

EVIDENCE OF PURCHASING POWER PARITY FROM ASEAN DATA

(Kewujudan Pariti Kuasa Beli daripada Data Negara-negara Asean)

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ABSTRACT

Purchasing power parity (PPP) is a theory of long-term equilibrium exchange rates based on relative price levels of two countries. The concept is based on the law of one price; the idea that in the absence of transaction costs, identical goods will have the same price in different markets. PPP exchange rate (the "real exchange rate") fluctuations are mostly due to different rates of inflation between the two economies. Aside from this volatility, consistent deviations of the market and PPP exchange rates are observed. In this study, the PPP hypothesis is examined on a sample of six ASEAN members, namely Indonesia, Malaysia, Myanmar, Philippine, Singapore and Thailand. Specifically, the paper discusses the restricted model for PPP, and briefly describes the derivation of PPP models in cointegrating form and in dynamic error-correction (DECM) form. The results are mixed; the cointegration approach seems to have some advantage over the DECM approach. Nevertheless, assuming that the results fairly represent the ASEAN economies, the evidence in favor of PPP is an early indication of the integration in financial and goods markets within the South-East Asia region.

Keywords: Purchasing power parity; cointegration; dynamic error-correction

ABSTRAK

Pariti kuasa beli (PPP) merupakan teori mengenai keseimbangan jangka panjang kadar pertukaran yang berasaskan kepada aras harga relatif antara dua negara. Konsep ini terbit daripada hukum satu harga; hukum tersebut menyarankan bahawa dengan mengetepikan kos urus niaga, barang-barang yang serupa akan diletakkan harga yang sama di pasaran yang berlainan. Turun-naik kadar pertukaran PPP ("kadar pertukaran sebenar") lazimnya disebabkan oleh perbezaan kadar inflasi antara kedua-dua ekonomi. Seiring dengan ketaktentuan ini, terdapat jurang yang tekal antara kadar pertukaran pasaran dan kadar pertukaran PPP. Dalam kajian ini, hipotesis PPP diuji ke atas sampel yang terdiri daripada enam negara anggota ASEAN, iaitu Indonesia, Malaysia, Myanmar, Filipina, Singapura dan Thailand. Secara khususnya, perbincangan dalam makalah ini memberi tumpuan kepada model berkekangan untuk PPP, dan secara ringkas menerangkan terbitan model terbitan untuk PPP dalam kerangka ko-kamiran dan juga dalam kerangka pembetulan ralat dinamik (DECM). Hasil kajian ini bercampur-campur, dengan pendekatan ko-kamiran seolah-olah memiliki beberapa kelebihan berbanding pendekatan DECM. Walau bagaimanapun, dengan anggapan bahawa keputusan secara keseluruhannya memberi gambaran yang adil untuk negara-negara ASEAN, bukti yang menyokong PPP merupakan tanda-tanda awal tentang wujudnya kamiran dalam pasaran kewangan dan barangan di rantau Asia Tenggara.

Kata kunci: Pariti kuasa beli; ko-kamiran; pembetulan ralat dinamik

1. Introduction

The analysis of exchange rate behavior has been a perennial topic in international monetary economics. The widespread reference to the exchange rate stems from the belief that it is a useful summary measure of key economic information. For instance, it is commonly used as a measure of competitiveness of the traded goods sector and to some extent even as a measure of the standard of living in one country relative to another. In addition, changes in the exchange rate are also seen as an important part of the adjustment process to real shocks.

Purchasing-power parity (PPP) theory postulates that variation in prices between countries will be matched by exchange rates; that is, nominal exchange rates will reflect differences in inflation rates among economies. In particular, the absolute PPP suggests that the long-run equilibrium exchange rate between two countries equals the ratio of their price levels. However, in reality there are several factors that can weaken the relation between exchange rates and price levels, such as the existence of non-traded goods and services, trade barriers, transportation costs and imperfect markets. Furthermore, international differences in consumption patterns, variations in product qualities, and differences between listed and transaction prices are some of difficulties that can also affect the link of exchange rates and price levels.

