Does trade openness explain the deviation of purchasing power parity and exchange rate movement?

A L Ang¹, Y T Thum² and S K Sek³
¹,²,³School of Mathematical Sciences, Universiti Sains Malaysia, 11800 Minden, Penang, Malaysia
³E-mail: sksek@usm.my

Abstract. Real exchange rate movements are important in determining a country’s competitiveness and trade flows. The real exchange rate also plays an important role in postulating a relationship between exchange rates and prices as explained in the theory of purchasing power parity (PPP). In this study, we examine the validity of PPP theory in four groups of economies (developed, developing, high, and low trade openness economies) from 1980 to 2016. Our main objective is to examine if trade openness matters in determining the validity of PPP. The study applied the panel unit-root tests to test for the PPP theory. Besides, a static panel threshold regression is applied to investigate the main determinants of real exchange rate movements besides testing the relative PPP theory. The panel unit-root tests revealed the validity of relative PPP theory in all cases. However, the threshold regression reported that the PPP condition may not hold in all regimes when a nonlinearity relationship exists. Foreign and domestic prices are influential in determining the PPP relationship.

Keywords: purchasing power parity (PPP) theory; real exchange rate; static panel threshold regression; trade openness

1. Introduction

Purchasing power parity (PPP) or sometimes called “Cassel’s theory” is among the most radically hypothesized theories in international finance and economies which postulates a nexus between exchange rates and price. According to the PPP theory, the price of a domestic country should equal to the price denominated in a foreign currency in the foreign market. The PPP theory is used as a measurement of living standard and competitiveness. It is used to determine the IMF shareholding [1] and the formulation of the poverty lines for the international development studies [2]. Besides, PPP is also a critical element to determine competitiveness. According to [3], those countries with an undervalued real exchange rate benchmarked on PPP are identified to be more competitive in export and tend to have higher economic growth. In addition to these, PPP is also a determinant to study the exchange rate behavior/adjustment towards variation in price levels. PPP theory can consider as a good instrument in providing insight into the potential valuation of a currency to be overvaluation or undervaluation. The over or undervalued currencies will be adjusted over time. Such adjustments may lead to long-term economic impacts and fluctuations in the exchange rate. It contributed to providing some predictability to these economic impacts.
The concept of PPP has been extensively analyzed and it is the foundation of an extensive number of empirical studies in the international economics area. Previous literature agreed that PPP might not hold in the short run and hence studies mainly examine PPP hypothesis as a long-run phenomenon. Empirical examination through conventional unit-root tests, for instance, augmented Dickey–Fuller (ADF) tests, using data of individual countries during the post-Bretton Wood period mainly reported very little support for PPP [4]. Such failure in detecting PPP effect might be explained by the low power of conventional unit-root tests using short span of data [5]. The low power of unit-root tests could be handled by using long-span of data [6], [7]. Besides, panel unit-root and panel cointegration tests could be other alternatives to test the stationarity of real exchange rates [8], [9], [10].

Besides examining the validity of long-run PPP among industrial countries, empirical studies have extended the PPP theory to investigate the effects of country characteristic. [11] and [12] found that countries with high openness tend to reveal the validity of PPP. This phenomena can be explained by the arbitrage effect that corrected PPP deviations and imposed price parities of tradable goods. On the other hand, [13] and [14] reported little evidence of PPP based on trade openness factor.

To sum up, there are inconclusive results to support the validity of the PPP hypothesis. The inconclusive results might due to limitations (low power) of estimation or statistical techniques. Besides, country’s specific characteristics/ behavior could also matter. Taking into consideration of these two issues, this study aims to close the gaps of previous literature by grouping the countries according to the country-specific characteristic (trade openness): high versus low openness economies. This study has a two-fold objective: Firstly, we seek to validate the PPP hypothesis by applying panel unit-roots and panel cointegration tests; Secondly, a static panel threshold regression of [15] is applied to study the threshold variables that contribute to deviation in PPP and exchange rate movements in both groups of economies. Our results contribute to a better understanding of the economic transmission and the PPP hypothesis examination across groups of economies.

