Economics Bulletin

Volume 32, Issue 3

De facto exchange rate regimes in post-crisis Asia

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Abstract

This paper empirically examines the behaviour of exchange rates in order to identify de facto exchange rate regimes in post-crisis Asian countries. We use the multivariate GARCH model to estimate the conditional correlation among the value of currencies, which include the currencies of Thailand, Korea, Indonesia, and China. The results indicate that the degree of flexibility has increased substantially in the post-crisis exchange rate regimes in those economies, except for China. Even after the introduction of new system in 2005, the renminbi continues to be effectively pegged to the dollar.

The author is grateful to Shigeyuki Hamori for his very useful comments on an earlier version of this paper.
Citation: Takuji Kinkyo, (2012) "De facto exchange rate regimes in post-crisis Asia", *Economics Bulletin*, Vol. 32 No. 3 pp. 2155-2165.
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Submitted: November 30, 2011. **Published:** August 01, 2012.

1. Introduction

The Asian crisis of 1997-98 has highlighted the vulnerability of pegged-but-adjustable exchange rate regimes to speculative attacks and sudden capital flow reversals. It has also demonstrated how disorderly exits from pegged exchange rate regimes could result in economic disaster. In response to the crisis, Asian countries abandoned *de facto* dollar pegs and officially claimed to adopt floating exchange rate regimes. However, it is widely recognized that there is a discrepancy between *de jure* and *de facto* exchange rate regimes, and there is no consensus on the type of *de facto* exchange rate regimes in post-crisis Asian countries.

For example, Cohen (2008) argues that there is strong continuity in Asia's exchange rate policies, and the US dollar remains the key anchor currency. McKinnon (2005) even contends that dollar pegs are being revived and proposes that a formal dollar system should be established in East Asia.

However, Kawai (2008) claims that there has been a substantial change in Asia's exchange rate regimes. His analysis indicates that Indonesia has shifted towards floating rates, whereas Korea and Thailand have adopted managed floating rates that reference a currency basket comprised of the US dollar and the Japanese yen. Reinhart and Rogoff (2004) construct a new classification system of exchange rate regimes, according to which Indonesia and Korea have moved to managed floating rates, whereas Thailand has adopted a band regime.

The purpose of this paper is to identify *de facto* exchange rate regimes in post-crisis Asia by empirically examining the actual behaviour of exchange rates using advanced econometric technique. In particular, it addresses the following questions: 1) which currencies have been chosen to anchor post-crisis exchange rates in East Asia? 2) has a dollar peg been revived, or has a basket of multiple currencies been chosen as an alternative anchor? 3) to what extent has the flexibility of the post-crisis exchange rate regimes increased? And 4) have Asian countries continued to manage exchange rates tightly around the anchor, or have they adopted more flexible rate regimes, such as the managed floating rates?

The empirical analysis in this paper is based on the approach developed by Frankel and Wei (1994). This approach attempts to identify the anchor currency by estimating weights in a synthetic basket of currencies using the OLS (ordinary least squares) technique. The original framework was primarily designed to analyze the case of a basket peg. In subsequent papers, this framework has been extended to take account of greater flexibility in the exchange rate and regime shift (Frankel and Wei, 2008; Frankel and Xie, 2009). However, this extended framework is not readily applicable to our analysis due to the limited availability of high frequency data on foreign reserves.

In this paper, we employ a multivariate GARCH model to estimate the conditional correlation among currency values using only daily exchange rate data. The sample includes the currencies of four Asian countries (Thailand, Korea, Indonesia, and China) and

three major currencies (US dollar, Japanese yen, and euro). In doing so, we seek to both identify the anchor currency and measure the time-varying degree of exchange rate flexibility in post-crisis Asia. The advantage of this alternative approach is an absence of data constraints, as this framework uses only exchange rate data.

The rest of this paper is structured as follows. Section 2 briefly reviews the Frankel-Wei approach. Section 3 describes the estimation method of the multivariate GARCH model. Section 4 presents the estimation results. Section 5 concludes.

