International Parities among China and Her Major Trading Partners in Asia Pacific

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Abstract: As China's role in world economy has steadily grown, her importance to the international trading and finance has also increased apace. A joint investigation of the international parity conditions for China and her thirteen major trading partners in Asia Pacific is thus conducted. Monthly observations and sub-samples within 1986-2007 are being considered to accentuate the effects of institutional changes and financial crisis. Advanced econometric procedures including the heterogeneous panel and endogenous break tests for unit root and correction factor model for half-life estimation are utilized in the analyses. Our findings reveal that first, endogenous and exponential breaks are confirmed for the real exchange and real interest differential series, which mostly occur in 1988, 1993/94 and 1997/98. Second, RIP holds better than PPP, suggesting the greater financial integration than trade integration among APEC-China. The undervalued exchange rate regime may exert some drawbacks against the PPP theorem. Third, both parities tend to hold better in the post-liberalization and post-crisis era, attributed not only to the financial liberalization process among APEC economies, but also to the Chinese trade policy and the regional commitment for the ASEAN+3+2+1 cooperation. Fourth, APEC members have has improved their ability to absorb external shocks as indicated by the shortened half-life reported overtime, especially when the post-crisis era is included.

Keywords: PPP, RIP, Non-linear Endogenous Breaks, Panel Unit Root Tests, Economic Integration

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INTERNATIONAL PARITIES AMONG CHINA AND HER MAJOR TRADING PARTNERS IN ASIA PACIFIC

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Abstract

As China's role in world economy has steadily grown, her importance to the international trading and finance has also increased apace. A joint investigation of the international parity conditions for China and her thirteen major trading partners in Asia Pacific is thus conducted. Monthly observations and sub-samples within 1986-2007 are being considered to accentuate the effects of institutional changes and financial crisis. Advanced econometric procedures including the heterogeneous panel and endogenous break tests for unit root and correction factor model for half-life estimation are utilized in the analyses. Our findings reveal that first, endogenous and exponential breaks are confirmed for the real exchange and real interest differential series, which mostly occur in 1988, 1993/94 and 1997/98. Second, RIP holds better than PPP, suggesting the greater financial integration than trade integration among APEC-China. The undervalued exchange rate regime may exert some drawbacks against the PPP theorem. Third, both parities tend to hold better in the post-liberalization and post-crisis era, attributed not only to the financial liberalization process among APEC economies, but also to the Chinese trade policy and the regional commitment for the ASEAN+3+2+1 cooperation. Fourth, APEC members have has improved their ability to absorb external shocks as indicated by the shortened half-life reported overtime, especially when the post-crisis era is included.

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1. Introduction

Unlike her neighboring economies in the East Asia, China's economic reform process is relatively recent, mainly due to the constraint of socialist economics during 1940-1970s. However, the affluent human capital and economic resources has provided China the new impetus to and reinvigorate the economic reforms since 1978 and the progress is eye-catching. Within three decades, China has transformed from a rigid central-planning system to an increasingly open and market-oriented economy, with the achievement of averagely 9.7% real GDP growth per annum. In 2008, China recorded a nominal GDP of US$4.33 trillion and became the third largest economy after the US and Japan. But after adjusted for PPP, China is in fact the largest economy in Asia and the second in the world, with a GDP of $7.8 trillion.

As China's role in world economy has steadily grown, her importance to the international trading and finance has also increased apace, especially after the accession to WTO (Nov, 2001). In 2007, China's total trade was reported at US$2170 billion (hundred times the total trade in 1978 - US$20.6 billion) and her current account surplus amounting US$372 billion ranked top globally (World Factbook, 2008). Despite being the major trading partners for many Asia Pacific economies (APEC)[1], China has

[1] The directions of trade for selected APEC are accounted for 61% and 59% of the Chinese total exports and imports respectively in 2006 (EAEA, 2007). These selected APEC include the US, Australia, New Zealand, Taiwan, South Korea, Singapore, Indonesia, Malaysia, Philippines and Thailand.

also actively involved with the Chiang Mai Initiative (2000), the Bali Accord (2003) and the Singapore Declaration (2007) and devoted for closer cooperation within the ASEAN+3+2+1 framework. In line with the trade and exchange rate liberalization[2], China has gradually opened up the financial markets by permitting a wide variety of private enterprise in services and light manufacturing; developing a more diversified banking system and capitalized stock market; and increasing the foreign investments. According to the World Bank statistics, China has doubled her accumulated FDI since 1999 from US$39 billion to about US$80 billion in 2005, to become the largest FDI destination in East Asia. Besides the European counterparts, Hong Kong, Taiwan, Japan and the US hold the major shares of foreign investments. Similarly, half of the stocks of foreign bank lending are also sourced from the US and East Asian trading partners (EAEA, 2007).

