TESTING PPP HYPOTHESIS IN MAJOR ASEAN ECONOMIES: *DOES DATA GENERATING PROCESS MATTER?*

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ABSTRACT

This study employs the Johansen and Juselius (1990) cointegration test and the recently proposed Bierens (1997) non-parametric cointegration methodology to test the purchasing power parity PPP hypothesis for five major ASEAN economies-Indonesia, Malaysia, the Philippines, Singapore and Thailand, with U.S. as reference. Both tests are used jointly since this approach provides framework to address the issue of whether the underlying data generating process has strong bearing on the empirical cointegration testing of PPP hypothesis. Using the Johansen and Juselius cointegration approach, the null hypothesis of no cointegrating vector for all the five ASEAN countries cannot be rejected. Further analysis using the Bierens's method provides strong support for the PPP proposition for Malaysia, Singapore and Thailand. The discrepancy between the findings from both techniques is interpreted as a consequence of significant non-linearity in the adjustment process of real exchange rate towards its PPP equilibrium level. Specifically, these findings provide empirical evidence against the robustness of the Johansen and Juselius method at detecting cointegration when the data generating process is non-linear. Thus, this study points to the need to examine the underlying dynamics of the data generating process before further empirical testing of PPP hypothesis, especially those utilizing Johansen approach.

Keywords: Nonparametric cointegration; Purchasing power parity; ASEAN economies; Non-linearity; Data generating process.

JEL classification: F30, H60, H62

INTRODUCTION

The hypothesis of purchasing power parity (PPP) has been one of the most extensively researched areas over the past few decades. The basic idea of PPP was initially advanced by classical economists such as David Ricardo in the 19th century. But it was Gustav Cassel, a Swedish economist, who popularized the PPP in the 1920s. The PPP hypothesis in its absolute form states that the exchange rate between currencies of two countries should be equal to the ratio of the countries' price level: $S_t = \frac{P_t}{P_t^*}$, where P_t is the domestic price level (in domestic currency) and P_t^* is the foreign price level (in foreign currency). Equivalently, PPP asserts that the real exchange rate, which can be calculated as $E_t = S_t \frac{P_t^*}{P_t}$, should be constant. Although in the short run, deviation of exchange rate from PPP might occur[1], most economic theories suggest that PPP should hold in the long run.

The PPP hypothesis can be considered as the oldest method of defining long-term exchange rate equilibrium, and is the central building block of many theoretical and empirical models of exchange rate determination. For example, the monetary approach by Frankel and Johnson (1978) is based on two basic tenets: purchasing power parity and the quantity theory of money. Another popular sticky-price exchange rate model developed by Dornbusch (1976) also has to preserve the PPP as a long run equilibrium condition for exchange rates. On the other hand, the PPP has some practical appeal for policy makers and exchange rate arbitragers. Generally, one can use the PPP-determined exchange rate as a benchmark in deciding if a country's currency is undervalued or overvalued against other currencies. In international trade, PPP also has a role to play. For example, if PPP holds, countries' competitive positions in world export markets will not be systematically affected by exchange rate changes. However, if there are deviations from PPP, changes in real exchange rates will affect the international competitive positions of countries.

Over the years, there has been an explosion of empirical research on the validity of PPP hypothesis in the real world[2]. Two widely employed empirical tests for PPP are the unit root methodology and cointegration analysis. A necessary condition for PPP to hold in the long run is that the real exchange rate must be covariance stationary. The standard method for detecting non-stationary behaviour in a time series is to test for the presence of a unit root. Thus, rejection of a unit root in real exchange rate provides evidence supporting PPP. Another stream of literature is based on the cointegration technique. To provide empirical support for PPP, [illegible] the bilateral nominal exchange rates and relative prices must form a cointegrated system with parameters [1, -1]. Specifically, if real exchange rates are stationary, the nominal exchange rates and relative prices should move together one-for-one in the long run.

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[1] The deviation can due to factors such as transaction costs, price rigidity, the differential composition of [illegible] baskets and prices indices, and imperfect markets (as results of subsidy, taxation, trade barriers, foreign exchange market interventions and the like).

[2] Taylor (1995), Rogoff (1996) and Edison *et al.* (1997) have done an excellent survey on the empirical literature of PPP.

