# Inflation targeting in Korea, Indonesia, Thailand, and the Philippines : the impact on business cycle synchronization between each country and the world

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Inflation Targeting in Korea, Indonesia, the Philippines, and Thailand:

The Impact on Business Cycle Synchronization between Each Country and the World

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Abstract

This paper empirically analyzes whether and to what extent the adoption of inflation targeting (IT) in Korea, Indonesia, the Philippines, and Thailand has affected their business cycle synchronization with the rest of the world. By employing the dynamic conditional correlation (DCC) model developed by Engle (2002), we find that IT in Asia has little effect on international business cycle synchronization and the effect is positive in some of the countries, if any. These findings basically seem to be consistent with the evidence from relevant literature.

**Introduction**

For the last two decades, a growing number of countries have introduced what's known as "inflation targeting." Inflation targeting (IT) is generally defined as a monetary policy framework wherein the central bank would adjust the policy interest rate to keep the conditional inflation forecast close to the inflation target, and to achieve price stability and low inflation as the primary objectives of monetary policy. In the initial phase, IT was adopted mainly in developed countries. Due to successful experience especially in terms of price stabilization, the introduction of IT has spread not only to other developed countries but also to emerging and developing countries, currently amounting to approximately 30 countries.

With the number of IT countries increasing, recent literature has placed much more emphasis on this policy framework, examining it from a variety of viewpoints. Among other things, most studies empirically indicate the positive impacts of IT on domestic macroeconomic variables. For instance, Neumann and von Hagen (2002) state that the introduction of this framework has permitted IT countries to reduce inflation to low levels and to curb the volatility of inflation and interest rates. In addition, Levin et al. (2004) suggests that IT plays a role in anchoring inflation expectations and in reducing inflation persistence. Furthermore, Mishkin and Schmidt-Hebbel (2007) show that IT actually helps countries achieve lower inflation in the long term. Earlier empirical literature tended to explore IT largely in industrial countries, while there was limited evidence of IT in less developed countries partly because of the lack of data as well as the credibility problem of central banks. As data and experience have gradually accumulated, however, growing numbers of empirical studies have analyzed the impact and/or the effectiveness of the IT framework in emerging and developing countries. In line with this recent trend, this paper focuses on the last decade of experience in IT for selected Asian countries, such as Korea, Indonesia, Thailand, and the Philippines.

Specifically, in this paper, we attempt to analyze the extent to which the adoption of IT in these Asian countries has affected their business cycle synchronization with the rest of the world. To this end, we apply the dynamic conditional correlation (DCC) model developed by Engle (2002). This is a relatively novel approach, since the surveyed literature indicates that empirical studies tend to characterize IT by estimating the monetary reaction function for each country. Our empirical evidence states that the adoption of IT in Asia has little impact on

business cycle synchronization with the rest of the world. This is basically consistent with Flood and Rose (2010), in spite of the different methodologies applied. Apart from this, in the former part of this paper, we also summarize the history of monetary policy in each of these countries.

This paper is organized as follows. The next section briefly sets out the historical background and specific features of IT in Korea, Indonesia, Thailand, and the Philippines. In Section 2, we survey the recent empirical literature on IT focusing on these Asian countries. Based on the Engle (2002) procedure, the third section empirically analyzes whether and to what extent the adoption of IT in Asia has affected business cycle synchronization with the rest of the world. The final section offers concluding observations regarding this paper.

## 1.   Background and features of IT in the four Asian countries

IT is typically defined as a monetary policy framework in which the central bank explicitly sets the inflation target, controls the policy rate to close the gap between the announced target and the expected inflation, and aims to achieve price stabilization and low inflation. In this section, we briefly review IT in Korea, Indonesia, Thailand, and the Philippines in terms of the circumstances under which IT was introduced, the practical characteristics, and the inflation developments before and after adoption.

### 1.1   Korea

For a few decades before IT, Korea had conducted its monetary policy under monetary targeting. The Bank of Korea (BOK) set the M1 growth rate as the intermediate target in 1976 and changed the target to the M2 growth rate in 1979. Largely because of the stability of M2 demand, the bank had been able to keep it closer to the target value until the middle of the 1990s (Kim and Park, 2006, pp. 141–142). However, since changes in the trust account system in 1996 made the demand for M2 unstable, the BOK added a broader monetary aggregate called MCT to the list of intermediate targets (ibid, pp. 141–142)[1]. Subsequently, the usefulness of M2 and MCT substantially declined with the diversification of financial products as well as due to the change in the required reserve system in 1997.

Under this circumstance, the financial crisis that began in Thailand in July 1997 spread

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[1]  MCT is the sum of M2, the certificate of deposits, and the money in trust.

to Korea at the end of the year. To cope with the crisis, under the IMF program, the government set about broad-based structural reform, as a part of which it began monetary policy reform and amended the BOK Act. This revised central bank act that came into effect in April 1998 ensures the political and institutional independence of the BOK, clearly sets out price stability as the primary objective of the BOK, and announces the shift of its policy framework to IT. Since then, the bank has decided on the inflation target in consultation with the government and has conducted monetary management by controlling short-term interest rates. Later, Korea switched to a pure inflation targeting in 2001, up until which time the central bank made public the inflation target, setting M3 growth as the operational target (ibid., p. 142)[1].