The organisation of this paper is as follows: section 2 provides review of the literature that emphasises the empirical studies on the PPP hypothesis; section 3 outlines the mathematical model and statistical strategies that describe the methodology of this study; section 4 discusses the empirical results; and section 5 summarises and concludes.

2. Literature Review

Although there is little empirical evidence to support PPP in the short-run, there is evidence of the long-run PPP relation. The term “long-run” is used in the literature to indicate that temporary deviations may take place, but over a sufficiently long time horizon, the deviations will be stationary. A variety of data sets and statistical techniques are apparent though more recent research focuses on the application of unit root tests and cointegration tests.

Rogoff (1996) provides an overview of the issues in research on PPP. The study discussed the random walk hypothesis on exchange rates and the long-run convergence to PPP. The study argues that the exchange rate series exhibit strong, but extremely slow, mean reversion properties. This raises a puzzle as to the nature of the shocks driving real exchange rate changes, as real shocks to productivity and preferences cannot be volatile enough to explain the immense short-term volatility of exchange rate.

Among the shortcomings of PPP studies are the low power of the tests to distinguish among alternative hypotheses in the short periods covered by the studies, and the dearth of empirical work aimed at testing a well-defined PPP hypothesis using cointegration techniques (Edwards and Savastano, 1999). Holmes (2001) attempts to overcome the low test power of the unit root and cointegration tests on individual countries by applying a t-bar test, which is a panel data unit root test which is based on calculation of the average augmented Dickey-Fuller statistic. Anoruo, Braha and Ahmad (2002) employed the dynamic error-correction model (DECM). Their results suggest the robustness of DECM method in detecting the existence of PPP compares to the conventional univariate ADF unit root test.

The measure of price level has become an issue in PPP literature. Cheung and Lai (1993) used both the CPI and the WPI in their study and found out a slight advantage of WPI over CPI. They further conclude that measurement error of the CPI could be the reason behind the rejections of the PPP's proportionality and symmetry restrictions. Xu (2003) suggested that price index of traded-goods (TPI) is a more appropriate price index for PPP tests and also for exchange rate forecasting.

The choice of base currency could also produce different results in the PPP studies. While most of the studies use the US dollar as their base currency, Papell (1997) shows stronger evidence against unit root hypothesis when German mark is used as the base currency.

Another issue of the PPP is the causality relation between prices and exchange rates. The fact that PPP holds true does not indicate anything about causation. Schnabl and Baur (2001) found evidence of vicious circle of yen appreciation and price adaptation; that is, appreciation

influenced the pricing of export industry, and consequently, when the Japanese industries lowered their price to adapt to the appreciation, it put additional appreciation pressure on the yen.

The quasi purchasing power parity (QPPP) attempts to overcome the limitation conventional unit root tests by allowing the possibility that even though most deviations dissipate, a few remain as permanent shocks. Specifically, QPPP suggests that exchange rates may show substantial mean reversion, but to a changing mean rather than to the constant PPP value. Hegwood and Papell (2002) present evidence of QPPP in 16 countries, and shows that the speed on mean reversion increases with the inclusion of structural changes in the model.

3. Methodology

Given the importance of the exchange rate, there is surprisingly little agreement concerning both how to measure and interpret movement in it. In large part, disagreement stems from the fact that the term exchange rate has been applied to different concepts. One of these concepts is the purchasing-power parity (PPP) theory. The concept was introduced by the Swedish economist name Casell to estimate the equilibrium exchange rate at which nations could return to the gold standard after the disruption of international trade and the large change in relative commodity prices in various nations caused by World War I. The absolute PPP theory postulates that the equilibrium exchange rate is equal to the ratio of the price levels in the two nations. Specifically,

$$E_t = P_t / P_t^* , \quad (1)$$

where E_t is the nominal exchange rate (units of domestic currency per unit of foreign currency) at time t , P_t is the domestic price level at time t , and P_t^* is the foreign price level at time t . Thus, the exchange rate between two nations is equal to the ratio of their price levels. An alternative representation is

$$e_t = p_t - p_t^* , \quad (2)$$

where e_t is the natural log of E_t , p_t is the natural log of P_t , and p_t^* is the natural log of P_t^* .

