Testing the Evidence of Purchasing Power Parity for Southeast Asia Countries

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Abstract. This paper tests the validity of purchasing power parity (PPP) hypothesis using panel methods for nine countries in Southeast Asia in US Dollar and Japanese Yen. The results show that the absolute PPP is rejected by the panel unit root test for Southeast Asia countries over the January 1995 to February 2017. However, when we use developed panel unit root that accounts for structural breaks in the data, and test the PPP hypothesis over the July 1997 to August 2008, the PPP proposition seems to hold for after the Asian financial crisis period 1997 and before the global financial crisis 2008. In addition, this paper has used recent developed panel cointegration tests and found the long-run relationship between the nominal exchange rate and the relative prices – the relative PPP – and the results offer more evidence in Japanese Yen based in favor of cointegration in long-run compared with US Dollar is the base currency.

Keywords: Purchasing power parity (PPP) · Panel data · Unit root Cointegration · Southeast Asia countries

1 Introductuon

Purchasing power parity theory – was developed by Gustav Cassel in 1918 – analyzes the relationship between inflation and the exchange rate. There are two kinds of purchasing power parity: the absolute PPP – also known as the Law of One price – and the relative PPP. The Southeast Asia countries has many similarities on the economic conditions. This also supports the validity of purchasing power parity hypothesis within the region. However, because of the presence of exogenous shocks affect each particular country, PPP theory does not hold.

Inflation and its effect on the exchange rate have always been interested by many researchers over the world. Besides, after many years establishment of the Association of Southeast Asian Nations (ASEAN), it is important to investigate whether goods markets in these countries had been more integrated, towards the establishment of a monetary union in the future. Therefore, this paper tests the validity of purchasing power parity in Southeast Asian countries, namely Vietnam, Laos, Cambodia, Thailand, Malaysia, Singapore, Myanmar,

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Indonesia, and the Philippines from January 1995 to February 2017. This is done by comparing the PPP proposition between two numeraire currencies – US Dollar and Japanese Yen – as based currencies by using panel unit root test and panel cointegration test.

2 Literature Review

The theory of purchasing power parity has been tested in many countries around the world; of which, the PPP holds or not is still debated fiercely. In particular, several studies find that the relative PPP holds in long-term (Zhou (2013)). However, many other researchers as Caporale and Gil-Alana (2010) have strongly rejected the PPP hypothesis, and they also offer explanations for that matter.

Besides, a number of researchers have discovered two PPP Puzzles. Specifically, the first PPP Puzzle statement that although the absolute purchasing power parity exists, we also uncertain that the relative purchasing power parity holds. Besides, the second PPP Puzzle statement that PPP holds in the long run also suggested that the speed at which real exchange rates adjust to the PPP exchange rate was extremely slow (Huizinga (1987)); in addition, some researchers also proposed some solutions of this second PPP puzzle (Becmann (2013)).

On the other hand, a number of studies have been undertaken to test the validity of PPP in the Southeast Asia countries, they show that many base currencies are used in the data. Since then, according to some studies as Ridzuan and Ahmed (2011), have concluded that we will have different results when using different based currencies. However, some researches show that despite any base currencies, the testing results remain unchanged (Kim et al. (2009)). In addition, the testing with the presence of the structural breaks in real exchange rate is also made, such as the Asian financial crisis in 1997. And they conclude that the existence of purchasing power parity is different in different times, before and after the structural breaks (Choudhry (2005)). Purchasing power parity is also tested by unit root tests, and most of them could not find evidence in favour of PPP. Besides, cointegration tests are also applied to examine the PPP hypothesis, and they show that results will vary depending on the study. Over the last decade, the empirical unit root and/or cointegration tests of the long run purchasing power parity relationship have shifted from a linear towards a nonlinear setup (Bec and Zeng (2012)).

However, there are few studies use this method with data of Southeast Asia countries. Yet, as stressed by Kim et al. (2009), the PPP assumption has a special meaning to Southeast Asian countries. Therefore, this paper tests the validity of purchasing power parity in Southeast Asian countries.

