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Yen-Synchronization of Floating East-Asian Currencies: A Regime-Switching Regression Model and Micro-Structural Analysis

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Abstract. Using a regime-switching regression model, we find evidence of synchronization between floating East-Asian-currencies' dollar exchange rates and yen-dollar exchange rates over the period 1999-2006. We also find, contrary to traditional arguments concerning the yen-bloc, that the "export similarity index" and FDI between Japan and East Asian countries are the two main determinants of yen-synchronization in the region. In addition, micro-structural analysis of yen-synchronization shows that the synchronization period persists once it has begun and that the volatility of dollar exchange rates is higher during the synchronization period than the de-synchronization period. Finally, we show that our estimation results are robust with respect to different econometric techniques.

Keywords: Export similarity, FDI, yen-synchronization, Markov-switching regression model.

1. Introduction

Most studies on the co-movement of the two bilateral exchange rates focus on evaluating the foreign-exchange-rate system in East Asia after the Asian financial crisis. In particular, using Frankel and Wei (1994)'s methodology, many studies analyzed the relative importance of the U.S. dollar (USD) and the Japanese yen (JPY) in determining the East-Asian-countries' exchange rates. Below we summarize the findings of recent relevant studies.

Those are Baig (2001), McKinnon and Schnabl (2004), Ogawa and Yang (2008), Bowman (2005), and Kearney and Muckley (2007).

2. Markov-Switching Regression Model

The random variable (St) determines the state of the change of dollar exchange rates and we assume that this state of change follows a first-order Markov chain with the transition probability defined in equation (1):

$$\Pr[S_t = 0 \mid S_{t-1} = 0] = p, \;\; \Pr[S_t = 1 \mid S_{t-1} = 1] = q \qquad (1)$$

If St = 0 then the change in the U.S. dollar exchange rate is not affected by yen-dollar exchange rates but only by economic fundamentals. If St = 1, however, then the change in the U.S. dollar exchange rate is affected both by yen-dollar exchange rates and economic fundamentals. Thus, the East-Asian-countries' dollar exchange-rate determination equations can be written as follows:

$$If \;\; S_t = 0, \;\; \Delta y_t = \alpha_0 + \gamma_0 \Delta r_t + \delta_0 \Delta SP_t + \varepsilon_t \;, where \quad \varepsilon_t \mid S_t = 0 \sim N(0, \sigma_0^2) \qquad (2)$$

$$If \;\; S_t = 1, \;\; \Delta y_t = \alpha_1 + \beta_1 \Delta x_t + \gamma_1 \Delta r_t + \delta_1 \Delta SP_t + \varepsilon_t \;, where \quad \varepsilon_t \mid S_t = 1 \sim N(0, \sigma_1^2) \qquad (3)$$

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where Δy_t is the change in the U.S. dollar exchange rate; Δx_t is the change in the yen-dollar exchange rate; Δr_t is the change in the Euro currency rate of the U.S. dollar; and ΔSP_t is the change in stock prices in the East-Asian countries. All data are in natural logarithms. Note that the β in Equation (3) is our measure of yen-synchronization.

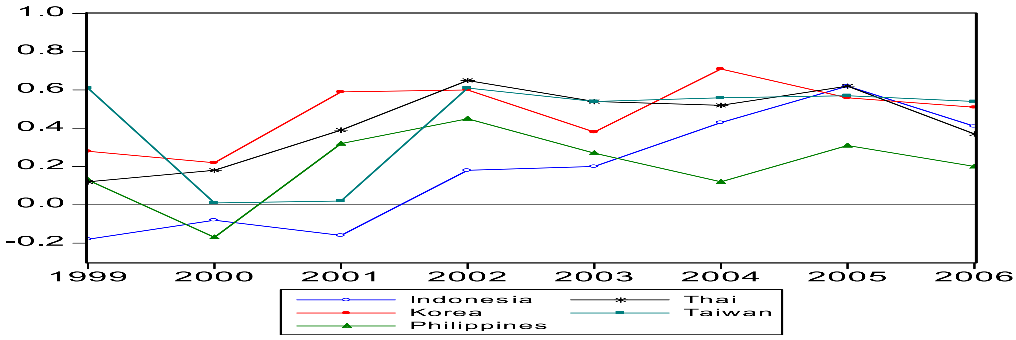
3. Estimation

3.1. Data and statistics

We used weekly exchange rates for the period January 1999-December 2006 from the Pacific Exchange Rate Service of the University of British Columbia. All other data were from the IMF's IFS CD-ROM, UN comtrade database, Customs Office of Taiwan, and Bank of Japan database.