2. The Frankel-Wei Approach

An officially announced, *de jure* exchange rate regime often differs from the *de facto* one that is implemented. Some countries that claim to have floating rates, actually heavily intervene in the foreign exchange market, which is a phenomenon known as 'fear of floating' (Calvo and Reinhart, 2002). Other countries that claim to have fixed rates, in fact frequently devalue their currency in the wake of market pressures. Against this background, there is a growing body of literature on the classification of exchange rate regimes based on the actual behaviour of exchange rates.

Broadly, there are two approaches to the classification of *de facto* regimes. One approach attempts to gauge the flexibility of exchange rate regimes by measuring the relative variability of exchange rates and foreign reserves (Gosh et al., 2002; Bailliu, 2003; Reinhart and Rogoff, 2004; Dubas, 2005; Levy-Yeyati and Sturzenegger, 2005, 2007). For example, an exchange rate regime is classified as a fixed regime when the relative variability of exchange rates is low and that of foreign reserves is high. Conversely, it is classified as a floating regime when the relative variability of exchange rates is high and that of foreign reserves is low.

The second approach, which was originally developed by Frankel and Wei (1994), seeks to identify the relevant anchor currency by estimating weights in a synthetic basket of currencies. For example, when the estimated weight of a single currency is statistically significant and close to one, this implies that that particular currency is used as an anchor in exchange rate management. Frankel and Wei (1994) estimate basket weights using a standard OLS technique.

These two approaches are complementary to each other. In this paper, we employ the latter Frankel-Wei approach to address the questions raised at the beginning of the paper. The original framework for the Frankel-Wei approach assumes that a currency is tightly pegged to the anchor currency. In practice, many countries adopt a degree of flexibility around the anchor. Such flexibility is captured only by the error term in the OLS regression within the original framework. To provide better estimates, Frankel and Wei (2008) introduce the exchange market pressure (EMP) variable in the regression. This variable is defined as the percentage change in the value of the currency plus the percentage change in foreign reserves. The estimated coefficient of the EMP captures the *de facto* degree of flexibility in the exchange rate. For example, if the estimated coefficient equals one, this

implies that the currency floats freely because there is no change in foreign reserves and thus no foreign exchange market interventions. Conversely, if the estimated coefficient equals zero, it implies that the exchange rate is tightly fixed because it never changes in value. Furthermore, Frankel and Xie (2009) use the estimation technique developed by Bai and Perron (1998, 2003) to allow parameters to change over time.

This extension of Frankel-Wei approach provides better estimates of basket weights by taking account of both exchange rate flexibility and regime shift. However, it has a major drawback in terms of the availability of data on foreign reserves. While exchange rate data are available on a daily basis, the data on foreign reserves are available only on a monthly basis for most developing countries. In Frankel and Xie (2009), the sample covers only five emerging market economies, in which weekly data are available for foreign reserves. It includes only Thailand from the East Asian region. Moreover, these data are available only after 1999. Due to data constraints, this extended framework is not readily applicable to our analysis.

In this paper, we employ a multivariate GARCH model to estimate the conditional correlation among currency values using only daily exchange rate data. The sample includes four Asian currencies and three major currencies. In doing so, we seek to both identify the anchor currency and measure the time-varying degree of exchange rate flexibility in post-crisis Asian countries. The advantage of this alternative approach is an absence of data constraints, as this framework only uses exchange rate data.

3. Data and Estimation Results

The multivariate GARCH model has the advantage of allowing the volatility of multiple variables to interact with each other. However, the estimation of multivariate GARCH models can be difficult without appropriate restrictions on general model form. For example, the number of parameters increases as more variables are added to the system, and the conditions that ensures that the covariance matrix is positive definite can be quite complex (Enders, 2010, pp.165-166). There are a number of different specifications for multivariate GARCH models to circumvent these problems. In this analysis, we estimate the Dynamic Conditional Correlation (DCC) model proposed by Engle (2002).