2. Theoretical background

PPP theory has modelled the nominal exchange rate between two countries to be equalized to the ratio of aggregate prices between these two countries. The validity of PPP theory implies the same purchasing power of a unit of currency in both the domestic and the foreign country. The general idea of PPP is that the amount of the same basket of goods that can be bought using a unit of currency in one country should be equivalent to the amount bought using the foreign currency at the going exchange rate.

This theory postulates how the deviation of PPP can anchor for the real exchange rate movement/ adjustment in the long-run. PPP theory provides a basic framework in examining the variant/ validity of PPP across countries. In addition, it is also a baseline model to study how the exchange rate is adjusted towards a purchasing power parity level in achieving the equilibrium in the international macroeconomic market/ system.

The reason that PPP should hold is explained by the Law of One Price, which said that the price of internationally traded goods should be the same anywhere by expressing the price in a common currency. In other words, when the prices of the goods are converted into the common currency, it would be in the same price even though sold in different places due to the elimination of arbitrage in long run.

However, there are 4 restrictions under this “law”. Firstly, the cost of trading such as transportation fees is free. Second, perfect information occurred which the economic agents know the prices of each good well between both countries. Thirdly, it’s assumed there are no trade restrictions or trade barriers such as tariffs or other voluntary restraint agreements (VRAs), all goods and services can be traded internationally. Forth, the goods are homogeneous or identical. In other words, in the absence of frictions (for instance, shipping costs, tariffs, etc.), all goods share the same price in every country.

To demonstrate the LOP, let $P_i$ be the domestic currency prices of goods $P$, $P^*$ as the foreign currency prices of goods, and $E$ as the nominal exchange rate indicated in units of foreign currency per unit of domestic currency [16].
Thus, the law of one price implies that:

\[ P = E \cdot P^* \]
\[ E = \frac{P}{P^*} \]  

(1)

Putting the equation into a logarithm form (which indicated in small capitals), we get the (absolute) PPP equation:

\[ e = p - p^* \]  

(2)

2.1. Absolute versus relative PPP

There are two versions of the PPP hypothesis: absolute versus relative term. PPP holds in absolute form when both purchasing powers of a unit of currency in the domestic economy and the foreign economy is equalized. In determining the exchange rate movement based on absolute PPP theory, the exchange rate should be adjusted equal to the level of purchasing power parity, i.e. the condition where equality prices of national baskets of goods and services between two countries are achieved. On the other hand, relative PPP is indicated in terms of the rate of exchange rate changes and the change of the rate of price differences between two countries. Both terms should be equalized. Symbolically, the variables for the relative PPP theory are as below:

\[ \frac{\Delta E}{E} = \frac{\Delta P}{P} \cdot \frac{\Delta P^*}{P^*} \]  

(3)

Or

\[ E = \frac{kP}{P^*} \]  

(4)

Converting equation (4) into a logarithm form, we get

\[ e = c + p^* - p \]

where \( k \) and \( c \) are in constant values. This means that if the relative PPP holds, then nominal exchange rate will be a constant proportionate to the ratio of domestic relative to foreign prices. In either version of PPP, the validity of the theory implies a constant in real exchange rate, \( Q \).

\[ Q = \frac{EP^*}{P} \]

Or in logarithm form:

\[ q = e + p^* - p \]  

(5)

In a real situation, PPP theory might not always hold. It is more reasonable to apply the relative PPP hypothesis as one might not well determined if the same basket of goods is available in the two countries. The hold of absolute PPP implies the hold of relative PPP but not this does not apply to the other way relationship. The deviation of PPP might happen due to barriers, such as transaction costs. However, such deviations are temporary, as prices will converge to each other in the long-run. In other words, the real exchange rate should be stationary or mean-reverting in the long-run. This condition can be checked using the unit-root tests. The rejection of unit-root implies the stationarity of real exchange rate or the validity of the PPP hypothesis in the long-run.
3. Empirical review

PPP theory provides a basic to understand the real exchange rate movement and deviation of PPP as well as to examine the country’s specific characteristic indicated by level of purchasing power. At the same time, it also provides useful information for the monetary policy and exchange rate evaluation if a currency is under or overvalued, and hence an early policy action should be taken to cater the problem. Many studies have been conducted to examine the existence of PPP theory. Some empirical studies reported results to support the validity of the PPP hypothesis, for instance [18], [19], [20]. On the other hand, some studies reported mixed results with partial countries evident PPP hypothesis, among them include [21], [22], [23]. Some studies did not detect any proof of PPP, among them are [24], [25], and [26].

