Jurnal Ekonomi dan Bisnis Indonesia
Vol. 22, No. 1, 2007, 43 – 56

NON-TRADED GOODS AND PURCHASING POWER PARITY DEVIATION: EVIDENCE FROM ASEAN COUNTRIES

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ABSTRAKSI

Paper ini membahas pengaruh barang tidak diperdagangkan (efek Balassa-Samuelson) pada Purchasing Power Parity (PPP) antara empat negara ASEAN – yaitu Singapore, Malaysia, Indonesia, dan Philippine – dengan negara mitra dagang utama. Paper ini mengaplikasikan tiga metode: runtun waktu (univariate time series)*, regresi multi-variabel* (multivariate regression) *dan kointegrasi multi-variabel* (Johansen framework of multivariate cointegration)*. Paper ini ditujukan untuk menjawab pertanyaan-pertanyaan berikut: Apakah PPP hipotesis berlaku dalam kasus negara ASEAN? Apakah harga relatif barang tidak diperdagangkan memainkan peranan penting dalam penyimpangan PPP? Tiga metode memberikan kesimpulan yang sama. Pertama, hipotesis PPP tidak berlaku di keempat negara ASEAN. Kedua, barang tidak diperdagangkan memiliki peranan signifikan dalam penyimpangan PPP di keempat negara ASEAN. Hal ini terbukti dengan keberadaan efek Balassa-Samuelson yang signifikan di keempat negara ASEAN.*

Kata kunci: Purchasing Power Parity (PPP), Balassa-Samuelson Effect, Stationary, Multivariate Cointegration.

INTRODUCTION

Purchasing Power Parity (PPP) is one of the oldest and most studied topics in international economics. PPP is a simple empirical preposition that once converted to a common currency; national price levels should be equal. The theory of PPP explains movements in the exchange rates between two countries' currencies by changes in the countries' price levels (Krugman & Obstfeld, 2000:394). It proposes that the exchange rate between two countries' currencies equals the ratio of countries' price level. The variation in prices between countries will be matched by the exchange rate. In other words, the nominal exchange rate will reflect differences in inflation among countries.

The theory of PPP therefore predicts that a fall in a currency's domestic purchasing power (as indicated by an increase in the domestic price level) will be associated with proportional currency depreciation in the foreign exchange market. Although there is little empirical evidence to support the application of this result of the "law of one price" in short run (Frenkel, 1981; Rogoff, 1996), there is evidence in the long run. The term long run is used in the literature to indicate that temporary deviation may take place, but over a sufficiently long time horizon, the deviations will be stationary.

The PPP hypothesis might not hold for some determinants. One important deter-

* The author would like to thank Prof. Masumi Hakogi (HUE), Prof. Yokokawa Kazuo (GSICS-Tohoku University), Prof. Daitoh Ichiro (GSICS-Tohoku University), and all participants of the discussion at Graduate School of International and Cultural Studies (GSICS) – Tohoku University, October 30th , 2006 for the valuable comments.

minant is familiarly called Balassa-Samuelson effect after two seminal papers by Balassa (1964) and Samuelson (1964), which placed the foundation for the structural models of inflation. In addition, many studies from the mid 1980s and onward have also examined whether divergence from PPP and national price levels can be explained in terms of the Balassa-Samuelson effect. The literature does, however, provide a unanimous agreement on how to interpret the evidence.

This paper is addressed to answer some critical questions: first, does PPP not hold in the strong sense in the case of East Asian countries? Many researches have found evidence that support the PPP condition in developed countries, while evidence for developing countries is almost nonexistent. ASEAN (Association of South East Asian Nations) countries which have different policies of exchange rate, international trade, and domestic regulation are interesting object to be analyzed. Second, do relative prices of non-traded goods and the terms of trade play an important role in causing deviations away from PPP? This paper tests the PPP hypotheses adjusted for Balassa-Samuelson effect.

The rest of this paper is organized as follows. Part 2, the literature review is described. It consists of types of PPP, empirical techniques widely used in analyzing the PPP hypothesis, previous findings about PPP across different techniques, and Balassa-Samuelson effect. In Part 3, methodology applied in this paper is presented. It covers description about sources and kinds of data, and derivation of the model. In Part 4, the empirical analysis is presented. This part discusses stationary test of variables, analysis of PPP hypothesis in the 4 selected ASEAN countries based on the three methods i.e. univariate time series, multivariate regression and Johansen multivariate framework of cointegration. Some conclusions is presented in part 5.

LITERATURE REVIEW

1. Types of PPP

There are two types of PPP which have been developed over time i.e. absolute PPP and relative PPP. The first PPP hypothesis states that the exchange rate between the currencies of two countries (E) should be equal to the ratio of the price levels of the two countries ($\frac{P}{P^f}$). It is formulated as:

$$E = \frac{P}{P^f} \tag{1}$$

where E is nominal exchange rate measured in units of domestic currency per unit foreign currency, P is the domestic price level, and P^f is the foreign price level. On the other hand, the relative PPP hypothesis states the exchange rate (E) should be proportionate to the price levels of the two countries. It is expressed as:

$$E = \theta \frac{P}{P^f} \tag{2}$$

where θ is a constant parameter.

2. Empirical techniques

The empirical study on the PPP hypothesis has long story (Froot & Rogoff, 1995; Sarno & Taylor, 2002). Basically, the empirical techniques in analyzing PPP can be divided into some types i.e. naive techniques, multivariate cointegration techniques, long-span and panel techniques; and application of non-linear techniques (Calderon & Duncan, 2003). The following paragraphs briefly summarize the empirical techniques.