3 Methodology and Data

3.1 Empirical Metholodogy

In this paper, we employ the panel data methods. There are two approach to study purchasing power parity, the monetary approach (panel cointegration tests) and real exchange rate approach (panel unit root tests).

Both tests are conducted by using Eviews 8.0 software.

3.2 Data

The empirical results of this study produced by using monthly data, including the nominal exchange rate and consumer price index for nine Southeast Asia countries, namely Vietnam, Laos, Cambodia, Thailand, Myanmar, Malaysia, Singapore, Indonesia, and the Philippines over the period January 1995 until February 2017. We do not test the PPP hypothesis in Brunei Darussalam and Timor-Leste because of the limitations of data. Besides, the monthly consumer price index of Japan and United State are also used.

The nominal exchange rate used in this study are pegged into two major currencies; one is US Dollar and the other one is Japanese Yen, to check whether research results are inconsistent.

These data can be obtained for website Fxtop, and the International Financial Statistic published by International Monetary Fund. Each of the consumer price index and nominal exchange rate series was transformed into natural logarithms before the econometric analysis.

As mentioned in the content above, we will test the PPP hypothesis with the monetary approach and real exchange rate approach. So, we use the nominal exchange rate and consumer price index to calculate the real exchange rate.

The real exchange rate is defined as the nominal exchange rate adjusted for changes in the home and foreign price levels, is given by the following formula:

$$\mathrm{R_{it}} = (\mathrm{E_{it}} \mathrm{p_t^*})/\mathrm{P_{it}}$$

Where $\mathrm{R_{it}}$ is the real exchange rate for country i at time t, $\mathrm{E_{it}}$ is the nominal exchange rate for country i at time t, $\mathrm{P_{it}}$ is the domestic price index for country i at time t, $\mathrm{P^*{}_t}$ is the foreign price index (USA or Japan) at time t, and i is an index for Vietnam, Laos, Cambodia, Thailand, Myanmar, Malaysia, Singapore, Indonesia, and the Philippines.

Using lowercase to denote variables in their natural logarithm form yields:

$$\mathrm{r_{it}} = \mathrm{e_{it}} - \mathrm{p_{it}} + \mathrm{p_t^*}$$

Where $\mathrm{r_{it}}$ is the natural logarithm of the real exchange rate for country i at time t, $\mathrm{e_{it}}$ is the natural logarithm of the nominal exchange rate for country i at time t, $\mathrm{p_{it}}$ is the natural logarithm of the domestic price index for country i at time t, $\mathrm{p^*{}_t}$ is the natural logarithm of the foreign price index (USA or Japan) at time t, and i is an index for Vietnam, Laos, Cambodia, Thailand, Myanmar, Malaysia, Singapore, Indonesia, and the Philippines.

3.3 The Sequence of Testing

- Step 1: This study employs the panel unit root tests with the real exchange rate over the period January 1995 to February 2017 in order to test the absolute PPP.
- Step 2: With two major structural changes occur at the Asian financial crisis in 1997 and the global financial crisis in 2008, the same panel unit root tests were re-run with the real exchange rate by using the data set from July 1997 to August 2008 (respectively after the Asian financial crisis in 1997 and before the global financial crisis in 2008), and the data set from September 2008 to February 2017 (respectively after the global financial crisis of 2008 onwards), to examine whether differences in the existence of the absolute PPP before and after these structural breaks. There are two reasons for choosing these structural breaks, including economic theories and literature review. The Asian financial crisis in 1997 and the global financial crisis in 2008 are two crises that affect negatively many Southeast Asia countries. In addition, July 1997, the Asian financial crisis started in Thailand.
- Step 3: We apply traditional panel unit root tests with a data set of nominal exchange rate and relative prices over the period January 1995 to February 2017 in order to prepare for panel cointegration tests.
- Step 4: We test for a long run relationship between nominal exchange rate and relative prices, which known as the relative PPP, over the period January 1995 to February 2017.

