# 3. LONG-RUN PURCHASING POWER PARITY WITH ASYMMETRIC ADJUSTMENT: EVIDENCE FROM MAINLAND CHINA AND TAIWAN

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## Abstract

*This study applies threshold cointegration test advanced by Enders and Siklos (2001) to investigate the properties of asymmetric adjustment in long-run purchasing power parity (PPP) for both Mainland China and Taiwan during the January 1986 to October 2009 period. Although there is evidence of long-run PPP for both Mainland China and Taiwan, the adjustment mechanism is asymmetric. These results have important policy implications for both Mainland China and Taiwan under study.*

**Keywords:** threshold cointegration test; Purchasing Power Parity; asymmetric adjustment; Mainland China; Taiwan
**JEL Classification**: C22, F31

## 1. Introduction

During the past several decades, considerable effort has been put into testing the validity of long-run purchasing power parity (PPP) hypothesis as it has important policy implications in international finance. Long-run PPP is indicative of a long-run relationship between the nominal exchange rate and the domestic and foreign prices of a particular economy. When PPP exists, it can then be used to determine the equilibrium exchange rate; however, when PPP does not hold, the use of any monetary approach to determine the exchange rate is invalidated since a monetary approach necessitates that PPP holds true. According to Holmes (2001), PPP is important to policymakers for two reasons. First of all, it can be used to predict the exchange rate and, thus, determine whether a currency is over or undervalued.

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Whether a currency is over or undervalued is particularly important for less developed countries and also for those experiencing large differences between domestic and foreign inflation rates. Secondly, the notion of PPP is used as the foundation on which many theories of exchange rate determination are built. Consequently, the validity is important to those policymakers in developing countries who base their adjustment on PPP (for other reasons about the policy implications of PPP, see Taylor and Taylor, 2004).

While some empirical evidence of long-run PPP for both developed countries and less-developed countries seems convincing, unfortunately thus far none has been proven to be conclusive. As for methodology, recent studies of long-run PPP have mostly utilized conventional unit root tests for real exchange rates and cointegration tests for the relationship between various measures of domestic and foreign prices as well as nominal exchange rates. The conclusions drawn from these studies have primarily been based on linear tests of stationarity and/or cointegration. Since ample evidence in support of asymmetric reactions in key economic variables has been widely acknowledged in recent years, there is no reason to assume that the long-run PPP adjustment process toward equilibrium is always symmetric. As shown by Madsen and Yang (1998) and Ramsey and Rothman (1996), for example, economic variables such as inflation rates, etc., follow an asymmetric adjustment process. Besides, as pointed out by Balke and Fomby (1997), the power of linear cointegration tests is lower in an asymmetric adjustment process. More to the point, it is very likely that the assumption of symmetric adjustments yield poor results when it comes to equilibrium relationships because conventional cointegration tests do not take asymmetric adjustments into account. Enders and Granger (1998) also show that the standard tests for unit root and cointegration all have lower power in the presence of misspecified dynamics This is important since the linear relationship is inappropriate if prices are sticky in the downward, but not in the upward direction. Madsen and Yang (1998) have provided evidence that prices are sticky in the downward direction and that such stickiness means that real exchange rate adjustments are asymmetric. Other reasons for the asymmetric adjustment are the presence of transactions costs that inhibit international goods arbitrage and official intervention in the foreign exchange market may be such that nominal exchange rate movements are asymmetric (see, Taylor, 2006; Taylor and Peel, 2000; Juvenal and Taylor, 2008). Kilian and Taylor (2003) also suggest that nonlinearity may arise from the heterogeneity of opinion in the foreign exchange market concerning the equilibrium level of the nominal exchange rate: as the nominal rate takes on more extreme values, a great degree of consensus develops concerning the appropriate direction of exchange rate movements, and traders act as accordingly. All these motivate us to use in our study threshold (asymmetric) cointegration tests. A number of studies have provided solid empirical evidence for the non-linear and/or asymmetric adjustment of the exchange rate in the developed countries (Baum *et al*., 2001; Taylor *et al*., 2001; Enders and Dibooglu, 2001), in the G-7 countries (Kilian and Taylor, 2003), in the 17 OECD countries (Serletis and Gogas, 2000), in the Middle East (Sarno, 2000), in Asian economies (Enders and Chumrusphonlert, 2004), in African countries (Chang *et al*., 2010)., as well as in oil-exporting countries (Chang and Liu, 2010).

