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Monetary Policy Responses to the Exchange Rate: Empirical Evidence from Three East Asian Inflation-Targeting Countries

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Abstract

Using monetary policy reaction functions, this paper examines whether monetary policy responds to the exchange rate in three East Asian inflation-targeting countries, namely, Korea, Thailand and the Philippines. Contrary to the results in existing studies, it finds no evidence that monetary policy in these countries responds to the exchange rate. While extant work employs sample periods including the Asian financial crisis between 1997 and 1998, this paper focuses on the inflation-targeting regimes adopted in the period following the crisis. The strong monetary policy response to the exchange rate to defend against currency depreciation during the crisis is found to contribute to the difference in results.

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1. Introduction

Many emerging market economies under independently floating or managed floating exchange rate regimes have responded contrary to their official exchange rate classification. Calvo and Reinhart (2002), for instance, show that the volatility of interest rates and foreign exchange reserves is larger than expected in countries with independent or managed floating exchange rate official classifications. They conclude that these countries control exchange rate fluctuations with foreign exchange reserves and the interest rate as two policy instruments. They call this reluctance to tolerate exchange rate fluctuations, despite the official classification, a "fear of floating."

On the contrary, the recent literature on optimal monetary policy focusing on inflation-targeting regimes suggests little role for the exchange rate. According to Taylor (2001), given that the exchange rate influences expected inflation and the expected output gap, the exchange rate does not have additional information, and often it is difficult to extract "appropriate" information from exchange rate movements due to disturbance and noise.[1] Taylor also argues that to the extent that exchange rate movements reflect real shocks, such as productivity and terms of trade, it is better not to respond to the exchange rate. In addition, under an inflation-targeting regime, targeting the exchange rate may cause the loss of credibility in targeting inflation.

This paper empirically investigates the monetary policy response to the exchange rate in three East Asian inflation-targeting countries: Korea, Thailand and the Philippines. It estimates monetary policy reaction functions that include the exchange rate as well as inflation and the output gap. Although these countries were reluctant to tolerate exchange rate fluctuations before the Asian financial crisis between 1997 and 1998, shifting their monetary frameworks to inflation targeting may have changed their response to the exchange rate. It is, then, of some interest to examine whether, and by how much, monetary policy responds to the exchange rate under the more flexible exchange rate and inflation-targeting regimes adopted after the crisis.

Most existing studies conclude that monetary policy strongly responds to the exchange rate in many emerging market economies and emphasize that for some countries, the response to the exchange rate is stronger than that to either inflation or the output gap.[2] However, these studies do not consider structural breaks, even though monetary and exchange rate policy regimes change during the sample period. Mohanty and Klau (2005) estimate policy reaction functions for the three Asian countries included in this analysis, as well as ten other emerging market economies.[3] While they conclude that all three countries respond to the exchange rate, they use quarterly data between the first half of the 1990s and 2002. Including the sample during the Asian financial crisis overestimates the monetary policy response to the exchange rate, because exchange and interest rates fluctuated widely in tandem during the crisis.[4] In fact, Mohanty and Klau (2005) also estimate monetary policy reactions

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[1] In fact, simulation results indicate that gains from the monetary policy response to the exchange rate are limited with respect to macroeconomic stability. See, for example, Taylor (2001).

[2] See, for example, Clarida et al. (1998) for the empirical evidence on the monetary policy response to the exchange rate in industrial countries. They show that monetary policy responds to the exchange rate, but that the quantitative effects are small.

[3] The ten countries are India, Taiwan, Brazil, Chile, Mexico, Peru, the Czech Republic, Hungary, Poland, and South Africa. See Corbo (2000) for five Latin American countries (Chile, Colombia, Costa Rica, El Salvador, and Peru), and Minella et al. (2003) for Brazil.

[4] Statistical tests such as the Chow breakpoint test confirm structural breaks during the crisis period with regression equations in Section 3.

with a shorter sample period using monthly data between 1998 and 2002 to take into account the structural break associated with the crisis. However, as post-crisis adjustment was prolonged until the end of 1999, or even until the beginning of 2000, including 1998 and 1999 in the sample period is still inappropriate (see Section 2). This paper reexamines monetary policy responses to the exchange rate by focusing on the sample period under the inflation-targeting regime adopted after the crisis. Given that Thailand and the Philippines implemented inflation targeting in 2000 and 2002, respectively, the sample periods under an inflation-targeting regime overcomes the structural break problem.

The remainder of the paper proceeds as follows. Section 2 reviews exchange rate and monetary policy in the three selected countries before and after the crisis. It also discusses the differences in exchange rate policies before and after the crisis. This is because identifying the changes in the exchange rate and monetary regimes are crucial to assessing the monetary policy response to the exchange rate. Section 3 provides empirical evidence of the policy reaction functions. Some concluding remarks follow in Section 4.

2. Brief Review of Exchange Rate and Monetary Policy

2.1. Exchange Rate Policy

2.1.1. "No Fear of Floating"

While Calvo and Reinhart (2002) study central bank behavior up to the late 1990s, the three selected Asian countries changed their exchange policies since then. They explicitly or implicitly changed their exchange rate policies after the Asian financial crisis from more "rigid" to more flexible forms. Table 1 summarizes each country's official exchange rate classification before and after the crisis. Korea and Thailand moved to more flexible exchange rate regimes after the crisis, while the Philippines maintained its floating exchange rate regime – Korea's shift was relatively less drastic than Thailand as it moved from a managed floating regime to an independently floating regime.

<Table 1: Official Exchange Rate Classifications>

Korea	March 1980–October 1997	Managed Floating
	November 1997–present	Independently Floating
Thailand	January 1970–June 1997	Fixed
	July 1997–present	Managed Floating
Philippines	January 1988–present	Independently Floating

