MONETARY POLICY RULES UNDER THE INFLATION TARGETING FRAMEWORK IN EMERGING ASEAN ECONOMIES

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EXECUTIVE SUMMARY

Understanding the performance of a central bank in controlling inflation is crucial for the formulation of monetary policy. There is skepticism and debate regarding the efficacy of monetary policy in achieving stable inflation in developing economies. To provide a more recent performance assessment through a series of studies, this dissertation explores the linkages of emerging ASEAN economies' monetary policy rules under the inflation targeting (hereafter IT) framework. This dissertation is hereby divided into the following four chapters.

Chapter 1 provides the background on monetary policy frameworks in emerging ASEAN economies which are specifically grouped into inflation targeting economies (Indonesia, the Philippines, and Thailand) and non-inflation-targeting economies (Malaysia and Vietnam). This deepens the understanding of each country's monetary policy objectives and stances and also highlights the similarities and differences between IT adopters and non-IT adopters.

Chapter 2 examines the monetary policy rules of five emerging ASEAN economies: Indonesia, the Philippines, and Thailand as the adopters of IT, and Malaysia and Vietnam as non-IT adopters. This study applies a generalized method of moments (hereafter GMM) that provides a consistent and efficient estimator for the policy-rule estimation that contains endogenously determined variables. The major research questions are twofold: whether the monetary policy rules of the IT adopters have fulfilled the Taylor principle, and what has been the difference in monetary policy rules between the IT adopters and the non-IT adopters. The main findings are as follows. Regarding the IT adopters, their monetary policy rules are characterized by inflation-responsive rules fulfilling the Taylor principle. As for the non-IT adopters, while Malaysia solely follows an output-gap responsive rule, Vietnam follows mixed rules with inflation and exchange rate-responsiveness. The policy implications for the IT adopters are that there may be room to make their policy-rate responses more elastic to inflation, and non-IT adopters may feel the need to adopt an explicit IT framework to ensure a robust effect of policy rate on stabilizing inflation.

Chapter 3 investigates the relationship between the IT framework and the exchange rate pass-through (hereafter ERPT) to consumer prices in small open ASEAN economies using a two-variable vector autoregressive (hereafter VAR) model with quarterly data covering the whole sample period from the first quarter of 1990 to the first quarter of 2020. The empirical analysis is divided into two sub-periods: pre-IT and post-IT. The results from the impulse response analysis identify the existence of the ERPT during the pre-IT sub-period and the loss of the ERPT during the post-IT sub-period in all sample countries. The study further considers that the loss of the ERPT is also attributable to the inflation-responsive monetary policy rule in Indonesia, the Philippines, and Thailand.

Chapter 4 aims to reassess the monetary policy rule under IT in Indonesia, the Philippines, and Thailand, with a focus on its conformity to the Taylor principle, through the New Keynesian dynamic stochastic general equilibrium (hereafter DSGE) model, with Bayesian estimations, and a small open economy version of the model. The main findings are summarized below. First, the GMM estimations identified inflation responsive rules fulfilling the Taylor principle, with a forward-looking manner in Indonesia and Thailand. Second, the Bayesian estimations of the New Keynesian DSGE endorsed the GMM estimation results from Chapter 2, as the former estimations produced outcomes consistent with the latter ones regarding policy rate reactions to inflation, while conforming to the Taylor principle.

Based on the empirical findings in Chapters 2-4, the conclusions can be summarized as follows. First, emerging ASEAN economies' monetary policy rules have been upgraded to the forward-looking rule in most cases, except the Philippines and Malaysia. Second, non-IT economies are encouraged to develop an explicit-IT implementation to achieve a more robust performance. Third, the inflation-responsive rule fulfilling the Taylor principle is emphasized as a contributor to the loss of the ERPT after the adoption of IT in Indonesia, the Philippines, and Thailand. Fourth, the responses to inflation in these emerging ASEAN economies, however, are far weaker than those of advanced economies, implying that there is room to make their reactions more elastic to inflation. Lastly, it is proved that both estimations of partial policy reaction functions and the New Keynesian macroeconomic model with micro-foundations are producing results consistent with the modality of monetary policy rules in emerging ASEAN economies.

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LIST OF ABBREVIATIONS

ADF	Augmented Dicky Fuller
AIC	Akaike Information Criterion
ASEAN	Association of Southeast Asian Nations
BI	Bank Indonesia
BNM	Bank Negara Malaysia
BOT	Bank of Thailand
BSP	Bangko Sentral ng Pilipinas
DSGE	Dynamic Stochastic General Equilibrium
ERPT	Exchange Rate Pass-Through
FPE	Final Prediction Error
FX	Foreign Exchange
GMM	Generalized Method of Moments
HQ	Hannan-Quinn Information Criterion
IT	Inflation Targeting
LR	Likelihood-Ratio
OPR	Overnight Policy Rate
PP	Philips-Perron
RPP	Reserve Repurchase
SBV	State Bank of Vietnam
SC	Schwarz Information Criterion
VAR	Vector Auto-Regressive

LIST OF EQUATIONS

INTRODUCTION

We all aim to avoid the experience of inflation spiraling out of control. Inflation can damage several components of an economy by distorting prices, discouraging investment, and inhibiting growth. Therefore, a country's monetary authority puts great effort into controlling inflation through a wide range of frameworks.

Financial deregulation and liberalization have encouraged the introduction of changes in the structure of the financial system in the past two decades. The changes, however, appear to have weakened the traditional relationship linking money supply to income and prices, which has prompted many central banks to reconsider their approach to monetary policy. Many central banks have diverted from conducting monetary policy that rely on intermediate targets such as monetary aggregates or exchange rates, to focusing on inflation itself. One of the widely adopted approaches is the inflation targeting (IT) framework. IT is a straightforward system to control inflation that can be easily understood by the public. It also allows a central bank to maintain greater focus on achieving price stability and provides an opportunity to tighten monetary policies before inflationary pressures become intense (Debelle et. al., 1998). The keys to successful inflation targeting implementation are: a strong commitment to price stability, central bank independence, great forecasting ability, transparency, and a sound financial system. Nevertheless, in practice, a country may have dual or triple goals such as output growth and employment promotion – aside from targeting inflation, which results in an inflationary bias according to economists, since those goals can conflict with price stability. One of the requirements of inflation targeting is to avoid targeting other indicators such as exchange rates. Despite that, some countries under IT either explicitly or implicitly intervene in the foreign exchange (FX) market due to the "fear of floating." The exchange rate target may interfere with the inflation targets and become the cause of the authority's lack of attention to price stability, resulting in the loss of public assurance. This practice usually occurs in emerging economies, which are the main focus of this dissertation.

One of the preliminary steps to have a monetary policy centered on IT is to have sufficient technical capacity to employ a model for domestic inflation forecasting (Debelle et. al., 1998). The heart of inflation forecasting lies in a forward-looking operating procedure that considers indicators and information on future inflation to get closer to the decided targets. However, the findings from previous studies show that, unlike advanced economies, many developing economies technically remain on a backward-looking practice. This issue has urged this dissertation to reveal the most recent performance of emerging ASEAN economies in terms of their monetary policy rules progression, and whether they have proceeded to adopt the forward-looking rules.

In this dissertation, we focus on assessing the performance of small open ASEAN economies under IT in stabilizing inflation, while diving into the evidence on the conformity to the Taylor principle and the link between inflation-responsive monetary policy rules and the loss of the ERPT. For these purposes, this study applies methodologies such as the estimations of a monetary policy reaction function, the VAR model, and the New-Keynesian DSGE model. The dissertation is organized into four chapters as follows. Chapter 1 details the in-depth study of each sample economy's past and current monetary policy frameworks. Chapter 2 shows the link between their announced monetary policy rules and the estimated policy rules, with a focus on their reactions to inflation. Chapter 3 maps the linkage between the IT framework and the loss of the ERPT. Finally, Chapter 4 showcases the reassessment of the conformity of their monetary policy rules to the Taylor principle via the use of a macroeconomic model with micro-foundations, namely the New-Keynesian DSGE model.

CHAPTER 1 EMERGING ASEAN ECONOMIES' MONETARY POLICY OVERVIEW

This chapter provides an overview of the monetary policy frameworks of the five emerging ASEAN economies. Figure 1 displays key indicators related to the monetary policy operation: consumer prices, central bank policy rates, and inflation targeting points and bands. The following three sections, Section 1.1, Section 1.2, and Section 1.3, provide institutional descriptions for exchange rate regimes, inflation targeting basic frameworks, and non-inflation targeting frameworks, respectively.

The monetary policy framework incorporates both the institutional setup of the central bank, that is, mandate, governance structure, and decision-making process, and the specification of its objectives, instruments, strategies, operating targets, and communications (Corbacho and Shanaka, 2018). The monetary policy strategy assists the central bank in adjusting policy instruments to implement operating targets and procedures. Furthermore, effective communication fosters the central bank's transparency and credibility, which are vital in shaping market expectations.

1.1 Exchange Rate Regimes

One phenomenon that prompted central banks in the ASEAN region to reexamine monetary policy frameworks and reevaluate the appropriateness of exchange rate regimes was the Asian Financial Crisis in 1997. Before the crisis, the monetary policy environment in Indonesia, the Philippines, Thailand, Malaysia, and Vietnam was characterized by tightly managed exchange rates or pegged exchange rate regimes. The fixed exchange rate regime proved successful in curbing inflation and promoting economic growth. However, severe exchange rate pressures and exchange rate depreciations caused by excessive borrowing and currency mismatches by corporates and banks urged these economies to increase their exchange rate flexibility. The transition from the pre-crisis to post-crisis regimes has been different across countries.

Indonesia, in its pursuit of macroeconomic stability, abolished its crawling peg exchange rate regime and moved toward a more flexible exchange rate regime – alongside the introduction of capital flow management measures. The Philippines moved from a managed exchange rate regime and a closed capital account – which limited its monetary policy independence – toward gradually liberalizing its capital account and adopting a more flexible exchange rate regime. Thailand transitioned from a managed exchange rate regime to adopting a more flexible exchange rate regime as well as managing its capital account more tightly. Malaysia took a slightly different approach. It adopted a fixed exchange rate regime but eventually moved to a flexible exchange rate regime later in 2005. As for Vietnam, the country shifted from a pegged exchange rate regime to a managed floating exchange rate regime and has been emphasizing greater exchange rate flexibility as an appropriate strategy going forward but has limited it to gradual adjustments to avoid disruptions in confidence and economic activity (International Monetary Fund, 2009).

The adoption of a flexible exchange rate regime has enabled the three countries to gain greater interest rate autonomy. Currently, the de jure exchange rate regime is "free floating" in Indonesia and the Philippines, "floating" in Thailand and Malaysia, and "managed floating" in Vietnam, respectively. Whereas, the de facto exchange rate regime, as classified by the International Monetary Fund (IMF), see International Monetary Fund (2019a)), is "floating" for all previously mentioned economies – except Vietnam, whose exchange rate arrangement is classified as a "stabilized arrangement[1]" (see Appendix A for the summary of the status of monetary policy frameworks and operational practices in emerging ASEAN economies as of the last quarter of 2020). On a side note, compared to advanced economies, emerging ASEAN economies have relatively lower de facto exchange rate flexibility. However, their exchange rates exhibit lower volatility than other free-floating currencies, such as the Japanese yen, which implies the impact of extensive use of FX intervention[2] on both short-term and long-term exchange rate volatility.

[1] See Annual Report on Exchange Rate Arrangements and Exchange Restrictions 2018 (IMF, 2019).

[2] As for a role to manage exchange rate, the following statements are contained in the BI and BOT mandates: "Bank Indonesia also operates an exchange rate policy designed to minimize excessive rate volatility" and "the Bank of Thailand stands ready to intervene in the foreign exchange market such that volatility of the exchange rate is at a level that the economy can tolerate".

1.2 Inflation Targeting Basic Framework

Regarding the evolution of monetary policy frameworks in emerging ASEAN economies, the inflation targeting system (IT) was introduced in Indonesia in July 2005, the Philippines in January 2002, and Thailand in May 2000, respectively, to replace their previous monetary targeting systems, in response to the lack of structural reforms following the crisis. Medium-term objectives and intermediate targets were set as the foundation of their monetary policy actions. The primary objective of their central banks was "price stability." While prioritizing inflation as the primary monetary policy objective, central banks may simultaneously work on achieving several other goals. For example, the Bank Indonesia (BI) also focuses on maintaining exchange rate stability, namely minimizing the excessive exchange rate volatility, as it is believed to help achieve price stability.

Under the IT framework, central banks announce the explicit inflation targets that they promise to achieve over a given time horizon, which serves as a guide for the public's long-term inflation expectations. The inflation target settings in Indonesia, the Philippines, and Thailand are officially decided in coordination with their government agencies[3]. The decisions are made based on considerations like current inflation conditions, risk of future inflationary pressure, and long-term inflation targets. Their targeted inflation settings are of two kinds: a point target with a tolerance band in Indonesia and the Philippines (3±1 percent for 2020), and a range target in Thailand (1-3 percent for 2020). As for inflation target measures, their targets are denoted as the year-on-year change in headline inflation – Consumer Price Index (CPI). Additionally, the Philippines announces the target two years in advance while Thailand focuses on the medium-term horizon, whereas Indonesia has no explicit target horizon. Their IT operational instrument is a policy interest rate set by the central bank: BI (Bank Indonesia)'s 7-day reverse repo rate, BSP (Bangko Sentral ng Pilipinas)'s overnight reverse repurchase rate

[3] For Indonesia, the inflation target is established by the government under the Decree of the Minister of Finance (KMK). This law was enacted in 2014, which allows the government to set inflation targets in three periods. For the Philippines, BSP works together with a government agency, the Development Budget, and Coordination Committee (DBCC) which is an inter-agency economic planning body, in setting the annual inflation targets. For Thailand, the Monetary Policy Committee (MPC), under the BOT, works closely with the Ministry of Finance in determining monetary policy targets for the following year. For Malaysia, BNM coordinates with Malaysia's Securities Commission and other financial regulators in the Financial Stability Committee in discharging its financial stability mandate.

or borrowing rate, and BOT (Bank of Thailand)'s 1-day bilateral repurchase rate, respectively. Central banks control inflation by adjusting the policy interest rate which leads to corresponding movements in market interest rates and affects households' and firms' demand. Fundamentally, central banks gain credibility when their medium-term objectives are achieved. However, in case the intermediate targets do not fall within the target range or point, central banks are bound to clarify the rationale for the monetary policy decisions undertaken.

The central banks with the IT have adopted forward-looking monetary policy frameworks and have developed forecasting and policy analysis systems to advance their forecasting performance and promote effective communication with the public. BI's core forecasting model, along with other small-scale and medium-term macroeconomic structural models, is the Aggregate Rational Inflation-Targeting Model for Bank Indonesia, which is a reduced form of the DSGE model with four equations. For BSP, the Multiple Equation Model, Single Equation Model, and the quarterly Medium-Term Macroeconometric Model are its major forecasting models. The BOT mainly uses the Bank of Thailand Macroeconometric Model, which comprises 25 behavioral equations and 44 identities, as well as the DSGE model, vector autoregression models, and corporate and household models.

1.3 Non-Inflation Targeting Frameworks

Regarding the monetary policy frameworks from the perspective of non-IT economies, both Malaysia and Vietnam aim at price stability but operate differently than IT adopters.

Malaysia has a dual monetary policy stance. The financial system in Malaysia is unique such that it is a dual financial system consisting of the conventional financial system and the Islamic financial system. The Bank Negara Malaysia's (hereafter BNM) monetary policy framework concentrates on price stability and the sustainability of economic growth; it also considers the impact of monetary policy on financial stability. The BNM states its mission as follows: "promoting monetary and financial system stability and fostering a sound and progressive financial sector, to achieve sustainable economic growth". Thus, the BNM seems to prioritize "growth" in its objective, and the IMF (2016) also evaluates the BNM's mandate as emphasizing sustainable growth over the medium-term, distinguished from inflation targeting and other regimes. Despite being a non-IT economy, Malaysia communicates its inflation forecast and risks in the inflation outlook. As part of its macroeconomic outlook assessments, the BNM announces year-ahead inflation forecasts. In addition, the BNM's policy instrument is the overnight policy rate (OPR), similar to those of IT adopters. The bank also implements the ceiling and floor rates of the corridor for the OPR.

Regarding the idea of adopting explicit inflation targeting, Muhammad bin Ibrahim, an ex-governor of BNM, commented that it would limit Malaysia's policy flexibility and that it is not an ideal framework for Malaysia, a small open economy with a sizeable financial market that is vulnerable to external shocks such as volatile capital inflows and exchange rates. According to Ibrahim, Malaysia is currently adopting a so-called inflation anchoring framework, which also aims at achieving price stability but is processed differently. The BNM insists on adhering to inflation anchoring to avoid focusing on a single price indicator and neglecting other potential risks like asset price bubbles. This is also the case since Malaysia's high inflation is externally driven by global oil prices, and does not need a monetary policy response.

Vietnam, another non-IT-adopter, has a different monetary policy framework. The State Bank of Vietnam's (hereafter SBV) monetary policy framework is classified as exchange rate anchoring (composite). Its objectives, according to the recent resolution in 2014, contain multiple mandates such as "control inflation," "support economic growth," "ensure the value of Vietnam dong" and so forth. Despite its multiplicity of monetary policy objectives and goals, the SBV has considered controlling inflation as a top priority since 2011 to achieve a more stable macroeconomic environment conducive for structural reforms (IMF, 2014).

To control inflation, the SBV has started setting an "inflation ceiling[4]" since 2010 with the operation of policy rate (refinancing interest rate). The central bank has announced refinancing interest rates, base interest rates, and other interest rates to implement the monetary policy and to prevent high-interest lending. Furthermore, the latest version of the IMF country report (2019b), pointed out: "in addition to the target inflation rate, the SBV daily announces the target foreign exchange rate vis-à-vis the US dollar as an external nominal anchor," and "there is consensus in the SBV for a shift to inflation targeting (IT)", and recommended introducing more exchange rate flexibility to modernize and shift their monetary policy

[4] According to the Law on the State Bank of Vietnam 2010, the decision on the annual inflation targets shall be based on the consumer price index and overseeing the implementation of the national monetary policy. The annual inflation target is set by the National Assembly as a permitted ceiling for inflation of particular year.

framework toward the IT regime. From this evaluation, the Vietnamese monetary policy appears to be transitioning from a pervasive “fear of floating” toward the IT framework.

CHAPTER 2 MONETARY POLICY RULES IN EMERGING ASEAN ECONOMIES: ADAPTABILITY OF TAYLOR PRINCIPLE

2.1 Introduction

The monetary policy rules in emerging ASEAN economies have progressed greatly since the 2000s. As mentioned in Chapter 1, Indonesia, the Philippines, and Thailand, have adopted the IT framework to control inflation, and have managed their policy interest rates to create the IT system. The Asian currency crisis in the late 1990s was the backdrop of their IT adoption: the crisis caused them to switch their exchange rate regimes from a pegged one to a floating one, and created the necessity for an alternative anchor for price stability instead of a pegged currency regime (Mishkin, 2000). Another factor was that emerging ASEAN economies had never applied a monetary aggregate target before the 2000s. The monetary aggregate approach has lost its significance because financial deregulation and innovation during the recent decades have weakened the linkage between monetary aggregate and inflation rate, thereby requiring an alternative framework for monetary policy targets. There has been less evidence regarding the evaluations of IT performances in emerging ASEAN economies due to relatively shorter histories of its adoption and some difficulties in its management, whereas the IT performances in advanced countries are widely appreciated (Mishkin & Posen, 1998; Mishkin & Schmidt-Hebbel, 2007).

One of the criteria for judging a monetary policy rule's relevance is, in general, the adaptability of the Taylor principle: for inflation to be stable, the central bank must respond to an increase in inflation with an even greater increase in the nominal interest rate (Mankiw, 2016). The Taylor principle is considered to hold up in the monetary policy rules of advanced economies such as the US and Japan (Clarida & Gertler, 1997; Clarida et al., 1998a; Clarida et al., 1998b; Belke and Polleit, 2007). For emerging market economies, however, there is relatively less evidence that their policy rules fulfill the Taylor principle, although the principle would be of vital importance particularly for adopters of the IT framework.

Another point to be noted is that the monetary policy rules of emerging market economies have not worked well enough to control inflation, due to the "fear of floating" suggested by Calvo and Reinhart (2002). The monetary policy independence for controlling inflation is secured only under the floating exchange rate with capital mobility according to the "impossible trinity" constraint. Emerging market economies are, however, afraid of their exchange rate fluctuations due to a lack of confidence in their currency values, and thus tend to face a trade-off between keeping their monetary autonomy and managing their exchange rate.

This chapter aims to examine the monetary policy rules for emerging ASEAN economies: Indonesia, the Philippines, and Thailand as the IT adopters, and Malaysia and Vietnam as the non-IT adopters. It estimates monetary policy reaction functions by using the GMM on each sample economy. The major research questions here are twofold: whether the monetary policy rules of the IT adopters have fulfilled the Taylor principle for controlling inflation, and what has been the difference in monetary policy rules between the IT adopters and non-IT adopters, including the reaction to the fear of floating.

The remainder of this chapter is structured as follows: Section 2.2 reviews the literature and clarifies the contributions; Section 2.3 conducts the GMM estimation of monetary policy rules; Section 2.4 discusses the estimation results and compares them to those of previous studies; Section 2.5 concludes this chapter.

2.2 Literature Review and Contribution

This section reviews the literature related to the studies on monetary policy rules focusing on ASEAN economies and clarifies this study's contributions. There are a limited number of studies targeting ASEAN economies. Hsing (2009) estimated monetary policy reaction functions for Indonesia, Malaysia, the Philippines, and Thailand, and verified the existence of the inflation-responsive rule in a contemporaneous manner. Taguchi and Kato (2011), and Taguchi and Sohn (2014) examined the implementation and performance of monetary policy rules in East Asian emerging market economies. Regarding ASEAN economies, they found that Indonesia and Thailand conducted inflation-responsive but backward-looking policy rules, whereas Malaysia and the Philippines did not follow inflation-responsive rules.

