.054)	(0.000)	(0.034)

Notes: Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. Automatic selection of maximum lags is based on SIC: 0 to 5. Newey-West automatic bandwidth selection and Bartlett Kernel are followed.

Table 2. Panel Unit Root Tests for Real Exchange Rates (Variable in First Difference)

	Sub -periods	Without trend				With trend			
		LLC	IPS	ADF-Fisher Chi-square	PP-Fisher Chi-square	LLC	IPS	ADF-Fisher Chi-square	PP-Fisher Chi-square
Monthly	1980-1990	-0.215 (0.414)	-12.525 (0.000)	194.116 (0.000)	569.028 (0.000)	1.630 (0.948)	-11.842 (0.000)	164.663 (0.000)	521.628 (0.000)
	1991-2000	1.197 (0.884)	-10.280 (0.000)	145.196 (0.000)	518.564 (0.000)	2.908 (0.998)	-9.351 (0.000)	116.859 (0.000)	475.912 (0.000)
	2001-2013	-1.987 (0.023)	-13.717 (0.000)	221.133 (0.000)	615.700 (0.000)	-1.014 (0.155)	-13.294 (0.000)	192.351 (0.000)	576.136 (0.000)
	1980-2013	-19.285 (0.000)	24.621 (0.000)	554.926 (0.000)	1262.40 (0.000)	-27.307 (0.000)	-25.369 (0.000)	540.994 (0.000)	1471.35 (0.000)
Quarterly	1980-1990	0.525 (0.700)	-3.365 (0.000)	39.533 (0.002)	173.148 (0.000)	1.562 (0.941)	-2.230 (0.012)	27.166 (0.075)	168.283 (0.000)
	1991-2000	0.940 (0.826)	-3.799 (0.000)	42.981 (0.000)	195.140 (0.000)	2.993 (0.998)	-2.342 (0.009)	27.922 (0.063)	173.707 (0.000)
	2001-2013	3.563 (0.999)	-4.923 (0.000)	57.617 (0.000)	248.532 (0.000)	5.952 (1.000)	-3.756 (0.000)	42.548 (0.000)	242.200 (0.000)
	1980-2013	-30.627 (0.000)	-30.727 (0.000)	582.299 (0.000)	591.499 (0.000)	-34.924 (0.000)	-32.239 (0.000)	551.357 (0.000)	558.981 (0.000)
Annual	1980-1990	-12.725 (0.000)	-4.566 (0.000)	55.302 (0.000)	52.589 (0.000)	-6.677 (0.000)	-1.281 (0.100)	35.707 (0.016)	56.279 (0.000)
	1991-2000	-7.212 (0.000)	-2.582 (0.004)	40.617 (0.004)	47.541 (0.000)	-6.865 (0.000)	-0.627 (0.265)	30.635 (0.060)	53.619 (0.000)
	2001-2013	-6.700 (0.000)	-4.334 (0.000)	57.417 (0.000)	66.369 (0.000)	-6.656 (0.000)	-2.644 (0.004)	47.770 (0.000)	80.812 (0.000)
	1980-2013	-10.587 (0.000)	-11.258 (0.000)	151.80 (0.000)	158.005 (0.000)	-9.180 (0.000)	-8.995 (0.000)	140.970 (0.000)	151.743 (0.000)

Note: Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. Automatic selection of maximum lags is based on SIC: 0 to 5. Newey-West automatic bandwidth selection and Bartlett Kernel are followed.

Table 3. Pesaran (2007) Panel Unit Root Test for Real Exchange Rates

	Sub -periods	Lags	Variable	Without Trend			With Trend		
				[t-bar]	Z [t-bar]	P-value	[t-bar]	Z [t-bar]	P-value
Monthly	1980-1990	0	REER	-2.246	-1.519	0.064	-2.318	0.150	0.560
		1	REER	-2.300	-1.699	0.045	-2.369	-0.034	0.486
		0	ΔREER	-6.190	-14.667	0.000	-6.420	-14.675	0.000
		1	ΔREER	-6.144	-14.515	0.000	-6.391	-14.570	0.000
	1991-2000	0	REER	-2.159	-1.228	0.110	-2.334	0.093	0.537
		1	REER	-2.289	-1.664	0.048	-2.458	-0.354	0.362
		0	ΔREER	-6.190	-14.667	0.000	-6.420	-14.675	0.000
		1	ΔREER	-6.190	-14.667	0.000	-6.393	-14.579	0.000
	2001-2013	0	REER	-2.006	-0.721	0.236	-2.616	-0.926	0.177
		1	REER	-2.232	-1.475	0.070	-2.945	-2.114	0.017
		0	ΔREER	-6.190	-14.667	0.000	-6.420	-14.675	0.000
		1	ΔREER	-6.190	-14.667	0.000	-6.420	-14.675	0.000
	1980-2013	0	REER	-3.455	-5.548	0.000	-3.316	-3.456	0.000
		1	REER	-3.627	-6.123	0.000	-3.605	-4.502	0.000
		0	ΔREER	-6.190	-14.667	0.000	-6.420	-14.675	0.000
		1	ΔREER	-6.190	-14.667	0.000	-6.420	-14.675	0.000
Quarterly	1980-1990	0	REER	-1.700	0.256	0.601	-1.946	1.344	0.911
		1	REER	-1.627	0.489	0.688	-1.800	1.840	0.967
		0	ΔREER	-5.015	-10.325	0.000	-5.166	-9.633	0.000
		1	ΔREER	-4.082	-7.347	0.000	-4.281	-6.616	0.000
	1991-2000	0	REER	-1.626	0.491	0.688	-1.984	1.212	0.887
		1	REER	-1.718	0.197	0.578	-2.122	0.742	0.771
		0	ΔREER	-5.358	-11.420	0.000	-5.431	-10.536	0.000
		1	ΔREER	-4.174	-7.641	0.000	-4.229	-6.439	0.000
	2001-2013	0	REER	-1.781	-0.002	0.499	-2.476	-0.438	0.331
		1	REER	-2.095	-1.026	0.152	-2.694	-1.198	0.115
		0	ΔREER	-5.855	-13.288	0.000	-6.021	-12.805	0.000
		1	ΔREER	-5.089	-10.791	0.000	-5.092	-9.567	0.000
	1980-2013	0	REER	-3.019	-4.097	0.000	-2.941	-2.099	0.018
		1	REER	-2.452	-2.208	0.014	-2.735	-1.357	0.087
		0	ΔREER	-6.190	-14.667	0.000	-6.420	-14.675	0.000
		1	ΔREER	-6.156	-14.553	0.000	-6.420	-14.675	0.000

