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Preliminary report

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Does Inflation Targeting Work in Emerging East-Asian Economies?

Summary: This paper evaluates on the performance of the inflation-targeting regime in three emerging East-Asian economies that have experienced changes in monetary policy regimes, from rigidities to a flexible exchange rate and inflation targeting, after the financial crisis of 1997-98. In particular, the evaluation focuses on the inter-relationship between inflation and the output growth/gap in these emerging economies between the pre- and post-inflation-targeting periods. A bivariate GARCH (1,1) model is applied. The results reveal lower variability in inflation and output growth after the implementation of the inflation targeting regime. The persistency of inflation and output also decline. The study finds no evidence of greater disinflation cost experienced in these economies after the implementation of the inflation-targeting regime. Overall, the results imply that inflation targeting works well in these emerging markets.

Key words: Disinflation cost, Inflation targeting, Macroeconomics, Trade-off, Monetary policy.

JEL: E52, N10.

Inflation targeting has gained popularity around the world since its implementation in the early 1990s. A growing number of countries, especially emerging countries, implement this regime implying a greater concern of central banks over price stability, low inflation, and sustainability in growth. Lessons from the international experiences suggest that the preconditions for the success of inflation targeting are central bank independence and exchange rate flexibility, political commitment and the institutional set-up and economic structure (Ferya Kadioğlu, Nilufer Özdemir, and Gokhan Yilmaz 2000). Many emerging countries are lack of these preconditions for a proper implementation of the inflation targeting regime. Therefore, it is argued that emerging countries face a greater challenge in achieving inflation targets compared with developed countries.

Can the inflation targeting regime work well in emerging East-Asia under exchange rate stability objectives? Is there any trade-off relationship between inflation and output variables? This paper seeks to answer the above questions. The paper, in particular has two main objectives: (1) to evaluate the performance of inflation targeting regimes in emerging countries, and (2) to investigate the relationship between inflation and output variables. The analysis focuses on three inflation-targeting East-Asian countries. These countries were selected because their monetary policy regimes have gone through extreme big switching following the financial crisis of 1997-98 from a rigid exchange rate to a flexible exchange rate and inflation targeting. The change in the monetary policy regime and the impacts on these economies constitute an interesting topic. This study seeks to find out if inflation targeting can

work well in emerging markets and what the impacts of inflation targeting are on the macroeconomic variables in these countries, the objective being to evaluate the effectiveness of the inflation-targeting regime in these markets. Furthermore, this study contributes to the extent of monetary policy analysis in two ways. First, a GARCH model is used to analyze the causal relationship of output-inflation variability in the emerging markets context in which large changes are experienced, from a rigid exchange rate to the flexible one and inflation targeting. Second, the analysis is divided into pre- and post-inflation-targeting periods (pre-IT and post-IT, respectively), towards determining if the causal relationship of output-inflation variability changes between the two different regimes.

Our results show that the variability and persistency in both output and inflation in these economies declined after the implementation of the inflation-targeting regime. The conditional variance approach also reveals no significant causal correlation between inflation and output variability in the pre-IT and post-IT periods. Implementation of the inflation targeting regime also does not induce disinflation cost, i.e. a lower inflation rate does not lead to lower output growth after the implementation of the inflation-targeting regime. Overall, the results imply the effectiveness of the inflation-targeting regime in these emerging markets.

1. Literature Review

In general, empirical studies on the effect of inflation targeting can be divided into two main groups. The first group reports no statistical difference in performance due to inflation targeting (e.g. Stephen Cecchetti and Michael Ehrmann 2000; Yuzo Honda 2000; Hakan Berument and Ebru Yuksel 2006). The second group reports an opposite result, in which inflation targeting does lead to a structural change/break in the inflation path (e.g. Chan Huh 1996; Frederic S. Mishkin and Adam S. Posen 1997; Carlos J. T. Garcia 2000).