Generally, empirical studies on PPP have yielded contradictory results. Even in ASEAN countries, which have been the focus of both economic growth and success in the last decade and the recent financial turmoil, the results have been mixed, creating a debate among policy makers on the robustness of the empirical findings. Study by Baharumshah and Ariff (1997) using unit root and Engle and Granger (1987) cointegration approach rejected the PPP proposition for all the five selected ASEAN countries- Indonesia, Malaysia, the Philippines, Singapore and Thailand. Further analysis using the Johansen and Juselius (1990) multivariate approach also failed to support the PPP hypothesis in these countries. Bahmani-Oskooee (1993) who used the Engle and Granger procedure have found evidence in favour of strong PPP hypothesis in the Philippines and weak form in Indonesia, Malaysia, Singapore and Thailand. On the other hand, a recent study by Bahmani-Oskooee and Mirzai (2000) failed to support the mean reversion in real effective exchange rate for Indonesia, Malaysia, the Philippines and Thailand by using the conventional ADF and KPSS unit root tests. To take into account the presence of structural breaks, Aggarwal *et al.* (2000) employed both the single and multiple breaks unit root tests to test the validity of PPP for ASEAN exchange rates. They found strong evidence of long run PPP hypothesis for most of the ASEAN currencies when the Japanese yen is used as the numeraire currency. However, such evidence of PPP is weaker with the U.S. dollar, German mark and the Australian dollar. Another recent study by Azali *et al*. (2001) using panel unit root and panel cointegration showed that PPP does hold in the long run between Japan and ASEAN economies.

With abounding empirical evidence supporting the presence of non-linearity in exchange rate time series data (see, for example, Hsieh, 1989; De Grauwe *et al*., 1993; Steurer, 1995; Brooks, 1996; Mahajan and Wagner, 1999), many researchers started asking themselves to what extent one should trust the results of linear methods like the conventional unit root tests and cointegration tests if the underlying data generating process is non-linear. Taylor and Peel (1997) and Sarno (2000), amongst others, illustrated that the adoption of linear stationarity tests is inappropriate in detecting mean reversion if the true data generating process of exchange rate is in fact a stationary non-linear process. On the other hand, the Monte Carlo simulation evidence in Bierens (1997) indicated that the standard linear cointegration framework presents a mis-specification problem when the true nature of the adjustment process is non-linear and the speed of adjustment varies with the magnitude of the disequilibrium. Other related work is provided by Pippenger and Goering (1993) and Balke and Fomby (1997) which suggest a potential loss of power in standard unit root and cointegration tests under threshold autoregressive data generating process.

Due to the growing views that the world is non-linearly dynamics (Pesaran and Potter, 1993; Campbell *et al*., 1997; Barnett and Serletis, 2000), recent work on non-linear studies has reenergized fresh attention on the PPP hypothesis. Serletis and Gogas (2000) applied non-line techniques to test for non-linearity in real exchange rate series and found evidence that behaviour of real exchange rate series under investigate are governed by non-linear dynami Other studies like Micheal *et al*. (1997), Sarno (2000) and Baum *et al*. (2001) employ nonlinear models such as the threshold autoregressive (TAR), smooth transition autoregress (STAR) and exponential smooth transition autoregressive (ESTAR) models to model the beha of real exchange rates. All these studies provided strong support for the validity of long run in which the real exchange rates adjust non-linearly towards its equilibrium PPP level.

Theoretically, non-linearities in real exchange rate adjustment can be explained by the occurr of market frictions such as transaction costs. According to Dumas (1992), the presence transaction costs in international trade implies that deviations from PPP will only be arbitra away by rational arbitrageurs if the price differentials exceed transaction costs. Thus, there be persistent behaviour when PPP deviations are within no-arbitrage bands, that is exchange is left unadjusted. However, beyond this band of inaction, there will be mean reversion. Specifica the larger the deviation, the stronger is the tendency for the exchange rate to adjust back equilibrium. Thus, the speed of adjustment varies with respect to the size of deviation, there justifying the non-linear adjustment of exchange rate towards PPP.

Along this line of inquiry, the main objective of this study is to utilize the Johansen and Jus (1990) cointegration test and Bierens's (1997) non-parametric cointegration test in a sequen way to examine whether the underlying data generating process plays an important role in the PPP hypothesis. As pointed out by Bierens (1997), the non-parametric cointegration in the same spirit with Johansen and Juselius (1990) approach. The test statistics involved both approaches are obtained from the solutions of a generalized eigenvalue problem, but Bierens' approach a data generating process does not need to be specified and thus this completely non-parametric. Therefore, in principle, both approaches should generate a sim outcome. Since the Bierens's method allow for non-linearity in the data generating process discrepancy of the findings from both methods indicate the presence of non-linearity adjustment process of the real exchange rates under investigate. This is consistent with interpretations in Ma and Kanas (2000) and Coakley and Fuertes (2001).