Figure 1 show the estimated correlation coefficients for the two bilateral exchange rates -- the dollar exchange rates for various East-Asian countries and the yen-dollar exchange rates. On average, the correlation is strong for the Korean won, the New Taiwanese dollar, and the Thai baht, whereas it is low for the Indonesian rupiah and the Philippine peso. For most countries, the correlation was lowest in the year 2000 and then increased thereafter.

Figure 1. Correlation Coefficients for the East-Asian-Countries' Dollar Exchange Rates with the Yen-Dollar Exchange Rate



3.2. Testing the validity of restrictions in the MSRM

In this study, we assume that there are two different states for the two bilateral exchange rates, a synchronized period and de-synchronized period. If our assumption is true then the estimates of β_t, which is a measure of synchronization, should be different for these two different states. Using Hansen (1992)'s likelihood-ratio test, we test whether indeed the estimated β_t coefficients are different under these different states.[1]

Table 1 shows that we can reject the null hypothesis that the two estimates of β_t are the same ($\beta_0 = \beta_1$) at the 5% critical level (except in the case of the Philippines). Thus, we can conclude that we have two different states and that in the second state the yen-dollar exchange rate can affect the East-Asian-countries'-dollar exchange rates. We can therefore estimate the synchronization between the East-Asian-countries'-dollar and yen-dollar exchange rates. For the sake of simplicity, we assume that β_0=0 and $\beta_1 \neq 0$.

Table 1. Likelihood-Ratio Test of Hansen (1992)

Null Hypotheses	Korea	Taiwan	Thailand	Indonesia	Philippines
$\alpha_0 = \alpha_1$	2.517 (0.12)	2.314 (0.21)	2.013 (0.32)	2.536 (0.12)	1.483 (0.55)
$\beta_0 = \beta_1$	2.883** (0.04)	3.977*** (0.01)	2.911** (0.03)	3.146** (0.03)	0.459 (0.95)

[1] The range of the grid is [0.001, 0.991] and the step size is 0.11.

$\gamma_0 = \gamma_1$	0.037 (0.99)	0.021 (0.99)	0.389 (0.97)	0.929 (0.93)	0.190 (0.99)
$\theta_0 = \theta_1$	0.9396 (0.85)	0.371 (0.98)	2.574 (0.17)	0.479 (0.99)	1.838 (0.389)

Notes: Estimates in the parentheses are p-values. Double asterisks (**) denote significance of the estimate at 5 % critical level and triple asterisks (***) denote significance at 1% critical level.

3.3 Estimation of the MSRM

Since Hansen (1992)'s likelihood-ratio test statistic rejects the restriction that two parameters are the same, we estimate the Markov-switching models with the restrictions ($\alpha_0 = \alpha_1, \gamma_0 = \gamma_1, \theta_0 = \theta_1, \beta_0 = 0, \beta_1 \neq 0$). Table 2 reports the maximum-likelihood estimation results for the Markov-switching regression model with the restrictions ($\alpha_0 = \alpha_1, \gamma_0 = \gamma_1, \theta_0 = \theta_1, \beta_0 = 0, \beta_1 \neq 0$). The estimated coefficients of β, which is a measure of the synchronization between the East-Asian-countries'-dollar and yen-dollar exchange rates, are statistically significant and positive, implying that there is indeed synchronization of the two bilateral exchange rates.