The approaches and methods applied are different as well. In general, previous studies on the performance of inflation-targeting can be divided into two main groups. The first group applies econometric techniques/models to analyze the dynamics/performance of inflation targeting such as value-at-risk, autoregressive and generalized autoregressive conditional heteroskedasticity (GARCH) models. Applying the system equation of the value-at-risk model, some authors attempt to investigate if the adoption of inflation targeting leads to a structural change in inflation and interest rates (e.g. Huh 1996; Ben S. Bernanke et al. 1999; Honda 2000). The second group evaluates the performance of inflation targeting through disinflation cost and observations on country-specific data. Some authors evaluate the effect of inflation targeting by looking at it from the aspect of disinflation cost, the so-called sacrifice ratio. Studies that evaluate the effect of inflation targeting using the sacrifice ratio include Carlos Eduardo Soares Goncalves and Alexandre Carvalho (2006), Takashi Senda and Julie K. Smith (2008), Demet Tunali (2008).

Overall, empirical studies on the effect of inflation targeting imply that improves the performance of the economy. However, a small number of studies show an insignificant effect of inflation targeting. The effectiveness of the impact of inflation targeting may vary across countries and dimensions, and over time (Carlos

Capistrán and Manuel Ramos-Francia 2007). The type of economy or the structure of economy and the credibility of the central bank do contribute to the different outcomes of this regime. For example, Arminio Fraga, Ilan Goldfajn, and André Minella (2003) find that developed countries perform better than emerging market economies with output, inflation, interest rate and exchange rate being more volatile in the latter countries. In addition, the exchange rate, (Michael Bleaney 2000; Menachem Brenner and Meir Sokoler 2006) and the type of shock (demand or supply) (Ching-chong Lai and Juin-jen Chang 2001) can also matter in determining the effect of inflation targeting. John H. Green (1996) also cautions on the cyclical factor effect in his study of inflation targeting in industrial countries.

2. Methodology

To evaluate the performance of the inflation targeting regime in terms of policy gains, this investigation focuses on revealing the trade-off relationship between inflation and output. For the purpose of analysis, a bivariate GARCH (1,1) model is applied. The GARCH specification measures public perception inflation variability rather than the variance itself (Berument and Yuksel 2006). A lower variability in inflation implies the effectiveness of the inflation-targeting regime. Although ARCH and GARCH models are used to analyze high frequency financial data, they are also commonly used to analyze the dynamic of economic volatilities and uncertainties such as exchange rate and inflation uncertainties. Among the studies that apply GARCH-type specifications to model inflation and inflation uncertainty are Alexandros Kontonikas (2004), Menelaos Karanasos and Jinki Kim (2005), Hassan Heidari and Sahar Bashiri (2010), Komain Jiranyakul and Timothy P. Opiela (2010). In this study, our main focus is on the relationship between inflation and output variability. Therefore, a bivariate GARCH specification is applied. The model can be represented in the following equation:

$$\begin{aligned} y_t &= \mu + \varepsilon_t, \\ \varepsilon_t &\sim N(0, H_t) \end{aligned} \tag{1}$$

where $y_t \equiv [\pi_t, Y_t]$, $\varepsilon_t \equiv [\varepsilon_\pi, \varepsilon_Y]'$ μ is the 2x1 vector of constants, and H_t denotes the 2x2 time-varying conditional variance-covariance matrix.

Following Robert F. Engle and Kenneth F. Kroner (1995), H_t follows the BEKK representation and is parameterized as

$$H_t = CC' + A\varepsilon_{t-1}\varepsilon_{t-1}'A' + BH_{t-1}B', \tag{2}$$

where C denotes the 2x2 upper triangular matrix with intercept parameters and A and B are 2x2 matrices of parameters, i.e.,

$$C = \begin{bmatrix} c_{\pi\pi} & c_{\pi Y} \\ 0 & c_{YY} \end{bmatrix}, \; A = \begin{bmatrix} \alpha_{\pi\pi} & \alpha_{\pi Y} \\ \alpha_{Y\pi} & \alpha_{YY} \end{bmatrix}, \; B = \begin{bmatrix} \beta_{\pi\pi} & \beta_{\pi Y} \\ \beta_{Y\pi} & \beta_{YY} \end{bmatrix}.$$

To get a plausible multivariate GARCH model, H_t should be positive definite. To assure this requirement, C is identified to be upper triangular.

