

# The Impact of Renminbi Appreciation on Stock Prices in China

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**ABSTRACT:** Since removal of the peg in July 2005, China has entered a new era of a managed floating exchange rate system. Although many observers have raised concerns about the impact of such a policy change on China's trade surplus, less attention has been paid to its effects on financial markets. This paper investigates the impact of recent renminbi appreciation on stock prices in China since removal of the peg, using threshold cointegration and momentum threshold error-correction model (M-TECM). The results clearly illustrate that no short-run causal relation exists, and an asymmetric causal relationship running from the renminbi/U.S. dollar exchange rate to Chinese Shanghai A-share stock prices in the long run is based on M-TECM. Policy and the broader implications of the findings are discussed.

**KEY WORDS:** asymmetric causality, exchange rates, momentum threshold error-correction model (M-TECM), stock prices.

China's currency, the renminbi (RMB), which for the previous decade was tightly pegged at RMB8.28 to the U.S. dollar, was revalued to RMB8.11 per U.S. dollar on July 21, 2005. Following removal of the peg, due in part to political pressure from the United States and the United Kingdom, the Chinese authorities also announced that the renminbi would be pegged to a basket of foreign currencies, rather than being strictly tied to the U.S. dollar (USD), and it would be allowed to float within a narrow 0.3 percent daily band against this basket.<sup>1</sup>

The revaluation of the RMB/USD exchange rate has marked a new era of a managed floating exchange rate system. The significance of exchange rate system reform is that the shift to a flexible exchange rate regime, especially the adoption of a currency band that refers to a basket of currencies, provides the monetary authorities with a certain degree of freedom in implementing policies. The new system would most likely act as a crawling peg, rather than being strictly fixed, allowing China greater flexibility either through adjustments in the crawling peg regime that has involved the basket of currencies or through reweighting of the basket.

Observers have frequently suggested that the yuan is undervalued, often on the basis of purchasing power parity arguments (Cline 2005; Goldstein 2004; Goldstein and Lardy 2006), contributing to growing large trade surpluses and portfolio capital inflows. As investment (both domestic and foreign) boomed in 2003–4 and inflation accelerated,

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some argued that rapid RMB appreciation would be helpful in dealing with the increasing pressure of domestic inflation on the economy (Frankel 2007; McKinnon 2006). However, it was also argued that further RMB appreciation might bring a significant decline in China's exports. Hence, Chinese policymakers have been facing the dilemma of choosing between the two options (i.e., RMB appreciation vs. depreciation). Credible, gradual RMB appreciation is recommended as an alternative strategy (see Kutan and Tsai 2007).

Although much attention has been focused on trade flows, Chinese policymakers face a similar dilemma in terms of the impact of expected renminbi appreciation on domestic financial markets, in particular, the stock market. For instance, if the exchange rate appreciates, exporters are likely to lose competitiveness on international markets, causing a drop in profits and hence in stock prices. On the other hand, depreciation of the renminbi is likely to cause importers to lose competitiveness on domestic markets (consumers may not be able to afford "higher priced" imported products), causing a decline in profits and hence in stock prices.

Due to the mutual effects of exchange rates on stock prices, the impact of recent changes in the renminbi on domestic stock prices is an important concern in policy circles and among investors. The purpose of this paper is to address these issues and examine whether an asymmetric causal relationship exists between the RMB/USD exchange rate and stock prices since removal of the peg.

## Literature Review

The issue of whether stock prices and exchange rates are related has long been studied. Two major theories, the traditional and portfolio approaches, are applied to test the dynamic relationship between exchange rates and stock prices. The traditional approach argues that a depreciation of domestic currency makes local firms more competitive, which leads to an increase in exports, and consequently raises stock prices. The traditional approach implies that exchange rates lead stock prices.

The portfolio approach, on the contrary, argues that an increase in stock prices induces investors to demand more domestic assets and thereby causes appreciation of the domestic currency, which implies that stock prices lead exchange rates. The "stock-oriented" model of exchange rates by Branson (1983) views the exchange rate as serving to equate supply and demand for assets such as stocks and bonds.