The present empirical study contributes significantly to this field of research, because, first of all, by using the threshold cointegration test of Enders and Siklos (2001) it determines whether long-run PPP exists in both Mainland China and Taiwan. Although empirical studies of similar design have previously been conducted for developed countries and Asian countries, this is not the case for Mainland China and Taiwan. This study fills this gap in the literature. Secondly, to the best of our knowledge, this study is the first of its kind to utilize the threshold cointegration test for long-run PPP in Mainland China and Taiwan. Precisely what we find is that long-run PPP holds for both Mainland China and Taiwan, but that the adjustment mechanism is asymmetric. Our empirical results have important policy implications for both Mainland China and Taiwan under study.

Mainland China and Taiwan provide an interesting area of research for several reasons. First, Mainland China and Taiwan both have made remarkable economic progress over the past two decades. Both Mainland China and Taiwan's average annual economic growth rates over the past two decades (1990-2009) were 9.76% and 4.86%, respectively. In 2009, per capita GDP in Mainland China and Taiwan were US$ 3,566 and US 16,442, respectively. Second, both Mainland China and Taiwan have become the world's first and 16$^{th}$ largest trading countries with the foreign exchange reserves estimated at US$ 2,400 billion and US$ 348 billion, respectively, at the end of 2009. Third, Mainland China started its openness policy in the late 1970s and Taiwan liberalized economic institutions in the early 1980s, thus sufficient data are available for researchers to evaluate the effect of economic liberalization on economic phenomena.

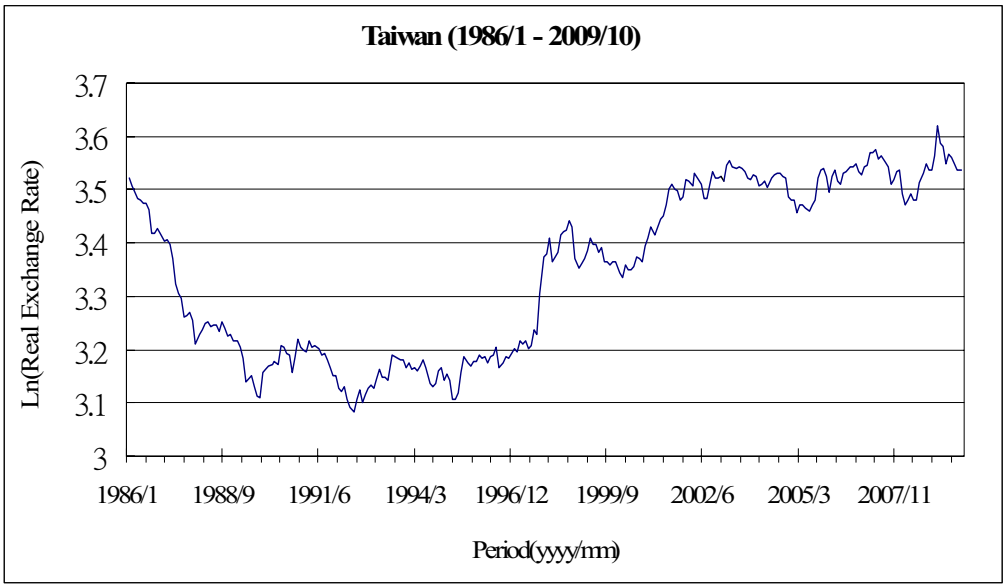
The organization of the remainder of this paper is as follows. Section II presents the data used in the study. Section III briefly describes the threshold cointegration test of Enders and Siklos (2001), and Section IV shows our empirical results and policy implications. Section V concludes the paper.

