Inflation Targeting and Pass-through Rate
in East Asian Economies

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Abstract

This article sets out to assess the performance of inflation targeting (IT) frameworks from the perspective of the pass-through effect of external price shocks into consumer price inflation, focusing on the four East Asian economies which have adopted IT, during the period of 1990-2009. We first examine their monetary policy rules to identify the IT implementation, and then investigate the linkage between inflation-responsive rules and pass-through rates, as suggested by Gagnon and Ihrig (2004). Our main findings are as follows. First, under the IT adoption, Korea has taken an inflation responsive rule in a forward-looking manner, while Indonesia and Thailand have adopted the rule in a backward-looking manner. Second, only Korea has lost pass-through under IT adoption, thereby showing the clear linkage between inflation-responsive rules and the loss of pass-through. Third, the sensitivity test of inflation expectations to import price shocks in Korea also supports this linkage. These findings imply that IT adoption, if conducted in a forward-looking manner, can be a resisting power against external price shocks, even in small, open, emerging market economies, as tested under the latest global financial crisis in Korea.

Key words: inflation targeting, pass-through, East Asian emerging market economies, policy reaction function, inflation expectations.
JEL Classification Codes: E52, F31, F41.

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1. Introduction

Inflation targeting (abbreviated as "IT") has become popular as a framework of monetary policy among not only advanced countries but also emerging market economies since the 1990s. Given the background that many countries in the world had seriously suffered from high inflation since the latter half of the 1970s, the necessity arose for monetary authorities to make a solid commitment to lower inflation through curbing expected inflation, without sacrificing output and employment, and thereby inflation targeting frameworks were adopted, first by such advanced countries as New Zealand, Canada, the United Kingdom, Sweden and Australia, in the early stages of the 1990s. A number of emerging market economies with pegged exchange rate regimes experienced unhappy financial crises under the drastic increase in international capital flow in the 1990s, and thus most of them switched to a floating exchange rate regime. Given the need for emerging-market countries to search for alternative nominal anchors, inflation targeting has been adopted by such countries as Chile, Brazil, South Africa and East Asian countries (such as Korea, Indonesia, Thailand, and the Philippines) since the 1990s and in the 2000s. This seems to have been probably because inflation targeting, which appears to have been successfully used by a number of advanced countries, has become as an attractive alternative anchor for emerging market economies.

The question is how we can evaluate the performance of the inflation targeting framework that has so far been adopted. There appears, by and large, to be a consensus in the academic literature that inflation targeting adopted in advanced countries is a supportive framework for monetary policy and macro-economy. As far as the cases of emerging market countries are concerned, however, there have been less than sufficient advances in research on inflation targeting to date, and no consensus views have been formed in the literature. Especially, in East Asian countries, which only started to introduce inflation targeting about ten years ago, there is little accumulation of academic studies and analyses on the performance of inflation targeting (see Section 2 below).

The largest difficulty that emerging market economies, especially small, open ones, are facing in performing inflation targeting is the issue of exchange rate fluctuations in the following two senses. First, a framework of inflation targeting can be realized only when monetary autonomy is secured under a floating exchange rate regime. Emerging market economies have, however, the problem of a "fear of floating," as suggested by Calvo and Reinhart (2002), which comes from a lack of credibility toward currency value, especially under the condition that their external debt is primarily denominated in

U.S. dollars. Their efforts to avoid exchange rate volatility prevent their monetary authorities from concentrating fully on inflation targeting. Second, exchange rate fluctuation itself gives some influence on domestic prices through the so-called "pass-through" effect, thereby making it difficult for their monetary authorities to control inflation and to perform inflation targeting. There is, however, a counter-argument against the negative message of the pass-through effect on inflation targeting. Some argue that an inflation targeting framework reduces the pass-through effect, in the sense that domestic agents are less inclined to change prices in response to a given exchange rate shock under the strong commitment of the monetary authority toward price stability.

This article, given the background mentioned above, aims at assessing the performance of inflation targeting frameworks from the perspective of the pass-through effect of external price shocks into consumer price inflation, focusing on the cases of the four East Asian countries which have adopted IT during the period of 1990-2009. The East Asian countries, which adopted IT soon after the 1997-98 Asian financial crises, experienced a global financial crisis in 2008-09 for the first time since IT adoption. As a typical example, Korea suffered from serious currency depreciation in 2008 under the post-IT regime, as well as in 1997 under the pre-IT regime. Our concern is whether or not there was any difference in the exchange rate pass-through effect between the pre- and post- IT regimes; in other words, whether domestic agents are really less likely to try to pass-through cost increases arising from exchange rate depreciation when the central bank acts aggressively to stabilize the domestic inflation rate under the IT regime. If we could identify a decline in the exchange rate pass-through effect in accordance with the shift to the IT regime, it might signify a resisting power of IT against external price shocks like exchange rate fluctuation even in small, open, emerging market economies. Gagnon and Ihrig (2004) developed a theoretical model that attributes the decrease in the rate of pass-through to increased emphasis on inflation stabilization by central banks. Our study will first identify whether IT adoption has really led monetary policy rule into stabilizing inflation in the four East Asian economies, and then examine, as the hypothesis of the model of Gagnon and Ihrig (2004) suggested, whether the inflation-responsive rule has led to a decline in pass-through effect, using latest quarterly data including the 2008-09 global financial crisis period. We will further conduct a sensitivity test of inflation expectations to import price shocks, focusing on the case of Korea, to verify the linkage between monetary policy and pass-through.

The rest of this paper is structured as follows. Section 2 reviews previous studies

and clarifies this paper's contribution. Section 3 conducts empirical analyses, introducing the methodology and data and discussing the estimate results. Section 4 summarizes the results and concludes.

2. Previous Studies and Our Contribution

This section first gives an overview of the literature on assessing the performance of inflation targeting frameworks, and then focuses on previous studies on the relationship between inflation targeting and exchange rate pass-through, and finally clarifies the contribution of this paper.