Note: We report the [t-bar] and Z [t-bar] statistics in the Table. The null of all cross-sectional (country) series contain a non-stationary process and this statistic has a non-standard distribution. 1. In monthly data, and over the different sub-periods, and in 1980-2013 sample, the critical values without trends are -2.210 for 10%, -2.320 for 5%, and -2.530 for 1%, and including trends are -2.730 for 10%, -2.830 for 5%, and -3.030 for 1% significance level, respectively. 2. For quarterly data, and in 1980-1990 and 1991-2000 samples, the critical values without trends are -2.210 for 10%, -2.330 for 5%, and -2.550 for 1%, and including trends are -2.730 for 10%, -2.840 for 5%, and -3.060 for 1% significance level, respectively. 3. In 2001-2013 samples, the critical values without trends are 2.210 for 10%, -2.330 for 5%, and -2.540 for 1%, and including trends are -2.720 for 10%, -2.830 for 5%, and -3.040 for 1% significance level, respectively.

Table 3. Pesaran (2007) Panel Unit Root Test for Real Exchange Rates (Cont')

	Sub -periods	Lags	Variable	Without Trend			With Trend		
				[t-bar]	Z [t-bar]	P-value	[t-bar]	Z [t-bar]	P-value
Annual	1980-1990	0	REER	-2.316	-1.758	0.039	-2.649	-1.136	0.128
		1	REER	-2.157	-1.296	0.097	-2.683	-1.232	0.109
		0	ΔREER	-2.834	-2.679	0.004	-2.786	-1.100	0.136
		1	ΔREER	-2.422	-1.716	0.043	-4.159	-3.866	0.000
	1991-2000	0	REER	-1.680	0.023	0.509	-1.956	0.573	0.717
		1	REER	-1.306	0.900	0.816	-2.173	0.134	0.553
		0	ΔREER	-2.173	-1.131	0.129	-2.059	0.365	0.642
		1	ΔREER	-2.015	-0.762	0.223	1.700	7.936	1.000
	2001-2013	0	REER	-1.078	1.833	0.967	-2.923	-1.916	0.028
		1	REER	-1.121	1.708	0.956	-2.991	-2.112	0.017
		0	ΔREER	-3.145	-4.162	0.000	-3.031	-2.225	0.013
		1	ΔREER	-2.631	-2.673	0.004	-2.540	-0.825	0.205
	1980-2013	0	REER	-2.054	-0.921	0.179	-2.041	1.075	0.859
		1	REER	-2.386	-2.038	0.021	-2.206	0.483	0.686
		0	ΔREER	-4.643	-9.631	0.000	-5.061	-9.780	0.000
		1	ΔREER	-0.562	-5.994	0.000	-4.356	-7.246	0.000

Notes: 4. In annual data for 1980-1990 and 2001-2013 samples, the critical values without trends are -2.220 for 10%, -2.370 for 5%, and -2.660 for 1%, including trends are -2.760 for 10%, -2.920 for 5%, and -3.210 for 1% significance level, respectively. The critical values in first difference without trends are -2.280 for 10%, -2.470 for 5%, and -2.850 for 1% significance level, respectively. 5. For 1980-1990, and 1991-2000 samples, critical values in first difference including trends are -2.870 for 10%, -3.100 for 5%, and -3.510 for 1%, and critical values without trends in level and first differences are -2.820 for 10%, -2.470 for 5%, and -2.850 for 1% significance level, respectively. 6. In 1980-2013 samples, critical values in level and first difference including trends are -2.730 for 10%, -2.840 for 5%, and -3.060 for 1% significance level, respectively.

Table 4. Speed of Adjustment Using the Panel Approach

Level of aggregation	Sub-periods	$\hat{\rho}$	t-statistics ($\hat{\rho}$)	Average beta (β_i)	Half-life years
Monthly	1980-1990	0.991*	3.962	0.853	4.383
	1991-2000	0.986*	6.756	0.868	4.915
	20001-2013	0.995*	6.886	0.758	2.502
Quarterly	1980-1990	0.974*	5.846	0.886	5.761
	1991-2000	0.970*	6.603	0.932	9.926
	20001-2013	0.993*	12.698	0.910	7.397
Annual	1980-1990	1.231*	8.156	0.949	13.325
	1991-2000	1.166*	9.537	0.968	21.745
	20001-2013	0.895*	5.069	0.959	16.904

Note: Estimates of β_i are derived from a demeaned regression of $\Delta q_{i,t} = \alpha + \delta q_{i,t-1} + \sum_{j=1}^{p} c_{ij} \Delta q_{i,t-j} + \varepsilon_{i,t}$ where $\delta = (\beta_i - 1)$. The calculation of half-life is taken as the $ln(0.50)\,/ln[average(\beta_i)]$. The speed of adjustment measured by 16.904 annual in 2001-2013 sub-period is equal to 1.408 years.

This suggests that the speed of adjustment towards the equilibrium is at a faster pace for the third sub-periods. In addition, the results reveal that the adjustment is at low pace during the first and second sub-periods, reflecting the negative spillover effect of the East Asian crisis in 1998. Similarly, with quarterly and annual data, the calculated values of half-life are found to be high during the second sub-periods in comparison to the other two sub-periods, suggesting that the adjustment towards the long-run equilibrium is at lower pace during the period 1991-2000. This finding indicates the negative impact of the country-specific financial crisis, the balance of payment of crisis,[12] and the East Asian crisis in 1997-98, as a consequence the adjustment speed reverts to its parity is at a low rate during the period 1991-2000.