Since the adoption, Korea has modified IT in several respects. One of them is the changes in the benchmark indicator. In the early years, the inflation target was based on the CPI inflation rate. In 2000, it was changed to the core CPI inflation rate, which strips out the prices of petroleum products and non-grain agricultural products from the CPI. However, since 2007, the CPI inflation rate has been again used as the benchmark indicator. In addition, after introducing IT in 1998, the BOK came to establish an annual inflation target every year, but from 2004 onward, a medium-term inflation targeting system has been put in place in line with the entry into the effect of the revision of the central bank act in 2004[2]. Another major change regards the policy rate. Following the introduction of IT, the Monetary Policy Committee, the policy-making body of the BOK, defined the uncollateralized overnight call rate as the policy rate, and set the target level of the call rate every month. In March 2008, the policy rate was switched from the call rate to the Bank of Korea Base Rate (Base Rate), while the BOK continues to use the call rate as an operational target and seeks to ensure that it does not deviate too widely from the Base Rate by using its policy instruments such as open market operations[3].

Figure 1 and Table 1 depict both the developments of the inflation target and the actual inflation rate after the adoption of IT in Korea. From Figure 1, on a monthly basis, it seems that the inflation rate has sometimes deviated from the target range. However, given that average

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[1] In 2001, the BOK decided to set the M3 growth not as the intermediate target but as the monitoring range. Since 2003, the bank has carefully monitored the movement of M3 as an information variable for the conduct of monetary policy.
[2] From 2000 to 2003, the BOK announced the medium-term inflation target as well as the annual inflation target based on the average core inflation. The medium-term target was set at 2.5% from 2000 to 2002 and at 2.5–3.5% for 2003.
[3] The BOK Base Rate is the standard rate applied to transactions between the central bank and the counterpart financial institutions.

annual inflation determines whether the inflation target is achieved or not, they show that actual inflation has been often times within the target range, that is, in six years out of nine years.



Figure 1: Actual inflation and the inflation target in Korea (%)
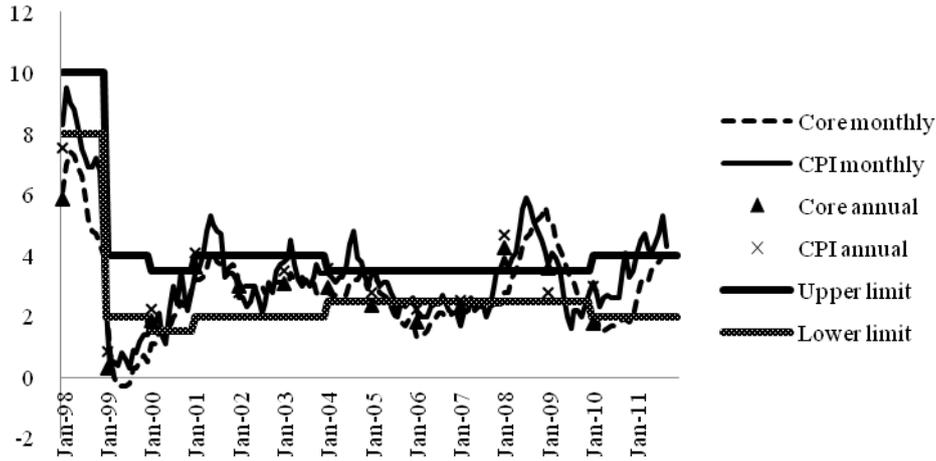
Source: Complied by the authors from the BOK (various issues) and the BOK web page (http://ecos.bok.or.kr/EIndex_en.jsp) (accessed on October 14)

Table 1: Actual inflation and the inflation target in Korea

| Time Horizon | Target Indicator | Target Range % | Performance Evaluation | Actual Rate % |
|---|---|---|---|---|
| 1998 | CPI Inflation | 9.0±1.0 | Annually | 7.5 |
| 1999 | | 3.0±1.0 | | 0.8 |
| 2000 | Core CPI | 2.5±1.0 | | 1.9 |
| 2001 | Inflation | 3.0±1.0 | | 3.6 |
| 2002 | | | | 3.0 |
| 2003 | | | | 3.1 |
| 2004–2006 | | 2.5–3.5 | Average during | 2.3 |
| 2007–2009 | CPI Inflation | 3.0±0.5 | the Term | 3.3 |
| 2010–2012 | | 3.0±1.0 | Annually | 2.9 |

Source: The same sources as those from Figure 1.

Note: The actual rate for 2010–2012 represents the inflation rate for 2010.

## 1.2 Indonesia

For many years, as Indonesia's central bank, Bank Indonesia (BI) had conducted monetary policy by using mainly base money as the operational instrument to control other monetary aggregates and thus inflation (Alamsyah et al., 2001, p. 311). In addition, the BI had used the nominal exchange rate with a pre-announced crawling band as the main anchor of monetary policy and implemented the steady depreciation of the rupiah in order to maintain international competitiveness rather than control inflation itself (McLeod, 1997, p. 22). Although the use of base money as the operational instrument seemed to have been effective in the 1980s and early 1990s, this approach using quantity targets was challenged thereafter, as the relationship between money aggregates and nominal income became tenuous in the mid-to-late 1990s due to the instability in the income velocity of money resulting from global financial innovations and deregulation (Alamsyah et al., 2001, p. 311; Mariano and Villanueva, 2006, p. 218)[1]. Thus, the BI attempted to gradually shift its policy from quantity targeting to price (interest rate) targeting, and has widened the exchange rate tolerance band to ease the conflict with monetary policy (Alamsyah et al., 2001, p. 312).

Nevertheless, this attempt to move to the price targeting approach was postponed due to the turbulence caused by the Asian financial crisis, and targeting of the monetary base continued to be used after the crisis as a temporary measure (ibid., p. 312, 314). Affected by the crisis, the crawling band exchange rate regime was abandoned in August 1997, and the rupiah was allowed to float. As a result, the rupiah depreciated significantly, and soon after this, the BI sharply increased the short-term interest rate, which proved fatal to the banking and real sectors (Mariano and Villanueva, 2006, p. 218). Reacting to these developments, the BI injected large-scale liquidity into the banking system, but the excessive monetary creation exerted further pressure on the exchange rate, doing the same to prices (ibid., p. 219). Accordingly, the bank re-absorbed the excess liquidity from the banking system by targeting the monetary base (Alamsyah et al., 2001, p. 314).