An Overview of the Literature on Inflation targeting

There have been a number of studies that deal with theories and empirical analyses of inflation targeting. In the early stage of the literature, Bernanke and Mishkin (1997), Mishkin and Posen (1997), and Bernanke *et al*. (1999) were the prominent papers that described a comprehensive overview of the major issues on inflation targeting that was adopted by industrial economies in the 1990s. Especially, Bernanke *et al*. (1999) clearly presented the following five elements as characterizing a framework of inflation targeting: (a) making public a specific numerical inflation target; (b) the central bank making an explicit commitment, by means of institutional arrangements, to setting price stability as its ultimate goal, and economic growth and employment as its secondary goals; (c) a forward-looking monetary policy by comprehensive consideration of all the economic indicators related to price stability; (d) accountability to market participants and the public about the monetary policy decisions, and the reasons that led to them, in relation to achieving inflation targets; and (e) the central bank holding itself accountable to achieving the inflation target. In the latest study of IT performance, Mishkin and Schmidt-Hebbel (2007) conducted a comprehensive examination focusing on industrialized countries, and suggested that inflation targeting helps countries achieve lower inflation in the long run, have smaller inflation response to oil-prices and exchange-rate shocks, strengthen monetary policy independence, improve monetary policy-efficiency, and obtain inflation outcomes closer to target levels. All in all, there seems to be a consensus that inflation targeting adopted in advanced countries is a supportive framework for monetary policy and macro-economy.

When we look at the cases of emerging market economies, however, the empirical evidence has been relatively scarce to date, because of the short- term of their experiences since IT adoption, and no consensus views have yet been formed in the

literature, due to their several hardships in managing the IT framework. Some have argued the conditional success of IT in emerging market economies. Mishkin (2000; 2004), discussing the advantages and disadvantages of inflation targeting in emerging market countries, argued that although inflation targeting is more complicated in emerging market countries and thus is not a panacea, when done correctly, inflation targeting can be a powerful tool to help promote macroeconomic stability in these countries. Picking up on the successful Chilean and Brazilian examples, he also noted that the success of inflation targeting cannot be solely attributed to the actions of the central bank: supportive policies such as the absence of large fiscal deficits and rigorous regulation and supervision of the financial sector have been crucial to its success. In the latest study, Lin (2009) evaluated the treatment effect of inflation targeting in thirteen developing countries, and found that the performance of a given inflation targeting regime can be affected by a country's characteristics such as the government's fiscal position, the central bank's desire to limit the movements of the exchange rate, its willingness to meet the preconditions of policy adoption, and the time length since the policy adoption.

Other studies presented suggestions and recommendations in managing IT in emerging market economies. Fraga *et al.* (2003), picking up on the Brazilian experience, argued that inflation targeting in emerging market economies has proven to be a challenging task due to the volatility of output, inflation, and interest rates and exchange rates, and recommended: i) high levels of communication and transparency; ii) target bands be treated mainly as communication devices; iii) a methodology to calculate convergence paths following a shock; and, iv) better IMF conditionality under inflation targeting. Ito and Hayashi (2004), through a cross-country comparison of inflation targeting practices among Korea, Indonesia, Thailand, and the Philippines, presented the following two recommendations: emerging market countries should set an inflation target central rate slightly higher and a target range slightly wider than typical advanced countries; small, open economy countries may pursue both an inflation target range and an implicit basket band exchange rate regime, as both targets are expressed in a range (the targets work as the source of stability in expectations, and the ranges allow some flexibility).

While the fore-mentioned studies represented rather supportive assessments toward IT in emerging market economies, Eichengreen (2002) offered negative messages on this issue. He argued that inflation targeting is difficult in emerging markets for three reasons: they are open; their liabilities are dollarized; and their policy makers lack credibility, which often comes from the difficulty of forecasting inflation. He also

stressed that although emerging markets that are less open, have well regulated financial institutions and markets on which foreign exposures can be hedged, and whose central banks possess a reasonable degree of policy credibility may prefer inflation targeting, the question is how many emerging markets will soon fall under this heading.

When we focus on the cases of East Asian economies, there is extremely little accumulation of empirical studies, because only about ten years have passed since IT adoption. East Asian countries adopted inflation targeting soon after the 1997-98 Asian currency crisis: Korea instituted it in 1998, followed by Indonesia and Thailand in 2000, and by the Philippines in 2002. Some of these countries have been studied from the viewpoint of a quantitative assessment of their IT adoption. In terms of the Korean evidence, Kim and Park (2006) examined the mode of operation in the Bank of Korea (BOK) by a monetary reaction function and the effects of its monetary policy on macroeconomic variables by a structural VAR model since IT adoption. They found that the BOK adjusts interest rates in response to changes in inflationary pressure as well as to the output gap, and also that in the impulse response to monetary policy shock the core CPI gradually decreases over time until it turns up about three years later. Regarding the evidence of Indonesia and Thailand, Siregar and Goo (2008), assessing their IT implementation by employing a markov-switching approach to examine the monetary reaction functions, showed that controlling inflationary expectations has indeed been the focus of the monetary policies of these economies, whereas the commitment prevailed during both stable and volatile regimes in Indonesia and only during the stable regime in Thailand (They also examined the relationship between IT adoption and pass-through effect, which will be described in the next section).

The Literature on Inflation Targeting and Exchange Rate Pass-through

We herein focus on the previous studies on the relationship between inflation targeting and exchange rate pass-through. The critics of IT adoption in emerging market economies emphasized the difficulties in controlling inflation due to exchange rate pass-through effect in small, open economies. The fore-mentioned study by Eichengreen (2002) argued that: changes in import prices due to movements in the exchange rate are passed through into domestic prices faster in emerging markets than in industrial countries; a history of inflation may have raised agents' awareness of, and sensitivity to, imported inflation and led to formal indexation; since the commitment to price stability may lack credibility, the transitory shocks leading to depreciation of the exchange rate may be validated by policy and hence become permanent; and, the high pass-through effect also makes inflation forecasting more difficult.