This paper is organized as follows. Following this introduction, a brief description methodology used in this study is given. This is followed in Section III by a discussion empirical results. Concluding remarks are given at the end of the paper.

METHODOLOGY

The PPP hypothesis states that the nominal exchange rate (in domestic currency per foreign) should be equal to the ratio of domestic to foreign price as:

$$S_t = \frac{P_t}{P_t^*} \tag{1}$$

where S_t is the domestic currency per unit of foreign currency, P_t and P_t^* are the domestic and foreign price indices respectively. If PPP holds, the deviation from long run PPP: $E_t = S_t \frac{P_t^*}{P_t}$, where E_t is the real exchange rate, should imply a stationary process or that shocks have no permanent effect. In the methodology of cointegration, long run PPP is implied by a cointegrating relationship between nominal exchange rates and relative prices, with the cointegrating vector being [1, -1]. Specifically, if real exchange rates are stationary, the nominal exchange rates and relative prices should move together one-for-one in the long run. This study uses both the Johansen and Juselius (1990) and Bierens's (1997) non-parametric cointegration tests to examine the long run PPP hypothesis.

Johansen and Juselius (1990) Cointegration Test

The Johansen and Juselius (JJ) (1990) multivariate cointegration technique uses maximum likelihood procedures to determine the number of cointegrating vectors among a vector of time series. Assume that y_t is modelled as a vector autoregression (VAR):

$$y_t = \Pi_1 y_{t-1} + \Pi_2 y_{t-2} + \ldots\ldots + \Pi_k y_{t-k} + \mu_t \tag{2}$$

where y_t is a column vector of two endogenous variables. Equation (2) can be transformed into first-difference form as follows:

$$\Delta y_t = \sum_{j=1}^{k-1} \Gamma_j \Delta y_{t-j} + \Pi y_{t-k} + \mu_t \tag{3}$$

where Π is the long run relationship between the variables in y_t process. The estimation of the cointegrating vectors can be determined from the matrix of Π, which is written as:

$$\Pi = \alpha\beta' \tag{4}$$

where β' is the (r x p) matrix of cointegrating vectors and α is the (p x r) matrix of error correction parameters that measure the speed of adjustment in Δy_t. Since the rank of Π is related to the number of cointegrating vectors, thus, if the rank of $\prod$ equals to p or full rank, then y_t is a stationary process. If the rank of $\prod$ is $0 < r < p$, implying that there are r cointegrating vectors and hence the group of time series contain a (p-r) common trends. However, if the rank of $\prod$ is zero, then the variables in y_t are non-cointegrated. Here, two likelihood ratio (LR) test statistics, namely the trace and maximum eigenvalue statistics are used to determine the number of cointegrating vectors.

The trace statistic tests the $H_0(r)$ against $H_1(p)$, and is written as:

$$\text{Trace} = -T\sum_{i=r+1}^{p} \ln(1-\hat{\lambda}_i) \tag{5}$$

On the other hand, the maximum eigenvalue statistic tests the $H_0(r)$ against $H_1(r+1)$, which is given by:

$$\text{Maximum eigenvalue} = -T \ln(1-(1-\hat{\lambda}_{r+1}) \tag{6}$$

In testing for long run PPP hypothesis in the bivariate case, nominal exchange rates and relative prices must exhibit only one cointegrating vector (p-1) or one common trend, thus require the imposition of restriction on the coefficients of JJ long-run cointegrating vector in the form of [1, -1]. If the restriction test fails to reject the null hypothesis, then nominal exchange rates will move one-for-one with relative prices, suggesting that PPP holds in the long run.

Bierens (1997) Non-parametric Cointegration Test

The Bierens non-parametric cointegration test considers the general framework as:

$$z_t = \pi_0 + \pi_1 t + y_t \tag{7}$$

where $\pi_0(q \times 1)$ and $\pi_1(q \times 1)$ are optimal mean and trend terms, and y_t is a zero-mean unobservable process such that Δy_t is stationary and ergodic. The general framework assumes that z_t is observable q-variate process for t = 0, 1, 2, ..., n.

Apart from some mild regularity conditions, or estimation of structural and/or nuisance parameters, further specification of the data-generating process for z_t are not required and thus this test is completely non-parametric.