Naive techniques. Very beginning studies apply the following basic linear equation or multivariable regression for testing PPP:

$$e_t = \alpha_o + \alpha_1 p_t + \alpha_2 p_t^f + u_t \tag{3}$$

where e_t is the nominal exchange rate (NER), p represents domestic prices and p^f denotes foreign price. All variables are in logarithm form. Error term u_t is assumed to be white noise error terms (disturbances). Then, the ordinary least square (OLS) is applied to estimate the coefficients in equation (3)[1]. Since the fact that exchange rate and prices are non stationary series, the inference obtained from the standard econometric techniques might not be valid (Griffith *et al*., 1993; Gujarati 2000). If u_t is non-stationary, any relationship obtained from equation (3) is spurious. Therefore, this technique should be followed by examining the stochastic properties of the error term in equation (3).

Univariate Time Series techniques. Univariate time series basically examines the behavior of series. Regarding to the non-stationary problem in naive technique, univariate techniques use unit root and cointegration techniques on Real Exchange Rate (RER). Researchers who apply this technique always conduct a test whether RER is stationary or not. Respectively, if e, p and p^f denote the logarithm of foreign exchange, domestic price level and foreign price level, long run PPP requires that e+ p^f-p –which is called Real Exchange Rate, RER, in the logarithm form- must be stationary. In specific time (t), RER can be represented (Enders, 1995):

$$RER_t = e_t + p_t^f - p_t \quad (4)$$

The evidence found is manly against PPP. The unit root (stationary) test on the RER completely assumes the validity of two conditions: symmetry ($\alpha_1 = -\alpha_2$ in equation (3)) and proportionality ($\alpha_1 = 1$ and $\alpha_2 = -1$ in equation (3)).

Parallel with the development of analytical tools and computer program, researchers use different approaches to analyze the stationarity of RER, such as: Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) test, Phillip-Perron (PP) test, Dickey-Fuller test with GLS Detrending (DF-GLS), Ng-Perron test (NP), Kwiatkowski et.al (KPPS)[2]. Some stationary tests commonly used are ADF and PP tests.

The ADF test constructs a parametric correction of the typical Dickey-Fuller test for highest-order correlation by assuming that the series (RER_t) follows autoregressive with order p -denoted as AR(p)- process and adding lagged difference terms of the dependent variable RER_t to the right hand side of original test regression. The general equation of the ADF is:

$$\Delta RER_t = \beta_o + \beta_1 RER_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta RER_{t-i} + \sum_{j=1}^{q} \gamma_i x_{jt} + \delta t + \varepsilon_t \quad (5)$$

where x_{jt} is exogenous variables and ε_t is the error term. The RER_t is non-stationary if we accept the hypothesis[3] saying that β_1=0. For testing the hypothesis, researcher must follow conventional Student's t-distribution $t_{\beta_1} = \frac{\beta_1}{se(\beta_1)}$ and it must be compared with McKinnon (1991, 1996) critical value.

The PP test estimates the non-augmented DF test equation (equation 5 with p=0) and modifies t-ratio of β_1 coefficient in equation (5) so that serial correlation does not effect the asymptotic distribution of the test statistic. In fact, the PP test is an alternative (non-parametric) method of controlling for serial correlation when testing for unit root. The PP test is based on the statistic:

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1 Hypothesis for PPP testing: the null hypothesis H_o: α_1 =1, α_2=-1 ; and the alternative hypothesis H_1: otherwise.

2 For detail explanation, see Enders (1995), Calderon & Duncan (2003) and Griffith *et al.* (1993)

3 Hypothesis for PPP testing (or stationary of RER): the null hypothesis H_o: β_1 =0; and the alternative hypothesis H_1: $\beta_1 \neq 0$.

$$\tau_{\beta_1} = \frac{\gamma_o^{\frac{1}{2}} t_{\beta_1}}{\hat{\omega}} - \frac{\left(\hat{\omega}^2 - \gamma_o\right) T s_{\beta_1}}{2\hat{\omega} s} \quad (6)$$

where $\hat{\omega}^2 = \gamma_o + 2\sum_{v=1}^{q}\left(1 - \frac{v}{q+1}\right)\gamma_j$;

$$\gamma_j = \left(\sum_{t=j+1}^{T} \hat{\varepsilon}_t \hat{\varepsilon}_{t-j}\right) / T$$

t_{β_1} and s_{β_1} are the t-statistic and standard error of β_1. s denotes the standard error of the test regression. Similar with the ADF test, this statistic must be compared with McKinnon (1991) critical value.

Multivariate Cointegration Techniques. This technique applies cointegration techniques to test the existence of long-run relationship between exchange rate and prices. Cointegration offers an alternative method to check the PPP hypothesis. If PPP holds, the sequence formed by the sum $(e+ p^f)$ should be cointegrated with the p sequence. Lets denote $v=(e+ p^f)$. Long run PPP affirms that there exists a linear combination of the form

$$v_t = \theta_o + \theta_1 p_t + u_t \quad (7)$$

Error term u_t is stationary and the cointegrating vector such that $\theta_1 = 1$ in equation (7). This technique applied not only single equation (Engle & Granger, 1987) but also Vector Auto-Regression (VAR) (Johansen 1988, 1995). The main findings of the studies which applied this technique are: *first*, it is more probable to get support for the PPP hypothesis if fixed exchange rate regimes prevail instead of flexible one. *Second*, it is more probable to reject the null of no-cointegration if the research used Whole Price Index (WPI) instead of Consumer Price Index (CPI) or Gross Domestic Product deflator (GDP deflator). *Third*, it is more probable to get evidence against PPP if the research employ trivariate system instead of bivariate ones (Sarno & Taylor, 2002).

