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**Productivity Differentials and Purchasing Power Parity:
Cases of Indonesia and Korea**

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Abstract

This paper provides a test of purchasing power parity (PPP) adjusted with the productivity differentials between tradable and non-tradable goods (Balassa-Samuelson effect) in the cases of Indonesia and Korea by applying Johansen cointegration test and a multivariable regression model with quarterly data 1971:I-2005:III. Least squares (LS) and autoregressive conditional heteroskedasticity (ARCH) methods are applied to estimate the model. To consider the foreign exchange regimes and the Asian currency crisis, this paper divides the analysis into two sub-samples i.e. 'before crisis' (1971:I-1997:II) and 'after crisis' (1999:I-2005:III). The analysis yields some conclusions. *First*, Johansen cointegration test confirms the long run equilibrium relation between foreign exchange and inflation rates. *Second*, the PPP hypothesis (symmetry and proportionality restrictions) does not hold and the Balassa-Samuelson effect significantly exists in the case of Indonesia for the both sub-samples 'before crisis' and 'after crisis'. *Third*, the PPP hypothesis also does not hold and the Balassa-Samuelson effect does not exist in the case of Korea for the sub-sample 'before crisis'. Korea exhibits a deviation against the PPP hypothesis for the sub-sample 'after crisis'.

Keywords: Purchasing Power Parity; Balassa-Samuelson Effect; Autoregressive Conditional Heteroskedasticity.

JEL: F31, F33, F36, F42

1. Introduction

Purchasing Power Parity (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 two countries' price levels (Officer, 1982; Krugman and Obstfeld, 2000). It proposes that the exchange rate between two countries' currencies equals the ratio of countries' price level. The theory of PPP therefore predicts that the decrease in the currency's domestic purchasing power (as indicated by the increase in the domestic price

level) will be associated with the proportional currency depreciation in the foreign exchange market.

The PPP hypothesis might not hold for some determinants. One important determinant is productivity differentials that alter equilibrium relative prices between tradable and non-tradable goods. It is commonly called Balassa-Samuelson effect after two seminal papers which have placed the foundation for the structural models of inflation were published by Balassa (1964) and Samuelson (1964). 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. Froot and Rogoff (1995) stated that the Balassa-Samuelson effect may be relevant in the medium term, but that the spreading of knowledge, together the mobility of physical as well human capital generates a tendency toward absolute PPP over the very long run.

Many researches investigating PPP as an explanation for long-term foreign exchange rate movements have been conducted for developing countries which have various international economic policies including exchange rate system and degrees of trade liberalization, such as East Asian countries. Baharumshah and Ariff (1997), Razzaghipour et al. (2000), Khoon and Mithani (2000), Choudhry (2005), among others, examined the PPP hypothesis in the cases of East Asian countries. However, they did not consider the existence of the productivity differentials between tradable and non-tradable goods (the Balassa-Samuelson effect). Therefore, this paper is addressed to provide tests

of the PPP hypothesis adjusted with the Balassa-Samuelson effect in the cases of two East Asian countries i.e. Indonesia and Republic of Korea (hereafter Korea).

Indonesia and Korea are nicely chosen as comparative case studies for some reasons. *First*, both Korean and Indonesian economies were seriously hit by the East Asian currency crisis in 1997. Korea together with the other East Asian countries in the crisis (Thailand, Malaysia, Singapore, Hong Kong, and Taiwan) was able to quit from the crisis much faster than Indonesia. *Second*, together with Thailand, both countries Korea and Thailand opted to accept assistance from the International Monetary Fund (IMF). However, the IMF liquidity and prescriptions seemed to have worked for Korea and Thailand, but not for Indonesia (Rao, 2001). *Third*, based on IMF characterization of country exchange rate regimes – managed, independently floating and pegged - Korea and Indonesia implemented relatively similar foreign exchange system namely manageable floating exchange rate system before the crisis (Razzaghipour et al., 2000) and independently floating after the crisis. Meanwhile all the others East Asian countries have implemented various exchange rate systems.

The rest of this paper is organized as follows. Part 2 describes briefly the literature review comprising types of PPP, empirical techniques, previous findings, and the Balassa-Samuelson effect. Part 3 exhibits the methodology encompassing data, derivation of the model, and estimation. In Part 4, analysis of the results is presented. Policy implications are presented in Part 5. Finally, part 6 provides some conclusions.

2. Literature Review

2.1. Types of PPP

There are two types of PPP which have been developed over time i.e. absolute PPP and relative PPP. The absolute PPP hypothesis states that the nominal 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:

$$E = \frac{P}{P^f} \quad (1)$$

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 formulated as:

$$E = \theta \frac{P}{P^f} \quad (2)$$

where θ is a constant parameter.

2.2. Empirical techniques

The empirical studies on the PPP hypothesis have a long story. Basically, the empirical techniques in analyzing PPP can be divided into five types i.e. naive techniques, univariate time series, multivariate cointegration techniques, long-span and panel techniques; and application of non-linear techniques (Officer, 1982; Froot and Rogoff, 1995; Sarno and Taylor, 2002; Calderón and Duncan, 2003). The following paragraphs briefly summarize the empirical techniques.