Taking concern of such development, markets convergence and future economic events that anchored by China are well expected in the Asia Pacific region. Yet, to what extent has China truly integrated with the regional economies, remains as major apprehension. Two unsolved but essential questions thus arise. First, is regional trade competition sufficient to eliminate prices arbitrage and hence reflecting the exchange value of Chinese Yuan when more and more trading of goods and services (capital and labor, too) are promoted across borders? Second, are China's pricing and investment structures integrated with the regional standards to facilitate cross-border financial assets substitutability or allowed for greater portfolio diversification? The former question relates to the Purchasing Power Parity (PPP hereinafter) whereas the latter directs to the Real Interest Parity (RIP hereinafter) condition.

Without the answers, we are unable to draw any inclusive commendation about the extent of economic integration between China-APEC, and hence intricate the formulation of regional monetary and exchange rate policy coordination. In this regard, a joint investigation of both the PPP and RIP conditions are relevant and necessary as they combine analytical tractability with theoretical desirability. Support for PPP would imply the goods market integration attributed to price convergence and apposite alignment of exchange rate, or otherwise. Similarly, acceptation of the RIP will uphold the regional financial integration among China-APEC while rejection of RIP may imply the greater degree of monetary autonomy. Such practice of joint investigation is not frequently applied in the literature but supported by Johansen and Juselius (1992), and Juselius and MacDonald (2000), among others. Additionally, a different insight or perspective may be gained from examining China and Asian emerging economies with different regulatory regimes at different stages of development. More important perhaps, monetary and exchange rate coordination policies derived from the PPP and RIP conditions would enable the Asia Pacific region to exert an important influence upon the future evolution of the global trade and financial system.

This paper is designed to assess the PPP and RIP conditions of China vis-à-vis her thirteen major trading partners in the Asia Pacific region. A convenient strategy is to scrutinize the mean-reversion behaviors of bilateral real exchange rates (REX) and real interest differentials (RID) among China-APEC. Monthly observations and sub-samples within 1987-2007 are being considered to accentuate the effects of institutional changes and financial crisis. Due to the deficiency in extant econometric tests, various estimation methods are adopted to increase the likelihood of establishing well-defined results. These include the newly proposed endogenous break test by Saikkonen and Lütkepohl (2002) as well as the homogenous and heterogeneous panel tests advocated by Levin-Lin-Chu (2002) and Im-Pesaran-Shin (2003) respectively. Results of both univariate and panel tests are compared in considering of the robustness within the macro-panel setting. To capture the degree of shock adjustments towards

[2] China has repeatedly devalued its currency as a means of trade expansion and external competitiveness gains in the 1980s and the early 1990s. In 1994, 1996 and 2005, unification of multiple rates and liberalization of exchange rates drive the RMB a step further toward the full convertibility. Likewise, the portion of foreign trade under direct administrative controls has been substantially reduced while more subject to the market forces.

equilibrium, we also estimate the half-life and corresponding confidence intervals by means of the correction factor model put forward by Rossi (2005).

The present study is organized in the subsequent manner. In Section 2, a brief discussion of relevant literature is presented. This is followed by the theoretical framework, estimation procedures and data description reported in Section 3. Estimation results are then presented and discussed in Section 4. Finally, conclusions are drawn in the closing section.

2. Brief Review of Literature

PPP and RIP constitute as fundamental building block of international macroeconomics. PPP enquires a constant real exchange which at least exhibits reversion towards the long run mean rate over time, and not driven by stochastic trends. On the other hand, RIP is verified via the real interest differential hypothesis or real interest co-movement that support for financial asset substitutability and capital mobility across borders. While PPP is an elegant hypothesis, much failure appears in the early studies. Among others, see Hakkio (1984), Edison (1985), Frankel (1986), and Meese and Rogoff (1988), Mark (1990), Edison and Pauls (1993). The consensus arrived by recent literature survey (see *inter alia*, Rogoff, 1996; Taylor and Taylor, 2004) suggests that despite the presence of excessive short-term exchange rate volatility, the deviations from the long run equilibrium PPP rates are too persistent with the estimated half-life[3] of real exchange shocks at about 3-5 years.

Likewise, the empirical supports were overwhelmingly poor when the absolute condition of RIP was being examined in the 1980s (see *inter alia* Mishkin, 1984; Cumby and Obstfeld, 1984; Frankel and MacArthur, 1988). Numerous efforts using both univariate and multivariate techniques have emerged in the empirical literature to examine RIP and the German- or US-dominant hypothesis[4] among developed nations but still, the empirical evidences are at best mixed. Later, due to the recognition of 'Asia Miracle' and the outbreak of 'Asia Financial Crisis', a sizeable literature on Asian economies emerge (Bhoocha-Oom and Stansell, 1990; Chinn and Frankel, 1995; Phylaktis, 1997, 1999; Chan *et al.*, 2003; Sun, 2004; among others). The findings are generally supportive for capital market integration but again the US- and Japan-leading role in the Asia Pacific region is inconclusive[5]. On top of that, assessment of economic integration based on China-denominated exchange rates and financial securities are notably lacking.

