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MONETARY POLICY: INDICATORS AND IDENTIFICATION

PhD Dissertation

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DECLARATION

Candidate's Declaration

I hereby declare that this dissertation is an original work that is conducted by my own and the guidance of the supervisor. The thesis has not been submitted for other degree in the University of Szeged or elsewhere.

Candidate's Signature: .....

Date: .....

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Supervisor' Declaration

I hereby declare that the thesis was prepared and presented in accordance with the supervision of the University of Szeged.

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Date: .....

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ABSTRACT

Monetary policy is a crucial tool used by most, not to say all, central banks to finetune macroeconomic conditions. However, empirical evidence regarding its effectiveness is mixed and based on the premise that monetary policy is appropriately measured and identified. Compared with the vast literature for advanced economies, studies investigating the problem of the indicator and identification of monetary policy are limited in emerging economies.

The thesis attempts to address both the indicator problem and identification problem in emerging economies that follow inflation targeting. Firstly, it uses Granger causality test, impulse response function (IRF), and forecast error variance decomposition (FEVD) to investigate the relative effectiveness of monetary policy indicators as well as the performance of different strategies to measure monetary policy. Since emerging economies use multiple instruments to conduct monetary policy even though they follow the inflation targeting framework, interest rates may not fully capture the intention of monetary authorities. Therefore, the first objective of the thesis is to shed light about the effectiveness of money supply, interest rates, and monetary condition index (MCI) in measuring the stance of monetary policy. Secondly, the thesis uses the GMM model and the Taylor rule to investigate the behaviour of monetary authorities in inflation-targeting emerging economies. It examines the matter of exchange rates, the effect of foreign exchange intervention, and the asymmetries of the Taylor rule driven by a nonlinear Phillips curve or an asymmetric preference. The thesis contributes to the existing literature by considering both linear and nonlinear form of the Taylor rule for a group of emerging economies. Such a comparative analysis provides a more comprehensive picture about the behaviour of the central bank in emerging economies.

The empirical results show critical findings. Firstly, in emerging economies, money supply contains a significant information about changes in monetary policy and the role of interest rates is weaker than that in advanced economies. The price puzzle still happens after a contraction shock caused by interest rates. Secondly, MCI, which is a weighted average of changes in interest rates and exchange rates relative to a benchmark level, is a useful indicator of monetary policy for inflation-targeting emerging economies. The reason is that inflation negatively responds to a contractionary shock of MCI in most emerging economies. Such an impulse response function is of expected and consistent

with monetary theories. Thirdly, exchange rates play a critical role in the decision-making process of monetary authorities in inflation-targeting emerging economies. To begin with, monthly changes of exchange rates matter more than yearly changes, which suggests a close look of monetary authorities at the exchange rate market in the last month. Moreover, the exchange rate effect is asymmetric, characterized by a more pronounced effect during the post-crisis period, which is consistent with changes in the exchange rate policy in many countries such as Hungary or Poland. Furthermore, there is strong evidence for the fear of appreciation. Fourthly, exchange rate interventions matter and a Taylor rule augmented by changes in foreign reserves can better approximate the behaviour of monetary authorities in emerging economies targeting price stability. However, it should be noted that interest rate responses are different between economies. Finally, monetary authorities show a departure from the linear reaction to output and inflation gap, suggesting that their behaviour should be captured by an asymmetric or nonlinear Taylor rule. The empirical results show evidence for the asymmetry caused by a concave Phillips curve. Furthermore, there is evidence for the asymmetry caused by the asymmetric preference: inflation avoidance in Brazil, Colombia, Hungary, Philippines, and South Africa whereas deflation avoidance in other emerging economies. With respect to output preference, recession avoidance emerges in most emerging economies.

Key words: monetary policy indicator, nonlinear Taylor rule, foreign exchange intervention, multiple instruments

JEL classification: E50, E52, E59

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CHAPTER 1: INTRODUCTION

1.1. Introduction

Monetary policy involves policies that influence the movement of interest rates or money supply in order to achieve macroeconomic outcomes (Howells and Bain, 2003). The New Keynesian model that supports the significant effect of monetary policy on output and prices at least in the short run establishes the theoretical framework for the worldwide application of monetary policy by central banks (Walsh, 2010).

The existing literature remains debates about the choice of an overall indicator and the approximation of the reaction function of monetary policy. While these problems have been extensively investigated for developed economies, evidence on these issues is scant for emerging economies. Firstly, the indicator problem refers to difficulties in determining the significance of various indicators in measuring changes in monetary policy. The vast literature about the indicator problem for advanced economies (Laurent, 1988; Bernanke, 1990b) reached a general consensus that interest rates are the most preferred indicator of monetary policy. On the contrary, the literature is limited for emerging economies. In addition, most studies using emerging economy data assume that monetary policy is properly measured by interest rates. However, institutional differences between emerging and advanced economies raise questions about the fact that interest rates are a "clean" indicator of monetary policy for emerging economies. Since monetary authorities in emerging economies rely on more than one instrument to achieve a range of macroeconomic objectives, it is possible that no single indicator can fully or adequately measure changes in the stance of monetary policy.

Furthermore, interest rates are the main instrument in the conduct of monetary policy in the regime of inflation targeting (Akdeniz, 2021). While interest rates are the primary operating target in advanced economies (Egan and Leddin, 2016), their role is weaker in the inflation targeting in emerging economies because these countries are price takers and they have high exposure to international shocks such as sudden increases in oil or commodity prices. The high openness of emerging economies indicates that changes in official interest rates can alter exchange rates, which then influences the relative price of domestic and foreign goods, import, and finally aggregate demand and inflation. Moreover, changes in exchange rates have a crucial effect on the price of

domestic goods and thus demand. According to Poon (2010), both interest rate channel and exchange rate channel are active the transmission of monetary policy in emerging economies. As argued by Nucu and Anton (2018), emerging economies are still in the process of transitioning toward an open market economy and thus the stance of monetary policy requires a look at principal transmission channels such as interest rates and exchange rates. The lagged effect of monetary policy is another reason that questions the importance of exchange rates in the assessment of monetary conditions. The lagged effect motivates monetary authorities to rely more on intermediate targets such as monetary aggregates and exchange rates. Therefore, monetary authorities should respond to these intermediate targets when setting the primary instrument like interest rates. Hence, in emerging economies, a good measure of monetary policy should consider changes in both interest rates and exchange rates.

Secondly, the identification problem involves the attempt to approximate the behaviour of the central bank. There is a controversy about how to approximate the actual process of decision making of monetary authorities in emerging economies because the function of monetary policy requires more information for these economies than for advanced economies. Monetary authorities in emerging economies have different rules of making decisions and these rules are not always equivalent.

There are three main concerns about the conduct of monetary policy in inflation-targeting emerging economies. One, monetary authorities in these economies are less likely to allow excessive fluctuations in exchange rates although many of them have shifted to inflation-targeting and adopted flexible exchange rate regime since the 1990s. This phenomenon has been termed as the "fear-of-floating" in the seminal work of Calvo and Reinhart (2002). Many studies (Minella et al., 2003; Mohanty and Klau, 2005; Paez-Farrell, 2007; Aizenman et al., 2011; Sánchez-Fung, 2011; Cermeño et al., 2012; Caporale et al., 2018) argue that exchange rates are a significant determinant of interest rate setting in emerging economies. However, these studies often use a single measure of exchange rate changes (which can be effective, bilateral, nominal, or real exchange rate) and mainly focus on the linear response of monetary policy to exchange rates. There is a dearth of studies examining the asymmetric or post-crisis effect of exchange rates. Furthermore, to the best knowledge of the author, no study emphasises on the problem of measurement sensitivity when analysing the effect of exchange rates on the setting of interest rates.

Two, to avoid sharp changes in exchange rates, monetary authorities can intervene in the exchange rate market, which can be captured by changes in the stock of foreign reserves. In emerging economies, monetary authorities can intervene to finetune the trend of exchange rate changes and stabilize their movement. As noted by Reinhart and Rogoff (2004), the de facto regime of exchange rates is often different from de jure regime in emerging economies. Most emerging economies often leave the corners, fixed or floating regimes, and move to the intermediate regimes. However, the effect of interventions is an ongoing issue in emerging economies (Menkhoff, 2013). Since foreign exchange intervention is an important instrument in emerging economies, its effect on monetary policy becomes critical decisions. Despite of these, the literature on the interdependence between monetary policy and foreign exchange interventions is very limited, especially for emerging economies that follow inflation targeting. In addition, little is known about the potential asymmetry in the effect of foreign exchange intervention. It is probable that purchase and sales intervention may have different effects on the setting of interest rates.

