Evaluating the performance of inflation targeting regime in three Asian economies*

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ABSTRACT

We conduct empirical analysis in evaluating the performance of inflation targeting (IT) in three emerging East-Asian economies that have implemented this regime. These three economies are Korea, Philippines and Thailand. The performance of inflation targeting regime is evaluated by comparing the economic achievement and structure changed between the pre- and post- IT periods. In particular, evaluation is focused on the inter-relationship between inflation and output growth / gap in these emerging economies between the pre- and post-IT periods. The inflation rate and the change in the macroeconomic variables are observed through country specific data. A bivariate GARCH (1,1) model is applied to study the inter-relationship between inflation and output gap. The results also enable us to detect if IT regime induces disinflation cost by causing lower growth or higher output gap. We compare the results of GARCH with the results of structural VAR for robustness checking. Both analyses provide consistent results. We observe lower inflation rate in the post-IT period. However, there is no significant correlation between inflation and output gap and we find no evidence that lower inflation causes lower growth or higher output gap. Both output gap and inflation are determined mainly by their own impulses. Besides, output gap is more persistent than inflation. We conclude that IT regime has improved the economies of these countries.

Keywords: inflation targeting, trade-off, persistency of shock, emerging markets

JEL Classifications: C54, E58, E52

1. INTRODUCTION

Instability in price and hyper inflation are the problems faced by many countries in the world. High inflation can lead to financial instability and affect the economic performance as a whole. By targeting at price stability and low inflation, inflation targeting seeks to target on low inflationary environment and price expectation. This regime has gained its popularity due to many success cases. Many emerging markets start to adopt this regime. IMF reports (2005) 21 countries are inflation targeters in which 13 of them are emerging markets. In East-Asia

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alone, four of the emerging countries have adopted the inflation targeting after the financial crisis of 1997-98.

The implementation of inflation targeting in emerging markets is related to several issues. The main issues to be argued are: Is there a trade-off between inflation and output growth? Can IT be implemented successfully in emerging market? Can inflation targeting work well if there is an exchange rate intervention?

Literatures of international macroeconomics show that the closed and open economy models are of different structures (Monacelli, 2003). Hence the effectiveness of a policy rule can be different when applying in different economic contexts. Many studies show that exchange rate may play an important role in the monetary policy transmission in the open economy context, e.g. Ball, 1999; Senay, 2001 and Adolfson, 2007. A rise of a demand shock in the closed economy leads to the increase in the interest rate in which the change in the interest rate does not have impact on inflation. However, the increase in interest rate in the open economy may have impacts on inflation and output due to the response of exchange rate, i.e. exchange will appreciate. The appreciation in exchange rate may induce the trade-off between inflation and output variability (Sek, 2010). Due to this reason, it is argued that emerging markets may face the disinflation cost in terms of lower output growth when they reduce the inflation rate by implementing the IT regime.

Besides, there is always an argument on the performance of IT regime in the emerging markets. There are arguments that IT regime cannot work well in emerging markets as emerging markets lack the preconditions for a proper implementation of IT regime. According to Kadioğlu et. al (2000), the preconditions for the success of inflation targeting include central bank independence and exchange rate flexibility, political commitment, the institutional set-up and economic structure. The lack of these preconditions implies greater challenge for emerging markets to achieve the inflation target in compare to the developed countries. The study conducted by Cukierman, Webb, and Neyapti (1992) shows that developing economies including Korea, Philippines and Thailand have higher turnover rate of central bank governors, implying lower credibility of their central banks. Cukierman, Webb, and Neyapti (1992) also show that the index of legal independence for central banks is higher in developed economies than developing economies, indicating higher independence of central banks in developed economies. Besides, the economic structure in developing Asian countries also matter. These economies are very open in trade, financially not stable and are excessively influenced by the external impacts from advanced economies (see Sek, 2010). These unfavorable conditions make these economies face higher challenge to achieve the objective set under inflation targeting regime.

