CHAPTER 4

EMPIRICAL RESULTS

This chapter consists of three parts. The first part describes empirical results of examining PPP between Thailand and two groups of trade partners, FTA negotiation countries and Southeast Asian neighbors, by using time series analysis. The second part provides the outcomes of PPP evaluation based on panel analysis of the same groups. In these two parts, findings on testing the evidence of relative PPP on the real exchange rates, examining weak and strong PPP via cointegration analysis between the nominal exchange rate and the price ratio are included, along with a discussion.

Apart from the Thai baht numeraire in the first two parts, the third part provides the evaluation of PPP between Thailand and two groups of trade partners using the US dollar as the numeraire. This will highlight the effect of cross-sectional dependence in panel.

4.1 Testing for PPP Based on Time Series Analysis

Before the panel analysis is applied to examine the existence of PPP between Thailand and trade partners, the analysis based on time series is conducted. This will provide some pictures for further steps. Moreover, this makes a comparison between traditional approach and recent approach possible.

4.1.1 Testing Validity of PPP Based on Real Exchange Rate

Firstly, the evidence of PPP can be found by examining the stationarity of the real exchange rates. If the real exchange rates exhibit stationarity, it implies mean reversion and hence affirms the validity of PPP. Since the data employed in this study is quarterly data, the CPI series are adjusted to remove cyclical seasonal movements and extract the underlying trend component of the series. Subsequently, the real exchange rate is calculated by these adjusted CPIs. Two univariate unit root tests, ADF test and PP test, are used with the optimal lag length is selected by Schwarz

Information Criterion (SIC) and appropriated lag truncation for Bartlett kernel is automatically selected by Newey-West. The test statistics of ADF test and PP test on (seasonally adjusted) the real exchange rates of each individual country are presented in Table 4.1.

Table 4.1

Unit Root Tests of Individual Real Exchange Rate

Country	ADF	lag	PP	lag	Critical values	
FTA partners						
Australia	-1.616	0	-1.684	4	1% level	-3.516
China	-1.741	0	-1.900	1	5% level	-2.899
India	-2.117	1	-1.839	1	10% level	-2.586
Japan	-2.549	1	-2.310	3		
New Zealand	-1.755	1	-1.418	0		
United States	-1.586	1	-1.394	3		
SEA partners						
Indonesia	-3.147	1	-2.514	6		
Malaysia	-2.672	0	-2.890	3		
Philippines	-2.582	1	-1.888	6		
Singapore	-2.954	1	-1.670	6		

Unsurprisingly, the null hypothesis of unit root cannot be rejected in all countries since there is no statistic that has greater value than the critical values of any levels. Therefore, this result does not support the validity of relative PPP between Thailand and each trade partners.

4.1.2 Testing Weak and Strong PPP Based on Engle-Granger Cointegration Test

Beside the unit root tests of real exchange rates, the cointegration tests are also conducted to reveal if any long run relationship exists between the nominal exchange rate and price levels which is required for strong and/or weak version of PPP to hold. In order to test for cointegration, each series is required to have the integrated of the same order. Therefore, unit root tests are applied to log of nominal exchange rate, consumer price index and price ratio of each country, both in level and first difference form. The preliminary results ensured that all series are I(1).

The two-step cointegration test developed by Engle and Granger (1997) is performed to test for the validity of PPP. The adjusted-R^2, CRDW statistic and ADF statistic of the residual, along with the estimated coefficients are reported in Table 4.2.

Table 4.2

Results of the Cointegration Regression using Engle and Granger's Test

Restricted model: $\ln E_t = \alpha + \beta \ln(P_{it} / P_{TH,t}) + u_t$

Country	α	β	adjusted R^2	CRDW	ADF
FTA partners				. .	
Australia	-3.234	1.494	0.449	0.136	-1.713*
China	-1.458	1.086	0.510	0.152	-1.766*
India	0.158	1.101	0.570	0.081	-1.987**
Japan	1.144	1.320	0.858	0.328*	-2.794***
New Zealand	-3.092	1.653	0.603	0.138	-2.115**
United States	-3.657	2.778	0.720	0.131	-1.624*
SEA partners					
Indonesia	5.204	1.113	0.915	0.326*	-3.166*
Malaysia	-2.355	0.674	0.350	0.312	-2.678
Philippines	0.133	0.741	0.774	0.211	-2.784
Singapore	-3.117	1.685	0.933	0.325*	-3.401**