The Bierens's method is based on the generalized eigenvalues of matrices A_m and $\left[B_m + n^{-2}A_m^{-1}\right]$, where A_m and B_m are defined in the following matrices:

$$A_m = \frac{8\pi^2}{n}\sum_{k=1}^{m} k^2\left[\frac{1}{n}\sum_{t=1}^{n}\cos(2k\pi(t-0.5)/n)z_t\right]\times\left[\frac{1}{n}\sum_{t=1}^{n}\cos(2k\pi(t-0.5)/n)z_t\right]'$$

$$B_m = 2n\sum_{k=1}^{m}\left[\frac{1}{n}\sum_{t=1}^{n}\cos(2k\pi(t-0.5)/n)\Delta z_t\right]\times\left[\frac{1}{n}\sum_{t=1}^{n}\cos(2k\pi(t-0.5)/n)\Delta z_t\right]' \quad (8)$$

which are computed as sums of outer-products of weighted means of z_t and Δz_t, and n is the sample size. To ensure invariance of the test statistics to drift terms, the weight functions of $\cos(2k\pi(t - 0.5)/n)$ are recommended here.

Similar to the properties of the Johansen and Juselius likelihood ratio method, the ordered generalized eigenvalues of this non-parametric method are obtained as solution to the problem $\det[P_n - \lambda Q_n] = 0$ when the pair of random matrices $P_n = A_m$ and $Q_n = \left[B_m + n^{-2}A_m^{-1}\right]$ are defined. Thus, it can be used to test hypothesis on the cointegration rank r.

To estimate r, two test statistics are used. First, Bierens (1997) derived the 'lambda-min' $(\lambda_{min})\ \hat{\lambda}_{n-r_0,m}$, which corresponds to the Johansen's maximum likelihood procedure, to test for the hypothesis of $H_0(r)$ against $H_1(r + 1)$. The critical values for this test are tabulated in the same article. Second, Bierens's approach also provides the $g_m(r)$ which is computed from the Bierens's generalized eigenvalues:

$$\hat{g}_m(r) = \left[\prod_{k=1}^{q}\hat{\lambda}_{k,m}\right]^{-1} \qquad \text{if } r = 0$$

$$= \left[\prod_{k=1}^{q-r}\hat{\lambda}_{k,m}\right]^{-1}\left[n^{2r}\left[\prod_{k=n-r+1}^{q}\hat{\lambda}_{k,m}\right]\right] \qquad \text{if } r = 1, \ldots.., n-1$$

$$= n^{2n}\prod_{k=1}^{q}\hat{\lambda}_{k,m} \qquad \text{if } r = n$$

This statistic uses the tabulated optimal values (see Bierens, 1997, Table 1) for r, provi $r > q$, and $m = q$ is chosen when $r = n$. Then $\hat{g}_m(r)$ converges in probability to infinity if the true number of cointegrating vector is unequal to r, and $\hat{g}_m(r) = O_p(1)$ if the true number cointegrating vector is equal to r. Therefore, we have $\lim_{n\to\infty} P(\hat{r}_m = r) = 1$, whe $(\hat{r}_m = \arg\min_{0\le r\le} \lbrace \hat{g}_m(r)\rbrace$. Thus, this test statistic is useful as a tool to double-check on the determination of r.

Finally, a linear restriction on the cointegrating vectors in the form of [1 , −1] is needed to for long run PPP. For this purpose, Bierens proposed the use of the trace and lambda-ma statistics. The critical values of trace ($m = 2q$, $F_k(x) = \cos(2k\pi x)$) and lambda-max te ($m = 2q$, $F_k(x) = \cos(2k\pi x)$) are given in Bierens (1997, Tables 3 and 4).

EMPIRICAL RESULTS

Data

This study is based on monthly data from 1974.1 to 2002.5 for five major ASEAN countr Indonesia, Malaysia, the Philippines, Singapore and Thailand, with the U.S. data as refer The consumer price indices are used to construct the relative price series, which are the ra of domestic to foreign (U.S.) prices. The nominal exchange rates are expressed as units of currency per U.S. dollar. All the data used in this study are obtained from the *Interna Financial Statistics* database published by the International Monetary Fund. Both the nomin exchange rates and relative prices are transformed into logarithm form.

Unit Root Tests

It is important to determine the characteristic of the individual series (in this case, the nomin exchange rates and relative prices) before conducting the cointegration analysis. This is du the fact that only variables of the same order of integration may constitute a potential cointegr relationship. Specifically, cointegration means that the nominal exchange rate and relative p series may be individually non-stationary, but there may exist a linear combination of these two series which is stationary. Thus, in a cointegrated system, the variables involved cannot move "too far" apart from each other and any short-run deviation from the long-term trend will be corrected.