Long-Span Research and Panel Data. This technique analyzes the behavior RER in the very long term. The main shortcoming of this technique is that the presence of real shocks that may shift the RER permanently (Hegwood & Papell, 1998). Panel data is data from combination of time series data and cross-sectional data.

Non-Linear Technique. This technique assumes that RER might have some sort of non-linearity based on the following facts: (i) the slope coefficient of changes in the nominal exchange rate and inflation differential is always unity and it increases with the length of the observation interval (ii) the PPP link is stronger under hyperinflation than under modest inflation.

In sum, the PPP literature illustrates mixed result. The empirical evidence might tend to accept of the PPP theory in the long run. A variety of data sets and statistical (econometrics) techniques are apparent though more recent research focuses on the application of unit root test and tests of cointegration. Glen (1992); and Abuaf & Jorion (1990) use long time periods while Frankel & Rose (1996) and Lothian (1997) provide comparison across a number countries. Cheung & Lai (1993) and Razzaghipour *et al.* (2000) apply Johansen test of cointegration for a fairly short time period in for a number of countries. Sarno & Taylor (2002) stated that if there is a consensus, it is probably reversion towards the view that long-run PPP does hold, at least for the major exchange rate, although some questions have not answered yet.

3. Purchasing Power Parity and Balassa-Samuelson Effect

The structural models of inflation states that two economies with different growth rates of productivity will experience different rates of inflation even the exchange rate does not change. In this case, the classical PPP hypothesis holds, but it has to be adjusted for the different rates of labor productivity. The structural models divide the economy into two sectors i.e. sector producing tradable (T) and sector producing non-tradable (N). It is assumed that the two sectors have Cobb-Douglas production function. Therefore, the production of tradable and non-tradable goods is a function of inputs (capital (K) and labor (L)):

$$Q_T = \rho L_T^{\phi} K_T^{1-\phi} \tag{8}$$

$$Q_N = \rho L_N^{\varphi} K_N^{1-\varphi} \tag{9}$$

Labor is assumed to be perfectly mobile between the sectors. It implies nominal wage (ω) equalization:

$$\omega_T = \omega_N \tag{10}$$

The profit margin in two sectors is assumed to be constant, and workers are paid the value of their marginal product, which is expressed as:

$$\frac{\partial Q_i}{\partial L_i} = \frac{\omega_i}{P_i} \qquad \text{i=T, N} \tag{11}$$

The ratio of marginal productivities to the ratio of average productivities under Cobb-Douglas production technology can be exhibited as follows:

$$\frac{\partial Q_T / \partial L_T}{\partial Q_N / \partial L_N} = \frac{\phi \frac{Q_T}{L_T}}{\varphi \frac{Q_N}{L_N}} \tag{12}$$

Inserting (10) and (11) into (12) yields:

$$\frac{P_N}{P_T} = \frac{\partial Q_T / \partial L_T}{\partial Q_N / \partial L_N} = \frac{\phi Z_T}{\varphi Z_N} \tag{13}$$

where labor productivity (average product of labor) Z is defines as output Q divided by L(i.e. $Z_T = \frac{Q_T}{L_T}$ and $Z_N = \frac{Q_N}{L_N}$). Assuming that labor intensity is equal in the two sectors ($\phi = \varphi$) and expressing equation (13) in the natural logarithm, it becomes:

$$p_N - p_T = z_T - z_N \tag{14}$$

where $p_N = \ln P_N$; $p_T = \ln P_T$; $z_T = \ln Z_T$ and $z_N = \ln Z_N$. Parallel with the structural models, it is assumed the price level in the economy to be equal to the weighted average (convex combination) of the price level in the two sectors, that is

$$p = \tau p_N + (1-\tau) p_T \qquad 0 \le \tau \le 1 \tag{15}$$

where τ is the weight of non-tradable goods in the consumer price index. Similarly, for the foreign economy this equation will be

$$p^f = \tau p_N^f + (1-\tau) p_T^f \qquad 0 \le \tau \le 1 \tag{16}$$

It is assumed that the weight of non tradable τ is the same in the domestic and foreign economies. Parallel with the structural models, it is assumed that PPP between prices in the tradable sectors of the two economies, which is stated as $\ln E = \ln \theta \frac{P_T}{P_T{}^f}$:

$$e = \psi + p_T - p_T^f \tag{17}$$

where $\psi = \ln \theta$. Equation (17) together with equation (15) and (16) can be expressed as

$$\begin{aligned} e &= \psi + p - p^f - \tau bse \\ e &= \psi + (\tau p_N + (1-\tau) p_T) - \\ &\quad (\tau p_N^f + (1-\tau) p_T^f) - \tau bse \end{aligned} \tag{18}$$

where

$$bse = (p_N - p_T) - (p_N^f - p_T^f) \tag{19}$$

is called the Balassa-Samuelson effect after two seminal papers by Balassa (1964) and Samuelson (1964), which laid the ground for the structural models of inflation. If equation (14) is inserted into equation (19) the Balassa-Samuelson effect can also be expressed in terms of labor productivity differential:

$$bse = (z_N - z_T) - (z_N^f - z_T^f) \quad (20)$$

PPP might be difficult to test empirically because information about national price level is available only in the form of price indices rather than absolute one. PPP hypothesis does not make any general statement about the direction of causality between the variable. Therefore, it is not clearly stated which one is dependent variable and which one is independent variable. It only states the relationship. The exchange rate might respond to a change in the ratio of the national price level, in the way around, a change in exchange rate might cause the ratio of the national price.