Unrestricted model: $\ln E_t = \alpha + \beta_1 \ln(P_{it}) + \beta_2 \ln(P_{TH,t}) + u_t$

Country	α	β_1	β_2	adjusted R^2	CRDW	ADF
FTA partners						
Australia	-0.163	-0.139	-0.520	0.622	0.203	-2.606
China	0.959	1.633	-2.168	0.625	0.205	-2.478
India	5.826	2.502	-3.734	0.587	0.094	-1.725
Japan	3.281	0.777	-1.243	0.859	0.332*	-2.886*
New Zealand	0.325	0.109	-0.842	0.643	0.148	-2.400
United States	-2.012	1.721	-2.074	0.730	0.138	-2.106
SEA partners						
Indonesia	2.201	0.809	-0.154	0.926	0.387**	-3.502**
Malaysia	-0.865	-0.534	0.210	0.401	0.373*	-3.424**
Philippines	3.174	1.525	-2.195	0.814	0.295	-2.999
Singapore	0.918	0.299	-1.175	0.943	0.364*	-3.672**

Note: *, ** indicates that null hypothesis is rejected at the 10% and 5% level, respectively.

To begin with the group of FTA partners, CRDW statistics yield unacceptable results for cointegration for all cases, except for Japan. Similarly, ADF statistics show identical results to CRDW statistics. Only the unrestricted case of Japan can be found to have a cointegration relationship between the nominal exchange rate and price levels. In the case of Japan, the symmetry condition is attained by the positive sign of β and β_1. However, the proportionality conditions of PPP are not satisfied since β does not approach unity and β_1 and β_2 have different magnitudes. It can be concluded that strong PPP does not exist between these countries and Thailand. Moreover, weak PPP is also not found in all cases except for Japan, which exhibits very little evidence in favor of weak PPP.

For the group of SEA neighbors, considering the case of restricted model, CRDW and ADF statistics report cointegration for the case of Indonesia and Singapore, with different levels of significance. This provides little support for weak PPP to hold between Thailand-Indonesia and Thailand-Singapore. However, there is no evidence for strong PPP because estimated β for both cases do not approach unity. Hence, the condition of proportionality is not fulfilled and this leads to the rejection of strong PPP.

In the case of the unrestricted model, CRDW and ADF statistics of all countries, except Philippines, indicate, at differents level of significant, the cointegration relationship between the country's exchange rate, country's CPI and CPI of Thailand. Although these results do not provide much strong evidence, these again support weak PPP between Thailand and SEA countries. Nevertheless, the strong version of PPP can not be obtained since Malaysia fails to achieve the symmetry condition and all cointegrating vectors do not follow the proportionality condition.

Even though these results do not strongly confirm the existence of weak PPP between Thailand and SEA countries, it is quite explicit that weak PPP is more likely to hold in the case of SEA countries compared to the case of FTA partners.

4.1.3 Testing Weak and Strong PPP Based on Johansen Multivariate Cointegration

Apart from Engle-Granger's two-step cointegration that shows very little evidence supporting weak PPP, another approach is to use multivariate cointegration

test suggested by Johansen (1988) and Johansen and Juselius (1990). After ensuring that all series are I(1), the cointegration test is performed to the series of nominal exchange rate and consumer price indices of country i and Thailand. The results are reported in Table 4.3.

To start with the group of FTA partners, one cointegration relationship is found for China, Japan, New Zealand and the United States as reported by trace statistic and maximal eigenvalue statistic. For the case of Japan and New Zealand, both statistics confirm one cointegration. However, for China and the United States, trace statistic indicates one cointegration relationship while maximal eigenvalue statistic reports no cointegration. On the other hand, this cointegration approach fails to discover any cointegration relationship in the case of Australia and India.

When considering symmetry condition, China and Japan have the correct signs of estimated cointegrating vector, but New Zealand and the United States do not. Nonetheless, all these results fail to satisfy the proportionality condition of PPP. Therefore, strong PPP can not be found in any country and little evidence supporting weak PPP are obtained from China, Japan, New Zealand and the United States.