Under these circumstances, a new central bank act was enacted in May 1999. This

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[1] So far, there have been several empirical studies to examine the stability of money demand functions in Indonesia with different techniques and specifications. Some studies using sample data from before 2000, such as Bahmani-Oskooee and Rehman (2005) and James (2005), state that the money demand function is stable, whereas more recent studies using data from even after 2000, such as Narayan (2007) and Kubo (2009), indicate the instability of money demand functions for Indonesia.

legislation clearly prescribed that the primary objective of monetary policy is to achieve and maintain the stability of the rupiah's value. It also provided the BI with the legal independence as well as the authority to formulate and implement monetary policy considering the inflation target that the bank set. Subsequently, the central bank act was amended in 2004, which empowered the government to set the inflation target (Mariano and Villanueva, 2006, p. 220).

Although the BI has explicitly announced the inflation target since 2000 following the enactment of the new central bank act in 1999, it was in July 2005 that Indonesia formally adopted IT and replaced the previous policy framework using base money as the policy instrument. Under the IT framework, the Board of Governors of the BI set "the BI rate" as the policy instrument to reflect the monetary policy stance[1]. For 2000 and 2001, the inflation target was set for the core CPI, which excludes the impacts of government-administered prices and income policy on the CPI. However, in 2002 it was changed to be based on the headline CPI (ibid., p. 219). Figure 2 shows the developments of actual inflation and the inflation targets in Indonesia after the introduction of IT in 2005. From this figure, we find that it was only two times during the seven years from 2005 to 2011 that actual inflation was within the inflation target range.



Figure 2: Actual inflation and the inflation target in Indonesia (%)
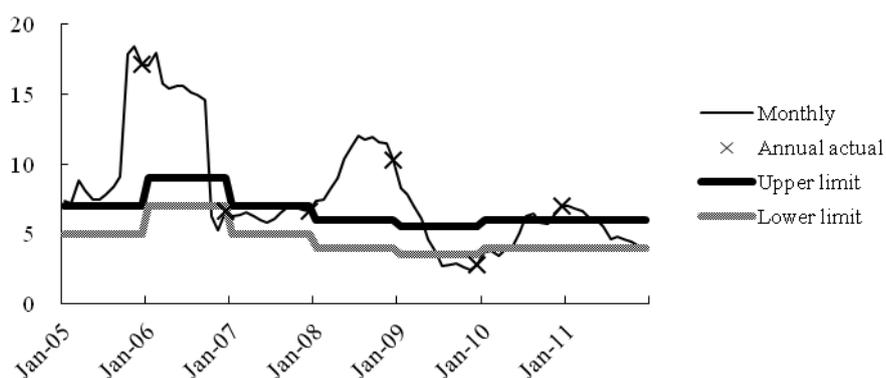
Source: Complied by the authors from the web pages of the BI (http://www.bi.go.id/web/en) and BPS-Statistics Indonesia (http://dds.bps.go.id/eng/) (accessed on December 16, 2011)

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[1] In addition, the BI rate is used as a reference rate in monetary control operations to ensure that the weighted average of one-month Bank Indonesia Certificates (SBI) rate derived in open market operation auctions remains at around the level of the BI rate (Siregar and Goo, 2010, p. 116).

1.3   Thailand

For a long time after the Second World War, Thailand adopted a fixed exchange rate regime. Since 1984, the value of the baht had been pegged to a basket of currencies, although the financial crisis that occurred in July 1997 posed challenges to Thailand's monetary policy. Following both the adoption of the floating exchange rate system and the IMF program, a monetary targeting regime was adopted (Phuvanatnaranubala, 2005, p. 272). Under this regime, the Bank of Thailand (BOT) set the daily and quarterly monetary base targets and put upward pressure on interest rates if base money was running ahead of the medium-term targets, and put downward pressure on interest rates if base money was below such targets (Fane, 2005, p. 176). However, as the relationship between the money supply and output growth became less stable over time, the targeting of the money supply was deemed inappropriate. Moreover, with the exit from the IMF program, it became necessary for the authorities to identify a new appropriate policy anchor. Accordingly, in April 2000, the BOT appointed the Monetary Policy Board (MPB) as the policy-making body and officially announced the adoption of IT with the main objective of maintaining price stability in the following month.

The MPB defined the quarterly average of core inflation as the policy target and set the core inflation target at between 0.0–3.5% per year. Core inflation is expressed in terms of the year-on-year percentage change of the CPI, which excludes fresh food and energy prices. In addition, the MPB decided to use the 14-day repurchase rate as the key policy rate to signal the monetary policy stance. In July 2001, a new Monetary Policy Committee (MPC) was formed and took over the MPB's function and responsibility as the policy-making body.

In March 2008, the Bank of Thailand Act was amended for the first time in over 60 years. Before then, although the BOT had been granted *de facto* independence in the conduct of monetary policy, the amended act clearly states the BOT's objectives and responsibilities as the nation's central bank in maintaining monetary stability, the stability of the financial system, and the stability of the payment system. The new act requires that the MPC set out the inflation target in conjunction with the Minister of Finance each December for the following year, with formal approval from the Cabinet (Grenville and Ito, 2010, p. 82). At this juncture, the MPC and the Minister of Finance have carefully considered the appropriateness of the inflation target, and in order to reduce the probability of deflation, the MPC adjusted the target range from 0.0–3.5% to 0.5–3.0% per annum in 2009 (BOT, 2009, p. 8). In addition, the MPC changed the policy rate

from the 14-day repurchase rate to the one-day repurchase rate from January 2007 onward.