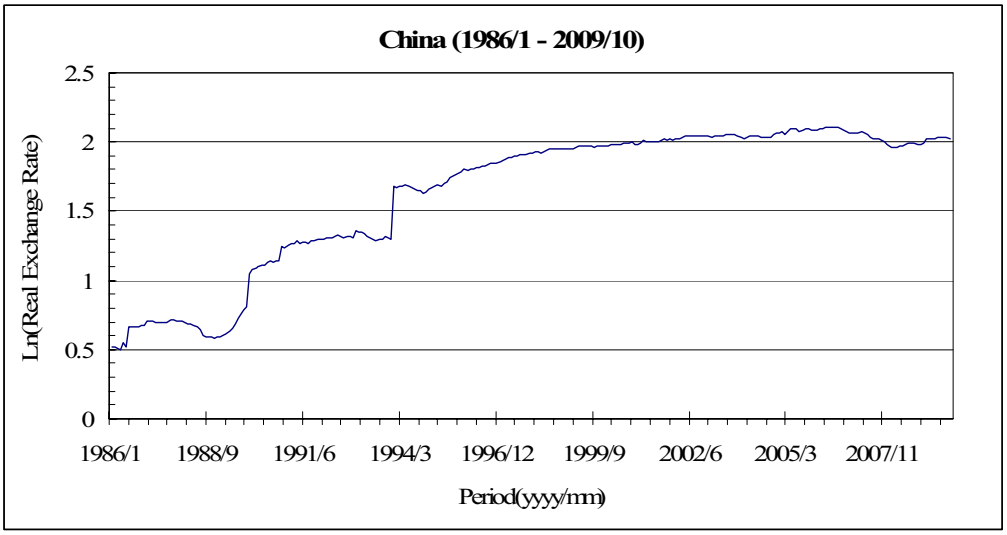
## II. Data

Monthly data are employed in our empirical study, and the time span is from January 1986 to October 2009. All consumer price indices, CPI (based on 2000 = 100) for the USA, Mainland China, and Taiwan, and the nominal exchange rates relative to the USA dollar data, respectively, are taken from the International Monetary Fund's International Financial Statistics CD-ROM. Each of the consumer price index and nominal exchange rate series was transformed into natural logarithms before the econometric analysis. Figure 1 plots the real exchange rates series for both Mainland China and Taiwan using the USA as the base country. Testing for PPP against the USA is based on the argument that internal foreign exchange markets are mostly dollar dominated. In addition, the USA is the major trading partner for both Mainland China and Taiwan. From the figure, we do find some significant upward or downward trend in the real exchange rate series. From these, there seem to be some nonlinear adjustment patterns.

**Figure1**

**The plots for Ln (Real Exchange Rate)**



## III. Threshold Cointegration Tests Based on Enders and Siklos' (2001) Approach

In this empirical study, we employ the threshold cointegration technique advanced by Enders and Siklos (2001) to test for long-run PPP with asymmetric adjustments for both Mainland China and Taiwan. This test involves a two-stage process. In the first stage, we estimate a long-run equilibrium relationship in the form:

$$e_t = \alpha_0 + \alpha_1 p_t^* + \alpha_2 p_t + u_t \quad , \tag{1}$$

where: $e_t$ is the logarithm of the foreign exchange rates in the domestic currency; $p_t^*$ and $p_t$ represent the logarithm of foreign and domestic price levels, respectively, and $u_t$ is the stochastic disturbance term.[4] The second stage pertaining to the OLS estimates of $\rho_1$ and $\rho_2$ is based on the following regression:

$$\Delta u_t = I_t \rho_1 u_{t-1} + (1 - I_t)\rho_2 u_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta u_{t-i} + \varepsilon_t \quad , \tag{2}$$

where: $\varepsilon_t$ is a white-noise disturbance and the residuals, $\mu_t$, in (1) are substituted into (2). $I_t$ is the Heaviside indicator function such that $I_t = 1$ if $u_{t-1} \geq \tau$, and $I_t = 0$ if $u_{t-1} < \tau$, where $\tau$ is the threshold value. The necessary condition for $\{\mu_t\}$ to be stationary is: $-2 < (\rho_1, \rho_2) < 0$. If the variance of $\varepsilon_t$ is sufficiently large, it is also possible for one value of $\rho_j$ to be between –2 and 0 and for the other value to be equal to zero. Although there is no convergence in the regime with the unit-root (i.e., the regime in which $\rho_j = 0$), a large realization of $\varepsilon_t$ will switch the system to the convergent regime. Enders and Granger (1998) and Enders and Siklos (2001) share the view that in either case, under the null hypothesis of no convergence, the F-statistic for the null hypothesis of $\rho_1 = \rho_2 = 0$ has a nonstandard distribution since the critical values for this non-standard F-statistic depend on the number of variables used in the cointegrating vector. In this study, we follow Enders and Siklos (2001) to calculate the critical values for the three-variable case. These critical values are not reported here but are available upon request. Enders and Granger (1998) also show that if the sequence is stationary, the least square estimates of $\rho_1$ and $\rho_2$ have an asymptotic multivariate normal distribution.

The model using equation (2) is referred to as the Threshold Autoregression (TAR) Model, while the test for the threshold behavior of the equilibrium error is termed the

[4] Equation (1) is more appropriate for a floating exchange rate regime. For a fixed exchange rate regime, the nominal exchange rate $e_t$ should be replaced by the domestic price level $p_t$ as the dependent variable in that equation so that $e_t$ now constitutes a regressor.

threshold cointegration test. If we assume the system is convergent, $\mu_t = 0$ can be considered the long-run equilibrium value of the sequence. If $\mu_t$ is higher than the long-run equilibrium, the adjustment is $\rho_1 \mu_{t-1}$, but if $\mu_t$ is lower than the long-run equilibrium, the adjustment is $\rho_2 \mu_{t-1}$. The equilibrium error, therefore, behaves like a threshold autoregressive process. The null hypothesis of $\rho_1 = \rho_2 = 0$ tests for the cointegration relationship and if this null is rejected, then this is evidence of cointegration among the variables. When the null hypothesis of $\rho_1 = \rho_2 = 0$ is rejected, it is worth testing further for symmetric adjustments (i.e., $\rho_1 = \rho_2$) by using a standard F-test. When adjustment is symmetric i.e., $\rho_1 = \rho_2$, equation (2) becomes the prevalent augmented Dickey-Fuller test. Rejecting both the null hypotheses of $\rho_1 = \rho_2 = 0$ and $\rho_1 = \rho_2$ indicates the existence of threshold cointegration and the asymmetric adjustments.

Instead of estimating equation (2) with the Heaviside indicator, which depends on the level of $\mu_{t-1}$, the decay can also be allowed to depend on the change in $\mu_{t-1}$ in the previous period. The Heaviside indicator can then be specified as $I_t = 1$ if $\Delta u_{t-1} \geq \tau$ and as $I_t = 0$ if $\Delta u_{t-1} < \tau$, where $\tau$ is the threshold value. According to Enders and Granger (1998), this model is especially valuable when adjustment is asymmetric as the series exhibits more 'momentum' in one direction than in the other. This model is called the Momentum-Threshold Autoregression (M-TAR) Model. The TAR model can capture a 'deep' cycle process if, for example, the positive deviations are more prolonged than the negative ones. The M-TAR model, on the other hand, allows the autoregressive decay to depend on $\Delta\mu_{t-1}$. Thus, the M-TAR representation is able to capture 'sharp' movements in a sequence.