The DCC model is estimated for the daily changes in the value of seven currencies, which include four Asian currencies (Thai baht, Korean won, Indonesian rupiah, and Chinese renminbi) and three major currencies (US dollar, Japanese yen, and euro) [1]. The currency values are measured using the Swiss franc as a numeraire, and they are expressed in logarithm terms. The sample period is from 1 February 1994 through 31 December 2010. The period starts in February 1994 to rule out the effect of the major change in the Chinese exchange rate regime in January 1994, during which the dual exchange rates were unified and the official rate was devalued by a large degree.

[1] The DCC model was estimated using Microfit 5.0 (Pesaran and Pesaran, 2009).

The estimates of the parameters obtained under the assumption of the multivariate normal distribution and the *t*-distribution are reported in Table 1. The estimated parameters are all highly significant for both cases. However, the maximum log-likelihood value for the *t*-distribution is significantly larger than that for the normal distribution. In addition, the estimated degree of freedom for the *t*-distribution is well below the value expected for the normal distribution. These results suggest that the *t*-distribution is more appropriate for modelling the dynamic conditional correlation among the currencies. In the following analysis, the estimation results based on the *t*-distribution are used.

Table I. Estimation Results

	Normal distribution			*t*-distribution		
	Estimate	Standard error	*P*-value	Estimate	Standard error	*P*-value
λ_1 (baht)	0.94999	0.0014666	0.000	0.93666	0.0035736	0.000
λ_1 (won)	0.94998	0.0017284	0.000	0.93763	0.0039145	0.000
λ_1 (rupia)	0.95000	0.0015366	0.000	0.93928	0.0033079	0.000
λ_1 (renminbi)	0.95001	0.0012879	0.000	0.93988	0.0031898	0.000
λ_1 (dollar)	0.95001	0.0013085	0.000	0.93950	0.0031504	0.000
λ_1 (yen)	0.95000	0.0035469	0.000	0.95993	0.0043926	0.000
λ_1 (euro)	0.95000	0.0031612	0.000	0.93787	0.0063145	0.000
λ_2 (baht)	0.050002	0.0014536	0.000	0.055894	0.0029739	0.000
λ_2 (won)	0.050019	0.0017277	0.000	0.057758	0.0033844	0.000
λ_2 (rupia)	0.050003	0.0015370	0.000	0.059011	0.0031314	0.000
λ_2 (renminbi)	0.049982	0.0012968	0.000	0.051766	0.0026429	0.000
λ_2 (dollar)	0.049984	0.0013089	0.000	0.052165	0.0026227	0.000
λ_2 (yen)	0.049990	0.0035687	0.000	0.035900	0.0037003	0.000
λ_2 (euro)	0.049999	0.0031216	0.000	0.047562	0.0044078	0.000
δ_1	0.95000	0.0008439	0.000	0.95528	0.0015416	0.000
δ_2	0.049995	0.0008173	0.000	0.033683	0.0010137	0.000
Degrees of freedom	-	-	-	3.6148	0.047309	0.000
Maximized log-likelihood		186537.2			197154.2	

Note: λ_1 and λ_2 denote the asset-specific volatility parameters. δ_1 and δ_2 denote the common conditional correlation parameters.

The estimated conditional correlation between the Asian currencies and the major currencies are plotted in Figure 1 (a) – (d). The annual average and standard deviation of these correlations for each year are reported in Table 2 in Appendix. All Asian currencies were closely correlated with the dollar during the period before the Asian crisis. Among the four Asian currencies, the renminbi was most closely correlated with the dollar. The renminbi-dollar correlation remained above 0.99, whereas the standard deviation was as low as 0.001- 0.002. The baht and the rupiah were also closely correlated with the dollar. The annual average of the correlation between these currencies and the dollar ranged from

0.97 to 0.99. The won-dollar correlation was relatively more volatile, though the annual average of this correlation exceeded 0.9.

In comparison, the correlations of the Asian currencies with the yen and the euro were much weaker. The annual average of the correlations with the yen and the euro were about 50-60% of that with the dollar, and the standard deviations were much larger. These results are consistent with the common understanding that these Asian currencies were effectively pegged to the dollar before the crisis.