Among studies on individual countries, Wimanda et al. (2011) showed that the inflation rate in Indonesia is significantly determined by backward-looking inflation expectations with higher weight than by forward-looking ones, although Wimanda et al. (2012) argued that the most efficient rule for Indonesia is an inflation forecast-based rule. For Malaysia's monetary policy rule, IMF (2016) reported a significant positive reaction to the output gap, but an insignificant reaction to inflation. Regarding the Philippines' policy rule, Salas (2006) revealed that the policy rate reacted to inflation effectively enough to stabilize inflation in a forward-looking manner after the IT adoption. As for Thailand's policy rule, Lueangwilai (2012) verified the contemporaneous rule of the policy rate, responding to inflation and exchange rate movement, and McCauley (2006), and Taguchi and Wanasilp (2018) identified the inflation-responsive rule with the forward-looking manner. Vietnam's monetary policy rule has not been examined specifically by a policy reaction function, although the monetary policy has been studied from an administration perspective (To et al., 2012) and a transmission mechanism perspective (e.g., Bui and Tran, 2015).

Hence, previous studies reveal mixed results of monetary policy rules in terms of the policy rate's responsiveness and the expectation (forward-looking or backward-looking) specifications and do not necessarily clarify the relationship between IT adoption and the adaptability of the Taylor principle. This study's contributions are summarized as follows. First, this study provides updated evidence of monetary policy rules of emerging ASEAN economies with a focus on the linkage between IT adoption and Taylor principle's adaptability: the counter-cyclical reaction of the policy rate to inflation is a vital factor for a successful IT performance. As mentioned in the introduction, the Taylor principle has already been identified in "advanced" countries' monetary policy rules by several studies such as Clarida & Gertler (1997), Clarida et al. (1998a), Clarida et al. (1998b), and Belke and Polleit (2007). Thus, for advanced economies, there is no gap between a theoretical policy rule and an actual policy practice. As for emerging ASEAN economies, however, a gap remains between the theoretical Taylor principle and actual IT practices, due to difficulties in IT management and the lack of empirical evidence. This study contributes to filling this gap by enriching the empirical evidence for emerging ASEAN economies.

Second, this study uncovers the difference in the policy rules between IT adopters and non-IT adopters. In particular, it would be significant to quantitatively investigate Vietnam's monetary policy rule as there is a lack of evidence in the literature.

2.3 Empirical Analysis

This section conducts empirical analyses of the monetary policy rules by applying policy reaction functions on five sample economies. The focus of the analyses is how the announced monetary policies (shown in Chapter 1) are linked to the estimated policy rules in individual economies, particularly from the adaptability perspective of the Taylor principle under the IT framework. The section first clarifies the data and methodology and then presents estimation results and their interpretations.

2.3.1 Variables and Data

The policy reaction function contains the following four variables: central bank policy rate (denoted by *por*), consumer prices (*cpi*), output gap (*gap*), and exchange rate (*exr*). The consumer prices are seasonally adjusted and expressed as the year-on-year percentage change. The output gap is expressed as the deviation of the volume index of seasonally adjusted Gross Domestic Product (GDP) from the potential GDP generated by the Hodrick-Prescott filter of the same series, and the exchange rate is expressed as the year-on-year percentage change of domestic currency per U.S. dollar in the period average. The data for the variables are in quarterly frequency and retrieved from the International Financial Statistics (IFS) of the IMF.[5] The sample periods target the adoption periods of policy rate and inflation targeting but are limited by data availability. To be specific, the time-series of sample data are ranged as follows: from Q3 2005 (the third quarter of 2005) to Q3 2018 in Indonesia, from Q1 2002 to Q4 2018 in the Philippines, from Q3 2000 to Q2 2019 in Thailand, from Q2 2004 to Q4 2018 in Malaysia, and Q1 2008 to Q1 2019 in Vietnam.

[5] For Vietnam, the study uses the data of industrial production instead of GDP, since the quarterly GDP is not available there. The industrial production is retrieved from the General Statistics Office of Vietnam.

2.3.2 Monetary Policy Reaction Function

The monetary policy reaction function is renowned for its wide application in analyzing or describing the monetary policy rule practiced by central banks. Its standard specification is that a central bank adjusts the nominal policy interest rate in response to the gaps between expected inflation and output, and their respective targets. The function originated from the so-called Taylor rule. Taylor (1993) showed that the average reaction of the Federal Reserve to US inflation and the output gap could be captured by the following simple equation.

$$r = p + 0.5 * y + 0.5 * (p - 2) + 2$$

where r is the federal funds rate, p is the inflation rate, and y is the output gap. The rule allows the rise in federal funds rates if the inflation rate increases above a target of 2 percent, or if real GDP rises above the trend GDP. If both inflation rate and real GDP are on target, then the federal funds rate would equal 4 percent, or 2 percent in real terms, which can be interpreted as the neutral level of the real interest rate.

The policy reaction function could be interpreted as a more generalized rule of the Taylor rule – the simple backward-looking reaction function. Before the function is specified, the following points, regarding the design of the function, are worth noting. The first point is the adaptability of the Taylor principle: for inflation to be stable, the central bank must respond to an increase in inflation with an even greater increase in the nominal interest rate (Mankiw, 2016). When there is an increase in inflation, if the nominal interest rate does not rise enough, the real interest rate would decline, which reduces the cost of borrowing and increases the demand of output beyond the natural level. The higher demand of output pressurizes firms to set higher prices, which leads to higher actual inflation afterward, thereby ending up in a vicious circle of ever-higher inflation and expected inflation, and eventually, inflation spirals out of control. In the aforementioned Taylor rule, a 1-percentage-point increase in inflation p induces an increase in the nominal interest rate r by 1 + 0.5 = 1.5 percentage points, and thus whenever inflation increases, the central bank raises the nominal interest rate by an even larger amount.

Second, the policy reaction function demonstrates a "forward-looking" rule as well as a backward-looking one like the Taylor rule. The forward-looking manner means that a central bank does not react to lagged inflation, but reacts to expected inflation instead. The forward-looking estimation originated from Clarida et al. (1998a and 1998b) and Mehra (1999). They predicted the behavior of the federal funds rate and found that the US Federal Reserve System pursued a forward-looking rule, responding to anticipated inflation as opposed to lagged inflation. Since then, the forward-looking specification has been applied, in general, to the analyses of monetary policy rules in both advanced and emerging-market countries, though some of the latter may follow backward-looking rules due to difficulties in IT management as argued by Eichengreen (2002).

Third, the policy reaction function often considers the reaction to exchange rate movements, in particular, when the monetary policy rules in emerging market economies are analyzed. Emerging market economies have a "fear of floating," as suggested by Calvo and Reinhart (2002). They argued that although a developing country announced "floating" in its exchange rate regime, it would hold soft-pegging or managed-floating in practice, due to a lack of confidence in its currency value. IT could work well only if the independence of monetary policy is secured under the floating exchange rate with capital mobility under the "impossible trinity" constraint; thus emerging market economies tend to face a trade-off between a fear of floating and IT management.

2.3.3 Methodology

This study applies the methodology of Clarida et al. (1998b) and modifies it by following this study's analytical concerns. The original form of the policy reaction function presented by Clarida et al. (1998b) is shown as the following Equation (1).

$$r_t^{\ *} = \bar{r} + \beta(E[\pi_{t+n}|\Omega_t] - \pi^*) + \gamma(E[y_t|\Omega_t] - y_t^{\ *}) \tag{1}$$

where $\bar{r}$ is the long run equilibrium nominal rate, π_{t+1} is the rate of inflation between periods t and $t+n$, y_t is real output, π^* and $y_t^{\ *}$ are respective bliss points for inflation and output ($y_t^{\ *}$ is given by the potential output), E is the expectation operator, and Ω_t is the information available to the central bank at the time it sets interest rates.

Rearranging Equation (1), the implied target of the ex-ante real interest rate is also presented as follows.

$$rr_t^{\ *} = \overline{rr} + (\beta - 1)(E[\pi_{t+n}|\Omega_t] - \pi^*) + \gamma(E[y_t|\Omega_t] - y_t^{\ *}) \tag{2}$$

where $\overline{rr}$ represents the long run equilibrium of the real interest rate. This equation shows that the target real rate adjusts in response to deviations of either expected inflation or output from their desired targets. Clarida et al. (1998b) emphasized that the parameter β provides an important yardstick for evaluating a central bank's policy rule: if the magnitude β is more than unity, the target real rate adjusts to stabilize the inflation, whereas if it is less than unity, the target real rate moves to accommodate changes in inflation instead. This condition on the magnitude β is the aforementioned "Taylor principle."

Equation (1) can be rewritten for an empirical specification. Since Equation (1) does not capture the practice of "smoothing" changes in interest rates of the central bank, the parameter ρ (0<ρ<1), the degree of interest rate smoothing is added with the assumption that the actual policy rate partially adjusts to the target. The estimable specification also eliminates the unobserved forecast variables from the expression by rewriting the equation in terms of realized variables and reorganizing it by adding the exchange rate terms due to the aforementioned "fear of floating" problem and a linear combination of forecast errors of inflation and output, ε.

$$por_t = (1-\rho)*\alpha + (1-\rho)*\beta*cpi_{t+n} + (1-\rho)*\gamma*gap_t + (1-\rho)*\delta*exr_t + \rho*por_{t-1} + \varepsilon_t \tag{3}$$

where por, cpi, gap, and exr are the variables defined in Section 2.3.1 and are applied for empirical specification reorganized from Equation (1). In this equation, the subscript n of cpi_{t+n} could take positive values: 1, 2, 3, and 4 as a forward-looking specification in the inflation responsiveness, and zero and negative values: 0, -1, -2, and -3 as a backward-looking one.

For the technique of estimating the parameter vector [α, β, γ, δ, ρ], the study adopts the GMM estimation. One of the assumptions required for regression analysis is that the explanatory variables are uncorrelated with the disturbance term. In the case that the equation contains endogenously determined variables as explanatory ones, the assumption is violated, and the estimator of ordinary least squares is biased and inconsistent. The case could be applied to the estimation of Equation (3) in this study since the policy interest rate might also affect the explanatory variables. The standard approach to eliminate the effect of variable and residual correlation is to estimate the equation using "instrumental variables" regression. In this context, the GMM estimator is excellent in terms of consistency, asymptotic normality, and efficiency in its property. It has been widely used since seminal works such as Hansen (1982) applied the estimator to their empirical works. Thus, this study adopts the GMM estimator and equips the instrumental variables of one- and two-quarter lagged values of cpi, gap, and exr. For confirming the validity of instrumental variable estimators, Table 2 reports the J-statistics. The estimated J-statistics implies that these instrumental variables are valid in the sense that the over-identifying restrictions cannot be rejected, except for the case of cpi_{t+4} in Thailand.

2.4 Estimation Results

This section discusses the results of the policy reaction function estimations. Table 1 reports the estimation results of Indonesia, the Philippines, Thailand, Malaysia, and Vietnam by forward-looking and backward-looking specifications, and Table 2 summarizes them. In each category of Table 1, the upper section reports the short-term coefficients, and based on those coefficients, the lower section calculates the long-term coefficients. Some of the long-term coefficients are blanked with the degree of smoothing ρ being unexpectedly over unity. The results with the long-term coefficients are summarized as follows.

Focusing on the IT-adopters in Indonesia, the Philippines, and Thailand, it is worth noting that the inflation-responses satisfying the Taylor principle are significantly identified in all three countries regardless of their different specifications: the cases of π_{t+2} in Indonesia (β=1.909), π_{t-2} in the Philippines (β=1.316) and π_{t+1} in Thailand (β=1.145). In contrast, the responses to the output gap are not significant in the majority of cases, except a few in Thailand. The significant reactions to the exchange rate are found in the case of π_{t+2} in Indonesia and π_{t+1} in Thailand.

Malaysia exhibits a clear contract with IT-adopters in the policy reactions: the responses to the output gap are significant in the majority of cases, whereas the responses to inflation (and exchange rate) are not significant in any case.

Vietnam shows a mixed result in the reactions to inflation and exchange rate: the Taylor principle on the response to inflation is confirmed in the π_{t+3} case (β=1.565), and simultaneously, the reactions to exchange rate are also verified in the majority of the cases.

2.5 Discussion

We discuss how to interpret the estimations above in relation to the official monetary policy stances of sample countries in Chapter 1, and to the previous studies presented in Section 2.2 in this chapter.

The estimation result on the IT adopters reveals that their monetary policies are characterized by inflation-responsive rules fulfilling the Taylor principle, with a forward-looking manner in Indonesia and Thailand, and a backward-looking manner in the Philippines. This result is consistent with the IT adopters' primary objective – price stability. Compared to previous studies, there are several differences in estimation outcomes on the policy rates' reaction to inflation. Indonesia has a forward-looking rule outcome in this study vs. a backward-looking rule outcome in Hsing (2009), Taguchi and Kato (2011), and Wimanda et al. (2011). The Philippines has a backward-looking rule outcome in this study vs. a no inflation-responsive rule outcome in Taguchi and Kato (2011) and a forward-looking rule outcome in Salas (2006). Finally, Thailand has a forward-looking rule outcome in this study vs. a backward-looking rule outcome in Hsing (2009), Taguchi and Kato (2011), Taguchi and Sohn (2014), and Lueangwilai (2012). These differences might emerge due to the difference in sample periods between studies: the updated samples in this study might reflect the recent progress in IT management and operation except for the study of Salas (2006). The significant responses to exchange rate in Indonesia and Thailand, confirmed in this study, seem to be in line with their policy stances regarding interventions in the FX market to avoid excessive rate volatilities, in particular, with the "stabilized arrangement" in Indonesia (before the reclassification to floating in 2020). These "fear of floating" effects, however, have a limited effect on monetary policy independence, because the Taylor principle holds up despite the reactions to exchange rate volatilities.

Regarding Malaysia as a non-IT adopter, this study's estimation result of output-gap responsive rules is consistent with the central bank's policy stance to prioritize economic growth and the quantitative evaluation by IMF (2016). As for Vietnam, another non-IT adopter, the mixed result in the reactions to inflation and exchange rate might reflect the current transition process of the monetary policy framework. The central bank has set an inflation ceiling while keeping the "stabilized arrangement" as exchange rate management and is preparing for IT adoption by raising exchange rate flexibility, according to IMF (2019b).

Another point to be discussed is a comparison of the degree of policy rate reaction to inflation between emerging ASEAN economies' policy rules, and those of advanced economies. This study obtained the inflation-responsive coefficients: 1.909 in Indonesia, 1.316 in the Philippines, 1.145 in Thailand, and 1.565 in Vietnam compared to 2.27-2.57 in the United States (Belke and Polleit, 2007), and 2.04 in Japan (Clarida et al., 1998b). Thus, although emerging ASEAN economies' policy rules fulfill the Taylor principle, their policy rate reactions to inflation are less elastic than those of advanced economies.

The policy implications derived from the estimation outcomes are summarized as follows. First, regarding IT adopters, their policy-rate reactions have an effect to stabilize inflation under the Taylor principle, but there might be room to make their reactions more elastic to inflation, compared to advanced economies. Second, the Philippines has still remained with a backward-looking manner in its policy rule. Thus, there would be policy space to transform it into a forward-looking rule, since the forward-looking rule 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. Third, for non-IT adopters, it can be recommended that they adopt an explicit IT framework to ensure a robust effect of policy rate on stabilizing inflation. Vietnam can improve the elasticity of policy rate to inflation along with raising exchange rate flexibility under an explicit IT management, despite its policy rule satisfying the Taylor principle.

2.6 Chapter Summary

This chapter examined the monetary policy rules for five emerging ASEAN economies: Indonesia, the Philippines and Thailand as the IT adopters, and Malaysia and Vietnam as the non-IT adopters. The major research questions in this chapter were twofold: whether the monetary policy rules of the IT adopters have fulfilled the Taylor principle for controlling inflation, and what has been the difference in monetary policy rules between the IT adopters and the non-IT adopters, including the reaction to the fear of floating.

The main findings from an empirical study are summarized as follows. Regarding the IT adopters, their monetary policy rules are characterized by inflation-responsive rules fulfilling the Taylor principle, with a forward-looking manner in Indonesia and Thailand and with a backward-looking way in the Philippines. The "fear of floating" effects, identified in

Indonesia and Thailand, seem to have no serious repercussions on their monetary policy independence. As for the non-IT adopters, Malaysia follows solely an output-gap responsive rule, which is consistent with the central bank's policy stance to prioritize an economic growth; and Vietnam exhibits the mixed rules of inflation- and exchange rate- responsive ones, which might reflect the transition process from pervasive "fear of floating" toward the IT framework.

The policy implications derived from the estimation outcomes are that, for IT adopters there might be room to make their policy-rate responses more elastic to inflation, based on a comparison with advanced economies; and that for the non-IT adopters, there would be a need to adopt an explicit IT framework to ensure a robust effect of policy rate on stabilizing inflation.

The limitations of this study and the future scope for research are as follows. First, the study needs more in-depth analyses of selected individual economies (i.e., case studies). Reviewing and comparing the economies using different monetary policies and investigating the antecedents and outcomes due to differences would contribute to enriching the evidence and justifying the policy implications. Second, this study depends on a single monetary policy reaction function for the analysis and lacks a macroeconomic foundation. To check the consistency of monetary policy rules with macroeconomic frameworks, Chapter 4 extends and further develops the study by applying a New Keynesian DSGE model. Chapter 4 is expected to contribute to providing a more comprehensive perspective for reviewing monetary policy rules.

CHAPTER 3 THE EXCHANGE RATE PASS-THROUGH IN EMERGING ASEAN ECONOMIES UNDER THE INFLATION TARGETING FRAMEWORK

3.1 Introduction

There seems to be a consensus on the viability of the IT framework in achieving low and stable inflation based on the evidence from several advanced economies (e.g., Mishkin & Posen, 1997; Freedman, 2001; Fregert & Jonung, 2008; Svensson, 2010). However, there is still limited evidence supporting the performance of IT in small open emerging market economies.

As mentioned, Indonesia, the Philippines, and Thailand are three of the five founding members of the ASEAN and the only three countries in the region who have been adopting an explicit IT framework since 2005, 2002, and 2000 respectively. Before the adoption, Indonesia shifted from the managed floating exchange rate regime while the Philippines and Thailand shifted from the fixed exchange rate regime towards the floating exchange rate regime in 1998, 1985[6], and 1997 respectively. Except for the Philippines, the decision for the change was due to their currencies being severely under speculators' attack during the Asian financial crisis, which consequently led to a dramatic depreciation. Currently, their central banks can maintain currency stability by occasional intervention in the FX market.

Common difficulties with IT management in small, open economies include exchange rate volatility. Emerging markets tend to have a "fear of floating", namely being reluctant to let their currencies fluctuate due to, for instance, a lack of credibility (Calvo & Reinhart, 2002) and effects of liability dollarization (Eichengreen, 2002). The action of restricting exchange rate swings may distract a central bank from effectively focusing on its first priority under IT – price stability. In another aspect, exchange rate fluctuation also hinders IT performance as it influences domestic prices via the pass-through effect, which is known as ERPT. Gagnon and Ihrig (2004), however, suggested that the IT framework implementation helps mitigate the

[6] The starting year of the flexible exchange rate regime in the Philippines was stated by Houben (1997). However, Calvo and Reinhart (2000) argued that the Philippines was grouped under the "soft-peg" label along with other crisis-hit Asian countries after 1997.

pass-through effect. They pointed out that such a reduction in the pass-through effect is possible because domestic agents are less inclined to change prices in response to price shocks under IT, given the strong commitment of the monetary authority towards price stability. Despite such a hypothesis being unanimously supported in the case of advanced economies, a question still lies on emerging economies, given their difficulties in managing IT.

This chapter concentrates on the relationship between IT and the ERPT in the selected ASEAN economies as a representation of small open economies and provides empirical evidence on the loss of the ERPT specifically in Indonesia, the Philippines, and Thailand after they adopted IT, in comparison to their pre-IT pass-through effects. VAR estimation is applied for the study.

The remainder of the chapter is structured as follows. An overview of the literature and the contributions of this chapter are discussed in Section 3.2. Methodology, data, and modeling approaches are presented in Section 3.3. Estimation results are discussed in Section 3.4. Finally, Section 3.5 concludes the chapter.

3.2 Literature Review and Contribution

This section reviews related literature on the ERPT and clarifies this study's contribution. There has been significant evidence indicating the decline in the ERPT to consumer prices and discussing sources attributable to it. Early evidence had concentrated more on explaining external influences on domestic inflation such as McCarthy (1999) who clearly showed the decline in the ERPT in all nine advanced economies with external factors having a modest disinflationary effect, which implied other factors such as a central bank's effort in reducing inflation might as well cause disinflation. Likewise, Kang and Wang (2004) found statistically insignificant responses of consumer prices to an exchange rate shock in all samples (Japan, Korea, Singapore, and Thailand) before the Asian financial crisis. However, they added that the floating exchange rate regime adopted by Korea and Thailand after the crisis had magnified the pass-through effects. A more recent study found that the pass-through effect is lower after a domestic currency appreciation than a depreciation, in the long run, implying weak market competition (Delatte & López-Villavicencio, 2012).