Table 2. Estimation of MSRM ($\alpha_0 = \alpha_1, \gamma_0 = \gamma_1, \delta_0 = \delta_1, \beta_0 = 0, \beta_1 \neq 0$)

Parameter	Korea	Taiwan	Thailand	Indonesia	Philippines
α	-0.0504 (-1.482)	-0.0019 (-0.083)	0.0126 (0.434)	-0.0049 (-0.544)	0.0503** (2.012)
β	0.3471** (10.847)	0.2428** (6.226)	0.3011** (6.145)	0.1677** (4.932)	0.1782** (2.200)
γ	-0.0089 (-0.989)	0.0041 (1.367)	0.0068 (0.971)	-0.0030 (-1.500)	0.0002 (0.033)
δ	-0.0565** (-3.767)	-0.0098** (-1.960)	-0.0599** (-7.488)	-0.0072** (-2.400)	-0.0452** (-5.022)
σ^2_0	0.0529** (2.204)	0.0376 (1.880)	0.1566** (6.264)	0.0156** (5.200)	0.1620** (6.480)
σ^2_1	0.7778** (13.183)	0.3729** (8.107)	0.7709** (8.964)	0.3075** (8.786)	1.4789** (4.755)
p	0.7725** (6.438)**	0.8418** (5.766)	0.9050** (24.459)	0.8992** (28.100)	0.8994** (26.453)
q	0.9791** (57.597)	0.8588** (8.854)	0.9208** (28.775)	0.8653** (22.187)	0.7474** (7.867)
Log Likelihood	-516.6	-231.4	-426.5	-369.7	-402.6

Notes: Figures in the parentheses are t-values.Double asterisks (**) denote significance of the estimate at 5% critical level.

Our most critical finding from Table 2 is that the synchronization estimate (β) is the largest for Korea at 0.3471, followed by Thailand and Taiwan. But the β estimates for Indonesia and the Philippines are relatively small, implying that the strength of those currencies' synchronization with the yen-dollar exchange rates during the period under study is quite low.

When we compare actual co-movements (the correlation coefficients in Figure 1) with our synchronization measures (the β estimates in Table 2), it seems that the synchronization coefficients capture the pattern of actual co-movements pretty well. For example, the synchronization coefficient is largest for Korea, followed by Taiwan and Thailand, and the actual co-movement is the strongest for Korea, followed by Thailand and Taiwan. In addition, while the actual co-movements are quite weak for Indonesia and the Philippines, so too are these countries' synchronization coefficients. However, while Indonesia's synchronization coefficient is significant, that of the Philippines is insignificant.

If we use estimates of co-movement (β in Tables 2) as proxies for the weight in a currency basket, then our estimates are a little larger than those proposed by Frankel-Wei. For example, the estimate for the Thailand baht was 0.12 in Frankel-Wei, but it is 0.30 in our regression. Similarly, our estimates for the Taiwanese dollar and Korean won are both larger, increasing from Frankel-Wei's 0.13 to our 0.24, and from their 0.02 to our 0.41, respectively.2 Table 2 also shows that synchronization and de-synchronization periods tend to persist according to the estimates of transition probability. For countries like Korea, Thailand, and Taiwan that have strong synchronization with the Japanese yen, the probability estimate of synchronization persistence (q) is larger than that of de-synchronization (p). For Korea, the estimate of q is 0.979 and that of p is 0.772.

Another important finding from Table 5 is that for all five countries, the volatility of their dollar exchange rates during synchronization periods (σ_1^2) is larger than it is during de-synchronization periods (σ_0^2).[3] It is also interesting to see that changes in the stock prices of the East-Asian countries significantly affect their dollar exchange rates. Negative and significant estimates of δ mean that an increase in these countries' stock prices will cause capital inflows, which will in turn cause an appreciation of their dollar exchange rates.[4]