The parameters of estimates are obtained using the quasi-maximum likelihood procedure of Tim Bollerslev and Jeffrey M. Wooldridge (1992). The term $\{\varepsilon_t\}$ is said to have covariance stationarity if and only if the modulus of all eigenvalues of $A \otimes A + B \otimes B$ are less than unity (Karanasos and Kim 2005). The (quasi) log likelihood function of the multivariate GARCH model is (Helmut Herwartz 2004):

$$\log\left(f\left(\varepsilon\left|\Omega_{t-1}\right.\right)\right)\Sigma = -\frac{K}{2}\log\left(2\pi\right) - \frac{1}{2}\log\left|\Sigma_t\right| - \frac{1}{2}\varepsilon_t^{'}\Sigma_t^{-1}\varepsilon_t . \tag{3}$$

The GARCH model provides analysis on the persistency of shocks, the correlation between real and nominal uncertainty, and the impacts of uncertainty of one variance on the conditional variance of another variance.

3. Results and Discussion

This study is based on three economies that have adopted inflation-targeting economies in Asia, namely, Korea, the Philippines, and Thailand. The data are obtained from the International Financial Statistics of the International Monetary Fund (IMF). The dataset includes the monthly consumer price index (CPI) and the monthly industrial production index (IPI). These data are used to construct the two variables of the GARCH model, i.e., inflation (π) and the output variable (Y). Following previous studies that use an annualized inflation rate, e.g. Philip Arestis, Guglielmo Maria Caporale, and Andrea Cipollini (2002), the inflation is defined to be the log current CPI deviates from its log 12$^{\text{th}}$ lagged, i.e., $\pi_t = \log CPI_t - \log CPI_{t-12}$, which is the annualized inflation rate. Since data for GDP are not available, the output gap is constructed based on IPI data of IPI data and is defined as the log difference of IPI from its HP-filtered trend series, i.e. $\log IPI_t - \log IPI_t^{HP}$. The data start from 1980M9, 1985M1 and 1987M1 to 2010M6 for Korea, the Philippines, and Thailand, respectively. For purposes of comparing and evaluating on the inflation-targeting regime, the data are divided into two sub-periods: the pre-IT and post-IT. These countries started implementing the inflation-targeting regime at different times. Korea took the first initiative to implement the inflation-targeting regime in April 1998, followed by Thailand in May 2000, and the Philippines in January 2002. Therefore, the pre-IT period will be 1990M1 until the last month before the implementation of inflation-targeting, and the post-IT period will be the date of the beginning of inflation-targeting to 2010M6.

The discussions of the results can be divided into two parts: i.e. observations from country-specific data and estimation results from the GARCH (1,1) model.

Table 1 Descriptive Statistics (Mean Values)

Parameter	Pre-IT		
	Korea	Philippines	Thailand
Dex	0.007988	0.005756	0.003161
Gap	0.003380	-0.00118	-0.002422
I	13.8384	13.3689	9.3006
Logcpi	4.1698	4.3027	4.2082
Logex	6.6939	3.4441	3.3498
Logy	3.7307	4.1765	4.2819
pi	0.06013	0.0829	0.0470

Parameter	Post-IT		
	Korea	Philippines	Thailand
Dex	-0.001397	-0.00105	-0.001312
Gap	-0.005	-0.007337	-0.000578
I	4.5706	6.5478	2.316885
Logcpi	4.5680	4.8972	4.54115
Logex	7.0387	3.9198	3.6501
Logy	4.5011	4.8978	4.9869
pi	0.0309	0.0501	0.0250

Notes: Dex denotes the change in the nominal exchange rate; Gap is the output gap; I is the interest rate; Logcpi is the consumer price index in logarithms; Logex is the nominal exchange rate in logarithms; Logy is the industrial production index in logarithms; and pi is the inflation rate.

Source: Authors' estimations.