Three, monetary authorities of emerging economies have asymmetric preferences to positive and negative shocks of output and inflation gap. This is a result of the departure from the linear-quadratic framework of the Taylor rule. Blinder (1998) pointed out that monetary authorities consider political pressures more seriously when reducing interest rates to solve unemployment than when increasing interest rates to reduce inflation. By contrast, monetary authorities may prefer to anti-inflation policies when they concern about the building of credibility. In addition to asymmetric preferences, a nonlinear Phillips curve can justify the asymmetry of the Taylor rule because it shows the asymmetry of the inflationary pressure caused by output changes. In other words, it is costly to reduce (increase) inflation once inflation reaches too high (low) level. Because of these, the linear rule may have limited use in emerging economies.

Recent studies provide increasing evidence challenging the linear-quadratic framework. In fact, the Taylor rule can be asymmetric because of either a nonlinear Phillips curve (Nobay and Peel, 2000; Bec et al., 2002; Schaling, 2004; Dolado et al., 2005) or an asymmetric preference to negative and positive shocks of inflation and output gap (Bec et al., 2002; Nobay and Peel, 2003; Dolado et al., 2004; Surico, 2007; Aguiar and Martins, 2008; Komlan, 2013; Caglayan et al., 2016; Tawadros, 2016; Tawadros, 2020). Although these studies give crucial policy implications, their main constraint is that they mainly focus on advanced economies.

Few studies (Vašíček, 2012; Aragón and de Medeiros, 2013; Sznajderska, 2014; Aragón et al., 2016; Klose, 2019; Kobbi and Gabsi, 2019) addressed the asymmetric Taylor rule for emerging economies, especially those in Asia or Latin America. Moreover, studies covering the post-crisis period is rather scant. The objective of this thesis is to examine the implication of a nonlinear Phillips curve and an asymmetric preference for the asymmetric setting of interest rates in inflation-targeting emerging economies.

1.2. Research objectives

The thesis aims to fill these aforementioned gaps by investigating the indicator and identification problem for emerging economies that follow inflation targeting. The first objective is to investigate the performance of three measures of monetary policy: money supply, interest rates, and MCI. It answers crucial aspects of measuring monetary policy:

- What is the relative significance of interest rates and money supply in measuring monetary policy?
- What is the application of MCI in measuring overall changes in monetary policy?

The second objective is to examine the specification of monetary policy rule (augmented Taylor rule) for emerging economies. It makes several extensions into the traditional Taylor rule:

- How do exchange rates matter in the process of setting interest rate?
- How does foreign exchange intervention affect monetary policy?
- Is the reaction of monetary policy asymmetric with respect to output gap and inflation gap?

1.3. Research hypotheses

The literature review suggests two important problems that require rigorous treatments before conducting any analysis about the effectiveness of monetary policy in emerging economies. The first problem is the ambiguity about the representative power of money supply, interest rates, and MCI as a measure of monetary policy in emerging economies. The second problem involves the approximation of the behaviour of monetary authorities. This requires serious consideration of the unique characteristics of emerging economies such as the “fear-of-floating”, foreign exchange intervention, and the

asymmetric preferences of policymakers. The thesis addresses the two problems in the context of inflation-targeting emerging economies.

With respect to the indicator problem, it tests the following emerging hypotheses:

- Hypothesis 1: Interest rates and money supply contain comparable information about changes in monetary policy.
- Hypothesis 2: MCI is a useful indicator of monetary policy in emerging economies.

With respect to the identification problem, it tests the following hypotheses:

- Hypothesis 3: Exchange rates have a significant effect on monetary policy in emerging economies.
- Hypothesis 4: Foreign reserves have a significant effect on monetary policy in emerging economies.
- Hypothesis 5: Monetary authorities in emerging economies asymmetrically respond to positive and negative shocks of inflation and output gap.

1.4. Justifications for the thesis

The thesis contributes to the literature in several aspects. Firstly, the thesis sheds light on the representative power of various indicators (money supply, interest rates, and MCI) in measuring changes in the stance of monetary policy in emerging economies that follow inflation targeting. It should be noted that while the literature is vast for emerging economies, little is known on this issue for emerging economies, especially Asia, Latin America, and South Africa. It answers the question whether using only one indicator is enough to measure monetary policy changes or it is necessary to construct a composite measure. Secondly, the thesis helps understand the behaviour of monetary authorities in emerging economies that target price stability. It answers how they respond to economic variables. It also extends the Taylor rule by considering the potential influence of the "fear-of-floating", foreign exchange intervention, and the asymmetric preference. Thirdly, the thesis conducts a comparative analysis by focusing on a group of emerging economies. Fourthly, it covers the post-crisis period during which exchange rates and foreign exchange intervention may have important implications for the implementation of monetary policy. Therefore, the thesis provides an update analysis for previous studies. Finally, the focus on emerging economies is of importance because these economies play an increasing role in the global economy. As pointed out by Duttagupta and Pazarbasioglu

(2021), the top 20 emerging economies contribute a large share of the world GDP, 34 percent in nominal terms and 46 percent in purchasing-power-parity terms.

1.5. Outline of the thesis

In addition to the introduction, the thesis is organized as follows:

- Chapter 2: Literature review
- Chapter 3: Methodology and data
- Chapter 4: Measuring monetary policy
- Chapter 5: Reaction function of monetary policy
- Chapter 6: Main conclusions and implications

Chapter 2 (Literature review) discusses related literature about the hypothesis 1 to hypothesis 5. Section 2.4 indicates the challenges in determining the most appropriate indicator of monetary policy in emerging economies that follow inflation targeting. In this section, it starts with the theoretical justifications and empirical evidence for the hypothesis 1 and 2. To begin with, it discusses the relative significance of money supply and interest rates as a measure of monetary policy, especially for emerging economies (hypothesis 1). Then, it shows the importance of a composite indicator, especially MCI, for measuring monetary policy in emerging economies where they employ multiple instruments and can follow other objectives beyond price stability (hypothesis 2).

Section 2.5 is divided into three subsections, which discusses the existing literature for hypothesis 3, 4, 5 respectively. These subsections discuss differences of institutions between emerging and advanced economies, which explains the complexity of the monetary policy reaction function in emerging economies. General speaking, emerging economies are smaller than advanced economies. They are price-takers and they have high level of external exposures. To remain competitive advantages in the global market, monetary authorities in emerging economies show the fear of floating, which involves the attempt to remove extreme changes and stabilize the movement of exchange rates by changing interest rates or intervening in the exchange rate market. The theoretical and empirical justifications for these two choices involve the hypothesis 3 and 4 respectively. The literature for hypothesis 5 is presented in the subsection 2.5.3, which discusses the reasons why and how emerging economies depart from the linear and symmetric reaction function of monetary policy and display asymmetric reactions to changes in basic variables such as output and inflation.

Chapter 3 indicates how these hypotheses are studied. First, we determine the significance of various indicators of monetary policy (hypothesis 1 and 2) by identifying the strength in the relationship between them and a monetary policy objective. Inflation is chosen as the objective of monetary policy because the sample includes emerging economies that follow inflation targeting. Granger causality, impulse response function, and forecast error variance decomposition are used. Granger causality can determine whether changes in monetary policy indicators can precede changes in inflation. Forecast error variance decomposition indicates how much a monetary policy indicator contributes to the variation of inflation. Impulse response function shows how inflation reacts to a shock of monetary policy. Following previous studies, we use the vector autoregressive (VAR) model to determine the Granger causality, impulse response function, and forecast error variance decomposition. Second, we use the extended Taylor rule to account for institutional differences of emerging economies. By adding exchange rates or foreign reserves (hypothesis 3 and 4 respectively), we can measure how the fear of floating affects the behaviour of monetary authorities in inflation-targeting emerging economies. By employing the methodology developed by Dolado et al. (2005) and Caglayan et al. (2016), we show how a nonlinear Phillips curve and an asymmetric preferences affect the reaction function of monetary policy (hypothesis 5). Third, we discuss how structural breaks may affect the stationarity of variables and suggests methods that can deal with the potential effect of these breaks. The analysis of these methods provides a robustness test for the VAR or GMM estimation, which is considered as the baseline analysis. Such an analysis examines whether the empirical results of the baseline analysis are robust to the presence of the structural break.

Chapter 4 and 5 present the empirical results. Chapter 4 displays the results for hypothesis 1 and 2, which are related to the indictor problem. It comprises of two sections. The first section indicates that both money supply and interest rates contain significant information about changes in monetary policy. This favours the use of a composite measure of monetary policy for emerging economies that follow inflation targeting. The second section further investigates this issue. It discusses and shows the importance of MCI as an indicator of monetary policy.