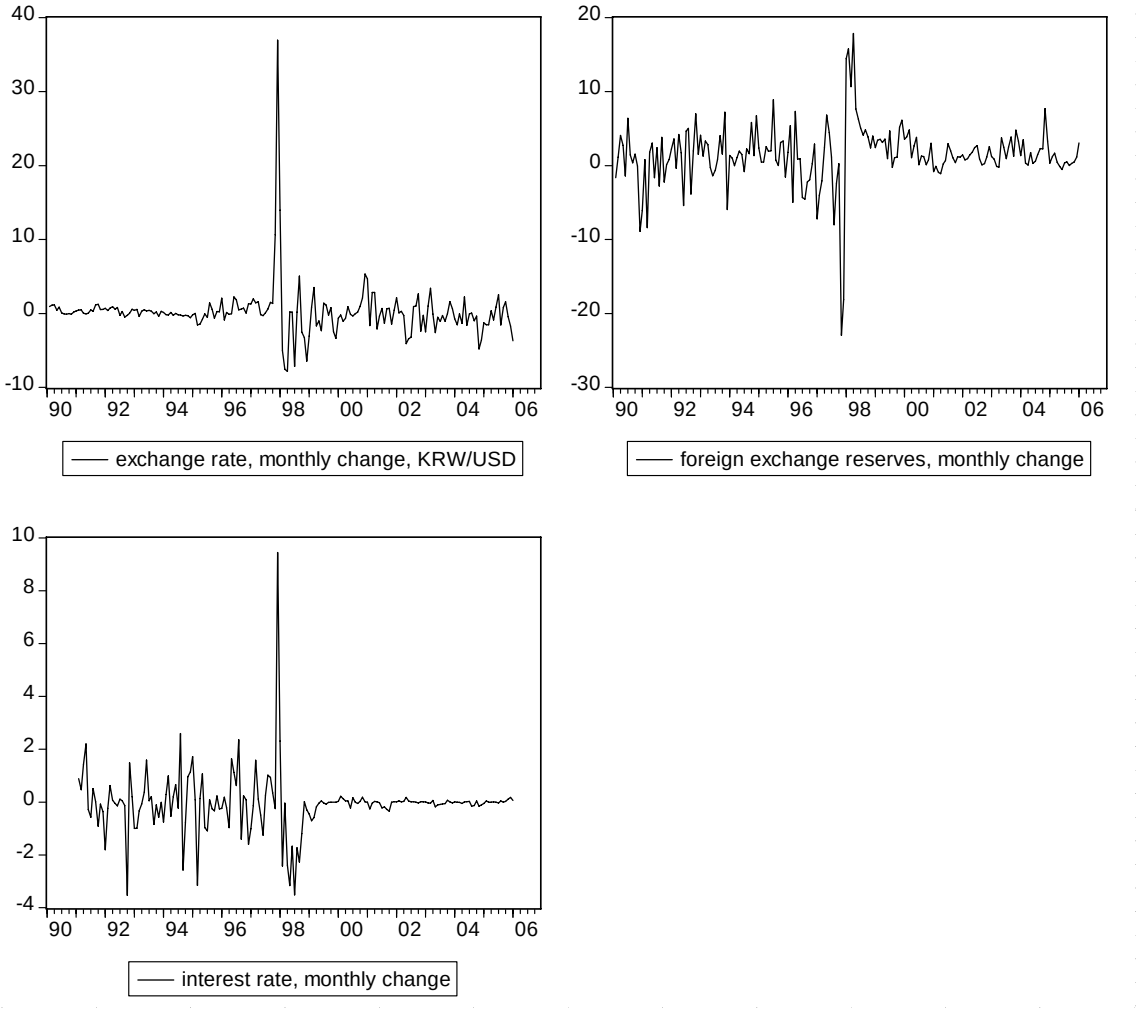
(Source) IMF, Exchange Arrangements and Exchange Restrictions, several issues.

Under the floating exchange rate regimes before the crisis these countries, in practice, undertook different exchange rate policies from their official classification. Korea maintained its exchange rate against the US dollar within a narrow band before the crisis, while the Philippines virtually pegged its currency to the US dollar from late 1995 to June 1997. According to Calvo and Reinhart (2002), both countries were reluctant to tolerate exchange rate movements throughout the late 1990s. After the crisis, whether officially or unofficially, all three countries moved from rigid exchange rate regimes to more flexible regimes, as shown below.

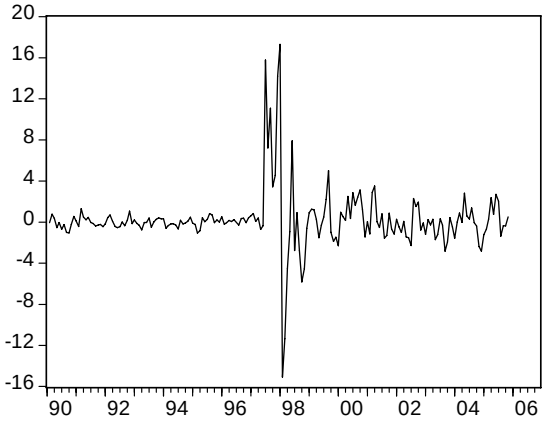
Figure 1 depicts the movement of monthly percentage changes in the exchange rate (domestic currency per US dollar), foreign exchange reserves, and the short-term nominal interest rate for Korea, Thailand and the Philippines. A large spike of the exchange rate in late 1997 in each country corresponds to their currencies' sharp depreciation during the crisis. The movements of the exchange rate in Korea and Thailand have drastically changed before and after that date. While no obvious difference is observed in the Philippines, movements of the exchange rate under the inflation-targeting regime since 2002 – when it implemented the inflation-targeting regime – have been less volatile. Movements of the exchange rate were less volatile before the crisis and more volatile after the crisis in all three countries. On the contrary, movements of foreign exchange reserves and the interest rate were more volatile before the crisis and less volatile following the crisis.

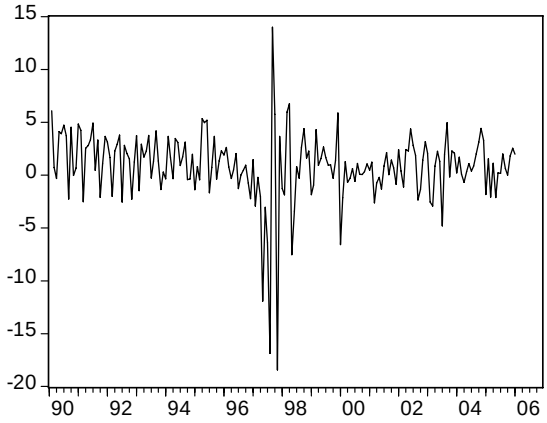
<Figure 1: Exchange Rate, Foreign Exchange Reserves, and Interest Rate>

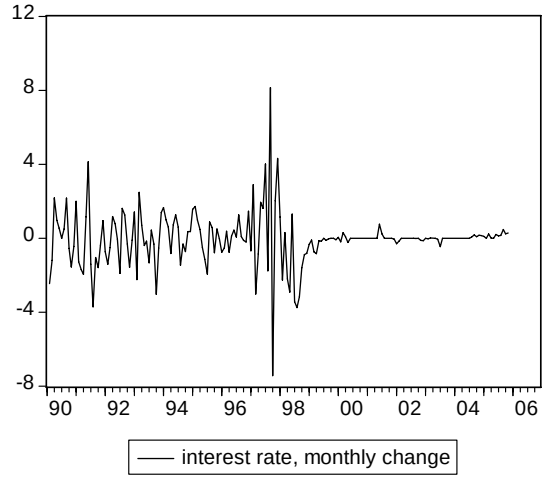
(Korea)