Empirical evidence using both approaches has yielded no consensus on the validity of either theory. For example, Mok (1993) found weak bidirectional causality between stock prices and exchange rates, while Bahmani-Oskooee and Sohrabian (1992) and Nieh and Lee (2001) argued for bidirectional causality between stock prices and exchange rates in the short run, but not in the long run. In addition, some studies found a weak or no association between stock prices and exchange rates (e.g., Bartov and Bodnar 1994; Fernandez 2006; Franck and Young 1972).

More recently, it has been suggested that some of the mixed results may be driven by extensive use of linear conventional time-series methodologies, which fail to consider information across regions, and thus lead to inefficient estimations and lower testing power. Recent studies therefore allow for a nonlinear causal relationship between the two variables and also use threshold cointegration methods, which further allow for nonlinear adjustment to long-run equilibrium (Balke and Fomby 1997).<sup>2</sup>

## Methodology

This paper employs threshold cointegration techniques as elaborated by Enders and Granger (1998) and Enders and Siklos (2001), which extend the residual-based, two-stage estimation method developed by Engle and Granger (1987). The difference between them lies in the formulation of linearity and nonlinearity from their second stage of unit-root tests. The nonlinear model of Enders and Granger (1998) and Enders and Siklos (2001) can be expressed as

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

where  $\varepsilon_t$  is a white-noise disturbance, and the residuals,  $\mu_t$ , are extracted from the linear combination of variables considered.  $I_t$  is the Heaviside indicator function such that  $I_t = 1$  if  $u_{t-1} \geq \tau$  and  $I_t = 0$  if  $u_{t-1} \leq \tau$ , where  $\tau$  is the threshold value. A necessary condition for  $\{u_t\}$  to be stationary is  $-2 < (\rho_1, \rho_2) < 0$ .

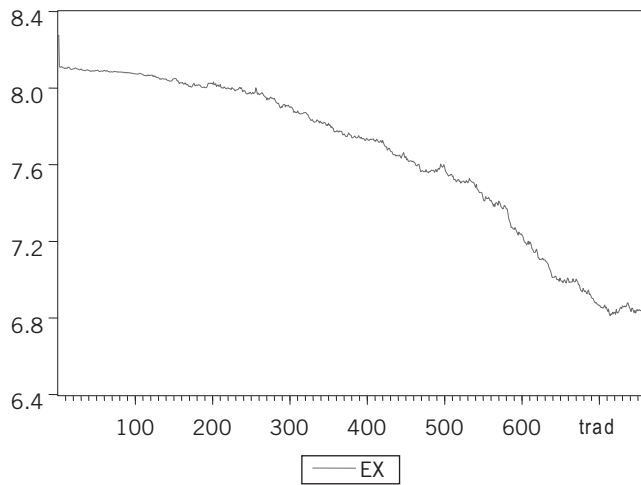
Equation (1) is basically a regime-switching model—a threshold autoregressive (TAR) model of the disequilibrium error, where the test for the threshold of the disequilibrium error is termed a threshold cointegration test. The result of rejection of the null hypothesis of  $\rho_1 = \rho_2 = 0$  implies the existence of a cointegration relationship between the variables. This enables us to proceed with a further test for symmetric adjustment (i.e.,  $H_0: \rho_1 = \rho_2$ ), using a standard  $F$ -test. When the coefficients of regime adjustment are equal (symmetric adjustment), Equation (1) converges the prevalent augmented Dickey-Fuller (ADF) test. Rejecting both the null hypotheses of  $\rho_1 = \rho_2 = 0$  and  $\rho_1 = \rho_2$  implies the existence of threshold cointegration with asymmetric adjustment.

Instead of estimating Equation (1) with the Heaviside indicator depending on the level of  $\mu_{t-1}$ , the decay could also be allowed depending on the previous period's change in  $\mu_{t-1}$ . The Heaviside indicator could then be specified as  $I_t = 1$  if  $\Delta \mu_{t-1} \geq \tau$  and  $I_t = 0$  if  $\Delta \mu_{t-1} \leq \tau$ . According to Enders and Granger (1998), this model is especially valuable when the adjustment is asymmetric, such that the series exhibits more “momentum” in one direction than the other. This model is then termed a momentum threshold autoregressive (M-TAR) model. The TAR model is used to capture a deep-cycle process if, for example, positive deviations are more prolonged than negative deviations. On the other hand, the M-TAR model allows autoregressive decay to depend on  $\Delta \mu_{t-1}$ . As such, M-TAR representation may capture sharp movements in a sequence. As there is generally no presumption as whether to use the TAR or M-TAR model, the recommendation is to select the adjustment mechanism by a model selection criterion such as the Akaike information criterion (AIC) or the Schwarz Bayesian criterion (SBC).