There are some factors contribute to the failure of PPP theory. Among these factors, the presence of transaction costs may induce a violation of PPP. Transaction costs can be in terms of transport costs, taxes, tariffs, and duties as well as non-tariff barriers. The price differentials will be larger if the distance between two countries or cities is longer, this is termed as a “border effect” [27].

[17] examined the PPP hypothesis using the data of US and UK CPI covering the period of 1820-2001. The result of CPI was compared with that of PPI. They found three main findings. First, absolute PPP is not perfect and continuously holds. Second, there is a tendency that the two national price levels expressed in the common currency to move together in a longer period. Third, the correction between the two national price levels is stronger at the producer level than at the consumer level. The results also revealed that relative and absolute PPP tend to be held in a long-run but not in the short-run. The closer relationship of PPP also holds better in PPI than CPI.

Empirical studies in the late 1970s showed support in testing the validity of PPP theory [28]. [17] argued that such a result may due to the condition of exchange rate of the dollar and the lack of data. Whenever the dollar showed a higher volatility, results of using a monetary approach to the exchange rate were rejected. On the other hand, when longer data was applied to the real exchange rate approach, results indicated a drastic drop in the real exchange rate of the dollar since 1977, and that continuous PPP failed to hold, triggering by a relatively higher volatility in the nominal exchange rate than the national price levels.

There are debates on the PPP puzzle, which leads to the deviation of PPP. Among the reasons include the methodology constraints. Previous studies suffered from logical and methodology constraints. Early studies on testing PPP theory failed to show a mean revert process in the real exchange rate but a random walk process. Some authors argued that the random walk property could due to the implication of the international market efficiency. On the other hand, there are claims that the application of Sharper tools and unit-root tests suffered from the low power of the test. [17] claimed that empirical results lead to uncertainty in modeling exchange rate. In terms of theoretical, economists failed to achieve a consensus view about the non-mean reverting in real exchange rate phenomena. However, there is a belief that long-run PPP is coupled with exchange rate overshooting.

More recently, there is increasing interest to apply nonlinear approaches to examine the PPP hypothesis. By assuming a nonlinearity dynamic in real exchange rate adjustment, the PPP puzzle can be solved. According to [29], the presence of transaction costs in international arbitrage may lead to a nonlinear adjustment and this context started to be discussed more formally in the late 1980s (i.e., [30], [31], [32]).

According to [17], by allowing the autoregressive parameter to be varied in the models estimated, nonlinearity in the exchange rate can be examined using mean reversion. For instance, purely randomized changes in the real exchange rate may be due to the transaction costs of arbitrage. The process stopped when a threshold equal to the transaction cost is reached. When there is an arbitrage and the real exchange rate is reverted toward the band, triggered by the influence of goods arbitrage, this condition is named as “threshold autoregressive.” However, the threshold autoregressive model may subject to the conceptual difficulties as transaction costs are varying across goods. Thus, the arbitraging price differential rate may differ across goods [33].
Besides, nonlinearity might be explained by the heterogeneity in the foreign exchange market [34]. Other than that, [35] argued that the intervention operations of central banks may also cause exchange rate nonlinearity: Invention probably may happen and the action is effective when there is a large violation or deviation of nominal and real exchange rate movements from the PPP fundamental equilibrium.

4. Data
In this study, the analyses were conducted by using panel data and focused on two groups of economies, high trade openness (HTO) versus low trade openness (LTO) countries.