During the Asian crisis, there was a sharp decline in the correlation between crisis-hit Asian currencies and the dollar. Between 1996 and 1998, the level of correlation with the dollar declined by more than 50% for the baht and the won and by more than 85% for the rupiah. There was also a large decline in the correlation of these Asian currencies with the yen and the euro. In sharp contrast, the correlation between the renminbi and the dollar remained as strong as before the crisis because China's dollar peg survived the Asian crisis.

The correlation between the crisis-hit Asian currencies and the dollar rose again after the crisis. But the level of correlation remained lower than before the crisis. Consequently, the difference between the correlation of these Asian currencies with the dollar and that with the yen narrowed substantially. The correlation between the Asian currencies and the euro became lower and more volatile after the crisis. There were even negative correlations between them in the first half of 2001, thereby reflecting the depreciation of the euro against other currencies. The correlation turned positive as the euro began to appreciate in the second half of 2001.

Among the crisis-hit Asian currencies, the baht maintained the closest correlation with the dollar after the crisis. During the period between 2000 and 2005, the annual average of the baht-dollar correlation ranged from 0.76 to 0.83, which was significantly higher than the baht-yen correlation. However, the level of the correlation with the dollar declined from the pre-crisis level, and its volatility increased substantially. These results suggest that, although the dollar continued to serve as the major anchor currency in exchange rate management, the Thai exchange rate regime became more flexible after the crisis.

The correlation between the won and the dollar was relatively strong until 2001. The annual average of the correlation ranged between 0.69 and 0.78, which was significantly higher than the won-yen correlation. However, the won-dollar correlation began to decline in 2002, narrowing the difference between the won-dollar correlation and the won-yen correlation. The average won-dollar correlation declined to 0.35 in 2006 due to the rapid appreciation of the won against other currencies. It seems that the won-dollar correlation became weaker as the Korean exchange rate regime increased its flexibility over time.

Indonesia was severely affected by the crisis and it took longer for its currency market to stabilize. Due to the prolonged instability, the rupiah-dollar correlation began to rise only after 2000. In addition, the level of the correlation remained about half of the pre-crisis level, and its volatility increased substantially. The rupiah-dollar correlation picked up slightly in 2003 but declined again in the latter half of 2005. The weak rupiah-dollar

correlation indicates that the Indonesian exchange rate regime became more flexible after the crisis.

Figure 1 (a) Conditional Correlation (Thai baht)