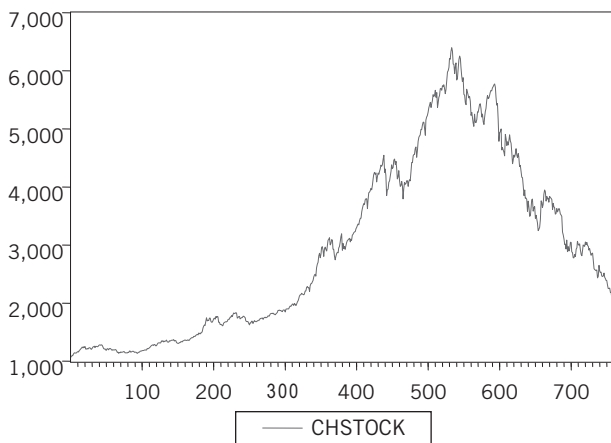
## Empirical Results

### *Data and Descriptive Statistics*

We employ data on the RMB/USD nominal closing exchange rate and Chinese Shanghai A-share stock prices obtained from the AREMOS Statistical Data Bank of the Ministry of Education, Taiwan. The daily sample period runs from July 21, 2005, to September 30, 2008, with a total of 765 observations. This period was chosen because the RMB/USD exchange rate was revalued on July 21, 2005. The RMB has gradually appreciated over time against the USD, as the regime has changed from a relatively pegged exchange rate



**Figure 1. Exchange rate movement of RMB against USD**



**Figure 2. Chinese Shanghai A-share stock prices movement**

to a more flexible exchange rate system. The RMB changed from a peak of 8.28 at the beginning of July 21, 2005, and the first part of the descent is not steep; however, RMB appreciation suddenly accelerated starting from 7.94 on September 19, 2006, to around 6.8 toward the end of the period (Figure 1). At the same time, a dramatic increase in Chinese Shanghai A-share stock prices occurred (Figure 2). The A-share prices reached a peak of 6,251 on October 31, 2007, from their lowest level of 1,073 (July 21, 2005). However, mostly due to the financial market turmoil in the United States sparked by the subprime mortgage crisis, the most recent stock prices dropped from the turning point of

**Table 1. Descriptive statistics for stock prices and exchange rates**

	CHStock	STK Returns	EX	EX Returns
Mean	2926.68	0.28186	7.64008	-0.01987
Maximum	6395.76	5.34000	8.27650	0.27100
Minimum	1073.86	-8.84000	6.81140	-2.05314
Std. dev.	1518.07	1.73104	0.42167	0.12747
Skewness	0.52590	-0.90443	-0.68390	-7.22626
Kurtosis	2.01345	6.20667	2.119790	116.5855
Jarque-Bera	66.2868***	317.9713***	84.3296***	307551.4***
Observations	765	765	765	765

Notes: CHStock and EX are symbols for the Chinese Shanghai A-share stock prices and RMB/USD exchange rate, respectively; STK Returns and EX Returns are symbols for the Chinese Shanghai A-share stock returns and RMB/USD exchange rate returns, respectively.

\*\*\* significance at the 1 percent level.

Daily observations are selected from the period of July 21, 2005–September 9, 2008, including the transaction days when both Chinese Shanghai A-share stock market and New York currency exchange market are open.

6,251 to 2,408 at the end of September 2008. Summary statistics of the Chinese Shanghai A-share stock and the RMB/USD exchange rate are illustrated in Table 1.

### Threshold Cointegration Test Results

The results of the threshold cointegration tests are illustrated in Table 2.<sup>3</sup> Both AIC and SBC suggest that M-TAR is the most applicable model for adjusting variables to long-run equilibrium with threshold value (M-TART), where the threshold value of  $\tau$  is found to be 0.0048, based on Chan's (1993) method. In addition, the evidence in Table 2 shows that both the null hypotheses of no cointegration ( $\hat{F}_c$ ) and symmetric adjustment ( $\hat{F}_c$ ) are rejected at 5 percent, which suggests the existence of an asymmetric threshold cointegration relationship.