To test for non-stationary behaviour in the time series of nominal exchange rates and relative prices, we use the non-parametric PP ρ-test (Phillips and Perron, 1988) and non-parametric Bierens and Guo (1993) Cauchy test #3 (BG3). The null hypotheses for both the PP and BG3 tests are nonstationarity and stationarity respectively. Table 1 and 2 report the results of the stationarity tests on both the nominal exchange rates and relative prices. The results from both the PP and BG3 tests clearly indicate that both variables are not stationary in the level but are able to attain stationary in the first-difference. In other words, all nominal exchange rates and relative prices are integrated of the same order one, or denoted as $I(1)$. With these findings, we can proceed with the cointegration tests to check the validity of the long run PPP hypothesis.

Table 1

Unit Root Tests Results (Series in Level)

	Nominal Exchange Rates		**Relative Prices**	
	PP	**BG-3**	**PP**	**BG-3**
Indonesia	-0.1251 (0.8160)	77.9351** (0.00817)	0.8875 (0.9720)	589.2986** (0.00108)
Malaysia	-1.6383 (0.7350)	15.1406* (0.04199)	-3.5615 (0.6610)	115.5459** (0.00551)
Philippines	-0.3673 (0.9010)	183.1502** (0.00348)	-0.4697 (0.9430)	904.5574** (0.00070)
Singapore	-2.6778 (0.7020)	21.8977* (0.02905)	-2.0109 (0.9140)	485.6073** (0.00131)
Thailand	-0.5455 (0.7620)	27.5533* (0.02309)	-1.6820 (0.8990)	35.0945* (0.01814)

Notes: *p*-values of both tests are given in brackets.
* and ** denote significant at the 5% and 1% levels respectively.

Table 2
Unit Root Tests Results (Series in First-difference)

	Nominal Exchange Rates		Relative Prices	
	PP	**BG-3**	**PP**	**BG-3**
Indonesia	-272.0997** (0.0090)	4.1177 (0.15167)	-207.4784** (0.0000)	0.7223 (0.60178)
Malaysia	-319.0172** (0.0010)	1.0566 (0.48249)	-346.3239** (0.0000)	0.3548 (0.78292)
Philippines	-430.9464** (0.0000)	2.7912 (0.21901)	-227.4220** (0.0000)	1.0746 (0.47711)
Singapore	-320.7142** (0.0000)	4.5307 (0.13829)	-372.3297** (0.0000)	0.4024 (0.75646)
Thailand	-236.6784** (0.0010)	1.1593 (0.45311)	-289.0520** (0.0000)	0.7468 (0.59163)

Notes: *p*-values of both tests are given in brackets.
** denoted significant at the 1% level.

Johansen and Juselius (1990) Cointegration Test

Under the Johansen and Juselius method, we use the Akaike Information Criterion (AIC) to determine the order of the VAR model. Table 3 reports the trace and maximal eigenvalue statistics based on unrestricted intercepts and no trend in the VAR options. Both statistics are then used to determine the number of cointegrating vectors. In this bivariate case, if both the nominal exchange rates and relative prices are cointegrated, we then proceed with the test of restriction on the cointegrating vector in the form of [1, -1]. The acceptance of the null hypothesis provides empirical support for the long run PPP hypothesis.

Results summarized in Table 3 show that both the trace and maximal eigenvalue statistics cannot reject the null hypothesis of no cointegrating vector (r = 0) for all the five ASEAN countries. In this case, there is no need to proceed with the restriction test on the cointegrating vector. These results are in line with those reported in Baharumshah and Ariff (1997), Aggarwal *et al.* (2000) and Wang (2000) using Johansen cointegration technique.