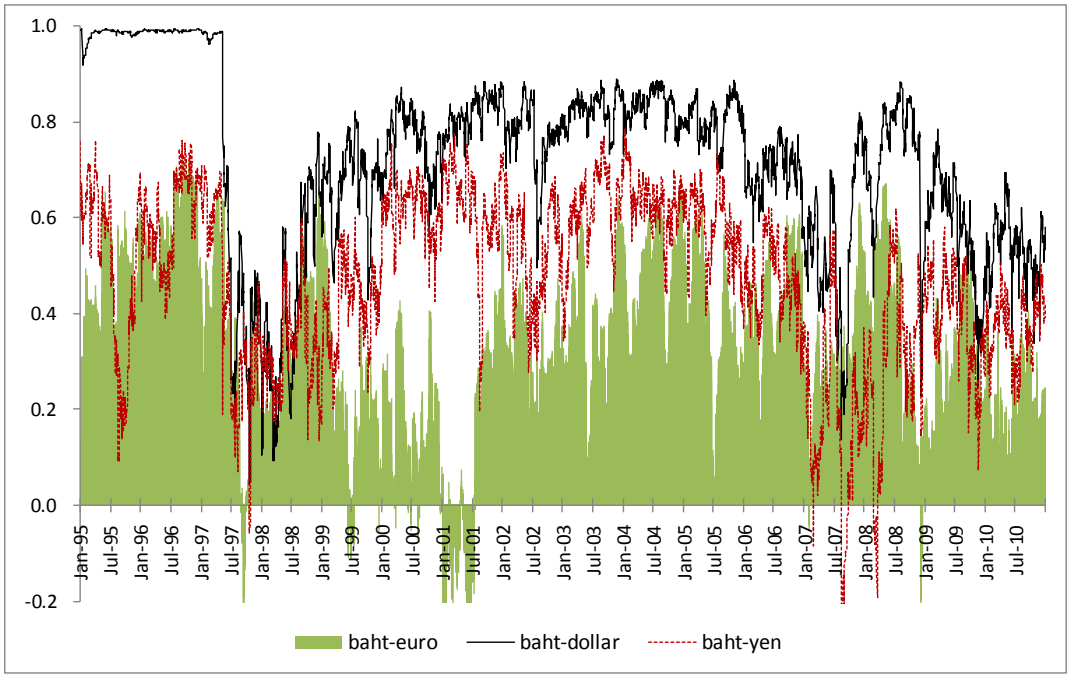


Figure 1 (b) Conditional Correlation (Korean won)

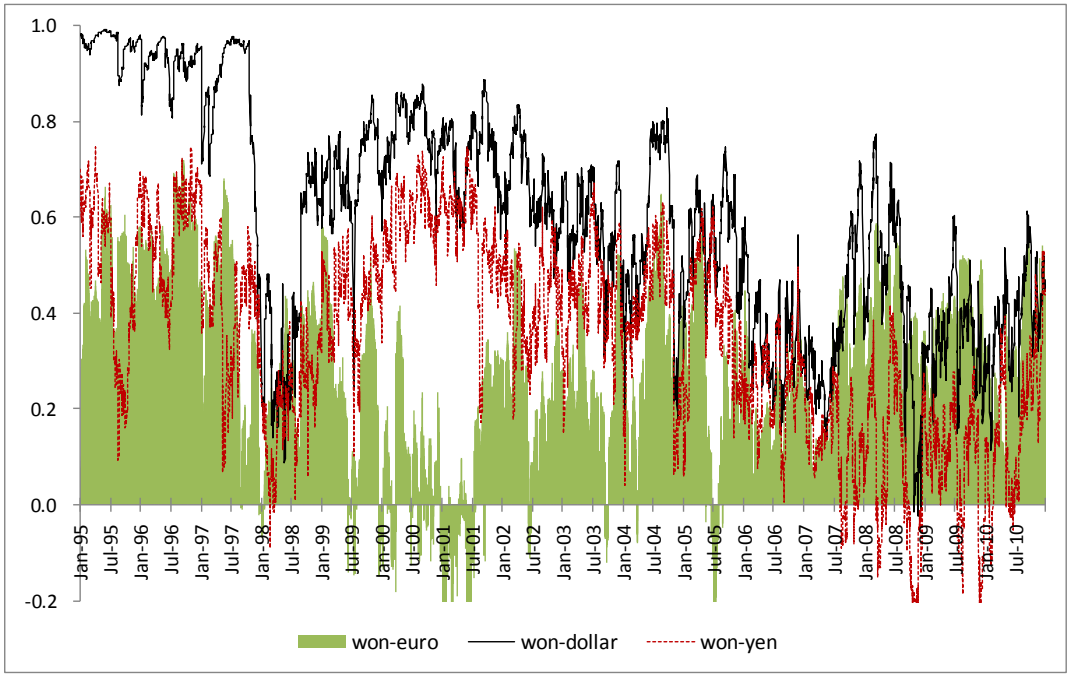


Figure 1 (c) Conditional Correlation (Indonesian rupiah)