### Granger Causality Tests

Given the threshold cointegration results, we next apply the Granger causality tests using the advanced momentum threshold error-correction model (M-TECM). The M-TECM is expressed as

$$\Delta Y_{it} = \alpha + \gamma_1 Z_{t-1}^+ + \gamma_2 Z_{t-1}^- + \sum_{i=1}^{k_1} \delta_i \Delta Y_{1,t-i} + \sum_{i=1}^{k_2} \theta_i \Delta Y_{2,t-i} + v_t \quad (2)$$

where  $Y_{it} = (CHStock_t, EX_t)$ ,  $Z_{t-1}^+ = I_t \hat{u}_{t-1}$ ,  $Z_{t-1}^- = (1 - I_t) \hat{u}_{t-1}$ , given that  $I_t = 1$  if  $\Delta u_{t-1} \geq 0.0048$  and  $I_t = 0$  if  $\Delta u_{t-1} \leq 0.0048$ , and  $v_t$  is a white-noise disturbance.

$CHStock_t$  and  $EX_t$  denote Chinese Shanghai A-share stock prices and the RMB/USD exchange rate at time  $t$ , respectively.

Based on Equation (2), Granger causality tests are employed to examine whether all coefficients of  $\Delta Y_{1,t-i}$  or  $\Delta Y_{2,t-i}$  are jointly statistically different from zero based on a standard  $F$ -test or whether the  $\gamma_i$  coefficients of the error-correction term are significant. Because Granger causality tests are sensitive to the selection of lag length, applying the

**Table 2. Model specification: Enders and Granger (1998 approach)**

	CH (TAR)	CH (M-TAR)	CH (TART)	CH (M-TART)
$\hat{\rho}_1$	-0.0012 (-0.4784)	0.0026 (0.9865)	-0.0015 (0.0023)	0.0054 (1.7967)*
$\hat{\rho}_2$	0.0010 (0.3270)	-0.0035 (-1.2509)	0.0026 (0.0036)	-0.0043 (-1.7014)*
$\hat{F}_C$	0.1681 [0.8453]	1.2707 [0.2812]	0.4823 [0.6175]	3.0653 [0.0472]**
$\hat{F}_A$	0.3158 [0.5743]*	2.5210 [0.1128]	0.9443 [0.3315]	6.1100 [0.0137]**
$l$	1	1	1	1
$\tau$	0	0	-0.4047	0.0048
AIC	-746.3572	-748.5669	-746.9876	-752.1498
SBC	-732.4454	-734.6552	-733.0758	-738.2380

Notes: CH represents Chinese stock prices. M-TART indicates momentum-threshold autoregressive model with threshold value.

Lag-length ( $l$ ) selection is based on the Ng and Perron (2001) unit root procedure.

Numbers in parentheses and brackets are  $t$ -statistics and  $p$ -value, respectively.

$\hat{F}_C$  and  $\hat{F}_A$  denote the  $F$ -statistics for the null hypothesis of no cointegration and symmetry. Critical values are taken from Enders and Siklos (2001).

The threshold value,  $\tau$ , of TART and M-TART models is -0.4047 and 0.0048, respectively.

The model is specified, based on the “principle of parsimony” of AIC and SBC, as M-TART model with the threshold value of 0.0048.

\*, \*\*, and \*\*\* significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

AIC criterion to determine the appropriate lag lengths, we find empirically that the lag lengths of  $k_1$  and  $k_2$  equal two (i.e.,  $k_1 = k_2 = 2$ ).

Table 3 presents the results of Granger causality tests, symmetric and asymmetric, based on the corresponding ECM and M-TECM. The null hypothesis of  $H_0: \theta_1 = \theta_2 = 0$  is applied to test the short-run causal relation running from  $EX$  to  $CHStock$ , and  $H_0: \delta_1 = \delta_2 = 0$  tests for a short-run causal relation in the reverse direction. Among other causal relations, the null hypotheses of  $H_0: \theta_1 = \theta_2 = \gamma_1 = 0$  and  $\theta_1 = \theta_2 = \gamma_2 = 0$  are applied to test a causality running from  $EX$  to  $CHStock$  when the difference in the previous disequilibrium term is above or below the threshold value in the long run;  $H_0: \delta_1 = \delta_2 = \gamma_1 = 0$  and  $\delta_1 = \delta_2 = \gamma_2 = 0$  test for long-run causal relations in the reverse direction.