4 Results

4.1 Panel Unit Root Tests

Results for panel unit root tests of real exchange rates for two difference base numeraire currencies from January 1995 to February 2017, are reported in Table 1.

The panel unit root tests fail to reject the null of a unit root in level of data set from January 1995 to February 2017 (except for the test which advocated by Levin et al. (2002) for US Dollar base cannot be rejected at 1% significance level). Therefore, the results strongly indicate the presence of unit root in real exchange rates for Southeast Asia countries over the period estimation. There are many reasons why the absolute PPP does not hold: the difference in interest rates, income levels, government strategies or substitutes for imported goods and services. The difference in calculation the price index is also a reason to explain this matter, namely the difference of the selected items of goods and services in CPI "basket".

To examine the purchasing power parity hypothesis aftermath financial crises. Results for panel unit root tests of real exchange rates with the presence structural breaks for two difference base numeraire currencies from July 1995 to August 2008, are reported in Table 2.

Table 1. Panel unit root tests of real exchange rates

Common root	Individual root	Individual root
Levin, Lin and Chu t-stat	Im, Pesaran and Shin W-stat	ADF – Fisher Chi-square
US Dollar = base currency		
−3.976*** (0.000)	−1.267 (0.103)	25.795 (0.105)
Japanese Yen = base currency		
−0.709 (0.225)	−1.709 (0.126)	26.353 (0.105)

Note: ***, ** and * indicates significant at 1%, 5% and 10% significance levels respectively; "Common root" indicates that the tests are estimated assuming a common AR structure for all of the series; "Individual root" is used for tests which allow for different AR coefficients in each series. Exogenous variables: Individual effects, individual linear trends. Newey-West bandwidth selection using Bartlett kernel. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. () indicates p-value, respectively.

Table 2. Panel unit root tests of real exchange rates with the presence of structural breaks

	Common root	Individual root	Individual root
Period	Levin, Lin and Chu t-stat	Im, Pesaran and Shin W-stat	ADF – Fisher Chi-square
US Dollar = base currency			
7/1997 – 8/2008	−3.289*** (0.000)	−2.003** (0.022)	55.214*** (0.000)
9/2008 – 6/2013	1.886 (0.970)	3.192 (0.999)	4.535 (0.999)
Japanese Yen = base currency			
7/1997 – 8/2008	−1.929** (0.027)	−1.991** (0.023)	34.800** (0.010)
9/2008 – 6/2013	−3.118 (0.491)	−3.847 (0.127)	49.142*** (0.000)

Note: ***, ** and * indicates significant at 1%, 5% and 10% significance levels respectively; "Common root" indicates that the tests are estimated assuming a common AR structure for all of the series; "Individual root" is used for tests which allow for different AR coefficients in each series. Exogenous variables: Individual effects, individual linear trends. Newey-West bandwidth selection using Bartlett kernel. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. () indicates p-value, respectively.

During the period from July 1997 to August 2008, empirical results show that even though sample span is short (compared with the data set from January 1995 to February 2017), purchasing power parity hypothesis seems to hold for nine

Southeast Asia countries in post Asian financial crisis and pre global financial crisis period. This reinforced the earlier findings, that is, the behaviour of real exchange rate after Asian financial crisis as a group is noticeably different from pre-crises period as discussed by Ridzuan and Ahmed (2011).

This matter can be explained as follows: After the Asian financial crisis occurred, the Southeast Asian countries have not maintained the anchor currency as in earlier periods anymore, example the national governments change policies, improve the competitiveness of goods and services, reduce monopolies and trade barriers.

During the period September 2008 to February 2017, the null hypothesis of unit root for real exchange rate cannot be rejected for nine Southeast Asia countries (except for the test which advocated by Maddala and Wu (ADF – Fisher) for Japanese Yen base can be rejected at 1% significance level). Therefore, the real exchange rate seem failed to find evidence supporting validity of PPP for post global financial crisis 2008 period.

4.2 Panel Cointegration Tests

Results for panel unit root tests with a data set of nominal exchange rate and relative prices over the period January 1995 to February 2017 in order to prepare for panel cointegration tests, are reported in Table 3.