Comparing these to the results from Engle-Granger's two-step cointegration, Japan is the most possible case to have a cointegration relationship between nominal exchange rate and price levels.

In the case of SEA neighbors, Johansen multivariate cointegration test mostly yields unacceptable results for PPP. Both trace statistic and maximal eigenvalue statistic fail to discover any cointegration in the case of Indonesia, Malaysia and Singapore. It is only Philippines in which a cointegration relationship can be confirmed with correct signs of coefficients. Nonetheless, magnitudes of β_1 and β_2 are definitely not equal and therefore the proportionality condition is not satisfied.

To summarize, applying time series analysis can only give weak evidence supporting PPP in both groups of trade partners. While unit root tests of real exchange rate overwhelmingly reject the relative PPP, the cointegration tests indicate that weak PPP may exist in few cases. However, no strong evidence of any form of PPP between Thailand and these trade partners can be found by the time series approach.

Table 4.3

Results from Johansen Multivariate Cointegration Test

Country	Null hypothesis	Trace statistic	Maximal eigenvalue statistic	No. of cointegrating vector	Cointegrating vectors β_1	Cointegrating vectors β_2
FTA partners						
Australia	$H_0: r = 0$	34.390	19.324	0	-	-
	$H_0: r \leq 1$	15.066	8.238			
	$H_0: r \leq 2$	6.828	6.828			
China	$H_0: r = 0$	44.696**	21.895	1	2.032	-1.974
	$H_0: r \leq 1$	22.801	18.781		(0.452)	(1.727)
	$H_0: r \leq 2$	4.020	4.020			
India	$H_0: r = 0$	35.354	22.156	0	-	-
	$H_0: r \leq 1$	13.198	6.972			
	$H_0: r \leq 2$	6.226	6.226			
Japan	$H_0: r = 0$	48.149**	38.637***	1	1.132	-0.845
	$H_0: r \leq 1$	9.512	6.281		(0.896)	(0.659)
	$H_0: r \leq 2$	3.231	3.231			
NZ	$H_0: r = 0$	53.545**	30.975***	1	7.302	0.831
	$H_0: r \leq 1$	22.569	17.827		(1.151)	(0.626)
	$H_0: r \leq 2$	4.742	4.742			
US	$H_0: r = 0$	45.266**	24.409	1	1.746	0.487
	$H_0: r \leq 1$	20.857	13.215		(1.391)	(0.689)
	$H_0: r \leq 2$	7.642	7.642			
SEA partners						
Indonesia	$H_0: r = 0$	37.276	16.535	0	-	-
	$H_0: r \leq 1$	20.741	14.365			
	$H_0: r \leq 2$	6.376	6.376			
Malaysia	$H_0: r = 0$	37.667	22.152	0	-	-
	$H_0: r \leq 1$	15.514	10.456			
	$H_0: r \leq 2$	5.058	5.058			
Philippines	$H_0: r = 0$	52.274***	38.589***	1	1.399	-3.096
	$H_0: r \leq 1$	13.685	9.066		(-0.144)	(-0.266)
	$H_0: r \leq 2$	4.618	4.618			
Singapore	$H_0: r = 0$	35.684	19.722	0	-	-
	$H_0: r \leq 1$	15.962	10.591			
	$H_0: r \leq 2$	5.371	5.371			

Note: **, *** indicates that the null hypothesis is rejected at the 5% and 1% level, respectively.
NZ and US stand for New Zealand and United States, respectively.
Number in parenthesis is standard error of coefficient.

4.2 Testing for PPP Based on Panel Analysis

As reported in the previous section, tests based on time series analysis provide little evidence supporting PPP. In this section, analysis based on panel data is carried out with the expectation that advance methodology may lead to stronger conclusion favoring PPP, if it does exist.

Similar to the time series approach, the empirical analysis based on panel data consists of two main tasks. The first task is to investigate the relative PPP via the panel of real exchange rates. The second task is to determine if the weak and/or strong version of PPP exists using panel cointegration tests.