Figure 3 illustrates the developments of the inflation rate and the inflation target in Thailand. From April 2000 to July 2011, actual inflation was within the target range for 42 quarters, that is, more than 90% of the total time. The inflation rate remained below the lower bounds of the target from 2009 Q2 until 2010 Q1, which was mainly caused by the effects from the government's cost-of-living reduction measures and the 15-year free-of-charge education program (BOT, 2010, p. 9).

Figure 3: Actual inflation and the inflation target in Thailand (%)
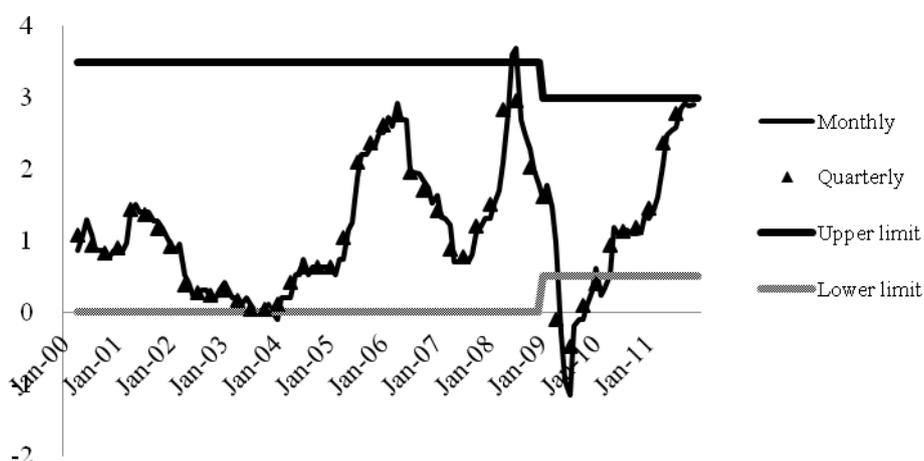


Source: Complied by the authors from the BOT web page (http://www.price.moc.go.th/price/cpi/index_new_e.asp) (accessed on December 5, 2011)

1.4   The Philippines

Pursuant to the 1987 Philippine Constitution and the new central bank act of 1993, the Bangko Sentral ng Pilipinas (BSP) was established in July 1993 as the central bank of the Philippines, which took over from the Central Bank of Philippines (CBP), established in 1949. Unlike the previous legislation, the new central bank act that took effect in July 1993 explicitly stated the maintenance of price stability conductive to balanced and sustainable growth as the primary objective of the BSP, and also gives the central bank fiscal and administrative autonomy which the CBP did not have.

Since the establishment, the BSP followed the monetary aggregate targeting approach to monetary policy. Beginning in the latter half of 1995, this approach was modified to put greater emphasis on price stability instead of rigidly observing the targets set for monetary

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aggregates. The reason was that the relationship between quantitative monetary targets and inflation had weakened due to structural breaks in the income velocity of money and due to volatilities and instabilities in the money multiplier caused by financial liberalization (Lim, 2008, p. 276). Under this modified framework, as far as inflation was below or at the target level, the BSP tolerated money supply in excess of the programmed level (Mariano and Villanueva, 2006, p. 211). However, this semi-IT framework was based on current inflation, rather than forecast inflation (ibid., p. 211).

Following this transitional phase, in January 2000, the BSP's policy-making body, the Monetary Board, approved in principle the shift from monetary targeting to inflation targeting, and two years later, the BSP formally adopted IT as a framework for conducting monetary policy. The inflation target is defined in terms of the average year-on-year change in the CPI over the calendar year and is set by the government through an inter-agency economic planning body—the Development Budget and Coordination Committee. Initially, the inflation target was set in terms of a range. In 2006, the government re-specified the inflation target from a range target to a point target with a tolerance interval of ±1.0 percentage points starting in the target for 2008. In addition to this modification, in July 2010, the BSP also announced the shift from a variable annual inflation target to a fixed inflation target for the medium-term, and set the inflation target of 4.0±1.0% for the period of 2012–2014. In order to achieve the inflation target, the BSP has so far used the overnight repurchase rate and reverse repurchase rate as the primary policy instruments.

Figure 4 illustrates the developments of the actual inflation rate and the inflation target in the Philippines since the adoption of IT in 2002. This figure shows that after the failure to meet the target from 2002 to 2008, headline inflation has been within the pre-announced target range for 2009 and 2010. In cases where the BSP fails to achieve the inflation target, the BSP governor issues an "Open Letter to the President." This outlines the reasons why actual inflation did not fall within the target, along with the steps that will be taken to bring inflation toward the target. So far, the BSP has issued this letter to the President six times in total for the inflation target from 2003 to 2008.