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

$$e_t = \alpha_0 + \alpha_1 p_t + \alpha_2 p_t^f + u_t \quad (3)$$

where e_t is the nominal exchange rate, 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). Since the fact that exchange rate and prices are non stationary series, the inference obtained from the standard econometric techniques might not be valid. If u_t is non-stationary, any relationship obtained from equation (3) is spurious (Gujarati, 2002). 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 as Real Exchange Rate, RER, in the logarithm form-, must be stationary. In specific time (t), RER can be represented as (Enders, 1995):

$$\text{RER}_t = e_t + p_t^f - p_t \quad (4)$$

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)).

Multivariate Cointegration Techniques. This technique applies cointegration test in investigating the existence of long-run relationship between exchange rate and prices. 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

$$v_t = \theta_0 + \theta_1 p_t + u_t \quad (5)$$

Error term u_t is stationary and the cointegrating vector such that $\theta_1 = 1$ in equation (5). This technique applied not only single equation (Engle and Granger, 1987) but also Vector Autoregression (VAR) (Johansen, 1988).

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 may shift the RER permanently (Hegwood and 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 sorts 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.

2.3. Previous Findings

The empirical findings on PPP hypothesis are still inconclusive. Although there is little empirical evidence to prop up the application of this result of the law of one price in the short run (Rogoff, 1996), many researches contribute evidence of the PPP relation in

the long run. The long term is used in the literature to indicate that temporary deviation may happen, but over a sufficiently long time horizon, the deviation will be stationary. Sarno and 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.

Some studies have been conducted in the cases of East Asian countries, including Indonesia and Korea. Razzaghipour et al. (2000) conducted a test of PPP for the South Asia nations i.e. Indonesia, the Philippines, Malaysia, Thailand, and Korea. They found that symmetry and proportionality restrictions had little support in the unit root tests. However, the Johansen tests suggested that the foreign exchange rate and inflation rates were linked in a long run sense. By applying cointegration test and using exchange rates and price indices from end-quarter observation over twenty years, Baharumshah and Ariff (1997) found that the PPP proposition did not hold for all selected five Asian economies i.e. Indonesia, Malaysia, Philippine, Singapore and Thailand. The same result was also withdrawn when the Johansen-Juselius multivariate approach was applied.

More recently, Choudhry (2005) analyzed the effect of Asian currency crisis of 1997-1998 on the generalized PPP by using monthly log of real exchange rates of the currencies Thailand, Malaysia, Indonesia, the Philippines and Korea vis-à-vis the US dollar and the Japanese yen during 1990-2004. Tests were conducted for periods before and after the crisis. Results from the Johansen method of multivariate cointegration confirmed a significant change in the relationship between the real exchange rate before and after the Asian currency crisis. Widodo (2007) investigated PPP as an explanation for exchange rate movement by applying three common methods i.e. univariate time series of Real Exchange Rate (RER); multivariate regression; and Johansen framework of

multivariate cointegration. The first two methods gave the same conclusion that the PPP hypothesis does not hold in the strong sense in the case of all selected ASEAN countries. In addition, the relative non-traded goods prices played significant role in causing deviation away from PPP. The Johansen cointegration test also provided a standard result i.e. there were long run equilibrium relation between exchange rate and inflation rates.

2.4. Purchasing Power Parity and Balassa-Samuelson Effect

Theoretically, the structural model of inflation states that two economies with different growth rates of productivity will have different rates of inflation even if 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 productivity¹. The structural model divides the economy into two sectors i.e. sector producing tradable goods (T) and sector producing non-tradable goods (N). It is assumed that the two sectors have Cobb-Douglas production function. Therefore, the productions of tradable and non-tradable goods are functions of inputs (capital (K) and labor (L)):

$$Q_T = \rho L_T^\phi K_T^{1-\phi} \quad (6)$$

$$Q_N = \rho L_N^\varphi K_N^{1-\varphi} \quad (7)$$

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

$$\omega_T = \omega_N \quad (8)$$

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:

$$\frac{\partial Q_i}{\partial L_i} = \frac{\omega_i}{P_i} \quad i=T, N \quad (9)$$

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

$$\frac{\partial Q_T / \partial L_T}{\partial Q_N / \partial L_N} = \frac{\phi \frac{Q_T}{L_T}}{\phi \frac{Q_N}{L_N}} \quad (10)$$

Inserting (8) and (9) into (10) yields:

$$\frac{P_N}{P_T} = \frac{\partial Q_T / \partial L_T}{\partial Q_N / \partial L_N} = \frac{\phi Z_T}{\phi Z_N} \quad (11)$$