In general, the value of $\tau$ is unknown, and it must be estimated along with the values of $\rho_1$ and $\rho_2$. A consistent estimate of the threshold $\tau$ can be obtained by using Chan's (1993) method to search among possible threshold values to minimize the residual sum of squares from the fitted model. Enders and Siklos (2001) apply Chan's methodology to a Monte Carlo study to obtain the F-statistic for the null hypothesis of $\rho_1 = \rho_2 = 0$ when they estimate threshold $\tau$ using Chan's procedure. As there is generally no prescribed rule as to whether to use the TAR or M-TAR model, the recommendation is to select the adjustment mechanism using a model selection criterion such as the Akaike Information criteria (AIC) or Schwartz criteria (SC).

## IV. Empirical Results and Policy Implications

Table 1 reports the estimated coefficients ($\alpha_1$ and $\alpha_2$) of the cointegrating vector for Mainland China and Taiwan. We find that the estimated coefficients of the cointegrating vector are all significance at least at the 5% level. Table 2 presents the results from the application of the Engle-Granger procedure to equation (1) for both Mainland China and Taiwan, with the lag length selected using the AIC. These test

results indicate that the null of no cointegration can not be rejected for both cases. The absence of long-run PPP in these initial tests is most likely attributable to the use of linear tests of mean reversion even though there are in fact asymmetries with respect to positive and negative shocks in any adjustment toward long-run PPP. Added to this, this type of test for symmetric cointegration has lower power in the case of asymmetric adjustments. For these two reasons, we choose to use the threshold cointegration test. The results of this test with a threshold value of zero are reported

**Table 1**

**The estimated long-run relationship of exchange rate and price levels**

| | Taiwan | China |
|---|---|---|
| $\alpha_0$ | 3.0309 (10.3211)*** | -4.5670 (-4.3630)*** |
| $\alpha_1$ | -0.4548 (-2.4905)** | -0.1736 (-2.9237)** |
| $\alpha_2$ | 0.5481 (4.1852)*** | 1.2827 (19.6142)*** |

*Notes: 1. The long-run relationship is* $e_t = \alpha_0 + \alpha_1 p_t^* + \alpha_2 p_t + u_t$, *where* $e_t$ *is the logarithm of the nominal exchange rate,* $p_t$ *and* $p_t^*$ *are the logarithm of domestic and foreign price, respectively. 2. ** and *** indicate significance at the 5% and 1% levels, respectively. 3. The t-statistics are in parentheses.*

**Table 2**

**Estimated linear adjustment equations using Engle-Granger cointegration test**

| | Taiwan | China |
|---|---|---|
| $\rho$ | -0.0336 (-1.3354) | -0.0125 (-1.2974) |
| AIC | -5.0779 | -4.0646 |
| Lags | 0 | 0 |
| Critical Value | | |
| 1% | -3.4492 | -3.4492 |
| 5% | -2.8697 | -2.8696 |
| 10% | -2.5712 | -2.5712 |

*Notes: 1.The t-statistic for the null hypothesis of* $\rho = 0$ *with three variables in the cointegration relationship are in parentheses.*

in Table 3. Under these conditions, we can reject the null hypothesis of $\rho_1 = \rho_2 = 0$ at the 5% significance level for only Taiwan, which signifies that PPP does not hold for Mainland China. We conclude that PPP generally fails when we assume linear adjustment or allow for asymmetric adjustments. However, given the presence of measurement errors and/or adjustment costs, there is no reason to presume that the threshold value is equal to zero. As shown in Table 4, it is clearly apparent that there is much stronger support for the PPP theory when we use Chan's method to obtain a consistent estimate of the threshold value. The hypothesis of a symmetric adjustment is strongly rejected for both Mainland China and Taiwan. Further, when we use the AIC model selection criterion, the M-TAR model is favored in both cases. We find strong evidence of long-run PPP between the USA and Mainland China and Taiwan.