In assessing the evidence of PPP, many authors have suggested testing the panel unit roots tests of the real exchange rates. Alternatively, cointegration between the exchange rates and price ratios of domestic to foreign price level is a necessary condition for PPP, and the evidence of PPP could be found by testing the null hypothesis of no cointegration between these variables. Pedroni (2001) suggests that cointegration is necessary for PPP, but not sufficient condition. In addition, PPP requires the symmetry between domestic and foreign prices and the proportionality between relative prices and exchange rates. The results in favor of weak PPP do not contradict the stronger version of PPP. Furthermore, testing the unit root null for the real exchange rate in panel settings, and the way the null hypothesis is constructed for the panel, and the rejection of the unit root null simply suggests that the data from at least some countries are consistent with PPP. However, it does not simply suggest that the data from all countries of the sample are consistent with PPP, which would seem to be the more natural way to pose a question (Pedroni, 2001). So, the issue of empirical interest is to check the cointegration between nominal exchange rate and price ratios, and further testing the condition on the cointegration vectors are required for strong PPP to hold.

As discussed before, to handle the problem of cross-sectional dependence between the variables of interest in the NICs, it is instructive to apply the second-generation panel unit root proposed by Pesaran (2007).[13] The Tables 5, 6, and 7 reports the Pesaran (2007) panel unit roots test results of nominal bilateral US dollar exchange rate and price ratios of ten NICs. We do the robustness check at monthly, quarterly, and annual data over the

[12] During the 1980s, and 1990s, for instance the Indian economy had faced the problem of balance of payment crisis, due to growing fiscal imbalances in the 1980s. Similarly, the Latin American economies, such as Mexico suffered the problem of debt crisis during the period of 1980s. Moreover, the growing fiscal imbalances of the NICs during the 1990s, facilitate to low speed of adjustment in real exchange rates from its equilibrium path.

[13] Furthermore, in order to get the more robust empirical findings, the study has used the Pesaran unit root test and the results are reported in Table 5. We also do several first generation panel unit root tests along with the Pesaran test, however, the results of the first-generation unit root tests are not reported here. In addition, the most important consequence is that the first-generation panel unit root test results are more or less support the Pesaran test. The results are available from the author upon request.

different sub-periods from 1980 to 2013 by examining the unit roots of the underlying variables. Furthermore, the long-run PPP are tested by examining the cointegration between exchange rates and price ratios of the NICs over the different sub-periods from 1980 to 2013.

Table 5 reports the Pesaran unit roots test results using monthly data of the NICs, and the findings indicate the weak evidence against the unit root hypothesis over the different sub-periods from 1980 to 2013. Similarly, with quarterly and annual data, the results suggest the weak evidence against the presence of unit root. This suggests that the underlying variables are non-stationary at the level and cointegrated to order one. When the variables are cointegrated to order one, then the next issue of interest in empirical research is to search for a long-run relationship between them. Furthermore, to handle the problem of cross-sectional dependence, we use the panel cointegration test proposed by Westerlund (2007). The error-correction based test proposed by Westerlund (2007) provides the efficient estimation in case of cross-sectional dependence and simultaneously it takes into account of the various forms of heterogeneity in the panel.[14] Furthermore, since heterogeneity and cross-sectional dependence are so large in the case of the NICs, it is more instructive to apply the panel cointegration test proposed by Westerlund (2007), and to find out the more robustness in the empirical results, we also apply the Pedroni (2001, 2004) residual-based cointegration test.

Pedroni (2001, 2004) cointegration results are reported in Table 8. With monthly data, and during the first sub-periods 1980-19990, 6 out of 7 reported statistics are in favor of the cointegration. This suggests the presence of cointegration between the nominal exchange rates and price ratios of the NICs during the period 1980-1990, and indicative of PPP holding. However, during the other sub-periods, we do not find any strong evidence of cointegration between the underlying variables, and indicative of a failure of long-run PPP. Similarly, with quarterly data, we find the evidence of cointegration between the underlying variables during the period 1980-1990.[15] Furthermore, we do not find any presence of cointegration during the other sub-periods. With annual data and including time trend, we find the strong evidence of cointegration during the sub-periods 1980-1990, and 2001-2013. This indicates the evidence of PPP, during these two sub-periods in annual data. In addition, especially during the second and third sub-periods with monthly, quarterly, and annual data, the results suggest the weak evidence of cointegration. So, the mere evidence of cointegration does not reflect the strong supposition to the long-run relationship between the exchange rates and price ratios of the NICs, and certainly not supporting the strong holding of PPP during the

[14] The Westerlund (2007) test which accounts for cross-sectional dependence and various forms of heterogeneity in the panel is sensible to apply when the Pedroni test points towards the presentation of cointegration (Banerjee and Carrion-i-Silvestre, 2006).

[15] Pedroni (2001, 2004) proposes seven statistics to check the intensity of cointegration. Furthermore, out of seven statistics, if four statistics are in favour of the cointegration, then we infer high intensity of cointegration between the variables.

different sub-periods.

Table 5. Pesaran (2007) Panel Unit Root Test for NEER (based on CPI) and Price Ratios of NICs

	Sub -periods	Lags	Variable	Without Trend			With Trend		
				[t-bar]	Z [t-bar]	P-value	[t-bar]	Z [t-bar]	P-value
Monthly	1980-1990	0	s	0.744	0.655	-1.593	-1.512	3.063	0.999
		1	s	-1.654	0.455	0.675	-1.695	2.405	0.992
		0	pr	-1.580	0.699	0.758	-3.194	-3.014	0.001
		1	pr	-1.434	1.185	0.882	-2.958	-2.160	0.015
		0	Δs	-5.212	-11.407	0.000	-5.518	-11.414	0.000
		1	Δs	-5.212	-11.407	0.000	-5.518	-11.414	0.000
		0	Δpr	-5.702	-13.040	0.000	-5.915	-12.850	0.000
		1	Δpr	-5.616	-12.755	0.000	-5.830	-12.542	0.000
	1991-2000	0	s	-1.869	-0.263	0.396	-1.732	2.269	0.988
		1	s	-2.128	-1.128	0.130	-2.196	0.591	0.723
		0	pr	-1.520	0.900	0.816	-1.369	3.581	1.000
		1	pr	-1.838	-0.161	0.436	-2.063	1.073	0.858
		0	Δs	-6.190	-14.667	0.000	-6.420	-14.675	0.000
		1	Δs	-6.147	-14.524	0.000	-6.325	-14.331	0.000
		0	Δpr	-5.149	-11.198	0.000	-5.460	-11.205	0.000
		1	Δpr	-4.933	-10.478	0.000	-5.267	-10.506	0.000
	2001-2013	0	s	-0.167	5.409	1.000	-0.705	5.980	1.000
		1	s	-0.373	4.722	1.000	-0.996	4.928	1.000
		0	pr	-2.733	-3.144	0.001	-3.251	-3.221	0.001
		1	pr	-2.412	-2.073	0.019	-2.927	-2.049	0.020
		0	Δs	-6.190	-14.667	0.000	-6.420	-14.675	0.000
		1	Δs	-4.415	-8.751	0.000	-4.545	-7.896	0.000
		0	Δpr	-6.116	-14.421	0.000	-6.409	-14.636	0.000
		1	Δpr	-6.068	-14.258	0.000	-6.328	-14.341	0.000
	1980-2013	0	s	-1.911	-0.402	0.344	-1.953	1.472	0.930
		1	s	-2.323	-1.776	0.038	-2.265	0.343	0.634
		0	pr	-0.698	3.641	1.000	-0.810	5.602	1.000
		1	pr	-1.096	2.315	0.990	-0.928	5.176	1.000
		0	Δs	-6.190	-14.667	0.000	-6.420	-14.675	0.000
		1	Δs	-6.098	-14.361	0.000	-6.302	-14.248	0.000
		0	Δpr	-6.013	-14.077	0.000	-6.331	-14.354	0.000
		1	Δpr	-5.887	-13.658	0.000	-6.227	-13.977	0.000