Chapter 5 displays empirical results for hypothesis 3, 4, and 5, which are related to the identification problem. The results show that both exchange rates and foreign reserves play a role in the conduct of monetary policy in inflation-targeting emerging

economies. These findings indicate the presence of the fear of floating in these countries. Furthermore, the empirical results also provide evidence for the asymmetry in the reaction function of monetary policy and they show that the asymmetry is conditional on both a nonlinear Phillips curve and an asymmetric preference.

Chapter 6 presents main conclusions, implications, and limitations. It summarizes the main findings of the thesis. It also provides suggestions for market participants and policy makers. Finally, it shows the drawbacks of the thesis, which remains gaps for future studies.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

The analysis of monetary policy requires an appropriate choice of a representative measure of monetary policy (Bernanke and Mihov, 1998) as well as an appropriate identification of monetary policy reaction function. According to Romer and Romer (2004), a sufficiently representative measure of monetary policy not only reduces the endogeneity between changes in monetary policy and changes in the state of the economy but also alleviates the underestimates of monetary policy effect on output and prices. Therefore, a representative measure helps reveal the true relationship between monetary policy and economic objectives. In addition, measuring monetary policy is the first step to investigate further issues of monetary policy such as transmission mechanisms or effectiveness. On the other hand, the estimate of monetary policy reaction function provides an important device to understand the behaviour of monetary authorities.

There is vast literature investigating the indicator and identification problem for advanced economies. The general consensus of these studies is that interest rates are the best measure of monetary policy and the Taylor rule is a good approximation of the setting of interest rates. Nevertheless, the literature about the effectiveness of various monetary policy indicators and the performance of augmented Taylor rules is limited for emerging economies.

With respect to the indicator problem, most studies using emerging-economy data assume that monetary policy is properly measured by interest rates. See, for instance, Cermeño et al. (2012) for Mexico; Furlani et al. (2010), Sánchez-Fung (2011), Jawadi et al. (2014) for Brazil; or De Mello and Moccero (2011) for 4 Latin America countries. However, differences in institutions between emerging and advanced economies raise questions about the appropriateness of the consensus that interest rates are the best representative measure of monetary policy. Economic and financial crises in 1990s motivated many countries to reform their financial system and monetary policy institutions as means to prevent hyperinflation and recover economic performance. Among many reforms, the most remarkable one is the adoption of inflation targeting framework in many emerging economies. From theoretical perspective, inflation targeting is characterized by a commitment to an explicit inflation target and a regime of

floating exchange rate. In inflation targeting, interest rates are the main instrument to achieve the preannounced inflation target whereas other variables such as monetary aggregates or exchange rates are determined by market forces. However, the practical conduct of monetary policy in emerging economies is quite different from the theoretical model and the practice of advanced economies. In practice, monetary authorities in emerging economies may rely on various instruments to finetune the movement of inflation as well as other objectives (output growth or exchange rate stability). Therefore, the role of interest rates as a measure of monetary policy remains ambiguous for emerging economies.

Furthermore, since both interest rate and exchange rate channel are active in the transmission of monetary policy in emerging economies (Poon, 2010), an indicator that captures the movement of both can be a better measure of monetary policy. MCI, a weighted average of interest rates and exchange rates from their value in a baseline period, is a common composite measure of monetary policy, especially in open economies (Goodhart and Hofmann, 2001; Osborne-Kinch and Holton, 2010). Changes in the index depict whether monetary policy is in loose or tight conditions (Osborne-Kinch and Holton, 2010). The use of MCI is attractive for both foreign and domestic institutions and agents. Since MCI accounts for the two primary transmission channels of monetary policy (Hyder and Khan, 2007; Osborne-Kinch and Holton, 2010), it provides an important guide to understand the behaviour and general condition of a small and open economy and policy making (Ericsson et al., 1998; Zulkhibri, 2012). Although there is vast literature about the construction of MCI (Freedman, 1994; Freedman, 1995; Eika et al., 1996; Ericsson et al., 1998; Peeters, 1999; Gerlach and Smets, 2000; Batini and Turnbull, 2002; Osborne-Kinch and Holton, 2010; Majid, 2012), much less evidence on its impact on the objective of monetary policy is available for emerging economies, especially those in Asia, South America, and Africa.

With respect to the identification problem, studies on this field receives less attention in emerging economies. The vast literature for advanced economies argued that the adopters of inflation targeting should use the interest rate instrument and set it based on expected changes in output and inflation. However, Ball (1999) argued that such design may be suboptimal in small-open economies, suggesting the necessity of certain modifications. Monetary policy rules for emerging economies require crucial modifications to account for their specific economic and institutional factors. To begin

with, external factors or exchange rates in particular are of importance for the decision of monetary authorities in emerging economies (Calvo and Reinhart, 2002) even though these countries follow flexible exchange rates other than fixed exchange rates (Ghosh et al., 2016). As convincingly proved by Reinhart and Rogoff (2004), the officially stated regime of exchange rates is often different from de factor regime. Most emerging economies often leave the corners, fixed or floating regimes, and move to the intermediate regimes (Menkhoff, 2013). This means that emerging economies can experience the dilemma between the strict inflation targeting characterized by a price stability commitment and floating exchange rates and the flexible inflation targeting characterized by interventions in the foreign exchange market.

Moreover, since emerging economies have underdeveloped financial sectors, they may experience output loss when exchange rates are volatile (Mundaca, 2018). As a result, monetary authorities in emerging economies can intervene to affect the trend of exchange rates and stabilize their movement. In fact, intervention is an ongoing issue in emerging economies (Menkhoff, 2013). The intervention can be conducted directly through the purchase or sales of foreign reserves or indirectly through changes in interest rates. Regardless sterilization or not, monetary policy indictors such as interest rates and money supply can be affected. Therefore, the departure from the strict inflation targeting suggests the importance of foreign reserves or exchange rates in the conduct of monetary policy (Berganza and Broto, 2012).

Finally, monetary authorities in emerging economies can show some departures from the linear-quadratic framework, suggesting the relevance of an asymmetric reaction function of monetary policy. The asymmetry can stem from either a nonlinear Phillips curve or the asymmetric preference of monetary authorities. The existing literature focuses mainly on advanced economies and a few addresses the asymmetry issue for emerging economies. Furthermore, empirical studies showing a comparative analysis about these types of asymmetries is scant, especially for emerging economies.

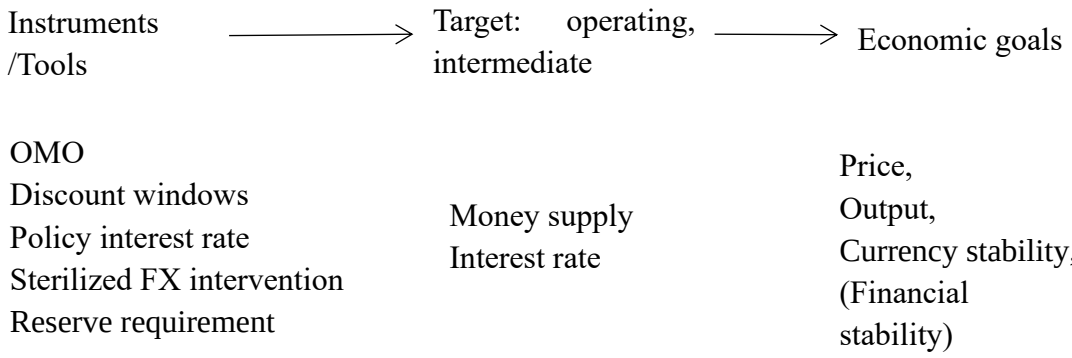
2.2. Definition of basic concepts

The framework of monetary policy can be described by three components: instruments, operating and intermediate targets, and goals (Handa, 2009) (see Figure 1). Firstly, monetary policy instruments are tools under the control of the central bank through which they can affect the fluctuation of output and inflation. These tools are various: reserve requirement, open market operations (OMO), discount windows, and

many others. However, these instruments are not always under the observation of the public, which restrain their ability in measuring changes in the stance of monetary policy.

Secondly, monetary policy objective is a variable that monetary authorities tend to affect. Monetary authorities can follow one or several objectives. In principle, an inflation-targeting central bank focuses on price stability as their primary target. Most of countries that are inflation targeting tend to remain a stable inflation rate of 2 percent. However, this may not hold for emerging economies that have high level of external exposure, uncertainty, and low level of central bank independence. For instance, during time of recessions, monetary authorities can put a high emphasis on output growth than price stability. Moreover, monetary authorities in emerging economies tend to remain a stable exchange rate that can stimulate domestic production and export.