Based on country specific data as summarized in the descriptive table, the inflation rate and the interest rate for these three economies declined after the adoption of inflation-targeting. On the other hand, output growth increased between the two sub-periods. Moreover, the exchange rate fluctuated more under the inflation-targeting regime. The result is reasonable, as inflation-targeting cannot co-exist with a fixed exchange rate regime and inflation-targeting should be implemented under a flexible exchange rate regime. Comparisons of the macroeconomic variables between the two sub-periods in these economies also reveal that the exchange rate tended to appreciate in the post-IT period. In general, the dataset shows improvement in the macroeconomics, i.e. lower inflation rate and interest rate. However, is the improvement in inflation rate associated with higher cost? Or is there a trade-off relationship between inflation and output?

Apart from the observation and analysis based on country specific data, the performance of inflation-targeting regime can be evaluated using a bivariate GARCH (1,1) model. Table 2(a) summarizes the estimated results of the bivariate GARCH (1,1) model. By comparing the results between the two sub-periods, the performance of inflation-targeting across countries and over time may be evaluated.

C is the mean levels of the conditional variances, i.e. c_{11} and c_{22} are the means conditional variances of inflation and the output variable, respectively; c_{21} is their mean covariance. The results show that the mean of the conditional variance of inflation is larger than that of the output variable in the pre-IT period for all countries considered in the analysis. This condition holds after the implementation of inflation-targeting in the Philippines and Thailand, with lower values in both c_{11} and c_{22}. In the case of Korea, however, c_{22} is larger than c_{11} in the post-inflation-targeting pe-

riod. The results imply an improvement in terms of lower variance in inflation, relative to that in the output variable, after the implementation of inflation-targeting regime in these economies. Indeed, the variance in the output variable is even greater than the variance in inflation in the post-inflation-targeting period. On the other hand, the mean of conditional covariance of inflation and the output variable is not significant in all cases.

A indicates the correlation between the conditional variance of inflation and the output variable with their past squared errors. The off-diagonal elements show the impacts of the past information/squared error of one variable on the conditional variance of another variable. The results show that the past information on inflation has a larger impact on the conditional variance of inflation than it has on the conditional variance of the output variable. On the other hand, the past information on the output variable has a larger impact on the increment of output than it has on the increment of inflation. This result holds in all cases (in all countries and in the two sub-periods). Apart from this, the past information of inflation (output variable) on the conditional variance of the output variable (inflation) is not statistically significant in all cases except in the post-IT case in Korea. In that case, the results reveal a negative significant impact of the past output information on inflation.

B shows the link/correlation between the current conditional variance of variables and their past conditional variances. The diagonal elements can be interpreted as the persistency in the conditional variance. The off-diagonal elements indicate how the conditional variance of one variable is correlated with the past conditional variance of another variable. The results show that the output variable is more persistent than inflation in all cases for both sub-periods. On the other hand, a comparison of the results of the pre-IT the post-IT periods shows that the persistency for inflation and the output variable declines a lot in the post-IT period in Korea and declines slightly in the case of the Philippines. The results imply the improvement in inflation and output variable after the implementation of the inflation-targeting regime in these economies.

Overall, the three inflation-targeting economies exhibit quite similar results. First, the variance of inflation is larger than the output variable in both pre-IT and post-IT periods but both variances declined in the post-inflation-targeting period. Second, output is more persistent than inflation. There is evidence of the decline of persistency in both variables in the post-inflation-targeting periods. Finally, there is no significant correlation (or trade-off) between inflation and the output variable.