Notes: We report the [t-bar] and Z[t-bar] statistics in the Table. Under the null of all cross-sectional (country) series containing a non-stationary process and this statistic has a non-standard distribution. In monthly sampled-data and over the different sub-periods, and during the entire period under study, i.e. 1980-2013 samples, the critical values without trends are -2.210 for 10%, -2.320 for 5%, and -2.530 for 1%, and including trends are -2.730 for 10%, -2.830 for 5%, and -3.030 for 1% significance level, respectively.

Table 6. Pesaran (2007) Panel Unit Root Test for NEER (based on CPI) and Price Ratios of NICs

	Sub -periods	Lags	Variable	Without Trend			With Trend		
				[t-bar]	Z [t-bar]	P-value	[t-bar]	Z [t-bar]	P-value
Quarterly	1980-1990	0	s	-0.934	2.700	0.997	-1.139	4.095	1.000
		1	s	-0.820	3.062	0.999	-1.341	3.405	1.000
		0	pr	-0.859	2.941	0.998	-2.472	-0.449	0.327
		1	pr	-1.383	1.267	0.897	-2.662	-1.098	0.136
		0	Δs	-3.754	-6.299	0.000	-4.002	-5.666	0.000
		1	Δs	-3.032	-3.996	0.000	-3.276	-3.191	0.001
		0	Δpr	-5.084	-10.546	0.000	-5.183	-9.692	0.000
		1	Δpr	-4.140	-7.532	0.000	-4.588	-7.662	0.000
	1991-2000	0	s	-1.930	-0.479	0.316	-2.031	1.054	0.854
		1	s	-2.244	-1.482	0.069	-2.373	-0.113	0.455
		0	pr	-2.321	-1.727	0.042	-1.570	2.623	0.996
		1	pr	-2.554	-2.471	0.007	-2.256	0.287	0.613
		0	Δs	-5.049	-10.432	0.000	-5.175	-9.664	0.000
		1	Δs	-4.031	-7.184	0.000	-4.228	-6.436	0.000
		0	Δpr	-4.246	-7.871	0.000	-4.386	-6.974	0.000
		1	Δpr	-3.754	-6.299	0.000	-3.901	-5.321	0.000
	2001-2013	0	s	-0.420	4.434	1.000	-1.138	4.227	1.000
		1	s	-1.524	0.833	0.798	-2.438	-0.309	0.379
		0	pr	-2.499	-2.345	0.010	-2.788	-1.527	0.063
		1	pr	-2.493	-2.325	0.010	-2.761	-1.433	0.076
		0	Δs	-3.983	-7.185	0.000	-4.060	-5.964	0.000
		1	Δs	-4.152	-7.734	0.000	-4.248	-6.622	0.000
		0	Δpr	-5.458	-11.993	0.000	-5.727	-11.779	0.000
		1	Δpr	-4.532	-8.975	0.000	-4.864	-8.771	0.000
	1980-2013	0	s	-2.411	-2.071	0.019	-2.217	0.517	0.697
		1	s	-2.902	-3.708	0.000	-2.747	-1.399	0.081
		0	pr	-1.770	0.067	0.527	-1.426	3.377	1.000
		1	pr	-2.283	-1.642	0.050	-2.418	-0.210	0.417
		0	Δs	-5.728	-13.127	0.000	-5.930	-12.904	0.000
		1	Δs	-5.146	-11.187	0.000	-5.289	-10.586	0.000
		0	Δpr	-5.654	-12.878	0.000	-5.953	-12.985	0.000
		1	Δpr	-4.994	-10.680	0.000	-5.261	-10.487	0.000

Notes: We report the [t-bar] and Z [t-bar] statistics in the Table. Under the null of all cross-sectional (country) series containing a non-stationary process and this statistic has a non-standard distribution. 1. In 1980-2013, 1980-1990, and 1991-2000 samples, for level and first difference without trends, the critical values are, -2.210 for 10%, -2.320 for 5%, and -2.530 for 1%, and including trends are, -2.730 for 10%, -2.830 for 5%, and -3.030 for 1% significance level, respectively. 2. For 1980-1990 and 1991-2000 samples, critical values including trends, are, -2.730 for 10%, -2.840 for 5%, and -3.060 for 1% significance level, respectively. 3. For 2001-2013 samples, the critical values in level and first difference without trends are, -2.210 for 10%, -2.330 for 5%, and -2.540 for 1%, and including trends are, -2.720 for 10%, -2.830 for 5%, and -3.040 for 1% significance level, respectively

Table 7. Pesaran (2007) Panel Unit Root Test for NEER (based on CPI) and Price Ratios of NICs

