

The Validity of PPP Theory in ASEAN-Five: Another Look on Cointegration and Panel Data Analysis

By

Chee-Keong, Choong*

*Faculty of Accountancy and Management, Universiti Tunku Abdul Rahman,
13, Jalan 13/6, 46200 Petaling Jaya, Selangor, Malaysia.*

Wai-Ching, Poon

*Faculty of Management, Multimedia University,
Jalan Multimedia, 63100 Cyberjaya, Selangor Darul Ehsan, Malaysia.*

Muzafar Shah Habibullah

*Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, 43400 UPM
Serdang, Selangor D.E., Malaysia.*

Zulkornain Yusop

*Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, 43400 UPM
Serdang, Selangor D.E., Malaysia.*

Abstract

The study aims to examine the robustness of different PPP models by applying different types of econometric techniques in ASEAN-Five economies from 1983:M1 to 2002:M9. Two versions of PPP theory have been estimated within Engle-Granger bivariate cointegration test, Johansen-Juselius multivariate cointegration model and panel data analysis proposed by Gujarati (2003). Based on the bivariate test, we found that PPP theory does not hold in the countries under concerned, while the validity of the PPP was confirmed if the multivariate procedure was applied. A supporting finding was documented when we analyse the robustness of the theory by looking on panel data analysis. Therefore, this study can be viewed as an additional work in providing justification for the theory of PPP in ASEAN-Five economies.

*Corresponding Author.

Address: Choong Chee Keong
Faculty of Accountancy and Management,
Universiti Tunku Abdul Rahman,
13, Jalan 13/6, 46200 Petaling Jaya,
Selangor, Malaysia
Telephone: 603-79582628
Fax: 603-79561923
E-mail: choongck@mail.utar.edu.my

I. INTRODUCTION

Ever since the pioneering work of Cassel in the early 1900s, the purchasing power parity (PPP) theory has been subjected to great controversial. The parity reveals that prices in two different economies should be identical to each other when they expressed in terms of the same currency. PPP has been attracted much attention from monetary economists because it can be viewed as a cornerstone of the monetary model in determining the exchange rate behaviour (Dornbusch, 1976).

Theoretically, PPP theory is a long run model in determining the equilibrium exchange rate, hence, the relationship might deviate in the short-run. A number of previous studies found evidence to against the robustness of the parity in the short-run (Dornbusch, 1976; Frenkel, 1978). It is widely accepted that the parity is valid in the long-run, nevertheless, the findings of the literature are mixed. For example, Ballie and Selover (1987), Abuaf and Jorian (1990), and Kim (1990) provide evidence that support the hypothesis of PPP in the long-run, while Meese and Singleton (1982) and Cooper (1994) have rejected the hypothesis.

The controversial of PPP theory arisen mainly caused by the data-generating process of the variables concerned. In their studies, Meese and Singleton (1982) found that nominal exchange rate has a unit root. This means that the series follows a random walk process and its movement is unpredictable. In other words, the level relationship of the series concerned would not be confirmed in both short- and long-run. Since then, the unit root tests such as Dickey Fuller (DF) test, Augmented Dickey Fuller (ADF) test, Phillips Perron (PP) test and the Bayesian unit root approaches have been applied to examine the robustness of the PPP theory. For example, Manzur and Ariff (1995) examined the presence of the PPP for the Group Seven and ASEAN countries. The hypothesis of unit root for these countries failed to be rejected when DF, ADF and PP tests were used. However, they found the evidence support the view that the exchange rate does not follow a random walk when they applied Sim's test. As a result, they concluded that there exists a long-run relationship between exchange rate and the price ratio for these economies. A similar conclusion also comes from Whitt (1992) by applying similar test, using monthly data.