The PPP and RIP studies have then progressed into few similar research directions, which mainly focused on the statistical power of the econometric tests. However, despite two decades of multiple applications of the estimation procedures, researchers are still unable to arrive at homogeneous conclusion. Among them, some have explored the application of panel tests of unit root and cointegration

[3] Half-life refers to the number of years it takes for at least half of the deviation from PPP to be eliminated, following a monetary or real shock (e.g. productivity, technology) on real exchange rates. It is of less useful to know PPP holds in the long run, if the degree of mean reversion in the real exchange rate is infinitely long.

[4] See Kirchgassner and Wolters (1993) and Moosa and Bhatti (1996) for the German-dominance hypothesis; Cumby and Mishkin (1986) and Modjtahedi (1988) for the US-dominance hypothesis; Pain and Thomas (1997) and Awad and Goodwin (1998) for the US- and German-dominance joint hypothesis.

[5] Chinn and Frankel (1995), for instance, found that although Indonesia and Thailand were integrated with Japan, RIP holds only for US-Singapore, US-Taiwan and Japan-Taiwan. On the other hand, Phylaktis (1997, 1999) found that Asia-Pacific capital markets are considerably integrated but that the results regarding the US' and Japan's leading roles in the regional market are contradictory. In a similar work on RIP, Chan (2001) confirmed the high degree of regional capital mobility and substantial financial integration among the East Asian economies but that the US leading role was greater than that of Japan's.

on PPP (e.g. Wu, 1996; Papell, 1997; O'Connell, 1998; Holmes, 2001; Alba and Papell, 2007; Baharumshah, *et al.*, 2007) and RIP (e.g. Holmes, 2002; Baharumshah, *et al.*, 2005; Chan, *et al.*, 2007) respectively. Others, with no less contribution, study the appliance of non-linearity for real exchange rates (Taylor and Sarno, 1998; Taylor and Peel, 1998, Sarno and Chowdhury, 2003) and real interest differentials (Baharumshah, *et al.*, 2009). In general, studies that adopted the first generation panel tests tend to uncover more evidence for PPP and RIP, attributed to the expansion of sample size and the exploitation of cross-country variations of the data which thereby yielding higher test power in the estimation. However, the outcome of the tests is sensitive to the selection of series included in the panel, as the null hypothesis of a common unit root (homogenous) may be rejected even if only one of the series is stationary. As a result, several studies proceed with the heterogeneous panel tests (allowed for cross-sectional independence) with uncorrelated errors or the second generation panel tests that account for cross-section correlation of errors (see Baltagi and Kao, 2000; Breitung and Pesaran, 2007; for details).

In addition, some researchers have also highlighted the importance of structural breaks or regime change (e.g. oil shocks, emerge of European monetary system, currency and financial crises) in influencing the assessment of both theorems (Fujii, 2002; Zurbruegg and Allsopp, 2004; Chow *et al.*, 2007). For instance, if real exchange rates are subjected to structural breaks, then large and permanent devaluations of the currencies during a currency crisis will bias the test toward acceptance of the unit root hypothesis. Likewise, cross-border real interest may vary for the period of monetary adjustments due to hyperinflations or currency instability. Of all, Perron (1989) and Rappoport and Reichlin (1989) are among the first to consider the importance of structural breaks for the implementation and interpretation of unit root tests. Nevertheless, the Perron (1989) method of assuming the break date as exogenously determined and known *ex ante* has often been considered inappropriate. Zivot and Andrews (1992) later developed the single endogenous structural break test of unit root which was widely applied in the PPP studies. Lumsdaine and Papell (1997) then further the work of Zivot and Andrews (1992) to allow for two endogenous breaks under the alternative hypothesis and additionally allow for breaks in the level and the trend. Series are generally interpreted as broken trend stationary if the null hypothesis of unit root is rejected in favor of the alternative of two breaks. Alternatively, Saikkonen and Lütkepohl (2002) and Lanne, *et al.*, (2002) develop endogenous break model which adds to the deterministic term shift functions of a general nonlinear form using GLS de-trending. The deterministic component is subtracted from the original series and then ADF tests are applied to the adjusted series. Unlike much of the literature that dealt with the case in which a break occurs during one period only, nonlinear break tests follow the reasoning logic that breaks occur over a number of periods and display smooth transition to a new level. The approach is extended to estimate unknown break date by Lanne *et al.* (2003).