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

($\phi = \phi$) and expressing equation (11) in the natural logarithm, it becomes:

$$p_N - p_T = z_T - z_N \quad (12)$$

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 model, 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:

$$p = \tau p_N + (1 - \tau) p_T \quad 0 \leq \tau \leq 1 \quad (13)$$

where τ is the weight of non-tradable goods. Similarly, for the foreign economy this equation becomes:

$$p^f = \tau p_N^f + (1 - \tau) p_T^f \quad 0 \leq \tau \leq 1 \quad (14)$$

It is assumed that the weight of non tradable τ is the same in the domestic and foreign economies. It is assumed that PPP between prices in the tradable sectors of the

two economies, which is stated as $\ln E = \ln \theta \frac{P_T}{P_T^f}$:

$$e = \psi + p_T - p_T^f \quad (15)$$

where $\psi = \ln \theta$. Equation (15) together with equation (13) and (14) can be expressed as

$$e = \psi + p - p^f - \tau bse$$

$$e = \psi + (\tau p_N + (1 - \tau)p_T) - (\tau p_N^f + (1 - \tau)p_T^f) - \tau bse \quad (16)$$

where

$$bse = (p_N - p_T) - (p_N^f - p_T^f) \quad (17)$$

is called the Balassa-Samuelson effect.

3. Methodology

3.1. Data

Bilateral exchange rates *rupiah* (Indonesian currency) and *won* (Korean currency) vis-à-vis the United States dollar (USD) spanning from the first quarter (I) of 1971 to the third quarter (III) of 2005 were extracted from *International Financial Statistics* published by the International Monetary Fund (IFS-IMF). There are three kinds of price indexes commonly employed in the literature. Researches which put great importance to the role of the non-tradable sector tend to use the relatively narrow commodity, export or import price indexes. Other researches rely on 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. For both domestic and foreign prices, 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 represented by the US's CPI and PPI². Bilateral exchange rates, producer price index and

consumer price index are standard choices in the literature (Frankel and Rose, 1996; Li 1999). Data on Balassa-Samuelson effect is calculated by applying equation (17).

It is important to consider the Asian currency crisis in 1997. The domestic currencies were extremely depreciated against USD. Rao (2001) notes that from January 1997 to January 1998 *won* and *rupiah* vis-à-vis USD were depreciated by 100 percent and 500 percent, respectively. To consider this abnormal depreciation, we exclude 1997:III-1998:IV data from the analysis. This is taken in considering also the adjustment process of change in exchange rate regime from the manageable floating to independent floating (Indonesia in July 1997 and Korea in November 1997). Therefore, we have two sub-samples i.e. 1971:I-1997:II (before the crisis) and 1999:I-2005:III (after the crisis). The first sub-sample follows Razzaghipour *et al* (2000).

3.2. Estimation

A multivariable regression model is applied to analyze the existence of PPP adjusted with Balassa-Samuelson effect. As explained in the previous part, equation (16) can be expressed in the econometric model as follows:

$$e_t = \beta_1 + \beta_2(\beta_3 p_{N,t} + (1 - \beta_3)p_{T,t}) + \beta_4(\beta_3 p_{N,t}^f + (1 - \beta_3)p_{T,t}^f) + \beta_3 bse_t + u_t \quad (18)$$

where u_t is error term. We follow some stages in estimating equation (18). *First*, the least squares (LS) method is applied to estimate the coefficients in equation (18). *Second*, since exchange rate and prices indexes have commonly periods of unusually large volatility followed by periods of relative tranquility (Enders, 1995; Gudjarati, 2002) we conduct a test of the existence of autoregressive conditional heteroskedasticity (ARCH) effect, by applying ARCH Lagrange multiplier (LM) test (Engle, 1982) on u_t in

equation (18). *Third*, once we conclude the existence of ARCH effect, the ARCH method is used to estimate the coefficients in equation (18).

The existence of PPP, then can be examined by testing the null hypothesis (H_0) $\beta_2=1$, $\beta_3=0$ and $\beta_4=-1$. Accepting H_0 means that PPP holds. Meanwhile, standard individual significance test on the null hypothesis (H_0) $\beta_3=0$ can be used to analyze the existence of Balassa-Samuelson effect.

4. Empirical Results

4.1. Stationary test

In order to estimate the model it is necessary to identify whether time series exchange rate, price indexes and the Balassa-Samuelson effect are stationary or non-stationary series. This paper applies both the Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979) and the Phillips-Perron (PP) test (Phillips and Perron, 1988). The null hypothesis (H_0) is that the series is non-stationary. Thus if the null hypothesis can not be rejected, the series is non-stationary.

Table 1 describes the summary of stationary tests for both the level and change in level (first difference) for the two sub-samples i.e. ‘before crisis’ and ‘after crisis’. ADF and PP with 4 lag term, intercept and trend are presented³. By using level of significance 1% and 5%, the ADF and the PP tests confirm that the level of all series in natural logarithm form are non-stationary series, except the natural log of CPI in the case of Korea for the sub-sample ‘after crisis’.