Resulting from the weaknesses of the traditional unit root tests, nevertheless, more and more researchers have been testing the validity of PPP hypothesis by applying traditional ADF tests within panel approaches and provides mixed evidence. Using the Levin and Lin (1993) method, Oh (1996), Wu (1996), Papell (1997) and Lothian (1997) found that real exchange rates follow stationary process during the floating exchange rate period in OECD economies. Wu (1996) estimated the speed of adjustment to be within 2.5 to 3 years using both the consumer price index and World price index for monthly, quarterly and annual data. Using the Generalized Least Square (GLS) approach, O'Connell (1998) demonstrated that cross correlations between economies have a significant impact on the results and led to the rejection of PPP, while Jorian and Sweeney (1996) found evidence support real exchange rate stationarity by using the same approach. In addition, Coakley and Fuertes (1997) adopted the IPS test and support real exchange rate stationarity; whereas, Canzoneri *et al.* (1999) found nonstationarity for real exchange rates. Recently, Lothian (1998), Siddique and Sweeney (1998) and Koedijk *et al.* (1998) also supported mean reversion using panel data.

The development of the cointegration and causality frameworks by Engle and Granger (1987), Johansen (1988), Stock and Watson (1988), Johansen and Juselius (1990), Toda and Yamamoto (1995) enable researchers to broader their research in investigating the validity of PPP theory by using these recent well-developed econometric techniques. For example, Cooper (1994) employed cointegration procedures to discern the long-run relationship between exchange rate and price ratio for three economies, namely, Australia, New Zealand and Singapore stemming from 1973-1992. However, they reported evidence against the validity of PPP theory in these economies. Huang and Yang (1996) reported similar conclusion when the Engle-Granger two-step cointegration was applied. But, Johansen (1988, 1991) maximum likelihood procedure confirmed the presence of PPP in the long-run. The finding, however, was biased because the result has violated the assumption of normality. Cheung and Lai (1993), Kugler and Lenz

(1993), Pippenger (1993) and Dutton and Strauss (1997) find a long run relationship between domestic and foreign prices and nominal exchange rates.

On the other hand, Lee (1999) has examined the validity of PPP in thirteen Asia Pacific economies using both the traditional unit root tests and newly developed error-correction model (ECM). They confirmed the PPP long-run relationship exists for most of these sample economies when the ECM procedure was applied. In addition, they concluded that the ECM is more superior to the traditional unit root test in testing the relationship. This means that a more appropriate method may be testing for cointegration between domestic and foreign price indices and nominal exchange rates. Canzoneri et al. (1999) and Pedroni (1996) employ a FMOLS panel cointegration approach and reject the strong version of PPP (real exchange rate stationarity), instead support the weak version of PPP (relative prices and nominal exchange rates are cointegrated, but not one-for-one).

Obviously, previous studies demonstrated mixed results for the robustness of PPP theory, either in the short- or long-run by using different types of econometric procedures. Few reasons have been figured out to explain the phenomenon. One of the biggest problems found from the previous studies was the heterogeneity problem, which led to the inconsistency of testing procedure (Azali *et al.*, 2001). For example, the use of DF, ADF and PP unit root tests with certain restrictions imposed result in difficulty in finding evidence to support the PPP theory. Besides, the use of the cointegration techniques, especially the residual-based cointegration test, provides inconsistent results and misspecification findings. Although the use of Johansen multivariate framework would overcome some weaknesses from bivariate cointegration, the procedure is biased when there exist non-Gaussian disturbances (Huang and Yang, 1996).

The present study, therefore, aims to overcome these weaknesses by comparing the findings of different techniques proposed by previous studies (or traditional tests) and the newly developed time series techniques and panel data regression within the vector autoregression (VAR) model. In particular, the panel data analysis is superior to other techniques mentioned above in terms of giving more informative data, less collinearity among variables, more degrees of freedom and more efficiency (Gujarati, 2003, p. 637). The most important feature of panel data analysis is that the technique can overcome the heterogeneity problem in both estimation of time series and cross-sectional data by allowing for individual-specific variables.

The remaining sections of the study are organized as follows. Section II briefly explains the theoretical view of PPP framework, data and methodology, while the argument of the findings and results will be reported in Section III. Finally, the conclusions are expressed in Section IV.

II. THEORETICAL VIEW OF PPP HYPOTHESIS

PPP is the earliest and simplest version of exchange rate determination by looking on the relationship between prices (or inflation) in two countries. Following previous studies, it is possible to specify the PPP theory into the following absolute model (restricted version).

$$e_t = \alpha + \beta \left(P_t / P_t^* \right) + \varepsilon_t \quad (1)$$

where e_t is nominal exchange rate (home currency/foreign currency), P_t and P_t^* are price indexes in the home country and foreign country, respectively. Equation 1 implies that PPP holds when the estimated coefficient of price ratio is equal to unity ($\beta = 1$).