It is important to note that PPP imposes two constraints on the data. The first is proportionality between exchange rates and prices, and the second is symmetry between domestic and foreign countries. If equation (2) is to be expressed in regression form, then the regression model is

$$e_t = \alpha \cdot p_t - \beta \cdot p_t^* + u_t , \quad (3)$$

where u_t is the error term capturing deviations from PPP. Given the regression in equation (3) composing all I(1) (i.e. integrated of order 1) variables, the model is only meaningful if the equation is interpreted as cointegrating relationship; if the residuals are stationary, then the series are cointegrated. Thus, for PPP to hold in the long run, the error term u_t should be stationary. While symmetry requires that $\alpha = \beta$, proportionality requires that $\alpha = \beta = 1$. This suggests a univariate test based on the pricing discrepancies in the restricted model, that is,

$$u_t = e_t - p_t + p_t^* . \quad (4)$$

The test for stationary (i.e. the unit root test) for the restricted model expressed in equation (4) can be performed through several approaches. In particular, we choose the augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The failure to reject the null hypothesis of non-stationary data thus would imply that there are not enough evidence to support the PPP restrictions of symmetry and proportionality.

As an alternative, by rearranging, equation (3) can also be expressed as

$$\lambda' X_t = u_t, \quad (5)$$

where $\lambda = [1 \quad -\alpha \quad \beta]'$ and X_t is a vector series given by $[e_t \quad p_t \quad p_t^*]'$. When the series in X_t is I(1), then u_t is generally also I(1). However, if there exist a vector λ such that u_t is I(0) or stationary, as implied by long-run PPP, X_t is said to be cointegrated and $\lambda' X_t$ represents the long run relationship. Hence, as an alternative to the more restrictive univariate test, a test for long-run PPP can be undertaken from the view of cointegration.

One of the approach for testing cointegration is the Johansen test which is based on the technique of reduced rank regression. Specifically, this approach can identify whether there is a cointegrating relation between the foreign exchange rate and the two price level indices together. The identification of at least one cointegrating vector between the three variables will provide evidence for long-run PPP. The test for the null hypothesis of at most x cointegrating vectors against a general alternative is called the Johansen's trace test.

The DECM approach is derived by expressing the natural log of the real exchange rate, r_t , as an AR(p) process as follow:

$$\Delta r_t = \alpha_0 + \beta_1 r_{t-1} + \sum_{i=1}^p \theta_i \Delta r_{t-1} + \varepsilon_t \quad (6)$$

Note that by definition, $r_t = e_t - q_t$, where q_t is the natural log of the ratio of the domestic to foreign price level. The DECM is then derived by modifying equation (6) to become

$$\Delta e_t = \alpha_0 + \beta \Delta q_t + \delta(e_{t-1} - q_{t-1}) + \sum_{i=1}^k \theta_i \Delta q_{t+i} + \sum_{i=1}^k (\gamma_{ei} \Delta e_{t-i} + \gamma_{qi} \Delta q_{t-i}) + v_t \quad (7)$$

The regression coefficient δ represents the deviation from the previous period's PPP. If $\delta < 0$, this would indicate a reduction in the exchange rate in the current period, provided that $e_{t-1} - q_{t-1} > 0$. A negatively statistically significant δ indicates the tendency for the exchange rate to revert to the previous period's equilibrium state. Nevertheless, if $\delta = 0$, it can be assured that there is no statistical relationship between the current period's exchange rate and the deviation from the previous period's PPP. In this case, there is no tendency for the exchange rate to revert to the previous period's equilibrium level.

