Examining the volatility of exchange rate: Does monetary policy matter?

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Abstract:
We conduct empirical analysis on examining the changes in exchange rate volatility under two monetary policy regimes, i.e. the pre- and post- inflation targeting (IT) regimes. In addition, we also investigate if the monetary decisions can have impacts on the volatility of exchange rate. The study is focused in four Asian countries that experienced drastic in the switch of monetary policy from the rigid exchange rate to flexible exchange rate and inflation targeting after the Asian financial crisis of 1997. The exponential generalized autoregressive conditional heteroskedasticity model is applied and our results show that exchange rate is more persistent and volatile in the pre-IT period as compared to post-IT period. The exchange rate persistency is higher in the long-run but the persistency is low in the short run. We fail to find evidence to show that the adoption of flexible exchange rate and inflation targeting lead to greater volatility in exchange rate. The monetary decisions can have impacts on the volatility of exchange rate but the impacts vary across countries.

Keywords: inflation targeting; volatility of exchange rate; fear of floating; monetary policy regime

1. Introduction

The choice of monetary policy and exchange rate regimes and the performances of the monetary policy regimes always appear to be a hot topic of debates especially for the small open developing economies like Asia. These emerging markets are always termed as 'fear of floating', i.e. these countries claim themselves to be free floaters but are reluctant to let the nominal exchange rate to freely move through intervention in foreign exchange markets. There are arguments that the emerging markets are fear to float their currencies due to some reasons, such as liability dollarization, lack of credibility and access to international capital markets (Calvo and Reinhart, 2002). High fluctuation of exchange rate under floating regime may affect the stability in financial markets especially the undeveloped financial markets like emerging countries. Therefore, the policy makers in emerging countries tend to influence the exchange rate movement through foreign exchange intervention. However, the question arisen here is: does floating the exchange rate lead to higher variation and fluctuation in exchange rate which will harm the economy? This is the question addressed in this paper.

In answering this question, we conduct empirical analyses to examine the volatility of exchange rate under two different policy regimes, i.e. pre- inflation targeting (pre-IT) or rigidity in exchange rate regime and post-IT or flexible exchange rate regime. We focus the study in four Asian countries that experienced drastic change in their monetary policy regimes after the Asian financial crisis of 1997. We also investigate if the monetary variables such as money supply, short term interest rate and international reserves have significant influence on determining the volatility of exchange rate between the two sub-periods. Our results indicate that there is no evidence showing that flexible exchange rate has led to higher volatility in exchange rate movement in these countries. Indeed, exchange rate is less volatile and less persistent in the post-IT period. The monetary variables have significant impacts on the volatility of exchange rate but the impacts differ across countries.

The remaining paper is organized as follows: section two reviews the literature; section three explain the data and methodology applied; section four discusses the results and section five concludes the findings.

2. Literature review

We tend to relate high exchange rate fluctuation with floating exchange rate regime as free floating regime implies freely move of exchange rate without control. However, how true does this view hold? Friedman (1953) argues that instability in exchange rate is due to the instability in the underlying economic structure and that flexible regime does not necessary be unstable exchange rate. Flood and Rose (1999) add that if the fundamental volatility does not vary across exchange rate regimes, then either floating or fixity should not lead to increase in exchange rate turbulence temporarily. The common opinion then says that floating regime is fine for large countries. On the other hand, small countries that experience fluctuation in fundamental should be tied to fixed exchange rates (Aslund (2010)).

Fernandez (2003) investigates this issue empirically for the case of Chile. The study shows that the increase in exchange rate volatility was not as sharp as predicted. Exchange rate was volatile highly around June 1999 prior to the adoption of floating regime.

On the other hand, Havemann and Kularatne (2007) investigate the reason differentiating the currencies volatility across countries. Focusing the study in a set of middle-income countries, the results show that higher reserves reduce exchange rate volatility and it is suggested that the appropriate level of reserves should be about 4.5 months of imports. Exchange rate volatility also will be higher with the increase of uncertainty and loose of fiscal policy and higher volatility of terms of trade. As discussed in this paper, dirty floats do not necessarily lead to lower volatility in exchange rate than free floating as intervention of central bank may lead to higher volatility in exchange rate.