4.2.1 Testing Validity of PPP Based on Panel of Real Exchange Rate

As shown in the first section, traditional univariate tests cannot reject the null hypothesis of unit root; consequently, panel unit root tests of both generations are performed on the real exchange rate in order to find if there is any evidence in favor of PPP. Series of countries' real exchange rates are pooled together in the panel. Various tests are employed and the results are reported in Table 4.4.

In the case of FTA partners, the results of these tests do not give any support to relative PPP. These results differs from those of Sethapramote (2006) in such a way that the validity of relative PPP between Thailand and FTA partners is overwhelmingly rejected while Sethapramote (2006) found some evidence of PPP via IPS test, Fisher test and Demeaned-IPS test. However, this may be affected from different countries used in panel. Another seven Asian countries, which might have many similar conditions to Thailand, are not included in this study.

Differing from the group of FTA partners, the results show evidence in favor of relative PPP for the group of SEA countries. The null hypothesis of unit root in model with intercept is rejected at 0.05 for all tests, except for Fisher-PP and Pesaran CIPS* test which can reject the unit root of real exchange rates only at 0.10. For model including time trend, LLC, IPS and Choi-ADF tests can capture the stationarity of real exchange rate at 0.05 level of confidence. Fisher-ADF test and Demeaned-IPS test can reject the unit root at 0.10 level of confidence. Thus, this shows supportive evidence of relative PPP to hold between Thailand and these four countries. This finding is consistent with previous literature that panel unit root tests have more power to detect the validity of relative PPP.

Table 4.4

Panel Unit Root Tests of Real Exchange Rates

Trade Partners:	FTA partners		SEA neighbors	
	Model with intercept	Model with intercept and trend	Model with intercept	Model with intercept and trend
Tests of the 1st generation				
LLC	-0.710	0.342	-2.177**	-2.493***
IPS	-1.025	-0.321	-2.271**	-1.701**
Fisher-PP	11.636	6.241	14.431*	7.219
Fisher-ADF	13.865	10.313	17.958**	13.562*
Choi-PP	-0.616	0.619	-1.802**	-0.167
Choi-ADF	-1.031	-0.363	-2.346**	-1.760**
Tests of the 2nd generation				
Demeaned-IPS	-1.096	0.933	-1.895**	-1.407*
Pesaran CIPS*	-0.822	0.522	-1.503*	0.767

Note: *, **, *** indicates that the null hypothesis is rejected at the 10%, 5% and 1% level, respectively.

4.2.2 Testing for Panel Cointegration between Exchange Rate and Price Ratio

Not only is relative PPP examined by panel unit root tests of the real exchange rate, but the weak version of PPP is also investigated by panel cointegration tests. Although the mean reversions of real exchange rate are not accepted for FTA partners, this does not imply the weak form of PPP has to be invalid. The test of weak PPP consists in testing the existence of cointegration between the nominal exchange rate and the price ratio.

Similar to the time series approach, the first step to perform cointegration testing is to verify whether these two series are integrated of the same order, I(d). Unless all series have the same order of integrated, they cannot be cointegrated. To determine the order of integrated series, the nominal exchange rate and the price ratio are tested to see if they contain any unit root, both at level and at first difference. If series exhibit unit root at level and the stationary at first difference, it is a cointegrated series of order 1, I(1). It should be noted that the price ratio used in this study is calculated from seasonally adjusted CPIs. This is similar to the way to calculate the real exchange rate.

As the results indicate that the nominal exchange rate and the price ratio are I(1), panel cointegration tests can be utilized to confirm the weak version of PPP. Pedroni test, Kao test and Fisher test are employed in this study and results are reported in Table 4.5.

Table 4.5

Panel Cointegration Tests of Nominal Exchange Rate and Price Ratio

Trade Partners:	FTA Partners		SEA Neighbors	
Pedroni test				
panel-v	1.311		1.609	
panel-rho	-0.411		-2.228**	
panel-ADF	-0.519		-2.893***	
Kao test				
ADF	-2.385		-4.221***	
Fisher test				
No. of CE.	None	At most 1	None	At most 1
Trace	24.25**	14.81	211.9***	6.648
Maximal Eigenvalue	22.01**	14.81	46.67***	6.648

Note: **, *** indicates that the null hypothesis is rejected at the 5% and 1% level, respectively.