4. Determinants of Yen-Synchronization in East Asia: Panel Regression Analysis

We employ panel regression to analyze the causes and effects of increased synchronization between values of the yen and the East-Asian currencies. The following panel regression is used to find the variables that might have caused yen synchronization:

$$p_{it} = \alpha_0 + \alpha_1 ESI_{it} + \alpha_2 \log\ (FDI_{it}) + \alpha_3 \log(FPI_{it}) + \alpha_4 \log(EX_{it}) + \alpha_5 \log(IM_{it}) + \varepsilon_{it} \quad (4)$$

where the dependent variable (p_{it}) is the quarterly average of the estimated smoothed probability from the Markov-switching regressions. The five independent variables or proxies are an export similarity index (ESI) and the East-Asian countries' growth rate of exports (EX_{it}) and imports (IM_{it}) to Japan as the measure of their current-account transactions with Japan. For the level of capital-account activities, we use the sum of Japan's FDI (FPI) in East Asia and the East-Asian countries' FDI (FPI) in Japan. These data are obtained from the Bank of Japan, the Customs Office of Taiwan, and the UN Comtrade database. We developed the ESI variable using an HS 4 code and 2 codes (2 codes for Taiwan)[5].

Table 3 provides parameter estimates using a fixed-effects model. This table shows that estimates of ESI and FDI between Japan and the East-Asian countries are positive and significant, but the estimates of FPI are insignificant. In addition, positive export and import growth rates (to and from Japan, respectively) cannot by themselves explain yen-synchronization.

Table 3. Estimation Results of Panel Regression Model (Equation 4)

ESI	FDI	FPI	Export growth rate	Import growth rate	Growth rate of sum of exports and

2 Our estimates are a little larger than those of Frankel-Wei for two reasons. First, our MSRM estimates the effect of yen-dollar rates on Eastern-Asian-countries' dollar exchange rates only when co-movement is strong (S_t=1), whereas Frankel-Wei estimate both cases (S_t=0 and S_t=1). Second, while the Frankel-Wei regression used Swiss franc exchange rates to estimate currency weights, our MSRM used only U.S. dollar exchange rates.

3 The larger volatility of East-Asian currencies when the synchronization is stronger may reflect the possibility that these countries' monetary authorities are keeping their currencies stable against the dollar, the intervention currency, when there are no large shocks.

4 After the U.S. subprime mortgage crisis in 2007, there were huge capital outflows from these East-Asian countries (by selling stocks), which caused significant depreciation of these countries' dollar exchange rates. However, there were significant capital inflows into Japan, which caused an appreciation of the Japanese yen. Thus, there was a decoupling of the floating East-Asian countries' currencies from the Japanese yen during the global financial crisis.

5 HS 4 code and 2 codes are commodity classification codes used in the UN's Comtrade database.

					imports
0.7624* (4.27)	0.2397* (2.09)	0.0018 (0.06)	-	-	0.1889 (1.25)
0.7603* (4.22)	0.2371* (2.05)	0.0027 (0.08)	0.0880 (0.69)		-
0.7752* (4.35)	0.2324* (2.03)	0.0021 (0.07)	-	0.1689 (1.10)	-

Notes: Figures in the parentheses are t-values. A single asterisk (*) denotes significance of the estimate at 10% critical level.

5. Conclusions

While recent studies focus on the increased importance of the yen in East Asia after the financial crisis, little is known about the causes and microstructure of the synchronization of East-Asian-countries' dollar exchange rates with yen-dollar rates. In this paper, we have investigated the causes of yen-synchronization in East Asia using Markov-switching regressions. Our key findings are summarized below.

First of all, the strength of synchronization is greatest in Korea, followed by Thailand and Taiwan, with Indonesia and the Philippines experiencing much smaller degrees of synchronization. Second, the estimated smoothed probability of transition shows that both the periods of synchronization and de-synchronization tend to persist once they occur. Third, the volatility of East-Asian countries'-dollar exchange rates is greater during periods of yen- synchronization than during periods of de-synchronization. Fourth, local returns on stock prices are a highly significant variable in explaining East-Asian-currencies' dollar exchange rates both for periods of synchronization and de-synchronization. Five, synchronization occurred not only when the yen was weak, but also when it was strong. Finally, the export similarity index and FDI are the most important variables affecting yen-synchronization.

Unlike previous studies of the yen-bloc, we can conclude that the increased trade dependence of East-Asian countries on Japan is not the main cause of the co-movement of East-Asian-countries' dollar exchange rates with yen-dollar rates. Rather, it is the increased export competition of East-Asian countries in the world market and FDI that are the major driving forces of yen-synchronization in Asia.

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