By relaxing some of its restrictions, equation (7) can be expressed as follow:

$$\Delta e_t = \alpha_0 + \Delta q_t + \delta(e_{t-1} - q_{t-1}) + \sum_{i=1}^k (\gamma_{ei} \Delta e_{t-i} - \gamma_{qi} \Delta q_{t-i}) + v_t \quad (8)$$

We will use DECM in equation (8) to examine the validity of DECM in the long-run. The estimated model is then checked for serial correlation in the residuals to ensure that it includes

enough lags necessary to avoid biased inferences. The model is valid only if the hypothesis of residual serial correlation is rejected.

4. Empirical Results

In this study, we use the quarterly data of nominal exchange rates (domestic prices of a US dollar) and the quarterly CPIs for six ASEAN countries, namely Indonesia, Malaysia, Myanmar, the Philippines, Singapore and Thailand. The data is obtained (online) from International Monetary Fund and covers the period from the first quarter of 1975 to the fourth quarter of 2009.

In order to test for PPP, it is necessary to identify whether the natural log of exchange rate and price level time series are stationary. The augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) tests are applied to test the nonstationarity of the time series of natural logs of exchange rate and price level. Specifically, if the null hypothesis of nonstationarity cannot be rejected for levels but is to be rejected for the change in levels, then it is generally held that the series contain one unit root, i.e. in other words, the series is I(1). The results of both ADF and PP tests for the natural log of exchange rate series and the natural log of CPI, which is exhibited in Table 1, suggest that both series are I(1).

Table 1: Unit-root tests on natural log of exchange rates and natural log of CPI

Country		log of exchange rates		log of CPI	
		ADF	Phillips-Perron	ADF	Phillips-Perron
Indonesia	level	-2.7916	-2.5091	-2.1514	-2.1682
	First difference	-7.0066*	-9.2391*	-6.1858*	-6.1336*
Malaysia	level	-2.3333	-2.2195	-2.4258	-1.5316
	First difference	-10.2674*	-10.27*	-4.0211*	-10.115*
Myanmar	level	-2.7786	-2.8259	-2.8666	-1.8217
	First difference	-4.7241*	-11.104*	-7.3628*	-7.4727*
The Philippines	level	-1.3938	-1.1683	-0.8165	-0.6884
	First difference	-6.0718*	-11.211*	-5.0451*	-6.4701*
Singapore	level	-1.7932	-1.8419	-2.7403	-1.5866
	First difference	-11.954*	-11.962*	-4.1263*	-7.9891*
Thailand	level	-2.0328	-2.0892	-3.1214	-1.7194
	First difference	-11.244*	-11.304*	-4.2053*	-7.5402*

Note: The lags that are used for each tests are determined by using the Akaike Information Criteria (AIC). The “*” indicates that the statistics is significant at the .05 level.

Table 2 provides a summary of the trace tests for the number of cointegrating vectors for each country. To this end, the null hypothesis to be tested is at most r cointegrating vectors against a general alternative. If the null hypothesis is rejected for $r = 0$, that would imply that there is at least one cointegrating vectors. If the null hypothesis is rejected at $r = 1$, that would imply that there is at least two cointegrating vectors. If the null hypothesis is rejected at $r = 2$, that would imply that the series is stationary. From Table 2, it appears that for Indonesian data, the null hypothesis of no cointegration between variables cannot be rejected at .05 level. These results indicate that there is no long-term relationship between nominal exchange rates of Indonesia, Indonesia's consumer price index and those of the United States. These results do not prove the validity of long-run purchasing power parity for Indonesia. For the cases of Malaysia, Singapore and Thailand, the null hypothesis of $r = 0$ can be rejected at .05 level, thus suggests that at least one cointegration vector between the nominal exchange rate variable and the consumer price index. This result means that there exists long-term relationship between the nominal exchange rate variable and the consumer price index,

therefore supports the validity of purchasing power parity for these three countries. Similarly, for Myanmar and the Philippines, the null hypotheses $r = 0$ and $r = 1$ can be rejected at .05 level, which means at least there are two cointegration vectors among the variables. The existence of cointegration vectors proves the existence of long-term relationship between variables and thus support the purchasing power parity hypothesis for Myanmar and the Philippines. In conclusion, there is enough evidence that supports the long term purchasing power parity for the cases of Malaysia, Myanmar, Philippines, Singapore and Thailand. On the contrary, there is not enough evidence of long term purchasing power parity from the Indonesian data.