**Table 3**

**Estimated asymmetry adjustment equations using threshold cointegration test with $\tau = 0$**

| | Taiwan | China |
|---|---|---|
| $\rho_1$ | -0.0383 (-3.3267)*** | -0.0132 (-0.9539) |
| $\rho_2$ | -0.0138 (-1.0264) | -0.0068 (-0.4967) |
| $\Phi_\mu{}^1$ | 6.0767** | 0.5759 |
| $\rho_1 = \rho_2{}^2$ | 1.9014 | 0.1073 |
| AIC | -759.9241 | -369.1836 |
| Flag | TAR | TAR |
| Lags | 1 | 1 |

*Notes: 1. This F-statistic for the null hypothesis of $\rho_1 = \rho_2 = 0$ follows a nonstandard distribution; the critical values are calculated followed the Enders and Siklos (2001). 2. The F-statistic for the null hypothesis $\rho_1 = \rho_2$ with two variables in symmetric adjustment follows a standard F-distribution. 3. ** and *** indicate significance at the 5% and 1% levels, respectively. 4. The t-statistics are in parentheses.*

A major difference between these results and those in Table 2 is that the evidence for cointegration and long-run PPP is substantially strengthened when we allow for asymmetries. In addition, whenever long-run PPP holds, we also reject the null hypothesis of symmetric adjustment for both Mainland China and Taiwan. In Taiwan, the evidence indicates that $|\rho_2| < |\rho_1|$, which suggests that the speed of adjustment toward long-run PPP is faster in the case of a positive shock with respect to $\mu_t$ (see Table 4).

**Table 4**

**Estimated asymmetry adjustment equations using threshold cointegration test with a consistent estimate of the threshold value $\tau = 0.0433$**

| | Taiwan | China |
|---|---|---|
| $\rho_1$ | -0.2013 (-2.8495)*** | -0.0068 (-0.7201) |
| $\rho_2$ | -0.0251 (-2.8739)*** | -0.5837 (-4.8806)*** |
| $\Phi_\mu{}^1$ | 12.2581*** | 16.1423*** |
| $\rho_1 = \rho_2{}^2$ | 16.1115*** | 23.1543*** |
| AIC | -764.1195 | -391.5625 |
| Flag | M-TAR | M-TAR |
| $\tau$ | 0.0284 | -0.0397 |
| Lags | 1 | 1 |

*Notes: 1. This F-statistic for the null hypothesis of $\rho_1 = \rho_2 = 0$ follows a nonstandard distribution; the critical values are calculated followed the Enders and Siklos (2001). 2. The F-statistic for the null hypothesis $\rho_1 = \rho_2$ with two variables in symmetric adjustment follows a standard F-distribution. 3. *** indicates significance at the 1% level. 4. The t-statistics are in parentheses.*

To illustrate, the real exchange rate of Taiwan converges to its long-run equilibrium $\tau(=0.0433)$ at the rate of 20.13% with a positive deviation, but at a considerably lower rate of 2.51% with a negative deviation. However, we find opposite evidence for Mainland China ($|\rho_2| > |\rho_1|$), which suggests that the speed of adjustment toward long-run PPP is faster in the case of a negative shock with respect to $\mu_t$.