Contrastingly, Taylor (2000) suggested that the decline in the pass-through is actually due to a low inflation environment itself, associated with a lower expected persistence of inflation, which was reflected in the decrease in firms' pricing power. The evidence from developing countries whose monetary policy regimes shifted during the 1990s were also found to be consistent with Taylor's hypothesis (Karim & Jouini, 2008). The positive correlation between the ERPT and the average inflation rate was also confirmed in subsequent studies (Choudhri & Hakura, 2006; Ca' Zorzi et al., 2007). Gagnon and Ihrig (2004) later supported Taylor's hypothesis that countries with low and stable inflation, especially those whose monetary policy is strongly committed to stabilizing inflation, tend to have a low pass-through to consumer prices, while they also linked it to the role of IT for the decline. Their additional findings are as follows. The estimation on the sample of 20 industrial countries showed that a long-run average estimated pass-through was 0.23 for the entire sample period (from 1971 to 2003). After splitting the sample by country-wise breakpoints, the estimated pass-through appeared to be 0.05 for the latter period, which was when the regime shifted towards stabilizing inflation. This implies a 10 percent depreciation, but inflation rises by only 0.5 percent. More evidence supported the argument of Gagnon and Ihrig (2004) and further explained the decline of the ERPT by improved monetary policy credibility and better anchored expectations of agents due to gradual disinflation (Kabundi & Mlachila, 2019). Similar results were also found in Carrière-Swallow et al. (2016) who sampled 31 emerging economies and 31 advanced economies from 1995 to 2016.

While there seems to be an agreement on the decline in the ERPT in developed countries, existing works on the degree of the pass-through effects in developing countries are rather mixed. In opposition to the argument by Karim and Jouini (2008), Toh and Ho (2001) found a high ERPT to consumer prices in Malaysia, Singapore, Taiwan, and a nearly complete pass-through in the case of Thailand. Anh et al. (2018), however, argued that there is an incomplete ERPT to consumer prices in all five founding ASEAN members.

Beyond the previously mentioned debate, there are a limited number of studies linking the role of IT to the cases of small open economies to explain the decline of the ERPT, following the work of Gagnon and Ihrig (2004). It is widely proved that IT has been effectively implemented in advanced economies as they met the conditions of considerable exchange rate flexibility and central bank autonomy, which are rarely seen in developing countries (Debelle et. al., 1998). Due to this problem, the effect of IT on the decline in the pass-through in developing countries is still questionable. Taguchi and Sohn (2014) found an ambiguous change in the ERPT to consumer prices in Thailand, whose monetary policy rules were classified as inflation-responsive but backward-looking, after IT adoption. However, their estimation on Korea, whose rule was identified as inflation-responsive and forward-looking, supported the argument by Gagnon and Ihrig (2004). The authors explained the differences in the degrees of the ERPT under the IT as subject to whether the IT is accompanied with an inflation-responsive monetary policy rule in a forward-looking manner. Taguchi and Bolortuya (2019) later supported the argument by Taguchi and Sohn (2014) with the case of Mongolia, which shows the loss of the ERPT after IT adoption while being identified as inflation-responsive and forward-looking.

This study contributes to the previously reviewed literature by 1) enriching the case of a small open developing economy in the ASEAN region adopting the IT framework, particularly Indonesia, the Philippines, and Thailand as the impact of IT on the loss of the ERPT is still debatable in their cases, 2) confirming Taylor's hypothesis in Indonesia, the Philippines, and Thailand, 3) confirming whether there is a relationship between the forward-looking monetary policy rule and the ERPT, and 4) updating the estimation to the recent phase as several crucial monetary policy improvements have been made in the aforementioned countries, which may affect the change in the outcome.

3.3 Empirical Analysis

This section provides an empirical analysis on the relationship between IT and the loss of the ERPT in three targeted small open ASEAN economies: Indonesia, the Philippines, and Thailand. The estimation of the VAR model and the impulse response function will be carried out to examine the pass-through effects. The section first explains key variables and data used in the analysis, followed by the methodology for the VAR estimation, and finally interprets the estimation results.

3.3.1 Key variables and data

Two key variables are incorporated in the VAR model in this study: an exchange rate (denoted by exr) and a consumer price index (CPI) (denoted by cpi). The data set, quoted in a quarterly frequency, are obtained from the International Financial Statistics (IFS) of the IMF, where cpi is expressed in terms of "Consumer Price Index, All Items" with 2010=100 as a base year, and exr is expressed in terms of "Domestic Currency per U.S. Dollar, Period Average". The cpi series is later seasonally adjusted using the autoregressive integrated moving average (ARIMA) model. The sample period coverage starts from the first quarter of 1991 and continues to the first quarter of 2020. Changes in the exchange rate and CPI in Indonesia, the Philippines, and Thailand are illustrated in Figure 2. The vertical line in each graph marks the breakpoint of pre- and post-IT adoption of each country, statistically identified by the Chow breakpoint test (see Table 3). The starting year, 1991, of the pre-IT sub-period is limited by the availability of exchange rate data in the IFS. The CPI fluctuations in each country seem to be subdued after IT adoption, based on a rough observation of the graphs.

To reflect Taylor's hypothesis of the persistence of inflation as mentioned in the previous section, a year-on-year growth rate of CPI (denoted by $cpig$) is also added to the model as a control variable.

Next, a unit root is tested on each time series variable to check its stationarity property. The null hypothesis is defined as the presence of the unit root, and the alternative hypothesis is otherwise. If the null hypothesis cannot be rejected in the level series, the test shall be conducted further for the first-difference time series. Table 4 reports the unit root test results of the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests. Both tests include trend and intercept in the test equation. Given that the ADF and PP tests only confirm the stationarity of the exchange rates (exr) and CPI (cpi) variables of order one, $I(1)$ (i.e., there are stochastic trends), a VAR model of first differentials is justified as an appropriate specification.

3.3.2 Methodology

In this subsection, the construction of the model is explained along with the empirical analysis strategy. First, this study follows the two-variable VAR model by Taguchi and Bolortuya (2019), as the priority is to directly focus on the effects of the pass-through on domestic inflation in all three sample countries. Second, the VAR estimation for each sample country is divided into two sub-sample groups, namely pre- and post-IT periods. Third, the impulse response of the CPI to the exchange rate shock is examined to provide evidence of the decline in the ERPT after IT adoption. Finally, a sensitivity analysis is carried out to confirm the robustness of the model.

The VAR Model

Advocated by Sims (1980), a VAR model is practically useful for dealing with the endogeneity of the macroeconomic time series since it generally treats all variables as priori endogenous (Luetkepohl, 2011). Many academic literatures have applied the VAR approach to investigate the ERPT. However, the modifications in a VAR model vary from paper to paper. For example, Ca' Zorzi et al. (2007) used a 6-variable model consisting of the exchange rate, oil price index, output index, import price index, consumer price index, and interest rate. Kang and Wang (2004) used a 5-variable model consisting of growth rates of M2 and industrial production, changes in a nominal effective exchange rate, import price index, and consumer price index. Taguchi and Sohn (2014) used a 3-variable model consisting of exchange rate, import price index, and consumer price index, with the growth rate of a consumer price index used as an exogenous variable. However, as mentioned, unnecessary variables that are out of this study's concern have been eliminated and only two variables have been considered. Thus, the VAR model specification can be constructed in a reduced form as follows.

$$Y_t = c + V_1 Y_{t-1} + V_2 z_t + \varepsilon_t \tag{4}$$

where Y_t is a column vector of endogenous variables, Y_t = $(\triangle exr_t, \triangle cpi_t)'$, c is a constant term, V_1 and V_2 are coefficient matrices, Y_{t-1} is a vector of lagged endogenous variables, Y_{t-1} = $(\triangle exr_{t-1}, \triangle cpi_{t-1})'$, z_t is a vector of an exogenous variable, z_t = $(cpig)'$, and ε_t is a vector of error terms, ε_t = $(\varepsilon_{1t}, \dots, \varepsilon_{nt})'$.

Since the main purpose of this paper is to investigate changes in the degrees of the ERPT after the adoption of IT by each sample country, the comparison between the pre- and post-adoption should be observed. Therefore, the VAR estimation of Equation (4) is to be conducted across two periods, as specified by the Chow breakpoint test as follows. The pre-IT periods are from Q1 1990 extending to Q3 2005 for Indonesia, Q1 2002 for the Philippines, and Q2 2000 for Thailand, respectively. The post-IT periods are from Q4 2005 for Indonesia, Q2 2002 for the Philippines, and Q3 2000 for Thailand, to Q1 2020, respectively.

Before proceeding to the estimation, an optimal autoregressive lag length is determined by various selection criteria, including a sequentially modified LR test statistic, final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ) (see Table 5). The results suggest that the optimal number of lags is one for all country samples.

Impulse response analysis

The impulse response analysis is a structural analysis based on the VAR model to trace the dynamic effects on endogenous variables in response to structural shocks. In this study, the impulse response of the CPI to the exchange rate shock is examined to investigate the pass-through effects. Based on the reduced-form VAR model (4), a shock enters through the residual vector, ε_t. Assuming a contemporaneous impact on the variables, the short-run restrictions are imposed to identify the structural shocks, which are computed with the Cholesky decomposition of the Equation (4) residuals' covariance matrix. The recursive ordering is thus $[(\triangle exr_t, \triangle cpi_t)]$. On a side note, the structural shocks on ε_t would only be appropriately identified if it is based on an economic intuition. The impulse responses are then examined along an 8-quarter horizon to allow for some delays of the effects from the time of policy implementation.

Robustness

The sensitivity analysis is conducted to confirm the VAR model's robustness by imposing an alternative recursive ordering of $[(\triangle cpi_t, \triangle exr_t)]$. If the results are consistent with the baseline recursive ordering results, then the VAR model (4) is robust.

3.4 Estimation Results

The results of the VAR estimation are reported in Table 6. The accumulated impulse response outcomes of the pre- and post-IT sub-periods are displayed in Figure 3 and Figure 4 respectively, along with the outcomes of an alternative recursive ordering, and are numerically presented in Table 7. The key findings are summarized as follows. First, the proxy variable of the persistence of inflation ($cpig$) is found to be significantly positive in all cases with the changes of CPI as an explained variable, which reflects Taylor's hypothesis that the inflation itself is positively correlated with the persistence of inflation. This also confirms the variable to be appropriate for the model.

Second, according to Figure 3 and Figure 4, there is a contrast in the ERPT in the pre- and post-IT sub-periods for all sample countries. Figure 4 shows the loss of the pass-through effects from exchange rates to consumer prices in Indonesia, the Philippines, and Thailand after they adopt the IT framework. Specifically, according to Table 7, consumer prices react positively to exchange rates shock in the cases of Indonesia, the Philippines, and Thailand, during the pre-IT sub-period. However, the responses of the CPI to exchange rates shock during the post-IT sub-period are insignificant for all country samples.

Third, the sensitivity analysis is conducted under an alternative recursive ordering, $[(\triangle cpi_t, \triangle exr_t)]$, to confirm the robustness of the model. The results of the impulse responses are shown in the lower sections of Figure 3, Figure 4, and Table 7. They suggest outcomes similar to the baseline recursive ordering, that there is an existence of the ERPT before the adoption of IT and a loss of the ERPT after the adoption of IT in all sample countries. Therefore, the model is considered robust given the consistent results.

In addition, Figure 5 displays a scatter chart of each country's average inflation plotted with the accumulated response of the CPI to a 1 percentage exchange rate shock. The graphs imply that when a country faces a lower inflation environment, it also experiences relatively lower pass-through effects to consumer prices. This confirms Taylor's principle. The positive correlation between the average inflation and the ERPT is also consistent with Choudhri and Hakura (2006) and Ca' Zorzi et al. (2007).

The results of the impulse response analysis thereby confirm the relationship between the IT and the loss of the ERPT in ASEAN economies. Going forward, it is also worth extending the discussion towards the relationship between the inflation-responsive and "forward-looking" monetary policy rules and the loss of the ERPT as evidenced by Gagnon and Ihrig (2004), Taguchi and Sohn (2014), and Taguchi and Bolortuya (2019), by applying the cases of Indonesia, Philippines, and Thailand. In brief, several studies examined the monetary policy rules of the three countries under IT and found the following results. The monetary policy rules were identified as inflation-responsive in a forward-looking manner for the cases of Indonesia and Thailand, and in a contemporaneous manner in the case of the Philippines (McCauley, 2006; Taguchi & Wanasilp, 2018; Taguchi et al., 2020). By combining the previous studies' findings and the evidence of the loss of the ERPT after IT adoption in Indonesia, the Philippines, and Thailand from this study, it can be concluded that although there is a relationship found between the inflation-responsive monetary policy rule under IT and the loss of the pass-through effects, there is no obvious link to the forward-looking rule.

Regarding the forward-looking rule in monetary policies, there seems to be another discussion on whether the forward-looking modality would be still significant under the existence of the persistence of low inflation and the loss of linkage between the forward-looking rule and ERPT. A point worth noting is that the forward-looking rule has worked well in crisis times rather than in normal times. Taguchi and Sohn (2014), for instance, conducted a case study on Korea, for which data on inflation expectations were available, to investigate the sensitivity of inflation expectations to fluctuations in import prices under the pre-IT and post-IT regimes within the sample period of 1990–2009. They showed there is a clear contrast in the movements of inflation expectations between the 1997–98 currency crisis and the 2008 financial crisis: expectations are synchronized with import price fluctuation in the 1997–98 crisis and there is a maintenance of stability despite the import price hike in the 2008 crisis (see Appendix E). They interpreted this finding such that the forward-looking manner with reliable information of forecasted inflation and strong commitment of the monetary authority to price stability under IT adoption contributed to a lower sensitivity of inflation expectations toward the external price shock in the 2008 crisis, thereby avoiding an inflation spiral.

3.5 Chapter Summary

Focusing on the case of the inflation-targeting ASEAN economies (i.e., Indonesia, the Philippines, and Thailand), this study aims to provide evidence on the relationship between IT and the ERPT to consumer prices. Since there are limited papers with mixed results discussing the degrees of the ERPT in small open economies, this study selected ASEAN economies to enrich the debate. The empirical analysis is divided into the pre- and post-IT sub-periods for each sample country covering the whole period from the first quarter of 1990 to the first quarter of 2020. The two-variable VAR model is estimated along with an exogenous variable, the growth rate of changes in the consumer price index (CPI) as a proxy of the persistence of inflation, and the impulse response analysis is conducted to examine the pass-through effects.

The estimated results identified the existence of the ERPT in the pre-IT sub-period and the loss of the ERPT in the post-IT sub-period for Indonesia, the Philippines, and Thailand. The results also support Taylor's principle of low pass-through effects under a low inflation environment. Moreover, these results agree with the arguments by Gagnon and Ihrig (2004), Taguchi and Sohn (2014), and Taguchi and Bolortuya (2019) in the sense that there is a relationship between the inflation-responsive monetary policy rule under IT and the ERPT, but also disagree with their arguments on the relationship between the forward-looking monetary policy rule and the loss of the ERPT as only Indonesia and Thailand satisfy all the requirements.

There is room for extending this study further. Future research can update the assessment of the monetary policy rules of the ASEAN economies and identify factors contributing to their losses of the ERPT other than IT, especially in the case of the Philippines. Investigating more factors behind the changes in the pass-through effects will shape policy implications which can help monetary authorities better understand and cope with variability and uncertainty of domestic as well as international agents.

CHAPTER 4 MONETARY POLICY RULE AND THE TAYLOR PRINCIPLE IN EMERGING ASEAN ECONOMIES: DSGE APPROACH

4.1 Introduction

This chapter extends from Chapter 1 and aims to reassess the performance of IT in Indonesia, the Philippines, and Thailand by incorporating a macroeconomic framework. The monetary policy rules are examined with the focus on their conformity to the "Taylor Principle", through the Bayesian estimation of the New-Keynesian DSGE model. While focusing on comparing the estimation results from the Bayesian estimation of the DSGE model to those from the GMM estimations in Chapter 2, the major research question of this chapter is whether the monetary policy rules of "IT adopters" have fulfilled the Taylor principle by controlling inflation in the macroeconomic framework.

The remainder of this chapter is structured as follows. Section 4.2 reviews the literature and highlights this study's contributions. Section 4.3 conducts the empirical analyses using the Bayesian approach. Section 4.4 presents the estimation results. Finally, Section 4.5 concludes the chapter.

4.2 Literature Review and Contribution

Recent studies focused on the link between the inflation-responsive rule and the conformity to the Taylor principle have incorporated the Bayesian estimation of the New-Keynesian DSGE model on top of the GMM approach.

Taguchi et al. (2020) examined the monetary policy rules in Indonesia, the Philippines, and Thailand by using both GMM and Bayesian (closed economy model) approaches. Taguchi and Gunbileg (2020) adopted a similar approach while assessing the case of Mongolia, using the small open economy DSGE model. Their findings point in the same direction and are as follows. First, the sample economies' inflation-responsive rules fulfilled the Taylor principle. Second, both GMM and DSGE-model estimations produced consistent outcomes.

This study's contributions are thus summarized as follows. First, this study contributes to enriching the evidence on the relationship between the inflation-responsive rules and the conformity to the Taylor principle. Second, this study does not use a closed economy version of the DSGE model but a small open economy version of the DSGE model, since the sample economies are considered small open economies, per Taguchi et al. (2020). Third, this study provides evidence that the adaptability of the Taylor principle can be verified through alternative approaches.

4.3 Empirical Analysis

This section conducts the empirical analysis using the Bayesian estimation of the New-Keynesian DSGE model to confirm the validity of the Taylor principle. This section specifies the model structure, demonstrates the methodology, and finally presents the estimation results.

The Specification of the New Keynesian DSGE Model

Macroeconomists observe the mechanisms of the economy through building models to understand business cycle fluctuations (Duarte, 2015). Before the DSGE model, researchers relied on traditional macroeconomic models, which are based on historical data without theoretical linkages. Starting from the theoretical foundation based on Lucas and Prescott (1971) which is that business cycles can be studied using dynamic general equilibrium models, the DSGE model started with the Real Business Cycle (RBC) models which emphasize the role of real shocks on driving business fluctuations. These models centered on the idea that economic agents in competitive markets form rational expectations about the future. In addition, it is possible to calibrate models with parameters obtained from microeconomic studies as well as long-run properties of the economy and use them to generate artificial data which can be compared to actual data. The RBC-based models are successful at mimicking the cyclical behavior of macroeconomic quantities, hence they have been widely used for the study of optimal fiscal and monetary policy (Rebelo, 2005). However, the controversial aspect of the early DSGE model is that it assumes a "perfect world" with flexible prices, perfectly functioning markets, and zero friction, but no effective role for monetary policy in affecting the economic outcomes (Dacharux, 2015).

To reflect the imperfections of the real-world economies, the New Keynesian DSGE model was developed, which has come to dominate modern macroeconomics especially for addressing monetary policy issues. One of the useful features of the DSGE model is that it is built on micro-foundations, which characterize the behaviors of different sectors in the economy. It was developed to incorporate economic principles and macroeconomic data.

The New Keynesian DSGE model combines the DSGE structural characteristic of the Real Business Cycle (RBC) models with the following key assumptions: nominal rigidities, monopolistic competition, and short run non-neutrality of monetary policy (Gali, 2008). Additionally, there are three components of the New Keynesian model as summarized by Walsh (2003): 1) expectational IS curve implied by intertemporal optimization of households; 2) Phillips curve relationship between inflation and output gap; 3) specification of a monetary policy. Furthermore, the New Keynesian approach emphasizes the role of forward-looking expectations and highlights the importance of central banks' influence on these expectations about future policy actions (Walsh, 2003).

The New Keynesian DSGE model has been widely used in macroeconomic studies. It is also frequently used for forecasting, while the use of the Bayesian estimation approach is also beneficial in terms of fitting DSGE models to the data. The Bayesian approach allows researchers to input their initial beliefs determined from past information or previous experiments, which are simply known as "priors." As for the posterior estimation, it is the probability that takes into account both prior knowledge and new data (estimation results). Yun (1996), for instance, first incorporated Calvo-type price-setting behavior (price stickiness) and monopolistic competition in a fully-fledged DSGE system. One of the adaptations of the simple New Keynesian DSGE model is the extension to the *small open economy*. Gali and Monacelli (2005), for instance, constructed a small open economy version of the Calvo sticky price model. The study demonstrated the equilibrium dynamics reflecting the degree of openness and world output fluctuations while considering three alternative rule-based policy regimes for small open economies including domestic inflation, CPI-based Taylor rules, and exchange rate pegs.

Since Indonesia, the Philippines, and Thailand are considered small open economies, this study applies a small open economy version of the New Keynesian DSGE model to examine their monetary policy rules. Based on Gali and Monacelli (2005), the estimable model consists of ten equations (see Appendix G), which can be written as follows.

$$\tilde{x}_t = E_t[\tilde{x}_{t+1}] - (1/\sigma_\alpha)(\tilde{r}_t - E_t[\pi_{H,t+1}] - \overline{rr}_t) \tag{5}$$

$$\overline{rr}_t = -\sigma_\alpha \Gamma(1-\rho_a)a_t + \alpha\sigma_\alpha(\Theta+\Psi)E_t[\Delta\tilde{y}^*{}_{t+1}] \tag{6}$$

$$\pi_{H,t} = \beta E_t[\pi_{H,t+1}] + (\kappa_\alpha \tilde{x}_t + e_t) \tag{7}$$

$$\tilde{r}_t = \phi_r \tilde{r}_{t-1} + (1-\phi_r)(\phi_\pi \pi_t + \phi_x \tilde{x}_t) + \varepsilon_{rt} \tag{8}$$

$$\pi_t = \pi_{H,t} + \alpha\Delta s_t \tag{9}$$

$$s_t = \sigma_\alpha(\tilde{y}_t - \tilde{y}^*{}_t) \tag{10}$$

$$\tilde{y}_t = \tilde{x}_t + (\Gamma a_t + \alpha\Psi\tilde{y}^*{}_t) \tag{11}$$

$$a_t = \rho_a a_{t-1} + \varepsilon_a \tag{12}$$

$$e_t = \rho_e e_{t-1} + \varepsilon_{et} \tag{13}$$

$$\tilde{y}^*{}_t = \rho_w \tilde{y}^*{}_{t-1} + \varepsilon_{wt} \tag{14}$$

The list of endogenous and exogenous variables, and definitional identities and fixed parameters are presented in Tables 8 and 9, respectively. The log-linearized variables are expressed by the percentage deviation from the zero-inflation steady-state level.