	Sub -periods	Lags	Variable	Without Trend			With Trend		
				[t-bar]	Z [t-bar]	P-value	[t-bar]	Z [t-bar]	P-value
Annual	1980-1990	0	s	-1.289	1.221	0.889	-2.298	-0.137	0.445
		1	s	-0.638	3.110	0.999	-2.349	-0.283	0.389
		0	pr	-0.147	4.535	1.000	-1.912	0.963	0.832
		1	pr	-0.395	3.814	1.000	-1.820	1.224	0.890
		0	Δs	-2.207	-1.210	0.113	-2.839	-1.207	0.114
		1	Δs	-2.057	-0.859	0.195	-2.404	-0.330	0.371
		0	Δpr	-2.314	-1.461	0.072	-2.611	-0.748	0.227
		1	Δpr	-1.885	-0.456	0.324	-2.800	-1.128	0.130
	1991-2000	0	s	-1.442	0.582	0.720	-1.244	2.005	0.978
		1	s	-2.020	-0.773	0.220	-1.511	1.469	0.929
		0	pr	-1.969	-0.653	0.257	-1.393	1.705	0.956
		1	pr	-1.945	-0.598	0.275	-2.066	0.351	0.637
		0	Δs	-1.866	-0.412	0.340	-2.952	-1.435	0.076
		1	Δs	-1.112	1.354	0.912	1.700	7.936	1.000
		0	Δpr	-1.486	0.479	0.684	-1.336	1.821	0.966
		1	Δpr	-1.995	-0.716	0.237	1.700	7.936	1.000
	2001-2013	0	s	-1.058	1.893	0.971	-2.092	0.450	0.674
		1	s	-1.538	0.499	0.691	-1.845	1.153	0.876
		0	pr	-2.136	-1.235	0.108	-2.605	-1.011	0.156
		1	pr	-1.198	1.484	0.931	-1.519	2.082	0.981
		0	Δs	-2.895	-3.438	0.000	-2.765	-1.467	0.071
		1	Δs	-1.778	-0.197	0.422	-1.735	1.468	0.929
		0	Δpr	-3.002	-3.747	0.000	-2.882	-1.799	0.036
		1	Δpr	-1.683	0.079	0.532	-1.754	1.414	0.921
	1980-2013	0	s	-2.305	-1.764	0.039	-2.602	-0.941	0.173
		1	s	-1.914	-0.450	0.326	-1.980	1.292	0.902
		0	pr	-1.031	2.520	0.994	-1.400	3.377	1.000
		1	pr	-1.203	1.941	0.974	-1.790	1.978	0.976
		0	Δs	-4.402	-8.820	0.000	-4.490	-7.728	0.000
		1	Δs	-3.454	-5.632	0.000	-3.737	-5.022	0.000
		0	Δpr	-3.437	-5.574	0.000	-3.963	-5.833	0.000
		1	Δpr	-2.289	-1.713	0.043	-2.664	-1.164	0.122

Notes: We report the [t-bar] and Z [t-bar] statistics in the Table. Under the null of all cross-sectional (country) series containing a non-stationary process and this statistic has a non-standard distribution. 1. For different sub-periods, the critical values without trends are -2.220 for 10%, -2.370 for 5%, and -2.660 for 1%, and including trends are -2.760 for 10%, -2.920 for 5%, and -3.210 for 1% significance level, respectively. The critical values in first difference without trends are -2.280 for 10%, -2.470 for 5%, and -2.850 for 1%, and including trends are -2.870 for 10%, -3.100 for 5%, and -3.510 for 1% significance level, respectively. 2. For 1980-2013 samples, the critical values, for level and first difference, without trends are -2.210 for 10%, -2.330 for 5%, and -2.550 for 1%, and including trends are, -2.730 for 10%, -2.840 for 5%, and -3.060 for 1% significance level, respectively.

Table 8. Pedroni Cointegration Test

			Within dimension				Between dimension		
			Panel v-Statistic	Panel rho-Statistic	Panel PP-Statistic	Panel ADF-Statistic	Group rho-Statistic	Group PP-Statistic	Group ADF-Statistic
Monthly	1980-1990	Without trend	-49.819 (1.000)	-7.971 (0.000)	-6.084 (0.000)	-4.308 (0.000)	-5.436 (0.000)	-3.617 (0.000)	-1.779 (0.037)
		With trend	-45.982 (1.000)	-1.901 (0.028)	-2.857 (0.002)	-2.544 (0.005)	-1.776 (0.037)	-2.117 (0.017)	-2.137 (0.016)
	1991-2000	Without trend	1.653 (0.049)	-0.025 (0.489)	0.437 (0.669)	-0.111 (0.455)	-1.143 (0.126)	-1.048 (0.147)	-1.301 (0.096)
		With trend	1.646 (0.049)	-1.293 (0.098)	-1.202 (0.114)	-2.240 (0.012)	-0.237 (0.406)	-1.324 (0.092)	-2.042 (0.020)
	2001-2013	Without trend	17.025 (0.000)	-1.282 (0.099)	1.812 (0.965)	1.567 (0.941)	-0.571 (0.283)	0.849 (0.802)	-0.167 (0.433)
		With trend	14.272 (0.000)	-0.218 (0.413)	3.462 (0.999)	2.962 (0.998)	1.380 (0.916)	3.103 (0.999)	1.196 (0.884)
	1980-2013	Without trend	15.866 (0.000)	-2.657 (0.003)	0.554 (0.710)	0.471 (0.681)	-1.352 (0.088)	-2.408 (0.008)	-1.799 (0.036)
		With trend	14.104 (0.000)	-1.370 (0.085)	2.389 (0.991)	2.259 (0.988)	0.7314 (0.767)	1.805 (0.964)	1.350 (0.911)
Quarterly	1980-1990	Without trend	-15.569 (1.000)	-1.569 (0.058)	-4.235 (0.000)	-5.909 (0.000)	-0.209 (0.417)	-1.445 (0.074)	-2.206 (0.013)
		With trend	-19.422 (1.000)	-0.154 (0.438)	-2.283 (0.011)	-4.059 (0.000)	0.707 (0.760)	-0.950 (0.170)	-2.997 (0.001)
	1991-2000	Without trend	-0.230 (0.591)	0.616 (0.731)	0.394 (0.653)	0.123 (0.549)	1.177 (0.880)	0.485 (0.686)	-0.142 (0.443)
		With trend	-0.943 (0.827)	2.185 (0.985)	2.574 (0.995)	2.423 (0.992)	0.942 (0.826)	-0.362 (0.358)	-1.049 (0.146)
	2001-2013	Without trend	69.294 (0.000)	-6.464 (0.000)	1.140 (0.872)	1.588 (0.943)	-3.594 (0.000)	-0.931 (0.175)	-0.984 (0.162)
		With trend	49.724 (0.000)	-4.671 (0.000)	2.653 (0.996)	1.237 (0.892)	-1.281 (0.100)	0.856 (0.804)	-0.891 (0.186)
	1980-2013	Without trend	22.341 (0.000)	-3.595 (0.000)	0.476 (0.683)	0.037 (0.514)	-0.655 (0.256)	-1.957 (0.025)	-2.448 (0.007)
		With trend	19.805 (0.000)	-0.864 (0.193)	3.391 (0.999)	2.841 (0.997)	0.982 (0.837)	0.457 (0.676)	-0.426 (0.334)
Annual	1980-1990	Without trend	-6.281 (1.000)	-2.981 (0.001)	-10.048 (0.000)	1.907 (0.971)	0.434 (0.667)	-4.153 (0.000)	-0.418 (0.337)
		With trend	-8.903 (1.000)	-1.530 (0.062)	-8.175 (0.000)	-2.300 (0.010)	2.007 (0.977)	-3.199 (0.000)	-7.991 (0.000)
	1991-2000	Without trend	0.574 (0.282)	0.334 (0.631	-0.653 (0.256)	-2.905 (0.001)	1.547 (0.939)	-1.416 (0.078)	-0.908 (0.181)
		With trend	0.427 (0.334)	2.253 (0.987)	1.167 (0.878)	0.976 (0.835)	2.988 (0.998)	-2.382 (0.008)	0.110 (0.543)
	2001-2013	Without trend	14.877 (0.000)	-3.782 (0.000)	-1.423 (0.077)	-0.764 (0.222)	0.786 (0.784)	-1.164 (0.122)	-2.198 (0.013)
		With trend	7.144 (0.000)	-2.196 (0.014)	-3.511 (0.000)	-2.504 (0.006)	2.216 (0.986)	-1.486 (0.068)	-3.289 (0.000)
	1980-2013	Without trend	14.470 (0.000)	-2.661 (0.003)	0.263 (0.603)	2.427 (0.992)	-1.548 (0.060)	-3.583 (0.000)	1.420 (0.922)
		With trend	10.644 (0.000)	-0.908 (0.181)	1.970 (0.975)	4.190 (1.000)	-0.280 (0.389)	-1.604 (0.054)	2.945 (0.998)