Table 1. Stationary Test of Variables

| Variable | Indonesia | | | | Korea | | | | USA ¹ | | | |
|--|---------------|--------|--------------|--------|---------------|---------|--------------|---------|------------------|---------|---------------|---------|
| | Before Crisis | | After Crisis | | Before Crisis | | After Crisis | | 1971:I-1997:II | | 1999:I-2005:3 | |
| | ADF(4) | PP(4) | ADF(4) | PP(4) | ADF(4) | PP(4) | ADF(4) | PP(4) | ADF(4) | PP(4) | ADF(4) | PP(4) |
| 1. Natural log of bilateral exchange rate | | | | | | | | | | | | |
| Level | -2.01 | -1.94 | -3.57 | -2.08 | -2.25 | -1.89 | -1.67 | -1.48 | | | | |
| First difference | -4.50* | -8.06* | -2.50 | -8.36* | -3.69** | -7.37* | -2.49 | -3.03 | | | | |
| 2. Natural log of consumer price index | | | | | | | | | | | | |
| Level | -3.69** | -1.42 | -2.04 | -1.98 | -1.47 | -0.97 | -4.07** | -4.41* | -1.24 | -0.01 | -2.27 | -1.63 |
| First difference | -3.92** | -7.90* | -5.96* | 3.65** | -3.14 | -6.26* | -3.08 | -5.67* | -2.78 | -3.87** | -1.63 | -3.90** |
| 3. Natural log of producer price index | | | | | | | | | | | | |
| Level | -2.05 | -1.19 | -2.32 | -1.78 | -1.96 | -1.25 | -0.49 | -1.39 | -1.84 | -1.20 | -0.95 | -1.11 |
| First difference | -4.64* | -7.63* | -2.20 | -6.05* | -3.52** | -6.03* | -2.91 | -3.55 | -3.30 | -6.45* | -2.47 | -3.15 |
| 4. Natural log of Balassa-Samuelson effect | | | | | | | | | | | | |
| Level | -1.76 | -1.60 | -2.94 | -1.93 | -1.70 | -1.59 | -3.08 | -2.13 | | | | |
| First difference | -4.29* | -9.08* | -2.07 | -7.04* | -4.87* | -10.78* | -3.50 | -3.97** | | | | |

Notes: * statistically significant at 1% level of significance, ** statistically significant at 5% level of significance. Statistics for both level and change in level (first difference) are reported. ADF(4)=Augmented Dickey Fuller test with 4 lag terms, including intercept and trend. PP(4)=Phillips Perron test with 4 lag terms, including intercept and trend. ¹ We use 1971:I-1997:II and 1999:I-2005:3 instead of words 'Before Crisis' and 'After Crisis' although the defined periods are the same.
Source: IFS-IMF, author's calculation.

4.2. Long run equilibrium: cointegration

This paper uses Johansen cointegration test in investigating whether there is a cointegrating relations between variables in the model i.e. $(e, p_N, p_T, p_N^f, p_T^f)$. Since Balassa-Samuelson effect (bse) is only a linear combination of the existing variables (p_N, p_T, p_N^f, p_T^f) as presented in the equation (17), it can not be included in the Johansen cointegration tests otherwise the singular matrix problem will be found. Evidence for PPP is provided where the Johansen test yields at least one cointegrating vector between the five variables $(e, p_N, p_T, p_N^f, p_T^f)$.

Table 2 exhibits a summary of the test for the number of cointegrating vector. The test are divided into a number of levels with test statistic for $r=0$ (no cointegrating vectors); $r=1$ (one cointegrating vector); $r=2$ (two cointegrating vectors); $r=3$ (three cointegrating vectors); and $r=4$ (four cointegrating vectors). The test follows this procedure: if there is no cointegrating vector then none of hypotheses are rejected; if

there is one cointegrating vector, $r=0$ is rejected but $r=1$ can not be rejected; if there are two cointegrating vectors, $r=0$ and $r=1$ are rejected but $r=2$ can not be rejected; if there are three cointegrating vectors, $r=0$, $r=1$ and $r=2$ are rejected but $r=3$ can not be rejected; and if there are four cointegrating vectors, $r=0$, $r=1$, $r=2$, and $r=3$ are rejected but $r=4$ can not be rejected. The results in Table 2 confirm that there is at least one cointegrating vector for each country and for each sub-sample for 1 percent or 5 percent level of significance. It means that there are evidences of the long run relationships between foreign exchange rate and the four price indexes ($e, p_N, p_T, p_N^f, p_T^f$). This is supportive of PPP in the long run sense.

Table 2. Johansen Test (Trace Statistics) for Number of Cointegrating Vectors

| Hypothesis | Indonesia | | Korea | |
|----------------------------------|--|---|---|---|
| | Before Crisis | After Crisis | Before Crisis | After Crisis |
| $r=0$ (none) | 89.1* | 284.8* | 124.9* | 318.8* |
| $r=1$ (at most 1) | 45.6 | 127.1* | 78.7* | 164.8* |
| $r=2$ (at most 1) | 23.2 | 66.4* | 36.7** | 95.* |
| $r=3$ (at most 1) | 10.9 | 33.0* | 17.0 | 43.5* |
| $r=4$ (at most 1) | 3.0 | 10.8 | 3.6 | 16.1** |
| Cointegration Test Specification | Intercept (no trend) in CE and test VAR Lags:4 | Intercept and trend in CE – No trend in VAR Lags:3 | Intercept and trend in CE – linear trend in VAR Lags:4 | Intercept and trend in CE – No trend in VAR Lags:3 |

Notes: * trace statistic is statistically significant at 1% level of significance, ** trace statistic is statistically significant at 5% level of significance. The model chosen for the testing is a vector autoregressive (VAR) with the specified number of lags, trend and intercept. The number of lags was chosen with reference to information statistics including the the Akaike criterion information (AIC). The last row shows the cointegration test specification. CE stands for Cointegrating Equation.