Equations (5) to (8) characterize the dynamic behavior of three key macroeconomic indicators, including output gap, inflation, and nominal interest rate. Equation (5) is the "expectational IS curve". Equation (6) captures the determination of the natural rate of interest rate. Equation (7) is the New-Keynesian Phillips Curve, which describes how monopolistically competitive firms set their prices in a random, staggered manner as an optimizing behavior, as suggested by Calvo (1968). Equation (8), corresponding to the equation specified in the GMM estimation in Chapter 2, represents the monetary policy rule. Equation (9)-(11) describe the nexus between the change in consumer prices, or CPI inflation, and the change in domestic goods prices, or domestic inflation. Such connections represent the character of a small open economy, where the linkage between a small open economy and the world economy is reflected in the economic openness and the terms of trade. Equations (12)-(14) show the specifications of productivity shock, cost-push shock, and world-output shock.

Data and model estimations

This study adopted the Bayesian approach to estimate the parameters of the New-Keynesian DSGE model specified above for Indonesia, the Philippines, and Thailand. The Bayesian estimation uses priors that allow for uncertainty in parameter values and then draws their posterior distributions by using the observed data. The posterior estimates of the behavioral parameters and structural shocks in the models show the characteristics of the monetary policy (Dacharux, 2015).

Regarding the observed data, the estimation uses output gap ($\tilde{x}$), domestic inflation (π_H), and nominal interest rate ($\tilde{r}$). The domestic inflation is calculated by the year-on-year percentage change of the seasonally adjusted GDP deflator[7]. The output gap is expressed as the deviation of the volume index of seasonally adjusted Gross Domestic Product (GDP)[8] from the potential GDP generated by the Hodrick-Prescott filter of the same series. The nominal interest rate is represented by the central bank policy rates[9] of Indonesia, the Philippines, and Thailand.

As this study concentrates on the estimation of the parameters in the monetary policy rules expressed in Equation 4, other parameters are treated as fixed. As presented in Table 9, the parameters of the degree of economic openness of Indonesia, the Philippines, and Thailand are fixed at 0.24, 0.35, and 0.61, respectively. The degree of economic openness was calculated by the average import/GDP ratio[10] over the sample period of each country. The settings of the parameters [β, γ, η, θ, σ, φ, ρ_a, ρ_e, ρ_w] correspond to various types of DSGE studies as in

[7] The seasonally adjusted GDP deflator time series data of Indonesia and Thailand were retrieved from the International Financial Statistics (IFS) of the IMF. The non-seasonally adjusted GDP deflator time series data of the Philippines were also retrieved from the IFS of the IMF and manually seasonally adjusted by the X-13 ARIMA-SEATS in EViews.

[8] The data for the seasonally adjusted GDP in volume in Indonesia, the Philippines, and Thailand were retrieved from the IFS of the IMF.

[9] The central bank policy rates of Indonesia, the Philippines, and Thailand were retrieved from the IFS of the IMF.

[10] The data for imports of goods and services, GDP of Indonesia, the Philippines, and Thailand were retrieved from the IFS of the IMF.

Smets and Wouters (2003, 2007), Gali and Monacelli (2005), and Gali (2008). Finally, the parameters [κ_α, λ, σ_α, ω, Γ, Θ, Ψ] are set as specified in Gali and Monacelli (2005).

The prior-value settings are reported in Table 10. According to it, the prior means of parameters on the reaction to inflation and smoothing degree of Indonesia, the Philippines, and Thailand are as follows. The values correspond to the cases of π_{t+2} in Indonesia (β=1.909, ρ=0.901), π_{t-2} in the Philippines (β=1.316, ρ=0.902) and π_{t+1} in Thailand (β=1.145, ρ=0.906), which fulfill the Taylor principle in Chapter 2. In contrast, the prior values of the output gap are set to zero since all the coefficients obtained from the GMM estimations turned out insignificant.

4.4 Estimation Results

The posterior distributions obtained from the Bayesian estimation are presented in comparison with the prior distributions in Table 10 and Figure 6. When comparing the posterior means of parameters on the reaction to inflation and smoothing degree to those of the prior means, it is worth noting that the values are close. In the case of the reaction to inflation; 1.889(posterior) vs. 1.909(prior) for Indonesia, 1.291 vs. 1.316 for the Philippines, and 1.250 vs. 1.145 for Thailand. In the case of the reaction to smoothing degree, 0.873 vs. 0.901 for Indonesia, 0.947 vs. 0.902 for the Philippines, and 0.726 vs. 0.906 for Thailand. Regarding the reaction to the output gap, as opposed to the insignificant outcomes in the GMM estimations, it appears here that the posterior means have significantly positive values in all sample countries; 0.161 for Indonesia, 0.124 for the Philippines, and 0.033 in Thailand. This implies that there is a possibility to further investigate the cause of such differences between the GMM and Bayesian approaches.

Comparing the degree of policy rate reaction to inflation between policy rules of Indonesia, Philippines, and Thailand, representing emerging ASEAN economies, and those of advanced economies, this study found that magnitudes in emerging ASEAN economies are smaller than those of advanced economies. As mentioned, the posteriors obtained are 1.889 for Indonesia, 1.291 for the Philippines, and 1.250 for Thailand. However, the policy rate reaction to inflation is 2.27-2.57 in the United States (Belke and Polleit, 2007), and 2.04 in Japan (Clarida et al., 1998b). Thus, the policy rate reactions to inflation in emerging ASEAN economies are considered to be weaker despite fulfilling the Taylor principle.

In short, as the outcomes from both approaches are consistent, it can be concluded that the Bayesian estimation of the New Keynesian DSGE model endorsed the GMM estimation of the monetary policy reaction functions in Chapter 2. Furthermore, we confirmed that the monetary policy rules of all sample countries truly fulfill the Taylor principle.

4.5 Chapter Summary

This study re-examines the IT performance of emerging ASEAN economies (Indonesia, the Philippines, and Thailand) through the Bayesian estimation of a small open economy version for the New Keynesian DSGE model. The purpose of this chapter is to confirm the validity of the Taylor principle via the macroeconomic framework and to double-check the robustness and consistency of the outcomes obtained from the GMM estimations in Chapter 2. The major contributions of this study are as follows. First, with a focus on IT adopters and their adaptability to the Taylor principle, this chapter updated and enriched the evidence of monetary policy rules of emerging ASEAN economies. Second, a small open economy version of the New Keynesian DSGE model is adopted as an extension to Taguchi et al (2020), which focused on a closed economy. Third, this study provides evidence that the adaptability of the Taylor principle can be verified through both the partial estimation of policy reaction functions and the New Keynesian macroeconomic model with micro-foundations.

The main findings are summarized as follows. First, this study identified the inflation-responsive rules fulfilling the Taylor principle in all sample economies, with a forward-looking manner in Indonesia and Thailand; a backward-looking manner in the Philippines. Second, the results from the Bayesian estimations of the New Keynesian DSGE model correspond to the results from the GMM estimations in Chapter 2 by producing consistent outcomes. Likewise, the results show consistency with the IT primary objective, price stability.

The policy implications are, as previously addressed in Chapter 2, that despite Indonesia, the Philippines, and Thailand fulfilling the Taylor principle, their policy rate reactions to inflation have been weaker when compared to those of advanced economies.

CONCLUDING REMARKS

This dissertation seeks to examine the performance of monetary policies under the inflation targeting (IT) framework, focusing on their capability to control inflation in emerging ASEAN economies: Indonesia, Philippines, and Thailand for IT adopters, and Malaysia and Vietnam for the non-IT adopters. In doing so, the series of studies in this dissertation adopted the following methodologies. GMM estimations of both backward-looking and forward-looking versions of monetary policy reaction functions proposed by Clarida et.al., (1998) for examining the link between an economy's announced monetary policy rule and the estimated monetary policy rule, particularly from the perspective of the adaptability of the Taylor principle. The VAR model and impulse response function estimation were adapted from Taguchi and Bolortuya (2019) for identifying the link between the adoption of IT and the loss of the exchange rate pass-through (ERPT). Finally, the Bayesian estimation of a small open economy version of the New Keynesian DSGE model proposed by Smets and Wouters (2003, 2007), Gali and Monacelli (2005), and Gali (2008), was used for reassessing the adaptability of the Taylor principle by a macroeconomic model with micro-foundations. With these approaches, this dissertation expects to enrich the evidence of the performance of IT in emerging ASEAN economies.

Chapter 1 explores and presents the announced monetary policy rules of each economy, divided into two groups – IT adopters (Indonesia, Philippines, and Thailand) and non-IT adopters (Malaysia and Vietnam). The major differences found among both groups can be summarized as follows: first, despite "price stability" being positioned as an ultimate goal in all sample economies, IT adopters stick to a single goal, while non-IT economies may adopt multiple goals on the side to maintain policy flexibility which could hinder their capability to stabilize inflation; and second, IT adopters explicitly announce their inflation targets to the public while non-IT adopters conduct implicit inflation targeting. Regarding exchange rates management, Indonesia, the Philippines, Thailand, and Malaysia are classified as "floating" while Vietnam is classified as "stabilized arrangement." In practice, these countries casually intervene in the FX market to avoid excessive exchange rate volatilities, which is regarded as the phenomenon of "fear of floating."

The empirical analysis in Chapter 2 aims to answer the following two major research questions: whether the monetary policy rules of the IT adopters have fulfilled the Taylor principle, and what has been the difference in monetary policy rules between IT adopters and non-IT adopters. Regarding the first research question, the findings show that IT adopters' monetary policy rules are characterized by inflation-responsive rules fulfilling the Taylor principle – this means that their policy rate reactions to inflation are counter-cyclical. The link between the announced monetary policy rules and the estimated ones is identified in the sense that their actual practices are in line with their "price stability" objective. Additionally, as the adaptability of the Taylor principle is now identified among emerging ASEAN economies, it can be concluded that there is no gap between the theoretical Taylor principle and their actual practices. Surprisingly, Vietnam's monetary policy rules also fulfill the Taylor principle. This may imply its efforts in transitioning to explicit inflation targeting adoption. Regarding the second research question, the difference in monetary policy rules between the two groups is that non-IT adopters' monetary policy rules are not centered on an inflation-responsive rule. Malaysia follows solely an output-gap responsive rule while Vietnam exhibits mixed rules with inflation- and exchange rate- responsiveness. On a side note, although the "fear of floating" effect was assumed to have a negative impact on an economy's monetary policy independence, the findings reveal that the effect had no serious repercussions since the Taylor principle holds under the "fear of floating".

Chapter 3 focuses solely on IT-adopters and seeks to answer the following research questions: first, whether the relationship between the IT framework and the loss of the ERPT is valid in emerging ASEAN economies; and second, whether there is a relationship between the forward-looking monetary policy rule and the loss of the ERPT. In examining the first research question, the empirical results show the existence of the ERPT in the pre-IT period and a clear loss of ERPT in the post-IT period for Indonesia, the Philippines, and Thailand. Therefore, we can conclude that there is a valid relationship between IT and the loss of the ERPT in emerging ASEAN economies. Thus, the results could highlight the role of the inflation-responsive monetary policy rule in contributing to the loss of the ERPT. The additional finding is that the sample economies' average inflation in the post-IT period has been much lower compared to the pre-IT period, thereby supporting Taylor's hypothesis which suggests low pass-through effects under a low inflation environment. Regarding the second question, the empirical results show no evidence of the link between the forward-looking monetary policy rule and the loss of the ERPT as the Philippines, whose monetary policy rule remains backward-looking, satisfied the requirements of the loss of the ERPT.

With the use of a macroeconomic model, the empirical results from Chapter 4 endorsed the validity of the Taylor principle verified by the GMM estimation in Chapter 2. The posterior estimates produced similar results to those from the partial GMM estimations. However, the significantly positive posterior means of the reaction to output gap suggests a need for further investigation into the cause of such discrepancy between the two approaches.

Based on the empirical results from Chapter 2, Chapter 3, and Chapter 4, the policy implications can be highlighted as follows. First, despite their policy-rate reactions having an effect to stabilize inflation, the monetary authorities in Indonesia, the Philippines, and Thailand should emphasize on improving the policy-rate responses to be more elastic to inflation as their reactions are found to be much weaker compared to those of advanced economies. Second, for non-IT adopters, an explicit IT framework is suggested to be adopted to ensure a robust effect of policy rate on stabilizing inflation. Third, to better anchor public expectations, the Philippines should focus on upgrading its monetary policy rules to a forward-looking rule.

There are some limitations in this dissertation to be noted. First, the VAR model specification in the empirical analysis in Chapter 3 involves only two major variables due to the focus on the effects on consumer prices. However, there is room to extend the scope of variables in the baseline model in future research and investigate more comprehensively. Second, since small open economies are prone to foreign shocks and emerging market economies are suffering from the fear of floating problems, control variables such as external exposure and external debt should also be added in future research. Third, the focus only on emerging ASEAN economies limits room for comparison with other literature to come to a clear conclusion, and thus, the analytical targets should be enriched, for instance, by including the emerging market economies in areas other than the ASEAN region.

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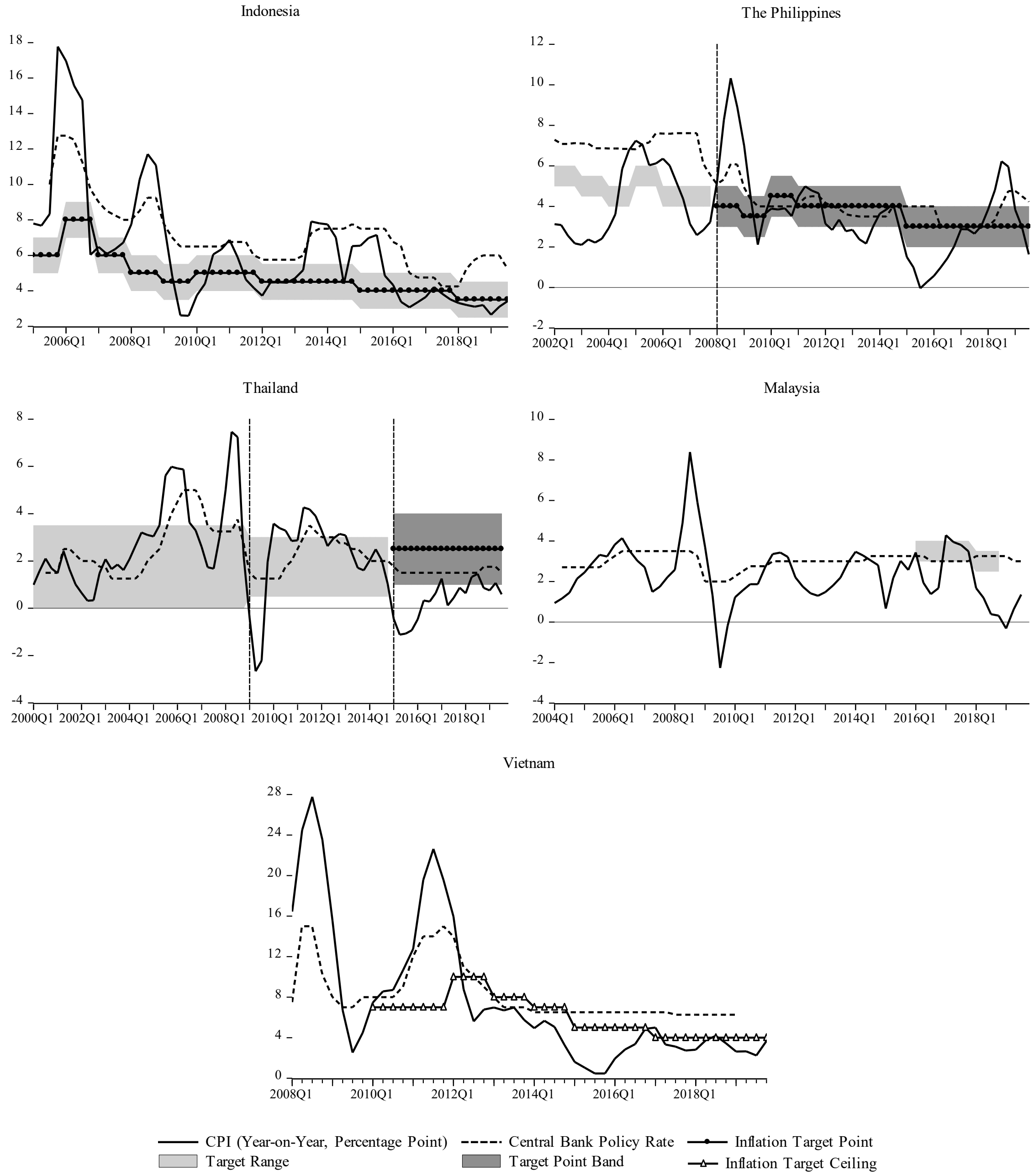
Figure 1 Key Indicators of Inflation Targeting



Sources: IFS of IMF and each central bank's website (see Note 1)

Table 1 Estimation Results of Policy Reaction Function

[Indonesia]

Forward-looking	cpi_{t+1}	cpi_{t+2}	cpi_{t+3}	cpi_{t+4}
$(1-\rho)\alpha$	1.136*** (3.125)	-0.476 (-1.129)	-1.507** (-2.629)	-1.916** (-2.138)
$(1-\rho)\beta$	0.314*** (7.699)	0.189** (2.626)	0.075 (1.038)	0.081 (0.716)
$(1-\rho)\gamma$	-0.394** (-2.129)	0.159 (0.558)	0.570* (1.752)	0.681** (2.077)
$(1-\rho)\delta$	0.007 (1.001)	0.014* (1.769)	0.012 (0.792)	0.012 (0.649)
ρ	0.567*** (7.472)	0.901*** (8.919)	1.145*** (14.861)	1.200*** (16.139)
J-statistics	1.126 (0.570)	1.180 (0.554)	1.237 (0.539)	1.135 (0.567)
Long-term Coefficients				
α	2.624***	-4.808	-	-
β	0.725***	1.909**	-	-
γ	-0.910**	1.606	-	-
δ	0.016	0.141*	-	-

Backward-looking	cpi_{t}	cpi_{t-1}	cpi_{t-2}	cpi_{t-3}
$(1-\rho)\alpha$	1.428*** (3.006)	1.628 (1.675)	1.189 (1.331)	-0.764 (-0.825)
$(1-\rho)\beta$	0.209*** (4.437)	0.156 (1.473)	0.027 (0.297)	-0.180* (-2.29)
$(1-\rho)\gamma$	-0.108 (-0.467)	0.082 (0.287)	0.241 (1.033)	0.224 (0.858)
$(1-\rho)\delta$	0.008 (1.046)	0.008 (0.908)	0.009 (1.517)	0.012* (2.333)
ρ	0.609*** (6.301)	0.618*** (2.814)	0.783*** (3.917)	1.247*** (6.288)
J-statistics	2.313 (0.315)	2.899 (0.235)	2.796 (0.247)	1.650 (0.438)
Long-term Coefficients				
α	3.652***	4.262	5.479	-
β	0.535***	0.408	0.124	-
γ	-0.276	0.215	1.111	-
δ	0.020	0.021	0.055	-

[The Philippines]

Forward-looking	$\boldsymbol{cpi_{t+1}}$	$\boldsymbol{cpi_{t+2}}$	$\boldsymbol{cpi_{t+3}}$	$\boldsymbol{cpi_{t+4}}$
$(1-\rho)\alpha$	-0.814 (-1.661)	-1.449** (-2.262)	-0.534 (-0.770)	-0.162 (-0.385)
$(1-\rho)\beta$	0.071 (1.228)	0.001 (0.015)	-0.079 (-1.663)	-0.064* (-1.695)
$(1-\rho)\gamma$	-0.058 (-0.237)	0.197 (0.676)	0.266 (1.064)	0.175 (1.192)
$(1-\rho)\delta$	0.036 (1.370)	0.061* (1.866)	0.031 (0.923)	0.023 (1.008)
ρ	1.099*** (10.508)	1.257*** (12.313)	1.148*** (8.565)	1.071*** (11.269)
J-statistics	0.037 (0.982)	1.529 (0.466)	3.376 (0.184)	2.779 (0.249)
Long-term Coefficients				
α	-	-	-	-
β	-	-	-	-
γ	-	-	-	-
δ	-	-	-	-

Backward-looking	$\boldsymbol{cpi_{t}}$	$\boldsymbol{cpi_{t-1}}$	$\boldsymbol{cpi_{t-2}}$	$\boldsymbol{cpi_{t-3}}$
$(1-\rho)\alpha$	-0.688 (-1.226)	-0.494 (-1.187)	0.079 (0.204)	-0.044 (-0.086)
$(1-\rho)\beta$	0.057 (1.152)	0.071* (1.849)	0.129*** (2.930)	0.101** (2.220)
$(1-\rho)\gamma$	-0.021 (-0.101)	-0.014 (-0.090)	-0.088 (-0.724)	0.064 (0.576)
$(1-\rho)\delta$	0.033 (1.197)	0.030 (1.483)	0.016 (0.831)	0.027 (1.184)
ρ	1.086*** (8.921)	1.041*** (11.412)	0.902*** (9.596)	0.939*** (7.790)
J-statistics	0.091 (0.956)	0.039 (0.981)	0.940 (0.625)	0.397 (0.819)
Long-term Coefficients				
α	-	-	0.806	-0.721
β	-	-	1.316***	1.656**
γ	-	-	-0.898	1.049
δ	-	-	0.163	0.442

[Thailand]