Apart from these factors, inflation targeting also has a close relationship with the exchange rate regime or flexibility in exchange rate. Exchange rate plays an important role in the open economy like East-Asia. Exchange rate acts as a transmission channel for the monetary policy and at the same time has great influences on the real economy. Excessive volatility in the exchange rate may be detrimental to trade and growth. Due to this reason, emerging countries tend to react to the exchange rate movements. The 'liability dollarization' also contributes to the intervention of central bank on exchange rate movements (Eichengreen & Hausmann, 2003 and Hausmann, et al., 2004). Reacting to inflation and exchange rate variability directly in the policy function may lead to the possibility of trade-off between the inflation variability and exchange rate variability. For instance, if the central bank expects that the inflation will increase, interest rates could be raised to tighten the price of tradable goods. Once the inflationary pressure is under control, interest rates could be lowered and the exchange rate depreciates. So the drop in inflation variability has led to the increase in the volatility of exchange rate. The exchange rate stability is not consistent with inflation targeting regime, since inflation targeting regime necessarily requires exchange rate flexibility (Debelle, 2000). According to Brenner & Sokoler (2006), the foreign exchange intervention policy cannot coexist with the inflation targeting as there is conflict between the two policies which may lead to the abandonment of one of these policies. Taguchi and Kato (2011) in their study on the evaluation of inflation targeting in several East- Asian economies reveals that the inflation responsive monetary rule in Philippines cannot be identified as Philippines adopted fixed exchange rate after the financial crisis in Asia. Their result implies that flexibility in exchange rate is a necessary condition to achieve effectiveness in inflation targeting regime.

On the other hand, there are contradictory opinions that intermediate regimes could be good for inflation targeting. The case studies of Chile and Israel demonstrate that exchange rate objectives can be accommodated within an inflation targeting regime (Debelle, 2000). Can inflation targeting regime work effectively in the emerging East-Asia that implements the exchange rate stability objectives? Does lower inflation cause lower output growth?

Tempting to answer these questions, this paper has two main objectives: (1) to compare the economic achievement between the pre- and post-IT periods; (2) to study the relationship between inflation and output variable in the pre- and post-IT periods. The analysis is focused on the three inflation targeting East-Asian economies of Korea, Philippines and Thailand.

2. LITERATURE REVIEW

Previous studies apply different techniques/ methods in evaluating the performance of inflation targeting (IT) regime. In studying the performance of monetary policy, one should also study the trade-off relationship between inflation and output. Therefore, this section first discusses the previous findings in evaluating the IT regime followed by a review on the study on the inflation-output variability trade-off.

2.1. The performance of inflation targeting regime

Previous studies on the performance of inflation targeting regime report different results. The first group of empirical studies reports no statistical improvement in the economies between pre- and post-IT or between the economies of IT countries and non-IT countries (for examples Honda, 2000; Ball & Sheridan, 2005; Berument & Yuksel, 2006 and Cecchetti & Ehrmann, 2000). The second group reports significant improvement as IT leads to improvement in the structure of economics and inflation path (for examples Pétursson, 2004; Garcia, 2000; Huh, 1996; Mishkin & Posen, 1997 and so on). These empirical studies investigate the effect of inflation targeting from different dimensions or aspects. The main aspects to be investigated include the average of inflation rate, the variability and persistency of inflation, the level of output growth, and the structure of macroeconomics in the pre- and post- inflation targeting periods. These macroeconomics variables include the pricing levels, the short-run and long-run interest rate and exchange rate.

Previous studies apply different approaches and methods in evaluating the performance of IT regime. The studies that apply system equation models (multivariate GARCH and VAR) seek to investigate if the adoption of inflation targeting leads to a structural change in the inflation and interest rate (for instance, Huh, 1996; Bernanke et.al, 1999 and Honda, 2000). These authors apply the dynamic out-of-sample forecast values approach in which the estimated model is used to predict the future values for the system variables and these predicted values are compared with the actual observed values. Significant differences between the forecast and actual values may indicate a change in the structure/ regime between the pre- and post-inflation targeting periods.

Apart from this, some authors apply single equation approach of AR, ARCH and GARCH models to model the inflation rate. As in the case of VAR model, the values prior to the period of inflation targeting are used to make predictions for the post- target period as indication on the effect of inflation targeting on inflation path (for instance, Garcia, 2000). Besides, the effect of inflation targeting on inflation can be investigated through the inclusion of dummy variables in the GARCH models (for example Berument & Yuksel, 2006). Others methods used to analyze the effect of inflation targeting include a non-parametric approach (the evolutionary spectral analysis) by Ftiti & Essaadi (2008), a difference-in difference estimator approach by Vega & Winkelried (2005), Ball & Sheridan (2005) and so on.