Table 3 indicates that the unit root null could not be rejected (except for the test which advocated by Levin, Lin and Chu for US Dollar base cannot be rejected at 1% significance level, and the test which advocated by Levin, Lin

Table 3. Panel unit root tests for nominal exchange rate and relative prices

	US Dollar based		Japanese Yen based	
	Nominal exchange rate	Relative price	Nominal exchange rate	Relative price
Methods	Statistic	Statistic	Statistic	Statisitc
Levin, Lin and Chu t-stat	−5.052*** (0.000)	−3.295*** (0.000)	−1.843** (0.033)	−2.482 (0.139)
Im, Pesaran and Shin W-stat	−2.262 (0.206)	0.027 (0.511)	−0.627 (0.265)	1.244 (0.893)
ADF-Fisher Chi-square	34.076 (0.328)	14.133 (0.720)	17.166 (0.512)	12.175 (0.838)

Note: ***, ** and * indicates significant at 1%, 5% and 10% significance levels respectively; "Common root" indicates that the tests are estimated assuming a common AR structure for all of the series; "Individual root" is used for tests which allow for different AR coefficients in each series. Exogenous variables: Individual effects, individual linear trends. Newey-West bandwidth selection using Bartlett kernel. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. () indicates p-value, respectively.

and Chu for Japanese Yen base cannot be rejected at 5% significance level), and hence these two series are generated by a I(1) process despite US or Japan being base country. Therefore, the panel cointegration test can be applied.

Results for the Pedroni (1999, 2004) panel cointegration regression are presented in Table 4.

Table 4. Panel cointegration tests for nominal exchange rate and relative prices

	US Dollar based real exchange rates		Japanese Yen based real exchange rates	
	Constant	Constant + Trend	Constant	Constant + Trend
Alternative hypothesis: common AR coefs. (within-dimension)				
Panel v-statistics	−2.088 (0.982)	6.296*** (0.000)	−2.296 (0.989)	8.636*** (0.000)
Panel Rho-statistics	1.005 (0.843)	−2.609** (0.005)	0.881 (0.811)	−4.594*** (0.000)
Panel PP-statistics	−0.259 (0.398)	−2.077** (0.019)	0.033 (0.513)	−3.381*** (0.000)
Panel ADF-statistics	0.256 (0.601)	1.134 (0.871)	0.123 (0.549)	−2.979** (0.001)
Alternative hypothesis: individual AR coefs. (between-dimension)				
Group Rho-statistics	2.292 (0.989)	0.617 (0.731)	2.249 (0.988)	−0.989 (0.161)
Group PP-statistics	1.437 (0.925)	1.045 (0.852)	2.207 (0.986)	−0.424 (0.336)
Group ADF-statistics	1.346 (0.911)	1.364 (0.914)	1.821 (0.966)	−1.588* (0.056)

Note: ***, ** and * indicates significant at 1%, 5% and 10% significant levels respectively. Trend assumption based on no deterministic trend and deterministic intercept and trend. Automatic lag selection based on AIC with 16 maximum lag. Newey-West bandwidth selection using Bartlett kernel. () indicates p-value, respectively.

Table 4 shows that only three statistics (i.e., Panel v-statistics, Panel Rho-statistics, Panel PP-statistics) out of seven are able to reject the null of non-cointegration in US Dollar based real exchange rate of nine Southeast Asia countries. In particular, most of statistics favour the relative purchasing power parity hypothesis in Japanese Yen based real exchange rate, because the null hypothesis is rejected most at 1% significant level; while US Dollar is base currency, most of the null hypothesis is rejected at 5% significant level. There is vary between different numeraire currencies, similar to previous studies. Besides, results seem to support the existence of a long-run relationship between nominal exchange rate, domestic and foreign prices for full panel of Southeast Asia countries – known as the relative PPP – although the absolute PPP does not hold over the period January 1995 to February 2017.