3.1 Theoretical Framework

If we let s_t be the log spot exchange rate, p_t^* and p_t be the log foreign and domestic price levels respectively, the PPP condition is defined as

$$s_t = p_t - p_t^* \tag{1}$$

Real exchange rates (REX), q_t (in logarithm) as deviation from the PPP is then given by

$$q_t = s_t + p_t^* - p_t \tag{2}$$

And, the ex ante PPP can be shown as

$$\Delta s_{t,t+k}^e = \pi_{t,t+k}^e - \pi_{,t+kt}^{e*} \tag{3}$$

which imply that PPP holds in expectation that expected depreciation ($\Delta s^{e}_{t,t+k}$) equals the expected inflation differential with * denotes foreign variables. Subsequently, RIP can be obtained by combining the Fisher effect in each country, the ex ante PPP and the Uncovered Interest Parity (UIP) relationship. UIP anticipates expected depreciation as being explained by interest rate differentials so that

$$\Delta s^{e}_{t,t+k} = i^{k}_{t} - i^{k*}_{t} \tag{4}$$

Equating (3) and (4) thus yields $i^{k}_{t} - \pi^{e}_{t,t+k} = i^{k*}_{t} - \pi^{e*}_{,t+kt}$. If Fisher equation holds so that real interest equals nominal interest minus expected inflation, the ex ante RIP condition will be

$$E_t(r_{t+k}) = E_t(r^{*}_{t+k}) \tag{5}$$

When rational expectations are considered, ex post RIP also implies ex ante RIP. And, the Real Interest differential (x_t, RID) as deviation from RIP is shown as

$$r_t - r^{*}_{t} = x_t \tag{6}$$

Given the respective specification of PPP and RIP in (2) and (6), both international parities hold if REX and RID are mean reverting. Suppose that q_t and x_t follow AR (1) process, then

$$q_t = \rho q_{t-1} + \varepsilon_t \tag{7}$$

and $$x_t = \varpi x_{t-1} + \mu_t \tag{8}$$

where $0 < |\rho| < 1$ and $0 < |\varpi| < 1$ whereas ε_t and μ_t are white noise innovations. Evidence of long run PPP and RIP can be verified by a test of unit root in REX (q_t) and RID (x_t). A common test of unit root relies on the augmented Dickey-Fuller (ADF) regression with intercept and time trend which is given by

$$\Delta g_t = \mu + \beta t + \varphi g_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta g_{t-i} + \varepsilon_t \tag{9}$$

where g_t represents q_t or x_t. Δg_t is the first difference of REX or RID, *k* is the number of lagged g_{t-i} whilst ε_t is the error term. To be consistent with the international parities, both the q_t and x_t must exhibit mean reversion behavior devoid of a unit root. The φ is thereby to be significantly less than 0. Otherwise, deviations from PPP or RIP are permanent after shocks. For stationary REX and RID, the degree of mean reversion can be further estimated by half-life (h) – a concept defined as the horizon at which the percentage deviation from the long run equilibrium of PPP or RIP is one-half. By formula, $h = \dfrac{\ln(1/2)}{\ln(\alpha)}$, where $\varphi = (\alpha - 1)$. The two-sided 95% confidence intervals of the half-life which are based on normal sampling distributions is then defined as $\hat{h} \pm 1.96\hat{\sigma}_{\hat{\alpha}}\left(\dfrac{\ln(0.5)}{\hat{\alpha}}[\ln(\hat{\alpha})]^{-2}\right)$, where $\hat{\sigma}_{\hat{\alpha}}$ is an estimate of the standard deviation of α. Rossi (2005) then defined half-life as $h = \ln(0.5)b(1)/\ln\alpha$ with $b(1) = (1 - \sum_{j=1}^{k} \alpha^{*}_{j-1})$, being the correction factor that sums the estimated AR coefficients of an AR (ρ) model fitted onto the residuals of the ADF regression. In present study, we applied both methods on REX and RID series which are found stationary.

3.2 Alternate Estimation Strategy

The ADF test may be distorted, however, if a potential structural break (currency crises, oil shocks, Great Crash, etc.) in the real exchange series is simply ignored. Saikkonen and Lütkepohl (2002, SL hereinafter) put forward that structural breaks may occur over a number of periods and display smooth transition to a new level. Say, a level shift function, which is here denoted by a general nonlinear form $f_t(\theta)'\gamma$, is added to the deterministic term, ε_t of the data generating process. Hence, the model of

$$g_t = \varepsilon_0 + \varepsilon_1 t + f_t(\theta)'\gamma + v_t \tag{10}$$

is shown, where θ and γ are unknown parameters, whereas v_t are residual errors generated by an AR(p) process with possible unit root. In this study, we consider the shift function based on the exponential distribution function which allows for a nonlinear gradual shift to a new level starting at time T_B,

$$f_t(\theta) = \begin{cases} 0, & t < T_B \\ 1 - \exp\{-\theta(t - T_B + 1)\}, & t \geq T_B \end{cases}. \tag{11}$$