Another version of PPP namely, unrestricted version can be obtained by imposing the log and rearrange the Equation 1 as follows.

$$\ln e_t = a + \beta_1 \ln P_t - \beta_2 \ln P_t^* + \eta \quad (2)$$

where $\ln e_t$ is the logarithm of the nominal exchange rate, defined as domestic price of foreign currency, $\ln P_t$ is the logarithm of domestic prices, $\ln P_t^*$ the logarithm of foreign prices, a , β_1 and β_2 are the parameters, and η is the error term. The restrictions commonly imposed on the parameters are $a = 0$, $\beta_1 = 1$ and $\beta_2 = -1$. Relatively, Equation 2 is superior to Equation 1 in terms of specification model (Bleaney, 1991; Kugler and Lenz, 1993; Moosa, 1994). As generally agreed, the bivariate model is potentially yield a specification bias by omitting some relevant variables, while the multivariate model would overcome this problem (Gujarati, 2003).

In testing the robustness of the PPP theory, cointegration procedures are applied. There are two types of cointegration test. First, the residual-based cointegration formalized by Engle and Granger (1987) and system-based cointegration procedures proposed by Johansen (1988), Stock and Watson (1988) and Johansen and Juselius (1990). The tests, however, require that the variables must have a same order of integration. Many previous literatures demonstrated that the use of non-stationary macroeconomic variables in regression would produce spurious results and lead to a misleading conclusion (Granger and Newbold, 1974; Gujarati, 2003). Indirectly, this implies that the conventional test statistics such as t- and F-statistics are not longer valid in making inferences. The series, therefore, have to differentiate properly in order to get stationary time series. ADF and PP unit root tests¹ will be applied in achieving this objective.

Besides, both the residual-based and system-based frameworks are used in comparing the findings of these techniques. The system-based framework has some advantages than residual-based approach². The pre-condition of conducting these approaches are the variables concerned must share a same order of integration. But, the difference of the variables removes and dissipates the long-run information (or low-frequency information) if a set of variables is cointegrated. As a consequence, the error correction model (ECM) is applied in order to overcome the loss of the long run information resulting from the data differencing. This model is constructed by including the error correction (EC) term as the lagged-one residuals that generated from the cointegration equation between the variables in the model.

The empirical results of this study are produced by using monthly time series and panel data on nominal exchange rate (home currency/US\$) and the relative price index (measured as the ratio of domestic CPI to foreign CPI) over the period 1983:1 to 2002:9. The countries concerned are Indonesia, Malaysia, Philippines, Singapore and Thailand. These data were collected from the *International Financial Statistics* published by International Monetary Fund (IMF).

III. RESULTS AND INTERPRETATION

As the first step in testing the long-run equilibrium between nominal exchange rate and prices, the order of integration of each variable has been examined. Two unit root tests, namely Augmented Dickey-Fuller (ADF) and Phillips-Perron³ (PP) tests were applied. The results of the unit root tests were reported in Table 1. The null hypothesis of unit root cannot be rejected, hence it is concluded that all series under concerned are non-stationary at level. As a consequence, higher order of differencing is a must. After first differencing, the null hypothesis of unit root is easily been rejected for all series tested. Since all series have the same order of integration, then we can proceed to test the long-run relationship, or steady state equilibrium between the variables concerned.

The findings of the bivariate Engle-Granger and Johansen and Juselius cointegration tests were demonstrated in Table 2 and Table 3 respectively. It is surprisingly contended that the validity of PPP theory is not sustainable in

¹ The model and application of both ADF and PP tests are clearly explained by Dickey and Fuller (1979, 1981), Phillips and Perron (1988) and Enders (1995).

² See Johansen and Juselius (1990).