In the light of the weight of evidence in support of asymmetric adjustments, we can use an asymmetric error-correction model to investigate the movement of the variables in a long-run equilibrium relationship. We estimate the following system of asymmetric error-correction models for both Mainland China and Taiwan using the USA as the base country:

$$\Delta e_t = \alpha_{10} + \sum_{i=1}^{K} \alpha_{1i} \Delta e_{t-i} + \sum_{i=1}^{K} \beta_{1i} \Delta p^*_{t-i} + \sum_{i=1}^{K} w_{1i} \Delta p_{t-i} + \gamma_{1e} Z^+_{t-1} + \gamma_{2e} Z^-_{t-1} + \varepsilon_{1t},$$

$$\Delta p^*_t = \alpha_{20} + \sum_{i=1}^{K} \alpha_{2i} \Delta e_{t-i} + \sum_{i=1}^{K} \beta_{2i} \Delta p^*_{t-i} + \sum_{i=1}^{K} w_{2i} \Delta p_{t-i} + \gamma_{1p^*} Z^+_{t-1} + \gamma_{2p^*} Z^-_{t-1} + \varepsilon_{2t}, \quad (3)$$

$$\Delta p_t = \alpha_{30} + \sum_{i=1}^{K} \alpha_{3i} \Delta e_{t-i} + \sum_{i=1}^{K} \beta_{3i} \Delta p^*_{t-i} + \sum_{ii=1}^{K} w_{3i} \Delta p_{t-i} + \gamma_{1p} Z^+_{t-1} + \gamma_{2p} Z^-_{t-1} + \varepsilon_{3t},$$

where: $Z^+_{t-1} = I_t \mu_{t-1}$ and $Z^-_{t-1} = (1 - I_t)\mu_{t-1}$; $\mu_{t-1}$ are the residuals from equation (1); and $I_t = 1$ if $\Delta u_{t-1} \geq \tau$ and $I_t = 0$, otherwise.

Our choice of the appropriate lag length is based on the multivariate AIC. The choice of a non-zero threshold value follows the same procedure as that outlined earlier. The results from the estimated asymmetric error-correction models with a consistent estimate of the threshold value are given in Table 5. We will discuss the empirical results and policy implications for both Mainland China and Taiwan as the follows:

**Mainland China:** The estimated coefficients of $Z^+_{t-1}$ and $Z^-_{t-1}$ determine the speed of adjustment for positive and negative deviations from long-run PPP, respectively. We find that both the coefficients of $Z^+_{t-1}$ and $Z^-_{t-1}$ ($\gamma_{1p}$ and $\gamma_{2p}$) for the domestic price equation are statistically significant. These results highlight the domestic price is responsible for most of the adjustments in Mainland China. For the nominal exchange rate equation, we find only the coefficient of the $Z^-_{t-1}$ ($\gamma_{2e}$) is statistically significant. This result also highlight the nominal exchange rate is responsible for the adjustments. For the foreign price equation, we find both the coefficients of $Z^+_{t-1}$ and $Z^-_{t-1}$ ($\gamma_{1p^*}$ and $\gamma_{2p^*}$) are not statistically significant. It is obvious that negative deviations from PPP are eliminated more quickly than are positive ones and both the domestic price and the nominal exchange rate are responsible for most of the adjustments. The results reported in Table 5 highlight the more general roles played by the domestic price and the nominal exchange rate adjustments in Mainland China. For comparison, we also estimate the symmetric error-correction model for Mainland

China. The results reported in Table 5 again confirm that the domestic price level is responsible for most of the adjustments. Finally, we find that the speed of the adjustment coefficients on the domestic price level tends to be large in magnitude and statistically significant, a finding which is not consistent with those reported by Enders and Dibooglu (2001), Enders and Chumrusphonlert (2004), and Chang *et al*. (2010) for European, Asian, and African countries, respectively.

**Taiwan:** We find that both the coefficients of $Z_{t-1}^{+}$ and $Z_{t-1}^{-}$ ($\gamma_{1e}$ and $\gamma_{2e}$) for the nominal exchange rate equation are statistically significant. These results highlight the nominal exchange rate is responsible for most of the adjustments in Taiwan. For the domestic price equation, we find only the coefficient of the $Z_{t-1}^{+}$ ($\gamma_{1p}$) is statistically significant. This result also highlight the domestic price is responsible for the adjustments. For the foreign price equation, we find both the coefficients of $Z_{t-1}^{+}$ and $Z_{t-1}^{-}$ ($\gamma_{1p^*}$ and $\gamma_{2p^*}$) are not statistically significant. It is obvious that positive deviations from PPP are eliminated more quickly than are negative ones and both the nominal exchange rate and domestic price are responsible for most of the adjustments. The results reported in Table 5 highlight the more general roles played by the nominal exchange rate and domestic price adjustment in Taiwan.