Note: Automatic selection of lag length is based on SIC: 0 to 13. The Newey-West automatic bandwidth selection and Bartlett kernel are followed.

Table 9. Westerlund Cointegration Test

			G_τ	G_α	P_τ	P_α
Monthly	1980-1990	Without trend	-1.725	-8.439	-6.158	-9.686
			(0.570)	(0.237)	(0.034)	(0.000)
		With trend	-2.550	-13.272	-6.054	-10.121
			(0.249)	(0.289)	(0.627)	(0.280)
	1991-2000	Without trend	-1.890	-8.205	-3.259	-4.015
			(0.354)	(0.279)	(0.862)	(0.558)
		With trend	-2.537	-11.144	-8.852	-13.340
			(0.265)	(0.649)	(0.002)	(0.016)
	2001-2013	Without trend	-1.331	-50.614	-3.261	-12.812
			(0.932)	(0.000)	(0.862)	(0.000)
		With trend	-1.768	-46.656	-3.162	-15.184
			(0.986)	(0.000)	(1.000)	(0.001)
	1980-2013	Without trend	-2.385	-9.742	-4.402	-11.923
			(0.021)	(0.076)	(0.477)	(0.000)
		With trend	-2.202	-9.597	-4.675	-14.835
			(0.728)	(0.857)	(0.971)	(0.002)
Quarterly	1980-1990	Without trend	-2.343	-10.262	-9.654	-16.539
			(0.030)	(0.043)	(0.000)	(0.000)
		With trend	-3.167	-13.274	-8.126	-15.031
			(0.002)	(0.289)	(0.020)	(0.001)
	1991-2000	Without trend	-2.452	-7.150	-2.761	-2.798
			(0.012)	(0.498)	(0.944)	(0.833)
		With trend	-3.319	-10.267	-5.074	-6.174
			(0.000)	(0.779)	(0.926)	(0.911)
	2001-2013	Without trend	-1.298	-21.242	-0.930	-5.642
			(0.945)	(0.000)	(1.000)	(0.170)
		With trend	-1.823	-36.559	-1.491	-6.940
			(0.978)	(0.000)	(1.000)	(0.835)
	1980-2013	Without trend	-3.442	-16.209	-12.269	-22.479
			(0.000)	(0.000)	(0.000)	(0.000)
		With trend	-3.223	-15.660	-10.921	-22.931
			(0.001)	(0.054)	(0.000)	(0.000)
Annual	1980-1990	Without trend	-9.311	-30.689	-124.331	-129.605
			(0.000)	(0.000)	(0.000)	(0.000)
		With trend	-9.579	-38.185	-126.792	-203.294
			(0.000)	(0.000)	(0.000)	(0.000)
	1991-2000	Without trend	-1.763	-4.261	-3.684	-3.845
			(0.520)	(0.953)	(0.816)	(0.608)
		With trend	1.990	-1.890	-4.499	-5.262
			(0.929)	(1.000)	(0.994)	(0.971)
	2001-2013	Without trend	-1.274	0.529	-2.322	-5.059
			(0.962)	(1.000)	(0.988)	(0.278)
		With trend	-3.530	-1.673	-4.485	-1.178
			(0.000)	(1.000)	(0.994)	(1.000)
	1980-2013	Without trend	-3.858	-5.942	-4.380	-9.885
			(0.000)	(0.757)	(0.579)	(0.000)
		With trend	-3.876	-6.598	-3.625	-8.963
			(0.000)	(0.994)	(1.000)	(0.494)

Note: The Westerlund (2007) tests take no cointegration as the null. The test regression is fitted with a constant and trend, lag: 0 to 1 and lead: 0 to 1. The width of the Bartlett kernel window is used in the semi-parametric estimation of long-run variances. The P-values are for a one-sided test based on the normal distribution and reported in the parenthesis.