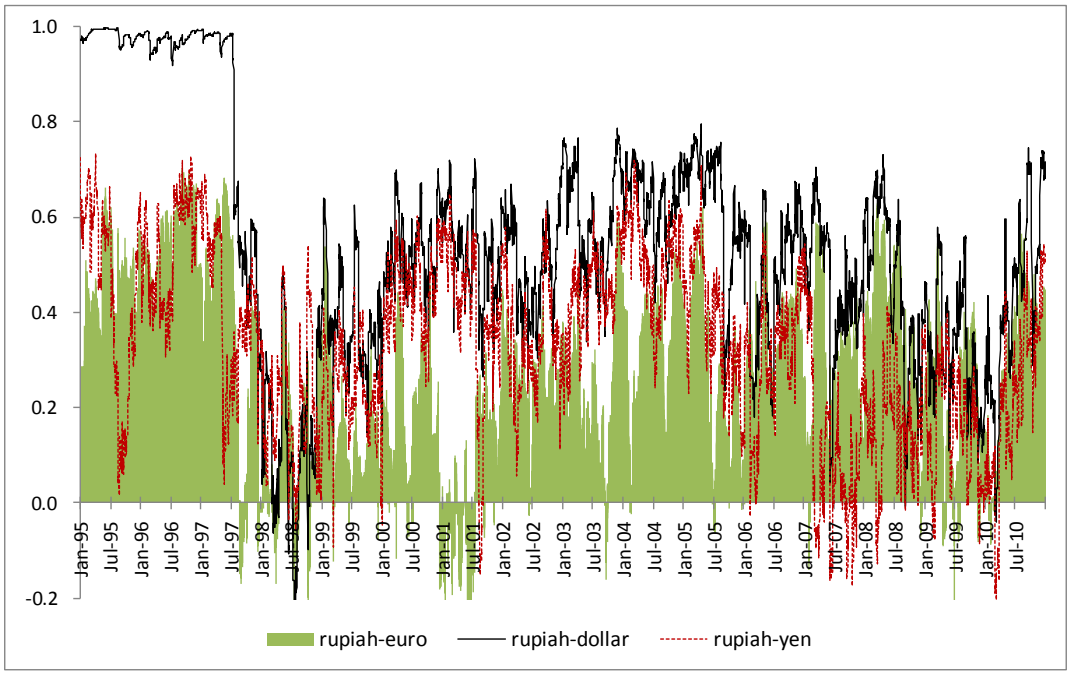
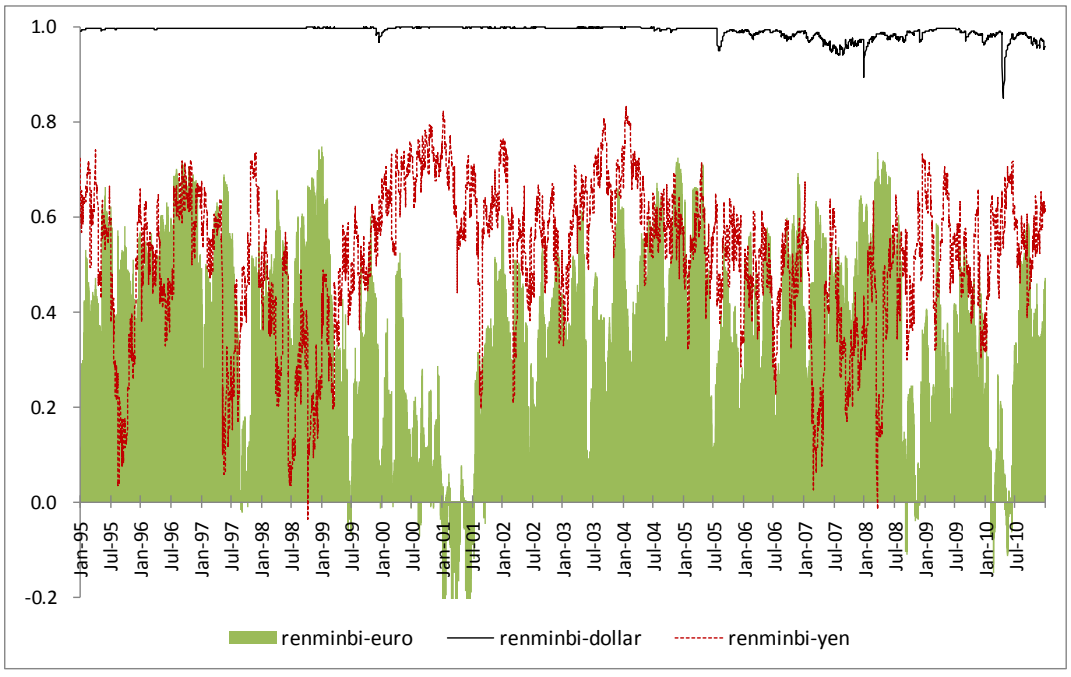