METHODOLOGY

1. Data

Data on domestic and foreign price are also obtained from IFS. There are three kinds of price indexes commonly employed in the literature. Research which put great importance to the role of the non-tradable sector tends to use the relatively narrow commodity, export or import price indexes. Other research believes that the broader price indexes best capture the price change in the economy, for such indexes as the Labor Cost Index. Those who believe a heavier weight needs to be placed on the tradable sector may use the Wholesale Price Index. The narrower indexes are ruled out since they do not incorporate those goods and services at periphery of being traded. Furthermore, there may be price manipulations by large multinationals that may bias these indices.

This paper uses the Consumer Price Index (CPI) as a proxy for the non-tradable goods price index and the Producer Price Index (PPI) as a proxy for the tradable goods price index. The external price indices are calculated as weighted geometric averages of the price indices of the main East Asian countries' trading partners which are United States (US), Canada, Australia, New Zealand, Finland, Denmark, Netherlands, Switzerland and United Kingdom (UK). The weight is derived from the share of the total sum up of export and import values.

Table 1. Summary of Data Used

	Singapore	Malaysia	Philippine	Indonesia	
				Model I	Model II
Real Effective Exchange Rate	REER	REER	REER*	REER*	REER*
Nominal Exchange Rate	NEER	NEER	NEER	Market Rate (national currency per US $)	Market Rate (national currency per US $)
Tradable Price	PPI	PPI	PPI	PPI	PPI
Non-tradable	CPI	CPI	CPI	CPI	
Foreign Tradable Price	Weighted PPI	Weighted PPI	Weighted PPI	Weighted PPI	US PPI
Foreign Non-tradable Price	Weighted CPI	Weighted CPI	Weighted CPI	Weighted CPI	US PPI
Period	Quarterly: 1975:1 2005:3	Quarterly: 1984:1 2005:3	Quarterly: 1993:1 2005:3	Quarterly: 1971:1 2005:3	Quarterly: 1970:1 2005:3

Note: * calculated by applying equation (4); Real Effective Exchange Rate (REER) and Real Exchange Rate (RER) are interchangeable in this paper.

Source: International Monetary Fund, *International Financial Statistic* (IFS-IMF)

Table 3 summarizes the data used in this paper. Singapore and Malaysia have data on Real Effective Exchange Rate (REER) provided by IFS. For the other ASEAN countries, this paper constructs data on REER based on equation (4). Therefore, the univariate time series analysis for testing PPP hypothesis can be conducted. Indonesia has two models: model I and model II. The difference between model I and model II is on the foreign prices. Indonesia does not have data on Nominal Exchange Rate (NEER). This paper uses Market Exchange Rate which is in national currency per US $. Therefore, this paper uses both weighted foreign prices (model I) and the United State (US) price indexes (model II). Model II can be referred as bilateral analysis of PPP between Indonesia and US.

2. Estimation

This paper analyze the PPP hypothesis in the case of ASEAN countries by using three methods as previously explained: univariate time series, multivariate regression and Johansen framework of multivariate cointegration. Basically, univariate time series method looks at whether Real Exchange Rate (RER) stationary series of not. If it is, PPP hypothesis holds. This paper applies Phillips Perron (Phillips & Perron, 1988) test to analyze stationary of RER.

Multivariate regression is applied to scrutinize the existence of PPP and Balassa-Samuelson effect. As explained in the previous part, equation (18) can be expressed in the econometric model as follows:

$$e_t = \beta_1 + \beta_2(\beta_3 p_{N,t} + (1-\beta_3)p_{T,t}) + \beta_4(\beta_3 p^f_{N,t} + (1-\beta_3)p^f_{T,t}) + \beta_3 bse_t + u_t \quad (21)$$

The existence of PPP and the Balassa-Samueson effect, therefore, can be scrutinized by testing the null hypothesis (H_o) β_2=1, β_2=-1 and β_3=0. Accepting H_o means that PPP holds and Balassa-Samuelson effect does not exist.

The Johansen multivariate framework of cointegration is a method for estimating the cointegrating relationship that exist between a set of variables as well as testing these relationship. The application of this framework on the PPP relationship with the Balassa-Samuelson effect, as stated by equation (21), can be briefly be explained as follows. *First*, a vector autoregressive model with maximum distributed lag length of m is defined (equation system):