In the shift term $f_t(\theta)'\gamma$, both θ and γ are scalar parameters. θ is to be positive real line ($\theta > 0$), whereas γ may assumes any value. The SL test of model (10) is based on the estimation of the deterministic term first by a generalized least squares de-trending procedure under the unit root null hypothesis and subtracting it from the original series. An ADF-type test is then performed on the adjusted series which also includes terms to correct for estimation errors in the parameters of the deterministic part. The asymptotic null distribution is nonstandard and critical values are tabulated in Lanne *et al.* (2002). On the other hand, Levin, Lin and Chu (2002, LLC) proposed to modify the ADF statistics based on homogenous pooled statistics. An estimate of the coefficient α may be obtained from proxies for Δg_{it} and g_{it} which are standardized and free of autocorrelations and deterministic components, such that:

$$\Delta\tilde{g}_{it} = \alpha\tilde{g}_{it-1} + \eta_t \tag{12}$$

where $\Delta\tilde{g}_{it} = (\Delta\bar{g}_{it} / se_i)$ and, $\tilde{g}_{it-1} = (\bar{g}_{it-1} / se_i)$, with s_i being the estimated standard error from estimating single ADF statistics of the REX and RID series . Then, LLC show that under the null, a modified t-statistics for the resulting $\hat{\alpha}$ is asymptotically normally distributed

$$t_\alpha^* = \frac{t_\alpha - (NT)S_N\hat{\alpha}^{-2}se(\hat{\alpha})\mu_{mT}^*}{\alpha_{mT}^*} \rightarrow N(0,1) \tag{13}$$

where t_α^* is the standard t-statistics for $\hat{\alpha} = 0$, $\hat{\alpha}^2$ is the estimated variance of the error term η, $se(\hat{\alpha})$ is the standard error of $\hat{\alpha}$, S_N is the mean of the ratios of the long run standard deviation to the innovation standard deviation for each individual series, which is derived using kernel-based techniques, μ_{mT}^* and α_{mT}^* are adjustment terms for the mean and standard deviation respectively, and lastly $T = T - (\sum_i p_i / N) - 1$.

Additionally, Im, Pesaran and Shin (2003, hereafter IPS) proposed a popular panel test that assume cross-sectional independence among panel units (except for common time effects), but allows for heterogeneity in the form of individual deterministic effects (constant and/or linear time trend), and heterogeneous serial correlation structure of the error terms. The IPS testing procedure follows the mean group approach: the *t*-bar statistics and the group mean Lagrange Multiplier test (*LM*-bar). Conceptually, the IPS test is a way of combining the evidence on the unit root hypothesis from the *N* unit tests performed on the *N* cross-section units. Through Monte Carlo experiments, the average *LM* and the *t*-statistics have better finite sample properties than the homogenous panel tests. Briefly, the test statistics are given by

$$\Gamma_{\bar{t}} = \frac{\sqrt{N}\left\{\bar{t}_{NT} - E(t_{iT} \mid \beta_i = 0)\right\}}{\sqrt{Var(t_{iT} \mid \beta_i = 0)}} \qquad \Rightarrow \text{N (0,1) where } \bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT} \tag{14}$$

and

$$\Gamma_{\overline{LM}} = \frac{\sqrt{N}\left\{\overline{LM}_{NT} - E(LM_{iT} \mid \beta_i = 0)\right\}}{\sqrt{Var(LM_{iT} \mid \beta_i = 0)}} \Rightarrow \text{N (0,1) where } \overline{LM}_{NT} = \frac{1}{N}\sum_{i=1}^{N} LM_{iT} \tag{15}$$

such that $\bar{t}_{NT}$ is based on averaging individual ADF tests while $\overline{LM}_{NT}$ is the average across the group. Both means $E(t_{iT} \mid \beta_i = 0)$, $E(LM_{iT} \mid \beta_i = 0)$ and both variances $Var(t_{iT} \mid \beta_i = 0)$, $Var(LM_{iT} \mid \beta_i = 0)$ are obtained from the Monte Carlo simulations with i= 1,2,…,N.

3.3 Data Description

The various tests outlined in the previous section are applied to a sample of monthly observation for China and her thirteen major trading partners in the Asia Pacific. Except India, all trading partners are APEC members including the economic giants (US, Japan), the Oceania economies (Australia, New Zealand), the developed NIE-4 (Hong Kong SAR, Singapore, South Korea, Taiwan) and the developing ASEAN-4 (Indonesia, Malaysia, Philippines, Thailand). Our joint investigation of PPP and RIP involves the bilateral real exchange rates (REX) and real interest rate differentials (RID) of APEC-China. The construction of thirteen China-denominated REX is based on equation (2), which consists of nominal Yuan-based exchanges rates, individual APEC CPI as domestic price and China CPI as foreign price. As for RID, China is again considered as foreign variable (numeraire) and we follow the Fisher equation to construct real interest rate by subtracting the expected inflation from nominal interest rate. Since ex post RIP implies ex ante RIP, expected inflation is proxied by actual inflation. The nominal interest rates employed in the study are generally non-control and medium term lending rates due to the fact that long-term interest rates, such as government bond yields are incomplete or unavailable for most of these Asian countries. To maintain the consistency and reliability of the data, we cross check with various sources such as International Financial Statistics of IMF, Datastream and Central Banks of respective economies.