The Westerlund cointegration results are reported in Table 9. The results suggest that in case of monthly data, including time trends, 4 of reported 2 statistics are pointed towards the presence of cointegration between the underlying variables of interest during the sub-periods 1991-2000, and 2001-2013.[16] With quarterly data, the results suggest that 4 of reported 4 statistics are pointed towards the presence of cointegration, and including time trend, 3 out of 4 reported statistics are pointed towards the presence of cointegration during the period 1980-1990.

Therefore, with quarterly data, the results indicate the evidence of a long-run relationship between nominal exchange rates and price ratios; consequently, retain the PPP in the NICs during the period 1980-1990. This result, therefore, supports the overall Pedroni results. Moreover, with annual data, the results exhibit that the exchange rates and price ratios are cointegrated, and retaining the PPP in the NICs during the period 1980-1990. However, during the other sub-periods, we do not find any evidence of cointegration between the nominal exchange rates and price ratios, thereby supporting the overall Pedroni results. Moreover, the results suggest the weak evidence of long-run PPP during the period 1991-2000 is reflecting the negative impact of the East Asian financial crisis in 1997-98. During the period of the 1990s, most the NICs were passing through the phase of current account disturbances and the financial shock was so high that it became difficult for them to maintain their exchange rates and price ratios stable to retain the long-run PPP.

Table 10 reports the monthly, quarterly, and at annual sampled-level panel purchasing power parity test results of the NICs over the different sub-periods from 1980 to 2013. The results report the Pedroni (2001) group-mean fully modified OLS and Mark and Sul (1999) group-mean panel dynamic OLS estimators with and without time trend. With monthly data and over the different sub-periods, the results overwhelmingly reject the null hypothesis of strong PPP. The results show that the FMOLS and DOLS estimators are found to be significant at the 1% level with monthly data over the different sub-periods from 1980 to 2013. Similarly, with quarterly data, and over the different sub-periods from 1980 to 2013, 4 out of 12 reported FMOLS and DOLS estimators are found to be significant at least at the 5% level, and so firmly reject the null hypothesis of strong PPP. Likewise, in case of annual data and over the different sub-periods from 1980 to 2013, 6 out of 12 reported FMOLS and DOLS estimators, including the time trends are firmly rejected the null hypothesis of strong PPP.

[16] Westerlund (2007) had proposed four test statistics to test the cointegration between dependent and independent variables in equation. Out of four statistics, two are designed to test the alternative that the panel is cointegrated as a whole, while the other two are designed to test the alternative that the variables in at least one cross-section units are cointegrated. The former two statistics are referred to as group statistics (G_τ and G_α), while the latter two are referred to as panel statistics (P_τ and P_α). The null hypothesis of these tests is no error correction. If the null is rejected, then there is an evidence of long-run relationship between the variables in question.

Table 10. Purchasing Power Parity Tests of the NICs

			Estimates	β	R^2	$\bar{R}^2$	Durbin-Watson Stat	long-run variance	No. of Obs.
Monthly	1980-1990	Without trend	FMOLS	-0.078*(-3.628)	0.932	0.931	0.042	1.324	1179
			DOLS	-0.125*(-4.555)	0.939	0.938	0.083	1.156	1161
		With trend	FMOLS	-0.044(-0.934)	0.976	0.975	0.120	0.432	1179
			DOLS	-0.041(-0.849)	0.978	0.977	0.155	0.378	1161
	1991-2000	Without trend	FMOLS	-0.119*(-4.006)	0.945	0.9450	0.018	1.409	1071
			DOLS	-0.107*(-3.285)	0.955	0.954	0.093	1.077	1053
		With trend	FMOLS	-0.095*(-4.076)	0.990	0.990	0.107	0.214	1071
			DOLS	-0.097*(-4.573)	0.993	0.992	0.161	0.158	1053
	2001-2013	Without trend	FMOLS	-0.154(-0.778)	0.959	0.958	0.237	1.205	1395
			DOLS	-0.116(-0.70)	0.976	0.976	0.496	0.582	1377
		With trend	FMOLS	-2.122*(-3.860)	0.961	0.960	0.261	1.119	1395
			DOLS	-2.424*(-5.017)	0.979	0.978	0.549	0.494	1377
	1980-2013	Without trend	FMOLS	-0.062*(-4.983)	0.815	0.815	0.030	6.950	3663
			DOLS	-0.056*(-4.534)	0.840	0.839	0.077	5.778	3645
		With trend	FMOLS	-0.039*(-3.062)	0.955	0.955	0.124	1.438	3663
			DOLS	-0.042* (-3.398)	0.961	0.961	0.151	1.289	3645
Quarterly	1980-1990	Without trend	FMOLS	-0.0005(-0.019)	0.962	0.961	0.230	0.621	387
			DOLS	-0.009(-0.238)	0.974	0.973	0.328	0.375	369
		With trend	FMOLS	-0.002(-0.032)	0.980	0.979	0.423	0.292	387
			DOLS	-0.010 (-0.121)	0.986	0.985	0.551	0.147	369
	1991-2000	Without trend	FMOLS	-0.168*(-3.899)	0.960	0.958	0.092	0.868	351
			DOLS	-0.155*(-2.750)	0.968	0.966	0.153	0.656	333
		With trend	FMOLS	0.016(0.345)	0.986	0.986	0.262	0.261	351
			DOLS	0.006(0.123)	0.990	0.989	0.413	0.171	333
	2001-2013	Without trend	FMOLS	0.234(1.049)	0.952	0.951	0.858	0.436	459
			DOLS	0.036(0.225)	0.990	0.990	0.536	0.121	441
		With trend	FMOLS	-1.340** (-1.860)	0.957	0.955	0.938	0.373	459
			DOLS	-0.922**(-1.763)	0.991	0.991	0.608	0.095	441
	1980-2013	Without trend	FMOLS	-0.085*(-6.343)	0.901	0.900	0.186	2.574	1215
			DOLS	-0.072*(-5.751)	0.935	0.934	0.116	1.801	1197
		With trend	FMOLS	-0.029*** (-1.658)	0.953	0.952	0.395	0.887	1215
			DOLS	-0.032**(-2.078)	0.974	0.974	0.217	0.608	1197

Notes: The t-statistics are reported in the parenthesis. DOLS estimation includes one lead and one lag in the estimation. ***, ** and * indicate 10%, 5% and 1% level of significance, respectively. The numbers of observations are given after the adjustment of the samples.