Table 2(a) Estimation of GARCH Using Pre-IT Data

Parameter	Pre-IT		
	Korea	Philippines	Thailand
$c_{\pi\pi}$	0.0187	0.0237	0.0295
	(0.9991)	(1.0010)	(1.6727)
$c_{\pi y}$	0.0041	0.0033	0.0248
	(0.1741)	(-0.0691)	(0.3262)
c_{yy}	0.0004	0.0008	0.00004
	(0.0014)	(0.0021)	(0.0000)
$\alpha_{\pi\pi}$	0.3367	0.3580	0.6813
	(0.6804)	(1.9108)	(0.9219)
$\alpha_{\pi y}$	-0.0188	0.0151	-0.0057
	(-0.1719)	(0.1682)	(-0.0182)
$\alpha_{y\pi}$	-0.0022	0.0014	0.0075
	(-0.0037)	(0.0035)	(0.0240)
α_{yy}	0.1890	0.1585	0.1544
	(0.9229)	(1.1724)	(1.0986)
$\beta^1_{\pi\pi}$	0.8972	0.8843	0.4968
	(3.9795)	(6.9326)	(0.4527)
$\beta^1_{\pi y}$	0.02256	-0.0220	-0.1497
	(0.3623)	(-0.4193)	(-0.4245)
$\beta^1_{y\pi}$	-0.0627	0.0251	-0.1417
	(-0.1705)	(0.0794)	(-0.1999)
β^1_{yy}	0.9730	0.9848	0.8989
	(8.6431)	(14.5950)	(4.3045)
log likelihood	358.5430	381.1350	380.9050

Source: Authors' estimations.

Table 2(b) Estimation of GARCH Using Post-IT Data

Parameter	Post-IT		
	Korea	Philippines	Thailand
$c_{\pi\pi}$	0.0068	0.0227	0.0133
	(3.1291)	(1.4758)	(2.0828)
$c_{\pi y}$	0.0057	-0.0196	-0.0180
	(0.8540)	(-0.8204)	(-0.4298)
c_{yy}	0.01286	0.0005	0.0014
	(2.7200)	(0.0006)	(0.0028)
$\alpha_{\pi\pi}$	0.9432	0.7642	0.6795
	(6.5114)	(2.0470)	(1.7017)
$\alpha_{\pi y}$	-0.2035	0.0191	-0.0275
	(-2.4970)	(0.1266)	(-0.0921)
$\alpha_{y\pi}$	-0.0138	-0.0381	-0.0176
	(-0.4961)	(-0.2079)	(-0.1184)

α_{yy}	0.7257	0.2285	0.1798
	(6.2204)	(2.0684)	(1.7221)
$\beta^1_{\pi\pi}$	0.2514	0.4355	0.5856
	(2.3428)	(1.0667)	(1.4024)
$\beta^1_{\pi y}$	0.2753	0.15119	0.1892
	(2.8062)	(0.8610)	(0.4927)
$\beta^1_{y\pi}$	0.0180	0.0576	0.0873
	(0.3167)	(0.3600)	(0.4302)
β^1_{yy}	0.5480	0.9107	0.9257
	(5.1459)	(9.6865)	(9.3520)
log likelihood	642.9330	311.4070	458.5030

Source: Authors' estimations.

4. Conclusion

Focusing on three emerging East-Asian countries, this paper presents an empirical analysis of the performance of the inflation-targeting regime adopted in these emerging economies after the financial crisis of 1997-98. A bivariate GARCH (1,1) model is applied. This approach makes it possible to compare on the performance of inflation between the pre-IT and post-IT periods on the one hand, and to investigate the inter-relationship between inflation and output growth on the other hand. The results reveal lower variability and persistency in inflation and output growth in the post-inflation-targeting period. No significant correlation was found between inflation and output growth between the two sub-periods. The results show no evidence of a greater disinflation cost experienced in these economies after the implementation of the inflation-targeting regime. Overall, the results show that inflation targeting works effectively in these emerging markets.

References

Arestis, Philip, Guglielmo Maria Caporale, and Andrea Cipollini. 2002. "Does Inflation Targeting Affect the Trade-Off Between Output Gap and Inflation Variability?" *The Manchester School*, 70(4): 528-545.

Bernanke, Ben S., Thomas Laubach, Frederic S. Mishkin, and Adam S. Posen. 1999. *Inflation Targeting: Lessons from the International Experience*. Princeton, N. J: Princeton University Press.

Berument, Hakan, and Ebru Yuksel. 2006. "Effects of Adopting Inflation Targeting Regimes on Inflation Variability." *Physica A*, 375(1): 265-273.

Bleaney, Michael. 2000. "Exchange Rate Regimes and Inflation Persistence." *IMF Staff Papers,* 47(3): 387-402.