Apart from the evaluation on the performance of inflation, a group of studies seeks to evaluate the performance of IT through disinflation cost and observation on the country specific data. These authors construct indicators to measure the effect of inflation targeting. For instance, Pétursson (2004) observes the average inflation and output in the pre- and post- inflation targeting periods. Some authors evaluate the effect of inflation targeting by looking from the aspect of the cost of disinflation, the so-called sacrifice ratio (accumulated loss in output during the disinflations, i.e. the ratio of loss in output divided by the fall in inflation). The studies that evaluate the effect of inflation targeting using the sacrifice ratio include Goncalves & Carvalho, 2006; Tunali, 2008; Senda & Smith, 2008 and so on.

In general, previous findings show that the performance of IT varies across countries, dimensions and over time (as shown in Mishkin & Schmidt-Hebbel, 2007 and Ramos-Francia & Capistran, 2007). There are evidences that economic structure and credibility of central bank do contribute to the different outcome of IT regime. For example, Fraga, Goldfajn & Minella (2003) find that inflation targeting works well in developed economies than emerging market economies in terms of lower volatility in output, inflation, interest rate and exchange rate. Other factors determining the performance of IT regime include exchange rate (Brenner & Sokoler, 2006 and Bleaney, 2000) and type of shock (demand or supply, Lai & Chang, 2001).

3. THE MODEL AND METHODOLOGY

We apply two approaches of empirical analysis, the bivariate GARCH (1,1) model and the structural VAR of Blanchard-Quah (1989) identification. The first approach measures the inflation variability and persistency based on the perception of public while the second approach investigates the change in the economic structure and impacts of shocks through the results of short-run and long-run impact matrices.

3.1.Generalized Autoregressive Conditional Heteroskedasticity (GARCH)

In this paper, a bivariate GARCH (1,1) model is applied. GARCH enables analysis on the inter-relationship between and trade-off between inflation and output variable. Rather than evaluating the performance of inflation targeting based on the movement of inflation rate itself, we evaluate the performance of inflation based on the perception of the public on inflation variability using GARCH specification. Low variability in inflation can be interpreted as better performance of IT[1]. The GARCH model can be represented as follows:

$$y_t = \mu + \varepsilon_t \qquad \varepsilon_t | \Omega_{t-1} \sim N(0, H_t)$$

Where Ω_{t-1} is the past information to time *t*-1, μ denotes the 2x1 vector of constants while H_t is the 2x2 time-varying conditional variance-covariance matrix. In this study, H_t is mentioned in the BEKK representation as in Engle & Kroner (1995), i.e.:

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

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

$$C = \begin{bmatrix} c_{yy} & c_{y\pi} \\ 0 & c_{\pi\pi} \end{bmatrix}, \; A = \begin{bmatrix} \alpha_{yy} & \alpha_{y\pi} \\ \alpha_{\pi y} & \alpha_{\pi\pi} \end{bmatrix}, \; B = \begin{bmatrix} \beta_{yy} & \beta_{y\pi} \\ \beta_{\pi y} & \beta_{\pi\pi} \end{bmatrix}$$

H_t should be positive definite for the plausible multivariate GARCH model. One way to assure this requirement is to restrict matrix C to be upper triangular. The model is estimated using the exact quasi-maximum likelihood (QML) t-ratios as a product of the Gaussian likelihood function. Using the GARCH specification, the performance of IT is evaluated based on the coefficient matrices of C, A and B which provides analysis on the persistency of shocks, the intersection between real and nominal uncertainty and the effects of uncertainty induced by one variance on the conditional variance of another variance.

The parameter of C denotes the mean of conditional variances of π and Y and their covariance. The parameters in A demonstrate the correlations between conditional variances of π and Y and past squared errors. On the other hand, parameters in B depict the correlations between current conditional variances and the past conditional variances while the diagonal elements show the persistency of conditional variances (Lee, 1999).