The classification of the trade openness is based on the ranking of The Global Economy which took account for 173 countries in the year 2016. The trade openness from it is measured by using data from World Bank with export plus import as a percent of GDP of 2016 as base measurement. Top 40 and below 40 were chosen among 173 countries to be HTOC and LTOC respectively.

| Table 1. The classification of panel data set. |
|---------------------------------------------|
| **HTO** | Trade Openness (%) | **LTO** | Trade Openness (%) |
| Luxembourg | 407.43 | Nigeria | 20.72 |
| Singapore | 310.26 | Pakistan | 25.31 |
| Malta | 261.52 | Japan | 31.27 |
| Ireland | 221.16 | Columbia | 36.47 |
| Belgium | 164.54 | Australia | 40.77 |
| Netherlands | 153.89 | Uruguay | 41.31 |
| Bahrain | 139.55 | Cameroon | 42.00 |
| Malaysia | 128.64 | Iran | 43.21 |
| Cyprus | 130.20 | Gambia | 64.88 |
| Switzerland | 120.40 | New Zealand | 51.32 |

Data that were used were also collected from the World Bank database. The main independent variable of this study is consumer price indices (cpi) while the dependent variable is the real effective exchange rate (reer) and nominal exchange rate (ner). The other independent variables of this study are trade openness (to), producer price indices of the United States of America (ppi_usa), consumer price indices of the United States of America (cpi_usa). The role of data for the United States of America (USA) is to act as the foreign country price base, so it is not included in any group of the panel data. Besides, those data are presented in an annual format, range from the year 1980 to the year 2016, for a sample size of 37 years. The variables descriptions are shown in Table 2.

| Table 2. Descriptions of Variables. |
|-------------------------------------|
| **Variable** | **Description** |
| lner | Natural log of nominal exchange rate |
| lreer | Natural log of real effective exchange rate |
| lcp | Natural log of consumer price indices |
| lto | Natural log of trade openness |
| lppi_usa | Natural log of producer price indices for United States of America |
| lcpi_usa | Natural log of consumer price indices for United States of America |
5. Methodology

Prior to the Threshold Auto Regression Model, we need to perform the preliminary tests. First, we will check the stationarity of the data by using the unit-root test to verify the validity of PPP. If the data are stationary, then PPP holds. Next, a cointegration test is applied to test the presence of long-run relationships between the exchange rate and the independent variables.

5.1. PPP hypothesis

Generally, a minimum requirement for PPP to hold is that the real exchange rate (RER) is stationary. The validity of PPP hypothesis can be tested based on the following equation:

\[ q = \alpha_0 + \alpha_1 p^* + \alpha_2 p_t \]  

(6)

This equation is the linear regression form originated from the PPP equation (5) mentioned above with the nominal exchange rate remains constant.

The hypotheses of unit root test can be conducted based on equation (6) by assuming: (i) symmetry \( (\alpha_1 = -\alpha_2) \) and (ii) proportionality \( (\alpha_1 = 1, \alpha_2 = -1) \). The result is interpreted in this way: the stationarity of RER indicates the validity of PPP. However, studies found that the result might not support for PPP, e.g., [36] and [37]. In contrast, [38] and [39] rejected the null of unit root in the RER.

\( H_0: \) The series is non-stationary (has a unit root)
\( H_1: \) The series is stationary (no unit root)

If PPP holds or when the null hypothesis is rejected, the result implies the convergence of real exchange rate to its long-run equilibrium level.

Cointegration techniques have been used by many researchers to test PPP by estimating the following equation:

\[ e = \alpha + \beta_p p + \beta_p^* p^* + \varepsilon \]

Early tests were based on the equation of relative PPP. The existence of cointegration implies that \( e, p \) and \( p^* \) should be integrated of order one, denoted as \( I(1) \) and the residuals might be stationary, denoted as \( I(0) \) [40]. A cointegration test is conducted because a cointegration implies that the \( I(1) \) series achieve the long-run equilibrium, or the series are moving together.