There is, however, a counter-argument against the negative message of the pass-through effect on inflation targeting: the inflation targeting framework may reduce the pass-through effect, in the sense that domestic agents are less inclined to change prices in response to a given exchange rate shock under the strong commitment of the monetary authority toward price stability. Gagnon and Ihrig (2004) tried to link monetary policy and pass-through by empirical analysis with world-wide samples for the first time.[2] They developed a simple theoretical model to explain how monetary policy influences inflation expectations and exchange rate pass-through at the macroeconomic level. The model implied that the anti-inflationary actions and credibility of the monetary authorities are important factors behind the reduced pass-through of exchange rate changes into consumer price inflation. Based on this model, they examined the monetary and inflation experiences of a sample of 20 industrial countries between 1971 and 2003, and showed the following outcomes. First, countries with low and stable inflation rates tended to have low estimated rates of pass-through from exchange rates to consumer prices. Second, countries in which either the level or the standard deviation of inflation declined, tended to have large declines in estimated rates of pass-through. Third, pass-through tended to decline the most in countries where monetary policy shifted strongly towards stabilizing inflation (in particular to the adoption of inflation targeting), as evidenced by an increase in the responsiveness of policy interest rates to expected inflation.

Edwards (2006) extended the study of the pass-through effect under inflation targeting regimes by refocusing on the role of nominal exchange rates as shock absorbers. He argued that it is important to make a distinction between the pass-through of exchange rate changes into the price of nontradable goods and into the domestic price of tradable goods; a desirable situation is one where pass-through coefficients for tradables and nontradables are low and different, with the pass-through for tradables being higher than that for nontradables. His empirical study of seven countries which have adopted IT (Australia, Brazil, Canada, Chile, Israel, Korea and Mexico) during the period of 1985-2005 indicated that for the majority of sample countries, both the short and long run pass-through effects declined in the post-IT period. There was no evidence, however, of significant differences in the pass-through effects between tradables and nontradables– the effectiveness of nominal exchange rates as a shock absorber. Siregar

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[2] A decline in exchange rate pass-through itself has been identified by several studies, e.g. Taylor (2000), Goldfajn and Werlang (2000), and Campa and Goldberg (2002). As for empirical study of the linkage between monetary policy and pass-through, Parsley and Popper (1998), estimating pass-through for US non-durable goods by industry, found evidence that US monetary policy does influence pass-through.

and Goo (2008) put the hypothesis of Edwards (2006) to the empirical test by focusing on the cases of Indonesia and Thailand, which have adopted IT, from January 1990 to June 2007. They found that while the pass-through effects declined in the post-IT period in these two economies, differences in the declined effects between tradables and nontradables appeared in Indonesia, but not in Thailand (the significance in the difference in Indonesia was not verified statistically).

Our Contribution

This paper helps to place the fore-mentioned debates in the literature into the context of observed facts, and provides empirical evidence on a decline in the pass through effect in accordance with the shift to the inflation targeting regime, by focusing on the East Asian economies which have adopted IT, using the latest quarterly data with the 2008 global financial crisis period included in them. We basically follow the analysis of Gagnon and Ihrig (2004), because subsequent papers, such as those of Edwards (2006) and Siregar and Goo (2008), could not always provide clear evidence of the effectiveness of nominal exchange rate as a shock absorber, as we saw in the section on the previous literature.

This paper extends the analysis of Gagnon and Ihrig (2004) in the following directions. First, we focus on the cases of the East Asian countries, while Gagnon and Ihrig (2004) covered only the cases of industrialixed nations. As noted in the previous section, the evidence on IT-evaluation in East Asian economies has been extremely scarce untill now. It seems, thus, to be an appropriate time to intensify the assessment of IT performance, now that about ten years have passed since IT adoption in the East Asian economies. Second, our estimation includes the period of the latest global financial crisis in 2008, while most of the previous studies have not yet done so. In fact, Korea and Indonesia seriously experienced a drastic currency depreciation in 2008, affected by the latest global financial crisis. Thus, our estimation using latest data enables us to compare the exchange rate pass-through effects between those in the 1997 crisis without the IT regime and those in the 2008 crisis with the IT regime. Especially, it seems to be the very first time that the resisting power of the IT regime against exchange rate shock has been put to a real test since the adoption of IT. Until the latest global financial crisis in 2008, the four economies which had adopted IT enjoyed a relatively stable environment in terms of exchange rate movements, which made it difficult for the adopted IT to be evaluated in terms of its resisting power to shocks. Third, our study, focusing on the case of Korea, directly investigates the sensitivities of inflation expectations to import price shocks, and compares them between those under

the post-IT regime and those under the pre-IT regime. This enables us to confirm that domestic agents are less inclined to change prices in response to a given shock under the strong commitment of the monetary authority toward price stability.

3. Empirical Studies

As noted above, Gagnon and Ihrig (2004) developed a simple macro model that explains how monetary policy influences inflation expectations and exchange rate pass-through at the macroeconomic level. This model shows us that when the monetary authority focuses strongly on stabilizing inflation, there is less pass-through of exchange rate movements into consumer prices. We herein turn to the empirical tests of the Gagnon and Ihrig (2004) model for the cases of the East Asian countries. We first estimate policy reaction functions for identifying IT implementation, and then examine the relationship between monetary policy rules and pass-through rates in the four East Asian countries which have adopted IT. We further conduct a case study on Korea for investigating the sensitivities of inflation expectations against the fluctuations of import price.

3.1 Evidence in the Four East Asian IT Adopters

The analysis here targets the four East Asian countries which have adopted IT, i.e. Korea, Indonesia, Thailand, and the Philippines, with an entire sample period of 1990-2009. For the estimation below, we divide the sample period into the 1990s and the 2000s, and call the former period the pre-IT one, and the latter period the post-IT one. This division of the sample period does not strictly correspond to the date of the institution of IT, i.e. Korea's was in 1998, Indonesia and Thailand's were in 2000, and the Philippines' was in 2002. But this does not matter, however, since there does not seem to any guarantee that the date of the announcement of IT adoption is coincident with a change in central bank behavior. This is why we estimate policy reaction functions to verify IT implementation.