$$\begin{bmatrix} e_t \\ p_{N,t} \\ p^f_{N,t} \\ p_{T,t} \\ p^f_{T,t} \end{bmatrix} = \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} & \beta_{45} \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & \beta_{55} \end{bmatrix} \begin{bmatrix} e_{t-1} \\ p_{N,t-1} \\ p^f_{N,t-1} \\ p_{T,t-1} \\ p^f_{T,t-1} \end{bmatrix} + \begin{bmatrix} \mu_{11} & \mu_{12} & \mu_{13} & \mu_{14} & \mu_{15} \\ \mu_{21} & \mu_{22} & \mu_{23} & \mu_{24} & \mu_{25} \\ \mu_{31} & \mu_{32} & \mu_{33} & \mu_{34} & \mu_{35} \\ \mu_{41} & \mu_{42} & \mu_{43} & \mu_{44} & \mu_{45} \\ \mu_{51} & \mu_{52} & \mu_{53} & \mu_{54} & \mu_{55} \end{bmatrix} \begin{bmatrix} e_{t-2} \\ p_{N,t-2} \\ p^f_{N,t-2} \\ p_{T,t-2} \\ p^f_{T,t-2} \end{bmatrix} + \ldots + \begin{bmatrix} \delta_{11} & \delta_{12} & \delta_{13} & \delta_{14} & \delta_{15} \\ \delta_{21} & \delta_{22} & \delta_{23} & \delta_{24} & \delta_{25} \\ \delta_{31} & \delta_{32} & \delta_{33} & \delta_{34} & \delta_{35} \\ \delta_{41} & \delta_{42} & \delta_{43} & \delta_{44} & \delta_{45} \\ \delta_{51} & \delta_{52} & \delta_{53} & \delta_{54} & \delta_{55} \end{bmatrix} \begin{bmatrix} e_{t-m} \\ p_{N,t-m} \\ p^f_{N,t-m} \\ p_{T,t-m} \\ p^f_{T,t-m} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \\ u_{4t} \\ u_{5t} \end{bmatrix} \quad (22)$$

In the short version (matrix form), equation (22) can be expressed as:

$$Y_t = \sum_{i=1}^{m} \alpha_i Y_{t-m} + u_t$$

$$t=1,2,.....,T \quad ; m = 1,2,....,m \quad (23)$$

where

$$Y_t = \left[e_t \; p_{N,t} \; p^f_{N,t} \; p_{T,t} \; p^f_{T,t}\right]^T = \begin{bmatrix} e_t \\ p_{N,t} \\ p^f_{N,t} \\ p_{T,t} \\ p^f_{T,t} \end{bmatrix}$$

and α_i are 4x4 coefficient matrices and u_t is a 4x1 vector of independent and identically distributed error terms. The distributed lag length m should be specified long enough for the residual not to be serially correlated. The cointegrating matrix α, which defines the long-term solution of the equation system, is defined as:

$$\begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} & \alpha_{15} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} & \alpha_{25} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} & \alpha_{35} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} & \alpha_{45} \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & \alpha_{55} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} & \beta_{45} \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & \beta_{55} \end{bmatrix} + \begin{bmatrix} \mu_{11} & \mu_{12} & \mu_{13} & \mu_{14} & \mu_{15} \\ \mu_{21} & \mu_{22} & \mu_{23} & \mu_{24} & \mu_{25} \\ \mu_{31} & \mu_{32} & \mu_{33} & \mu_{34} & \mu_{35} \\ \mu_{41} & \mu_{42} & \mu_{43} & \mu_{44} & \mu_{45} \\ \mu_{51} & \mu_{52} & \mu_{53} & \mu_{54} & \mu_{55} \end{bmatrix} + \ldots + \begin{bmatrix} \delta_{11} & \delta_{12} & \delta_{13} & \delta_{14} & \delta_{15} \\ \delta_{21} & \delta_{22} & \delta_{23} & \delta_{24} & \delta_{25} \\ \delta_{31} & \delta_{32} & \delta_{33} & \delta_{34} & \delta_{35} \\ \delta_{41} & \delta_{42} & \delta_{43} & \delta_{44} & \delta_{45} \\ \delta_{51} & \delta_{52} & \delta_{53} & \delta_{54} & \delta_{55} \end{bmatrix} \quad (24)$$

In short:

$$\alpha = -I + \alpha_1 + \alpha_2 + \ldots + \alpha_m \quad (25)$$

where I is the 4x4 identity matrix. The Johansen procedure now continue with decomposing the matrix r into two Nxm matrices **π** and **η**,

$$\alpha = \pi \eta^T \quad (26)$$

The rows of the matrix **η** now define the cointegrating relationship among the five variables in the vector Y, and the rows of the matrix **π** show how these cointegrating vectors are loaded into each equation in the system. Johansen, furthermore suggest a maximum likelihood estimation procedure to estimate the two matrices **π** and **η** together with test procedures to test the number of distinct cointegrating vectors. Linear parameter restriction of causality within the system can be tested by testing the matrix **π**.

EMPIRICAL ANALYSIS

1. Stationary of Variables

In order to test for PPP it is necessary to identify whether exchange rate and price indexes time series are stationary. This paper applies Phillips-Perron Test (PP) which is an alternative (non-parametric) method of controlling for serial correlation when testing for unit root (stationary). Table 2 describes the summary of stationary test. By using level of significance 1%, 5% and 10%, the PP-statistic is greater than the critical value for all variables. Therefore, the null hypothesis, H_o, of unit root is accepted and we conclude that all variables are non-stationary series.

2. Univariate time series analysis

Time series analysis for PPP basically examines the behavior of an individual Real Exchange Rate (RER) series. This paper applies Phillips-Perron (PP) test to analyze the stationarity of RER. Table 3 summarizes the result of PP-test. PP-test statistic, level of significance and critical values are presented in column 2,3 and 4, respectively. Since PP-test statistic is greater than the critical value of corresponding level of significance used, we accept hypothesis (H_o) of unit roots and conclude that the series is not stationary. For all level of significance, we can conclude that RER is not stationary. Therefore, based on univariate time.