3.2. Structural vector autogressive regression (SVAR)

The system equation of VAR consists of two variables, i.e.π_t (inflation) and y_t output gap. All the variables entered in the system equation are in stationary form. Δ indicates the first differenced operator. The VAR model can be written in the structural form as:

[1] Low variability can be interpreted as an achievement of IT, but high rates with low variability is also possible. The country stabilizing its inflation to [85,90] band after IT implementation should not be appreciated.

$$A_0 X_t = A_1 X_{t-1} + ... + A_q X_{t-q} + B\varepsilon_t$$

$$A_0 X_t = \sum_{i=1}^{q} A_k X_{t-i} + B\varepsilon_t \qquad i=1,\ldots, q \qquad (1)$$

$$X_t = [y_t \quad \pi_t]'$$

where X_t is a $(K \times 1)$; K=2 vector of endogenous variables; A_0 and B are the $(K \times K)$ matrices indicating instantaneous relationship of variables in X_t and ε_t respectively ; A_i's are $(K \times K)$ coefficient matrices (i=1,…., q) and ε_t is the $(K \times 1)$ vector of structural shocks. ε_t consists of two shocks, i.e. supply/ output shocks and demand/ inflation shocks.

$$\varepsilon_t = \left[\varepsilon_t^y \quad \varepsilon_t^\pi\right]'$$

ε_t is independently multivariate normal (IMN) distributed with mean zero, i.e.

$$E[\varepsilon_t] = 0,$$

$$\varepsilon_t \sim IMN(0, \Sigma)$$

$$E\left[\varepsilon_t \varepsilon_t^{'}\right] = I_K \text{ and } \det(\Sigma) \neq 0$$

The reduced form of the model is the product of multiplication of equation (1) by A_0^{-1} (see Breitung et al., 2004):

$$X_t = \bar{A}_1 X_{t-1} + ... + \bar{A}_q X_{t-q} + e_t \qquad (2)$$

where $\bar{A}_j = A_0^{-1} A_j$; (j=1,…, q). The relationship between the observable reduced form of disturbance e_t and unobservable structural shocks can be observed from the term $e_t = A_0^{-1} B\varepsilon_t$

The variance-covariance matrix can be derived as $E\left[e_t e_t^{'}\right] = A_0^{-1} BE(\varepsilon_t \varepsilon_t^{'}) B^{'} A_0^{-1}$. The Blanchard-Quah (1989) identification is used to identify the structural parameters. The long-run restrictions set A_0 to be identity matrix, i.e. $A_0 = I_K$ but imposes no restriction on B such that $e_t = B\varepsilon_t$. In order to analyze the impacts of orthogonal shocks, the long-run impact matrix is in lower triangular choleski decomposition. This means that the first shock has an instantaneous effect on all variables below it but it does not receive any impact from any variable, the second shock has impact from the first variable only but it can have influences on the variables below it. This rule applies to other subsequent variables in the system equation. In this paper, the output gap is ordered first before the inflation. Therefore, output gap can influence the inflation but not the other way. The long-run impact matrix can be written in the following form:

$$e_t = C(1)\varepsilon_t$$

$$\begin{pmatrix} e_t^y \\ e_t^\pi \end{pmatrix} = \begin{pmatrix} C(1)_{11} & 0 \\ C(1)_{21} & C(1)_{22} \end{pmatrix} \begin{pmatrix} \varepsilon_t^y \\ \varepsilon_t^\pi \end{pmatrix}$$

where $C(1) = \sum_{i=0}^{\infty} C_i$ and $C(1)$ is the long-run matrix of *C(L).*

4. DATA

For the purpose of analysis and comparison, we divide the data into two sub-periods, i.e. pre- and post-IT periods. The East-Asian economies have adopted inflation targeting regime at different time i.e. Korea has implemented it since April 1998, Philippines in January 2002 and Thailand in May 2000. Since these economies have implemented the IT regime during or after the financial crisis of 1997-98, the evaluation on the economic performance may be affected by the impact of crisis. Due to this reason, we exclude the periods of crisis (1997M7-1998M12) in the analysis and define the pre-IT as 1980's to 1997M6 and the post-IT as 1999M1 until 2010M6 for Korea but 2002M1-2010M6 and 2000M5-2010M6 for Philippines and Thailand respectively (see Table 1). The data used in the analysis consist of monthly consumer price index (CPI) and the monthly industrial production index (IP). All monthly data are collected from International Financial Statistics (IFS), IMF. We need to construct two variables to be included in the GARCH model, i.e. inflation (π) and output gap (Y). The inflation series is constructed in annualized rate using the CPI data, i.e. $\pi_t = \log CPI_t - \log CPI_{t-12}$. The output gap is constructed as the log difference of IP from its Hodrick-Prescott (HP) filtered trend series, i.e., $\log IP_t - \log IP_t^{HP}$. The data are ranging from 1980M1 to 2010M6. The two variables inflation and output gap entered in the GARCH model starts from 1980M9, 1985M1 and 1987M1 to 2010M6 for Korea, Philippines and Thailand respectively.