4.1 Endogenous Breaks and Unit Root Tests

It is well noted lately that classical unit root tests might be biased by the presence of structural breaks and nonlinearities in the deterministic components. The alternative approach that captures the structural breaks with a smoother functional form for the transition period could be more informative. We hereby estimate the Saikkonen and Lütkepohl (2002, SL) test with the optimal lag length (k) being determined by the standard Schwarz Information Criterion (see Table 1.1). All the exponential shift parameters are highly significant to capture the endogenous shift dates. For REX, endogenous break(s) occur mainly in 1993 and two cases in 1997/98. The first break is due to the major downward adjustment (appreciation) of Chinese Yuan in 1993/94 against the USD and other major currencies. The second break date is due to the Asia financial turmoil that witnessed a sharp fall of currencies among the East Asian Economies. However, out of thirteen Yuan-based REX, only four cases (Taiwan, Indonesia, India, New Zealand) have weakly rejected the null hypothesis of unit root at 10% significant level to befall as stochastic stationary. The SL results indicate the absence of mean reversion behaviors even when graduate shifts are allowed. If this is true, then for any shocks on the REX series, deviations will be too persistent to witness necessary adjustment to the equilibrium level and the PPP puzzle remains unsolved. Such finding is inconsistent with the recent USD- and Japanese Yen-based PPP studies, but in line with the late argument that Chinese Yuan are misaligned and incompetent by the PPP rules.

Table 1.1: Endogenous Breaks Test on APEC-China's Parity Conditions

	REX –CHINA			RID -CHINA		
	k	Break	SL test	k	Break	SL test
US	7	1993M6	-2.515	3	1988M8	-2.920 [b]
Japan	1	1993M6	-1.764	5	1988M8	-2.951 [b]
India	4	1993M6	-2.707 [a]	5	1998M11	-2.998 [b]
Australia	1	1993M7	-1.984	3	1990M1	-2.747 [a]
New Zealand	7	1993M6	-2.614 [a]	2	1989M8	-3.191 [b]
Hong Kong	1	1993M6	-2.300	1	1988M8	-2.880 [b]
Taiwan	2	1993M7	-2.762 [a]	6	1989M9	-3.284 [b]
South Korea	2	1997M12	-2.062	2	1988M10	-2.312
Singapore	5	1993M6	-1.480	2	1992M4	-2.906 [b]
Indonesia	6	1998M1	-2.648 [a]	4	1999M2	-2.963 [b]
Malaysia	7	1993M6	-2.495	5	1988M8	-3.012 [b]
Philippines	1	1993M6	-1.562	2	1991M11	-3.221 [b]
Thailand	5	1993M6	-1.647	3	1989M8	-2.963 [b]

Critical values		
1% [c]	5% [b]	10% [a]
-3.48	-2.88	-2.58

Notes: a, b and c denote for the significant level at 10%, 5% and 1% respectively. Critical values are obtained from Lanne, Lütkepohl, and Saikkonen (2002).

As for RID, most breaks occurred at 1988 when China experienced high inflation that resulted in imbalance rate of real interest. Also, some adjustments of interest rates were found in 1998/99 among the crisis-affected nations to defend their currencies and to fight against the stagflation (e.g. Indonesia). Unlike the PPP finding, most China denominated-RID (except South Korea) have exhibited mean reversion behavior to support for RIP. Nevertheless, the rejection of univariate unit root alone is necessary but neither sufficient to gauge the degree of mean reversion of APEC-China series as a group nor to identify the potential changes in the process of integration due to market and policy reforms over time. We thus proceed with the panel tests that utilize both cross-sectional and time series information to allow us to testify the respective PPP and RIP condition by sub-samples.

Information about the endogenous break dates has been useful to construct our sub-samples in panels. Considering the frequency of break dates, we separate the study periods into 1987-1993, 1994-2007, 1987-1997, 1998-2007 and 1987-2007. However, we are unable to consider the 1988 break as the sample size is too short and inappropriate for econometric estimation. To improve the robustness of our findings, the homogenous and heterogeneous panel tests are both conducted. For the early sub-periods of 1987-1993 and 1987-1997, the panel results of REX support the SL findings reported earlier which generally against the PPP, suggesting that the inflexibility of exchange rate and deviations from equilibrium rate are permanent. This is indeed the period when Chinese Yuan practiced multiple rates and the official rates were de facto crawling band around USD (+/- 2%) with the premium peaks at 124% on June 1991. Even when the full sample size is considered, null hypothesis of unit root fail to be rejected and no evidence of mean reversion is captured. The results differ and improved drastically when the sub-sample of post-liberalization (1994-2007) and post-crisis (1998-2007) are considered. Rejections of unit roots are highly significant as reported by LLC and IPS tests, implying that the deviations of the group of Yuan-based REX are now temporal, and exchange rates are more responsive to changes in price ratios. These are mainly attributed to the unification of China's two main currency rates in 1994 and the deregulation on foreign invested enterprises in exchanging funds freely at selected banks without approval from the State Administration for Exchange Control (SAEC) in 1996 that drive the RMB a step further towards the full convertibility (Zhanng, 2006). The adjustment of under-valued Renminbi (RMB) since 2005 may also en route for some extent of market completeness by the PPP rules. Overall, the liberalization process is still insufficient to display full support for PPP and further flexibility in the exchange rate regime is needed.