³ The results of PP test are not reported to keep the number of tables to a minimum. However, the results are available and can be obtained from author upon request.

the long-run. Estimating Equation 1 by using Engle-Granger bivariate cointegration test, for example, the hypothesis of no cointegration cannot be rejected although ADF test was applied. A similar conclusion also comes from Johansen and Juselius cointegration procedure (Table 3). Recognizing the weaknesses of bivariate model in terms of specification biases, Equation 2 was estimated in order to examine the validity of PPP theory by expanding the bivariate model (Equation 1) to trivariate model (Equation 2). The results of both maximum eigenvalue and trace tests were reported in Table 4. The null hypothesis of no cointegration is rejected at 5% significance level for all countries, namely: Indonesia, Malaysia, Philippines, Singapore and Thailand. Therefore, it is concluded that the strong version of PPP theory is valid in the long run for ASEAN-Five countries.

As a complementary result to above findings, we apply panel technique⁴ which both cross-sectional and time series are pooled together to discern the long-run robustness of PPP theory. ADF unit root test shows that pooled data of all variables are stationary at first difference (Table 5, Panel A). Therefore, we re-estimate Equation 2 using panel data regression model. The empirical results from applying this technique demonstrate that three variables (that is, exchange rate, domestic CPI and US CPI) share a long-run relationship, or there exists a steady-state equilibrium between these variables (Table 5, Panel B). This is supportive of the findings obtained from time series data.

TABLE 1: RESULTS OF ADF UNIT ROOT TEST

	Level		First Difference	
	Constant, No Trend	Constant with Trend	Constant, No Trend	Constant with Trend
Indonesia				
Exchange Rate	0.1505 (13)	-2.4393 (13)	-5.3939** (13)	-5.4274** (13)
Price Ratio	1.1018 (13)	-0.9230 (13)	-4.4397** (16)	-4.5523** (16)
Indonesia CPI	-0.1502 (13)	-1.7799 (13)	-4.4382** (16)	-4.4270** (16)
Malaysia				
Exchange Rate	-0.6454 (6)	-1.9031 (6)	-6.7143** (7)	-6.7563** (7)
Price Ratio	-2.7846 (20)	-1.4323 (20)	-3.8869** (16)	-4.7236** (16)
Malaysia CPI	-1.5193 (16)	-1.2381 (16)	-4.8112** (16)	-4.9122** (16)
Philippines				
Exchange Rate	-0.5116 (12)	-2.6075 (12)	-4.3559** (12)	-4.3496** (12)
Price Ratio	-0.5618 (13)	-2.1621 (13)	-4.2884** (17)	-4.2670** (17)
Philippines CPI	-1.7273 (9)	-1.3811 (9)	-4.2384** (17)	-4.4536** (17)
Singapore				
Exchange Rate	-2.0869 (0)	-1.5938 (0)	-7.9700** (6)	-8.0010** (6)
Price Ratio	-1.9641 (8)	-2.4065 (8)	-5.1320** (15)	-5.8677** (15)
Singapore CPI	-1.6528 (18)	-1.2410 (18)	-7.6200** (12)	-7.6111** (12)
Thailand				
Exchange Rate	-0.3139 (7)	-2.1853 (7)	-5.5355** (12)	-5.6243** (12)
Price Ratio	-0.1958 (15)	-1.8042 (15)	-5.2874** (17)	-5.3472** (17)
Thailand CPI	-1.7552 (14)	-0.9174 (14)	-3.8892** (17)	-4.1314** (17)
US CPI	-2.2741 (18)	-1.5086 (18)	-3.7877** (4)	-5.3140** (4)

Note:

Lag length selected by using the Akaike Information Criterion.

The null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of null hypothesis for ADF test is based on the MacKinnon critical values. The critical values for rejection of the ADF test are -2.86 at a significance level of 5% for a model without a linear trend and -3.41 for model with a linear trend.

Figures within the parentheses indicate the number of lag structure.

** indicates the rejection of the null hypothesis of non-stationary at 5% significance level.

⁴ The detail information of panel data regression model is discussed comprehensively by Gujarati (2003), pp. 640-651.

TABLE 2: RESULTS OF ENGLE-GRANGER COINTEGRATION TEST

	ADF
Indonesia	-2.4490 (13)
Malaysia	-1.5546 (6)
Philippines	-2.0312 (15)
Singapore	-2.0813 (0)
Thailand	-2.1065 (14)

Note:

The null hypothesis is no cointegration. The rejection of null hypothesis for ADF test is based on the MacKinnon critical values. The critical values for rejection of ADF test are -3.4509 , -2.8699 and -2.5712 at significance levels of 1%, 5% and 10%, respectively.