Source: IFS-IMF, author's calculation.

4.3. Multivariate analysis: least square

The PPP holds when $\beta_2=1$, $\beta_3=0$ and $\beta_4=-1$ constraints are simultaneously fulfilled in equation (18). Therefore, testing for the existence of PPP basically testing whether the requirements $\beta_2=1$, $\beta_3=0$ and $\beta_4=-1$ are fulfilled or not. To carry out the test, we follow some stages. *Firstly*, we estimate the model in equation (18) by using the least squares (LS) method. The estimation results are presented in part A of Table 3. The sign of

estimates are properly matched with the PPP theory, except in the case of Korea for sub-sample ‘after crisis’ which is not in favor of the PPP theory.

Secondly, we run the stationary test of error term (u_t) for answering the spurious regression problem. It might be concerned about spurious regression in the regression model. As we see in the previous sub-part, all variables in this model are non stationary; therefore, the regression might curiously be spurious regression. To deal with that matter, we run the stationary test on error term (u_t) by using ADF and PP tests. Intercept, time trend and lag-length in ADF and PP tests are chosen by applying the Akaike criterion information (AIC). Both ADF and PP test statistics (presented in part B of Table 3) suggest that all the regression results are non-spurious regressions. The stationary error terms also confirm that the variables in the model ($e, p_N, p_T, p_N^f, p_T^f$) are cointegrated. This is consistent with the result of previous Johansen cointegration test.

Thirdly, after getting the estimation result and knowing the non-spuriousness of regression, we impose the restrictions or the null hypothesis (H_0) $\beta_2=1$, $\beta_3=0$ and $\beta_4=-1$ in the model to see whether PPP holds or not. We run Wald-coefficient restriction test with some restrictions $\beta_2=1$, $\beta_3=0$ and $\beta_4=-1$ simultaneously⁴. The results of Wald-test (F-statistic) are presented in part C of Table 3. The different results are found in the case of Indonesia and Korea.

In the case of Indonesia, both sub-samples ‘before crisis’ (1971:I-1997:II) and ‘after crisis’ (1999:I-2005:IV) provide evidence of weak existence of PPP which is shown by the positive value of β_2 (coefficient for domestic price) and negative value of β_4 (coefficient for foreign price). However, the symmetric and proportionality restrictions are not fulfilled. Hypothesis testing on the proportionality and symmetric restrictions (H_0 :

$\beta_2=1$, $\beta_3=0$ and $\beta_4=-1$) is shown in part C of Table 3. We reject H_0 and conclude that PPP hypothesis does not hold in Indonesia for both sub-samples ‘before crisis’ and ‘after crisis’. One reason strongly proposed is the existence of productivity differentials between tradable and non-tradable goods which shown by the significance of coefficient of Balasa-Samuelson effect (β_3).

Table 3. Estimation Result and Tests: Least Squares (LS)

| | Indonesia | | Korea | |
|--|-------------------------|-------------------------|-------------------------|-------------------------|
| | Before Crisis | After Crisis | Before Crisis | After Crisis |
| A. Estimation | | | | |
| Constant (β_1) | 14.384* | 7.988* | 6.832* | 13.179* |
| Coefficient of Domestic Prices (β_2) | 1.392* | 0.6328* | 0.961* | -1.620** |
| Coefficient of BSE (β_3) | -0.342* | -0.797* | -0.048 | -0.776 |
| Coefficient of Foreign Prices (β_4) | -2.486* | -0.397 | -0.973** | 0.292 |
| R-squared | 0.989 | 0.7937 | 0.923 | 0.644 |
| B. Stationary test of error term: | | | | |
| ADF ¹ | -4.388* | -4.177** | -3.775** | -4.417** |
| PP ² | -4.065* | -4.976* | -2.167** | -2.007** |
| Conclusion about Spurious egression | Non-spurious regression | Non-spurious regression | Non-spurious regression | Non-spurious regression |
| C. PPP and BSE tests: | | | | |
| Proportionality and symmetry | | | | |
| $H_0: \beta_2=1, \beta_3=0, \beta_4=-1$ (F-statistics) | 333.093* | 10.090* | 1.538 | 35.902* |
| Conclusion | PPP does not hold | PPP does not hold | PPP holds | PPP does not hold |
| Balassa-Samuelson effect | | | | |
| $H_0: \beta_3=0$ (z-statistics) | -7.860* | -5.250* | -0.429 | -1.407 |
| Conclusion | BSE exists | BSE exists | BSE does not exist | BSE does not exist |
| E. Classical assumption tests: | | | | |
| - Autocorrelation ³ | | | | |
| LM test (F-statistic) | 29.3* | 1.8 | 193.2* | 0.9 |
| Conclusion | Autocorrelation | No-autocorrelation | Autocorrelation | No-autocorrelation |
| - Heteroskedasticity ⁴ | | | | |
| White heteroskedasticity (F-statistic) | 12.9* | 2.97** | 9.1* | 3.7* |
| Conclusion | Heteroscedacticy | Heteroskedasticity | Heteroskedasticity | Heteroskedasticity |
| - ARCH LM test | | | | |
| F-statistic | 14.7* | 6.9* | 57.8* | 0.88 |
| Conclusion | ARCH Effect | ARCH Effect | ARCH effect | No-ARCH effect |