Beine *et al.* (2006) on the other hand, investigate the effect of intervention on realized volatility by controlling for the impact of macroeconomic announcements on volatility. The results show that intervention of central bank exacerbates higher exchange rate volatility.

Amod and Hassan (2014) study the volatility of currencies in several emerging markets after the adoption of inflation targeting and flexible exchange rate. They report that the ratio of the variance of exchange rate deviations from fundamentals to the variance of the change in fundamentals has increased after the implementation of inflation targeting. The increase is due to the reductions in the long run variances of exchange rates, lower variance of changes in fundamentals and also lower volatility in real exchange rate misalignment. They conclude that flexible inflation targeting enables exchange rate to react to changes in expected fundamentals, hence reduces the deviations of real exchange rate.

3. Data

We focus the study in four Asian countries (Indonesia, Korea, Philippines and Thailand) that experienced drastic change in their monetary policy regimes after the Asian financial crisis of 1997. Exchange rate measures the units of domestic currency per U.S dollar. Additionally, determinants of monetary variables on volatility of exchange rate to be tested include interest rate, money supply and international reserves.

The sample period spans 22 years from January 1990 until December 2012 except the series for the Thailand interest rate which is only collected from February 1991 to December 2012. For the purpose of analysis and comparison, the sample data is partitioned into pre-

Inflation Targeting (IT) and post-IT periods. Thailand has implemented inflation targeting in May 2000, Indonesia in January 2000, Korea in April 1998 and Philippines in January 2002 (see Table 1). All monthly data are obtained from *Datastream* and International Financial Statistic-CD ROM. Changes in exchange rates are computed as the first differences of the natural log, i.e. $R_t = \ln(E_t) - \ln(E_{t-1})$.

Table 1: Pre-IT and post- IT periods

Country	**Pre-IT**	**Post-IT**
Thailand	1990M1-2000M4	2000M5-2012M12
Indonesia	1990M1-1999M12	2000M1-2012M12
Korea	1990M1-1998M3	1998M4-2012M12
Philippines	1990M1-2001M12	2002M1-2012M12

4. Methodology

4.1 Unit Root Test

Unit root test is used to test whether a time series variables is non-stationary using autoregressive model. If the series of the variable exhibits unit root or stochastic trend then the analysis is not powerful and meaningless. If the series, y_t achieves stationary after differencing *d* times, then it can be denoted as *I*(*d*). In this study, we apply the Kwiatkowski, Phillips, Schmidt and Shin (Kwiatkowski *et al.* (1992)) (KPSS) unit root test for the checking of stationarity. The null hypotheses are y_t is *I*(0) or stationary against the alternative that it is *I*(1). Assuming no linear trend term, the model is expressed as $y_t = x_t + z_t$

where x_t is a random walk, $x_t = x_{t-1} + v_t$, $v_t \sim iid\ (0, \sigma_v^2)$ and z_t is a stationary process. The hypotheses to be tested are as follows:

$H_0 : \sigma_v^2 = 0 \Rightarrow y_t \sim I(0)$ versus $H_0 : \sigma_v^2 > 0 \Rightarrow y_t \sim I(1)$

Kwiatkowski *et al.* (1992) proposed the test statistic as $KPSS = \frac{1}{T}\sum_{t=1}^{T} S_t^2 / \hat{\sigma}_\infty^2$

where T is the sample size, $S_t = \sum_{j=1}^{t} \hat{\omega}_j$ with $\hat{\omega}_t = y_t - \overline{y}$ and $\hat{\sigma}_\infty^2$ is defined as $\sigma_\infty^2 = \lim_{T \longrightarrow \infty} T^{-1} Var(\sum_{t=1}^{T} z_t)$, where σ_∞^2 represents the estimator of the long run variance of process z_t .