The source of all the data used for the estimations below in quarterly term comes from the International Financial Statistics of the International Monetary Fund (IMF). We use "Money Market Rate" in line 60b for interest rate; "Consumer Prices (2005=100)" in line 64 for price index; "GDP Volume (2005=100)" in line 99bvpf for GDP; "Market Rate per US Dollar" in "Period Average" in line *rf* ("Official Rate" only in Thailand) for exchange rate. Regarding import prices, we use "Import Prices" in line

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76.x for Korea and the Philippines, and "Unit Value of Import" in line 75 for Thailand, but this is not available for Indonesia. The data availability is shown in the Appendix.

Monetary Policy Rules

We now start by estimating a policy reaction function during each of the pre- and post- IT periods in each sample economy. The purpose is to examine whether IT adoption in each country has really been linked with a monetary policy rule emphasizing on stabilizing inflation. We basically follow the estimation model of Clarida et al. (1998), and such subsequent studies as Gagnon and Ihrig (2004), Kim and Park (2006), and Siregar et al. (2008). We estimate two kinds of Taylor-type monetary policy rules using: a forward-looking specification and backward-looking one in the following equation of (1) and (2) respectively. It is because our estimation of policy reaction function is targeting emerging market economies, which seem to have not necessarily managed monetary policy in a forward-looking way, as Eichengreen (2002) pointed out that emerging market economies have often faced the difficulty of forecasting inflation as one of the hardships in their IT management. Clarida et al. (1998), in estimating the monetary policy rules of the G3 (Germany, Japan, and the US), took both of the forward-looking specifications as the baseline and the backward-looking function as the alternative for their comparison, and found that the G3 have pursued the forward-looking rule responding to anticipated inflation as opposed to lagged inflation. Regarding subsequent studies, while Gagnon and Ihrig (2004), and Kim and Park (2006) used the forward-looking specification for estimating policy reaction function in 20 industrial countries and in Korea respectively, Siregar et al. (2008) adopted the backward-looking one in the cases of Indonesia and Thailand.[3] Our estimation equations are as follows:

$$i_t = \theta_0 + \theta_1 i_{t-1} + \theta_2 E_t \Delta p_{t+4} + \theta_3 E_t gap_{t+4} \qquad (1)$$
$$i_t = \theta_0 + \theta_1 i_{t-1} + \theta_2 \Delta p_{t.t-4} + \theta_3 gap_t \qquad (2)$$

where i is the end-of-quarter nominal money market rate, p is the quarterly consumer price index, and *gap* is the output gap, calculated as the difference between real GDP and an HP-filter of the GDP series (as an estimate of potential GDP). $E_t \Delta p_{t+4}$ is the

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[3] The estimated equation of Siregar et al. (2008) includes the expected, but lagged inflation of $E_{t-1}\pi_t$, $E_{t-2}\pi_{t-1}$, and $E_{t-3}\pi_{t-2}$, thereby being classified into a backward-looking specification. Though the estimated equation of Siregar et al. (2008) includes exchange rate variable, our estimation excludes it because their estimation result does not show any significance in its inclusion and also because the inclusion itself is theoretically controversial. See, for example, Taylor (2001).

expectation at date t of the rate of inflation between date t and date $t+4$.[4] $\Delta p_{t,t-4}$ is the rate of inflation between date $t-4$ and date t. The coefficient θ_1 indicates the speed of monetary policy adjustment. The coefficient θ_2 represents the immediate response of monetary authority to inflation, while the coefficient θ_3 indicates that to output gap. The expression $\theta_2/(1-\theta_1)$, thus, shows the long-run response to inflation in the presence of slow adjustment ($\theta_1 > 0$). Similarly, the long-run response of the monetary authority to the output gap is $\theta_3/(1-\theta_1)$. We can confirm the significant existence of these long-run responses by the Wald test. For a monetary authority that moves to put more emphasis on stabilizing inflation in the post-IT period, we expect to find a significantly larger coefficient of $\theta_2/(1-\theta_1)$ as a long-run inflation response in the post-IT period than that in the pre-IT period.

Estimating the equations above may entail an endogeneity problem, in that they contain the lagged dependent variable among the explanatory variables, and that interest rates may also affect future changes in explanatory variables. For obtaining unbiased and consistent estimation, we herein adopt the Generalized Method of Moments (GMM). We use the first-differenced endogenous variables with necessary lagged periods as instrumental variables, and then verify instrumental validity by the Sargan test of over-identifying restrictions. (The Sargan test did not suggest rejection of the instrumental validity at conventional levels for any of the cases estimated in Table 1.)

Table 1 reports for each country regression the long-run monetary policy coefficient estimates with standard errors for both forward-looking and backward-looking specifications in the two estimation periods: the pre-IT period and the post-IT period. Korea has significantly positive coefficients on the responses to inflation and output gap only in the post-IT period under the forward-looking specification, and also indicates an increase in the coefficient levels on both responses from the pre-IT period to the post-IT period under that specification. Indonesia has the necessary data only for the post-IT period, in which significantly positive coefficients on the responses to inflation and output gap are identified under the backward-looking specification. Thailand has significantly positive coefficients on the responses to inflation and output gap only for the post-IT period under the backward-looking specification, and also represents an increase in the coefficient levels on both responses from the pre-IT period to the post-IT period under that specification. The Philippines, however, has no significant coefficients in any cases.

We interpret the estimation results above as follows. First, we could find some linkage between IT adoption and a monetary policy rule emphasizing on stabilizing

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[4] Since we presume rational expectations, we use observed data for estimating inflation expectations.

inflation except the Philippines, by observing the existence of a significantly positive and larger coefficient of inflation response in the post-IT period for the IT adopters except for the Philippines. Second, under IT adoption, Korea appears to have taken a forward-looking monetary policy rule, while Indonesia and Thailand seem to have adopted a backward-looking one. This outcome seems to be consistent with the results of the forward-looking estimation of Kim and Park (2006) regarding Korea, and those of the backward-looking estimation of Siregar et al. (2008) regarding Indonesia and Thailand. Third, the failure of the Philippines to prove an inflation-responsive policy rule even under its IT adoption may originate from its loss of monetary autonomy: the Philippines came back to a pegged exchange rate regime in December 1999 and has still maintained it even under IT adoption (Reinhart and Ilzetzki, 2009); and has kept high correlation of its domestic interest rate with US interest rate (Taguchi 2009).