Figure 1: Monetary policy framework



Source: Author's construction

Thirdly, monetary authorities must decide on instruments based on their abilities to control the instruments (Friedman, 1968; Howells and Bain, 2003) and to avoid sharp adjustments in those instruments (Friedman, 1968). However, unpredictable lags exist between observed changes in the instruments and their realized effects on economic goals. Monetary authorities depend much on operating/ intermediate targets that are almost under their influence and can provide information about the direction and size of policy changes. Two primary operating targets are short-term interest rates and money supply. In emerging economies, monetary authorities aim at both short-term interest rates and money supply. This is contrast to developed economies that primarily target short-term interest rate. It should be noted that the separation between instruments and targets is blurred and even mixed (Handa, 2009). In the analysis of monetary policy, money supply and interest rates can be considered as instruments or indicators of monetary policy.

2.3. Monetary framework in emerging economies

Crises in 1990s lowered economic growth, caused inflation, and led to difficulties in the implementation of monetary policy in many countries. To recover the economy, many countries conducted reforms in the financial system and monetary policy framework. Among many reforms, the most remarkable one is the adoption of inflation targeting that is characterized by the commitment to achieve an explicit inflation target. Such a commitment helps improve the communication, accountability, transparency, and credibility of monetary policy (Wong et al., 2001) as well as alleviate the problem of dynamic inconsistency (Lin and Ye, 2009). The economic gains of these improvements are a reduction in the expectation and volatility of inflation (Gonçalves and Salles, 2008; Lin and Ye, 2009; Lin, 2010) and a reduction in the trade-off between output and inflation (Wong et al., 2001).

However, institutional differences lead to differences in the implementation of inflation targeting between emerging and advanced economies. In emerging economies, governments can affect the setting of inflation target as well as the conduct of monetary policy (Jawadi et al., 2014), which is contrary to the high independence of the central bank in advanced economies. Since monetary authorities in emerging economies can follow objectives that are not appeared in advanced economies, the departure of the inflation target from the inflation forecast is of great concern (Svensson, 1997). As a result, they often implement a tolerance band, whereby inflation can be fluctuated in a specific range. More importantly, the existence of multiple objectives and uncertainty leads to the use of many instruments because these instruments are different in nature and they are useful in different situations. Conventionally, in inflation targeting regime, to achieve preannounced inflation targets, monetary authorities usually use a reference interest rate and leave market forces to determine other instruments such as money supply and exchange rates (Acosta-Ormaechea and Coble, 2011). In practice, however, monetary authorities can alter instruments beyond interest rates to control inflation in emerging economies (Gerlach and Tillmann, 2012). According to Acosta-Ormaechea and Coble (2011), exchange rates play an important role in the transmission mechanism in emerging economies such as Peru and Uruguay.

2.4. Indicator problem of monetary policy

This section reviews the literature related to the hypothesis 1 and 2. It discusses the rationale for the use of money supply and interest rates as a measure of monetary

policy. It also investigates whether MCI, which is a weighted average of the deviation of interest rates and exchange rates from their value in a base period, is a useful indicator of monetary policy.

2.4.1. Money supply and interest as a measure of monetary policy

The hypothesis 1 involves the decision on the relative significance of money supply and interest rates as a measure of monetary policy. Therefore, this section presents the theoretical and empirical justifications for the challenge in determining whether money supply or interest rates are the best measure of monetary policy for emerging economies that follow inflation targeting.

- Hypothesis 1: Interest rates and money supply contain comparable information about changes in monetary policy.

According to Handa (2009), the effectiveness of monetary policy depends on the appropriate selection of instruments, operating targets, intermediate targets, and goals. However, it should be noted that there is no clear-cut distinction between instruments and operational targets (Handa, 2009). In fact, they are often exchangeable. Monetary authorities first select instruments, which are tools under their control, to manage the future path of inflation or output. Popular instruments are open market operations, discount window, policy rates, foreign exchange interventions, to name a few. A proper choice of an instrument requires a thorough consideration of the ability to control the instrument (Friedman, 1968; Jawadi et al., 2014) as well as the ability to avoid large adjustments in that instrument (Friedman, 1968). Although instruments are under the control of monetary authorities, they cannot give numeric measures of monetary policy changes. Operational targets can be considered as the main indicators of monetary policy. Empirical analysis often uses interest rates and monetary aggregates as indicators of monetary policy. The reasons are that these variables can be influenced by changes in instruments such as policy interest rates or discount windows. Moreover, they show quantitative changes in the direction and size of monetary policy, and have relatively stable relationship with the objective of monetary policy.

The measure or indicator problem emerges because of the controversy about the effectiveness of interest rates and money supply in the implementation of monetary policy. It stems from the incomplete knowledge about the structure of the economy and the lagged effect of monetary policy on economic objectives. According to Poole (1970), the optimal choice of instruments depends on the sources of uncertainty in the economy

and the degree of knowledge about the economy. Poole (1970) uses a simple IS/LM framework to compare the performance of interest rates and money supply in controlling output volatility. The analysis assumes that monetary authorities have no errors in controlling interest rates or monetary base and they must choose only one instrument to minimize the output volatility. The analysis concludes that interest rates are optimal (causes less volatile output) to deal with shocks from the financial markets whereas money supply is optimal to deal with shocks from commodity shocks. Following studies (Bhattacharya and Singh, 2008) obtain a similar conclusion that interest rates are optimal to deal with nominal shocks whereas money supply is optimal to deal with real shocks. Atkeson et al. (2007) rank interest rates, money supply, and exchange rates based on the strength of the linkage between instruments and objectives (tightness) or the observability of instrument adjustments by the public (transparency). Their results indicate the superiority of interest rates over other instruments. Exchange rates are a less preferred instrument and money supply is at the bottom.

2.4.2. Disadvantages of a single monetary policy indicator in emerging economies

The consensus of Poole (1970) is open to question when applying it for emerging economies. Firstly, monetary authorities in emerging economies cannot control instruments as perfectly as counterparts in advanced economies. The large size of control error raises doubts about the application of the consensus of Poole (1970) for emerging economies. Secondly, it is cautious to conclude the superiority of interest rates or money supply in dealing with nominal or real shocks when monetary authorities focus on price stability rather than output stability. This issue is of great concern because the thesis focuses on a sample of emerging economies that follow inflation targeting. Thirdly, monetary authorities in emerging economies can use both instruments rather than rely on only interest rates. One reason is that, compared to advanced economies, monetary authorities in emerging economies have limited knowledge about the source of uncertainty in the economy. According to the policy theory under uncertainty, risk-averse monetary authorities can diversify the risk by using both money supply and interest rates (Handa, 2009) as they are different in nature and thus useful in different situations. Other reason is that two instruments can be complementary rather than competing. For instance, a reserve instrument can support an interest rate instrument when financial friction is high (Sensarma and Bhattacharyya, 2016). Moreover, reserve requirements are of importance for the central bank that wants to maintain financial stability (Glocker and Towbin, 2012).

Finally, monetary authorities can use interest rates even though it is not optimal according to Poole (1970). High output volatility when pegging interest rates allows individuals and firms more rooms to optimize the utility. Moreover, the use of interest rates can stem from political pressures (Cover and VanHoose, 2000).

Furthermore, small and open economies cope with more difficulties when deciding the superiority of interest rates and money supply. Gardner (1983) examined the performance of three instruments - interest rate, exchange rate, and money supply – with the assumption that monetary authorities have preference to money supply and exchange rates. Gardner (1983) found that the choice of optimal instruments depends on the understanding of money demand and money supply and the relative importance of exchange rates. If monetary authorities understand money demand perfectly, interest rates are superior to reserve instruments. If they know money supply perfectly, reserve instruments are superior. However, when exchange rates are of great concern, interest rates are preferable although monetary authorities have complete knowledge about the process of money supply. Under New Keynesian framework, Singh and Subramanian (2008) examined the superiority of money supply and interest rates under different types of shocks. Based on the welfare yardstick, they found the superiority of money supply in response to demand (fiscal) shocks and the superiority of interest rates in response to supply (productivity) or money (velocity) shocks.

In summary, from the theoretical perspective, it is a difficult task to decide what is the best measure of monetary policy in emerging economies. The primary reason is the unique of institutions in these countries. The problem of asymmetric information or low level of finance development increases the uncertainty in the economy, which stimulates monetary authorities to use various instruments in the conduct of monetary policy. Hence, it is of importance to investigate how interest rates and money supply work as a measure of monetary policy in emerging economies.

Empirically, both money supply and short-term interest rates can be used as a measure of monetary policy. Since the seminal work of Sims (1972), many studies use the innovation of short-term interest rates derived from the vector autoregression (VAR) model as exogenous changes in monetary policy (e.g., Bernanke and Mihov, 1998; Howells and Bain, 2003; Acosta-Ormaechea and Coble, 2011; Phiromswad, 2015; Peters, 2016).