Notes: * statistically significant at 1% level of significance, ** statistically significant at 5% level of significance. ¹ Indonesia-‘Before crisis’: ADF(6) with intercept and trend; Indonesia-‘After crisis’: ADF(9) with intercept and trend; Korea-‘Before crisis’: : ADF(9) with intercept and trend; Korea-‘After crisis’: : ADF(9) with intercept and trend. ² Indonesia-‘Before crisis’: PP(6) with intercept and trend; Indonesia-‘After crisis’: PP(9) with intercept and trend; Korea-‘Before crisis’: : PP(11) no intercept and no trend; Korea-‘After crisis’: PP(6) no intercept and no trend. ³ Breusch-Godfrey Serial Correlation LM Test with numbers of lags 4. ⁴ White heteroskedasticity test.

Source: IFS-IMF, author's calculation.

For the sub-sample ‘before crisis’, Korea provides an evidence of the existence of PPP. Proportionality and symmetric conditions are fulfilled. The Wald test results the acceptance of hypothesis H_0 $\beta_2=1$, $\beta_3=0$ and $\beta_4=-1$. The Balassa-Samulson effect is statistically insignificant in this sub-sample. For the period after crisis, PPP hypothesis does not hold. Moreover, the signs of estimate coefficients were contradictive with the PPP hypothesis.

Fourth, we conduct test of the classical assumptions i.e. autocorrelation and heteroskedasticity by applying Breusch-Godfrey serial correlation LM test and White heteroskedasticity test (no cross term), respectively. The results are presented in part E of Table 3. All cases exhibit heteroskedasticity. Indonesia and Korea for sub sample ‘before crisis’ exhibit autocorrelation. In contrast, no-autocorrelation appears in the case of Korea for sub-sample ‘after crisis’. ARCH LM test is then conducted. All cases, except Korea for sub-sample ‘after crisis’, confirm the existence of ARCH effect.

4.4. Multivariate analysis: ARCH

As indicated by Engle (1982) and Enders (1995), among others, time series like exchange rate and price indexes exhibit commonly periods of unusually large volatility followed by periods of relative tranquility. Our anticipation on this matter by dividing analysis into two sub-sample ‘before crisis’ and ‘after crisis’ still can not eliminate this nature of volatility. This is proved by the existence of ARCH effect as previously mentioned. Therefore, we estimate the equation (18) by considering ARCH method. Table 4 shows the results. The estimations (Part A), give the same sign with the LS estimations which are nicely matched with the PPP theory. Part B and C of Table 4

represent the tests on PPP and the Balassa-Samuelson effect, and the residual test (ARCH LM test and Jarque-Bera Normal distribution test), respectively.

Table 4. Estimation Results: ARCH and GARCH¹

| | Indonesia | | Korea | |
|--|------------------------|-----------------------|------------------------------|------------------------------|
| | Before Crisis | After Crisis | Before Crisis | After Crisis |
| A. Estimation | | | | |
| Constant (β_1) | 15.018* | 7.897* | 6.838* | 12.861* |
| Coefficient of Domestic Prices (β_2) | 1.450* | 0.623* | 0.961* | -1.621** |
| Coefficient of BSE (β_3) | -0.322* | -0.745* | -0.006 | -0.589 |
| Coefficient of Foreign Prices (β_4) | -2.672* | -0.369*** | -0.972* | 0.361 |
| R-squared | 0.988 | 0.789 | 0.922 | 0.619 |
| B. PPP and BSE tests: | | | | |
| Proportionality and symmetry | | | | |
| H ₀ : $\beta_2=1, \beta_3=0, \beta_4=-1$ (F-statistics) | | | | |
| Conclusion | 1736.818* | 9.501* | 23.940* | 160.360* |
| Balassa-Samuelson effect | PPP does not hold | PPP does not hold | PPP does not hold | PPP does not hold |
| H ₀ : $\beta_3=0$ (z-statistics) | | | | |
| Conclusion | -18.166* BSE exists | -5.038* BSE exists | -0.162 BSE does not exist | -1.023 BSE does not exist |
| C. Residual test | | | | |
| ARCH LM test | | | | |
| F-statistic | 2.206 | 0.497 | 0.002 | 0.182 |
| Conclusion | No ARCH effect | No ARCH effect | No ARCH effect | No ARCH effect |
| Normal distribution test | | | | |
| Jarque-Bera statistic | 0.37 | 1.678 | 9.360 ^a | 0.696 |
| Conclusion | Normal distribution | Normal distribution | Not Normal distribution | Normal distribution |