Pass-through Rates

We next turn to examining the pass-through effects of the four sample economies during both the pre- and post- IT periods. Figure 1 simply reports the quarterly percentage changes over last year about inflation rates, exchange rates and import prices in the targeting countries. It appears in each sample country that the average inflation rate went down from the 1990s toward the 2000s, and also that the relationship between inflation rate and exchange rate (or import price) has less linkage in the 2000s than in the 1990s. This section, then, intends to statistically clarify the trend of pass-through rates in the 1990s and 2000s. We specify the equation for estimating pass-through rates basically following Gagnon and Ihrig (2004), but modify it by diversifying lagged patterns and external price shocks in the following ways:

$$\Delta p = \delta_0 + \delta_1 \Delta p_{t-1} + \delta_2 \Delta(e_t + p^*_t) + \delta_3 \Delta(e_{t-1} + p^*_{t-1})$$
(a)

$$\Delta p = \delta_0 + \delta_1 \Delta p_{t-1} + \delta_2 \Delta(e_t + p^*_t) + \delta_3 \Delta(e_{t-1} + p^*_{t-1}) + \delta_4 \Delta(e_{t-2} + p^*_{t-2})$$
(b)

$$\Delta p = \delta_0 + \delta_1 \Delta p_{t-1} + \delta_2 \Delta(e_t + p^*_t) + \delta_3 \Delta(e_{t-1} + p^*_{t-1}) + \delta_4 \Delta(e_{t-2} + p^*_{t-2}) + \delta_5 \Delta(e_{t-3} + p^*_{t-3})$$
(c)

$$\Delta p = \delta_0 + \delta_1 \Delta p_{t-1} + \delta_2 \Delta(e_t) + \delta_3 \Delta(e_{t-1})$$
(a')

$$\Delta p = \delta_0 + \delta_1 \Delta p_{t-1} + \delta_2 \Delta(e_t) + \delta_3 \Delta(e_{t-1}) + \delta_4 \Delta(e_{t-2})$$
(b')

$$\Delta p \quad = \quad \delta_0 \quad + \quad \delta_1 \Delta p_{t\text{-}1} \quad + \quad \delta_2 \Delta(e_t) \quad + \delta_3 \Delta(e_{t\text{-}1}) \quad + \delta_4 \Delta(e_{t\text{-}2}) \quad + \delta_5 \Delta(e_{t\text{-}3})$$
(c')

The variables p, e and $p*$ are the quarterly consumer price index, the exchange rate per US dollar and import price index on US dollar base, respectively. As shown above, two types of pass-through equations with three lagged patterns are estimated: the one for import price (a, b, c), and the other for exchange rate (a', b', c'). The former equation is not estimated for Indonesia due to the lack of data availability. The coefficients δ_2, δ_3, δ_4 and δ_5 indicate the immediate lag impact of the change in exchange rate or import price on consumer price change. The equations incorporate lagged adjustment of inflation to shocks, so that $(\delta_2 + \cdots + \delta_5)/(1 - \delta_1)$ measures the long-run pass-through effect to overall inflation. We can verify the significant existence of the long-run pass-through rate by the Wald test.

Like the equations in the previous section, estimating the equations above may have an endogeneity problem, in that they contain the lagged dependent variable among the explanatory variables, and domestic inflation may affect future changes in exchange rate. We thus adopt the GMM for estimation, and conduct the Sargan test for verifying instrumental validity. (The Sargan test did not suggest rejection of instrumental validity at conventional levels for any cases estimated in Table 2.)

Table 2 reports for each country regression the long-run rates of pass-through and standard errors both for exchange rate and import price with three lagged patterns in the two estimation periods: the pre-IT period in the 1990s and the post-IT period in the 2000s. The estimation results show that it is only Korea that has a clear contrast in any specifications of pass-through equations: the significantly positive existence of pass-through in the pre-IT period and the loss of pass-through in the post-IT period. Indonesia, Thailand and the Philippines indicate mixed outcomes: the combination of the existence and loss of pass-through in the pre- and post-IT period differs depending on the specifications of pass-through equations, i.e. those for exchange rate and import price with three lagged patterns (Indonesia lacks the evidence on the pass-through of import prices).

We can then summarize the implications of estimation results combining those for policy reaction function and those for pass-through rates as follows. As noted earlier, the simple macro model of Gagnon and Ihrig (2004) showed that when the monetary authorities focus on stabilizing inflation, there is less pass-through of external price shocks into consumer prices. We could successfully identify this linkage, i.e. the one between the loss of pass-through effect and the inflation-responsive rule, only for Korea

in the post-IT period, which was proven to take a forward-looking policy rule. Indonesia and Thailand, which had an inflation-responsive rule in a backward-looking manner, and the Philippines, which had no inflation-responsive rule, could not signify a clear linkage with pass-through effect. The outcomes were consistent with Gagnon and Ihrig (2004), since their macro model presumes the forward-looking type of monetary policy rules for monetary authorities' behavior. We speculate that the difference in pass-through effects may come from the difference between the way that the private sector forms expectations on inflation under forward-looking and under backward-looking policy rules: the forward-looking rule of the central bank makes it easier for private agents to form their expectations consistent with the targeted inflation, by sharing reliable inflation-forecasting information presented by the central bank. Under the backward-looking rule, accompanied often with lack of reliable inflation forecasting, private agents cannot recognize the intent of the central bank (see Eichengreen (2002), pp23) regarding on what grounds and criteria the central bank has set an inflation target to certain level, which makes it difficult for them to believe in targeted inflation. The lack of credibility of targeted inflation, then, may render expectations on inflation subject to transitory external price shocks, thereby leading to high pass-through structure of economies. The difference in policy rules, thus, may create the difference in the way to form expectations on inflation, and so the difference in pass-through effects against external price shocks. The sensitivities of inflation expectations against external price shocks will directly be examined as the case study in Korea in the next section.