Table 1: Pre- and post-IT periods

Country	Pre- IT	Post-IT
Korea	1980M1-1997M6	1999M1 - 2010M6
Philippines	1981M1-1997M6	2002M1-2010M6
Thailand	1987M1-1997M6	2000M5-2010M6

5. RESULTS

Before discussing the results, we should compare the descriptive statistics for the two sub-periods data. Table 2 summarizes the descriptive statistics for output gap and inflation for the pre- and post-IT periods. It is observed that both output gap and inflation rate have declined after the implementation of IT in these economies with the exception of Philippines.

However, the standard deviation may not decline in all cases, implying that the decline in these variables does not mean lower volatility in these variables.

Table 2: Descriptive statistics

Pre-IT				
Country	**Output gap (index)**		**Inflation rate (%)**	
	Mean	**Standard deviation**	**Mean**	**Standard deviation**
Korea Philippines Thailand	0.0068 0.0017 0.0041	0.0305 0.0670 0.0658	4.6099 9.4016 5.7798	1.3028 4.0992 1.8559
Post-IT				
Parameter	**Output gap (index)**		**Inflation rate (%)**	
	Mean	**Standard deviation**	**Mean**	**Standard deviation**
Korea Philippines Thailand	0.0042 0.0032 0.0016	0.0484 0.0792 0.0574	2.2658 5.000 2.5000	2.1745 2.5100 2.1600

In Philippines, the mean of output gap and the standard deviation of output gap show slightly increase after the crisis. The data implies that output growth in Philippines becomes more volatile after the crisis and the deviation of actual output from the potential trend is larger. Although the inflation rate has improved (inflation has declined), the output gap is deteriorated after the implementation of inflation targeting[2].

5.1. Results – GARCH

The results of GARCH are summarized in Table 3(a) and 3(b). The results can be interpreted by observing the coefficient matrices of C , A and B .

[2] The reason behind this situation requires deeper investigation. According to Medalla and Jandoc (2008), Philippines shows quite different economic condition from other Asia economies in which domestic absorption, imports and exports move following the growth of GDP. They argue that the economic growth in Philippines has been overstated after the crisis period.

Table 3(a): Results of GARCH – pre-IT

Parameter	**Pre-IT**		
	Korea	**Philippines**	**Thailand**
c_{yy}	0.0122 (0.3234)	0.0280*** (5.8661)	0.0341*** (4.1223)
$c_{y\pi}$	0.0006 (0.2296)	-0.0386*** (-2.5989)	-0.0026 (-0.5449)
$c_{\pi\pi}$	0.0096*** (2.6932)	-0.0005*** (-2.8791)	-0.0017 (-0.9400)
α_{yy}	0.7263*** (14.6213)	0.3015*** (6.1597)	0.6819*** (6.6382)
$\alpha_{y\pi}$	0.0702* (1.8372)	-0.1767*** (-2.7507)	-0.0031 (-0.0839)
$\alpha_{\pi y}$	0.0022 (0.1195)	0.0241 (-0.0.8476)	0.2066*** (2.2489)
$\alpha_{\pi\pi}$	0.9039*** (14.1831)	0.5512*** (10.4929)	0.9816*** (41.0803)
β_{yy}	0.6764*** (16.9595)	0.8453*** (37.5118)	0.4979*** (2.5465)
$\beta_{y\pi}$	-0.1293** (-2.3277)	0.3148** (2.1980)	-0.1841*** (-5.1740)
$\beta_{\pi y}$	-0.0032 (-0.1222)	-0.0061 (-0.4063)	-0.2025 (-1.5323)
$\beta_{\pi\pi}$	0.4071*** (3.3528)	0.7153*** (22.5369)	-0.1857** (-2.2121)
log likelihood	829.820	355.773	411.078