For the case of FTA partners, all test statistics of Pedroni test fail to reject the null hypothesis of no cointegration in panel. Thus, results of the Pedroni test do not support PPP. On the other hand, Kao test and Fisher test provide some evidence of weak version of PPP. Kao's ADF statistic can reject the null of no cointegration at 0.05 level of significance. From Fisher test, both trace statistic and maximal eigenvalue statistic reject the null hypothesis of no cointegration and do not reject the null hypothesis that at most one cointegration equation exists. From the results of Fisher test, it can be concluded that there is one cointegration relationship between the nominal exchange rate and the price ratio. Hence, this indicates that weak PPP holds among Thailand and FTA's partners.

Nevertheless, it is necessary to further verify whether the strong PPP hold which can be done by testing if all the cointegration coefficients are unity. If the cointegrating coefficients are all 1, the strong PPP is confirmed. By contrast, if any of

them differ from unity, or some of them are different to each other, the validity of strong PPP is automatically rejected. By applying the test of parameter constancy suggested by Swamy (1970), test Chi-square is about 10,000 which totally exceed the critical value for any level of significance. Therefore, the null hypothesis of parameter constancy is rejected. Accordingly, the strong version of PPP does not exist since not all coefficients are equal.

In the case of SEA neighbors, it is obvious that not only the panel unit root tests, but results from panel cointegration tests also definitely confirm the validity of weak PPP. In this case, weak PPP is said to hold among this group of countries. Panel-rho statistic and panel-ADF statistic of Pedroni test can reject the null hypothesis of no cointegration. Similarly, Kao test and Fisher test yield the same results. The strong version of PPP is tested by applying the test of parameter constancy suggested by Swamy (1970). The test Chi-square is about 17,000 and hence the null hypothesis of parameter constancy is rejected. Therefore, the strong version of PPP does not exist since not all coefficients are equal.

While the overall results from the panel approach tend to confirm the validity of relative and weak PPP between Thailand and SEA neighbors, these results do not provide much evidence of PPP among Thailand and FTA partners. Though the results from panel cointegration tests somehow support PPP, the overall results do not certainly confirm the validity of PPP. There are some points to mention.

Firstly, it is affirmed that the tests used in this study can detect the existence of relative PPP and weak PPP in the case of SEA countries. This indicates that the panel tests have more power than the time series tests to detect PPP and it has enough power to capture PPP, if it does exist. As a consequence, the validity of PPP between Thailand and FTA partners is inevitably rejected.

Secondly, one might wonder why PPP does not hold in the group of FTA partners which is believed to have no trade barrier. The possible explanation is that the FTA is not as free as its name. As suggested by Kohpaiboon and Jongwanich (2006), FTA export creation seems to be very limited when the rule of origin (RoO) is taken into consideration. Since the RoO can also be used as a non-tariff trade barrier, this actually does not promote the required conditions of PPP. Therefore, PPP cannot be found to hold. Nevertheless, Thailand and SEA neighbors are all members of

ASEAN Free Trade Area (AFTA) which has been established since 1992 with the intention to reduce trade barriers between member countries as well. Another possible reason is that the period of FTA may be too short to detect long run evidence in favor of PPP. In addition, based on the concept of Paul (2004), the explanation is that trade between neighboring countries in SEA is considerable where intra-industry trade is a major factor and that derives the price from both countries.

4.3 Testing for PPP Based on the US Dollar Numeraire

It is theoretically suggested and empirically reported by numerous amonts of literature that choice of the numeraire currency matters. This study tried varying numeraire currency from Thai baht to US dollar to assess if the outcome of the analysis is sensitive to the numeraire currency. Data from both groups of countries is analyzed in the same way as the previous sections.

To begin with, the relative PPP is examined by univariate unit root tests and panel unit root tests. The statistics from the traditional time series approach give no evidence in favor of relative PPP which is exactly the same as when Thai bath is used as the numeraire. (See Table A1 in appendix).