Notes: * statistically significant at 1% level of significance, ** statistically significant at 5% level of significance, *** statistically significant at 10% level of significance. ¹ GARCH stand for Generalized Autoregressive Conditional Heteroskedasticity. In determining the ARCH (or GARCH) model this paper uses AIC criteria: Indonesia-Before crisis GARCH(1,1); Indonesia-After crisis: GARCH(1,1); GARCH (4,4); and Korea-After crisis: GARH(1,1). ^a is very close to the critical value at 1% level of significance.

Source: IFS-IMF, author's calculation.

The conclusion about the existence of PPP and the Balassa-Samuelson effect tests under the ARCH method are relatively similar with that of under the LS method, except in the case of Korea or sub-sample 'before crisis'. In the case of Indonesia for both sub-samples 'before crisis' and 'after crisis', we find that PPP does not hold, meanwhile Balassa-Samuelson effect exists. In the case of Korea, PPP does not hold and Balassa-Samuelson effect does not exist for the sub sample 'before crisis'. For the period after crisis, the signs of estimate coefficients were contradictive with the PPP hypothesis.

5. Policy Implications

The statistical significance of the constant (β_1) in equation (18) as presented in Table 3 and 4, indicates that some factors other than the Balassa-Samuelson effect also cause the deviation from PPP hypothesis. Theoretically, they include natural barriers (transportation cost), trade barriers (tariffs and other legal restrictions), imperfect competition markets and current account imbalances.

The inclusion of non-traded goods in the price indexes is often considered as the primary explanation for the deviations from PPP hypothesis. This paper has empirically proved the existence of the Balassa-Samuelson effect in the cases of Indonesia and Korea. Balassa (1964) and Samuelson (1964) argued that because non-tradable goods are included in price indexes, high income countries will have overvalued currencies relative to low income countries. This is caused by the differences in productivity across countries and sectors. Even in East Asian countries, the analysis of total factor productivity (TFP) shows different productivity across inputs (labor and capital) and countries. For example, in the case of Korea the contributions labor, capital, human capital, foreign capital and technical progress on output growth are 10.5%, 49.8%, 11.4%, 1% and 27.3% for 1969-1990 respectively; meanwhile in the case of Malaysia, they are 13.5%, 48.7%, 18.7%, 0.6% and 18.5%, respectively (Rao, 2001).

Natural barrier such as sea, mountainous areas and rivers will affect transportation cost (shipping, for example). Therefore, the transportation costs may drive a wedge between prices of the same good in different markets. A more important factor than the presence of natural barriers to trade is the trade impediment, i.e. tariffs and other legal restrictions on trade. Mostly, every country restricts the importation of agricultural goods

through the use of tariffs and quotas in order to protect its domestic agriculture sector. Not only agriculture sector, but also other sectors such manufactures are frequently protected by government. By 2001, China, Indonesia, Malaysia, and Philippines had average tariff 17.48%, 8.43%, 10.2% and 7.6%, respectively (Athukorala, 2005). Meanwhile Thailand had average tariff 18.48% by 2002 and Vietnam had average tariff 16.65% by 2003.

In the presence of imperfect competition, traded good prices may not equal across countries. To some extent, suppliers, producers or sellers have a certain degree of market power and then implement price discrimination strategies. Such inequalities will result in deviations from PPP. Markets in developing countries are sometime pointed to have high protection. Some studies have been conducted to analyze effective rate of protection (ERP) in the East Asian countries. World Bank (1993) and Fane and Condon (1996) found that Indonesia had ERP 74%, 70%, 59% and 25% in 1975, 1987, 1990 and 1995, respectively. Meanwhile, World Bank (1993) and Panagariya (1994) found that Korea had ERP 40%, 55%, 67%, 80% and 28% in 1970, 1975, 1980, 1985 and 1988, respectively.

Another reason for the deviation from PPP hypothesis is that exchange rates reflect international trade not only in goods and services, but also in financial assets. The PPP-based approach to evaluating exchange rates only considers the role of international commodity trade. However, trade in assets is arguably just as important (if not more important) in determining supply and demand for currencies. Cross-country asset flows are, in turn, closely related to positions of trade balance and imbalance among nations. Current account imbalances can be seen as reflection of discrepancies between domestic

investment and savings. As these imbalances generate demand and supply changes for assets denominated in various currencies, exchange rates might deviate significantly from PPP.