3.2 Case Study in Korea: Inflation Expectations and Import Price Shocks

We herein conduct a case study on Korea, for which the data of inflation expectations are available, for investigating the sensitivities of inflation expectations against the fluctuations of import price both under both the pre- and post- IT regimes. Figure 2 overviews the trends of time series of both inflation expectations and import price. The data on inflation expectations are obtained from the semi-quarterly Korea Development Institute (KDI) economic outlook which has been published since 1982[5], and the data on import price are from the Economic Statistics System (ECOS) managed

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[5] The KDI economic outlooks have normally published the inflation expectations for the year of publication and the next year. We calculated the inflation expectations for a specific month by the weighted-average of two numbers. For example, the inflation expectations for the next 12 months in September 2000 were calculated by 'inflation expectations for 2000 × 4/12 + inflation expectations for 2001 × 8/12'.

by the Bank of Korea. It indicates that inflation expectations have become more stable from the 1990s towards the 2000s although import prices have fluctuated to the same degree through both periods, and also that there is a contrast in the movements of inflation expectations between the 1997-98 currency crisis period and the 2008 financial crisis: synchronizing with import price fluctuation in the former crisis and rather keeping stability despite import price hike in the latest crisis.

We now put the overviewed relationship of both series into a statistical test. Kim and Park (2006) examined the sensitivity of inflation expectations to changes in actual inflation, and found that inflation expectations were more sensitive to changes in actual inflation in the period before than in the period after inflation targeting. We modify their estimation following our concerns, by replacing "actual inflation" with "actual change in import price". Our estimation equation is, thus, as follows:

$$\Delta p^e_{\text{t}} = \alpha + \beta \, \Delta imprice_{\text{t}} + \varepsilon_{\text{t}} \tag{3}$$

The variables p^e_{t}, $imprice_{\text{t}}$ are the inflation expectations for the next 12 months and the change in import price on Korean Won base for the past 12 months in the period of t, respectively. Table 3 reports the result of regression and it shows that the estimated values of β are significant at the conventional levels during the pre- and post- IT periods. However, it should be noted that the estimated β is smaller for the post- IT period than the pre- IT period.

The estimation result above in the Korean case, i.e. the lower sensitivity of inflation expectations against import prices in the post-IT period, shows us that under IT adoption domestic agents have been less inclined to change prices in response to a given external price shock. The previous section already identified the linkage between the loss of pass-through effect and the forward-looking inflation-responsive rule in Korea in the post-IT period. The Korean case study, thus, may endorse this linkage in the sense that it implies that the strong commitment of the monetary authority toward price stability in a forward-looking manner by IT adoption affects the way for private sectors to form expectations regarding inflation

4. Concluding Remarks

This article set out to assess the performance of inflation targeting frameworks from the perspective of the pass-through effect of external price shocks into consumer price inflation, focusing on four East Asian economies during the period for 1990-2009, i.e.

Korea, Indonesia, Thailand and the Philippines, which adopted inflation targeting frameworks soon after the 1997-98 Asian currency crisis. We first examine their monetary policy rules for identifying IT implementation, and then investigate the linkage between inflation-responsive rules and lower pass-through rates, suggested by Gagnon and Ihrig (2004).

Our main findings are as follows. First, under IT adoption, Korea takes an inflation responsive rule in a forward-looking manner, while Indonesia and Thailand take the rule in the backward-looking manner. Second, only Korea loses pass-through under IT adoption, thereby showing the clear linkage between the inflation-responsive rule and the loss of pass-through. Third, the sensitivity test of inflation expectations to import price shocks in Korea also supports this linkage. These findings imply that IT adoption, if conducted in a forward-looking manner, can be a resisting power against external price shocks even in small, open, emerging market economies, as tested under the latest global financial crisis in Korea.

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Appendix Data Availability for Estimation

	Korea	Indonesia	Thailand	Philippines
Money Market Rate	1990Q1~2009Q3	1990Q1~2009Q4	1990Q1~2009Q4	1990Q1~2009Q3
Consumer Prices	1990Q1~2009Q4	1990Q1~2009Q4	1990Q1~2009Q3	1990Q1~2009Q3
GDP Volume	1990Q1~2009Q3	1997Q1~2009Q3	1993Q1~2009Q3	1990Q1~2009Q4
Exchange Rate	1990Q1~2009Q4	1990Q1~2009Q4	1990Q1~2009Q4	1990Q1~2009Q4
Import Prices	1990Q1~2009Q3	-	-	1996Q1~2006Q4
Unit Value of Import	-	-	1990Q1~2009Q3	-

Table 1 Estimated Result of Policy Reaction Functions

	Korea	Indonesia	Thailand	Philippines
Pre-IT Period: the 1990s				
Forward-looking Functions				
Inflation	-2.740		8.519	-0.564
	(15.540)		(28.323)	(1.759)
GDP Gap	-2.019		26.542	16.081
	(28.851)		(84.974)	(28.150)
<Sargan test>	<0.985>		<0.997>	<0.999>
Backward-looking Functions				
Inflation	6.705		0.842	24.116
	(7.940)		(1.284)	(425.023)
GDP Gap	9.010		-1.574	-210.153
	(18.105)		(1.409)	(3,596.964)
<Sargan test>	<0.874>		<0.831>	<0.987>
Post-IT Period: the 2000s				
Forward-looking Functions				
Inflation	0.987 ***	-0.005	-2.067	-2.159
	(0.248)	(0.203)	(2.247)	(50.779)
GDP Gap	0.842 ***	7.380 *	1.153	19.177
	(0.194)	(4.261)	(1.951)	(428.017)
<Sargan test>	<0.992>	<0.997>	<0.998>	<0.999>
Backward-looking Functions				
Inflation	-5.521	0.766 ***	0.915 ***	0.006
	(6.323)	(0.245)	(0.323)	(0.226)
GDP Gap	-2.420	9.442 **	3.266 **	-0.183
	(2.729)	(3.983)	(1.409)	(1.335)
<Sargan test>	<0.854>	<0.991>	<0.990>	<0.979>

Notes:
1) ***, **, and * indicate that the coefficient is significant at the 90,95,and 99 percent levels, respectively.
2) Standard errors in parenthese.