The results clearly illustrate that no short-run causal relationship exists between  $EX$  and  $CHStock$  (insignificant to reject both  $H_0: \delta_1 = \delta_2 = 0$  and  $H_0: \theta_1 = \theta_2 = 0$ ). Besides, there also exists a unidirectional causality running from  $EX$  to  $CHStock$  in the long run, when the difference in the previous disequilibrium term is above the threshold value of 0.0048. ( $H_0: \theta_1 = \theta_2 = \gamma_1 = 0$  is rejected at the 10 percent significance level.) On the other hand, the null hypotheses of  $\delta_1 = \delta_2 = \gamma_1 = 0$ ,  $\delta_1 = \delta_2 = \gamma_2 = 0$ , and  $\theta_1 = \theta_2 = \gamma_2 = 0$  cannot be rejected. Furthermore, the significant finding rejecting the null hypothesis of  $\gamma_1 = \gamma_2$  in  $CHStock$  is consistent with the finding of our previous M-TART estimations and reconfirms the existence of an asymmetric causal relationship between the two variables considered. Nonetheless, the empirical results of conventional ECM estimations show that  $CHStock$  and  $EX$  are bidirectional causal related in the long run; whereas, there exists a unidirectional causality running from  $EX$  to  $CHStock$  in the short run.

Evidence of an asymmetric causal relation implies a co-movement through time between the exchange rate and stock prices, and deviation adjustment to the long-run equilibrium of stock prices responds significantly to RMB/USD shocks during different stages of evolution reflected in the higher regime.

Table 3. Asymmetric and symmetric Granger causality tests (M-TECM and ECM)

	Asymmetric		Symmetric	
	CHStock	EX	CHStock	EX
Constant	0.0011 (1.42489)	-0.0002 (-6.4379)***	10.8783 (6.1566)**	-1.4855e-03 (-6.1384)***
CHStock (-1)	0.0026 (0.07224)	-0.0707 (-1.9219)*	0.0022 (0.0863)	-0.1814 (-5.6286)***
CHStock (-2)	-0.412 (-1.1342)	-0.0355 (-1.1919)	-0.0517 (-1.9533)*	-0.0418 (-1.8089)*
EX (-1)	1.1834 (1.54486)	-0.0027 (-1.5124)	1330.46 (5.6533)***	-2.6116e-07 (-0.0723)
EX (-2)	0.2292 (0.3701)	0.0009 (0.5053)	303.37 (1.7993)*	7.1134e-06 (1.9604)*
$Z_{t-1}$	0.0065 (2.2660)**	-0.0076 (0.3228)		
$Z_{t-1}$	-0.0017 (-0.6993)	0.0002 (0.2703)		
$ECT_{t-1}$			0.6110 (29.6687)***	0.4171 (20.0235)***
$H_0: \gamma_1 = \gamma_2 = 0$	2.8097 [0.0609]*	0.5157 [0.5973]		
$H_0: \theta_1 = \theta_2 = 0$	1.2322 [0.2922]		16.4785 [0.0000]***	
$H_0: \delta_1 = \delta_2 = 0$		1.2832 [0.2778]		1.9239 [0.1470]
$H_0: \theta_1 = \theta_2 = \gamma = 0$				
$H_0: \theta_1 = \theta_2 = \gamma_1 = 0$	2.4505 [0.0623]*		301.702 [0.0000]***	

$H_0: \theta_1 = \theta_2 = \gamma_2 = 0$	1.0536 [0.3682]			134.77 [0.0000]**
$H_0: \delta_1 = \delta_2 = \gamma = 0$				
$H_0: \delta_1 = \delta_2 = \gamma_1 = 0$		1.0068 [0.3891]		
$H_0: \delta_1 = \delta_2 = \gamma_2 = 0$		0.8581 [0.4625]		
$H_0: (CHStock)\gamma_1 = \gamma_2$	4.7643 [0.0294]**			
$H_0: (EX)\gamma_1 = \gamma_2$		1.0180 [0.3133]		
AIC	-823.081	-5,447.507	7,680.77	-2,282.74
SBC	-790.629	-5,415.056	7,706.73	-2,256.78
Q(4)	10.1518 [0.00144] ***		2.9037 [0.0883]*	2.9636 [0.0851]*
Q(12)	320.8157 [0.0135] ***		16.9092 [0.0501]*	17.7644 [0.0380]**
ARCH(4)	8.30213[0.0000] ***		17.7383 [0.0000]***	18.2350 [0.0000]***

Notes: CHStock and EX represent Chinese Shanghai A-share stock prices and exchange rate of RMB/USD, respectively.