5 Conclusion

The results show that the absolute PPP is rejected by the panel unit root test for Southeast Asia countries over the January 1995 to February 2017. However, when we use developed panel unit root that accounts for structural breaks in the data, and test the PPP hypothesis over the July 1997 to August 2008, the PPP proposition seems to hold for after the Asian financial crisis period 1997 and before the global financial crisis 2008. In addition, this paper has used recent developed panel cointegration tests and found the long-run relationship between the nominal exchange rate and the relative prices – the relative purchasing power parity – and the results offer more evidence in Japanese Yen based in favor of cointegration in long-run compared with US Dollar is the numeraire currency.

Indeed, some researchers argue that a long-run PPP is a valid equilibrium relationship if Japanese Yen is used as the numeraire currency which mainly due to close trade and financial linkages among the Southeast Asia countries. The PPP hypothesis is important to economists not only because it is the centrepiece of many exchange rate models including the monetary model of exchange rate determination, but also because of its policy implications. If the purchasing power parity proposition hold in long run then national monetary authorities will be able successful to conduct independent monetary policy and simultaneously control the movement of exchange rates. Otherwise, invalid PPP will create high possibility unbounded gains from arbitrage in traded goods (Kapetanios et al. (2003)), disqualifies monetary approach to exchange rate determination and so on.

In addition, we can test purchasing power parity hypothesis by allowing for nonlinear dynamics in real exchange rate adjustment, because of transactions costs in international arbitrage, in order to explain the failure of linear models, thus solving the PPP puzzles. These challenges remain on the agenda for future research.

Appendix

US Dollar Based Real Exchange Rates

Jan 1995 to Feb 2017

Group unit root test: Summary
Series: R_CAM_USD, R_IND_USD, R_LAO_USD, R_MAL_USD, R_MYA_USD, R_PHI_USD, R_SIN_USD, R_THA_USD, R_VIE_USD
Date: 06/20/17 Time: 15:40
Sample: 1995M01 2017M02
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 12
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−3.97563	0.0000	9	2359
Breitung t-stat	0.28439	0.6119	9	2350
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	−1.26698	0.1026	9	2359
ADF - Fisher Chi-square	25.7954	0.1045	9	2359
PP - Fisher Chi-square	15.8372	0.6039	9	2385

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Jul 1997 to Aug 2008

Group unit root test: Summary
Series: R_CAM_USD, R_IND_USD, R_LAO_USD, R_MAL_USD, R_MYA_USD, R_PHI_USD, R_SIN_USD, R_THA_USD, R_VIE_USD
Date: 06/19/17 Time: 11:26
Sample: 1997M07 2008M08
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on AIC: 0 to 12
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−3.28666	0.0005	9	1206
Breitung t-stat	4.52276	1.0000	9	1197
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	−2.00361	0.0226	9	1206
ADF - Fisher Chi-square	55.2138	0.0000	9	1206
PP - Fisher Chi-square	66.8510	0.0000	9	1206

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Sep 2008 to Feb 2017

Group unit root test: Summary
Series: R_CAM_USD, R_IND_USD, R_LAO_USD, R_MAL_USD, R_MYA_USD, R_PHI_RSD, R_SIN_USD, R_THA_USD, R_VIE_USD
Date: 06/19/17 Time: 11:32
Sample: 2008M09 2017M02
Exogenous variables: Individual effects, individual linear Trends

Automatic selection of maximum lags
Automatic lag length selection based on AIC: 0 to 11
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	1.88556	0.9703	9	918
Breitung t-stat	1.87541	0.9696	9	909
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	3.19208	0.9993	9	918
ADF - Fisher Chi-square	4.53506	0.9994	9	918
PP - Fisher Chi-square	6.80443	0.9917	9	918

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Japanses Yen Based Real Exchange Rates