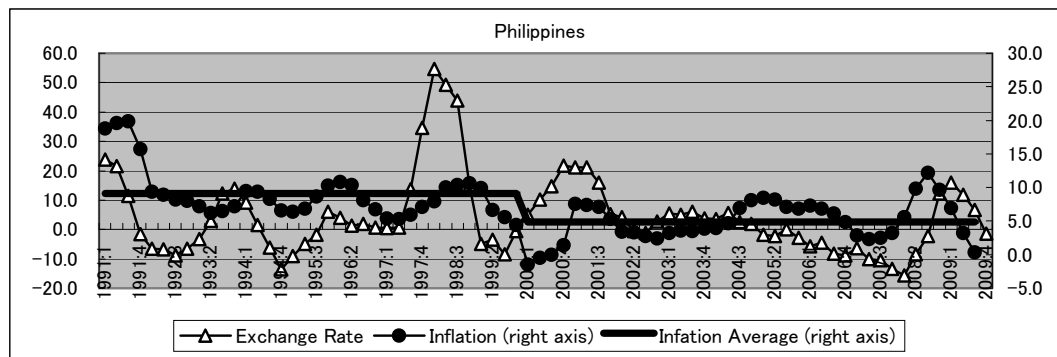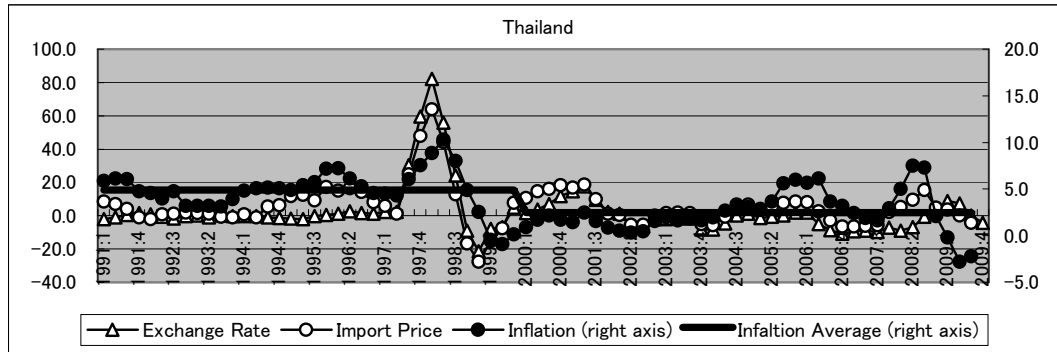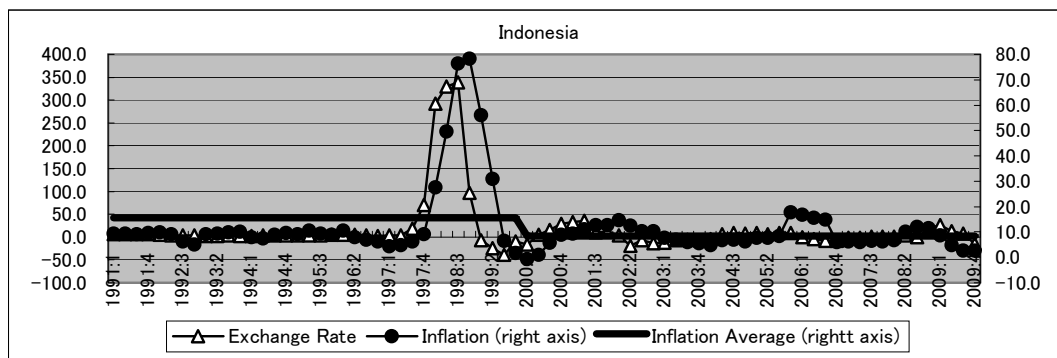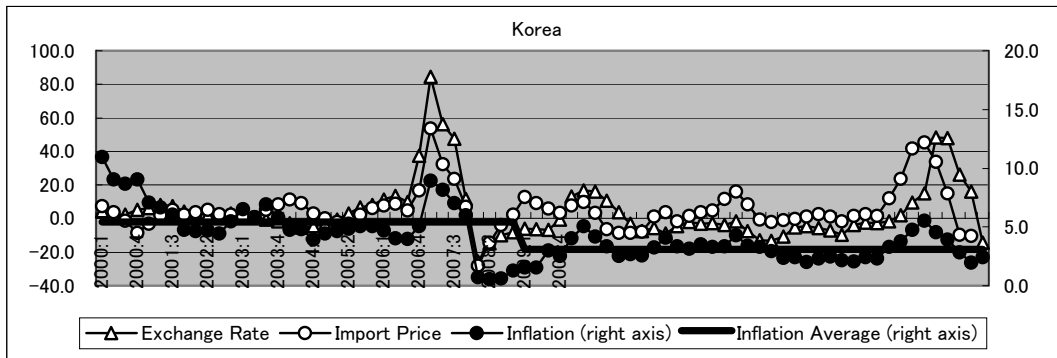# Figure 1 Inflation Rates, Exchange Rates and Import Prices