Numbers in parentheses and bracket are  $t$ -statistics and  $p$ -value, respectively.

Symmetric Error-Correction Model:

\*, \*\*, and \*\*\* significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Lag length is 2 for the VECM model specification.



For adjustment speed toward the long-run equilibrium, the results in Table 3 for the stock prices (*CHStock*) show that the adjustment coefficient (0.65 percent) in the higher regime is statistically significant at the 5 percent level, but it is not statistically significant in the lower regime. This finding implies that 0.65 percent of the deviations revert back to equilibrium in the higher regime, but there is no adjustment toward the long-run equilibrium in the lower regime. On the other hand, adjustment coefficients for the exchange rate (*EX*) in both high and lower regimes are insignificant, suggesting no significant adjustment toward equilibrium in either regime in the foreign exchange market. The above evidence shows that the speed of adjustment toward long-run equilibrium takes place only in the higher regime and only for *CHStock*.

Two reasons explain the finding that RMB/USD appreciation has an impact on stock prices. First, most companies listed on the Chinese A-share stock market are importers rather than exporters.<sup>4</sup> If the exchange rate appreciates, importers gain competitiveness on domestic markets, their sales and profits increase, and stock prices increase as a result. Second, because of continuous foreign direct investments in China, the listed companies benefit significantly from increased domestic demand, price rebounds, and profit margins.

## Conclusions and Policy Implications

This paper investigates the causal relationship between the renminbi/U.S. dollar exchange rate and stock prices in China since removal of the peg. Our results can be summarized as follows: first, we find a threshold cointegration link between the exchange rate and Chinese stock prices. This finding implies that it is possible to predict one market from another, which is inconsistent with the efficient market hypothesis. Second, there is a discontinuous adjustment to a long-run equilibrium in two separate regimes, indicating an asymmetric causal relationship between the two variables considered. Third, there exists a unidirectional causal relationship running from exchange rates to stock prices in the long run, suggesting that RMB/USD appreciation has a significant impact on stock prices. In particular, the estimated results show that the speed of the adjustment process toward equilibrium is faster in the Shanghai A-share stock market.

The results have important implications. First, policymakers need to consider the impact of exchange rate changes on financial markets in designing appropriate policy strategies. Given that the exchange rate is no longer fixed, the authorities consider the impact of exchange rate changes not only on trade flows but also on financial markets.

Second, our results have broader theoretical implications. We find no evidence to support the portfolio approach. On the other hand, although the findings show a unidirectional causal relationship running from exchange rates to stock prices in the long run, this does not completely follow using the traditional approach in the literature either. The traditional approach argues that a depreciation of domestic currency makes local firms more competitive, leading to an increase in exports, and consequently raising stock prices. On the contrary, the empirical results shown in this paper reveal that the appreciation of exchange rates leads stock prices because most companies listed on the Chinese A-share stock market are importers rather than exporters.

## Notes

1. The currency basket is dominated by the U.S. dollar, the euro, the Japanese yen, and the Korean won.

2. Some recent studies employing threshold cointegration models include Obstfeld and Taylor (1997), Enders and Granger (1998), Enders and Siklos (2001), Lo and Zivot (2001), Taylor (2001), and Hansen and Seo (2002).
3. Prior to estimations, we tested for stationarity of the series using traditional unit-root techniques, ADF (Dickey and Fuller 1981), PP (Phillips and Perron 1988), and NP (Ng and Perron 2001), as well as the nonlinear ESTAR unit-root test advanced by Kapetanios et al. (2003) (KSS). The results of these tests showed that the variables are nonstationary or  $I(1)$ , enabling us to proceed with further long-run equilibrium relationship (cointegration) testing.
4. As of March 2008, 1,548 companies were listed on the Chinese A-share stock market, consisting mostly of importers (73.71 percent) and only 26.29 percent exporters ([www.wind.com.cn/en/home.html](http://www.wind.com.cn/en/home.html)).

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