4.2 EGARCH(1,1) model

In order to overcome the weakness of symmetric assumption in generalized autoregressive conditional heteroskedasticity or GARCH model, Nelson (1991) introduced the asymmetric exponential GARCH or EGARCH model with a conditional variance formulation that can successfully capture the leverage effects of stock returns. The EGARCH model is a non linear transformation of the classical GARCH model. Hence, the EGARCH model is designed to consider the asymmetric impact of good and bad news on exchange rate volatility. To construct the EGARCH(1,1) model, we first assume that the changes in exchange rate equation follows the AR(1) process:

$R_t = C + \eta R_{t-1}$

where *C* represents the constant for the equation and η denotes the coefficient for the lagged one of changes in exchange rate. Under the conditional normality the conditional variance equation is computed as:

$$\log(\sigma_t^2) = \alpha_0 + \alpha_1 \left[\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] + \gamma \frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \beta_1 \log(\sigma_{t-1}^2)$$

$$\varepsilon_t \,|\, \Omega_{t-1} \sim N(0, \sigma^2)$$

α_0 denotes the mean of yesterday's forecast while the α_1 determines the size of shock or the symmetric effect of the model. β_1 measures the level of volatility persistency while γ measures the asymmetry impact on volatility or the leverage effects.

When $\gamma = 0$, the model is symmetry. When $\gamma < 0$, positive shocks (good news) generate less volatility than negative shocks (bad news). In addition, if $\gamma > 0$ then the results imply that positive innovations are more destabilizing than negative innovations. The biggest advantage of EGARCH is that even if the parameters are negative, the function of log will always produce positive value of σ_t^2. In this study, we modify the EGARCH(1,1) model by including three monetary variables (money supply, interest rate, international reserves) to the conditional variance equation to examine if monetary decisions have impacts on exchange rate volatility.

$$\log(\sigma_{1t}^2) = \alpha_0 + \alpha_1 \left[\frac{|\varepsilon_{1t-1}|}{\sqrt{\sigma_{1t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] + \gamma \frac{\varepsilon_{1t-1}}{\sqrt{\sigma_{1t-1}^2}} + \beta_1 \log(\sigma_{1t-1}^2) + aX_t + bD_t$$

where X_t = (*money supply, interest rate, international reserves*)

D_t = (*trend, seasonal dummy, IT dummy*)

where X_t denotes the exogenous variables and D_t represents the dummy for inflation targeting (1=adopt IT; 0= otherwise).

5. Results

Before conducting the analysis, we can compare the changes of exchange rate, R_t between the two sub-periods. Table 2 summarizes the descriptive statistics for R_t in the pre-IT and post-IT periods. It is observed that changes in exchange rate are mostly skewed to the right and not symmetry; the series do not show normal distribution. Comparing the mean values between the two sub-periods, we can see that changes of exchange rate are larger in the pre-IT periods compared to the post-IT periods although these countries adopted more rigid exchange rate regimes in the pre-IT periods and have switched to the floating regime and inflation targeting in the post-IT period. Also, the standard deviations of changes in exchange rate are larger in the pre-IT periods which implies larger variation in exchange rate during the rigid regimes compared to the floating regime. Therefore, the data imply that floating regime does not necessarily relate to higher fluctuation in exchange rate. To confirm this statement, we proceed with our analysis using EGARCH(1,1) models.

Table 2: Statistical features of the variables for Pre-IT and Post-IT

Period	Country	Mean	Std.Dev.	Skewness	Kurtosis
Pre-IT	Thailand	0.318	4.158	0.100	20.498
	Indonesia	1.149	10.522	3.709	30.843
	Korea	0.715	4.809	4.629	40.209
	Philippines	0.576	3.202	1.119	6.631
Post-IT	Thailand	-0.142	1.711	0.423	3.876
	Indonesia	0.199	3.698	-0.115	8.900
	Korea	-0.144	3.558	0.255	6.707
	Philippines	-0.167	1.678	0.583	4.122

NOTE: ** denote significance at 5%

5.1 Results – unit-root test

The KPSS unit-root test is performed preliminary to the estimation to check for stationarity of exchange rate series. When testing the exchange rate series in log level, the null hypothesis of no unit-root is rejected in all countries, implying that log exchange rate is not stationary. We further test the series in first differenced which is $R_t = \ln(E_t) - \ln(E_{t-1})$. Our results show that the series are stationary in first differenced term. We can proceed the estimation step using the data in first differenced form or changes in exchange rate which is R_t.