Consider the following panel-data model for the \( I(1) \) dependent variable \( \Delta e_{jt} \).

\[ \Delta e_{jt} = \mu_j + \alpha_j \Delta p_{jt} + \beta_j \Delta p_{jt}^* + \varepsilon_{jt} \]

where
\( \Delta e_{jt} \) = first difference of logarithm of nominal exchange rate
\( \Delta p_{jt} \) = first difference of logarithm of domestic price index
\( \Delta p_{jt}^* \) = first difference of logarithm of price index of United States

For each panel \( j \), each of the covariates in \( \Delta p_{jt} \) and \( \Delta p_{jt}^* \) is an \( I(1) \) series. In all tests, there is an assumption that the covariates are not cointegrated among themselves.

The hypotheses of a cointegration test are:
\( H_0: \) \( \Delta e_{jt} \), \( \Delta p_{jt} \), and \( \Delta p_{jt}^* \) are not cointegrated
\( H_1: \) \( \Delta e_{jt} \) and \( \Delta p_{jt} \), \( \Delta p_{jt}^* \) are cointegrated

The rejection of test implies that the series is stationary and that the series \( \Delta e_{jt} \) and \( \Delta p_{jt} \), \( \Delta p_{jt}^* \) are cointegrated.

5.2. Panel static threshold regression

The Panel threshold regression of [15] is applied to study the behavior of nominal exchange rate following the assumption of LOP. As stated in equation (2), the nominal exchange rate is adjusted based
on the price difference between domestic and foreign markets. Applying this concept, we further model the following threshold regression:

Model 1: single threshold effect

\[ dlner_{jt} = \mu + \left( \beta_{1}dlcpi_{jt} + \lambda_{1}dlcpi\_usa_{jt} \right)I(TV \leq \gamma) + \left( \beta_{2}dlcpi_{jt} + \lambda_{2}dlcpi\_usa_{jt} \right)I(TV > \gamma) + \varepsilon_{jt} \]

Model 2: double-threshold effect

\[ dlner_{jt} = \mu + \left( \beta_{1}dlcpi_{jt} + \lambda_{1}dlcpi\_usa_{jt} \right)I(TV \leq \gamma_{1}) + \left( \beta_{2}dlcpi_{jt} + \lambda_{2}dlcpi\_usa_{jt} \right)I(\gamma_{1} < TV \leq \gamma_{2}) + \left( \beta_{3}dlcpi_{jt} + \lambda_{3}dlcpi\_usa_{jt} \right)I(TV > \gamma_{2}) + \varepsilon_{jt} \]

where \( \gamma, \gamma_{1}, \text{and} \gamma_{2} \) are threshold parameters, TV is the threshold variable; \( \mu, \beta_{1}, \beta_{2}, \lambda_{1}, \lambda_{2}, \lambda_{3} \) are coefficients to be estimate and I is the indicator function. Different variables can be treated as threshold variables. In model 1, a single threshold effect may divide the regression into two-regimes, below the threshold and above the threshold value while in model 2, the results provide a 3-regimes regression, low regime, medium regime and high regime. Prior to the estimation, the threshold test is performed to evidence the threshold effect:

Model 1:

\[ \text{Model 1:} \quad H_{0}: \beta_{1} = \beta_{2}, \lambda_{1} = \lambda_{2} \quad \text{versus} \quad H_{1}: \beta_{1} \neq \beta_{2}, \lambda_{1} \neq \lambda_{2} \]

Model 2:

\[ \text{Model 2:} \quad H_{0}: \beta_{1} = \beta_{2} = \beta_{3}, \lambda_{1} = \lambda_{2} = \lambda_{3} \quad \text{versus} \quad H_{1}: \text{at least one } \beta_{i} \text{ and one } \lambda_{i} \text{ are not equal, } i = 1, 2, 3 \]

The rejection of the null hypothesis indicates the presence of threshold effect. In all cases, ***, ** and * indicate the significance results at 1%, 5% and 10% respectively.