Table 2. Stationary Test

Country	Nominal Exchange Rate				Domestic Consumer Price Index				Foreign Consumer Price Index				Balassa-Samuelson Effect			
	PP-Statistic	Level of Sig.	Critical Value	Conclusion	PP-Statistic	Level of Sig.	Critical Value	Conclusion	PP-Statistic	Level of Sig.	Critical Value	Conclusion	PP-Statistic	Level of Sig.	Critical Value	Conclusion
Singapore	-2.476330	1%	-4.0355	Non Stationary	-0.879130	1%	-4.0355	Non - Stationary	-3.296346	1%	-4.0355	Non - Stationary	-2.016328	1%	-4.0355	Non - Stationary
		5%	-3.4469			5%	-3.4469			5%	-3.4469			5%	-3.4469	
		10%	-3.1482			10%	-3.1482			10%	-3.1482			10%	-3.1482	
Malaysia	-2.196937	1%	-4.0673	Non Stationary	-1.917273	1%	-4.0673	Non - Stationary	-1.272493	1%	-4.0673	Non - Stationary	-2.560644	1%	-4.0673	Non - Stationary
		5%	-3.4620			5%	-3.4620			5%	-3.4620			5%	-3.4620	
		10%	-3.1570			10%	-3.1570			10%	-3.1570			10%	-3.1570	
Philippine	-2.280586	1%	-4.1498	Non Stationary	-1.865377	1%	-4.1498	Non - Stationary	-2.420848	1%	-4.1498	Non - Stationary	0.131626	1%	-3.5653	Non - Stationary
		5%	-3.5005			5%	-3.5005			5%	-3.5005			5%	-2.9202	
		10%	-3.1793			10%	-3.1793			10%	-3.1793			10%	-2.5977	
Indonesia (Model I)	-2.848215	1%	-4.0268	Non Stationary	-2.143524	1%	-4.0268	Non - Stationary	-1.573369	1%	-4.0268	Non - Stationary	-2.699749	1%	-4.0268	Non - Stationary
		5%	-3.4428			5%	-3.4428			5%	-3.4428			5%	-3.4428	
		10%	-3.1458			10%	-3.1458			10%	-3.1458			10%	-3.1458	
Indonesia (Model II)	-2.848215	1%	-4.0268	Non Stationary	-2.143524	1%	-4.0268	Non - Stationary	-0.851603	1%	-4.0268	Non - Stationary	-2.456392	1%	-4.0268	Non - Stationary
		5%	-3.4428			5%	-3.4428			5%	-3.4428			5%	-3.4428	
		10%	-3.1458			10%	-3.1458			10%	-3.1458			10%	-3.1458	

Table 2. Continued& .

Country	Domestic Producer Price Index				Foreign Producer Price Index			
	PP-Statistic	Level of Sig.	Critical Value	Conclusion	PP-Statistic	Level of Sig.	Critical Value	Conclusion
Singapore	-2.163849	1%	-4.0355	Non - Stationary	-2.831595	1%	-4.0355	Non Stationary
		5%	-3.4469			5%	-3.4469	
		10%	-3.1482			10%	-3.1482	
Malaysia	-2.884182	1%	-4.0673	Non - Stationary	-1.901755	1%	-4.0673	Non Stationary
		5%	-3.4620			5%	-3.4620	
		10%	-3.1570			10%	-3.1570	
Philippine	-1.957395	1%	-4.1498	Non - Stationary	-1.096473	1%	-4.1498	Non Stationary
		5%	-3.5005			5%	-3.5005	
		10%	-3.1793			10%	-3.1793	
Indonesia (Model I)	-2.263601	1%	-4.0268	Non - Stationary	-2.379643	1%	-4.0268	Non Stationary
		5%	-3.4428			5%	-3.4428	
		10%	-3.1458			10%	-3.1458	
Indonesia (Model II)	-2.263601	1%	-4.0268	Non - Stationary	-2.493704	1%	-4.0268	Non Stationary
		5%	-3.4428			5%	-3.4428	
		10%	-3.1458			10%	-3.1458	

Source: International Monetary Fund, *International Financial Statistic* (IFS-IMF). Authors Calculation .

Table 3. P series analysis of RER we can say that PPP hypothesis does not hold in the strong sense in these countries. PP Test Based on Real Exchange Rate (RER)

Country	PP test Statistic	Level of Significance	Critical Value	Conclusion	
				RER stationary or non-stationary	PPP Hold or not Hold
Singapore	-2.929594	1%	-4.0361	Non-stationary	Not Hold
		5%	-3.4472	Non-stationary	Not Hold
		10%	-3.1484	Non-stationary	Not Hold
Malaysia	-2.444519	1%	-4.0673	Non-stationary	Not Hold
		5%	-3.4620	Non-stationary	Not Hold
		10%	-3.1570	Non-stationary	Not Hold
Philippine	-1.072086	1%	-3.5683	Non-stationary	Not Hold
		5%	-2.9211	Non-stationary	Not Hold
		10%	-2.5985	Non-stationary	Not Hold
Indonesia (Model I)	-1.645692	1%	-3.4781	Non-stationary	Not Hold
		5%	-2.8824	Non-stationary	Not Hold
		10%	-2.5779	Non-stationary	Not Hold
Indonesia (Model II)	-1.748057	1%	-3.4781	Non-stationary	Not Hold
		5%	-2.8824	Non-stationary	Not Hold
		10%	-2.5779	Non-stationary	Not Hold

Source: International Monetary Fund, *International Financial Statistic* (IFS-IMF). **Author's calculation**.