Table 10. Purchasing Power Parity Tests of the NICs (Cont')

			Estimates	β	R^2	$\bar{R}^2$	Durbin-Watson Stat	long-run variance	No. of Obs.
Annual	1980-1990	Without trend	FMOLS	-0.014(-0.482)	0.989	0.988	0.202	0.169	100
			DOLS	-0.102**(-1.858)	0.997	0.996	1.084	0.019	80
		With trend	FMOLS	-0.001(-0.016)	0.998	0.998	0.995	0.068	100
			DOLS	-0.273(-2.351)	0.999	0.999	1.583	0.001	80
	1991-2000	Without trend	FMOLS	-0.243*(-3.484)	0.973	0.969	0.687	0.290	90
			DOLS	-0.329*(-3.768)	0.997	0.996	1.292	0.014	70
		With trend	FMOLS	-0.003(-0.052)	0.990	0.988	1.492	0.074	90
			DOLS	-3.129*(-4.280)	0.9997	0.9994	2.637	0.0009	70
	2001-2013	Without trend	FMOLS	2.582*(4.024)	0.815	0.798	1.089	1.405	120
			DOLS	1.009*(2.862)	0.995	0.994	0.790	0.039	100
		With trend	FMOLS	0.847(0.864)	0.865	0.838	1.352	0.879	120
			DOLS	-1.309(-1.281)	0.998	0.997	1.300	0.014	100
	1980-2013	Without trend	FMOLS	-0.098*(-3.845)	0.857	0.853	0.494	2.081	330
			DOLS	-0.078*(-3.836)	0.954	0.951	0.443	0.732	310
		With trend	FMOLS	-0.047(-1.160)	0.900	0.894	0.706	1.105	330
			DOLS	-0.055**(-2.175)	0.978	0.976	0.705	0.270	310

Notes: The t-statistics are reported in the parenthesis. DOLS estimation includes one lead and one lag in the estimation. ***, ** and * indicate 10%, 5% and 1% level of significance respectively. The numbers of observations are given after the adjustment of the samples.

The econometrics procedures employed in this study are based on the analysis of cointegration relationship between the nominal exchange rates and price ratios of the NICs. The previous studies have not properly examined the cointegrating relationship, which could be present between the exchange rates and price ratios of the emerging economies. The strong PPP by checking the unit root properties is understandably not contradictory to the latter discussion of the conventional weak approach of PPP. Raw panel unit root tests are essentially a test for the null hypothesis that PPP does not hold for all countries. In fact, when the null is rejected then it merely suggests that at least for some countries the data is more consistent with PPP than with the failure of PPP. In this study, when we reject the null hypothesis, it suggests that PPP does not retain in some sub-periods, reflecting the macroeconomic factors, whereas it would retain for some other sub-periods of the NICs. The failure of strong PPP evidently happens because of the current floating system in the currency with flexible exchange rates of the emerging economies. Furthermore, our empirical results seem to support the view that PPP holds better for countries are more open to a trade because trade barriers hinder international arbitrage. Since the 1980s, the NICs are moving through the phase of transition, as a major economy moving from the agricultural to industrial, and market-oriented sectors. Thus, during this phase of transition, as the inflation and exchange rates are so volatile, we have observed that PPP fails to hold in the NICs after the 1990s.

4. CONCLUSIONS AND IMPLICATIONS

A large body of literature has examined the empirical exchange-rate studies under the current float system, and their findings suggest that real exchange rate follow unit root processes, implying that PPP does not hold even as a long-run relationship exist between the exchange rate and price ratios. It is well acknowledged that the standard univariate unit-root tests have low power against local stationary alternatives in small samples; whereas the panel unit-root tests have strong power to examine the exchange rates refers to a group of countries. This paper investigates that the failure to support the long-run PPP as reported by previous studies may result from this shortcoming. To overcome the power problem related to small samples, we pool the data and conduct the more powerful test, especially; we apply the Pesaran (2007) second-generation panel unit-root tests to solve the issue of cross-sectional dependence among the newly industrialized countries (NICs). Furthermore, we have used several panel unit-roots test to examine the PPP of the NICs during the different periods from 1980 to 2013, and concurrently, we have also examined the cointegration between the exchange rates and price ratios of the NICs. Moreover, cointegration between the exchange rates and price ratios is a necessary condition for PPP, and facilitate to validate the strong PPP.

We have found some extent different results related to the first and second-generation panel unit-roots tests. Precisely, what we find here is that the unit root null cannot be overwhelmingly rejected during the different sub-periods of the NICs.

Moreover, followed by Pesaran (2007) unit-root test results, with monthly and annual data, we find that the real exchange rates are stationary during the period 1980-1990, whereas during the other sub-periods, the presence of unit root cannot be rejected. This indicates that the PPP has been invalidated after the 1990s. Alternatively, the results report the presence of cointegration between the exchange rates and price ratios during the period 1980-1990. However, during the other sub-periods, such as 1991-2000, and 2001-2013, we find weak evidence of cointegration between the variable of our investigations. The mere presence of cointegration after the 1990s would have reflected the negative impact of the East Asian financial crisis in 1997-98. In sum, the empirical result merely supports strong PPP. However, the long-run PPP during the period 1980-1990 is overwhelmingly supported, however, the speed at which the real exchange rates restore to its equilibrium is certainly slow. Furthermore, the speed of adjustment in real exchange rate restore to equilibrium is relatively slow during the period 1991-2000; reflect the impact of huge cross-border capital mobility with high volatile exchange rates regimes specific to the East Asian financial crisis in 1997-98.

The economic implications for the macroeconomic theory are very much dependent on the underlying causes for the failure of the strong PPP hypothesis. There are several potential mechanisms that can cause a failure of the strong PPP hypothesis, like measurement errors, differences in price indices between countries, transportation costs, and differential productivity shocks. For instance, in case of measurement errors, we should not be immediately misled by a model that imposes strong PPP, however, it might be problematic to consider the model to the data, which suffer from measurement errors. A worse scenario is that the failure of strong PPP is due to some omitted fundamental mechanism of the economy. Therefore, more research on the causes of the failure of the strong PPP hypothesis is necessary.

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