Note: the values in brackets are the exact t-ratios

Table 3(b): Results of GARCH – post-IT

Parameter	**Post-IT**		
	Korea	**Philippines**	**Thailand**
c_{yy}	0.0169 (0.9511)	0.0172 *** (4.1444)	0.0150 (1.0846)
$c_{y\pi}$	0.0009 (0.0028)	-0.0247*** (-4.9281)	-0.0146** (-2.0560)
$c_{\pi\pi}$	0.0061 (0.2790)	-0.0009*** (-3.3345)	0.0006 (0.3428)
α_{yy}	0.7024*** (5.0719)	0.2317*** (6.1002)	0.1769 (0.1062)
$\alpha_{y\pi}$	-0.0299 (-0.1614)	-0.0448 (-0.5709)	-0.0233 (-0.0990)
$\alpha_{\pi y}$	-0.1016 (-1.2228)	-0.0754 (-0.7243)	0.0157 (0.0113)
$\alpha_{\pi\pi}$	0.9725*** (18.8459)	-0.7572 *** (-11.9037)	0.6645 (1.2374)
β_{yy}	0.4126 (0.3701)	0.9122*** (64.3205)	0.9357*** (47.2186)
$\beta_{y\pi}$	0.0554 (0.4208)	0.0683 (0.5780)	0.0916 (0.0745)
$\beta_{\pi y}$	0.2906 (0.4471)	0.0994 (0.7666)	0.0785 (0.0196)
$\beta_{\pi\pi}$	0.1877 (0656)	0.4382*** (6.9120)	0.6026 (0.9150)
log likelihood	614.934	311.490	457.888

Note: the values in brackets are the exact t-ratios

C consists of mean levels of the conditional variances or covariance. The diagonal coefficient, i.e. c_{11} and c_{22} show the means conditional variances of output gap and inflation respectively while the off diagonal coefficient c_{21} is their mean covariance. Based on the results, we observe that the coefficients of C are very small especially the mean conditional variance of inflation is nearly zero. The mean conditional variance of output gap has declined in all countries and the mean conditional variance of inflation remains low in the post-IT period.

A shows the correlation between the conditional variance of variables with their past squared errors. The off-diagonal elements show the how the past information/ squared error of one variable can affect the conditional variance of another variable. In this study, we observe that the conditional variance of output gap is correlated positively to its past squared errors. However, the correlation has declined in the post-IT periods in all countries. The conditional variance of inflation also links positively to its past information. The correlation has increased in Korea and Philippines but declines in Thailand after the implementation of IT regime. The off diagonal coefficient, i.e. the correlation of past information of inflation (output gap) on the conditional variance of output gap (inflation) is insignificant in the post-IT periods.

B indicates the relationship between current conditional variance of variables and their past conditional variances. The diagonal elements imply the persistency in the conditional variance. The off-diagonal elements indicate the correlation between the conditional variance of one variable and the past conditional variance of another variable. The results show that Korea experiences decline in the persistency of conditional variance of output gap and inflation. The contrasting condition happens in Thailand. On the other hand, Philippines experiences an increase in the persistency of conditional variance in output gap but a decline in that of inflation. We also observe that the persistency in output gap is larger than that of the inflation in all cases. Apart from this, the past conditional variance of inflation has significant correlation (positive of negative) with the conditional variance of output gap in all economies before the implementation of IT regime. $\beta_{y\pi}$ is significant and positive in the case of Philippines but negative in Korea and Thailand in the pre-IT period. The positive value is not preferred as it shows that an increase in the past conditional variance in output gap leads to higher conditional variance in inflation. The correlation becomes insignificant in the post-IT periods. We do not observe any trade-off relationship between the two variables after the implementation of IT in these economies.

5.2.Results – SVAR

In order to investigate the intersection between output gap and inflation and detect the change in the economic structure between the pre- and post-IT periods, we apply the structural VAR analysis. We refer to the Swartz Criterion in the selection of lag length. The model specification varies across countries in which we seek to apply different specification that fits the model better in each case (see Table 4(a)). Testing with multivariate ARCH-LM test reveals that the models do not exhibit autocorrelation problem (see Table 4(b)).