Bollerslev, Tim, and Jeffrey M. Wooldridge. 1992. "Quasi Maximum Likelihood Estimation of Dynamic Models with Time Varying Covariance." *Econometric Review*, 11: 143-172.

Brenner, Menachem, and Meir Sokoler. 2006. "Inflation Targeting and Exchange Rate Regimes, Evidence From the Financial Markets." *Review of Finance*, 14(2): 295-311.

Cecchetti, Stephen, and Michael Ehrmann. 2000. "Does Inflation Targeting Increase Output Volatility? An International Comparison of Policymakers' Preferences and Outcomes." Central Bank of Chile Working Paper 69.

Engle, Robert F., and Kenneth F. Kroner. 1995. "Multivariate Simultaneous Generalized ARCH." *Econometric Theory*, 11(1): 122-150.

Fraga, Arminio, Ilan Goldfajn, and André Minella. 2003. "Inflation Targeting in Emerging Market Economies." *NBER Macroeconomics Annual*, 18: 365-400.

Garcia, Carlos J. T. 2000. "Chilean Stabilization Policy during the 1990s." Unpublished.

Goncalves, Carlos Eduardo Soares, and Alexandre Carvalho. 2006. "Inflation Targeting Matters: Evidence from OECD Economies' Sacrifice Ratios." *Journal of Money, Credit and Banking,* 41(1): 233-243.

Green, John H. 1996. "Inflation Targeting: Theory and Policy Implications." *IMF Staff Papers*, 43(4): 779-795.

Heidari, Hassan, and Sahar Bashiri. 2010. "Inflation and Inflation Uncertainty in Iran: An Application of GARCH-In-Mean Model with FIML Method of Estimation." *International Journal of Business and Development Studies*, 2(1): 131-146.

Herwartz, Helmut. 2004. "Conditional Heteroskedasticity." In *Applied Time Series Econometrics*, ed. Helmut Lütkepohl and Markus Krätzig, 197-220. New York: Cambridge University Press.

Honda, Yuzo. 2000. "Some Tests on the Effects of Inflation Targeting in New Zealand, Canada and UK." *Journal of Economic Letters,* 66(1): 1-6.

Huh, Chan. 1996. "Some Evidence on the Efficacy of the UK Inflation Targeting Regime: An Out-Of-Sample Forecast Approach." The Federal Reserve Board International Finance Discussion Paper 565.

Jiranyakul, Komain, and Timothy P. Opiela. 2010. "Inflation and Inflation Uncertainty in the ASEAN-5 Economies." *Journal of Asian Economics*, 21(2): 105-112.

Kadioğlu, Ferya, Nilufer Özdemir, and Gokhan Yilmaz. 2000. "Inflation Targeting in Developing Countries." Central Bank of the Republic of Turkey Discussion Paper 0006.

Karanasos, Menelaos, and Jinki Kim. 2005. "The Inflation-Output Variability Relationship in the G3: A Bivariate GARCH (BEKK) Approach." *Risk Letters*, 1(2): 17-22.

Kontonikas, Alexandros. 2004. "Inflation and Inflation Uncertainty in The United Kingdom, Evidence from GARCH Modeling." *Economic Modeling*, 21(3): 521-543.

Lai, Ching-chong, and Juin-jen Chang. 2001. "A Note on Inflation Targeting." *The Journal of Economic Education*, 32(4): 369-380.

Mishkin, Frederic S., and Adam S. Posen. 1997. "Inflation Targeting: Lessons from Four Countries." *Economic Policy Review*, 3: 9-110.

Capistrán, Carlos, and Manuel Ramos-Francia. 2007. "Does Inflation Targeting Affect the Dispersion of Inflation Expectations?" Banco de México Working Paper 2007-11.

Senda, Takashi, and Julie K. Smith. 2008. "Inflation History and the Sacrifice Ratio: Episode-Specific Evidence." *Contemporary Economic Policy*, 26(3): 409-419.

Tunali, Demet. 2008. "Inflation and the Sacrifice Ratio: The Effect of Monetary Policy Design." http://www.econ.rutgers.edu/dmdocuments/Tunali_October08.pdf.