While the most appropriate measure of monetary policy is an ongoing issue,

studies base on the prior that interest rates are an appropriate measure of monetary policy are popular for emerging economies. See for instance, Furlani et al. (2010), De Mello and Moccero (2011), Sánchez-Fung (2011), Cermeño et al. (2012), and Jawadi et al. (2014), to name a few. Cermeño et al. (2012) use the GMM method to analyse the reaction function of monetary policy in Mexico from January 1998 to February 2008 and argue that short-term interest rates can reflect the behaviour of the Bank of Mexico. However, it should be noted that short-term interest rates may not be a good measure of monetary policy in Mexico over the research period because it is not considered as the primary monetary policy instrument in this country before 2008 (Cermeño et al., 2012). Before 2008, monetary authorities in Mexico used an instrument, namely corto, to signal the market about their preference for the structure of the market interest rate. Aragón and de Medeiros (2015) use Selic interest rate, which is a primary monetary policy instrument, as a measure of monetary policy. Their study shows that monetary authorities have reduced their response to inflation since mid-2010, which does not satisfy the Taylor principle. Jawadi et al. (2014) examine the behaviour of two major emerging economies (China and Brazil) and use central bank interest rates as a measure of monetary policy. They find that monetary authorities in these countries react to both inflation and financial variables such as real exchange rates and commodity prices. Using money market interest rates as a measure of monetary policy, Acosta-Ormaechea and Coble (2011) investigate the transmission mechanism in Chile, New Zealand, Peru, and Uruguay. Using VAR models, they find that the effect of monetary policy on inflation is counter-intuitive in Peru (positive) and Uruguay (insignificant). They argue that the problem of dollarization and the low degree of financial development limit the impact of monetary policy in these economies. In summary, a limitation of these studies is that the empirical analysis is on the prior that interest rates are a good measure of monetary policy. Meanwhile, we know little about the indicator function of interest rates as well as money supply in emerging economies.

2.4.3. MCI as a measure of monetary policy

Solving hypothesis 2 needs to identify the role of MCI in measuring monetary policy for emerging economies that follow inflation targeting. Therefore, this section makes a contribution by discussing important aspects of MCI: its origin, functions, advantages and disadvantages of each function, its construction, and especially its relationship with monetary policy.

- Hypothesis 2: MCI is a useful indicator of monetary policy in emerging economies.

2.4.3.1. The role of MCI

MCI is a composite measure of monetary policy that captures information from two principal transmission channels of monetary policy: interest rates and exchange rates. Bank of Canada is one of the pioneers using MCI as an operational target in the late 1980s (Eika et al., 1996; Ericsson et al., 1998; Majid, 2012). In the 1990s, MCI became more popular in the analysis and implementation of monetary policy. Conventionally, MCI is the weighted average of the spread between interest rates and exchange rates with their value in a baseline time. As noted by Eika et al. (1996), the weight of MCI components reflect their relative effects on long-term target indicators such as output or inflation. Such a construction implies that MCI reflects the significance of both interest rate channel and exchange rate channel (Batini and Turnbull, 2002; Qayyum, 2002) when measuring monetary policy for emerging economies (Hyder and Khan, 2007).

General speaking, monetary authorities alter the official interest rates, which in turn lead to changes in money market interest rates and then affect the behaviour of investment and spending and finally aggregate demand and inflation. However, it should be noted that in emerging economies with flexible exchange rate regime, changes in the official interest rates also cause changes in the value of domestic currency. The fluctuation of exchange rates then affects the competitiveness of domestic export and import, leading to changes in the price of imported goods and hence aggregate demand and inflation. The transmission from exchange rates to inflation depends on many factors (Hyder and Khan, 2007). The presence of the exchange rate channel can magnify or lessen the contractionary stance of the setting of the official interest rates. Because of these, monetary authorities can alter interest rates and exchange rates to stabilize prices in the economy. As a result, observing the two as a separate indicator may provide misleading information about the expected changes in inflation. To put it differently, a composite measure of monetary policy that captures both channels can give a more accurate representation of the stance of monetary policy in emerging economies (Hataiseree, 1998; Batini and Turnbull, 2002; Hyder and Khan, 2007).

Previous studies (Freedman, 1994; Freedman, 1995; Ericsson et al., 1998; Peeters, 1999; Batini and Turnbull, 2002; Benazić, 2012) use the following equation to determine the MCI:

$$mci = \beta_i(i_t - i_b) + \beta_e(e_t - e_b)*100 \quad , \quad \beta_i + \beta_e = 1$$

where e_t is the logarithm of the nominal effective exchange rate. An increase in e_t reflects the appreciation of the domestic currency. i_t is the nominal short-term interest rate, which is a proxy for policy interest rates because it is closely linked and quickly responded to the central bank policy rate (Osborne-Kinch and Holton, 2010). i_b and e_b are the value of interest rates and exchange rates in the base period. β_i and β_e are estimated parameters that reflect the relative weight of interest rates and exchange rates in MCI, which can be derived from their significance in the output equation (Ericsson et al., 1998; Gerlach and Smets, 2000; Knedlik, 2006; Poon, 2010; Majid, 2012; Egan and Leddin, 2016) or price equation (Hataiseree, 1998; Kesriyeli and Kocaker, 1999; Qayyum, 2002) or both (Hyder and Khan, 2007).

From empirical perspectives, many studies use interest rates as a measure of monetary policy (Furlani et al., 2010; De Mello and Moccero, 2011; Sánchez-Fung, 2011; Cermeño et al., 2012; Jawadi et al., 2014; Mehra, 2020). The common use of interest-rate-based measure of monetary policy is conditional on the fact that it is a price-based instrument, which is easily monitored by both policymakers and market participants. Generally, short-term interest rates are a good measure of monetary policy when monetary policy effectively operates through the interest rate channel. Since the effectiveness of that channel depends on the existence of a well-functioned financial market, interest rates are a good indicator for advanced economies. For emerging economies where financial system is underdeveloped even though there are substantial improvements and liberalizations over the last decades, the interest rate channel is weak. Furthermore, compared to advanced economies, the exchange rate channel plays a more important role in emerging economies. The importance of exchange rates depends on the degree of the openness of the economy under investigation. Moreover, foreign exchange intervention can be a possible policy when capital flows are volatile (Goyal, 2016). According to Osborne-Kinch and Holton (2010), MCI rather than interest rates is a better indicator of monetary policy when exchange rates play an important role in the transmission mechanism.

According to Batini and Turnbull (2002), MCI can be used as an operational target, as an indicator of monetary policy or as a monetary policy rule. Firstly, as an indicator of monetary policy, MCI depicts the movement of both interest rates and exchange rates (Poon, 2010) and signals the timing of the expansion and restriction of

monetary policy (Şıklar and Doğan, 2015). This function is highlighted for many countries such as Nordic countries (Gerlach and Smets, 2000), Thailand (Hataiseree, 1998), Turkey (Kesriyeli and Kocaker, 1999), Croatia (Benazić, 2012), Pakistan (Hyder and Khan, 2007), Sweden and Norway (Eika et al., 1996; Engelbrecht and Loomes, 2002). Hataiseree (1998) argues that MCI rather than interest rates and exchange rates is effective in determining the stance of monetary policy as well as accessing the future behaviour of inflation in Thailand. Secondly, MCI can be used as an operational target. The central bank of Canada and New Zealand utilizes this capacity of the index (Ericsson et al., 1998; Engelbrecht and Loomes, 2002) because they believe that exchange rates can affect inflation through the impact on import price (Gerlach and Smets, 2000). In this case, the central bank can use monetary policy tools to set the desired MCI when the index deviates from desired levels (Osborne-Kinch and Holton, 2010). With this function, the desired MCI should be consistent with the objective of monetary policy such as inflation targets (Qayyum, 2002; Osborne-Kinch and Holton, 2010). Finally, MCI can be used as a monetary policy rule. This requires the rearrangement of the interest rate to construct the parallel between the interest rate and exchange rate (Batini and Turnbull, 2002). The idea obtains the support of Us (2004) for the case of Turkey.

However, it should be noted that the use of MCI as an operational target can cause difficulties for the practical implementation of monetary policy (Eika et al., 1996; Engelbrecht and Loomes, 2002). Firstly, many difficulties emerge because interest rates are a monetary policy instrument whereas exchange rates are a macroeconomic outcome (Osborne-Kinch and Holton, 2010). Therefore, it might cause conflict when monitoring or adjusting the movement of MCI. Secondly, MCI may provide ambiguous communication with financial markets when there exists a negative relationship between interest rates and exchange rates (Engelbrecht and Loomes, 2002). Because the depreciation of exchange rates causes inflation to increase whereas a rise in interest rates reduces inflation, the opposite movement between exchange rates and interest rates causes it difficult to interpret the effect of monetary policy changes on the economy and inflation. The transparency issue forces the Reserve Bank of New Zealand to replace MCI by an official cash rate in March 1999. Thirdly, changes in MCI require the understanding of drivers underlying changes in exchange rates (Ericsson et al., 1998; Gerlach and Smets, 2000; Engelbrecht and Loomes, 2002). If exchange rates are affected by changes in supply and demand, it is optimal to adjust the target of MCI. On the other hand, if exchange rates are affected by other shocks, it is optimal to maintain the current MCI and

adjust interest rates. The caution when using MCI as an operating target is intensified by the fact that the terms of trade have substantial effects on the exchange rate movement (Gerlach and Smets, 2000).