Korea

Indonesia

Thailand

Philippines

Table 2 Estimated Result of Pass-through Rates

	Korea	Indonesia	Thailand	Philippines
Pre-IT Period: the 1990s				
Import Price (a)	0.088 ***		0.382	-0.273
	(0.026)		(0.272)	(0.250)
<Sargan test>	<0.994>		<0.992>	<0.881>
Import Price (b)	0.093 ***		0.189 **	-0.673
	(0.035)		(0.088)	(0.769)
<Sargan test>	<0.977>		<0.976>	<0.831>
Import Price (c)	0.099 ***		0.094 **	0.191 ***
	(0.032)		(0.037)	(0.055)
<Sargan test>	<0.849>		<0.971>	<0.730>
Exchange rate (a')	0.165 ***	12.464	-2.394	0.131 ***
	(0.053)	(59.426)	(13.533)	(0.033)
<Sargan test>	<0.994>	<0.899>	<0.994>	<0.674>
Exchange rate (b')	0.168 *	0.658 ***	1.464	0.145 **
	(0.086)	(0.084)	(5.684)	(0.066)
<Sargan test>	<0.984>	<0.888>	<0.977>	<0.753>
Exchange rate (c')	0.088 ***	0.537 ***	0.041	0.196 ***
	(0.021)	(0.016)	(0.056)	(0.066)
<Sargan test>	<0.957>	<0.999>	<0.965>	<0.917>
Post-IT Period: the 2000s				
Import Price (a)	-0.028		0.330 ***	0.121 ***
	(0.032)		(0.122)	(0.036)
<Sargan test>	<0.998>		<0.989>	<0.954>
Import Price (b)	-0.001		0.145	0.285 ***
	(0.029)		(0.202)	(0.069)
<Sargan test>	<0.996>		<0.971>	<0.990>
Import Price (c)	-0.033		-0.795	0.267 **
	(0.056)		(0.967)	(0.110)
<Sargan test>	<0.850>		<0.988>	<0.887>
Exchange rate (a')	-0.053	-0.006	-1.145	-0.047
	(0.025)	(0.135)	(0.758)	(0.289)
<Sargan test>	<0.998>	<0.977>	<0.999>	<0.837>
Exchange rate (b')	0.042	-0.168	-1.472	-0.248
	(0.026)	(0.487)	(0.862)	(0.646)
<Sargan test>	<0.988>	<0.779>	<0.995>	<0.981>
Exchange rate (c')	-0.004	0.228 ***	-0.398	0.151
	(0.039)	(0.087)	(0.974)	(0.178)
<Sargan test>	<0.992>	<1.000>	<0.969>	<0.940>

Notes:

1) ***, **, and * indicate that the coefficient is significant at the 90,95,and 99 percent levels, respectively.

2) Standard errors in parenthese.

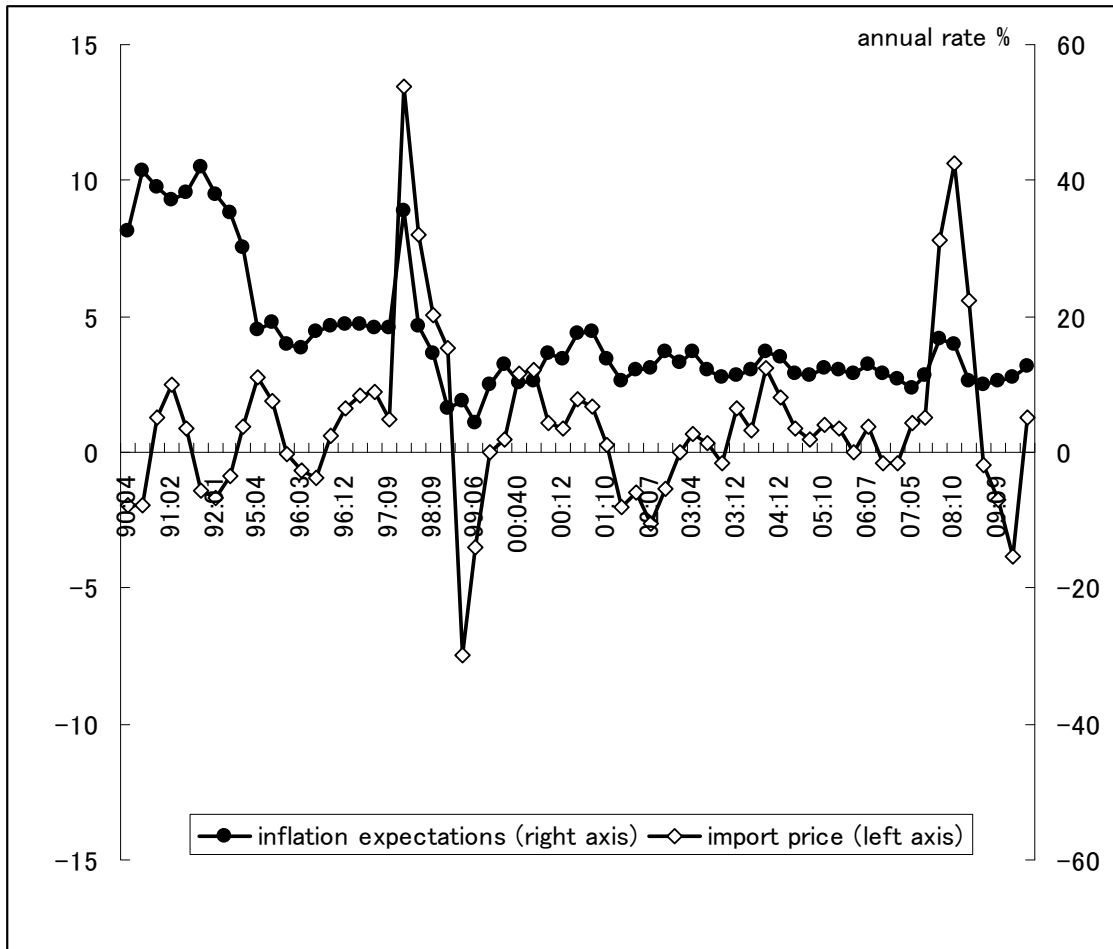**Figure 2 Inflation Expectations and Import Price in Korea**

Table 3 Estimated Results of Inflation Expectations in Korea

Δp^e_t	Pre-IT Period: the 1990s	Post-IT Period: the 2002s
Const.	-0.002	0.023
	(0.226)	(0.081)
$\Delta imprice_t$	0.044 **	0.033 ***
	(0.018)	(0.008)

Notes:
1) *, **, and *** indicate that the coefficient is significant at the 10%, 5%, and 1% level, respectively.
2) Import price is Korean Won base.
3) Standard errors in parentheses.