Forward-looking	cpi_{t+1}	cpi_{t+2}	cpi_{t+3}	cpi_{t+4}
$(1-\rho)\alpha$	-0.031 (-0.214)	-0.342 (-1.480)	-0.338 (-1.043)	0.386 (1.066)
$(1-\rho)\beta$	0.133*** (3.901)	0.072* (1.793)	0.058 (1.570)	-0.013 (-0.416)
$(1-\rho)\gamma$	0.012 (0.276)	0.030 (0.336)	0.078 (0.829)	0.160** (1.996)
$(1-\rho)\delta$	0.016** (2.200)	0.013 (1.098)	0.013 (1.164)	0.009 (0.667)
ρ	0.906*** (12.177)	1.113*** (11.887)	1.128*** (8.328)	0.820*** (5.223)
J-statistics	1.265 (0.531)	1.857 (0.395)	2.332 (0.312)	5.942* (0.051)
Long-term Coefficients				
α	-0.330	-	-	2.14
β	1.145***	-	-	-0.072
γ	0.128	-	-	0.889**
δ	0.170**	-	-	0.05

Backward-looking	cpi_{t}	cpi_{t-1}	cpi_{t-2}	cpi_{t-3}
$(1-\rho)\alpha$	0.120 (0.578)	0.160 (1.159)	0.343*** (2.789)	0.653*** (3.155)
$(1-\rho)\beta$	0.097*** (2.660)	0.034 (0.963)	0.059 (1.137)	0.099** (2.328)
$(1-\rho)\gamma$	0.008 (0.206)	0.055 (1.022)	0.100** (2.195)	0.192** (2.481)
$(1-\rho)\delta$	0.010 (1.357)	0.006 (0.740)	0.007 (0.818)	0.012 (5.044)
ρ	0.865*** (7.334)	0.902*** (13.075)	0.797*** (9.326)	0.632*** (5.044)
J-statistics	1.785 (0.410)	1.991 (0.369)	1.615 (0.446)	0.058 (0.972)
Long-term Coefficients				
α	0.889	1.633	0.14***	1.774***
β	0.719***	0.374	0.291	0.269**
γ	0.059	0.516	0.493**	0.522**
δ	0.074	0.061	0.034	0.033

[Malaysia]

Forward-looking	$\boldsymbol{cpi_{t+1}}$	$\boldsymbol{cpi_{t+2}}$	$\boldsymbol{cpi_{t+3}}$	$\boldsymbol{cpi_{t+4}}$
$(1-\rho)\alpha$	0.562 (1.570)	0.820 (1.672)	0.860 (1.940)	0.852* (1.865)
$(1-\rho)\beta$	0.012 (0.541)	-0.010 (-0.436)	0.003 (0.107)	-0.007 (-0.532)
$(1-\rho)\gamma$	0.050 (1.233)	0.085* (1.842)	0.088*** (2.770)	0.081** (2.324)
$(1-\rho)\delta$	-0.004 (-1.031)	-0.003 (-1.052)	-0.004 (-1.162)	-0.004 (-1.147)
ρ	0.809*** (6.994)	0.736*** (4.840)	0.714*** (5.206)	0.726*** (4.926)
J-statistics	3.373 (0.185)	3.434 (0.180)	2.194 (0.334)	2.204 (0.332)
Long-term Coefficients				
α	2.942	3.106	3.007	3.109*
β	0.063	-0.038	0.010	-0.026
γ	0.262	0.322*	0.308***	0.296**
δ	-0.021	0.011	-0.014	-0.015

Backward-looking	$\boldsymbol{cpi_{t}}$	$\boldsymbol{cpi_{t-1}}$	$\boldsymbol{cpi_{t-2}}$	$\boldsymbol{cpi_{t-3}}$
$(1-\rho)\alpha$	1.077** (2.197)	0.494 (0.729)	1.072** (2.032)	0.964** (2.167)
$(1-\rho)\beta$	0.033 (1.230)	-0.056 (-0.722)	0.018 (0.632)	0.001 (0.036)
$(1-\rho)\gamma$	0.090** (2.122)	0.606 (1.277)	0.102* (1.922)	0.087* (1.990)
$(1-\rho)\delta$	-0.003 (-0.770)	-0.003 (-1.150)	-0.004 (-1.172)	-0.003 (-1.004)
ρ	0.618*** (3.499)	0.887*** (3.124)	0.635*** (3.239)	0.688*** (4.340)
J-statistics	1.898 (0.387)	2.099 (0.350)	2.684 (0.261)	3.087 (0.214)
Long-term Coefficients				
α	2.819**	4.372	2.937**	3.080**
β	0.086	-0.496	0.049	0.003
γ	0.236**	5.363	0.279*	0.279*
δ	-0.008	-0.027	-0.011	-0.010

[Vietnam]

Forward-looking	cpi_{t+1}	cpi_{t+2}	cpi_{t+3}	cpi_{t+4}
$(1-\rho)\alpha$	1.089 (1.093)	0.746 (1.145)	-0.299 (-0.336)	-1.698 (-0.835)
$(1-\rho)\beta$	0.116** (2.039)	0.146** (2.691)	0.133** (2.113)	0.106 (0.824)
$(1-\rho)\gamma$	-0.000 (-0.119)	-0.002 (-0.709)	-0.002 (-0.395)	0.000 (0.041)
$(1-\rho)\delta$	0.133** (2.054)	0.076 (0.752)	0.002 (0.016)	-0.065 (-0.285)
ρ	0.718*** (4.286)	0.756*** (7.670)	0.915*** (7.496)	1.123*** (4.570)
J-statistics	5.653 (0.059)	2.962 (0.227)	0.649 (0.723)	0.605 (0.739)
Long-term Coefficients				
α	3.862	3.057	-3.518	-
β	0.411**	0.598**	1.565**	-
γ	-0.001	-0.008	-0.023	-
δ	0.472**	0.311	0.024	-

Backward-looking	cpi_{t}	cpi_{t-1}	cpi_{t-2}	cpi_{t-3}
$(1-\rho)\alpha$	0.627 (0.596)	-1.721 (-1.065)	-0.204 (-0.198)	0.392 (0.429)
$(1-\rho)\beta$	-0.017 (-0.228)	-0.237*** (-2.793)	-0.100*** (-2.877)	-0.037** (2.210)
$(1-\rho)\gamma$	-0.003 (-1.029)	-0.005 (-0.753)	-0.003 (-0.711)	-0.003 (-1.127)
$(1-\rho)\delta$	0.206*** (3.080)	0.261*** (3.346)	0.186*** (2.441)	0.156** (2.086)
ρ	0.845*** (4.605)	1.293*** (4.646)	1.028*** (5.612)	0.914*** (5.646)
J-statistics	2.126 (0.345)	1.221 (0.543)	0.803 (0.669)	0.874 (0.646)
Long-term Coefficients				
α	4.045	-	-	4.558
β	-0.110	-	-	-0.430**
γ	-0.019	-	-	-0.035
δ	1.329***	-	-	1.814**

Note: ***, **, * denote the rejection of null hypothesis at the 99%, 95% and 90% level of significance. The numbers in parentheses are t-values, except that those in J-statistics are their probabilities.

Sources: IFS of IMF and author's estimation

Table 2 Summary of Estimation Results

		Coefficient of Inflation β				
		Indonesia	Philippines	Thailand	Malaysia	Vietnam
Forward-looking	cpi_{t+4}	-	-	not sig.	not sig.	-
	cpi_{t+3}	-	-	-	not sig.	** >1
	cpi_{t+2}	** >1	-	-	not sig.	** <1
	cpi_{t+1}	*** <1	-	*** >1	not sig.	** <1
Backward-looking	cpi_{t}	*** <1	-	*** <1	not sig.	not sig.
	cpi_{t-1}	not sig.	-	not sig.	not sig.	-
	cpi_{t-2}	not sig.	*** >1	not sig.	not sig.	-
	cpi_{t-3}	-	** >1	** <1	not sig.	** <1

		Coefficient of Output Gap γ				
		Indonesia	Philippines	Thailand	Malaysia	Vietnam
Forward-looking	cpi_{t+4}	-	-	***	**	-
	cpi_{t+3}	-	-	-	***	not sig.
	cpi_{t+2}	not sig.	-	-	*	not sig.
	cpi_{t+1}	** neg.	-	not sig.	not sig.	not sig.
Backward-looking	cpi_{t}	not sig.	-	not sig.	**	not sig.
	cpi_{t-1}	not sig.	-	not sig.	not sig.	-
	cpi_{t-2}	not sig.	not sig.	**	*	-
	cpi_{t-3}	-	not sig.	**	*	not sig.

		Coefficient of Exchange Rate δ				
		Indonesia	Philippines	Thailand	Malaysia	Vietnam
Forward-looking	cpi_{t+4}	-	-	not sig.	not sig.	-
	cpi_{t+3}	-	-	-	not sig.	not sig.
	cpi_{t+2}	*	-	-	not sig.	not sig.
	cpi_{t+1}	not sig.	-	**	not sig.	**
Backward-looking	cpi_{t}	not sig.	-	not sig.	not sig.	***
	cpi_{t-1}	not sig.	-	not sig.	not sig.	-
	cpi_{t-2}	not sig.	not sig.	not sig.	not sig.	-
	cpi_{t-3}	-	not sig.	not sig.	not sig.	**

Note: ***, **, * denote the rejection of null hypothesis at the 99%, 95% and 90% level of significance in the coefficients; "not sig." means that the coefficients are not significant; and "neg." means that the coefficient is unexpectedly negative. ">1" and "<1" mean that the coefficients' magnitudes are more or less than unity, implying whether the Taylor principle is fulfilled or not.

Sources: Author's estimation

Table 3 Chow Breakpoint Test

	Indonesia	Philippines	Thailand
Chow breakpoint test	2005 Q3	2002 Q1	2000 Q2
F-statistics	46.79***	74.59***	122.62***

Note: *** indicates the rejection of the null hypothesis at the 99% level of significance.

Source: Author's estimation

Figure 2 Exchange Rates and Consumer Prices, Year-on-Year Percentage Changes

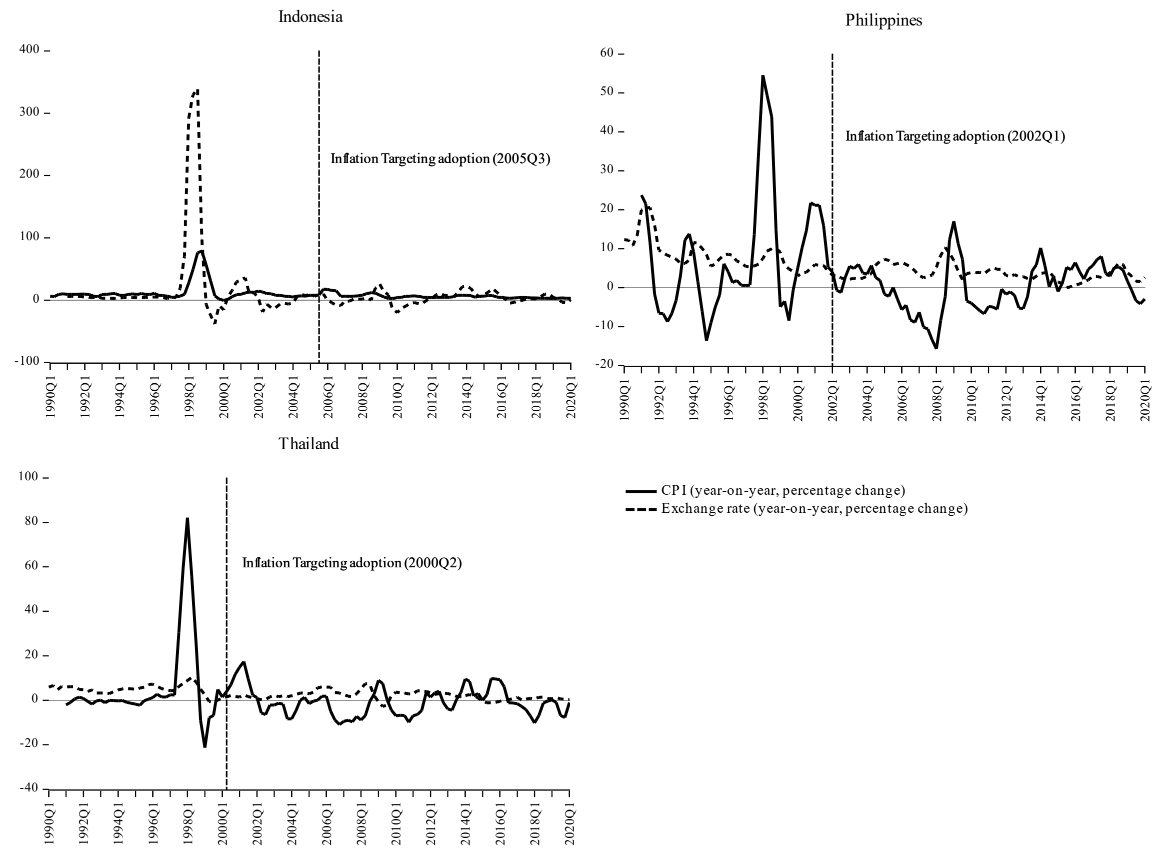


Table 4 Unit Root Test and Co-Integration Test

	Indonesia		Philippines		Thailand	
	ADF	PP	ADF	PP	ADF	PP
$\boldsymbol{cpi}$	-3.12	-3.15	-2.98	-1.66	-1.33	-0.74
$\boldsymbol{exr}$	-2.54	-2.82	-1.69	-1.55	-1.94	-1.64
$\boldsymbol{cpig}$	-3.96**	-4.00**	-4.15***	-3.79**	-5.25***	-4.05***
$\triangle\boldsymbol{cpi}$	-6.31***	-5.85***	-6.15***	-5.49***	-6.63***	-6.30***
$\triangle\boldsymbol{exr}$	-7.30***	-10.30***	-7.35***	-7.35***	-7.41***	-8.01***

Note: *** and ** indicate the rejection of the null hypothesis at the 99% and 95% level of significance respectively.

Source: Author's estimation

Table 5 Lag Length Selection Criteria

	Lag	LogL	LR	FPE	AIC	SC	HQ
Indonesia	1	-1111.32	1096.87*	433474.9*	18.66*	18.84*	18.73*
Philippines	1	-292.62	1270.64*	0.51*	5.01*	5.20*	5.09*
Thailand	1	-316.28	1106.70*	0.76*	5.40*	5.59*	5.48*

Note: * indicates a lag order selected by the criterion. LR is a sequential modified LR test statistic (each test at 5% level), FPE is a final prediction error, AIC is Akaike information criterion, SC is Schwarz information criterion, and HQ is Hannan-Quinn information criterion.

Source: Author's estimation

Table 6 The VAR Model Estimation Results

[Pre-Inflation-Targeting]

	Indonesia 1990Q1-2005Q2		Philippines 1990Q1-2001Q4		Thailand 1990Q1-2000Q1	
	$\triangle exr$	$\triangle cpi$	$\triangle exr$	$\triangle cpi$	$\triangle exr$	$\triangle cpi$
$\boldsymbol{c}$	202.520	0.243	1.389	0.381	0.363	0.066
	[1.202]	[1.881]	[2.270]	[3.383]	[0.392]	[0.478]
$\triangle \boldsymbol{exr_{-1}}$	0.170	0.000***	0.370	0.131**	0.162	0.085**
	[1.214]	[3.143]	[2.586]	[4.970]	[0.893]	[3.109]
$\triangle \boldsymbol{cpi_{-1}}$	-712.340	0.243	-0.179	0.067	1.481	-0.104
	[-2.795]	[1.245]	[-0.235]	[0.475]	[1.069]	[-0.499]
$\boldsymbol{cpig}$	42.149	0.032**	-0.097*	0.042**	-0.244	0.144**
	[2.232]	[2.225]	[-1.285]	[3.059]	[-0.822]	[3.209]
Adj. R^2	0.079	0.588	0.143	0.489	0.003	0.534

[Post-Inflation-Targeting]

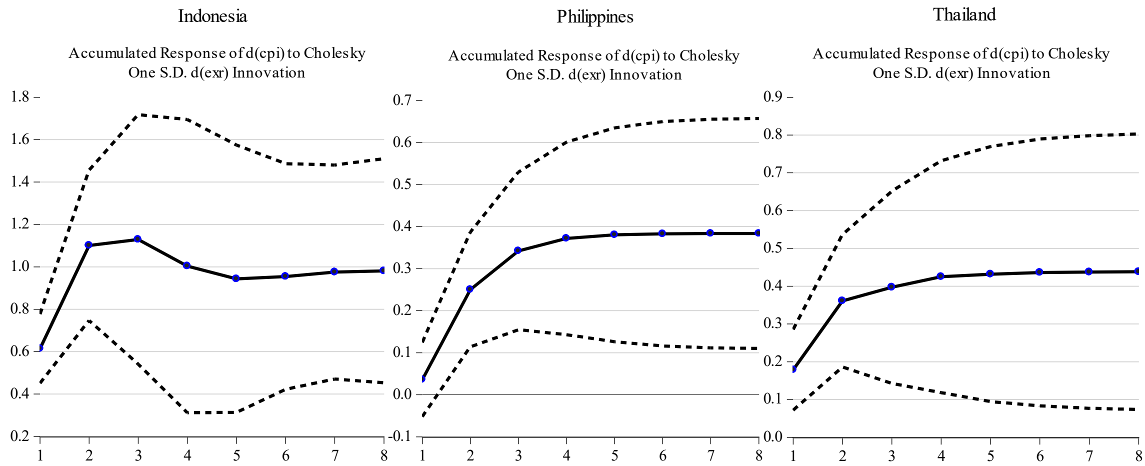
	Indonesia 2005Q2-2020Q1		Philippines 2002Q1-2020Q1		Thailand 2000Q2-2020Q1	
	$\triangle exr$	$\triangle cpi$	$\triangle exr$	$\triangle cpi$	$\triangle exr$	$\triangle cpi$
$\boldsymbol{c}$	-43.569	1.024	-0.083	0.229	-0.129	0.075*
	[-0.361]	[5.061]	[-0.303]	[1.778]	[-0.872]	[0.761]
$\triangle \boldsymbol{exr_{-1}}$	0.296	-0.000***	0.313	-0.064	0.302	-0.114*
	[2.257]	[-0.768]	[2.818]	[-1.221]	[2.819]	[-1.601]
$\triangle \boldsymbol{cpi_{-1}}$	45.656	0.070	0.738	0.230	-0.235	0.089
	[0.635]	[0.583]	[2.373]	[1.568]	[-1.090]	[0.615]
$\boldsymbol{cpig}$	5.001	0.045**	-0.150*	0.122**	0.073*	0.164*
	[0.223]	[1.202]	[-0.155]	[2.674]	[0.921]	[3.109]
Adj. R^2	0.065	0.026	0.129	0.329	0.071	0.285

Note: ***, **, and * indicate the rejection of the null hypothesis at the 99%, 95%, and 90% level of significance respectively. The figures in [] represent the t-value.