Table 4(a): Model specification

Country	**Pre-IT**	**Post-IT**
Korea	Constant, 5 lags	Constant, 4 lags
Philippines	Constant, 1 lag	Constant, 2 lags
Thailand	Constant, 1 lag	Constant, 6 lags

Table 4(b): Multivariate ARCH-LM test

Country	VARCHLM test	Pre-IT	Post-IT
Korea	Test statistic p-value	51.3581 0.2387	47.6044 0.3671
Philippines	Test statistic p-value	52.2104 0.2141	41.5322 0.6197
Thailand	Test statistic p-value	44.1118 0.5095	56.5676 0.1156

We do not compare the values of coefficients for the persistency and correlations of the two variables between GARCH and SVAR. This is because these two models apply different specifications (e.g. different lag length and identification) and different concept (GARCH interprets the variability and conditional variance of variables while SVAR interpret the impulses or impact of shocks on variables) which do not permit comparative comparisons. The comparisons are mainly on the change in the economic structures, direction of correlation and relationship between output gap and inflation in the pre- and post-IT periods.

We study the interactions between inflation and output gap from the contemporaneous impact and long-run impact matrices and the forecast error variance decomposition. Table 5(a) summarizes the results of contemporaneous impact matrix. The contemporaneous impact matrix provides information on the impacts of real and nominal shocks on output gap and inflation and implies the correlation and intersection between the two variables in the system equation in the short-run. The contemporaneous impact matrix indicates that both inflation and output gap are mainly determined by their own impulses as the diagonal coefficients of the contemporaneous impact matrix are highly significant in all cases. This result is consistent with the result shown in GARCH model. We also observe significant temporary impacts of real shock and nominal shock on inflation and output respectively in Korea (post-IT) and Philippines (pre-IT). However, the impacts are insignificant in the long-run as shown by the long-run impact matrix (see Table 5(b)). The long-run impact matrix in Table 5(b) summarizes the long-run impact of shocks on output gap and inflation between the two sub-periods. As in the case of contemporaneous impact matrix, both output gap and inflation are determined mainly by their own impulses in the long-run. Since no significant impact or interaction of shocks on inflation and output gap in the long-run, we could not detect any significant trade-off relationship between inflation and output gap after the implementation of inflation targeting in these economies. The results support the findings reported in GARCH model.

Table 5(a): Results of SVAR - Contemporaneous impact matrix

Country	**Contemporaneous impact matrix**	
	Pre-IT	**Post-IT**
Korea	$\begin{bmatrix} 0.0217^{***} & -0.0006 \\ 0.0001 & 0.0062^{***} \end{bmatrix}$	$\begin{bmatrix} 0.0147^{***} & 0.0194^{***} \\ -0.0031^{***} & 0.0024^{***} \end{bmatrix}$
Philippines	$\begin{bmatrix} 0.0493^{***} & -0.0215^{***} \\ 0.0066^{***} & 0.0107^{***} \end{bmatrix}$	$\begin{bmatrix} 0.0589^{***} & -0.0012 \\ 0.0003 & 0.0044^{***} \end{bmatrix}$
Thailand	$\begin{bmatrix} 0.0544^{***} & -0.0033 \\ 0.0004 & 0.0053^{***} \end{bmatrix}$	$\begin{bmatrix} 0.0446^{***} & -0.0020 \\ 0.0007 & 0.0068^{***} \end{bmatrix}$

Note: *** indicates the significance at 1% level; ** indicates the significance 5% level and * indicates the significance at 10% level

Table 5(b): Results of SVAR - Long-run impact matrix

Country	**Long-run impact matrix**	
	Pre-IT	**Post-IT**
Korea	$\begin{bmatrix} 0.1147^{***} & 0 \\ 0.0013 & 0.1190^{***} \end{bmatrix}$	$\begin{bmatrix} 0.0830^{***} & 0 \\ -0.0112 & 0.0220^{***} \end{bmatrix}$
Philippines	$\begin{bmatrix} 0.1402^{***} & 0 \\ 0.1000^{**} & 0.1198^{***} \end{bmatrix}$	$\begin{bmatrix} 0.1320^{***} & 0 \\ 0.0142 & 0.0717^{***} \end{bmatrix}$
Thailand	$\begin{bmatrix} 0.1242^{***} & 0 \\ -0.0006 & 0.0515^{***} \end{bmatrix}$	$\begin{bmatrix} 0.0609^{***} & 0 \\ 0.0192 & 0.0433^{***} \end{bmatrix}$