Table 1.2: Sub-sample Panel Unit Root Tests on APEC-China's Parity Conditions

	LLC-Homogeneous Panel Test		IPS-Heterogeneous Panel Test	
	REX-CHINA	RID-CHINA	REX -CHINA	RID -CHINA
1987M1-1993M12	2.887 (0.998)	-0.861 (0.195)	1.158 (0.876)	-1.595 [a] (0.055)
1987M1-1997M12	1.428 (0.923)	-0.155 (0.438)	2.476 (0.993)	-2.465 [b] (0.007)
1987M1-2007M1	-0.537 (0.296)	-2.065 [b] (0.020)	-0.376 (0.354)	-2.962 [c] (0.002)
1994M1-2007M1	-6.616 [c] (0.000)	-2.727 [c] (0.003)	-5.056 [c] (0.000)	-2.367 [c] (0.009)
1998M1-2007M1	-2.040 [b] (0.021)	-2.676 [c] (0.004)	-2.439 [c] (0.007)	-4.804 [c] (0.00)

Note: a, b and c denote for the significant level at 10%, 5% and 1% respectively.

A somewhat comparable trend of mean reversion behavior is found when the APEC-China real interest differentials are taken as a group. For instance, LLC test has failed to reject the null hypothesis of common unit root for two early sub-samples but highly rejected for two late sub-samples. Similar but not identical, the IPS heterogeneous panel test detected weak rejection of individual unit roots for the early period sub-samples but strong rejection of unit roots for late period sub-samples. Putting together, the supports for RIP are general weak during pre-liberalization era but improved evidently for the post-liberalization period, before and after the crisis (Table 1.2). Such findings are in line with the financial liberalization process and the gradual ruling out of restrictions on capital movements in APEC, including China. In June 1996, the ceiling rates of inter-bank loans were removed and the interest rates have expanded twice in China within 1998-99 while state-owned financial institutions are allowed to be

commercialized. By September 2000, the controls on large fixed deposits and foreign currency loans were lifted and the China Banking Association took over the responsibility of interest rates decision on small foreign currency deposit. Because China is taken as base country, support for RIP would confirm the improved influence of China in the regional capital markets since 1990s. Future fluctuations of the APEC real interest rates can possibly be determined or forecasted, using the Chinese real rates as part of the information set. In addition, the results point toward the benefits of using panel tests in exploiting the cross-nation variations of the data, thus yielding higher test power in the sub-sample estimation over time.

4.2 Half-Life Estimation and Confidence Intervals

To obtain an insight into the degree of mean reversion of REX and RID as further justification of PPP and RIP, the estimation of half-life for series that are found stationary is essential. But since the point estimates of half-life may provide an incomplete picture of the speed of convergence towards the equilibrium rates in long run, the corresponding confidence intervals are also computed. Such practice will offer better indications of the uncertainty around the estimates of half-life. For univariate series, this study estimates the half-life based on the AR (ρ) method and the correction factor model proposed by Rossi (2005). For panel series with sub-samples, only the AR (ρ) method is employed.

Table 2.1: Univariate Half-life Estimations

	REX-CHINA		RID-CHINA	
	HL- AR(ρ) [95%CI]	Rossi (2005) [95%CI]	HL- AR(ρ) [95%CI]	Rossi (2005) [95%CI]
US	-	-	27.33 [9.28, 45.38]	8.08 [0, 26.13]
Japan	-	-	24.85 [8.43, 41.26]	7.24 [0, 23.65]
India	15.87 [3.91, 27.84]	14.97 [3.01, 26.94]	19.16 [5.43, 32.90]	8.52 [0, 22.25]
Australia	-	-	28.05 [6.19, 49.91]	11.29 [0, 33.15]
New Zealand	26.13 [1.29, 50.96]	16.59 [0, 41.43]	25.31 [9.32, 41.31]	7.96 [0, 23.96]
Hong Kong	-	-	21.13 [5.49,36.77]	11.27 [0, 26.91]
Taiwan	58.85 [0, 160.04]	61.18 [0, 162.38]	15.32 [5.39,25.25]	6.20 [0, 16.14]
South Korea	-	-	-	-
Singapore	-	-	24.38 [8.23, 40.54]	8.53 [0, 24.69]
Indonesia	19.67 [2.92, 36.42]	12.89 [0, 29.64]	13.98 [7.55, 20.42]	3.06 [0, 9.50]
Malaysia	-	-	24.48 [7.98, 40.98]	7.50 [0, 24.00]
Philippines	-	-	17.37 [5.57, 29.17]	8.92 [0, 20.71]
Thailand	-	-	25.52 [7.56, 43.48]	9.26 [0, 27.22]

Notes: For univariate analysis, the half-life is computed based on two methods: the AR (ρ) and the correction factor model by Rossi (2005).