3. Multivariate analysis

The second method that we use in this paper is the multivariate regression analysis. The econometric model of PPP regarding Balassa-Samuelson effect is specified as equation (21). We rewrite the equation by considering the time (t):

$$e_t = \beta_1 + \beta_2(\beta_3 p_{N,t} + (1-\beta_3)p_{T,t}) + \beta_4(\beta_3 p^f_{N,t} + (1-\beta_3)p^f_{T,t}) + \beta_3 bse_t + u_t$$

The PPP hypothesis holds and Balassa-Samuelson effect dost not exist simultaneously when $\beta_2 = 1, \beta_4 = -1$ and $\beta_3 = 0$. Therefore, testing for the existence of PPP and Balassa-Samuelson effect is basically testing whether the requirements $\beta_2 = 1, \beta = -1$ and $\beta_3 = 0$ are fulfilled or not. To do the test, we follow some stages. *Firstly*, we run the model equation (21). The result of estimation is presented in Table 4. From the sign of coefficient, Singapore, Malaysia and Indonesia have theoretical support. In contrast, Philippine has the opposite sign suggested by theory.

Secondly, we run the stationarity test of error term (u_t) for answering the spurious regression problem. One might be concern about spurious regression in the regression model. As we see in part 4.1, all variables in this model are non stationary; therefore, the regression might curiously be spurious regression. Therefore, we run the test of stationarity of error (disturbance error) using PP-test. This test is used to determine whether the result is spurious regression or not. Basically, if the error terms are stationary, the regression is non-spurious regression. In contrast, if the error terms are non-stationary, the regression spurious regression. The PP-test statistic of error term and the conclusion are presented in row 5 of Table 4. All regression results are non-spurious regressions.

Table 4. Estimation Result

	Singapore	Malaysia	Philippine	Indonesia	
				I	II
Constant (β_1)	1.515054***	5.258861***	4.647062**	13.80879***	12.49905***
Coefficient of Domestic Prices (β_2)	1.146533***	0.054002	-0.999850***	0.952070***	1.051871***
Coefficient of Foreign Prices (β_4)	-0.484908***	-0.179149	0.999470	-1.975573***	-1.793272***
Coefficient of Balassa-Samuelson Effect (β_3)	0.817165***	1.254607***	573.8069	-0.970935***	-0.562650***
Stationary test of error term: PP statistic	-2.152706**	-2.192145**	-2.936059**	-3.354972**	-4.110787***
Conclusion about Spurious Regression	Non Spurious Regression	Non Spurious Regression	Non Spurious Regression	Non Spurious Regression	Non Spurious Regression

Note: *, ** and *** indicate significance at 10%, 5% and 1% respectively
Source: International Monetary Fund, *International Financial Statistic* (IFS-IMF). ***Author's calculation***.

Thirdly, after getting the estimation result and knowing the non-spuriousness of regression, we impose restrictions $\beta_2 = 1, \beta = -1$ and $\beta_3 = 0$ to see whether PPP and Balassa-Samuelson effect hold simultaneously. We run Walt-Coefficient restriction test with some restrictions $\beta_2 = 1, \beta = -1$ and $\beta_3 = 0$ proposed by the PPP hypothesis[4]. The result of Walt-test is presented in Table 5. Based on both of F-statistic and Chi-square statistic, we reject the hypothesis H_o (restrictions: $\beta_2 = 1, \beta = -1$ and $\beta_3 = 0$) for all countries. Therefore, we might conclude that PPP does not hold and Balassa-Samuelson effect exists in the all selected ASEAN countries.

4. Multivariate cointegration framework

In this part, the result of the Johansen cointegration test procedure -applied to test the PPP hypothesis- is be presented. This paper uses all variables -in logarithm form- nominal effective exchange rate, domestic consumer price index, weighted average external consumer price index, domestic producer price index and weighted average external producer price index. In the vector form the variables can be represented as,

$$\begin{bmatrix} e_t \\ p_{N,t} \\ p_{N,t}^f \\ p_{T,t} \\ p_{T,t}^f \end{bmatrix}$$

The system is tested by applying the following scheme. *First*, the maximum lag length is chosen by applying minimum Akaike information criteria together with the level and the signs of the parameters of the cointegrating vector. All countries have Vector Auto-Regressive lag 2 (VAR(2)) with drift.

Table 6 exhibits the result of the Johansen estimation of the model for the sample of the analysis for the all selected countries. The cointegrating vector shows that a valid purchasing power relationship exists. Note that β_3 is the weight of non-tradable in the both domestic and foreign consumer price indexes, and should be theoretically between zero and one. From the sign point view, Singapore, Malaysia and Indonesia (I) have theoretical support.

[4] See Gujarati (2000) for detail explanation about Wald coefficient restrictions test. Basically, the Wald test calculates the test statistic by estimating the unrestricted regression and the restricted regression- without and with imposing the coefficient restrictions specified by the null hypothesis, H_o. The Wald statistic measures how close the unrestricted estimates come to satisfying the restriction under the null hypothesis. If the restrictions are in fact true, then the unrestricted estimates should come close to satisfying the restrictions.