Lag length selected by using the Akaike Information Criterion.

Figures within the parentheses indicate the number of lag structure.

*, ** and *** indicate the rejection of the null hypothesis of no cointegration at 10%, 5% and 1% significance levels, respectively.

TABLE 3: RESULTS OF JOHANSEN MAXIMUM LIKELIHOOD TESTS (BIVARIATE MODEL)

Country	Lag	Hypothesis	Maximum Eigenvalue	Critical Value (5%)	Trace	Critical Value (5%)
Indonesia	9	None	10.3494	14.07	12.0746	15.41
		At most 1	1.7252	3.76	1.7252	3.76
Malaysia	2	None	10.7006	14.07	13.4149	15.41
		At most 1	2.7143	3.76	2.7143	3.76
Philippines	7	None	14.2663*	14.07	19.4167*	15.41
		At most 1	5.1503*	3.76	5.1503*	3.76
Singapore	7	None	9.9250	14.07	13.3288	15.41
		At most 1	3.4038	3.76	3.4038	3.76
Thailand	2	None	10.7325	14.07	14.3166	15.41
		At most 1	3.5840	3.76	3.5840	3.76

Note:

Lag length selected by using the Akaike Information Criterion.

Figures within the parentheses indicate the number of lag structure.

* indicates the rejection of the null hypothesis of no cointegration at 5% significance levels.

**TABLE 4: RESULTS OF JOHANSEN MAXIMUM LIKELIHOOD TESTS
(TRIVARIATE MODEL)**

Country	Lag	Hypothesis	Maximum Eigenvalue	Critical Value (5%)	Trace	Critical Value (5%)
Indonesia	9	None	26.1185**	20.97	39.2758**	29.68
		At most 1	8.3750	14.07	13.1573	15.41
		At most 2	4.7823	3.76	4.7823	3.76
Malaysia	2	None	48.5330***	20.97	70.0485***	29.68
		At most 1	14.8303	14.07	21.5155	15.41
		At most 2	6.6851	3.76	6.6851	3.76
Philippines	2	None	36.5378***	20.97	54.6548***	29.68
		At most 1	11.1858	14.07	18.1170	15.41
		At most 2	6.9312	3.76	6.9312	3.76
Singapore	9	None	28.2423***	20.97	41.2167***	29.68
		At most 1	10.3291	14.07	12.9744	15.41
		At most 2	2.6453	3.76	2.6453	3.76
Thailand	2	None	32.0705***	20.97	51.1057***	29.68
		At most 1	11.0111	14.07	19.0352	15.41
		At most 2	8.0240	3.76	8.0240	3.76

Note:

Lag length selected by using the Akaike criterion.

Figures within the parentheses indicate the number of lag structure.

*, ** and *** indicate the rejection of the null hypothesis of no-cointegration at 10%, 5% and 1% significance levels, respectively.

TABLE 5: RESULTS OF PANEL DATA REGRESSION MODEL (PANEL COINTEGRATION)

Panel A

	Level Constant with Trend	First Difference Constant with Trend
Exchange Rate	-1.5232 (12)	-11.7301** (12)
Domestic CPI	0.0688 (12)	-12.2254** (12)
USCPI	0.1221 (12)	-11.7872** (12)

Note:

The null hypothesis is that the series is non-stationary, or contains a unit root. The rejection of null hypothesis for ADF test is based on the MacKinnon critical values. The critical values for rejection of both ADF and PP test are -3.9879, -3.4242 and -3.1348 at significance levels of 1%, 5% and 10%, respectively.

Lag length selected by using the Akaike Information Criterion.

Figures within the parentheses indicate the number of lag structure.

** indicates the rejection of the null hypothesis of non-stationary at 5% significance level.

Panel B

	Lag	Hypothesis	Maximum Eigenvalue	Critical Value (5%)	Trace	Critical Value (5%)
ASEAN- Five Countries	11	None	18.2746	25.54	42.9238**	42.44
		At most 1	12.6682	18.96	24.6491	25.32
		At most 2	11.9809	12.25	11.9809	12.25

Note:

Lag length selected by using the Akaike Information Criterion.