Since using MCI as an operational target causes difficulties for the implementation of monetary policy, using MCI as an indicator of monetary policy gains more attention (Hyder and Khan, 2007; Osborne-Kinch and Holton, 2010). Hyder and Khan (2007) do not support the use of MCI as an operational target because the weight of components can be time-varying or MCI is sensitive to the choice of its components. Similarly, Benazić (2012) combined the effect of both interest rates and exchange rates to determine MCI for Croatia and suggested that the feasible function of MCI is an indicator of monetary policy rather than an instrument. One factor that constrains the use of the index as an instrument is the liberalization of the international financial flows and the popular use of the euro in Croatia.

It should be noted that as an indicator, MCI provides more information about the current status of monetary policy stance. In this case, monetary authorities do not need to change their tools to return MCI to its desired path. Another reason supporting the indicator function of MCI is that monetary authorities in emerging economies use multiple instruments to influence the movement of output or prices. It is likely that monetary authorities change many instruments at the same time or at two very close points of time. Consequently, observing changes in only interest rates can provide misleading interpretation about the intention of monetary policy. In particular, changes in interest rates may provide little information about changes in monetary policy when monetary authorities implement the framework of multiple instruments (He and Pauwels, 2008; Ma, 2014; Egan and Leddin, 2016; Bui and Gábor, 2021). According to Egan and Leddin (2016), MCI, which is the weighted average of five instruments, can be considered as an accurate representation of various monetary policy instruments.

2.4.3.2. Empirical studies about the use of MCI

From the empirical perspective, the literature about the role of MCI is extensive for advanced economies. Freedman (1994), Freedman (1995), Ericsson et al. (1998), and Peeters (1999) are seminal papers that provide excellent explanations about the construction of MCI. Gerlach and Smets (2000) argued that the construction of MCI requires small weight on exchange rates, which is associated with their effect on aggregate demand. Osborne-Kinch and Holton (2010) examined the role of MCI for Euro

Area, UK, and US from 1999 to 2009 and found that the index can be used as a timely indicator of monetary policy. However, they noted that the index copes with the uncertainty caused by its estimation and interpretation. Similarly, Batini and Turnbull (2002) studied the case of UK from 1984 to 1999 and concluded that MCI can be used as an indicator of monetary policy. Kucharčuková et al. (2016) showed the role of MCI in measuring monetary policy conducted by the ECB. They used the factor analysis to calculate the weight of MCI components. The result of a standard monetary VAR model showed that monetary policy has an effect on prices whereas it has a muted effect on output.

However, the literature for emerging economies is rather limited and mainly focus on the construction of MCI. Benazić (2012) used the Engle-Granger co-integration method to construct MCI for Croatia over the period 1998-2010. As shown in this study, the weight derived from the price equation suggests that exchange rates are more important than interest rates. Moreover, the observation of MCI movement shows that monetary policy is restrictive in this country over the period 1998-2000 while easing in the following period. Over the period of the Global financial crisis, MCI fluctuated strongly and arbitrarily in Croatia.

Qayyum (2002) took into account the openness of emerging economies when constructing MCI for Pakistan. The author defined MCI by summarizing the deviation of two quantitative variables, interest rates and exchange rates, from their bechmark values. The author determined the weight of MCI components by their relative importance in the inflation equation. Hyder and Khan (2007) used Johansen cointegration method to determine the weights of MCI components for Pakistan from March 1991 to April 2006. They used both price and output equation and found that the importance of exchange rates is model-dependent. Exchange rates have a greater effect on output than interest rates whereas its effect on price is smaller. However, their findings show that the MCIs calculated from the two equations show a strong co-movement and deviations between them and interest rates show a reduction after September 2001. Hataiseree (1998) constructed MCI with weights derived from the inflation equation and noted the advantage of MCI as an indicator of monetary policy in the short run in Thailand. The author used autoregressive distributed lagged model to estimate the inflation equation. The finding emphasized the significance of MCI relative to either exchange rates and

interest rates. The study also found the high correlation between MCI and inflation; therefore, MCI plays an important role in the conduct of monetary policy.

Berument (2007) argued that monetary authorities in a small and open economy such as Turkey cope with the problem of currency substitution and the fear of floating. As a result, they can use both interest rates and exchange rates to fulfil the objective of price stability. Therefore, monetary policy should be measured by an index that captures changes in both instruments. Berument (2007) introduced a new measure, the differential between the interbank interest rates and depreciation rates. In term of MCI construction, it implies that exchange rates and interest rates have equal weights. If the spread is positive, monetary policy is restrictive; otherwise, it is expansive. Using this measure, the author found that the response of output, prices, and exchange rates to a restrictive monetary policy is consistent with the theory. Especially, inflation shows a reduction after a contractionary shock of monetary policy, which indicates the absence of the price puzzle. Other studies construct the traditional MCI for Turkey but the relative importance of exchange rates and interest rates are different depending on the methodology of the weight calculation and research period. Kesriyeli and Kocaker (1999) derived the weights from the price equation and concluded that exchange rates are the principal source of the price fluctuation over the period 1987 - 1999 in Turkey. They emphasized the cautious use of MCI in the analysis and implementation of monetary policy.

Other studies emphasize other aspects of the weight of MCI components. To begin with, some studies emphasise that the weight of MCI components varies over time. Using TVP-VAR model, Akdeniz (2021) showed that in Turkey, interest rates had a rising weight after the adoption of inflation targeting whereas the weight of the real exchange rates showed a declining trend since its highest level in the 1990s when the capital movement was liberalized. Similarly, Şıklar and Doğan (2015) emphasized the time-varying characteristic of MCI weights over the period 1992- 2012 and concluded that interest rates are more important than exchange rates. They argued that the reduction in the importance of exchange rates may stem from the development of financial system, which strengthens the effectiveness of the interest rate policy in Turkey over the last decades. On the other hand, other studies put an emphasis on the variance structure of MCI components and used Principal Component Analysis in its calculation. For instance, Mishra et al. (2016) used the first principal component that summarizes about 50 percent of variance in the four instruments: repo rate, reserve repo rates, cash reserve ratio, and

statutory liquidity ratio. They used this composite measure as well as three other indicators to investigate the transmission of monetary policy in India. Their study indicated the ineffectiveness of monetary policy. Similarly, Memon and Jabeen (2018) used the Principal Component Analysis to compute the weight of MCI components and used Vector Autoregression Model to investigate the effect of MCI on the economy in Gulf countries – Bahrain, Iraq, Kuwait, Oman, Qatar, Kingdom of Saudi Arabia (KSA), and United Arab Emirates (UAE). They found that MCI rather than interest rates and exchange rates is a good device to predict prices and economic growth in the long run. Moreover, monetary authorities can use MCI to access the tight and loose condition for Gulf countries.

Recently, many studies attempt to construct a more sophisticated version of the MCI by augmenting one or several other variables. Hematy and Boostani (2014) augmented the standard MCI with the asset price channel. By observing the cross correlation between MCI and inflation, they concluded that changes in MCI can lead to inflation in Iran over the period 1991Q2-2014Q1. Poon (2014) took into account two critical issues when determining MCI for Philippines: (1) including additional variables such as changes in credit, share price, and long-run interest rates and (2) distinguishing between the long-run and short-run effect of MCI components on output movement. Using a UECM model, Poon (2014) used the long-run estimated parameters to determine the MCI and showed that interest rates are much less important than exchange rates, suggesting the high significance of exchange rates in the implementation of monetary policy in the Philippines. Kannan et al. (2007) added credit growth to the construction of MCI for India. They noted that interest rates are more powerful than exchange rates in affecting economic activity and inflation. Using graphical analysis, they reached a similar consensus that MCI is better than any single MCI component to represent the stance of monetary policy in India.

However, it should be noted that the augmentation of MCI may lead to the introduction of new indices that provide information about other aspects rather than the stance of monetary policy. This problem occurs when added variables capture little or no information about the transmission of monetary policy. For instance, Angelopoulou et al. (2014) added more variables into the MCI and named the estimated index as the financial condition index (FCI). The so-called FCI is highly likely to illustrate the condition of the financial system rather than that of monetary policy. Similarly, Kapetanios et al. (2018)

used the principal component analysis method to extract common factors from a set of 28 financial indicators, which includes interest rates and exchange rates, and considered them as FCIs for the United Kingdom. In their study, FCI provides a broader information about the status of financial market, excepting for the second factors derived from a small set of data that are considered as monetary condition indices.