Table 2: The result of Johansen's trace test

Country	H_0 : at least r cointegrating equation	Trace statistic	Critical values
Indonesia	$r = 0$	33.993	35.193
	$r = 1$	19.095	20.262
	$r = 2$	7.8577	9.1645
Malaysia	$r = 0$	56.415*	35.193
	$r = 1$	16.369	20.262
	$r = 2$	6.4353	9.1645
Myanmar	$r = 0$	42.475*	35.193
	$r = 1$	20.804*	20.262
	$r = 2$	6.1631	9.1645
The Philippines	$r = 0$	57.577*	35.193
	$r = 1$	25.882*	20.262
	$r = 2$	6.6315	9.1645
Singapore	$r = 0$	36.896*	35.193
	$r = 1$	17.402	20.262
	$r = 2$	4.9117	9.1645
Thailand	$r = 0$	53.819*	35.193
	$r = 1$	14.004	20.262
	$r = 2$	4.1972	9.1645

Note: The critical values are at .05 level. The mark "*" indicates that trace statistic is significant at the 5% level.

The results of estimation for DECM approach is exhibited in Table 3. To this end, we follow the approach of Anorou *et al.* (2002) by regressing the residuals on all the regressors and lagged values of the residuals, and jointly test that all coefficients are equal to zero using the F-test. Specifically, we pick the results at the lags which provide best evidence in support of the PPP. Judging from the p -values of these results, we can only conclude that there is evidence of δ being negatively statistically significant, at .05 level, for the Thailand data. At .10 level, only Singapore data is significant. For the other four countries, δ is not significant. The result of DECM approach therefore show contrasting results as compared to the previous cointegration approach.

Table 3: The DECM estimation and the test for the hypothesis of residual serial correlation

Country	To test for negative δ				To test for residual serial correlation	
	lags	estimated δ	t -value	p -value	F -statistic	p -value
Indonesia	1	-.00071	-0.1036	0.0976	5.8766	0.1873
Malaysia	1	-0.0013	-0.4110	0.6817	7.4591	0.1135
Myanmar	1	-0.0125	-1.2168	0.2256	1.2097	0.8765
The Philippines	4	-0.0197	-2.3693	0.0178	3.2556	0.5161
Singapore	3	-0.0196	-1.8493	0.0666	6.1131	0.1909
Thailand	2	-0.0960	-2.9671	0.0035	7.1336	0.1291

5. Summary and Conclusions

The main purpose of this paper is to provide and compare some alternative to examine the issue of PPP. In this paper, we tested the absolute PPP theory on the quarterly exchange rates data of six ASEAN countries, namely Indonesia, Malaysia, Myanmar, the Philippines, Singapore and Thailand, based on the US dollar. For the price level, we use the quarterly CPI for each countries, the multivariate test based on cointegrating vectors was supportive of long-run PPP for all countries except Indonesia. However, the DECM approach only showed evidence of the PPP for Singapore and Thailand data.

Assuming that the results fairly represent the ASEAN economies, the evidence in favor of PPP is an early indication of the integration in financial and goods markets within the South-east Asia region. Despite of the talks among some policy makers in ASEAN countries are in favor of a move towards currency union, more attention has to be focused to issues that may complicate further economic integration, such as differences in standard of living and economic maturity. On the other hand, there is evidence that currency unions are characterised by more trades, less volatile exchange rates, and more synchronised business cycles than do countries with their own currencies. Nevertheless, since well-integrated countries are more likely to adopt a common currency, some of these integration effects of currency union may be illusory, as the causality may flow from integration to currency union rather than the reverse.

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