Figure 4: Actual inflation and the inflation target in the Philippines (%)
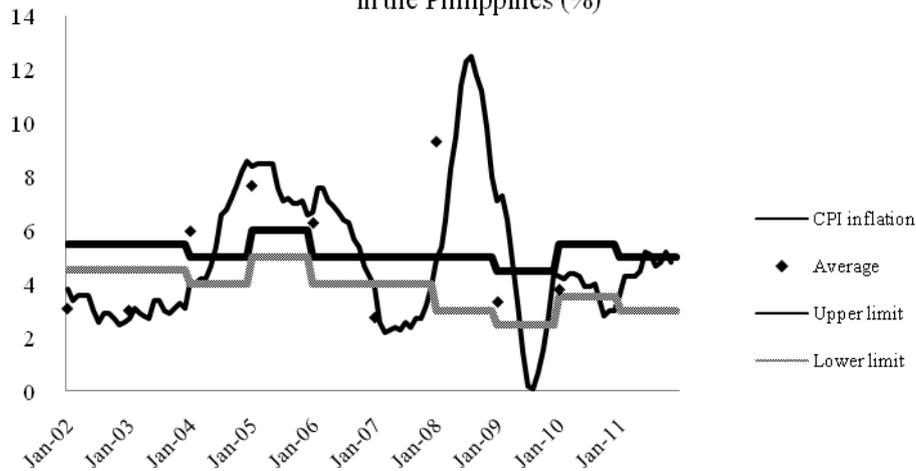
Source: Complied by the authors from the BSP (various issues) and the web pages of the BSP (http://www.bsp.gov.ph/downloads/Publications/FAQs/targeting.pdf) and the National Statistical Office (http://www.census.gov.ph/) (accessed on December 13, 2011)

Note: The base year for CPI inflation is 1994 for the period from January 2002 to December 2003, 2000 for January 2004 to May 2011, and 2007 for June 2011 onward.

1.5   Effectiveness of IT in the four Asian countries

After the Asian financial crisis in 1997, the four Asian countries excluding the Philippines adopted monetary targeting, accompanying the shift to the flexible exchange rate regime. Only the Philippines introduced monetary targeting before the crisis. Due to financial innovation and deregulation, however, the relationship between the money supply and output growth became less stable over time. Accordingly, the effectiveness of monetary targeting appeared to have been eroded, which encouraged these countries to switch to the alternative IT framework in Asia. Since the introduction of IT, the achievement of the inflation target has varied across the countries. In Thailand and Korea, actual inflation has relatively fallen well within the target range, while Indonesia and the Philippines have quite often failed to meet the target.

Typically, the main objectives of the IT framework are to achieve stable price levels and low inflation. In order to briefly assess to what extent the four Asian countries achieved these objectives, in Table 2, we report on basic statistics for the inflation rate in each country, comparing the sample mean, standard deviation, and the maximum and minimum before and after IT. From this table, it is found that each number except the standard deviation in the

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Philippines has been smaller than those prior to the IT period, suggesting that the inflation rate has been lower and less volatile since the introduction of IT. Therefore, although the achievement of the inflation target actually varies across the countries, the IT frameworks in these Asian countries generally seem to have achieved some positive results, at least in terms of low and stable inflation.

Table 2: Inflation performance in the Asian IT countries

| | Before inflation targeting | | | | After inflation targeting | | | |
|---|---|---|---|---|---|---|---|---|
| | Average | SD | Max | Min | Average | SD | Max | Min |
| Korea | 5.6 | 2.0 | 9.3 | 2.8 | 2.9 | 1.0 | 4.7 | 0.8 |
| | (5.4) | (1.7) | (8.4) | (3.0) | (2.6) | (1.1) | (4.2) | (0.3) |
| Indonesia | 8.7 | 3.0 | 12.6 | 5.1 | 6.8 | 2.9 | 11.1 | 2.8 |
| Thailand | 5.0 | 1.4 | 6.2 | 1.8 | 1.1 | 0.8 | 2.3 | 0.1 |
| The Philippines | 6.8 | 1.7 | 9.3 | 4.0 | 5.3 | 2.4 | 9.3 | 2.8 |

Source: Calculated by the authors from IMF (2011) and the same sources as those from figures 1, 2, 3 and 4, as well as Table 1.

Note 1: All values are calculated for the same period before and after the adoption of IT. We exclude the first year of the IT regime's implementation.

Note 2: The numbers in parenthesis are based on core inflation.

## 2. Literature review

In recent years, a growing body of empirical studies has analyzed IT in emerging and developing countries. In the previous section of this paper, we simply observed the basic statistics, while in this section we review the recent empirical literature on the performance of IT focusing on the emerging countries in Asia.

First, concerning Korea, Kim and Park (2006) analyze the monetary reaction function of the BOK to infer the way in which the bank conducted monetary policy during the IT period. Following Clarida et al. (1998, 2000), they estimate the reaction function for the period 1999 to August 2005 and find that the coefficients of both the deviation of inflation from the target and the output gap from the potential level are positive and significantly different from zero, though

the estimates of the output gap are relatively small. Therefore, Kim and Park (2006) point out that the BOK adjusts interest rates in response to changes in inflationary pressure, and that the BOK also includes stabilizing the output gap as policy objectives. Next, Sánchez (2010) calculates the BOK's parameters in the policy objective function to characterize the monetary policy in Korea during the IT period. Empirical results show that the central bank appears to have pursued an optimal policy geared toward achieving price stability, while displaying a significant degree of interest rate smoothing. He also states that the BOK's loss function is estimated to include negligible weights on output and exchange rate variability[1].

Regarding Thailand, McCauley (2006) estimates the monetary policy reaction function for the BOT, augmenting the Taylor rule with the change in the effective exchange rate. Taking the results with different variables and sample periods together, he states that the BOT's policy in the IT period can be most plausibly modeled using the bank's next-year forecast of inflation and that no specification finds a response of the policy rate to the exchange rate. In addition, Payne (2009) examines the impact of IT on inflation volatility in Thailand using monthly data during the period of 1965 to 2007. The estimation results obtained from the ARIMA-GARCH model indicates that the inflation targeting adopted marginally reduced the degree of volatility persistence in response to inflationary shocks. Moreover, Siregar and Goo (2010) employ the Markov-switching VAR framework to test for the shift in the monetary policy rules of the central banks in Thailand and Indonesia. The result shows that the IT policy in these countries has largely been flexible during the stable period, whereas a greater policy focus has been placed on anchoring inflationary expectation during the turbulent period.