The deviation from PPP poses important issues for macroeconomic measurement, linkages and policy, such as real income comparisons, interest rate linkages and exchange rate policy. Here are several implications. *First*, with strict PPP based on the law of one price, the purchasing power of a given income in one country and currency can be compared with the purchasing power of the income of any other country by simply measuring incomes in a common currency. But the fact that PPP, in the cases of Indonesia and Korea previously discussed, does not hold leads to systematic biases in comparisons. The real incomes of less developed countries frequently are underestimated when actual exchange rates are used to make the comparison. The low price of non-tradable goods in less developed countries (due to the productivity differential) yields for less developed countries true purchasing power of income significantly above what exchange rate-converted income suggests.

Second, under PPP the real exchange rates, which show a country's competitiveness, are constant. Violating PPP implies the competitiveness, in the cases of Indonesia and Korea, can be intervened by two instrument i.e. exchange rate and domestic price (inflation). Choices of exchange rate system become an important issue i.e. flexible, peg to composite basket, fixed or other systems. If exchange rate can be maintained stable – regardless what exchange rate system implemented- then a country might mainly focused on stabilizing domestic inflation.

Third, failure of one price and violating PPP imply welfare loss due to inefficiency associated with consumers in different location paying different prices for the same good. In a country with domestic currency overvaluation, consumers pay less for imported product. *Fourth*, the difference between PPP and exchange rate must be eliminated. Overvaluation or undervaluation of currency might invite the speculation-motive attacks and intervene frequently the domestic economic stability. Exchange rate movements in the short term are ‘news driven’. Domestic political issues, announcement about interest rate changes, idea of an economist about business cycle and so on are factors that might drive exchange rates fluctuating in the short run. PPP, by comparison, describes the long run behavior of exchange rates. The economic forces behind PPP will eventually equalize the purchasing power of currencies. However, it might take many years.

6. Conclusions

This paper has analyzed the Purchasing Power Parity (PPP) hypothesis adjusted with Balassa-Samuelson effect in the case of Indonesia and Korea over two sub-samples ‘before crisis’ (1971:I-1997:II) and ‘after crisis’ (1999:I-2005:III). Johansen cointegration test strongly confirm the common conclusion on PPP i.e. the foreign exchange and inflation rates are linked in a long run sense.

This paper applies least square (LS) and autoregressive conditional heteroskedasticity (ARCH) methods. Although we have divided our sample into two sub-samples ‘before crisis’ and ‘after crisis’, the nature of volatility in the least squares estimation still exists. The ARCH method is applied to consider the nature of volatility of

variables in the model. Some conclusions are withdrawn. In the case of Indonesia, although estimated sign are proper with PPP hypothesis, the symmetric and proportionally conditions are not fulfilled over both two sub-samples 'before crisis' and 'after crisis'. The PPP hypothesis does not hold in the strong sense and Balassa-Samuelson effect significantly exists. In the case of Korea, the PPP hypothesis also does not hold and Balassa-Samuelson effect does not exist only for sub-sample 'before crisis'. For sub-sample 'after crisis', Korea exhibits a deviation against PPP hypothesis although Balassa-Samuelson effect does not exist significantly.

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Notes

¹ This paper follows Rowland and Oliveros (2003) in deriving PPP adjusted with the Balassa-Samuelson effect.

² Ideally, the external price indices are calculated as weighted geometric averages of the price indices of the main Korea's and Indonesia's trading partners, since the US is only one of them. As of 2005, for instance 48 percent, 15.4 percent, 14.6 percent and 22 percent of Korean trade flows (exports and imports) were trades with to East Asian countries, European Union (EU), the United State (US) and the rest of the world, respectively (based on Direction of Trade Statistics, DOTS-IMF, 2006). In the case of Indonesia, 67.8 percent, 12 percent, 11.5 percent and 8.7 percent of Indonesian trade flows were trades with East Asian countries, European Union (EU), the United State (US) and the rest of the world, respectively. Accordingly, we use Nominal Effective Exchange Rate (NEER) since it represents the ratio of an index of a currency's period average exchange rate to a weighted geometric average of exchange rates for the currencies of selected countries and the euro area (IMF, 2006). Unfortunately, data on NEER are not available for both Korea and Indonesia. In addition, trades are commonly valued in USD. Isogai *et al* (2002) finds that currency used for trade settlement in Korea and Indonesia are dominantly USD. In the case of Korea, they were 88 percent (of exports) and 82 percent (of imports) using USD; meanwhile 5 percent (of exports) and 11 (of imports) using Yen Japan in 1998. In the case of Indonesia, they were 92 percent (of exports) and 78 percent (of imports) using USD; meanwhile 3 percent (of exports) and 8 (of imports) using Yen Japan in 1998. Therefore, it is nicely consistent if we use bilateral exchange rates (*rupiah/USD* and *won/USD*) and the US's price indexes.

³ Other ADF and PP models - selected based on Akaike criterion information (AIC) - give similar conclusion. AIC is formulated as: $AIC = T \ln(\text{residual sum of squares}) + 2n$, where T is number of usable observation and n is number of parameters estimated. A model is said to fit better than the others if the model has the smaller AIC (Enders, 1995). Lag choice appears to have little impact on the reported result.

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_0 . 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.