Figure 1 (d) Conditional Correlation (Chinese renminbi)



The renminbi continued to be strongly correlated with the dollar after the Asian crisis. The renminbi-dollar correlation almost always stayed above 0.99 until a new exchange rate regime was introduced in July 2005. Under this new regime, the renminbi was to be

managed referencing a basket of currencies rather than being pegged to the dollar. However, the renminbi-dollar correlation remained strong after the introduction of this regime. Although the renminbi-dollar correlation declined to around 0.95 immediately after the introduction of the new regime, it soon returned to levels above 0.98 and remained at approximately the same level until 2006.

Following the outbreak of the global financial crisis, there was a sharp decline in the correlation of Asian currencies with the dollar, except for the renminbi. After a temporary increase in the first half of 2008, the correlation with the dollar plunged again after the Lehman shock in September 2008. This rapid decline was due to the acceleration of de-leveraging by international financial institutions, which pushed down the exchange rates in emerging market economies, including those in Asia.

Among the Asian currencies, the won and rupiah were hit hardest, leading to a sharp decline in their correlation with the dollar. As a result, the difference between the correlation with the dollar versus that with the yen or the euro narrowed substantially. The bath-dollar correlation also became weaker. In sharp contrast, the renminbi continued to be strongly correlated with the dollar. Although the correlation between them became slightly more volatile, the annual average of the correlation ranged between 0.96 and 0.99 and the standard deviation remained as low as 0.007- 0.023.

To summarize, Thailand, Korea, and Indonesia seems to have adopted more flexible exchange rate regimes after the Asian crisis. In comparison, the Thai baht maintained a relatively strong correlation with the dollar, indicating that the dollar continued to serve as the major anchor currency in its exchange rate management. However, the correlation of the bath with the dollar declined and it became more volatile under the post-crisis exchange rate regime. Moreover, the correlation between the currencies of these Asian countries and the dollar further weakened in the wake of the currency instability during the global financial crisis of 2007-09. In sharp contrast, there seems to have been no fundamental change to China's exchange rate regime, even after the introduction of the new regime in 2005. The correlation between the renminbi and the dollar continued to be very strong, indicating that the renminbi continues to be effectively pegged to the dollar.

4. Conclusions

This paper empirically examined the behaviour of exchange rates to identify *de facto* exchange rate regimes in post-crisis Asia. The main contribution is that it presents evidence indicating that there is a clear tendency for the post-crisis Asian countries to shift out of a rigid exchange rate regime towards a more flexible one. We used the multivariate GARCH model to estimate the conditional correlation among the value of currencies. In doing so, we both identified the anchor currency and measured the time-varying degree of exchange rate flexibility in post-crisis Asia.

The econometric results indicate that the degree of flexibility has increased substantially in the post-crisis exchange rate regimes in Thailand, Korea, and Indonesia. There seems to

have been neither a revival of dollar pegs nor a shift towards basket pegs in these countries. Their exchange rate regimes can be best characterized as managed floating rates with a varying degree of flexibility.

A notable exception is China. There seems to have been no fundamental change to the exchange rate regimes in China, even after the introduction of new system in 2005. The renminbi continues to be effectively pegged to the dollar, as indicated by its strong correlation with the dollar.