**Table 5**

**Estimated asymmetric error-correction models**

| Dependent Variable | Linear ECM | | Threshold ECM | | | |
|---|---|---|---|---|---|---|
| | $\gamma$ | Lags | $\gamma_1$ | $\gamma_2$ | Flag | $\tau$ |
| Taiwan | | | | | | |
| $\Delta e_t$ | -0.0253*** (-2.9369) | 1 | -0.2393*** (-2.7284) | -0.0230*** (-2.6824) | M-TAR | 0.0433 |
| $\Delta p_t$ | -0.0234* (-1.6918) | 3 | -0.1249*** (-4.2121) | 0.0080 (0.4393) | M-TAR | 0.0055 |
| $\Delta p_t^*$ | 0.0016 (0.4304) | 3 | 0.0025 (0.6842) | -0.0549 (-1.1658) | M-TAR | -0.0322 |
| China | | | | | | |
| $\Delta e_t$ | -0.0106 (-1.0916) | 1 | -0.0074 (-0.7954) | -0.5761*** (-4.8426) | M-TAR | -0.0397 |
| $\Delta p_t$ | -0.0219*** (-2.8707) | 2 | -0.0171** (-2.2827) | -0.2978*** (-4.5705) | M-TAR | -0.0199 |
| $\Delta p_t^*$ | -0.0011 (-0.7231) | 2 | 0.0007 (0.3931) | -0.0119 (-1.2339) | M-TAR | -0.0057 |

*Notes: 1. The t-statistics are in the parentheses. 2. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. 3. Our choice of the appropriate lag length is based on the multivariate AIC.*

For comparison, we also estimate the symmetric error-correction model for Taiwan. The results reported in Table 5 again confirm that the nominal exchange rate and domestic price are responsible for most of the adjustments. Finally, we find that the

speed of the adjustment coefficients on price level tends to be small in magnitude and statistically significant, a finding which is similar to those reported by Enders and Dibooglu (2001), Enders and Chumrusphonlert (2004), and Chang *et al*. (2010) for European, Asian, and African countries, respectively.

One of the most important policy implications of our study is that PPP is able to determine the equilibrium exchange rate for both Mainland China and Taiwan. For example, for the government of Taiwan may prefer to use the nominal exchange rate to protect any gains in competitiveness following a positive shock to PPP, or may be wary of allowing a nominal depreciation following a positive shock to PPP. On the other hand, for the government of Mainland China may prefer to use the domestic price (and/or the nominal exchange rate) to protect any gains in competitiveness following a negative shock to PPP, or may be wary of allowing a nominal depreciation following a negative shock to PPP.

## V. Conclusions

The main aim of this research is to investigate the properties of long-run PPP in Mainland China and Taiwan using the Enders and Siklos (2001) threshold cointegration approach which allows for asymmetric adjustments. We show that when the Engle-Granger test which assumes symmetric adjustments is used, it fails to recognize the cointegration relationship for both Mainland China and Taiwan we study. The results from the threshold cointegration test, on the other hand, provide stronger evidence of long-run PPP with asymmetric adjustments for both Mainland China and Taiwan. In addition to this, based on the asymmetric error correction models, we find that compared to positive (negative) deviations, negative (positive) deviations tend to be adjusted faster than positive (negative) ones and that both the nominal exchange rates and domestic price are the primary mechanism in the adjustment process that leads to the long-run equilibrium of PPP in Mainland China (Taiwan). These results have particularly important policy implications for both Mainland China and Taiwan under study.

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