Concerning the Philippines, Salas (2006) explores the BSP's monetary policy behavior during the entire sample from January 1992 to September 2003 and the three sub-periods. By employing the forward-looking model by Clarida et al. (1998, 2000), he points out that the shift to IT in the Philippines was accompanied by string responses to inflationary pressures and an apparent disregard of the output deviations from trend. In addition, Angeles and Tan (2007) examine whether the inclusion of the output gap in the central bank's estimated reaction function would improve the conduct of IT in the Philippines. They conduct counterfactual simulations by replacing the interest rate equation from the VAR model with the Taylor rule, and

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[1] Besides, Hoffmaister (2001) and Eichengreen (2004) also examine monetary policy management in Korea.

unlike Salas (2006), find that the adoption of a Taylor-type rule involving the use of the output gap minimizes the deviations of inflation from the target.

Finally, Prasertnukul et al. (2010) analyze how the adoption of IT has influenced exchange rate pass-through and its volatility in Korea, Indonesia, Thailand, and the Philippines during the sample period from January 1990 to June 2007. The empirical results indicate that adopting IT caused a decline in exchange rate volatility in all four countries, while it helped reduce exchange rate pass-through only in Korea and Thailand. Besides, Taniguchi and Kato (2011) assess the monetary policy rule under IT by estimating the monetary policy reaction functions in the IT countries in Asia and Malaysia. The results indicate that there seems to be a linkage between the adoption of IT and the monetary policy rule emphasizing the stabilization of inflation excluding such in the Philippines. They also state that Korea seems to have adopted a forward-looking policy rule under IT, while Indonesia and Thailand seems to have adopted a backward-looking rule.

As mentioned above, the literature survey on IT in the Asian countries generally suggests that under the IT regime, the central bank in each country pays much more attention to inflation developments when conducting monetary policy. In this paper, we investigate the impact of IT on the economy from a different viewpoint than the literature surveyed. More specifically, in the following section, we attempt to evaluate whether and to what extent the adoption of IT in the Asian countries has affected their business cycle synchronization with the rest of the world.

## 3. Impact of IT adoption on business cycle synchronization with the rest of the World

### 3.1 Empirical techniques

This paper examines the dynamic conditional correlation between the world's business cycle and that of the four countries in this study that adopt inflation targeting; and this paper adopts the following two-step approach. In the first step, we estimate the conditional correlations using the dynamic conditional correlation (DCC) model developed by Engle (2002). For a more detailed analysis, we estimate the following equations:

$$r_t \setminus I_{t-1} \sim N(0, D_t R_t D_t)$$
$$D_t^2 = diag\{\omega_t\} + diag\{\kappa_t\} \circ r_{t-1} r_{t-1}' + diag\{\lambda_t\} \circ D_{t-1}^2$$
$$\varepsilon_t = D_t^{-1} r_t \tag{1}$$
$$Q_t = \overline{Q} \circ (\iota\iota' - A - B) + A \circ \varepsilon_{t-1} \varepsilon_{t-1}' + B \circ Q_{t-1}$$
$$R_t = diag\{Q_t\}^{-1} Q_t diag\{Q_t\}^{-1}$$

where $\iota$ is a vector of ones and where $\circ$ is the Hadamard product of two identically seized matrices, which is computed simply by element-by-element multiplication. The second equation expresses a univariate generalized autoregressive conditional heteroskedasticity (GARCH) process. The third equation expresses the standardized residual, the fourth one expresses the conditional covariance matrices, and the fifth one expresses the conditional correlations. If $A$, $B$, and $(\iota\iota' - A - B)$ are positive semidefinites, then $Q$ will be positive semidefinite.

In the second step, AR (1) models are applied to model the conditional correlations derived from the first step. Specifically, the dummy variables signifying the period that adopt each countries' inflation targeting and financial crisis period are included to test whether the inflation targeting and the financial crisis significantly altered the dynamics of the estimated conditional correlations between the global business cycle and that of the four countries; that is:

$$D\hat{C}C_t = \delta_0 + \delta_1 D\hat{C}C_{t-1} + \gamma_0 Dummy_t^i + \gamma_1 Crisis_t + v_t, \tag{2}$$

where $D\hat{C}C_t$ is the conditional correlation estimated from equation (1) and $v_t$ is the white noise. Estimating equation (2), the dummy variable $Dummy_t^i$ ($i = 1, \cdots 4$) and $Crisis_t$ is determined by the financial crisis; that is:

$$Dummy_t^1 = \begin{cases} 0 & (t = 03/1996, \cdots, 03/1998) \\ 1 & (t = 04/1998, \cdots, 06/2011) \end{cases}$$

$$Dummy_t^2 = \begin{cases} 0 & (t = 03/1996, \cdots, 06/2005) \\ 1 & (t = 07/2005, \cdots, 06/2011) \end{cases}$$

$$Dummy_t^3 = \begin{cases} 0 & (t = 03/1996, \cdots, 12/2001) \\ 1 & (t = 01/2002, \cdots, 06/2011) \end{cases} \tag{3}$$

$$Dummy_t^4 = \begin{cases} 0 & (t = 03/1996, \cdots, 04/2000) \\ 1 & (t = 05/2000, \cdots, 06/2011) \end{cases}$$

$$Crisis_t = \begin{cases} 0 & (t = 03/1996, \cdots, 08/2008) \\ 1 & (t = 09/2008, \cdots, 06/2011) \end{cases}.$$

where the dummy variable $Dummy_t^1$ shows the Korea dummy, $Dummy_t^2$ shows the

Indonesia dummy, $Dummy_t^3$ shows the Philippines dummy, and $Dummy_t^4$ shows the Thailand dummy.