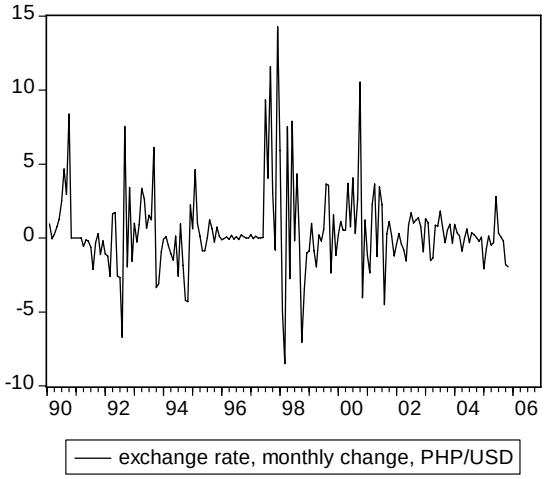
(Thailand)

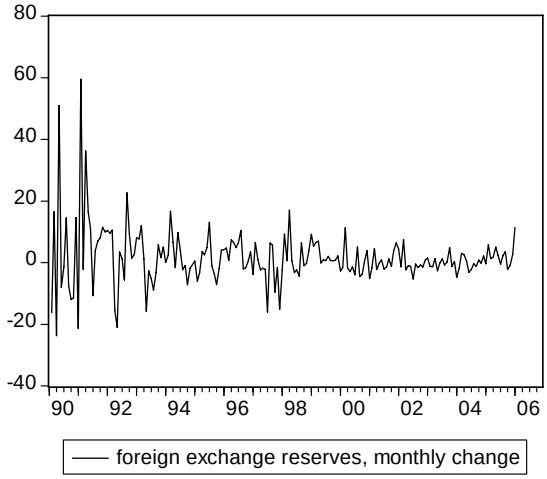






(Philippines)





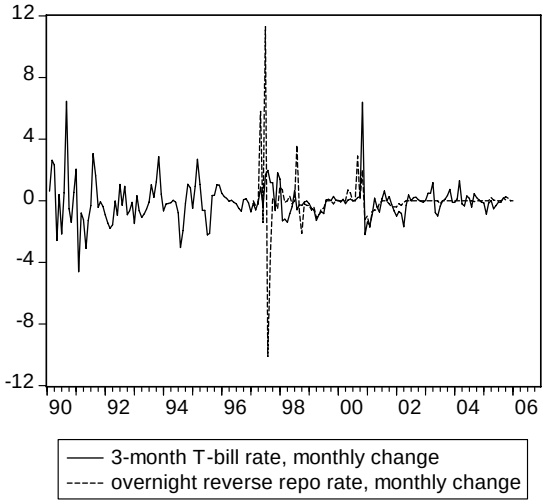


Table 2 presents the historical volatility of the exchange rate, foreign exchange reserves and the interest rate. The figures in these tables confirm the movements of the variables in Figure 1. For all three countries, the interest rate and foreign exchange reserves are more volatile, but the exchange rate is less volatile, during the pre-crisis period than during the post-crisis period.[5] The more volatile exchange rate after the crisis reflects Korea's and Thailand's behaviors toward the exchange rate of letting the exchange rate fluctuate. The Philippines' exchange rate remains as volatile in pre-crisis period as in post-crisis period, but less volatile foreign exchange reserves and the interest rate indicate the lesser policy response to the exchange rate.

Movements of the exchange rate, foreign exchange reserves, and the interest rate indicate regime shifts in the exchange rate policy. A central bank can control exchange rate fluctuations with two policy instruments. One instrument is to use foreign exchange reserves. A central bank buys or sells foreign currencies in the foreign exchange market using foreign exchange reserves. The other instrument is the interest rate. A central bank raises or lowers the interest rate. A higher interest rate, for example, attracts capital inflows, which, in turn, lead to an exchange rate appreciation.

Before the crisis, all three central banks were reluctant to tolerate exchange rate fluctuations. They maintained exchange rates within a narrow band by changing foreign exchange reserves and the interest rate. As a result, foreign exchange reserves and the interest rate fluctuated widely while the exchange rate did not.

After the crisis, all three central banks have been less reluctant to tolerate exchange rate fluctuations and have not intensively used foreign exchange reserves or the interest rate to control exchange rate fluctuations. As a result, the exchange rate has fluctuated more after the crisis than before the crisis, while foreign exchange reserves and the interest rate have fluctuated less after the crisis than before the crisis. These three countries then have far less "fear of floating" after the crisis.

Note that this evidence does not rule out the fact that these countries have responded to the exchange rate with foreign exchange reserves after the crisis. Specifically, the volatility of foreign exchange reserves in Thailand declined only

[5] The crisis period is defined by the starting date of the crisis and by movements of the monthly change in the exchange rate. The pre-crisis and post-crisis periods are defined as the periods before and after the crisis period. See the notes accompanying Table 2 for specific dates.

slightly. In fact, even after the crisis, Thailand has continued to intervene in the foreign exchange market in order to prevent excessive volatilities in the market, while letting the exchange rate be determined by market forces. Korea and the Philippines have also attempted to smooth exchange rate movements by foreign exchange intervention, albeit less aggressively after the crisis.

<Table 2: Volatility of Exchange Rate, Foreign Exchange Reserves, and Interest Rate>

	Korea		Thailand		Philippines	
	Pre-Crisis	Post-Crisis	Pre-Crisis	Post-Crisis	Pre-Crisis	Post-Crisis
Exchange Rate	0.70	2.18	0.46	1.95	2.21	2.28
Foreign Exchange Reserves	3.59	1.88	2.65	2.22	12.42	3.43
Interest Rate	1.07	0.60	1.39	0.75	1.46	0.89

(Note) Crisis periods are defined as November 1997–April 1998 for Korea, and as July 1997–April 1998 for Thailand and the Philippines. Pre-crisis and post-crisis periods are defined as before and after the crisis period for each country.

2.1.2. Asian Financial Crisis

The Asian financial crisis started in July 1997 in Thailand (see Figure 2). The Bank of Thailand (BOT) gave up its fixed exchange rate regime on July 2 and its exchange rate against the US dollar depreciated by about 20% by the end of the month. Subsequently, Banko Sentral ng Philipinas (BSP) gave up its de facto fixed exchange rate regime on July 11. The Philippines' peso, practically pegged against the US dollar since late 1995, declined substantially towards the end of August. The Bank of Korea (BOK) gave up its de facto peg against the US dollar in November and the Korean won plummeted by about 20% by the end of the month as investors linked Indonesian debtors to Korean creditors.