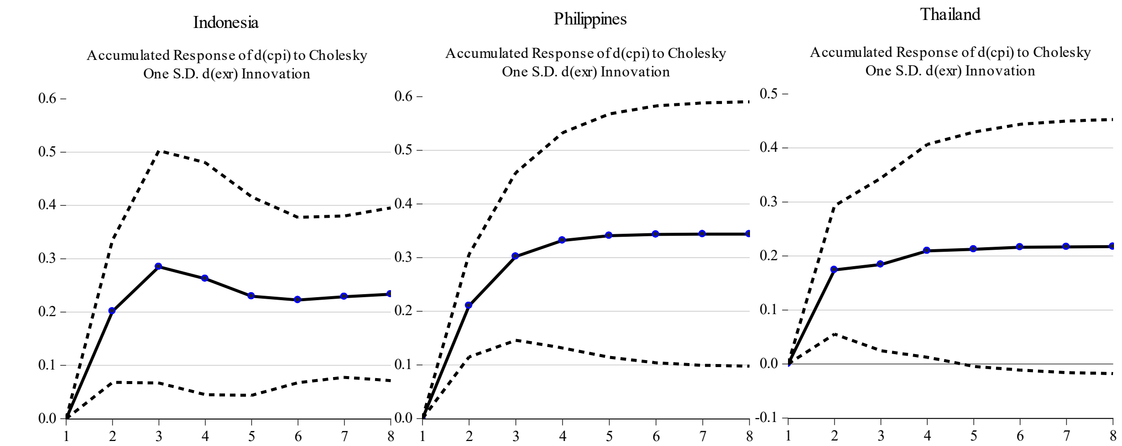
Source: Author's estimation

Figure 3 Impulse Responses: Pre-Inflation-Targeting

[Recursive order from $\triangle exr$ to $\triangle cpi$]



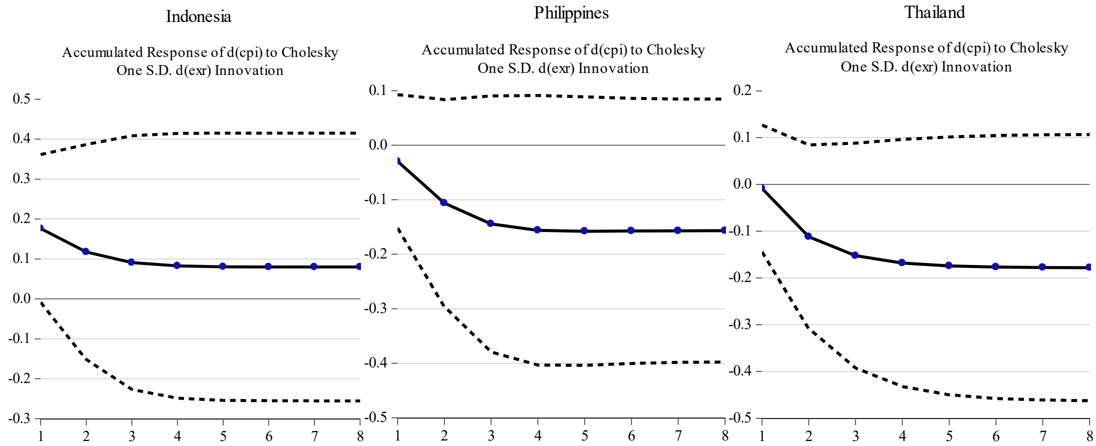
[Recursive order from $\triangle cpi$ to $\triangle exr$]



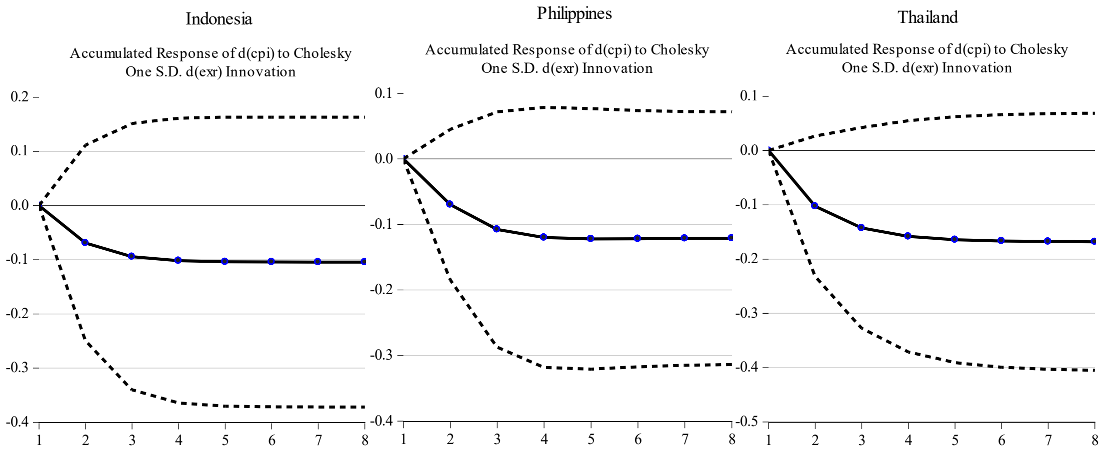
Source: Author's estimation

Figure 4 Impulse Responses: Post-Inflation-Targeting

[Recursive order from $\triangle exr$ to $\triangle cpi$]



[Recursive order from $\triangle cpi$ to $\triangle exr$]



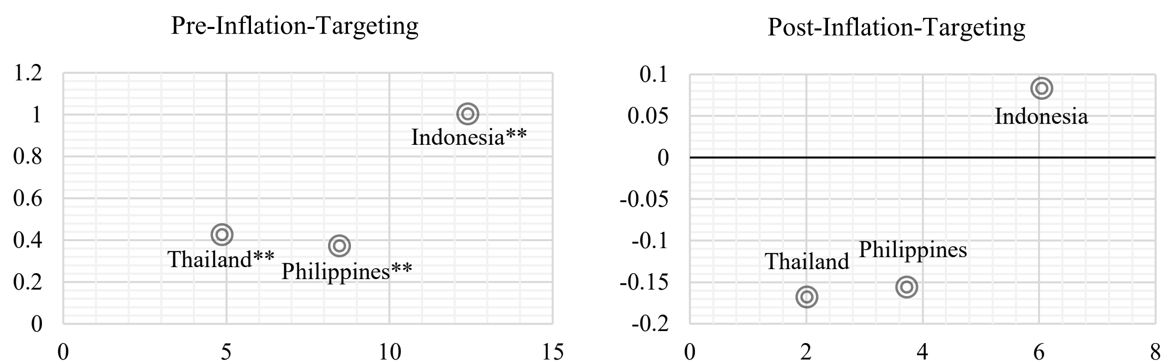
Source: Author's estimation

Table 7 Accumulated Impulse Responses of Consumer Prices to Cholesky 1 S.D. Exchange Rate Shock

	Indonesia		**Philippines**		**Thailand**	
	Pre-IT	Post-IT	Pre-IT	Post-IT	Pre-IT	Post-IT
Recursive order from $\triangle \boldsymbol{exr}$ to $\triangle \boldsymbol{cpi}$						
1st quarter	0.614**	0.176	0.036	-0.030	0.179**	-0.009
2nd quarter	1.101**	0.117	0.250**	-0.106	0.361**	-0.112
3rd quarter	1.129**	0.091	0.342**	-0.145	0.397**	-0.152
4th quarter	1.003**	0.083	0.372**	-0.156	0.425**	-0.168
5th quarter	0.943**	0.080	0.380**	-0.158	0.432**	-0.174
6th quarter	0.954**	0.080	0.383**	-0.157	0.436**	-0.177
7th quarter	0.975**	0.080	0.383**	-0.157	0.437**	-0.178
8th quarter	0.981**	0.080	0.384**	-0.157	0.438**	-0.178
Recursive order from $\triangle \boldsymbol{cpi}$ to $\triangle \boldsymbol{exr}$						
1st quarter	0.000	0.000	0.000	0.000	0.000	0.000
2nd quarter	0.201**	-0.069	0.210**	-0.070	0.174**	-0.103
3rd quarter	0.284**	-0.094	0.302**	-0.108	0.184**	-0.143
4th quarter	0.262**	-0.102	0.332**	-0.120	0.209**	-0.158
5th quarter	0.230**	-0.104	0.341**	-0.122	0.212**	-0.164
6th quarter	0.222**	-0.104	0.343**	-0.122	0.216	-0.167
7th quarter	0.229**	-0.104	0.344**	-0.121	0.217	-0.168
8th quarter	0.233**	-0.104	0.344**	-0.121	0.217	-0.168

Note: ** indicates the rejection of the null hypothesis at the 95% level of significance.
Source: Author's estimation

Figure 5 The ERPT to CPI and the Average Inflation in Indonesia, the Philippines, and Thailand



Note: y-axis indicates the accumulated response of $\triangle cpi$ to a 1 percentage $\triangle exr$ shock after 1 year, and x-axis indicates the average inflation (year-on-year percentage change) over each sub-period.

Source: Author's estimation

Table 8 List of Endogenous and Exogenous Variables

Endogenous variables	
$\tilde{\mathbf{x}}$	Output gap
$\tilde{\mathbf{y}}$	Output
π	CPI inflation
$\boldsymbol{\pi}_{\mathbf{H}}$	Domestic inflation
$\tilde{\mathbf{r}}$	Nominal interest rate
$\overline{\mathbf{rr}}$	Natural rate of interest rate
$\mathbf{s}$	Terms of trade
$\mathbf{E}$	Expectation operator
Exogenous variables	
$\tilde{\mathbf{y}}^{*}$	World output that follows first-order autoregressive with i.i.d. shock, ε_{w}
$\boldsymbol{a}$	Productivity shock that follows first-order autoregressive with i.i.d. shock, ε_{a}
$\boldsymbol{e}$	Cost-push shock that follows first-order autoregressive with i.i.d. shock, ε_{e}
$\boldsymbol{\varepsilon}_{\mathbf{r}}$	Monetary policy shock with i.i.d.

Source: Author's description

Notes: $\sim$ denotes the deviation from the steady-state level

Table 9 List of Parameters

	Descriptions	Assumptions			Notes
		Indonesia	The Philippines	Thailand	
Fixed parameters					
α	Degree of economic openness	0.24	0.35	0.61	Import/GDP ratio in the sample average
β	Discount factor for households	0.99	0.99	0.99	
γ	Substitutability between goods produced in different foreign countries	1.00	1.00	1.00	
η	Substitutability between domestic and foreign goods	1.00	1.00	1.00	
θ	Probability a firm does not change its price	0.75	0.75	0.75	
σ	Parameter on utility of consumption under constant relative risk aversion (CRRA)	1.00	1.00	1.00	Log utility of consumption
φ	Parameter on disutility of labor	0.00	0.00	0.00	Linear disutility of labor
$\boldsymbol{\rho_a}$	Autoregressive parameter for productivity shock	0.90	0.90	0.90	
$\boldsymbol{\rho_e}$	Autoregressive parameter for cost-push shock	0.90	0.90	0.90	
$\boldsymbol{\rho_w}$	Autoregressive parameter for world GDP shock	0.90	0.90	0.90	
Definitional identities					
$\kappa_\alpha \equiv \boldsymbol{\lambda\,(\sigma_\alpha + \varphi)}$					
$\boldsymbol{\lambda} \equiv \{\boldsymbol{(1-\beta\theta)(1-\theta)/\theta}\}$					
$\boldsymbol{\sigma_\alpha \equiv \sigma/(1-\alpha) + \alpha\omega}$					
$\boldsymbol{\omega \equiv \sigma\lambda + (1-\alpha)(\sigma\eta - 1)}$					
$\boldsymbol{\Gamma \equiv (1+\varphi)/(\sigma_\alpha + \varphi)}$					
$\boldsymbol{\Theta \equiv (\sigma\gamma - 1) + (1-\alpha)(\sigma\eta - 1)}$					
$\boldsymbol{\Psi \equiv -\Theta\sigma_\alpha/\sigma_\alpha + \varphi}$					
Estimated parameters					
$\boldsymbol{\phi_\pi}$	Policy rate reaction to CPI inflation				
$\boldsymbol{\phi_x}$	Policy rate reaction to output gap				
$\boldsymbol{\phi_r}$	Smoothing degree of policy rate				

Source: Author’s description

Table 10 DSGE Bayesian Estimation

[Indonesia]

Parameters		Prior			Posterior	
		Distribution	Mean	StDev.	Mean	90% HPD interval
Monetary policy rule						
CPI Inflation	ϕ_{π}	norm	1.909	0.050	1.889	1.808-1.970
Output gap	ϕ_{x}	norm	0.000	0.050	0.161	0.118-0.205
Smoothing	ϕ_{r}	norm	0.901	0.050	0.873	0.843-0.903
Shocks						
Monetary policy	$\varepsilon_{r\,t}$	invg	1.000	1.000	1.042	0.793-1.300
Productivity	$\varepsilon_{a\,t}$	invg	1.000	1.000	5.696	4.597-6.774
Cost-push	$\varepsilon_{e\,t}$	invg	1.000	1.000	0.665	0.551-0.769
World GDP	$\varepsilon_{w\,t}$	invg	1.000	1.000	0.995	0.308-1.769

[The Philippines]

Parameters		Prior			Posterior	
		Distribution	Mean	StDev.	Mean	90% HPD interval
Monetary policy rule						
CPI Inflation	ϕ_{π}	norm	1.316	0.050	1.291	1.207-1.369
Output gap	ϕ_{x}	norm	0.000	0.050	0.124	0.082-0165
Smoothing	ϕ_{r}	norm	0.902	0.050	0.947	0.933-0.963
Shocks						
Monetary policy	$\varepsilon_{r\,t}$	invg	1.000	1.000	0.324	0.293-0.405
Productivity	$\varepsilon_{a\,t}$	invg	1.000	1.000	0.816	0.322-1.344
Cost-push	$\varepsilon_{e\,t}$	invg	1.000	1.000	0.349	0.299-0.397
World GDP	$\varepsilon_{w\,t}$	invg	1.000	1.000	16.156	12.023-20.870

[Thailand]

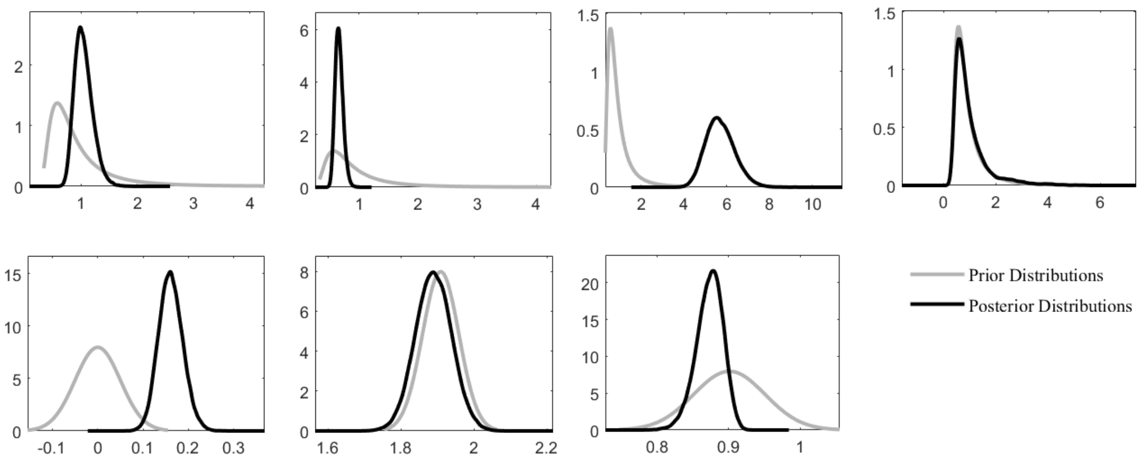
Parameters		Prior			Posterior	
		Distribution	Mean	StDev.	Mean	90% HPD interval
Monetary policy rule						
CPI Inflation	ϕ_{π}	norm	1.145	0.050	1.250	1.168-1.334
Output gap	ϕ_{x}	norm	0.000	0.050	0.033	0.006-0.058
Smoothing	ϕ_{r}	norm	0.906	0.050	0.726	0.683-0.767
Shocks						

Monetary policy	$\varepsilon_{r\,t}$	invg	1.000	1.000	0.319	0.263-0.372
Productivity	$\varepsilon_{a\,t}$	invg	1.000	1.000	4.452	3.180-5.706
Cost-push	$\varepsilon_{e\,t}$	invg	1.000	1.000	0.500	0.427-0.572
World GDP	$\varepsilon_{w\,t}$	invg	1.000	1.000	1.579	0.571-2.457

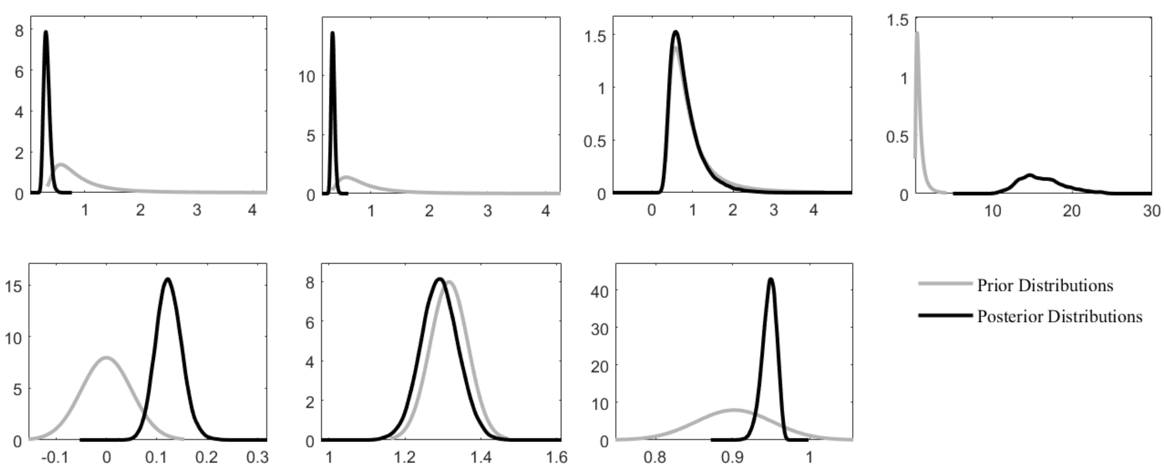
Source: Author's estimations

Figure 6 Prior and Posterior Distributions

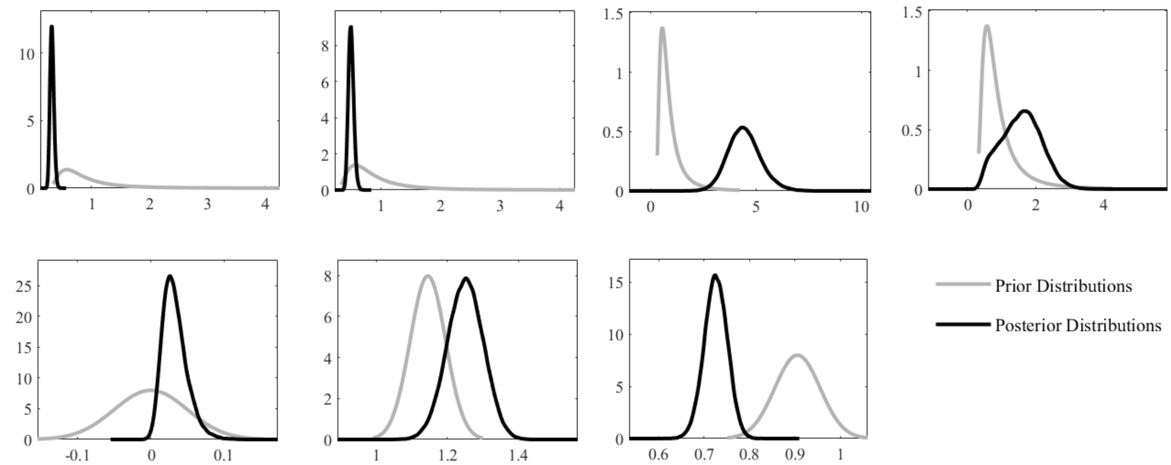
[Indonesia]



[The Philippines]



[Thailand]



Source: Author’s estimations

APPENDICES

Appendix A – Sample Economies' Monetary Profiles

	Inflation targeting economies			Non-inflation-targeting economies	
	Indonesia	The Philippines	Thailand	Malaysia	Vietnam
Monetary policy framework	Inflation targeting (2005-)	Inflation targeting (2002-)	Inflation targeting (2000-)	Implicit inflation targeting	Exchange rate anchoring
Primary objective	Currency stability (in terms of stable price of goods and services (inflation) and stable exchange rate)	Price stability	Price stability	Price stability and economic growth	Currency stability (denoted by inflation rate)
Central bank mandate	Achieving and maintain the stability of rupiah value	Promoting and maintaining price stability and strong financial system conducive to a sustainable and inclusive growth of the economy	Maintaining monetary, financial, and payment systems stability	Promoting monetary and financial stability conducive to sustainable economic growth	Managing the monetary policy in a proactive and flexible manner to control inflation, stabilize macro-economy, etc.
Inflation target	Point 2020: 3±1%	Point 2020: 3±1%	Range 2020: 1-3%	Comfort level 2018: 2.5-3.5%	Ceiling 2020: 4%
De jure exchange rate regime	Free floating (Adopted August 1997)	Free floating	Floating	Floating	Managed floating[11]

[11] The SBV determines based on a basket of currencies of countries with trade, financing, and investment relationship with Vietnam, in line with macroeconomic targets of each period (See Annual Report on Exchange Arrangements and Exchange Restrictions 2019, International Monetary Fund (2020a))

De facto exchange rate regime	Floating	Floating	Floating	Floating	Stabilized arrangement
Exchange rate stabilization/ Foreign exchange market intervention	The BI does not target a specific rate or maintain exchange rate movement within a specific band but rather provide liquidity to maintain stability.	The inflows of seasonal remittances (4th quarter) are taken into consideration for the estimation of possible intervention amount. However, the BSP does not target a specific level of exchange rate but rather allow the value of peso to be determined by the demand and supply of foreign currencies.	The data on the FX market intervention is not publicly available. However, the weekly and monthly data on gross international reserve[12] is published on the BOT's website.	The BNM does not publish any FX intervention data.	The dong-US dollar is allowed to fluctuate around the average interbank foreign currency market exchange rate announced within a daily transaction band of ±3%. In 2018, the dong remained stabilized within a 2% band[13] against the US dollar.
Central bank's policy rate	BI 7-day (reverse) repo rate	BSP overnight reverse repurchase rate or borrowing rate	BOT 1-day bilateral repurchase rate	BNM overnight policy rate	Refinancing interest rate
Inflation target measure	CPI, expressed in terms of year-over-year inflation at the end of the year, published monthly by	The average year-on-year change in CPI over the calendar year	Headline inflation Year-on-year change in CPI (all commodities) published monthly by the	-	CPI

[12] International reserve assets include monetary gold, SDRs, reserve position in the fund, and foreign currency assets. (International Monetary Fund, 2020a)

[13] The exchange rate band applies to only dong-US dollar transactions.

	the Indonesia Statistics Agency		ministry of commerce		
Target horizon	No explicit target horizon	Two-year policy horizon (current and one year ahead)	Medium-term horizon	-	-
Monetary operations	Open market operations, standing facilities	Open market operations, acceptance of term deposits, standing liquidity facilities	Reserve requirements, open market operations, standing facilities	Uncollateralized direct borrowings through open tender, repo transactions, open market operations	Re-financing, interest rates, reserve requirements, open market operations
Monetary authorities' roles	The inflation target is decided by the government (MOF) in coordination with the BI – through the consensus in the High Level Meeting forum. The decision is made based on the decision on current inflation conditions, the risk of future inflationary pressure, and the long-term inflation target.	The Development Budget Coordination Committee (DBCC), in coordination with the BSP, sets the inflation target over a multi-year period to promote a long-term view on inflation and help anchor inflation expectations.	The Monetary Policy Committee (MPC) decides the monetary policy target. With a cooperative agreement with the ministry of finance, the MPC determines monetary policy targets for the following year.	The BNM coordinates with Malaysia's Securities Commission and other financial regulators in the Financial Stability Committee in discharging its financial stability mandate.	The National Assembly (NA) decides the annual inflation targets by making decisions based on CPI. The prime minister and the SBV governor then decide on the use of tools and measures to achieve the national monetary policy objectives.