## 3.2   Data

We employ monthly data on the JCER World Business Climate Index from March 1996 to June 2011. This sample period is chosen on the basis of the availability of data from the Japan Center for Economic Research. We use the global index and the index of the four countries adopting inflation targeting: Korea, Indonesia, the Philippines, and Thailand. In addition, we estimate the following two main cases and four sub-cases considering the time trend of the data and the pairs of countries.

Case 1: In case of including the time trend of data

　　1-1: World vs Korea

　　1-2: World vs Indonesia

　　1-3: World vs the Philippines

　　1-4: World vs Thailand

Case 2: In case of excluding the time trend of data

　　2-1: World vs Korea

　　2-2: World vs Indonesia

　　2-3: World vs the Philippines

　　2-4: World vs Thailand

In case 2, we removed the time trend using the Hodrick-Prescott (HP) filter.

## 3.3   Empirical Results

First, we estimated the DCC models for each pairs of the business climate index. Next, we apply AR (1) models with a dummy variable representing the each countries' inflation targeting and financial crisis period to the evolution of the estimated dynamic conditional correlations.

Table 3 and Table 4 show the estimate results of the AR (1) models. As for case 1, the constant terms ($\delta_0$) are all positive and significant at the 5% significance level. The coefficients of AR terms ($\delta_1$) are also significant for all cases excluding case 1-1, with values of less than unity. The inflation targeting dummy ($\gamma_0$) and financial crisis dummy ($\gamma_1$) are positively significant at the 1% significance level in case 1-4. As for case 2, the constant terms ($\delta_0$) are

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positively significant at the 5% significance level in all cases excluding case 2-1. The coefficients of AR terms ($\delta_1$) are significant for all cases with values of less than unity. The inflation targeting dummy ($\gamma_0$) and financial crisis dummy ($\gamma_1$) are positively significant at the 5% significance level in case 2-3 and 2-4. As for case 2, the adjusted R-squared is higher than case 1 in all sub-cases.

Table 3

Case 1-1: World vs Korea

|  | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $\delta_0$ | 0.262 | 0.036 | 7.312 | 0.000 |
| $\delta_1$ | 0.106 | 0.077 | 1.381 | 0.169 |
| $\gamma_0$ | 0.004 | 0.029 | 0.141 | 0.888 |
| $\gamma_1$ | 0.038 | 0.020 | 1.859 | 0.065 |
| Adjusted R-squared | 0.020 | | | |

Case 1-2: World vs Indonesia

|  | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $\delta_0$ | 0.031 | 0.008 | 3.746 | 0.000 |
| $\delta_1$ | 0.822 | 0.046 | 18.050 | 0.000 |
| $\gamma_0$ | −0.001 | 0.004 | −0.196 | 0.845 |
| $\gamma_1$ | 0.011 | 0.007 | 1.723 | 0.087 |
| Adjusted R-squared | 0.766 | | | |

Case 1-3: World vs the Philippines

|  | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $\delta_0$ | 0.019 | 0.007 | 2.573 | 0.011 |
| $\delta_1$ | 0.893 | 0.035 | 25.805 | 0.000 |
| $\gamma_0$ | 0.009 | 0.007 | 1.305 | 0.194 |
| $\gamma_1$ | 0.013 | 0.008 | 1.652 | 0.100 |
| Adjusted R-squared | 0.893 | | | |

Case 1-4: World vs Thailand

|  | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $\delta_0$ | 0.057 | 0.016 | 3.605 | 0.000 |
| $\delta_1$ | 0.836 | 0.039 | 21.215 | 0.000 |
| $\gamma_0$ | 0.023 | 0.008 | 2.708 | 0.008 |
| $\gamma_1$ | 0.024 | 0.009 | 2.675 | 0.008 |
| Adjusted R-squared | 0.876 | | | |

Figure 5: DCCs of the world versus the four countries in Case 1
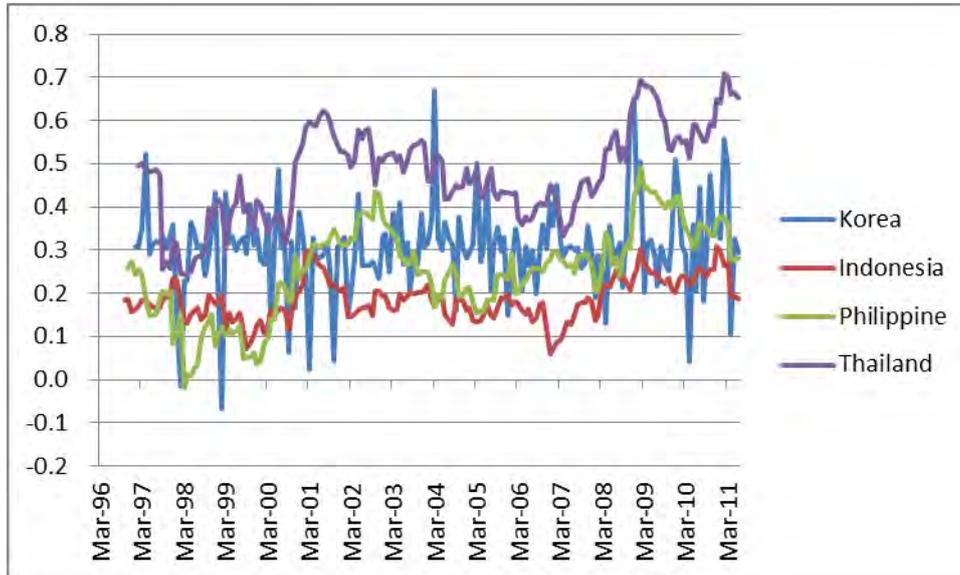