The response of the interest rate to the exchange rate is exceptional during the crisis period compared with the period before the crisis. The three central banks under devaluation (or depreciation) pressures of their exchange rates sharply raised the interest rate to defend their own currencies. The BOT began to raise the interest rate in early 1997 to defend its own currency. It continued to raise the interest rate, even after it was forced to devalue its own currency, the baht, in July. The BSP also raised the interest rate to defend its own currency, the peso, in the aftermath of the Thai baht devaluation.[6] However, the currency eventually depreciated by about 20% by the end of August. The BOK and the Korean won followed a similar path. During the crisis, the BOT raised the interest rate to 23% from the pre-crisis two year average of about 9%, the BSP to about 19% from about 12%, and the BOK to about 25% from about 12%.[7]

[6] BSP precipitously raised interest rates again in the fall of 2000 to counteract the rapid depreciation of the peso resulting from political instability.

[7] The interest rate in the Philippines is the 3-month T-Bill rate. The Overnight reverse repurchase rate (which is only available from January 1997) went up to about 26% after the crisis from about 10% before the crisis.

<Figure 2: Interest Rate and Exchange Rate>

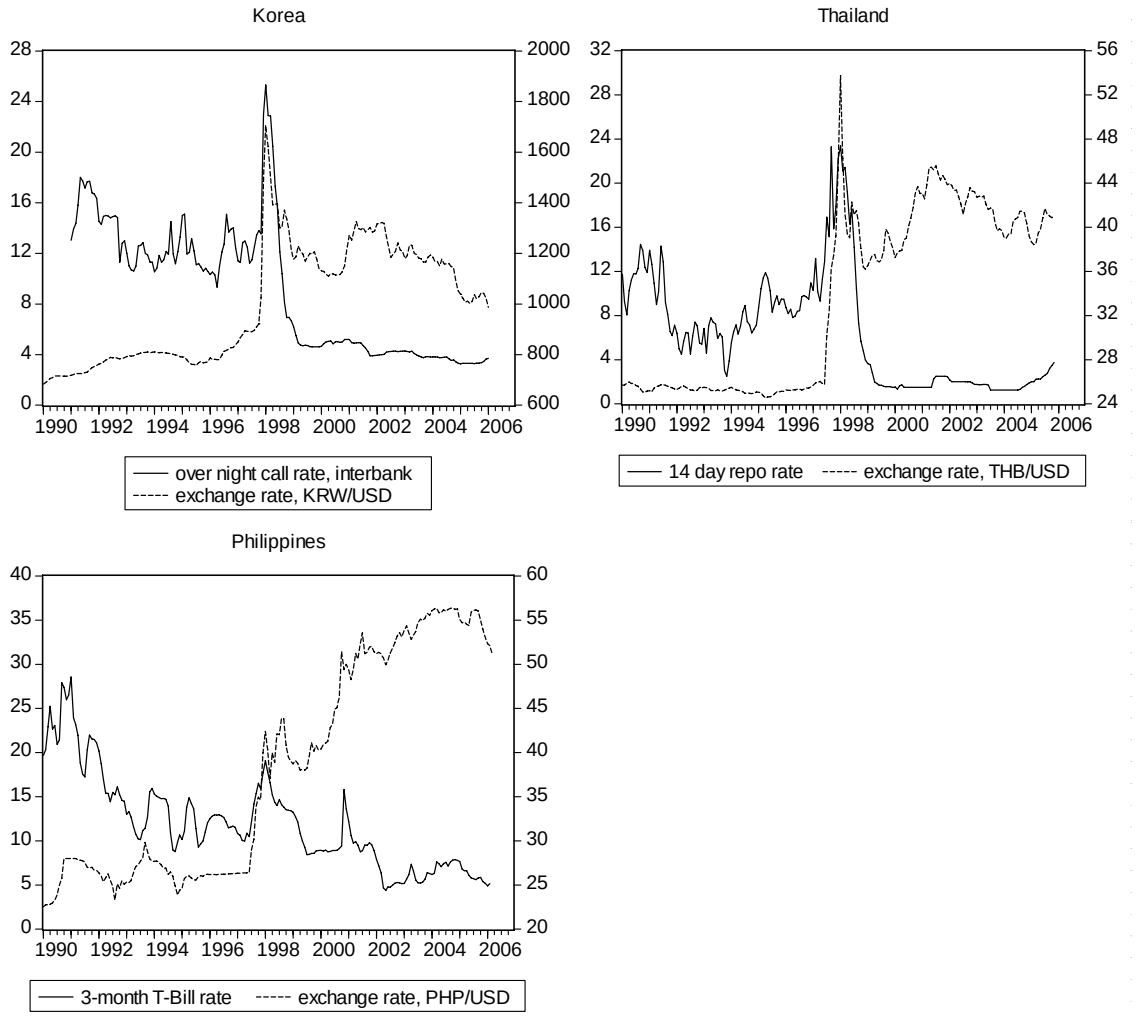


Table 3 presents the correlation coefficients between the monthly change in the interest rate and the monthly change in the exchange rate for sample periods before, during, and after the crisis. The correlation between the interest rate and the exchange rate for the full sample period since 1990 is fairly high at .59 for Korea. During the pre-crisis and the post-crisis periods, the correlation is weak at .13 and .08, respectively. The crisis period is high at .94, contributing to most of the strong correlation for the full sample. The case for Thailand and the Philippines is similar, albeit less strongly than is the case for Korea. Note that the correlation is weak, even before the crisis, for all three countries.[8] It is only during the crisis period that the

[8] The finding of no strong correlation during the pre-crisis period may appear at first counter-intuitive – while more stable exchange rates are naturally less correlated with more volatile interest rates – given the perception that these countries were reluctant to exchange rate fluctuations. The table below presents the correlation coefficients between the monthly change in the interest rate for these countries and the monthly change in the US Federal Funds rate. If these countries followed US monetary policy to limit exchange rate fluctuations, one would expect a strong correlation. The correlation is stronger for Thailand, which maintained a fixed exchange rate regime, and for the Philippines to a lesser extent, but not for Korea when compared with Table 3. This may indicate that Korea

correlation is strong.[9] The main reason for the strong correlation between the interest rate and the exchange rate in these three countries for the full sample is their efforts to defend their own currency during the crisis.

<Table 3: Correlation Coefficient between Interest Rate and Exchange Rate>

	Korea	Thailand	Philippines
Full Sample	0.59	0.34	0.11
Pre-Crisis	0.13	-0.15	0.03
Post-Crisis	0.08	0.30	-0.10
During Crisis	0.94	0.49	0.68

(Note) See Table 2 for the definitions on pre-crisis, during crisis, and post-crisis periods for each country.