Jan 1995 to Feb 2017

Group unit root test: Summary
Series: R_CAM_JPY, R_IND_JPY, R_LAO_JPY, R_MAL_JPY, R_MYA_JPY, R_PHI_JPY, R_SIN_JPY, R_THA_JPY, R_VIE_JPY
Date: 06/19/17 Time: 11:39
Sample: 1995M01 2017M02
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on AIC: 0 to 12
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−0.75693	0.2245	9	2367
Breitung t-stat	−3.20534	0.0007	9	2358
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	−1.70880	0.1264	9	2367
ADF - Fisher Chi-square	26.3532	0.1045	9	2367
PP - Fisher Chi-square	27.8788	0.0639	9	2385

** Probabilities for Fihser tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Jul 1997 to Aug 2008

Group unit root test: Summary
Jeries: R_CAM_JPY, R_IND_JPY, R_LAO_JPY, R_MAL_JPY, R_MYA_JPY, R_PHI_JPY, R_SIN_JPY, R_THA_JPY, R_VIE_JPY
Date: 06/19/17 Time: 11:42
Sample: 1997M07 2008M08
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on AIC: 0 to 12
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistis	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−1.92886	0.0269	9	1206
Breitung t-stat	−0.03302	0.4868	9	1197
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	−1.99167	0.0232	9	1206
ADF - Fisher Chi-square	34.8009	0.0100	9	1206
PP - Fisher Chi-square	41.6382	0.0012	9	1206

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Sep 2008 to Feb 2017

Group unit root test: Summary
Series: R_CAM_JPY, R_IND_JPY, R_LAO_JPY, R_MAL_JPY, R_MYA_JPY, R_PHI_JPY, R_SIN_JPY, R_THA_JPY, R_VIE_JPY
Date: 06/19/17 Time: 11:44
Sample: 2008M09 2017M02
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on AIC: 0 to 8
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−3.11784	0.4910	9	918
Breitung t-stat	−1.19804	0.1155	9	909
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	−3.84732	0.1270	9	918
ADF - Fisher Chi-square	49.1419	0.0001	9	918
PP - Fisher Chi-square	36.3889	0.0063	9	918

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

US Dollar Based Nominal Exchange Rates

Group unit root test: Summary
Series: CAM_USD, IND_USD, LAO_USD, MAL_USD, MYA_USD, PHI_USD, SIN_USD, THA_USD, VIE_USD
Date: 06/19/17 Time: 11:47
Sample: 1995M01 2017M02
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on AIC: 0 to 13
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−5.05152	0.0000	9	2332
Breitung t-stat	−0.22853	0.4096	9	2323
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	−2.26243	0.2060	9	2332
ADF - Fisher Chi-square	34.0760	0.3280	9	2332
PP - Fisher Chi-square	12.1710	0.8383	9	2385

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Japanese Yen Based Nominal Exchange Rates

Group unit root test: Summary
Series: CAM_JPY, IND_JPY, LAO_JPY, MAL_JPY, MYA_JPY, PHI_JPY, SIN_JPY, THA_JPY, VIE_JPY
Date: 06/19/17 Time: 11:48
Sample: 1995M01 2017M02
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on AIC: 0 to 12
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−1.84337	0.0326	9	2367
Breitung t-stat	−1.11867	0.1316	9	2358
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	−0.62710	0.2653	9	2367
ADF - Fisher Chi-square	17.1660	0.5117	9	2367
PP - Fisher Chi-square	11.5363	0.8702	9	2385

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Relative Prices (Between Southeast Asia Countries and USA)

Group unit root test: Summary
Series: USA_CAM, USA_IND, USA_LAO, USA_MAL, USA_MYA, USA_PHI, USA_SIN, USA_THA, USA_VIE
Date: 06/19/17 Time: 11:50
Sample: 1995M01 2017M02
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on AIC: 5 to 15
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−3.29551	0.0005	9	2283
Breitung t-stat	1.74157	0.9592	9	2274
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.02687	0.5107	9	2283
ADF - Fisher Chi-square	14.1325	0.7204	9	2283
PP - Fisher Chi-square	8.15953	0.9762	9	2385

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Relative Prices (Between Southeast Asia Countries and Japan)