Table 3
Johansen and Juselius (1990) Cointegration Test Results

	Lag	λ-max		λ-trace		β'
		H_0: r = 0	H_0: r ≤ 1	H_0: r = 0	H_0: r ≤ 1	H_0: β'= [1, -1]
Indonesia	7	6.134229	0.022675	6.156904	0.022675	-
Malaysia	2	11.21203	1.428881	12.64092	1.428881	-
Philippines	2	7.244978	0.095913	7.340891	0.095913	-
Singapore	1	8.377750	1.904240	10.28199	1.904240	-
Thailand	8	11.33645	1.373445	12.70990	1.373445	-

Note: The critical values for the trace and maximal eigenvalue statistics are tabulated in Osterwald-Lenum (1992)

Bierens (1997) Non-parametric Cointegration Test

Further analysis using the Bierens's nonparametric cointegration method can serve to check the robustness of the Johansen and Juselius (1990) method in views of the superiority of non-parametric method at detecting cointegration when the data generating process is non-linear. Table 4 reports the results of the Bierens's test. These results provide evidence of cointegration for Malaysia, the Philippines, Singapore and Thailand. By imposing the [1, –1] restriction, Malaysia, Singapore and Thailand fail to reject the null hypothesis. The evidence of mean reversion in dollar denominated real exchange rates for these three ASEAN countries are in sharp contrast with earlier findings obtained from Johansen and Juselius method.

Table 4
Bierens (1997) Non-parametric Cointegration Test Results

	λ-min		$g_m(r_0)$	β'
	H_0: r = 0	H_0: r = 1	r_0 = 0, 1, 2	H_0: β'= [1, -1]
Indonesia	0.03113	3.52019	**93.82913409E-001** 99.42319808E+001 14.24222884E+008	-
Malaysia	0.00395*	0.84960	**31.45882926E+001** 50.90829893E+001 42.47888530E+006	2.40
Philippines	0.00280*	4.57014	23.64402085E+002 **23.40867366E-001** 56.51898247E+005	12.37*
Singapore	0.00787*	0.30551	**54.53836448E+001** 22.70930414E+002 24.50267830E+006	1.33
Thailand	0.00227*	0.47225	96.79173390E+001 **53.55123598E+001** 13.80630294E+006	2.01

Note: * denotes significant at the 5% level.

As pointed out by Bierens (1997), the Bierens's method is in the same spirit with Johansen and Juselius (1990) approach. Therefore, in principle, both approaches should generate a similar outcome. Since the Bierens's method allows for non-linearity in the data generating process, the discrepancy between the findings from both approaches is interpreted as a consequence of significant non-linearity in the real exchange rate adjustment to PPP. According to Bierens (1997), deviation of Johansen test and estimation results from the corresponding non-parametric test may indicate mis-specification of the error-correction model. More specifically, Coakley and Fuertes (2001) explained that the non-linear adjustment process in the real exchange rate would cause the standard linear cointegration approach which assumes a constant speed of adjustment to present a mis-specification problem. In other words, the failure of Johansen and Juselius method to establish real exchange rate stationarity does not necessarily invalidate the long run PPP hypothesis. Instead, it is the presence of non-linearity that contributes to its poor performance at detecting cointegration.

CONCLUSIONS

In views of the profound significance of PPP hypothesis to international trade and finance, there has been an explosion of empirical research on this body of literature over the past few decades. Most of these earlier studies have generally make an implicit assumption that exchange rate behaviour is linear in nature (Taylor and Peel, 1997). However, with abounding evidence supporting the presence of non-linearity in exchange rate time series data, coupled with the growing literature suggesting real exchange rates adjust non-linearly towards its equilibrium PPP levels, researchers could no longer take for granted that exchange rate movements are linearly dependent. Thus, this study attempts to address the issue of whether the underlying data generating process of time series data has strong bearing on the empirical cointegration testing of PPP hypothesis in which the Johansen and Juselius (1990) method is widely employed.

To do that, this study employs both the Johansen and Juselius (1990) cointegration test and the recently proposed Bierens (1997) nonparametric cointegration methodology in a sequential manner to test the purchasing power parity (PPP) hypothesis, with application on five major ASEAN economies- Indonesia, Malaysia, the Philippines, Singapore and Thailand. Using the Johansen and Juselius cointegration approach, the null hypothesis of no cointegrating vector for all the five ASEAN countries cannot be rejected. Further analysis using the Bierens's method provides strong support for the PPP proposition for Malaysia, Singapore and Thailand. Since the Bierens's method allows for non-linearity in the data generating process, the discrepancy between the findings from both techniques is interpreted as a consequence of significant non-linearity in the real exchange rate adjustment to PPP. Specifically, these findings provide empirical evidence against the robustness of the Johansen's method at detecting cointegration when the data generating process is non-linear. Thus, this study points to the need to examine the underlying dynamics of the data generating process before further empirical testing. If the data generating process is non-linear in nature, then it would be inappropriate to employ linear methods, like the Johansen and Juselius (1990) cointegration test, which has been widely employed in the empirical testing of PPP hypothesis.

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