2.2. Monetary Policy

The Asian financial crisis between 1997 and 1998 prompted these countries to alter their monetary policy regimes in addition to exchange rate policy regimes. All three East Asian countries adopted inflation-targeting regimes, after giving up monetary targeting regimes. Korea was the first Asian country to implement the new regime on April 1998, followed by Thailand on May 2000, and the Philippines on January 2002.[10]

Figure 3 depicts the time series of the interest rate and inflation for the three countries since 1990. Post-crisis adjustments were prolonged as inflation and the interest rate did not stabilize until the end of 1999 or even until the beginning of 2000 (see also Figure 2 for the exchange rate). In the aftermath of the crisis, Korea adopted an inflation-targeting regime in April 1998 to help stabilize inflation. Annual average target rates for headline CPI inflation were 9 ± 1% for 1998 and 3 ± 1% for 1999, but actual rates were 7.5% for 1998 and 0.8% for 1999. This prompted Korea to replace headline CPI with core CPI as the target in January 2000 to exclude the more volatile components of CPI. Since January 2000, core inflation rates have stabilized in the range of about 2–4%.[11]

Thailand and the Philippines completed post-crisis adjustments of inflation and the interest rate well before the adoption of an inflation target. Thailand's core inflation rate increased to a little above 10% during the peak of the crisis in mid 1998,

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responded to exchange rate fluctuations with foreign exchange reserves, but not with the interest rate. Indeed, the correlation between the exchange rate and foreign reserves is stronger for Korea (the correlation is –.33).

<Correlation with US Interest Rate>

	Korea	Thailand	Philippines
Full Sample	0.05	0.14	0.12
Pre-Crisis	0.05	0.23	0.15
Post-Crisis	0.07	0.11	0.10
During Crisis	0.25	0.28	0.57

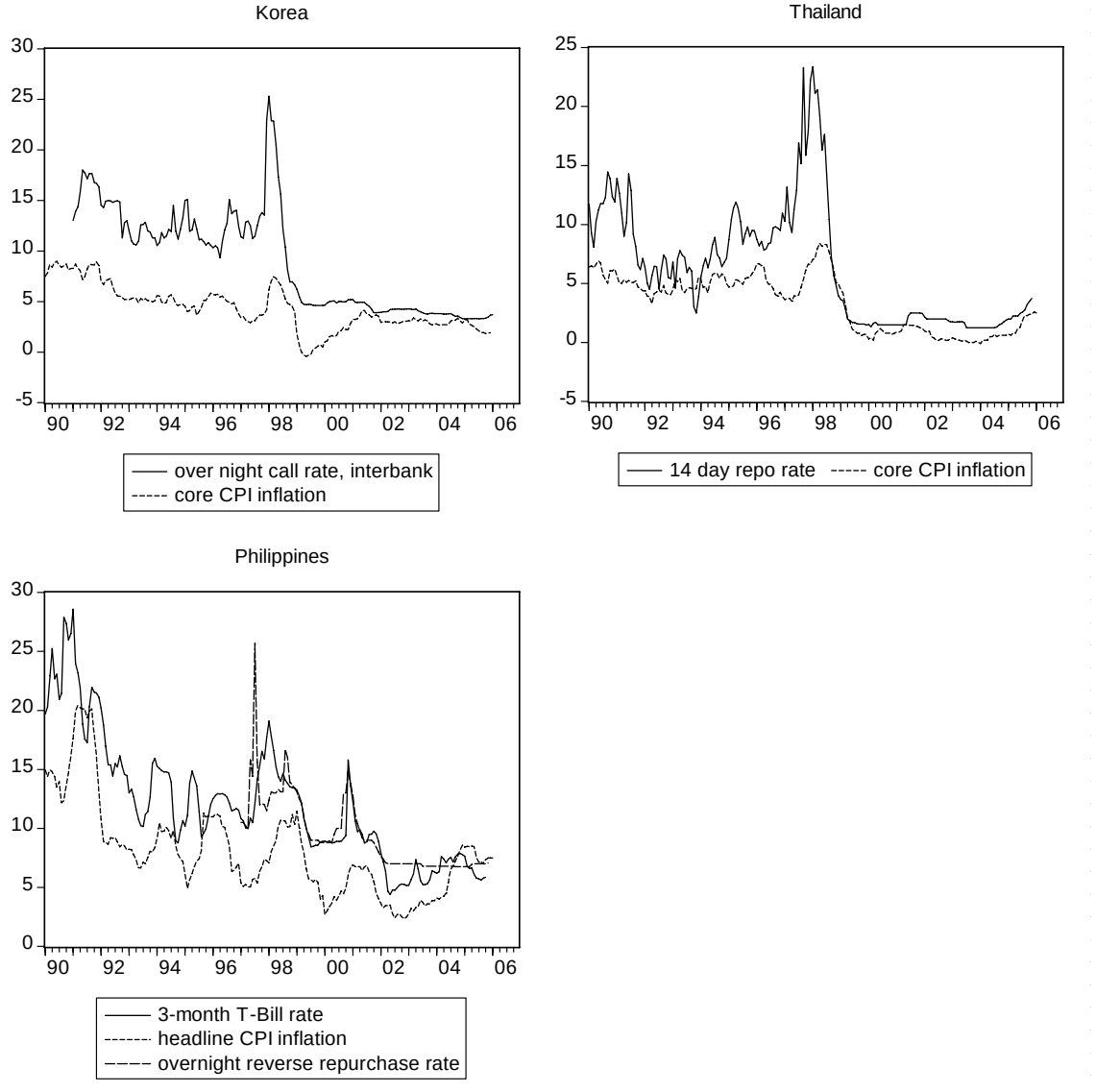
[9] Limiting the post-crisis sample to the post-inflation target sample, over which regression analyses estimate the monetary policy response in Section 3, reduces the correlation between the exchange rate and the interest rate. This strengthens the current paper's conclusions that the crisis sample overestimates the correlation.

[10] During the transition period between July 1997 and April 2000, Thailand maintained a monetary target after surrendering the fixed exchange rate regime.

[11] Korea's target inflation rates are: 2.5 ± 1% for 2000, 3 ± 1% for between 2001 and 2003, and 2.5–3.5% for between 2004 and 2006. Thailand's target inflation rates are 0–3.5% for the quarterly average. Philippines' target inflation rates are: 5–6% for 2002, 4.5–5.5% for 2003, and 4–5% for 2004 and 2005.

and then declined to around negative 1% in mid 1999. Since adoption of inflation target in May 2000, however, it has stabilized within the range of its target, 0–3.5%. Similarly to Thailand, the Philippines' inflation rate increased to a little above 10% during the crisis in the end of 1998, and then declined to a little below 3% in early 2000. Since the Philippines adopted its inflation target in January 2002, the inflation rate has stabilized relatively near its target range. Considering the dates when each country implemented its inflation-targeting regime, the sample period under the inflation-targeting regime overcomes the overestimation problem of the monetary policy response to the exchange rate.[12] On the other hand, examining the monetary policy response to the exchange rate for sample periods including the crisis between 1997 and 1998, as in most existing studies, overestimates the monetary policy response.