Group unit root test: Summary
Series: JP_CAM, JP_IND, JP_LAO, JP_MAL, JP_MYA, JP_PHI, JP_SIN, JP_THA, JP_VIE
Date: 06/19/17 Time: 11:52

Sample: 1995M01 2017M02
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on AIC: 5 to 15
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−2.48195	0.1390	9	2275
Breitung t-stat	2.65437	0.9960	9	2266
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.24354	0.8932	9	2275
ADF - Fisher Chi-square	12.1754	0.8381	9	2275
PP - Fisher Chi-square	7.08272	0.9894	9	2385

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Panel Cointegration Tests for Nominal Exchange Rate and Relative Prices (USD = base currency)

Trend Assumption Based on no Deterministic Trend

Pedroni Residual Cointegration Test
Series: CPI_USA NER_USD
Date: 06/19/17 Time: 15:02
Sample: 1995M01 2017M02
Included observations: 2394
Cross-sections included: 9
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
Automatic lag length selection based on SIC with a max lag of 15
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-2.087924	0.9816	-2.216234	0.9867
Panel rho-Statistic	1.005046	0.8426	1.655940	0.9511
Panel PP-Statistic	-0.259800	0.3975	1.118510	0.8683
Panel ADF-Statistic	0.256004	0.6010	1.116704	0.8679

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	2.291816	0.9890
Group PP-Statistic	1.436580	0.9246
Group ADF-Statistic	1.346219	0.9109

Trend assumption based on deterministic intercept and trend

Pedroni Residual Cointegration Test
Series: CPI_USA NER_USD
Date: 06/19/17 Time: 15:03
Sample: 1995M01 2017M02
Included observations: 2394
Cross-sections included: 9
Null hypothesis: No cointegration
Trend assumption: Deterministic intercept and trend
Automatic lag length selection based on SIC with a max lag of 15
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	6.295889	0.0000	-0.744054	0.7716
Panel rho-Statistic	-2.608702	0.0045	1.863090	0.9688
Panel PP-Statistic	-2.077368	0.0189	1.764214	0.9612
Panel ADF-Statistic	1.134335	0.8717	1.864502	0.9689

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	0.616626	0.7313
Group PP-Statistic	1.044948	0.8520
Group ADF-Statistic	1.363748	0.9137

Panel Cointegration Tests for Nominal Exchange Rate and Relative Prices (JPY = Base Currency)

Trend Assumption Based on no Deterministic Trend

Pedroni Residual Cointegration Test
Series: CPI_JAP NER_JPY
Date: 06/19/17 Time: 15:05
Sample: 1995M01 2017M02
Included observations: 2394
Cross-sections included: 9
Null hypothesis: No cointegration
Trend assumption: No deterministic trend
Automatic lag length selection based on SIC with a max lag of 15
Newey-West automatic bandwidth selection and Barltett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-2.296345	0.9892	-2.787317	0.9973
Panel rho-Statistic	0.881330	0.8109	1.505624	0.9339
Panel PP-Statistic	0.032539	0.5130	1.492832	0.9323
Panel ADF-Statistic	0.122709	0.5488	1.113075	0.8672

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	2.249583	0.9878
Group PP-Statistic	2.206913	0.9863
Group ADF-Statistic	1.820547	0.9657

Trend assumption based on deterministic intercept and trend

Pedroni Residual Cointegration Test
Series: CPI_JAP NER_JPY
Date: 06/19/17 Time: 15:08
Sample: 1995M01 2017M02
Included observations: 2394
Cross-sections included: 9
Null hypothesis: No cointegration
Trend assumption: Deterministic intercept and trend
Automatic lag length selection based on SIC with a max lag of 15
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	8.635564	0.0000	1.945228	0.0259
Panel rho-Statistic	-4.593599	0.0000	0.764611	0.7777
Panel PP-Statistic	-3.381250	0.0004	0.543331	0.7065
Panel ADF-Statistic	-2.979405	0.0014	-0.936730	0.1744

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	-0.989463	0.1612
Group PP-Statistic	-0.424091	0.3357
Group ADF-Statistic	-1.588199	0.0561

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