We first select four REX series that support PPP for estimation and 16-59 months (1.3 - 4.9 years) of half-life is reported by the classical method (Table 2.1). All except Taiwan has reported slightly shorter half-life when the Rossi method is applied and displayed moderate speed of adjustments to the equilibrium PPP rate. In the panel analysis with all APEC-13 pooled as a group (see Table 2.2), the post-liberalization and post-crisis period recorded half-life around 18-24 months (1.5 - 2 years). The standard errors are considered miniature and contribute to a less widen but stable confident intervals. There are signs that deviations of REX exhibit somewhat faster adjustments back to the long run PPP since 1994.

On the other hand, supports for RIP as indication of financial integration are somewhat greater than supports for PPP. Univariate series averagely show 14 - 28 months (1.2 – 2.3 years) of half-life. Then again, the scale of half-life drops to about 3 – 11.3 months under the Rossi estimation (see Table 2.1). For panel analysis, full sample (1987-2007) half-life is approximately 31 months. As for the post-liberalization with (1998-2007) and without the crisis (1994-2007), the half-lives are recorded at 7.6 and 27.4 months respectively. Consistent with the panel results, the shortened half-life bounded with more stable confident intervals has provided solid evidence in support for the RIP among APEC-China. The

signs of decreasing deviations from RIP are evident and in line with the increased regional financial integration prompted by financial liberalization, technological breakthroughs, and growth in the volume of trade (Baharumshah, *et al.*, 2005).

Table 2.2: Panel Half-life Estimations

	REX-CHINA		RID-CHINA	
	N	HL- AR(ρ) [95%CI]	N	HL- AR(ρ) [95%CI]
1987M1-2007M1	-	-	3108	30.96 [23.31, 38.61]
1994M1-2007M1	2041	18.10 [14.41, 21.80]	2041	27.41 [20.07, 34.75]
1998M1-2007M1	1417	23.98 [14.04, 33.92]	1417	7.60 [5.87, 9.33]

Notes: N represents the number of observations utilized in the panel analysis. Half-life is computed based on the AR (ρ) methodology only for stationary series confirmed by both LLC and IPS tests.

5. Conclusion and Policy Implications

This paper conducts a joint investigation of two international parities, namely the PPP and RIP, to assess the extent of goods and capital market integration among China and her thirteen trading partners in Asia Pacific. Based on the endogenous break test, we perform the panel analysis by sub-samples within 1987M1-2007M1. Our major findings are four-fold. First, endogenous and exponential breaks are confirmed for the real exchange and real interest differential series, which mostly occur in 1988, 1993/94 and 1997/98. Second, RIP holds better than PPP, suggesting the greater financial integration than trade integration among APEC-China. Third, both parities tend to hold better in the post-liberalization and post-crisis era. Fourth, APEC members have has improved their ability to absorb external shocks as indicated by the shortened half-life reported over time, especially when the post-crisis era is included.

Putting together, the greater integration among APEC-China implies the better equalization of the marginal utility of home and foreign currency (Renmimbi), which in turn allows for better risk sharing (Deveraux and Engel, 2002). The integration process is attributed not only to the liberalization process among the APEC economies, but also to the Chinese trade policy and the regional commitment for the ASEAN+3+2+1 cooperation. Besides, the prospect of WTO membership is indeed instrumental for China to move towards liberalizing its external sectors and capital accounts. However, in our study, PPP does not hold fully and the Yuan-denominated currencies are still not highly competent by the PPP rules. China's market size and its role as a production hub are yet sufficient to draw a full support for PPP as indication of perfect trade integration among APEC-China. While the more liberalized exchange rate regimes among APEC members may have facilitated for better integration, the prolonged undervalued Renmimbi, has as well exerted some drawbacks in the PPP theorem. Further flexibility in the Chinese exchange rate regime is thus needed.

In addition, the higher degree of mean reversion in the China-based real interest differentials signifies the increased influence of Chinese investments in the regional capital market. The rapid growth in the regional capital flows has contributed to cross-border investments and optimal allocation of resources and, in some cases has facilitated the movement towards financial convergence and closer monetary cooperation. Conservative policies directed at increasing domestic savings to increase the rate of capital formation and hence, productivity are no longer the solely option in open economy macroeconomics. Instead, cross-border capital flows raise the chances of risk-sharing and thus enable countries in the Asia Pacific region to smooth out consumption. Moreover, the shorter half-lives reported over time encourage us to foresee a brighter feasibility towards regional financial deepening and regional

currency arrangements. By taking cooperative action APEC members especially from the East Asia, would be in a better position to resist the adverse consequences of sudden and sizeable movements in global capital, and the potentially deleterious effects that may decelerate the growth and development of domestic economies. This is supported by Oh (2006) who views that monetary and exchange rate policy cooperation in East Asia would enable this region to exert an important influence upon the future evolution of the global trade and financial system.

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