<Figure 3: Interest Rate and Inflation>



[12] The case of Korea may be problematic as the sample under its inflation-targeting regime starts from April 1998 when Korea was still experiencing the post-crisis adjustment. See footnote 20 for the implications for the empirical evidence.

3. Empirical Evidence

3.1. Open-Economy Monetary Policy Reaction Function

Following Mohanty and Klau (2005), this paper assumes that as a baseline specification of open-economy monetary policy reaction functions, a central bank targets a nominal interest rate in period t, i^*_t, which is a function of inflation deviation from its target, the output gap, and the exchange rate.[13]

(1) $i^*_t = a + bCPI_t + cGAP_t + d_1\Delta FX_t + d_2\Delta FX_{t-1}$

where CPI is inflation (the target level of inflation rate is assumed to be zero), GAP is the output gap, FX is the nominal exchange rate expressed as the domestic price of foreign currency (an increase in FX corresponds to a depreciation of domestic currency), and Δ denotes the difference from the previous period.[14]

The coefficients b and c provide the implications of the policy responses to inflation and the output gap, respectively. A parameter $c = 0$ indicates that a central bank is concerned about only inflation, but not about output fluctuations (d_1 and d_2 are also assumed to be zero). A parameter $b > 1$ indicates that a central bank attempts to stabilize inflation. On the other hand, $b < 1$ indicates that a central bank accommodates changes in inflation because an increase in the nominal rate, for example, is not sufficient to raise the real interest rate to fully offset increased inflation shocks. Analogously, $c > 0$ indicates output stability while $c < 0$ suggests instability.

Similarly, the coefficients d_1 and d_2 provide the implications of the policy responses to exchange rate movements. A parameter $d_1 > 0$ indicates that a central bank is concerned about exchange rate movements, and the monetary policy rule stabilizes movements, as a depreciation of the exchange rate requires an increase in the interest rate. An increase in the exchange rate (a depreciation of the domestic currency), raises inflationary pressures directly through imported goods prices and indirectly through aggregate demand (via net exports) by expenditure switching. A priori, the sign of a parameter d_2 can be positive or negative.

In practice, a central bank does not follow a simple policy rule such as that suggested by equation (1), but tends to gradually respond to deviations from the target.

(2) $i_t = q[i_{t-1}] + [1 - q]i^*_t + u_t$,

where the coefficient q ($\in [0,1]$) measures the smoothness of the policy interest rate, u_t is a zero-mean exogenous interest rate shock, and i^*_t, interest rate target, is given by equation (1).[15] With the partial adjustment equation (2), a central bank smoothes its policy rate over several periods. Combining equation (2) with equation (1) yields a baseline expression for an open-economy policy reaction function,

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[13] A widespread literature shows that this form of policy rule is optimal for central banks that face a quadratic loss function over deviations from target indicators. See, for example, Svensson (1997) and Clarida et al. (1999).

[14] Equation (1) is an open-economy version of Taylor's (1993) rule with the exchange rate included. For example, Ball (1999) derives this type of optimal monetary policy rule with a simple three-equation system. An open-economy IS curve, an open-economy Phillips curve and uncovered interest parity conditions comprise the system. Other studies, such as Svensson (2000), discuss similar reduced-form equations.

[15] q can be generalized to the j-th order polynomial where j is any positive integer.

(3) $i_t = \alpha + \beta CPI_t + \gamma GAP_t + \delta_1 \Delta FX_t + \delta_2 \Delta FX_{t-1} + q[i_{t-1}] + u_t$,

where $\alpha = a[1 - q]$, $\beta = b[1 - q]$, $\gamma = c[1 - q]$, $\delta_1 = d_1[1 - q]$, and $\delta_2 = d_2[1 - q]$.

This paper takes equation (3) as the baseline specification to compare with the empirical results of Mohanty and Klau (2005). However, incorporating the exchange rate into closed-economy monetary policy rules can take many different forms besides equation (3). Following Gerlach and Smets (2000), this paper considers an alternative and more general specification to assess the robustness of the empirical results:

(4) $\Delta i_t = \alpha + \beta CPI_t + \gamma GAP_t + \delta_1 \Delta FX_t + \delta_2 FX_{t-1} + q i_{t-1} + u_t$.

Equation (4) is a more unrestricted version of equation (3) as it incorporates the case where q = 1 in equation (3) and also considers levels, as well as changes, in the exchange rate.[16]

Some econometric issues need to be mentioned. First, this paper assumes that current inflation and the current output gap are predetermined as current monetary conditions affect inflation and output only with a lag. Second, since the current exchange rate is endogenous, Two Stage Least Squares (TSLS) estimates the reduced form equations. Following Gerlach and Smets (2000), the instrumental variable set includes current inflation, the current output gap, lagged exchange rate, lagged interest rate, the current US interest rate (Federal Funds rate), and a constant.[17] Third, the exchange rate is the domestic currency against the US dollar. Other measures of the exchange rate such as nominal effective exchange rates, real effective exchange rates and the exchange rate gap (deviations from its trend) yield similar results to those with the nominal exchange rate against the US dollar. Fourth, since the small sample size leaves only a small number of degrees of freedom, any empirical results require cautious interpretation.

3.2. Data

This paper's dataset comprises monthly data taken from the CEIC database. It uses monthly data to maximize the restricted sample period for the inflation-targeting regime. For each country, the annual percentage change in the consumer price index (CPI) measures inflation and an index of industrial production measures output. Inflation rates are core CPI for Korea and Thailand, and headline CPI for the Philippines as these also serve as their respective countries' targets.[18] The output gap is the log difference between actual output and trend output calculated by the HP filter. The log of the exchange rate is measured as domestic currency per US dollar. Interest rates comprise the policy instruments for the three countries. As policy instruments,

[16] Clarida et al. (1998) use a forward-looking version of the Taylor (1993) rule and expected inflation and output gap as the central bank's targets with a GMM (Generalized Method of Moments) estimation methodology. This paper does not use their methodology because of the limited sample size. In fact, the results from their specification are extremely sensitive to the choice of instrumental variables and sample period.

[17] The instrumental variable set does not include oil prices. Given that oil prices do not explain inflation movements due to administered energy prices in Thailand and the Philippines, the instrumental variable set does not include a variable to measure oil prices. Although Korea has less-restrictive administered energy prices, the inclusion of the variable does not substantially change the regression results.

[18] Replacing headline CPI inflation with CPI inflation (excluding the energy and food components) does not substantially change the regression results.