Source: International Monetary Fund (IMF)

Appendix B – Range of Indicators

(Chapter 2 and Chapter 4)

Variables	Sample ranges				
	Indonesia	Philippines	Thailand	Malaysia	Vietnam
$\boldsymbol{por}$	2005Q3-2019Q3	2002Q1-2019Q3	2000Q3-2019Q3	2004Q2-2019Q3	2008Q1-2019Q1
$\boldsymbol{cpi}$	2005Q1-2019Q3	2002Q1-2019Q3	2000Q1-2019Q3	2004Q1-2019Q3	2008Q1-2019Q4
$\boldsymbol{gap}$	2005Q1-2018Q3	2002Q1-2018Q4	2000Q1-2019Q2	2003Q1-2018Q4	2008Q1-2019Q4
$\boldsymbol{exr}$	2005Q1-2019Q3	2002Q1-2019Q3	2000Q1-2019Q3	2004Q1-2019Q4	2008Q1-2019Q3

(Chapter 3)

Variables	Sample ranges		
	Indonesia	Philippines	Thailand
exr, cpi, $cpig$	1991Q1-2020Q1		

Source: Author's description

Notes: Chapter 4 includes only Indonesia, the Philippines, and Thailand.

The variable exr is excluded in Chapter 4

Appendix C – Datasets

Data sets	Indonesia	The Philippines	Thailand
Chapter 2 Monetary Policy Rules in Emerging ASEAN Economies: Adaptability of Taylor Principle			
Central bank policy rate	· Central Bank Policy Rate (End of Period) · Refers to the BI rate, which is the policy rate reflecting the monetary policy stance adopted by BI and announced to the public. · From August 2016, the rate is BI 7-day (reverse) repo rate.	· Central Bank Policy Rate (End of Period) · Refers to the reverse repurchase rate (RPP), which is the target rate on reverse repurchase agreements between the CBP and banks.	· Central Bank Policy Rate (End of Period) · Refers to the rate announced by the Monetary Policy Committee in conducting monetary policy under the IT framework. · From May 2000, the rate was 14-day repurchase rate; from January 2007, the rate was one-day repurchase rate; from February 2008, the rate was one-day bilateral repurchase rate.
Consumer prices	· Consumer Price Index (All Items, Seasonally Adjusted, 2010=100) · Year-on-year percentage change		
Output gap	· The deviation of volume index of Gross domestic Product (GDP) (Volume, Seasonally Adjusted, 2010=100) from the potential GDP generated by Hodrick-Prescott filter		
Exchange rates	· Market Rate (Period Average) · Central bank midpoint rate · Year-on-year percentage change of domestic currency per U.S. dollar	· Market Rate (Period Average) · Banker's Association reference rate – the weighted average rate of all transactions conducted through the Philippines Dealing System during the previous day	· Official Rate (Period Average) · Average midpoint rate of all commercial banks · The official rate is determined based on a weighted basket of currencies. · Year-on-year percentage change of domestic currency per U.S. dollar

Chapter 3 The Exchange Rate Pass-Through in Emerging ASEAN Economies under the Inflation Targeting Framework	
Exchange rates	Same as above
Consumer prices	Same as above
Chapter 4 Monetary Policy Rule and Taylor Principle in Emerging ASEAN Economies: DSGE Approach	
Output gap	Same as above
Domestic inflation	· GDP Deflator (Seasonally Adjusted, 2010=100) · Year-on-year percentage change
Nominal interest rate	· Central Bank Policy Rates · Details are same as above
The degree of economic openness	· The average of import/GDP ratio · Imports data refers to Imports of Goods and Services (Nominal, Domestic Currency) · GDP data refers to Gross Domestic Product (Nominal, Domestic Currency)

Source: World Notes, International Financial Statistics (IFS) of International Monetary Fund (IMF), and author's description

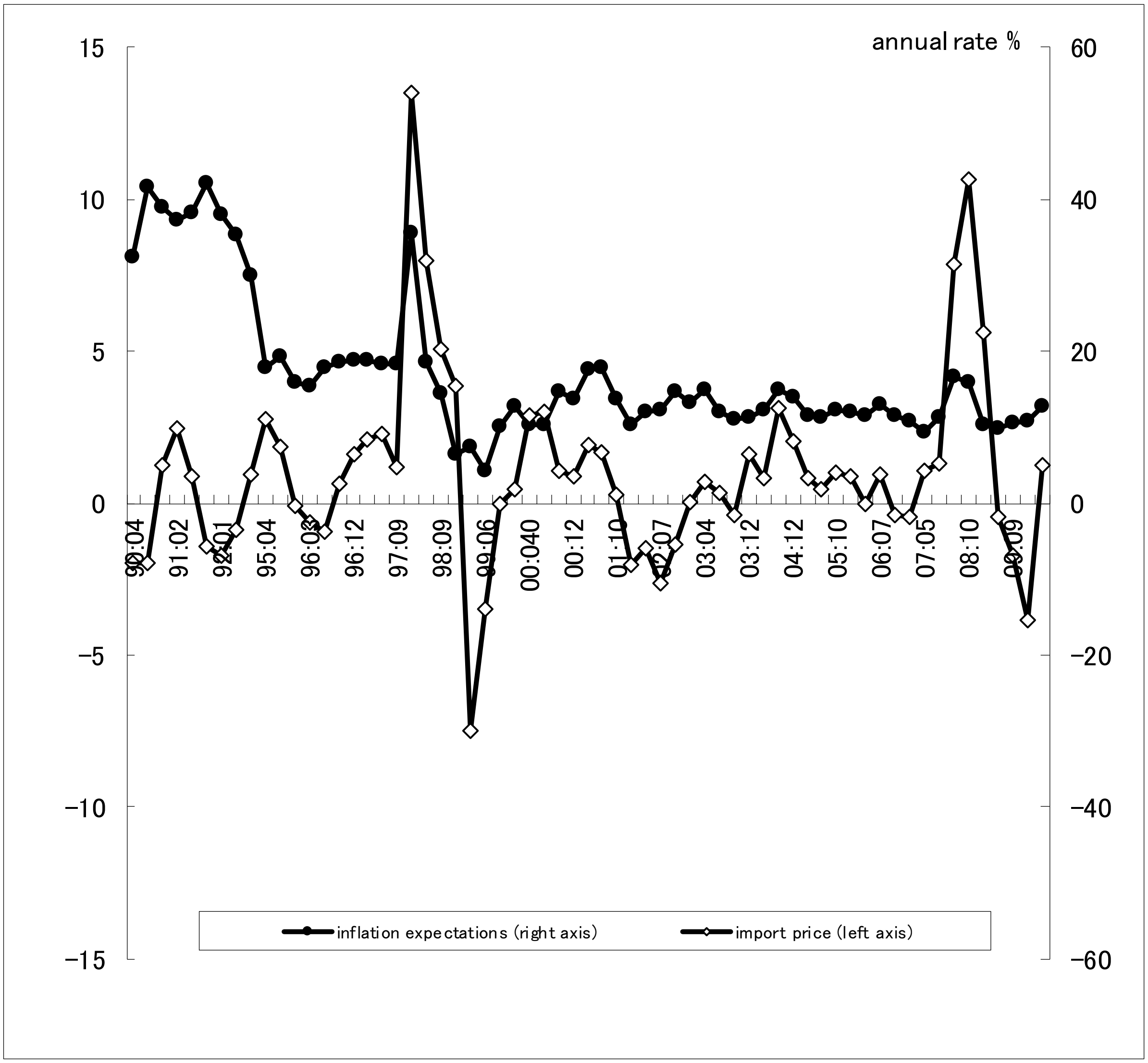
Notes: For Malaysia, the exchange rates refer to the Official Rate (Period Average), which is the closing interbank rate in Kuala Lumpur; the central bank policy rate refers to Central Bank Policy Rate (End of Period), which is the three-month intervention rate or the BNM's target for the three-month interbank rate. For Vietnam, the exchange rates refer to the Market Rate (Period Average), which is the midpoint of the average buying and selling rates quoted by the commercial banks authorized to deal in the organized FX market; the Industrial Production data retrieved from the General Statistics Office of Vietnam is used instead of the GDP data; the central bank policy rate refers to Central Bank Policy Rate (End of Period), which is the rate charged by the SBV on its lending facilities to all credit institutions.

Appendix D – Comparison between Announced Monetary Policy Rule and Estimated Monetary Policy Rule

Sample countries		Description
IT-Economies	Indonesia	Current regime: Inflation targeting Primary objective: Currency stability Estimated monetary policy rule: Forward-looking Inflation responsiveness: Yes Output gap responsiveness: - Exchange rate responsiveness: Yes Taylor principal fulfillment: Yes
	Philippines	Current regime: Inflation targeting Primary objective: Price stability Estimated monetary policy rule: Backward-looking Inflation responsiveness: Yes Output gap responsiveness: - Exchange rate responsiveness: - Taylor principal fulfillment: Yes
	Thailand	Current regime: Inflation targeting Primary objective: Price stability Estimated monetary policy rule: Forward-looking Inflation responsiveness: Yes Output gap responsiveness: - Exchange rate responsiveness: Yes Taylor principal fulfillment: Yes
Non-IT	Malaysia	Current regime: Others Primary objective: Dual – price stability and economic growth Estimated monetary policy rule: unidentified Inflation responsiveness: - Output gap responsiveness: Yes Exchange rate responsiveness: - Taylor principal fulfillment: -
	Vietnam	Current regime: Exchange rate anchoring Primary objective: Currency stability Estimated monetary policy rule: Forward-looking Inflation responsiveness: Yes Output gap responsiveness: - Exchange rate responsiveness: - Taylor principal fulfillment: Yes

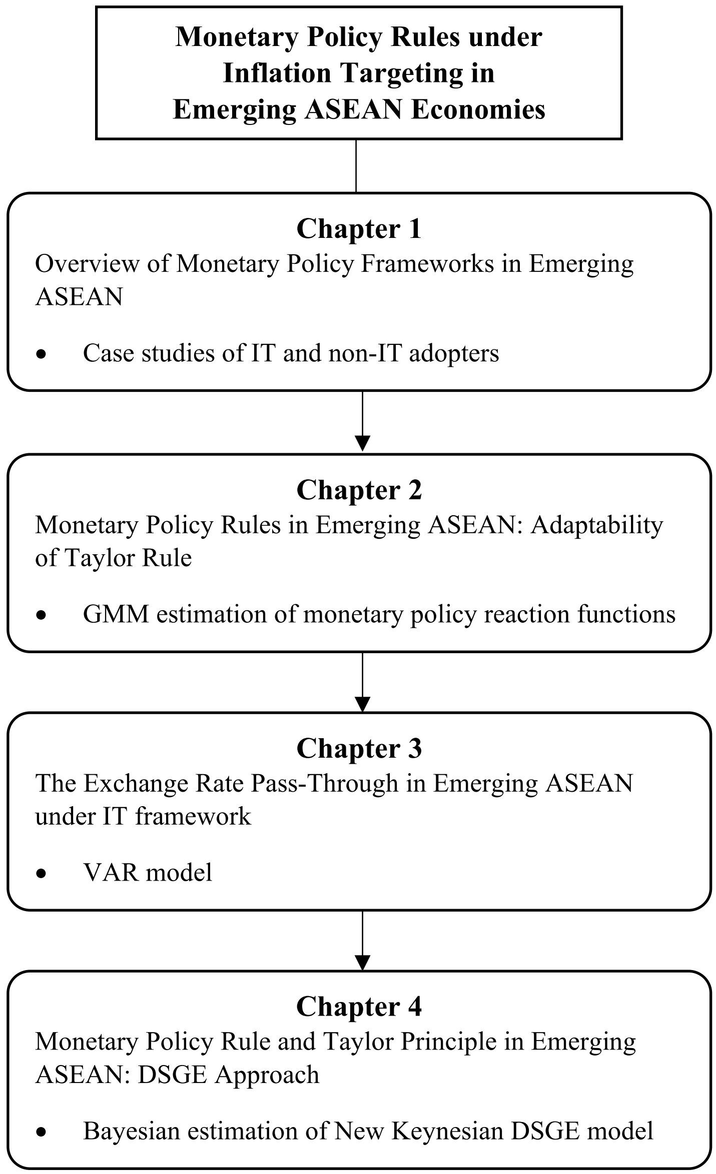
Source: Author’s description

Appendix E – Inflation Expectations and Import Prices in Korea



Source: Taguchi and Sohn (2014)

Appendix F – Dissertation Structure



Source: Author’s creation

Appendix G – The Small Open Economy New Keynesian DSGE Model Structure

In this section, we derive key structural equations of a small open economy New Keynesian DSGE model for emerging ASEAN economies following the model proposed by Gali and Monacelli (2005).

1. Demand Side

Households

A small open economy is inhibited by a representative household whose preferences are described by an intertemporal utility function. The representative household seeks to maximize the lifetime utility function:

$$E_0 \sum_{t=0}^{\infty} \beta^t \{U(C_t) - V(N_t)\} \tag{F.1}$$

where $U(C_t) = \frac{{C_t}^{1-\sigma}}{1-\sigma}$ and $V(N_t) = \frac{{N_t}^{1+\varphi}}{1+\varphi}$. C_t and N_t denotes household consumption and hours of labor, respectively. E is the expectation operator, β is the intertemporal discount factor of the household which describes the rate of time preference, σ is the inverse of the elasticity of intertemporal substitution in consumption, and φ is the inverse of wage elasticity of labor supply.

The variable C_t is the composite consumption index of domestic and foreign goods defined as:

$$C_t \equiv [(1-\alpha)^{\frac{1}{\eta}}(C_{H,t})^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}}(C_{F,t})^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \tag{F.2}$$

where parameter $\eta > 0$ measures the elasticity of intertemporal substitution of consumption between a bundle of domestic goods $C_{H,t}$ and a bundle of foreign goods $C_{F,t}$. Larger values of η implies that the goods are substitutes. The parameter $\alpha \in (0,1)$ is the trade share, or import ratio, that measures the degree of openness. The index of domestic goods consumption ($C_{H,t}$) and the index of imported goods ($C_{F,t}$) are given by the following CES functions:

$$C_{H,t} \equiv (\int_0^1 C_{H,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} d_j)^{\frac{\varepsilon}{\varepsilon-1}} \quad \text{and} \quad C_{F,t} \equiv (\int_0^1 C_{i,t}{}^{\frac{\gamma-1}{\gamma}} d_i)^{\frac{\gamma}{\gamma-1}} \tag{F.3}$$

where $C_{i,t} \equiv (\int_0^1 C_{i,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} d_j)^{\frac{\varepsilon}{\varepsilon-1}}$. $j \in (0,1)$ represents variety of goods, while $\varepsilon > 1$ is the elasticity of substitution between the differentiated goods. γ measures the substitutability between goods produced in different countries, and $C_{i,t}$ is the index of the quantity of goods imported from country i and consumed domestically.

The household maximize its utility level subject to the following intertemporal budget constraint:

$$\begin{aligned} &\int_0^1 P_{H,t}(j)C_{H,t}(j)dj \\ &\qquad + \int_0^1 \int_0^1 P_{i,t}(j)C_{i,t}(j)djdi + E_t\{Q_{t,t+1}D_{t+1}\} \\ &\qquad \leq D_t + W_tN_t + T_t \end{aligned} \tag{F.4}$$

for t = 0, 1, 2, …, where $P_{H,t}(j)$ denotes the price of domestic good j and $P_{i,t}(j)$ denotes the price of imported good j from country i. D_{t+1} is the nominal payoff in period $t+1$ of the portfolio held at the end of period t, $Q_{t,t+1}$ is the stochastic discount rate for nominal payoffs, W_t is the nominal wage, and T_t is the lumpsum taxes.

The optimal allocation for good j given by the CES aggregator for $C_{H,t}$ and $C_{i,t}$ from (F.3) yields the following demand functions:

$$C_{H,t}(j) = (\frac{P_{H,t}(j)}{P_{H,t}})^{-\varepsilon} C_{H,t} \quad \text{and} \quad C_{i,t}(j) = (\frac{P_{i,t}(j)}{P_{i,t}})^{-\varepsilon} C_{i,t} \tag{F.5}$$

for all $i, j \in (0,1)$, where $C_{i,t} = (\frac{P_{i,t}}{P_{F,t}})^{-\gamma} C_{F,t}$, and where $P_{H,t}$ and $P_{F,t}$ are the domestic price index and import price index, respectively. Furthermore, the optimal allocation of expenditures between domestic and imported goods is given by:

$$C_{H,t} = (1-\alpha)(\frac{P_{H,t}}{P_t})^{-\eta} C_t \quad \text{and} \quad C_{F,t} = (\frac{P_{F,t}}{P_t})^{-\eta} C_t \tag{F.6}$$

where $P_t \equiv \{(1-\alpha)P_{H,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta}\}^{\frac{1}{1-\eta}}$ is the consumer price index (CPI). Finally, since the total expenditure of the domestic household is given by $P_{H,t}C_{H,t} + P_{F,t}C_{F,t} = P_tC_t$, the intertemporal budget constraint from (F.4) can be simplified as:

$$P_tC_t + E_t\{Q_{t,t+1}D_{t+1}\} \leq D_t + W_tN_t + T_t \tag{F.7}$$

The representative household's optimizing problem obtained from (F.1) and (F.7) can be summarized by the following Lagrange function:

$$\max_{C_t,N_t} \sum_{t=0}^{\infty} \left\{\frac{{C_t}^{1-\sigma}}{1-\sigma} - \frac{{N_t}^{1+\varphi}}{1+\varphi} - \lambda_t[P_tC_t + E_t - D_t - W_tN_t - T_t]\right\} \tag{F.8}$$

Solving the above problem yields the following FOCs:

$$C_t^{-\sigma} = \lambda_t P_t \tag{F.9}$$

$${N_t}^{\varphi} = \lambda_t W_t \tag{F.10}$$

Combining (F.9) and (F.10), we get the marginal rate of substitution between consumption and labor, which is the intertemporal optimality condition:

$$C_t^{\sigma}{N_t}^{\varphi} = \frac{W_t}{P_t} \tag{F.11}$$

and,

$$\beta\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\left(\frac{P_t}{P_{t+1}}\right) = Q_{t,t+1} \tag{F.12}$$

$$\beta R_t E_t\left\{\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\left(\frac{P_t}{P_{t+1}}\right)\right\} = 1 \tag{F.13}$$

where (F.13) is the Euler equation, and $R_t = \frac{1}{E_t\{Q_{t,t+1}\}}$ is the gross return on riskless one-period discount bond maturing in $t+1$.

Finally, the respective log-linearized forms of (F.11) and (F.13), where lower case letters represent the logs, are:

$$w_t - p_t = \sigma c_t + \varphi n_t \tag{F.14}$$

$$c_t = E_t\{c_{t+1}\} - \frac{1}{\sigma}(r_t - E_t\{\pi_{t+1}\} - \rho) \tag{F.15}$$

Where $\sigma = \beta^{-1} - 1$ is the time discount rate and $\pi_t = p_t - p_{t-1}$ (with $p_t \equiv logP_t$) is CPI inflation.

Inflation, the Real Exchange Rate, and Terms of Trade

This section describes the open economy dynamics by examining the relationship between domestic inflation, CPI inflation, the real exchange rate, and terms of trade. On a side note, it is assumed that the law of one price holds for all goods in the empirical analysis in Chapter 4. The reason behind this is because the sample economies (Indonesia, the Philippines, and Thailand) are price takers with little bargaining power in international markets.

First, we define the terms of trade, which measures the competitiveness of the economy. The bilateral terms of trade between home country and country i is defined as $S_{i,t} = \frac{P_{i,t}}{P_{H,t}}$. Hence, the effective terms of trade is given by:

$$S_t \equiv \frac{P_{F,t}}{P_{H,t}} \tag{F.16}$$

and in log form as $s_t = p_{F,t} - p_{H,t}$, which is the relative price of imported goods in terms of domestic goods. This implies that the increase in the terms of trade indicates the improvement in international competitiveness.

Next, by log-linearizing the CPI formula $P_t \equiv \{(1-\alpha)P_{H,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta}\}^{\frac{1}{1-\eta}}$ around the steady state yields:

$$p_t \equiv (1-\alpha)p_{H,t} + \alpha p_{F,t} \tag{F.17}$$

$$p_t = p_{H,t} + \alpha s_t$$

By taking the first difference of (F.17), we get the linkages between the CPI inflation π_t, domestic inflation $\pi_{H,t}$, and the change in the terms of trade Δs_t as follows:

$$\pi_t = \pi_{H,t} + \alpha \Delta s_t \tag{F.18}$$

which implies that the difference between the CPI inflation and domestic inflation is proportional to the percentage change in the terms of trade.

Finally, the real exchange rate is defined as the ratio of the world price index P_t^* to the domestic price index P_t, both expressed in terms of domestic currency, as follows:

$$Q_t = \frac{\varepsilon_t P_t^*}{P_t} \tag{F.19}$$

where ε_t is the nominal exchange rate in terms of domestic currency. This implies that the law of one price and the purchasing power parity prevails if Q_t equals to unity. In addition, combining (F.19) with the definition of the terms of trade yields $s_t = e_t + p_t^* - p_{H,t}$.

It follows from (F.19) that:

$$q_t = \log(Q_t) = e_t + p_t^* - p_t$$
$$q_t = s_t + p_{H,t} - p_t$$

By log-linearizing $\frac{P_t}{P_{H,t}} = [(1-\alpha) + \alpha S_t^{1-\eta}]^{\frac{1}{1-\eta}}$ around a symmetric steady state, we obtain $p_t - p_{H,t} = \alpha s_t$. From this, we get:

$$q_t = s_t + p_{H,t} - (\alpha s_t + p_{H,t})$$
$$q_t = (1-\alpha) s_t$$

International Risk Sharing and the Uncovered Interest Parity

Under the assumption of complete international financial markets and perfect capital mobility, there is international risk sharing since economic agents in the open economy have access to the complete set of internationally traded securities. In addition, the expected nominal return from risk-free bonds (in terms of domestic currency) must equal to the expected domestic-currency return from foreign-bonds, which makes $E_t Q_{t,t+1} = E_t(Q^*_{t,t+1} \frac{\varepsilon_{t+1}}{\varepsilon_t})$. The assumption of international risk sharing implies the linkage between domestic consumption and the global consumption level. Such linkage can be derived using the Euler equation from (F.13), which can be rewritten as:

$$\beta \left(\frac{C^i_{t+1}}{C^i_t}\right)^{-\sigma} \left(\frac{P^i_t}{P^i_{t+1}}\right)\left(\frac{\varepsilon^i_t}{\varepsilon^i_{t+1}}\right) = Q_{t,t+1} \tag{F.20}$$

By combining (F.13), (F.20), and the real exchange rate definition from (F.19), we obtain the international risk sharing condition:

$$C_t = \vartheta_i C^i_t Q^{\frac{1}{\sigma}}_{i,t} \tag{F.21}$$

$$\begin{gathered} c_t = \log(C_t) = c^*_t + \frac{1}{\sigma} q_t \\ c_t = c^*_t + \left(\frac{1-\sigma}{\sigma}\right) s_t \end{gathered} \tag{F.22}$$

where ϑ is a constant depending on initial asset positions, and c^*_t is the world consumption index. Equation (F.22) hence shows the relationship between domestic and world consumption and the terms of trade.