Figures within the parentheses indicate the number of lag structure.

*, ** and *** indicate the rejection of the null hypothesis of no-cointegration at 10%, 5% and 1% significance levels, respectively.

IV. CONCLUSION

This paper investigated the long-run validity of PPP theory in ASEAN-Five countries, namely: Indonesia, Malaysia, Philippines, Singapore and Thailand stemming from 1973:M1 to 2002:M9. Some advanced econometric techniques were applied to perform the objectives of the study. The findings of PPP theory are mixed depending on the different version of PPP models and techniques used. We could not find any supportive evidence for PPP theory for all ASEAN-Five countries when both bivariate models of Engle-Granger and Johansen-Juselius cointegration procedures were applied (Equation 1). Nevertheless, when the bivariate model has been transformed into trivariate model (Equation 2), Johansen-Juselius multivariate cointegration test demonstrated supportive evidence for the robustness of PPP theory for all countries. In addition, the results of panel cointegration analysis confirmed the long-run relationship between the variables under concern. The study, therefore, concluded that PPP theory is hold in ASEAN-Five countries for the period under study.

ACKNOWLEDGEMENTS

We wish to acknowledge, with thanks, helpful suggestion and clarifications made by Professor Dr. Ahmad Zubaidi Baharumshah, a lecturer at the Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia. All errors and omissions are our own.

REFERENCES

- Abuaf, N. and Jorion, P. (1990), Purchasing Power Parity in the Long Run, *Journal of Finance*, 45: 157-174.
- Azali, M., Habibullah, M.S. and Baharumshah, A.Z. (2001), Does PPP Hold Between Asian and Japanese Economies? Evidence Using Panel Unit Root and Panel Cointegration, *Japan and the World Economy*, 13: 35-50.
- Baillie, R.T. and Selover, D. (1987), Cointegration and Models of Exchange Rate Determination, *International Journal of Forecasting*, 3: 43-51.
- Bleaney, M. (1991), Does Long-Run Purchasing-Power Parity Hold within the European Monetary System? *Journal of Economic Studies*, 19: 66-72.
- Canzoneri, M., Cumby, R., Diba, B. (1999), Relative Labor Productivity and the Real Exchange Rate in the Long Run: Evidence for a Panel of OECD Countries, *Journal of International Economics*, 47: 245-266.
- Cheung, Y.W., Lai, K.S. (1993), Long-run Purchasing Power Parity During the Recent Float, *Journal of International Economics*, 34: 181-192.
- Coakley, J., Fuertes, A.M. (1997), New Panel Unit Root Tests of PPP, *Economic Letters*, 57: 17-22.
- Cooper, J. (1994), Purchasing Power Parity: A Cointegration Analysis of the Australian, New Zealand and Singaporean Currencies, *Applied Economics Letters*, 1: 67-71.
- Dickey, D.A. and Fuller, W.A. (1979), Distribution of the Estimators for Autoregressive Time Series with a Unit Root, *Journal of the American Statistical Association*, 74: 427-431.
- Dickey, D.A. and Fuller, W.A. (1981), Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, *Econometrica*, 47: 1057-1072.
- Dornbusch, R. (1976), Expectations and Exchange Rate Dynamics, *Journal of Political Economy*, 84: 1161-1176.
- Dutton, M., Strauss, J. (1997), Cointegration Tests of Purchasing Power Parity: The Impact of Non-traded Goods, *Journal of International Money and Finance*, 16: 433-444.
- Enders, W. (1995), *Applied Econometric Time Series*, New York: John Wiley.
- Engle, R.F. and Granger, C.W.J. (1987), Cointegration and Error Correction: Representation, Estimation and Testing, *Econometrica*, 55: 251-276.
- Frenkel, J.A. (1978), Purchasing Power Parity: Doctrinal Perspective and Evidence from the 1920s, *Journal of International Economics*, 8: 169-191.