Table 3 Results of KPSS stationary test

Panel A: Unit root test for the Pre-IT period			
Country	**Variables**	**Levels**	**First difference**
Indonesia	E	2.7363**	0.1262
Korea	E	1.1718**	0.2230
Philippines	E	3.8010**	0.1490
Thailand	E	2.6139**	0.1118
Panel B: Unit root test for the Post-IT period			
Country	**Variables**	**Levels**	**First difference**
Indonesia	E	0.2255**	0.1108
Korea	E	1.2546**	0.0930
Philippines	E	3.7642**	0.1540
Thailand	E	4.7921**	0.2258
Panel C: Unit root test for the full sample period			
Country	**Variables**	**Levels**	**First difference**
Indonesia	E	7.2339**	0.1421
Korea	E	3.6180**	0.1020
Philippines	E	6.0954**	0.3325
Thailand	E	3.7855**	0.1974

Notes: E denotes the exchange rate return and S denoted the stock return
: ** denotes significance at 5%

5.2 Results – EGARCH(1,1)

Table 4 summarizes the results of EGARCH(1,1) estimation using sub-samples data and Table 5 is the estimates using full sample data. First, comparing the results across two sub-periods, the mean equation of changes in exchange rate has smaller autoregressive value η in the post-IT periods, this could be due to smaller changes in exchange rate. Next, we compare the conditional variance equation (Table 4).

It is observed that the mean conditional variance α_0 is relatively larger (absolute value) in the pre-IT period. This result holds for all countries. Besides, the exchange rate shock is more persistent in the long run β_1 compared to the persistency in the short run α_1 in majority cases. Comparing the persistency between the two sub-periods, majority cases show that the short run and long run persistency of exchange rate shocks are relatively higher in the pre-IT period than that in the post-IT period. The results imply that exchange rate is more volatile in the pre-IT period.

γ indicates the leverage effect of shocks. The leverage coefficients are positive, indicating destabilizing effects of shocks for all countries in the two sub-periods. However, the destabilizing effects are smaller in the post-IT periods.

Checking with the monetary impact on volatility of exchange rate, the results show that in the pre-IT period, interest rate has significant impact on exchange rate volatility in Korea and money supply and international reserves have significant impact in that of Thailand. In the post-IT period, these three monetary variables have significant impact on the exchange rate volatility in Korea but no significant impact in the other countries except the impact of interest rate in Indonesia.

Next, we compare the results from the full sample data. The results of full sample are consistent with that of sub-samples. The persistency of short run shock is lower than the persistency of long run shock. The leverage effect is positive which implies destabilizing, i.e. exchange rate shock leads to destabilizing in exchange rate volatility in all countries. The money supply has significant impact on exchange rate movement, higher money supply leads to higher volatility in exchange rate. Higher interest rate has significantly leads to higher exchange rate volatility in Indonesia. On the other hand, international reserves are able to reduce the exchange rate volatility in Thailand.

The coefficient of b_1 for IT dummy is only significant in Philippines but not in other countries. This means that the adoption of IT does not lead to significant changes in exchange rate volatility except in Philippines. In Philippines, the adoption of IT has successfully reduced the exchange rate volatility.

Overall, we conclude that exchange rate is more volatile in the pre-IT period. However, the higher fluctuation of exchange rate in the pre-IT and rigid regime period may also due to the financial crisis of 1997 as the pre-IT period include the crisis period (year 1997). On the other hand, using the full sample data, our results do not show evidence that the flexible exchange rate regime and inflation targeting lead to higher volatility in exchange rate. In the case of Philippines, IT has successfully reduced the exchange rate volatility. The monetary variables appear to have significant impacts on exchange rate volatility in some countries.