Furthermore, the assumption of complete international financial markets further allows us to derive the uncovered interest parity condition:

$$E_t = \left(Q_{t,t+1}\left\{R_t - R^*_t \frac{\varepsilon_t}{\varepsilon_{t+1}}\right\}\right) = 0 \tag{F.23}$$

Log-linearizing (F.23) around the perfect foresight steady stead yields the uncovered interest rate parity for the nominal exchange rate:

$$r_t - r^*_t = E_t \Delta e_{t+1} \tag{F.24}$$

Equation (F.24) shows that the expected change in the domestic currency is determined by the difference between domestic nominal interest rates and that of the rest of the world.

Similarly, we can rewrite (F.24) for the real exchange rate as:

$$E_t \Delta q_{t+1} = -(r_t - \pi_{t+1}) - (r_t^* - \pi_{t+1}^*) \quad \text{(F.25)}$$

2. Supply side

Firms

Technology

A small open economy is also inhibited by a continuum of identical monopolistically competitive domestic firms, indexed by $j \in (0,1)$, who produce differentiated goods with a linear technology production function:

$$Y_t(j) = A_t N_t(j) \quad \text{(F.26)}$$

where $Y_t(j)$ is domestic firm j's output, $N_t(j)$ is domestic firm j's labor demand, and A_t is the domestic total factor productivity shifter where $a_t = \log(A_t)$ which follows the AR(1) process $a_t = \rho_a a_{t-1} + \varepsilon_t$, which represents the productivity index.

Firms seek to minimize the production cost, given the real total cost of production as $TC_t = \frac{W_t}{P_{H,t}} \frac{Y_t}{A_t}$. Hence, the FOC of the firms' optimizing problem yields the following real marginal cost (in terms of domestic prices) of domestic firms:

$$mc_t = w_t - p_{H,t} - a_t \quad \text{(F.27)}$$

which implies that real marginal cost is positively correlated to real wages and negatively correlated to labor productivity.

Next, given $Y_t \equiv \left[\int_0^1 Y_t(j)^{1-\frac{1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}}$ as an index for aggregate domestic output, the first order log-linear approximation of the aggregate production function is:

$$y_t = a_t + n_t \quad \text{(F.28)}$$

Price-Setting

In this section, we assume that monopolistic firms set prices in a Calvo-staggered fashion. In any period, only a fraction of $1 - \theta$, where $\theta \in (0, 1)$ of randomly selected domestic firms resets their prices optimally, while a fraction of θ of firms keep their prices unchanged. Such remaining of firms θ are assumed to set their prices by indexing to the last period's inflation. $\bar{P}_{H,t}(j)$ denotes the price level set by firm j in period t. Furthermore, when setting a new price $\bar{P}_{H,t}$ in period t, a firm seeks to maximize the current value of its dividend stream subject to the sequence of demand constraints. The following function is maximized:

$$\max_{\bar{P}_{H,t}} \sum_{k=0}^{\infty} \theta^k E_t\{Q_{t,t+k}[Y_{t+k}(\bar{P}_{H,t} - MC_{t+k}^n)]\} \tag{F.29}$$

$$\text{subject to} \quad Y_{t+k} \leq \left(\frac{\bar{P}_{H,t}}{\bar{P}_{H,t+k}}\right)^{-\varepsilon} (C_{H,t+k} + C_{H,t+k}^*)$$

where MC_t^n is the nominal marginal cost. The corresponding FOC can be written as:

$$\sum_{k=0}^{\infty} \theta^k E_t \left\{Q_{t,t+k} Y_{t+k} \left(\bar{P}_{H,t} - \frac{\varepsilon}{\varepsilon - 1} MC_{t+k}^n\right)\right\} = 0 \tag{F.30}$$

where $\frac{\varepsilon}{\varepsilon-1}$ is the real marginal cost if prices were fully flexible. By substituting the Euler equation from (F.12), $Q_{t,t+k} = \beta^k \left(\frac{C_{t+k}}{C_t}\right)^{-\sigma} \left(\frac{P_t}{P_{t+k}}\right)$, to (F.30) above, we obtain:

$$\sum_{k=0}^{\infty} (\beta\theta)^k \frac{P_t}{C_t^{-\sigma}} \left[E_t \left\{\frac{C_{t+k}^{-\sigma}}{P_{t+k}} Y_{t+k} \left(\bar{P}_{H,t} - \frac{\varepsilon}{\varepsilon - 1} MC_{t+k}^n\right)\right\}\right] = 0 \tag{F.31}$$

Since $\frac{P_t}{C_t^{-\sigma}}$ is known at time t, we can remove it from the summation. Furthermore, rearranging (F.30) by dividing by $P_{H,t-1}$ yields:

$$\sum_{k=0}^{\infty} (\beta\theta)^k E_t \left\{C_{t+k}^{-\sigma} Y_{t+k} \frac{P_{H,t-1}}{P_{t+k}} \left(\frac{\bar{P}_{H,t}}{P_{H,t-1}} - \frac{\varepsilon}{\varepsilon - 1} MC_{t+k}^n \frac{P_{H,t+k}}{P_{H,t-1}}\right)\right\} = 0 \tag{F.32}$$

and, let $\Pi_{t-1,t+k}^H \equiv \frac{P_{H,t+k}}{P_{H,t-1}}$ and $MC_{t+k} = \frac{MC_{t+k}^n}{P_{H,t+k}}$ which is the real marginal cost, then (F.32) can be rewritten as:

$$\sum_{k=0}^{\infty} (\beta\theta)^k E_t \left\{C_{t+k}^{-\sigma} Y_{t+k} \frac{P_{H,t-1}}{P_{t+k}} \left(\frac{\bar{P}_{H,t}}{P_{H,t-1}} - \frac{\varepsilon}{\varepsilon - 1} \Pi_{t-1,t+k}^H MC_{t+k}\right)\right\} = 0 \tag{F.33}$$

Log-linearizing (F.33) around zero-inflation steady state with balanced trade yields:

$$\bar{p}_{H,t} = p_{H,t-1} + \sum_{k=0}^{\infty} (\beta\theta)^k \{E_t \pi_{H,t+k} + (1-\beta\theta) E_t \widehat{mc}_{t+k}\} \tag{F.34}$$

where $mc = -log \frac{\varepsilon}{\varepsilon-1} \equiv -\mu$ and $\widehat{mc}_t \equiv mc_t - mc$ denotes log deviation of real marginal cost from its steady state value mc. Equation (F.34) implies that a firm sets price according to expected discounted sum of inflation and deviations of real marginal cost from its steady state. Equation (F.34) can be rewritten as:

$$\begin{aligned} \bar{p}_{H,t} - p_{H,t-1} &= \pi_{H,t} + (1-\beta\theta)\widehat{mc}_t \\ &\quad + (\beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k \{E_t \pi_{H,t+k} + (1-\beta\theta) E_t \widehat{mc}_{t+k+1}\} \\ \bar{p}_{H,t} - p_{H,t-1} &= \pi_{H,t} + (1-\beta\theta)\widehat{mc}_t + \beta\theta\{\bar{p}_{H,t+1} - p_{H,t}\} \\ \bar{p}_{H,t} - p_{H,t-1} &= \beta\theta E_t\{\bar{p}_{H,t+1} - p_{H,t}\} + \pi_{H,t} + (1-\beta\theta)\widehat{mc}_t \end{aligned} \tag{F.35}$$

Substituting $\widehat{mc}_t = mc_t^n - p_{H,t} + \mu$ in (F.35) yields the following optimal price-setting rule in terms of expected nominal marginal cost:

$$\bar{p}_{H,t} = \mu + (1-\beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k E_t\{mc_{t+k}^n\} \tag{F.36}$$

The domestic price index is then defined as:

$$P_{H,t} \equiv \left[\theta P_{H,t-1}^{1-\varepsilon} + (1-\theta)(\bar{P}_{H,t})^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \tag{F.37}$$

Log-linearizing (F.36) around zero-inflation steady state yields:

$$\pi_{H,t} = (1-\theta)(\bar{p}_{H,t} - p_{H,t-1}) \tag{F.38}$$

Finally, by combining (F.38) with (F.35), we obtain the dynamics of domestic inflation in terms of real marginal cost as follows:

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \lambda\widehat{mc} \tag{F.39}$$

where $\lambda \equiv \frac{(1-\beta\theta)(1-\theta)}{\theta}$.

3. Equilibrium

Using the above all mentioned model setup, this section derives the general equilibrium dynamics around their steady state level. The general equilibrium is achieved from the goods market equilibrium derived from the aggregate demand side, and the labor market equilibrium derived from the aggregate supply side.

Demand Side: Aggregate Demand and Output

Goods market clearing in the representative small open economy requires that domestic output is equal to the sum of domestic consumption and foreign consumption of domestically produced goods. In other words, all domestic and foreign goods clear in the equilibrium. Under this assumption, the following is the market clearing condition:

$$Y_t(j) = C_{H,t}(j) + \int_0^1 C_{H,t}^i(j)di \tag{F.40}$$

First, by substituting $C_{H,t}(j) = (\frac{P_{H,t}(j)}{P_{H,t}})^{-\varepsilon} C_{H,t}$ from (F.5); $C_{H,t} = (1-\alpha)(\frac{P_{H,t}}{P_t})^{-\eta} C_t$ from (F.6); and $C_{H,t}^i(j) = \alpha \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\varepsilon} \left(\frac{P_{H,t}}{\varepsilon_{i,t} P_{F,t}^i}\right)^{-\gamma} \left(\frac{P_{F,t}^i}{P_t^i}\right)^{-\eta} C_t^i$ to (F.40) above, we obtain:

$$Y_t(j) = (\frac{P_{H,t}(j)}{P_{H,t}})^{-\varepsilon}(1-\alpha)(\frac{P_{H,t}}{P_t})^{-\eta} C_t + \int_0^1 \alpha \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\varepsilon} \left(\frac{P_{H,t}}{\varepsilon_{i,t} P_{F,t}^i}\right)^{-\gamma} \left(\frac{P_{F,t}^i}{P_t^i}\right)^{-\eta} C_t^i \, di$$

$$Y_t(j) = (\frac{P_{H,t}(j)}{P_{H,t}})^{-\varepsilon} \left[(1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t + \alpha \int_0^1 \left(\frac{P_{H,t}}{\varepsilon_{i,t} P_{F,t}^i}\right)^{-\gamma} \left(\frac{P_{F,t}^i}{P_t^i}\right)^{-\eta} C_t^i di\right] \tag{F.41}$$

Next, plugging (F.41) into the definition of aggregate domestic output $Y_t \equiv \left[\int_0^1 Y_t(j)^{1-\frac{1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}}$ yields:

$$Y_t = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t + \alpha \int_0^1 \left(\frac{P_{H,t}}{\varepsilon_{i,t} P_{F,t}^i}\right)^{-\gamma} \left(\frac{P_{F,t}^i}{P_t^i}\right)^{-\eta} C_t^i di \qquad \text{(F.42)}$$

Recalling that $S_{i,t} = \frac{P_{i,t}}{P_{H,t}}$ is the bilateral terms of trade, $S_t \equiv \frac{P_{F,t}}{P_{H,t}}$ is the effective terms of trade, and $C_t = \vartheta_i C_t^i Q_{i,t}^{\frac{1}{\sigma}}$, then (F.42) can be rewritten as:

$$Y_t = \left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \left[(1-\alpha) + \alpha \int_0^1 \left(S_t^i S_{i,t}\right)^{\gamma-\eta} Q_{i,t}^{\eta-\frac{1}{\sigma}} di\right] \qquad \text{(F.43)}$$

In the case that $\sigma = \eta = \gamma = 1$ and where the CPI takes the form of $P_t = (P_{H,t})^{1-\alpha}(P_{F,t})^{\alpha}$ which implies that $\frac{P_t}{P_{H,t}} = \left(\frac{P_{F,t}}{P_{H,t}}\right)^{\alpha} = S_t^{\alpha}$, then (F.43) can be rewritten as:

$$Y_t = \left(\frac{P_t}{P_{H,t}}\right) C_t$$

$$Y_t = S_t^{\alpha} C_t \qquad \text{(F.44)}$$

Furthermore, since $\int_0^1 s_t^i d_i = 0$, (F.43) can be log-linearized around the steady state for the symmetric case to yield:

$$y_t = c_t + \alpha\gamma s_t + \alpha\left(\eta - \frac{1}{\sigma}\right) q_t$$

$$y_t = c_t + \frac{\alpha\omega}{\sigma} s_t \qquad \text{(F.45)}$$

where $\omega \equiv \sigma\gamma + (1-\alpha)(\sigma\eta - 1)$.

A world market clearing condition is thus:

$$y_t^* = c_t^* \qquad \text{(F.46)}$$

where $y_t^* \equiv \int_0^1 y_t^i di$ is the (log) world output index and $c_t^* \equiv \int_0^1 c_t^i di$ is the (log) world consumption index.

Next, combining (F.45) with (F.21) and (F.46) yields:

$$y_t = y_t^* + \frac{1}{\sigma_\alpha} s_t \qquad \text{(F.47)}$$

$$\text{or} \quad s_t = \sigma_\alpha(y_t - y_t^*)$$

where $\sigma_\alpha \equiv \frac{\sigma}{(1-\sigma)+\alpha\omega} > 0$.

Finally, by combining (F.45) with the consumption Euler equation (F.15), we obtain:

$$y_t = E_t\{y_{t+1}\} - \frac{1}{\sigma_\alpha}\left(r_t - E_t\{\pi_{H,t+1}\} - \rho\right) + \alpha\Theta E_t\{\Delta y_{t+1}^*\} \qquad \text{(F.48)}$$

where $\Theta \equiv (\sigma\gamma - 1) + (1-\alpha)(\sigma\eta - 1) = \omega - 1$.

Supply Side

Marginal Cost and Inflation Dynamics

Given the firm's real total cost of production as $TC_t = \frac{W_t}{P_{H,t}}\frac{Y_t}{A_t}$, then its real marginal cost, which will be common across domestic firms, is:

$$mc_t = w_t - p_{H,t} - a_t \qquad \text{(F.49)}$$

$$mc_t = (w_t - p_t) + (p_t - p_{H,t}) - a_t$$

$$mc_t = \sigma c_t + \varphi n_t + \alpha s_t - a_t$$

$$mc_t = \sigma y_t^* + \varphi y_t + s_t - (1+\varphi)a_t \qquad \text{(F.50)}$$

In the third equality, $\alpha s_t = p_t - p_{H,t}$ is a log-linearized version of $S_t^\alpha = \frac{P_t}{P_{H,t}}$, and $\sigma c_t + \varphi n_t = w_t - p_t$ is a log-linearized version of the intertemporal consumption condition $C_t^\sigma {N_t}^\varphi = \frac{W_t}{P_t}$ from (F.11). The fourth equality uses (F.22) and (F.28). The above implies that the marginal cost is increasing in terms of world output and terms of trade.

To rewrite (F.50) in terms of domestic and world output and productivity, we plug in $s_t = \sigma_\alpha(y_t - y_t^*)$ from (F.47) to substitute for s_t, which yields:

$$\begin{gathered} mc_t = \sigma y_t^* + \varphi y_t + \sigma_\alpha y_t - \sigma_\alpha y_t^* - (1+\varphi)a_t \\ \text{or} \quad mc_t = (\varphi + \sigma_\alpha)y_t + (\sigma - \sigma_\alpha)y_t^* - (1+\varphi)a_t \end{gathered} \qquad \text{(F.51)}$$

Canonical Representation

This section demonstrates the linearized equilibrium dynamics of the small open economy in terms of output gap and domestic inflation. First, the output gap x_t is defined as:

$$x_t \equiv y_t - \bar{y}_t \tag{F.52}$$

where y_t is the domestic output and $\bar{y}_t$ is its natural level.

Assuming that $mc_t = -\mu$ for all t, the domestic natural level of output $\bar{y}_t$ is derived after solving for domestic output y_t in (F.51). Dividing (F.51) by $(\varphi + \sigma_\alpha)$ yields:

$$\frac{-\mu}{\varphi + \sigma_\alpha} + \frac{1 + \varphi}{\varphi + \sigma_\alpha} a_t - \frac{\sigma - \sigma_\alpha}{\varphi + \sigma_\alpha} y_t^* = y_t \tag{F.53}$$

Rearranging (F.53) by letting $\Omega \equiv \frac{-\mu}{\varphi+\sigma_\alpha}$, $\Gamma \equiv \frac{1+\varphi}{\varphi+\sigma_\alpha} > 0$, and $\Psi \equiv -\frac{\sigma-\sigma_\alpha}{\varphi+\sigma_\alpha}$, we get:

$$\bar{y}_t = \Omega + \Gamma a_t + \alpha \Psi y_t^* \tag{F.54}$$

It follows from (F.54), (F.53), and (F.52) that:

$$y_t = x_t + \Gamma a_t + \alpha \Psi y_t^* \tag{F.55}$$

It also follows from (F.51) that the domestic real marginal cost and output will be related such that:

$$\widehat{mc}_t = (\varphi + \sigma_\alpha) x_t \tag{F.56}$$

Next, to derive the New Keynesian Phillips Curve (NKPC), we combine (F.56) with $\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \lambda \widehat{mc}$, where $\lambda \equiv \frac{(1-\beta\theta)(1-\theta)}{\theta}$, from (F.39):

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \kappa_\alpha x_t \tag{F.57}$$

where $\kappa_\alpha \equiv \lambda(\varphi + \sigma_\alpha)$. On a side note, the Phillips equation for the small open economy is the same as that of the closed economy. Furthermore, the degree of openness α affects the inflation dynamics via its influence on the size of the slope of the Phillips curve, which is the size of the inflation response to any given variation in the output gap (Gali and Monacelli, 2005). In the small open economy, a change in domestic output affects the marginal cost through its impact on employment φ and the terms of trade σ_α.

Finally, we can derive the dynamic IS equation for the small open economy in terms of output gap by using (F.48). Since $x_t \equiv y_t - \bar{y}_t$, then:

$$x_t = E_t\{x_{t+1}\} - \frac{1}{\sigma_\alpha}\left(r_t - E_t\{\pi_{H,t+1}\} - \rho\right) + \alpha\Theta E_t\{\Delta y^*_{t+1}\} - (\Omega + \Gamma a_t + \alpha\Psi y^*_t)$$

$$x_t = E_t\{x_{t+1}\} - \frac{1}{\sigma_\alpha}\left(r_t - E_t\{\pi_{H,t+1}\} - \overline{rr}_t\right) \qquad \text{(F.58)}$$

where the following is the small open economy's natural rate of interest:

$$\overline{rr}_t = \rho - \sigma_\alpha\Gamma(1 - \rho_a)a_t + \alpha\sigma_\alpha(\Theta + \Psi)E_t\{\Delta y^*_{t+1}\}$$

It can be concluded that the small open economy is characterized by the forward-looking type IS equation. There are two characteristics unique to the small open economy model that are not found in the closed economy model; the degree of openness influences the sensitivity of the output gap to interest rate changes; and the natural interest rate depends on expected world output growth.

Policy Reaction Function

It is necessary to specify the behavior of the monetary authority in order to complete the small open economy model. As described in Chapter 2, the monetary authority adjusts the nominal interest rate in response to deviations of inflation and output gap from their steady-state level, such that:

$$r_t = \phi_r r_{t-1} + (1 - \phi_r)(\phi_\pi \pi_t + \phi_x x_t) + \varepsilon_{r,t} \qquad \text{(F.59)}$$

where ϕ_π and ϕ_x are weights put by the monetary authority on inflation and output gap, respectively, while ϕ_r indicates the interest rate smoothing. The monetary policy shock is captured by $\varepsilon_{r,t}$.

4. Model Structure

From all the above, the small open economy model is represented by the following equations.

Expectational IS curve	$x_t = E_t\{x_{t+1}\} - \frac{1}{\sigma_\alpha}\left(r_t - E_t\{\pi_{H,t+1}\} - \overline{rr}_t\right)$	(F.58)
Small open economy's natural rate of interest	$\overline{rr}_t = \rho - \sigma_\alpha \Gamma(1-\rho_a)a_t + \alpha\sigma_\alpha(\Theta + \Psi)E_t\{\Delta y^*_{t+1}\}$	(F.58)
New Keynesian Phillips Curve (NKPC)	$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \kappa_\alpha x_t$	(F.57)
Monetary policy rule	$r_t = \phi_r r_{t-1} + (1-\phi_r)(\phi_\pi \pi_t + \phi_x x_t) + \varepsilon_{r,t}$	(F.59)
Linkage between CPI and domestic inflation	$\pi_t = \pi_{H,t} + \alpha \Delta s_t$	(F.18)
	$s_t = \sigma_\alpha(y_t - y^*_t)$	(F.47)
	$y_t = x_t + \Gamma a_t + \alpha\Psi y^*_t$	(F.55)