Despite of the vast literature for the construction of MCI, little is known about its impact on the target variable of monetary policy such as output or inflation. In fact, there is a dearth of study investigating the relationship between MCI, monetary policy, and target variables such as output or inflation. A few studies stated that MCI has predictive power about changes in the stance of monetary policy by using graphical oberservation or cross correlation coefficients. For instance, Benazić (2012) provided a short description about the stance of monetary policy from 1998 to 2010 by observing the movement of MCI. Accordingly, the evolution of MCI indicated the restriction in the period 1998-2000 and expansion after 2000 excepting for some fluctuation during the Global financial crisis. Nucu and Anton (2018) used MCI to evaluate changes in the stance of monetary policy in four Central and Eastern European countries (Czech Republic, Hungary, Poland, and Romania) over the period August 2005 – December 2015 and to examine the spillover of the monetary condition from Euro area to mentioned countries. Their Granger causality analysis suggested that the spillover exists, which can to some extent provide some suggestions about their convergence with the Euro area. They also noted that MCI is useful to predict whether monetary policy moves towards loosening or tightening stances.

Nevertheless, to the best knowledge of the author, there are no studies investigating the dynamics in the impact of MCI on inflation or output. Hataiseree (1998) is one of rare studies illustrating that MCI has a relationship with inflation. Based on the graphical evidence, the author argued that there may be some relationship between MCI and inflation in Thailand. However, such a speculation provides no information about the possible impact of MCI on inflation. Similarly, Hematy and Boostani (2014) noted that there is a positive correlation between MCI and inflation and supported the view that MCI is a leading indicator of inflation in Iran. Nevertheless, Memon and Jabeen (2018) focused on the response of MCI to output or inflation rather than the reverse in gulf countries. In the same manner, Majid (2012) used Granger-causality test to examine the predictive power of MCI and stated that changes in inflation precedes changes in MCI components.

In summary, MCI can be considered as an indicator of monetary policy. However, the existing literature mainly focuses on the construction of MCI. Meanwhile, there is little evidence indicating the performance of MCI in measuring the stance of monetary policy in emerging economies that follow inflation targeting. Moreover, little is known about whether MCI is able to mitigate the problem of price puzzle in emerging economies that follow inflation targeting. Furthermore, a comparative analysis can give more insight into the indicator problem when implementing and analysing monetary policy in emerging economies.

2.5. The reaction function of monetary policy

This sections present the literature about the identification problem, which is related to the hypothesis 3, 4, and 5:

- Hypothesis 3: Exchange rate shocks have a significant influence on monetary policy in emerging economies.
- Hypothesis 4: Foreign reserves shocks have a significant influence on monetary policy in emerging economies.
- Hypothesis 5: Monetary authorities in emerging economies asymmetrically respond to positive and negative inflation gap and output gap.

General speaking, the identification problem involves the analysis of how monetary authorities react to changes in the state of the economy. This is an ongoing debatable area of monetary policy analysis. On one hand, a predetermined rule increases the credibility of policymakers and smooths the expectation of economic agents about the future condition of the economy. However, the usefulness of the monetary policy rule copes with the criticism that monetary authorities merely follow an explicit and simple rule in the conduct of monetary policy (McCallum, 2000). Instead, they desire to preserve certain discretion because of uncertainties in the economy. The reason is that excluded variables in the rule may contain useful information in an uncertain environment. The contradiction leads to a harmonized view that monetary authorities need a simple rule for credibility building while preserving some discretionary powers to deal with uncertain circumstances. Taylor (2000b) asserted that monetary policy rule works as a guideline and benchmark for or as an approximation of the decision-making process of monetary authorities. In fact, many studies modify the rule proposed by Taylor (1993) to capture specific characteristics of a country. In this thesis, we take into account the effect of exchange rates and foreign exchange intervention on the setting of interest rates in

emerging economies that follow inflation targeting. Furthermore, it considers an asymmetric Taylor rule is driven by a nonlinear Phillips curve and an asymmetric preference.

2.5.1. The role of exchange rates in the conduct of monetary policy

2.5.1.1. Reasons for the fear of floating

Many studies (Minella et al., 2003; Mohanty and Klau, 2005; Paez-Farrell, 2007; Aizenman et al., 2011; Sánchez-Fung, 2011; Cermeño et al., 2012; Caporale et al., 2018) support the view that monetary authorities in emerging economies may actively respond to exchange rates when setting interest rates. According to Calvo and Reinhart (2002), monetary authorities in emerging economies may not be willing to allow large swings in the exchange rate even though it is officially stated as flexible or free floating. In practice, these interventions can be implicitly conducted (Mohanty and Klau, 2005; Aizenman et al., 2011). In some economies, the response of monetary policy to exchange rates is even greater than that to expected inflation (Ghosh et al., 2016). Furthermore, some countries can slowly shift from a fixed to flexible regime after adopting inflation targeting (Frömmel et al., 2011), which suggests the relevance of exchange rates in conduct of monetary policy (Calvo and Reinhart, 2002; Galimberti and Moura, 2013), at least in the early phases.

The high concern of monetary authorities about exchange rate stability is referred to as the fear of floating (Calvo and Reinhart, 2002). There are many reasons for the explicit or implicit consideration of exchange rate. From theoretical perspectives, adding exchange rates into the Taylor rule may improve the welfare of interest rate setting. Wollmershäuser (2006) supports this idea by comparing seven specifications of the Taylor rule. Similarly, Yilmazkuday (2007) indicates that the welfare is highest under the flexible inflation targeting in Turkey from August 2001 to January 2005.

From practical perspectives, Aizenman et al. (2011) argue that inflation targeting countries prefer to stabilize exchange rates when they are exporters of basic commodities. In this case, volatile exchange rates lead to a strong fluctuation of import prices, thereby preventing monetary authorities from achieving inflation targets and thus reducing the credibility of the central bank (Minella et al., 2003). Moreover, the fear of floating can stem from the low confidence in the strength of domestic currency, especially when a large proportion of debts is denominated in foreign currencies (Acosta-Ormaechea and Coble, 2011). As noted by Georgiadis and Zhu (2021), when the balance sheet of an

economy has an exposure to foreign currency, the fear of floating is particularly pronounced. Furthermore, exchange rates may not be freely floating because of other reasons such as liquidity or reserve management (Montoro and Moreno, 2011), competitiveness, growth, and price stabilization (Keefe and Rengifo, 2015; Ghosh et al., 2016).

Nevertheless, in emerging economies the fear of floating can appear as the fear of appreciation or depreciation. This means that monetary authorities are reluctant to allow exchange rates to move in a specific direction and tolerate the movement in the other direction. The fear of appreciation happens when an appreciation has a seriously contractionary effect on the economy. According to the mercantilist view, an appreciation causes domestic goods to be more expensive in the foreign markets, which negatively affects export and current account balance. Consequently, export-oriented countries can experience a loss in the national competitiveness and output. To solve these problems, monetary authorities can adjust interest rates to reverse or postpone the appreciation. Furthermore, the fear of appreciation can contribute to economic growth through its positive effect on saving and capital accumulation (Levy-Yeyati and Sturzenegger, 2007) or its protection for immature or strategic industries. On the other hand, some countries may prefer to avoid depreciation. If a country copes with surges in capital inflows, financial distress may happen when there is a sudden stop or reversal in capital flows. If investors believe in the rigidity of the depreciation, the shortage of international liquidity can be severe, especially in time of crisis. Furthermore, high dollarization is another explanation for the fear of depreciation as it increases the debt burden of domestic borrowers.

Another justification that explains different reaction of interest rates to the appreciation and depreciation is the existence of information asymmetry. As pointed out by Gürkaynak et al. (2021), the conclusion of the public about the policy decision of monetary authorities can be based on their observations of some variables. For instance, the public may have strong reaction to an unexpected rise in the value of domestic currency when monetary authorities prefer to maintain a lengthy period of low “valued” domestic currency. This is likely to happen in emerging economies that a considerable proportion of gross domestic product comes from the export of low value-added products such as raw material or commodities. Because of the behaviour of the public, monetary

authorities require to have different responses to the appreciation and depreciation to maintain the effect of monetary policy on the course of the economy

2.5.1.2. Benefits of the fear of floating

Given the effect of exchange rates on economic management, many studies suggest the benefit of including exchange rates in the reaction function of monetary policy. Ball (1999) does not support the exclusion of exchange rates in the Taylor rule because it may lead to the instability of output and exchange rates. In the same spirit, Taylor (2000a) suggests that the augmentation of exchange rates can remove the direct effect of exchange rates on inflation. Furthermore, the augmentation can reduce exchange rates volatility and thus provide a buffer against external shocks. The augmentation can also mitigate the variance of the consumer price index (Ball, 1999) as well as the uncertainty in output and inflation (Debelle, 1999). Stone et al. (2009) and Garcia et al. (2011) argue that smoothing the exchange rate movement can protect an emerging economy that is financially vulnerable. However, it seems that developed countries obtain little benefits from the consideration of exchange rates (Garcia et al., 2011).