Korea uses the overnight call rate, Thailand the 14-day repurchase rate, and the Philippines the overnight reverse repurchase rate (RRP).[19] The starting point of the sample period is the date that each country adopted its inflation-targeting regime and the endpoint is the most recent data available. The sample periods for monthly data are then 1998:4–2006:2 for Korea, 2000:5–2006:2 for Thailand, and 2002:1–2006:1 for the Philippines.[20]

3.3. Empirical Results

Table 4 reports estimates of the interest rate rule parameters for the baseline specification of equation (3). The top panel in the table shows the regression results for sample under the inflation-targeting regime. Contrary to existing work, the coefficients for the exchange rate are not significant for all three countries. This is in accordance with the fact that none of the three central banks is explicit about responding to the exchange rate.

The lower panel in the table shows that the regression results for the sample including the crisis period starting in January 1996, captures the large movements in the interest rate and the exchange rate.[21] All three countries respond to the exchange rate. This indicates that inclusion of the crisis period overestimates the monetary policy response to the exchange rate. The results for Korea and Thailand show that the coefficients for the exchange rate are not significant using TSLS. However, they are significant with OLS (Ordinary Least Squares), an estimation method employed by most existing studies. This suggests that most existing studies using OLS are confronted with the problem of endogeneity.

<Table 4: Baseline Estimates>

Estimation Equation: $i(t) = \alpha + \beta*CPI(t) + \gamma*GAP(t) + \delta_1*\Delta FX(t) + \delta_2*\Delta FX(t-1) + q*i(t-1)$

(Inflation Targeting Regime: Estimation Method, TSLS)

		Constant α	CPI(t) β	GAP(t) γ	ΔFX(t) δ_1	ΔFX(t-1) δ_2	i(t-1) q	Adj R^2	S.E.	Sample
Korea	(1)	0.54	0.01	0.04	-0.05	0.00	0.85	0.99	0.27	1998:4-2006:2
		0.09	*0.02*	*0.01*	*0.07*	*0.02*	*0.02*			
Thailand	(2)	0.17	0.25	0.01	-0.11	0.01	0.82	0.93	0.19	2000:5-2006:2
		0.12	*0.07*	*0.01*	*0.07*	*0.02*	*0.09*			
Philippines	(3)	1.85	0.00	0.00	-0.09	0.01	0.74	0.76	0.11	2002:1-2006:1
		0.77	*0.01*	*0.01*	*0.10*	*0.03*	*0.10*			

[19] As an exception, the 3-month Treasury Bill (T-Bill) rate is used for the Philippines' estimation before the Asian financial crisis because the data series on RRP starts from January 1997. A missing observation for the T-Bill rate in December 2003 is remedied through interpolation.

[20] As noted in Section 2, Korea officially adopted an inflation-targeting regime in April 1998 with headline CPI serving as the inflationary target. BOK changed its target to core CPI in January 2000. This suggests that the sample period should be from January 2000. However, even with a sample period from January 2000, the exchange rate remains insignificant and the essential conclusions of this paper remain unchanged.

[21] The results are insensitive to the choice of starting date.

(Inclusion of Asian Finacial Crisis: sample period, 1996:1-2006:2)

		Constant α	CPI(t) β	GAP(t) γ	ΔFX(t) δ_1	ΔFX(t-1) δ_2	i(t-1) q	Adj R^2	S.E.	Estimation Method
Korea	(4)	0.05	0.07	0.07	0.08	0.06	0.95	0.97	0.85	TSLS
		0.14	*0.05*	*0.02*	*0.11*	*0.05*	*0.03*			
	(5)	0.04	0.08	0.06	0.18	0.02	0.95	0.98	0.98	OLS
		0.17	*0.06*	*0.02*	*0.06*	*0.02*	*0.03*			
Thailand	(6)	0.01	0.00	0.20	-0.62	0.16	1.02	0.70	3.11	TSLS
		0.40	*0.27*	*0.11*	*0.47*	*0.16*	*0.12*			
	(7)	0.07	0.00	0.07	0.19	-0.08	0.97	0.95	1.26	OLS
		0.16	*0.11*	*0.03*	*0.03*	*0.04*	*0.05*			
Philippines	(8)	0.15	0.11	0.01	0.24	0.15	0.88	0.93	0.92	TSLS
		0.28	*0.08*	*0.02*	*0.23*	*0.03*	*0.06*			
	(9)	0.23	0.06	0.02	0.06	0.15	0.92	0.95	0.75	OLS
		0.21	*0.04*	*0.02*	*0.02*	*0.02*	*0.03*			

(Note) Numbers in italic are standard errors of coefficient right above and shadow indicates a statistical significance level at 5%. Equations (8) and (9) use 3-month TB rate due to data availability for overnight repo rate.

Besides the monetary policy response to the exchange rate, only Thailand responds to inflation with an expected positive sign under the inflation-targeting regime. BOT raises the nominal interest rate as inflation rises. A long-term coefficient for the policy response is 1.39 (b = β/(1 – q) = .25/(1 – .82) > 1). BOT raises the real interest rate to stabilize inflation by raising the nominal interest rate more than the increase in inflation. On the other hand, BOT does not respond to the output gap.

While BOK does not respond to inflation, BOK positively responds to stabilize the output gap such that c > 0. BOK may be more concerned about output fluctuations than inflation under the inflation-targeting regime.[22] BSP does not respond to inflation or the output gap. Note, however, that the specifications without the exchange rate in Table 6 below yield a positive and significant coefficient for the output gap for both Thailand and the Philippines.

Table 5 reports estimates of an alternative specification, equation (4). The results are essentially the same as those of the baseline specification. No central bank responds to the exchange rate under the inflation-targeting regime except for Thailand.[23] Inclusion of the crisis period overestimates the monetary policy response to the exchange rate. BOT responds to inflation while BOK and BSP do not. BOK responds to the output gap while BSP does not respond to inflation or the output gap.

<Table 5: Alternative Estimates>

Estimation Equation: $\Delta i(t) = \alpha + \beta * CPI(t) + \gamma * GAP(t) + \delta_1 * \Delta FX(t) + \delta_2 * FX(t-1) + q * i(t-1)$

(Inflation Targeting Regime)

		Constant α	CPI(t) β	GAP(t) γ	ΔFX(t) δ_1	FX(t-1) δ_2	i(t-1) q	Adj R^2	S.E.	Sample
Korea	(1)	-1.85	0.00	0.04	-0.07	0.34	-0.15	0.80	0.28	1998:4-2006:2
		3.07	*0.03*	*0.01*	*0.04*	*0.44*	*0.01*			
Thailand	(2)	2.10	0.23	0.01	-0.08	-0.53	-0.15	0.02	0.15	2000:5-2006:2
		1.89	*0.06*	*0.01*	*0.03*	*0.50*	*0.07*			
Philippines	(3)	3.13	0.01	0.01	-0.03	-0.38	-0.24	0.35	0.08	2002:1-2006:1
		2.71	*0.01*	*0.00*	*0.04*	*0.57*	*0.08*			

[22] Note that no response to inflation does not necessarily imply the failure of the inflation-targeting regime. One can argue that BOK's adopting the regime may have induced inflation stability which made monetary policy response unnecessary. Statistically speaking, limited variations in inflation result in no response to inflation in Korea.