Table 4: Estimation of EGARCH(1,1) for Pre-IT and Post-IT periods

Panel (a) EGARCH(1,1) : Pre-IT				
	Indonesia	Korea	Philippines	Thailand
Mean equation : $R_t = C + \eta R_{t-1}$				
C	0.233**	0.147**	0.285	0.066
η	0.403**	0.522**	0.069	0.157**
Variance equation: $\log(\sigma_{1t}^2) = \alpha_0 + \alpha_1 \left[\frac{\lvert \varepsilon_{1t-1} \rvert}{\sqrt{\sigma_{1t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] + \gamma \frac{\varepsilon_{1t-1}}{\sqrt{\sigma_{1t-1}^2}}$ $+\beta_1 \log(\sigma_{1t-1}^2) +$ a_1 interest + a_2 money sup+ a_3 internat. res				
α_0	-4.674*	-24.449**	-1.821	17.086**
α_1	0.679**	0.798**	0.500**	0.175*
γ	0.356**	0.420**	0.125	0.506**
β_1	0.981**	0.671**	0.771**	0.979**
a_1	-0.152	2.988**	-0.167	-0.044
a_2	0.298	1.382	0.424	5.817**
a_3	0.362	0.810	-0.209	-5.148**
Panel (b) EGARCH(1,1) : Post-IT				
	Indonesia	Korea	Philippines	Thailand
Mean equation : $R_t = C + \eta R_{t-1}$				
C	0.096	0.395**	-0.032	-0.148
η	0.075	0.019	0.131	0.226**
Variance equation: $\log(\sigma_{1t}^2) = \alpha_0 + \alpha_1 \left[\frac{\lvert \varepsilon_{1t-1} \rvert}{\sqrt{\sigma_{1t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] + \gamma \frac{\varepsilon_{1t-1}}{\sqrt{\sigma_{1t-1}^2}}$ $+\beta_1 \log(\sigma_{1t-1}^2) +$ a_1 interest + a_2 money sup+ a_3 internat. res				
α_0	-2.310	-1.838**	-12.585	-0.288
α_1	0.387	-0.025	0.186	-0.222**
γ	0.334**	0.205**	0.073	0.051
β_1	0.542**	0.972**	0.592*	0.916**
a_1	0.983**	0.219**	0.485	0.035
a_2	-0.418	-0.155**	1.424	-0.216
a_3	0.277	0.213**	-0.342	0.176

NOTE: ** and * denote significance at 5% and 10% respectively

Table 5: Estimation of EGARCH(1,1) using full sample

EGARCH(1,1) : Full sample				
	Indonesia	**Korea**	**Philippines**	**Thailand**
Mean equation : $R_t = C + \eta R_{t-1}$				
C	0.284**	0.213**	-0.029	-0.007
η	0.239**	0.180**	0.092	0.243**
Variance equation: $\log(\sigma_{1t}^2) = \alpha_0 + \alpha_1 \left[\frac{\lvert \varepsilon_{1t-1} \rvert}{\sqrt{\sigma_{1t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] + \gamma \frac{\varepsilon_{1t-1}}{\sqrt{\sigma_{1t-1}^2}}$ $+\beta_1 \log(\sigma_{1t-1}^2) +$ interest $+ a_2$ money sup $+ a_3$ intern. reserv $+ b_1$ IT				
α_0	-2.006*	-4.052	-5.403**	-0.581**
α_1	0.408**	0.784**	0.433**	-0.072**
γ	0.282**	0.135**	0.082	0.214**
β_1	0.932**	0.819**	0.745**	0.988**
a_1	0.353**	0.411	0.229	0.029
a_2	0.441**	0.911**	0.643**	0.340**
a_3	-0.111	-0.290	-0.157	-0.147**
b_1	0.132	0.431	-0.456**	-0.010

NOTE: ** and * denote significance at 5% and 10% respectively

6. Conclusion

In this paper, we conduct empirical analyses to compare the exchange rate volatility between two different policy regimes, i.e. the rigid exchange rate regimes versus the inflation targeting and flexible exchange rate regimes. The main objective to conduct such analyses is to confirm if floating regime and inflation targeting leads to higher volatility in exchange rate. The study is focused in four Asian countries (Indonesia, Korea, Philippines and Thailand) that experienced drastic change in their policy regimes aftermath the financial crisis of 1997. We also investigate if the monetary variables matter in determining the exchange rate volatility. The EGARCH(1,1) model is applied and our results show that exchange rate is more volatile and more persistent in the pre-IT period. The exchange rate shock is more persistent in the long run. However, the higher volatility in exchange rate in the pre-IT period could be caused by the financial crisis of 1997. Therefore, further investigation can be conducted by excluding the crisis period. Our results do not find evidence that the adoption of IT leads to higher volatility in exchange rate. The monetary variables have some significance impacts on determining the exchange rate volatility. To get more robust results, one can compare these results with the results that exclude the crisis period.

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