Appendix

Table II. The Average and Standard Deviation of Conditional Correlations

	baht-dollar		*baht-yen*		*baht-euro*		*won-dollar*		*won-yen*		*won-euro*	
	Average	S.D.	Average	S.D.	Average	S.D.	Average	S.D.	Average	S.D.	Average	S.D.
1995	0.98	0.01	0.49	0.18	0.45	0.10	0.96	0.03	0.48	0.17	0.46	0.10
1996	0.99	0.00	0.60	0.09	0.57	0.08	0.93	0.04	0.58	0.09	0.53	0.09
1997	0.63	0.30	0.41	0.19	0.30	0.20	0.85	0.15	0.41	0.12	0.33	0.19
1998	0.43	0.19	0.32	0.10	0.31	0.15	0.42	0.19	0.20	0.10	0.25	0.12
1999	0.67	0.08	0.42	0.09	0.20	0.15	0.69	0.09	0.43	0.09	0.22	0.18
2000	0.76	0.06	0.62	0.05	0.15	0.12	0.78	0.06	0.60	0.07	0.06	0.13
2001	0.82	0.04	0.62	0.10	0.07	0.24	0.73	0.08	0.57	0.11	0.04	0.19
2002	0.77	0.07	0.52	0.11	0.30	0.09	0.66	0.08	0.42	0.09	0.22	0.13
2003	0.83	0.03	0.62	0.09	0.36	0.14	0.58	0.09	0.44	0.10	0.22	0.13
2004	0.83	0.03	0.64	0.06	0.46	0.12	0.56	0.17	0.40	0.14	0.29	0.15
2005	0.81	0.04	0.58	0.08	0.36	0.14	0.56	0.09	0.40	0.13	0.22	0.19
2006	0.70	0.05	0.47	0.08	0.40	0.12	0.35	0.09	0.24	0.08	0.20	0.09
2007	0.53	0.16	0.18	0.17	0.28	0.11	0.37	0.15	0.12	0.09	0.23	0.12
2008	0.73	0.13	0.31	0.17	0.35	0.20	0.44	0.20	0.09	0.18	0.36	0.11
2009	0.58	0.11	0.39	0.10	0.28	0.12	0.36	0.09	0.09	0.11	0.36	0.09
2010	0.54	0.07	0.37	0.07	0.21	0.08	0.39	0.10	0.17	0.14	0.30	0.12
	rupiah-dollar		*rupiah-yen*		*rupiah-euro*		*renminbi-dollar*		*renminbi-yen*		*renminbi-euro*	
	Average	S.D.	Average	S.D.	Average	S.D.	Average	S.D.	Average	S.D.	Average	S.D.
1995	0.98	0.01	0.45	0.20	0.44	0.10	0.997	0.002	0.455	0.196	0.446	0.094
1996	0.97	0.02	0.54	0.11	0.54	0.09	0.997	0.001	0.556	0.095	0.569	0.082
1997	0.76	0.25	0.41	0.15	0.33	0.24	0.998	0.000	0.469	0.175	0.391	0.190
1998	0.13	0.15	0.20	0.13	0.10	0.14	0.998	0.000	0.300	0.144	0.513	0.120
1999	0.38	0.11	0.24	0.09	0.14	0.11	0.997	0.005	0.473	0.094	0.310	0.177
2000	0.52	0.08	0.44	0.09	0.15	0.14	0.998	0.002	0.691	0.057	0.154	0.138
2001	0.53	0.09	0.40	0.16	0.04	0.16	0.999	0.000	0.621	0.115	0.094	0.248
2002	0.50	0.10	0.34	0.11	0.23	0.10	0.999	0.000	0.539	0.107	0.349	0.118
2003	0.60	0.11	0.44	0.09	0.23	0.15	0.999	0.000	0.632	0.092	0.380	0.152
2004	0.64	0.07	0.52	0.09	0.33	0.12	0.997	0.002	0.629	0.086	0.486	0.133
2005	0.63	0.13	0.39	0.12	0.25	0.16	0.992	0.011	0.531	0.083	0.385	0.171
2006	0.48	0.13	0.31	0.13	0.31	0.11	0.988	0.006	0.477	0.078	0.428	0.132
2007	0.46	0.13	0.11	0.17	0.26	0.15	0.967	0.013	0.344	0.144	0.452	0.102
2008	0.46	0.17	0.16	0.10	0.36	0.16	0.980	0.010	0.450	0.137	0.404	0.250
2009	0.32	0.12	0.17	0.12	0.21	0.15	0.991	0.007	0.529	0.101	0.325	0.112
2010	0.43	0.19	0.22	0.17	0.27	0.16	0.972	0.023	0.562	0.081	0.240	0.195

Note: S.D. stands for standard deviation.

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