6. Results

The panel unit-root tests (Levin Lim, & Chu test, Breitung test, and Im, Pesaran & Shin test) were performed. The results (Table 3) revealed that all variables are not stationary at level but stationary after first differenced, including the real exchange rate. Since we fail to reject the unit-root hypothesis at the level, this indicates the invalidity of PPP in the short-run. However, since all variables are \( \mathcal{I}(1) \), one may proceed to test for the cointegration (Table 4). The panel cointegration tests of Pedroni, Kao’s and Westerlund were performed. The results showed that in all cases, the test statistics can reject the null hypothesis of no cointegration, implying the existence of cointegration or the validity of PPP except Kao’s test for HTO. Combining the results of panel unit-root and cointegration tests, we conclude that PPP does not hold in the short-run but is valid in the long-run.

**Table 3. Result of panel unit-root tests.**

| Variables       | Levin, Lin & Chu t* | Breitung t-stat | Im, Pesaran and Shin W-stat |
|-----------------|---------------------|-----------------|-----------------------------|
|                 | Level | First-Difference | Level | First-Difference | Level | First-Difference | Level | First-Difference |
| **United States of America** |       |                 |       |                 |       |                 |       |                 |
| lcreer_usa      | -6.9843*** | -8.7009***       | 8.5991 | -1.8502**      | -3.39716*** | -15.5329***      |
| lpbpi_usa       | 1.3724   | -16.4431***      | -3.3833*** | -9.9365***     | 0.43859   | -16.3822***      |
| **High Openness Countries** |       |                 |       |                 |       |                 |       |                 |
| lcreer          | -0.4764  | -10.9802***      | -0.8411 | -6.1066***     | -0.8411  | -9.7353***       |
| lner            | 0.4455   | -11.1012***      | -1.5423* | -5.7246***     | -1.4644*  | -8.3170***       |
| lcpi            | -1.4616* | -5.0741***       | 3.3579  | -1.9891**      | -2.3423*** | -7.7988***       |
| lto             | -0.2662  | -13.8492***      | 0.3977  | -10.6272***    | 0.1695    | -8.3170***       |
| **Low Openness Countries** |       |                 |       |                 |       |                 |       |                 |
| lcreer          | -0.4291  | -9.3078***       | -0.0183 | -6.7236***     | -0.4004  | -10.5932***      |
| lner            | -2.2138** | -8.6538***      | 1.6270  | -7.9150***     | -0.4644  | -8.9933***       |
| lcpi            | -1.4915* | -7.4326***       | 1.0673  | -5.0391***     | -1.4188*  | -7.4845***       |
| lto             | -0.8154  | -10.3834***      | 0.2352  | -6.6479***     | 0.0269    | -12.3984***      |
Table 4. Results of panel cointegration tests.

| Pedroni Test          | High Trade Openness | Low Trade Openness |
|-----------------------|---------------------|--------------------|
|                       | Countries           | Countries          |
| Panel v-Statistic     | -3.44704            | -4.016101          |
| Panel rho-Statistic   | -4.683790***        | -6.584185***       |
| Panel PP-Statistic    | -8.587571***        | -11.37951***       |
| Panel ADF-Statistic   | -8.844063***        | -11.41883***       |
| Group rho-Statistic   | -3.806774***        | -3.516164***       |
| Group PP-Statistic    | -10.26083***        | -8.173012***       |
| Group ADF-Statistic   | -10.30884***        | -8.282007***       |
| Kao Test              |                      |                    |
| t-Statistic           | 0.759249            | -1.900561**        |
| Westerlund test       |                      |                    |
| Gt – stat             | -6.680***           | -5.136***          |
| Ga – stat             | -0.0000***          | -3.803***          |
| Pt – stat             | -6.243***           | -5.965***          |
| Pa – stat             | -8.697***           | -8.729***          |

Next, we move on one step further to study the behavior of exchange rate adjustment, triggering by threshold effects. Different threshold variables are tested but only the results that reveal threshold effects are summarized in Table 5.