Table 4

Case 2-1: World vs Korea

|  | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $\delta_0$ | 0.005 | 0.012 | 0.425 | 0.671 |
| $\delta_1$ | 0.953 | 0.024 | 40.126 | 0.000 |
| $\gamma_0$ | 0.009 | 0.010 | 0.877 | 0.382 |
| $\gamma_1$ | 0.011 | 0.008 | 1.498 | 0.136 |
| Adjusted R-squared | 0.936 | | | |

Case 2-2: World vs Indonesia

|  | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $\delta_0$ | 0.026 | 0.009 | 3.034 | 0.003 |
| $\delta_1$ | 0.879 | 0.039 | 22.611 | 0.000 |
| $\gamma_0$ | 0.002 | 0.003 | 0.745 | 0.458 |
| $\gamma_1$ | 0.002 | 0.004 | 0.614 | 0.540 |
| Adjusted R-squared | 0.813 | | | |

Case 2-3: World vs the Philippines

|  | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $\delta_0$ | 0.028 | 0.008 | 3.308 | 0.001 |
| $\delta_1$ | 0.869 | 0.037 | 23.316 | 0.000 |
| $\gamma_0$ | 0.010 | 0.005 | 2.066 | 0.040 |
| $\gamma_1$ | 0.015 | 0.006 | 2.602 | 0.010 |
| Adjusted R-squared | 0.921 | | | |

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Case 2-4: World vs Thailand

|  | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $\delta_0$ | 0.051 | 0.016 | 3.181 | 0.002 |
| $\delta_1$ | 0.856 | 0.038 | 22.522 | 0.000 |
| $\gamma_0$ | 0.028 | 0.010 | 2.711 | 0.007 |
| $\gamma_1$ | 0.021 | 0.011 | 2.032 | 0.044 |
| Adjusted R-squared | 0.896 | | | |

Figure 6: DCCs of the world versus the four countries in Case 2
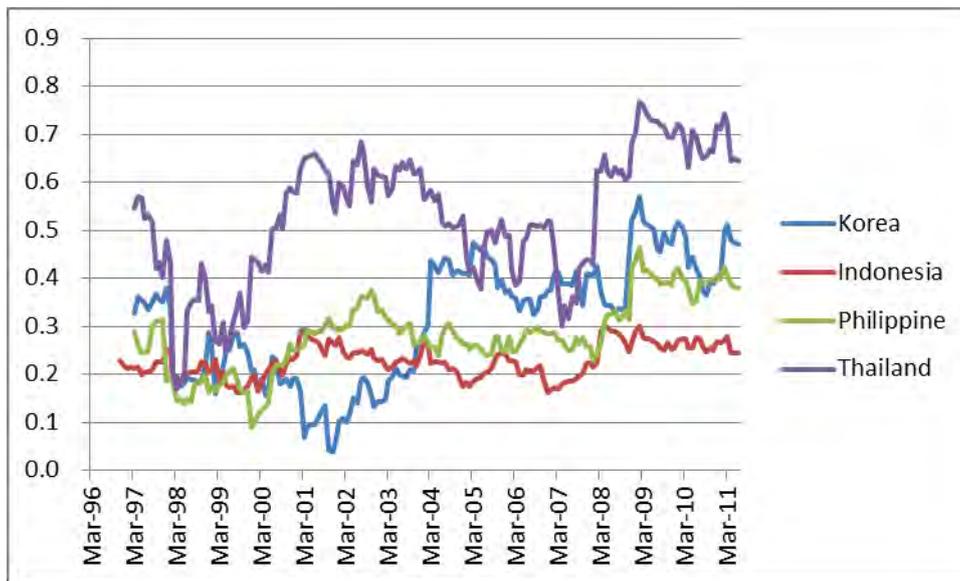


## 4. Concluding remarks

Before inflation targeting (IT), the four Asian countries, that is, Korea, Indonesia, Thailand, and the Philippines, commonly adopted monetary targeting. Due to financial innovation and deregulation, however, the relationship between money supply and output growth became less stable over time, which encouraged these countries to switch their policy framework from monetary targeting to IT.

Looking at the achievement of inflation targets, these countries show different outcomes. In Thailand and Korea, actual inflation has relatively fallen well within the target range, while Indonesia and the Philippines have quite often failed to meet the target. Therefore, the achievement of the inflation target varied across these countries, although the basic statistics such as the mean and standard deviation indicate that the numbers were generally smaller than

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those prior to the IT period, suggesting that the IT framework in Asia seems to have succeeded in attaining the objectives of low and stable inflation.

In recent years, a growing body of empirical studies has been conducted to analyze IT in the Asian emerging countries. These empirical studies tend to characterize IT by estimating the monetary reaction function for each country and generally confirm that the central banks under the IT regime have paid substantial attention to inflation developments when conducting monetary policy. In this article, we investigate the impact of IT on the economy from a different viewpoint than the surveyed literature. Specifically, we analyze whether and to what extent the adoption of IT in these countries has affected international business synchronization by employing the dynamic conditional correlation (DCC) model developed by Engle (2002). From this analysis, we find that IT in Asia has little effect on business cycle synchronization with the rest of the world and that the effect is positive in some of the countries, if any.

As relevant literature, Flood and Rose (2010) examine whether the advent of IT in developed and developing countries including the Asian countries can be linked to the rising international synchronization of the business cycle by applying different methods, and they point out that countries that target inflation seem to have cycles that move slightly more closely with foreign cycles. Therefore, our findings basically seem to be consistent with the evidence from Flood and Rose.

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