Empirical results from panel unit root in Table 4.6, however, are different for SEA countries compared to the results based on Thai baht. When the numeraire currency is Thai baht, panel unit root tests of real exchange rate definitely assert relative PPP. Contrastingly, when changing the numeraire currency to US dollar, all panel unit root tests of the first generation fail to reject the non-stationarity in panel of real exchange rates. Only the tests of the second generation yield supportive outcomes in favor of relative PPP.

The plausible reason is that the data is cross-sectional dependence which is caused by calculation of bilateral real exchange rates based on common currency. For this reason, tests of the first generation suffer from size distortions and, consequently, cannot detect the validity of PPP. As cross-sectional dependence is taken into account, the second generation of panel unit root tests can detect stationarity of real exchange rates and this confirms the existence of relative PPP between Thailand and SEA countries.

Table 4.6

Panel Unit Root Tests of Real Exchange Rates

Using the US Dollar Numeraire

Trade Partners:	FTA Partners		SEA Neighbors	
	Model with intercept	Model with intercept and trend	Model with intercept	Model with intercept and trend
Tests of the 1st generation				
LLC	-0.938	1.059	-0.391	-0.037
IPS	-0.742	0.853	0.077	0.453
Fisher-PP	11.725	7.124	6.518	5.403
Fisher-ADF	12.65	6.351	6.708	5.708
Choi-PP	-0.624	0.737	0.245	0.588
Choi-ADF	-0.695	0.929	0.168	0.49
Tests of the 2nd generation				
Demeaned-IPS	-1.212	0.359	-3.074***	-1.779**
Pesaran CIPS*	-0.384	0.272	-2.55***	-2.534***

Note: **, *** indicates that the null hypothesis is rejected at the 5% and 1% level, respectively.

In this study, Thai bath numeraire yields more convincing evidence for relative PPP between Thailand and SEA countries. Similar results have been found by Aggarwal and Mougoue (1996) and Chinn (2000) whose findings indicate that a long run PPP is valid in the case of Asian numeraire currency. Since these SEA countries are closer to Thailand than to the United Stated, both in sense of country's economy and distance between countries, it is reasonable to observe PPP among these countries.

By view of countries characteristics, evidence of PPP is stronger in countries that are closer and have similar economic growth rates to the base country (Alba and Papell, 2007; Lopez and Papell, 2007).

In order to satisfy LOP, it is crucial to have zero transaction costs. By view of location, transaction cost, say transportation cost, between two distant countries can be significant. Thus, countries located further away will suffer higher transaction costs compared to those located in closer area. When the transaction cost is significant, the international arbitrage will not take place as long as the transaction

cost is higher than the price difference. In other words, the greater the transaction cost, the wider the range that the price difference can move over. Consequently, in the presence of transaction cost, the difference between prices of identical goods sold in separated markets may not be mean reverting, but rather move in a pure random walk unless the difference in prices exceeds the transaction costs. Chen and Wu (2000) have examined PPP for Japan and Taiwan by incorporating the effect of transaction costs. They have found fast adjustment for large deviations from PPP, but random walk for small deviations. This implies that transaction cost matters.

Furthermore, the weak version of PPP is examined by cointegration analysis. Applying Engle-Granger's cointegration test, the results of FTA partners have no vital change, but results of SEA countries are much worse in such a way that no statistic is found to be in line with weak PPP. The outcomes from Johansen multivariate cointegration test, however, seem to show the long run relationship between exchange rate and countries' price levels, but most with incorrect signs in cointegrating vector. (See Table A2 and A3 in appendix). This again might be affected by changing the numeraire currency. The results obtained from panel cointegration tests, however, are quite consistent with Thai baht numeraire case. More details are reported in Table A4 in appendix. There is some evidence supporting weak PPP found for both groups of countries. Swamy's test of parameter constancy also fails to affirm the strong version of PPP in both groups.

To sum up, due to the effect of cross-sectional dependence, selected numeraire currency can affect the outcome of tests. In this study, varying base currency from Thai baht to US dollar significantly alters the results of panel unit root tests of the first generation. Thai bath numeraire provide much convincing outcomes for relative PPP to hold between Thailand and SEA neighbors. Fortunately, tests of second generation which already account for cross-sectional dependence yield consistent results and this reaffirms the conclusion that relative PPP really holds between Thailand and SEA countries and does not hold among FTA partners as shown by the tests of the second generation.