Table 5. Results of static threshold regression.

| Categories | TV | Variable | Coefficients          |       |
|------------|----|----------|-----------------------|-------|
|            |    | lcpi     | 4.0775<lcpi<4.4120    |       |
|            |    |          | lcpi> 4.4120          |       |
| HTO        |    | dlci     | 1.0391***             | 1.8785*** |
|            |    | dlcpi_usa| -0.0703               | 2.2269*** |
|            |    | intercept | 0.0250                | 0.0250  |
|            |    | R-squared | 0.2024                | 0.2024  |
|            |    | dtlo<0.0136| 1.173465***          |       |
|            |    | dlci     | 1.186366***          |       |
|            |    | dlcpi_usa| -1.43564***          | 0.1126685|
|            |    | intercept | -0.0143               | -0.0143 |
|            |    | R-squared | 0.1405                | 0.1405  |
| LTO        |    | lcpi_usa | 3.9933<lcpi_usa<4.3142|       |
|            |    |          | lcpi_usa> 4.3142      |       |
|            |    | dlci     | -5.9443***            | 0.3081  |
|            |    | dlcpi_usa| -21.3263***          | 19.3588*** |
|            |    | intercept | 4.0167***             | 4.0167*** |
|            |    | R-squared | 0.1995                | 0.1995  |
|            |    | dtlo<0.0924| 0.6722***            |       |
|            |    | dlci     | 1.0564***             |       |
|            |    | dlcpi_usa| -0.8117***           | 1.6396 |
|            |    | intercept | 0.0291                | 0.0291  |
|            |    | R-squared | 0.2004                | 0.2004  |

The examination is limited to at most 2 threshold values. The results have detected two threshold values (4.0775 and 4.4120) when lcpi is a threshold variable while one threshold value (0.0136) is triggered by dlto for the HTO group. dlto also triggered one threshold value in the LTO group (0.0924) while foreign price (lcpi_usa) triggered two threshold values in the LTO group. The presence of threshold effects implies that the PPP relationship is not linear, but may vary across regimes. For example, in HTO group
with changes in trade openness \((dlto)\) as the threshold variable, the nominal exchange rate is adjusted by the price difference between two countries as explained in equation (2), i.e. \(e^* = p - p^*\) with the correct coefficient signs in regime 1 \((dlto \leq -0.0136)\), relative PPP tends to hold in regime 1 but not in regime 2 \((dlto > -0.0136)\). The same condition also happens in the LTO group which relative PPP holds in regime 1 but not regime 2 when \(dlto\) is a threshold variable. Trade openness matters either directly or indirectly as it triggers varying PPP relationships across regimes. PPP tends to hold when the openness changes are low (regime 1) for both groups of economies. Despite the determinant of PPP deviation in explaining the exchange rate adjustment, there might be other important factors which are matter as PPP or PPP deviation alone only accounts for around 20% of the explanatory power.

7. Conclusion

The examination of the PPP hypothesis revealed that the unit root hypothesis failed to be rejected at level but could be rejected at first difference. This implies that the real exchange rate is mean-reverting at first difference and we can conclude that the absolute PPP does not hold but the relative PPP holds in the short-run. The panel cointegration tests revealed that there exists a long run equilibrium PPP relationship in both groups of economies.

On the other hand, the panel threshold regression has evident on the nonlinear relationship between nominal exchange rate adjustment and PPP or deviation of PPP in both groups of economies.

The relationship may vary under different regimes. Factor such as trade openness, domestic and foreign inflation, foreign production productivity impose an indirect effect on exchange rate adjustment and hence influence the exchange rate movement.

In most of cases, higher domestic CPI inflation is associated with the higher exchange rate (depreciation in the exchange rate) while the relationship between foreign price inflation and the exchange rate is negative in many cases, i.e. higher foreign price inflation causes the lower exchange rate (appreciation in the exchange rate). The results coincide with the economic theory, where higher domestic CPI inflation induces a decline in the currency value so that the exchange rate depreciate while higher. A stable trade openness enhances the validity of the PPP relationship. However, there are still other important factors that may explain the exchange rate adjustment behavior which requires further research.

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