Table 5. Test PPP Hypothesis and Balassa-Samuelson Effect

	Singapore	Malaysia	Philippine	Indonesia	
				I	II
F-stat	1922.362***	53.53983***	1.20E+08***	299.9080***	476.4563
Chi -square	5767.085***	160.6195***	3.61E+08***	899.7240***	1429.369
PPP hypothesis	Not hold	Not hold	Not hold	Not hold	Not hold
Balassa-Samuelson Effect	Exist	Exist	Exist	Exist	Exist

Note: *, ** and *** indicate significance at 10%, 5% and 1% respectively
Source: International Monetary Fund, *International Financial Statistic* (IFS-IMF). ***Author's calculation***.

Table 6. PPP Analysis: Multivariate Cointegration

	Singapore	Malaysia	Philippine	Indonesia	
				Model I	Model II
Model	VAR(2) With drift	VAR(2) With drift	VAR(2) With drift	VAR(2) With drift	VAR(2) With drift
Variables	(e pn pnf pt ptf)	(e pn pnf pt ptf)	(e pn pnf pt ptf)	(e pn pnf pt ptf)	(e pn pnf^ pt ptf^)
Cointegrating vector	$\begin{pmatrix}1.000000\\0.461405\\0.461405\\-12.02908\\12.02908\end{pmatrix}$	$\begin{pmatrix}1.000000\\1.365587\\1.365587\\-3.429373\\3.429373\end{pmatrix}$	$\begin{pmatrix}1.000000\\0.073939\\0.073939\\0.926044\\-0.926044\end{pmatrix}$	$\begin{pmatrix}1.000000\\0.351631\\0.351631\\-1.560514\\1.560514\end{pmatrix}$	$\begin{pmatrix}1.000000\\-0.043094\\-0.043094\\-1.048933\\1.048933\end{pmatrix}$
χ^2 Restriction Test $\begin{bmatrix}\beta_{11}=1\\\beta_{12}=0\\\beta_{13}=0\\\beta_{14}=-1\\\beta_{15}=1\end{bmatrix}$	10.55520**	31.21913***	23.99782***	15.19782***	15.91133***
PPP hypothesis	Not Hold	Not Hold	Not Hold	Not Hold	Not Hold
Balassa-Samuelson Effect	Exist	Exist	Exist	Exist	Exist

Note: *, ** and *** indicate significance at 10%, 5% and 1% respectively
^ United State (US)

However the parameter estimates of the cointegrating vector are relatively far from the value which PPP requires $\begin{bmatrix}1\\\beta_3\\\beta_3\\-1\\1\end{bmatrix}$ expressed by equation (18). In general, the estimates for domestic and external prices are relatively far from their parity values of minus one and one. Singapore has -12.03 and 12.03; Malaysia has -3.43 and 3.43; Philippine has 0.93 and -0.93. The closest models with PPP hypothesis is Indonesia (I) which has cointegrating vector:

$$\begin{bmatrix}1\\0.351631\\0.351631\\-1.560514\\1.560514\end{bmatrix}$$

Secondly, we conduct test of restriction with hypothesis H_o: $\begin{bmatrix}\beta_{11}=1\\\beta_{12}=0\\\beta_{13}=0\\\beta_{14}=-1\\\beta_{15}=1\end{bmatrix}$ as PPP theory required. If hypothesis H_o is accepted, we might conclude that PPP holds and Balassa-Samuelson effect does not exist in specific country. If hypothesis H_o is rejected, we might conclude that PPP does not hold and Balassa-Samuelson effect exists in specific country. The three last rows of Table 6 show the test. For all countries, we conclude that data do not support the hypothesis H_o. In other words, we can conclude that the homogeneity restrictions of minus one and one are rejected. The parameter estimates of the Balassa-Samuelson effect are out of its range of between zero and one. Furthermore, the Balassa-Samuelson effect in the case of Indonesia (II) is not only out of its range of between zero and one, but also the wrong sign. To sum up, the PPP hypothesis does not hold and the Balassa-Samuelson effect do exist in the case of all 4 selected ASEAN countries.

CONCLUSIONS

This paper has scrutinized the Purchasing Power Parity (PPP) hypothesis and the Balassa-Samuelson effect in the four selected ASEAN countries -i.e. Singapore, Malaysia, Indonesia and Philippine- by applying three widely used methods: univariate time series of Real Exchange Rate (RER); multivariate regression; and Johansen framework of multivariate cointegration. Some conclusions are withdrawn. *First*, the PPP hypothesis does not hold in the strong sense in the case of all selected ASEAN countries. *Second*, the relative non-traded goods prices plays significant role in causing deviation away from PPP. *Third*, the Balassa-Samuelson effect does exist in the case of ASEAN countries.

The result that the variables in PPP model are cointegrated, but not necessarily the PPP predicts is really a standard result in this field. For further research, it is better to have a look for something that has not been pointed out in the literature. By running the bilateral regressions, it might get some results like (i) using yearly data, the relation tends to be supported more frequently, (ii) the hypothesis gets stronger support for some groups of countries (e.g., countries with more open trade, those inside the same Free Trade Agreement (FTA), those under one exchange rate regime) than those others, although with no ex ante assurance of course.

Some other factors - which might cause the deviation from PPP hypothesis, such as (Balassa-Samuelson effect), natural barrier (transportation cost), barrier to trade (tariffs and other legal restrictions), imperfect competition and current account imbalances – are quite interesting to be analyzed for other researches.

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