Note: *** indicates the significance at 1% level; ** indicates the significance 5% level and * indicates the significance at 10% level

Table 6: Forecast error variance decomposition (FEVD)

Country	**Period (month)**	**Pre-IT**		**Post-IT**	
		FEVD for output gap by real shock	**FEVD for inflation by nominal shock**	**FEVD for output gap by real shock**	**FEVD for inflation by nominal shock**
Korea	1	1.00	1.00	0.63	0.63
	12	0.97	0.98	0.61	0.42
Philippines	1	0.84	0.73	1.00	0.99
	12	0.86	0.62	0.88	0.97
Thailand	1	1.00	1.00	1.00	0.99
	12	1.00	1.00	0.76	0.84

Next, we turn to the forecast error variance decomposition, i.e. how the variance of a variable can be explained by its forecast error terms. Table 6 summarizes the results for the first and 12^{th} month. We observe that inflation and output gap are mainly explained well by their own error terms/ movements. In some cases, inflation and output gap can be explained 100% by their own movements, implying low interaction impacts of each shock on inflation and output gap. The same results hold after the implementation of inflation targeting regime. This result is as shown by the long-run impact matrix and the results reported in GARCH, i.e. small or insignificant interaction between inflation and output gap.

The coefficients for the diagonal long-run impact matrix become smaller in the post-IT period, implying smaller impulses and impacts of shocks (real/ output and nominal/ inflation shocks) in the post-IT period. The GARCH model also report smaller mean conditional variance of inflation and output gap in the post-IT period. These results imply improvement gained in the inflation and output gap after the implementation of inflation targeting regime in these economies.

5.3. Discussions

Applying a bivariate GARCH and SVAR models, we obtain three main findings. First, the persistency of output gap is higher than that in inflation rate and both persistency rates have changed in the two sub-periods. The persistency rates of output gap and inflation have declined in the post-IT period in Korea. In contrast, both persistency rates have increased in the post-IT periods in Thailand. Philippines experiences lower persistency in inflation rate after the implementation of IT regime. Second, both inflation and output gap are determined mainly by their own past information or impulses. Both inflation and output gap do not have significant impact on each other. The correlation is weak and insignificant especially in the post-IT periods. Third, we do not find trade-off relationship between inflation and output gap after the implementation of inflation targeting in these economies. Comparisons on the means of output gap and inflation rate between the two sub-periods reveal that both variables have decline after the implementation of IT. The results from both GARCH and SVAR models also imply lower volatility in inflation and output gap in the post-IT period.

Although both GARCH and SVAR models cannot accurately estimate the persistency rate and correlation between inflation and output gap, both approaches result consistent outcomes in terms of economic performance, structure change, direction and correlation of variables. Based on these findings, we conclude that IT regime work effectively in these three emerging market, i.e. the inflation rate and output gap have declined. Besides, there are evidences that the persistency rates of to these two variables have declined in the post-IT periods. The decline in inflation rate does not lead to higher output gap, i.e. there is no trade-off relationship between inflation and output variable.

6. CONCLUSION

In this paper, we seek to investigate the performance and effectiveness of inflation targeting (IT) regime in three emerging East-Asian economies of Korea, Philippines and Thailand. We divide the data into two sub-periods, pre- and post-IT by excluding the crisis period. The system equations of bivariate GARCH and SVAR are applied to investigate the correlation and trade-off relationship between inflation and output gap. Both approaches give consistent results. The main findings include: the persistency rate of output gap is higher than that in inflation rate and there are evidences that the persistency rates of these two variables have declined after the implementation of IT regime; the correlation between output gap and inflation is insignificant and we do not detect any trade-off relationship between inflation and output gap variable after the implementation of IT regime in these economies. The means of inflation and output gap have declined in the post-IT period in these economies, implying the improvement in the economic structure and performance in these economies after the implementation of IT regime.

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