- Granger, C.W. and Newbold, P. (1974), Spurious Regression in Econometrics, *Journal of Econometrics*, 2: 111-120.
- Gujarati, D.N. (2003), *Basic Econometrics*, 4th Edition, New York: McGraw Hill.
- Huang, B.N. and Yang, C.W. (1996), Long Run Purchasing Power Parity Revisited: A Monte Carlo Simulation, *Applied Economics*, 28: 967-974.
- Johansen, S. (1988), Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control*, 12: 236-254.
- Johansen, S. (1991), Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models, *Econometrica*, 59: 1551-1580.
- Johansen, S. and Juselius, K. (1990), Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money, *Oxford Bulletin of Economics and statistics*, 52: 169-210.
- Jorian, P., Sweeney, R.J. (1996), Mean Reversion in Real Exchange Rates, *Journal of International Money and Finance*, 15: 535-550.
- Kim, Y. (1990), Purchasing Power Parity in the Long-Run: A Cointegration Approach, *Journal of Money, Credit and Banking*, 22: 491-503.
- Koedijk, K.G., Schotman, P.C., Van Dijk, M.A. (1998), The Re-emergence of PPP in the 1980s, *Journal of International Money and Finance*, 17: 51-61.
- Kugler, P., Lenz, C. (1993), Multivariate Cointegration Analysis and the Long Run Validity of PPP, *Review of Economics and Statistics*, 75: 180-184.
- Lee, D. (1999), Purchasing Power Parity and Dynamic Error Correction Evidence from Asia Pacific Economies, *International Review of Economics and Finance*, 8: 199-212.
- Levin, A., Lin, C.F. (1993), Unit Root Test in Panel Data: New Results, Discussion Paper 93-56, Department of Economics, University of San Diego.
- Lothian, J.R. (1997), Multi-country Evidence on the Behavior of Purchasing Power Parity, *Journal of International Money and Finance*, 16: 19-35.
- Lothian, J.R. (1998), Some New Stylized Facts of Floating Exchange Rates, *Journal of International Money and Finance*, 17: 29-39.
- Manzur, M. and Ariff, M. (1995), Purchasing Power Parity: New Methods and Extensions, *Applied Financial Economics*, 5: 19-26.

- Meese, R.A. and Singleton, K.A. (1982), On Unit Roots and the Empirical Modeling of Exchange Rates, *Journal of Finance*, 37: 1029-1035.
- Moosa, A. (1994), Testing Proportionality, Symmetry and Exclusiveness in Long-run PPP, *Journal of Economic Studies*, 21: 3–21.
- O’Connell, P.G.J. (1998), The Overvaluation of Purchasing Power Parity, *Journal of International Economics*, 44: 1–19.
- Oh, K.Y. (1996), Purchasing Power Parity and the Unit Root Tests Using Panel Data, *Journal of International Money and Finance*, 15: 405–418.
- Papell, D. (1997), Searching for Stationarity: Purchasing Power Parity Under the Recent Float, *Journal of International Economics*, 43: 313–332.
- Pedroni, P. (1996), Fully Modified OLS for Heterogeneous Cointegrated Panels and the Case of Purchasing Power Parity, Indiana University Working Paper.
- Phillips, P.C. and Perron, P. (1988), Testing for a Unit Root in Time Series Regression, *Biometrika*, 75: 335-346.
- Pippenger, M. (1993), Cointegration Tests of Purchasing Power Parity: The Case of Swiss Exchange Rates, *Journal of International Money and Finance*, 12: 46–61.
- Sidique, A., Sweeney, R.J. (1998), Forecasting Real Exchange Rates, *Journal of International Money and Finance*, 17: 63–70.
- Stock, J.H. and Watson, M.W. (1988), Variable Trend in Economic Time Series, *Journal of Economic Perspectives*, 2: 147-174.
- Toda, H. and Yamamoto, T. (1995), Statistical Inference in Vector Autoregressions with Possibly Integrated Processes, *Journal of Econometrics*, 66: 225-250.
- Whitt, J.A., Jr. (1992), The Long Run Behaviour of the Real Exchange Rate: A Reconsideration, *Journal of Money, Credit and Banking*, 24: 72-82.
- Wu, Y. (1996), Are Real Exchange Rates Nonstationary? Evidence from a Panel-Data Test, *Journal of Money, Credit and Banking*, 28: 54–63.