[23] In Thailand, the coefficients for the exchange rate are significant and negative. This is puzzling, but at the very least, monetary policy does not appear to respond to the exchange rate as suggested elsewhere.

(Inclusion of Asian Finacial Crisis: sample period, 1996:1-2006:2)

		Constant α	CPI(t) β	GAP(t) γ	ΔFX(t) δ_1	FX(t-1) δ_2	i(t-1) q	Adj R^2	S.E.	Estimation Method
Korea	(4)	-0.99	0.09	0.06	0.21	0.14	-0.05	0.57	0.77	TSLS
		3.97	*0.07*	*0.02*	*0.03*	*0.56*	*0.02*			
	(5)	-0.52	0.08	0.06	0.19	0.07	-0.05	0.57	0.77	OLS
		3.88	*0.07*	*0.02*	*0.02*	*0.54*	*0.02*			
Thailand	(6)	5.61	-0.12	0.07	-0.11	-1.49	0.01	-0.25	1.64	TSLS
		4.78	*0.18*	*0.06*	*0.14*	*1.28*	*0.07*			
	(7)	2.70	0.01	0.04	0.17	-0.70	-0.06	0.22	1.29	OLS
		3.61	*0.13*	*0.04*	*0.03*	*0.97*	*0.05*			
Philippines	(8)	2.24	0.01	0.03	0.05	-0.48	-0.06	0.06	0.86	TSLS
		1.64	*0.04*	*0.02*	*0.03*	*0.38*	*0.04*			
	(9)	2.24	0.01	0.03	0.05	-0.48	-0.06	0.06	0.86	OLS
		1.64	*0.04*	*0.02*	*0.03*	*0.38*	*0.04*			

(Note) Numbers in italic are standard errors of coefficient right above and shadow indicates a statistical significance level at 5%. Equations (8) and (9) use 3-month TB rate due to data availability for overnight repo rate.

Table 6 presents the regression results with a specification excluding the exchange rate.[24] This specification simplifies equation (4) by dropping variables whose coefficients are insignificant or inconsistent with their sign conditions. Compared with the results in the previous two tables, BOT and BSP respond to the output gap. While all three central banks respond to the output gap, only BOT responds to inflation.[25] Overall, compared with the results in Table 5, those in Table 6 indicate that excluding the exchange rate better describes three central banks' reaction functions as adjusted R^2s are higher. Specifically, Thailand's case is remarkable as the adjusted R^2 substantially rises from .02 to .27.[26]

<Table 6: Specifications without Exchange Rate>

Estimation Equation: $\Delta i(t) = \alpha + \beta * CPI(t) + \gamma * GAP(t) + q * i(t-1)$

(Inflation Targeting Regime: Estimation Method, OLS)

		Constant α	CPI(t) β	GAP(t) γ	i(t-1) q	Adj R^2	S.E.	Sample
Korea	(1)	0.52	0.01	0.04	-0.14	0.85	0.25	1998:4-2006:2
		0.07	*0.02*	*0.01*	*0.01*			
Thailand	(2)	-0.06	0.11	0.01		0.27	0.13	2000:5-2006:2
		0.02	*0.02*	*0.01*				
Philippines	(3)	1.18	0.01	0.01	-0.18	0.36	0.08	2002:1-2006:1
		0.33	*0.01*	*0.00*	*0.05*			

(Note) Numbers in italic are standard errors of coefficient right above and shadow indicates a statistical significance level at 5%.

[24] OLS estimates these specifications as current inflation and the current output gap are treated as predetermined. Estimation with TSLS yields similar results.

[25] The results for Thailand about the monetary policy response to inflation are robust in terms of the time horizon for expected inflation. Given that the BOT targets inflation about 2 years ahead, monetary policy tends to respond to expected, rather than current, inflation. The regression results with current inflation replaced by (ex post) expected inflation (for example, 12 months ahead) indicate that the BOT also responds to expected inflation. As an alternative interpretation, BOT responds to current headline inflation which may well forecast future core inflation.

[26] The adjusted R^2s are substantially higher for Korea than the other two countries in Tables 5 and 6. This probably reflects the fact that Korea's sample includes larger after-crisis movements.

4. Concluding Remarks

This paper estimates monetary policy reaction functions to investigate whether monetary policy responds to exchange rate movements under the inflation-targeting regimes in use in Korea, Thailand and the Philippines. Although the sample size is limited, the analysis focuses on the sample during the inflation-targeting regime to overcome instability in the estimated coefficients associated with structural breaks. The results indicate that all three countries do not react to exchange rate movements, contrary to the findings in existing work. It is argued that differences in the sample period contribute to the differences in the monetary policy response, as the inclusion of the Asian financial crisis period results in a stronger correlation between interest rates and the exchange rate.

The results contrast with the conventional wisdom reinforced by Calvo and Reinhart (2002) of a rigid exchange rate policy in emerging market economies. This paper argues that these countries have changed their rigid exchange rate policies to more flexible ones after the Asian financial crisis.[27] Since they respond less to the exchange rate, while using foreign exchange reserves and the interest rate less frequently to control exchange rate fluctuations, they have far less "fear of floating" in the post-crisis period.

One limitation of this paper's methodology is that it does not consider foreign exchange reserves as another instrument of monetary policy. One can argue that no monetary policy response to the exchange rate arises from the fact that central banks use foreign exchange reserves to control exchange rate movements instead of the interest rate. No matter how much the exchange rate fluctuates, the interest rate does not have to respond if foreign exchange reserves do. If foreign exchange reserves do respond, but the interest rate does not, no correlation between the exchange rate and the interest rate is observed in the regression analysis. In fact, following the literature on monetary policy rules, this paper's regression analysis does not consider foreign exchange reserves as yet another monetary policy instrument, rather focusing on interest rates. One approach to incorporating both the interest rate and foreign exchange reserves is to estimate monetary policy responses in VARs.[28]

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[27] Whether Amato–Gerlach's criteria do not apply to the East Asian countries in question during the inflation-targeting regime is beyond the scope of this paper. According to Amato and Gerlach (2002), emerging market economies tend to respond to the exchange rate for the following reasons. First, these countries face excessively volatile exchange rates due to underdeveloped foreign exchange markets. Second, a high degree of exchange rate pass-through results in higher inflationary pressures. Third, the large effects of exchange rate fluctuations cause sectoral imbalances in corporate profits. Fourth, high dependence on foreign currency loans leads to large balance sheet effects.

[28] See, for example, Kim (2003).

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