On the contrary, Torres (2003) argues that an augmented Taylor rule is of limited use. If exchange rates are strongly related to inflation and output, their inclusion may not be necessary because inflation and output already capture the inflationary pressure of exchange rate changes. On the other hand, there is no need for the appearance of exchange rates if they no effect of inflation or output. Granville and Mallick (2010) argue that high inflation happens in Russia because of the intention to target the exchange rate.

2.5.1.3. Empirical evidence for the exchange rate matter

Bjørnland and Halvorsen (2014) used a SVAR model to investigate whether exchange rates matter in six developed countries: Australia, Canada, New Zealand, Norway, Sweden, and the UK. Using both sign and zero (short-term) restriction, they find that there is a contemporaneous interaction between monetary policy and exchange rates in all countries but Australia and the UK. Particularly, a one-percent depreciation of exchange rates leads to a 10–30 basic points increase in interest rates. This indicates the offsetting response of monetary policy to exchange rate changes. Nevertheless, monetary policy does not respond to exchange rates in Australia and the UK. Dybowski et al. (2018) use a TVP-BVAR model to assess whether exchange rates play different roles over time in Canada. They find that after a long period of continuous reduction, exchange rates regain their importance by the onset of the recent Global financial crisis. Furthermore,

they emphasize that the augmented Taylor rule well captures the interest rate dynamics from the mid-1990s only. Demir (2014) uses various methods (OLS, IV, VAR) and finds that the ECB concerns about the exchange rate movement. Particularly, a 1-point appreciation leads to a rise of 20 basis point in the interest rate. However, Demir (2014) emphasises that the quantitative effect of exchange rate changes is too small to conclude their matter in the reaction function of monetary policy.

Since 2000s, there is increasing evidence about the matter of exchange rates in the conduct of monetary policy in emerging economies. Minella et al. (2003) investigate this problem in Brazil by using both yearly and monthly changes in the bilateral exchange rates. They find that only yearly changes are significant. Accordingly, interest rate adjustments accommodate rather than counter the exchange rate movement. In addition to this, the appearance of exchange rates causes the estimated coefficient on output gap to become insignificant, suggesting that external shocks have a significant effect on the domestic economy. Sánchez-Fung (2011) also support the accommodating response of monetary policy in Brazil by using an ADL model with twelve lags. They find evidence for the negative response of interest rates to yearly changes in the nominal exchange rate changes. This means that an appreciation leads to an increase rather than a decrease in interest rates. On the contrary, Furlani et al. (2010) use a VAR model to take into account the contemporaneous interaction between monetary policy and exchange rates and find opposite evidence for Brazil, whereby the interest rate response is consistent with the anti-inflation preference, a basic characteristic of the inflation targeting.

Hammermann (2005) uses VAR models to investigate the same issue for Poland and Chile. The study finds that there is a break in the response of interest rates to exchange rates in Poland. In this economy, an appreciation leads to an immediate reduction in interest rates during the period 1992-1998. From 1998 to 2002, an appreciation causes interest rates to reduce only in the medium run, suggesting that exchange rates are not as important as the previous period. In Chile, however, there is no break. An appreciation increases interest rates only from the fifth month, suggesting that monetary policy prefers to smooth the movement of exchange rate. Civcir and Akçağlayan (2010) also use the VAR model to investigate how exchange rate gap affects interest rate setting in Turkey before and after the crisis in 2001. They find that the response of interest rates is different between two periods. A positive depreciation gap is answered by a reduction in the interest rate in the first period and by an increase in the second period. This implies that

the intervention policy is consistent with the inflation targeting in Turkey in the following period. Furthermore, after the crisis, exchange rates become the main driving force of interest rate changes in Turkey. Using a similar method, Granville and Mallick (2010) investigate an augmented Taylor rule in Russia during the period 1995-2009. The results show that exchange rates are a determinant of interest rates. However, they emphasize that exchange rate targeting is a possible explanation for the failure of reducing double-digit inflation in Russia. Lueangwilai (2012) uses a Bayesian model to investigate the case of Thailand from June 2000 to June 2011. The author finds that the Bank of Thailand mainly focuses on stabilizing inflation and the focus on exchange rates is weaker than that on output.

It is apparent that the existing literature on the exchange rate matter is mainly on a case-by-case basis. Only a few empirical studies conduct a comparative analysis for a group of countries. Aizenman et al. (2011) use the LSDV method to investigate a panel of 16 emerging economies. They find evidence for the importance of exchange rates. Particularly, the exchange rate effect in inflation-targeting countries that export basic commodities has a similar size with that in non-inflation targeting countries. In other inflation-targeting countries, exchange rates have a weaker effect on interest rates. They also note that exchange rates are an objective of monetary policy beyond price stability.

Unlike Aizenman et al. (2011), others use time-series models to show a comparative results for emerging economies. Mohanty and Klau (2005) use a GMM model to estimate an open economy interest rate rule for 13 emerging economies. They find that interest rates strongly react to exchange rates in most emerging economies. In some economies, the response to exchange rates is larger than that to inflation or output gap. Such a finding may stem from either the persistence of exchange rate shocks or the preference of the central bank to the exchange rate stabilization. Yilmazkuday (2008) studies the reaction function for three Eastern European countries: Czech Republic, Hungary, and Poland. The author finds evidence for the matter of exchange rates in these countries. Remarkably, in Hungary, monetary policy responds to only exchange rates over the period January 1994 to June 2007 and respond to inflation and foreign interest rates in some subperiods. On the other hand, in Czech Republic and Poland, monetary policy responds to exchange rates as well as other variables. Frömmel et al. (2011) apply the cointegration approach to investigate whether monetary policy places a significant weight on exchange rates in six Central and Eastern European countries. They find

evidence that the role of exchange rates is diminishing in most countries excepting for Slovakia where exchange rates remain their significance.

Peters (2016) uses maximum likelihood estimation to investigate four emerging economies (South Africa, Indonesia, Mexico, and Thailand) and finds mixed evidence for the fear of floating over the period from 1980s to 2007. Particularly, the fear of floating does not emerge for South Africa and Mexico. By contrast, interest rates show an increase in the response to a real depreciation pressure in Indonesia and Thailand. According to Peters (2016), the fear-of-floating is strong in Indonesia and Thailand because these countries are more open than South Africa and Mexico. Caporale et al. (2018) use the GMM method to investigate the augmented Taylor rule in five emerging economies, including Indonesia, Israel, South Korea, Thailand, and Turkey. They make two extensions into the conventional Taylor rule: adding exchange rates and allowing the nonlinearity with respect to inflation. They find the significant role of exchange rates in the regime of low inflation, suggesting that in emerging economies there is a comfort zone to smooth the exchange rate movement (Mohanty and Berger, 2013; Ghosh et al., 2016). They also note that compared to a linear Taylor rule, an augmented nonlinear Taylor rule is better to capture the interest rate dynamics in these countries. Shrestha and Semmler (2015) use an ARDL model to examine five East Asian countries (Malaysia, Korea, Thailand, Indonesia and Philippines). They conclude the superiority of the augmented rule since it can account for financial instability. However, exchange rates play a significant role in only Thailand and Philippines.

Furthermore, much less evidence on the nonlinear response of interest rates to exchange rates is available for emerging economies. Cermeño et al. (2012) provide evidence for the fear of depreciation in Mexico by observing the squared and cubic term of real exchange rate changes. Using the GMM method, they find that monetary policy response is especially strong when the peso value loses and moves far from its long-term trend. On the other hand, there are many incentives for monetary authorities to avoid an appreciation. To avoid a loss in the competitiveness, exporting-oriented countries are not willing to allow their currencies to appreciate. Using a similar approach as Cermeño et al. (2012) and a dummy for the Global financial crisis, Keefe and Shadmani (2018) argue that interest rate response ties to the fear of appreciation rather than depreciation in emerging economies, even during the Global financial crisis.

In summary, while there is increasing evidence about the response of monetary policy to exchange rate changes in emerging economies, few studies conduct a comparative study about this problem. Furthermore, there is a dearth of studies examining the asymmetric effect of exchange rates on the setting of interest rates. Finally, most of previous studies emphasize on a specific measure of exchange rate changes. However, it is likely that the choice of exchange rate indicators can affect the interpretation about the role of exchange rates in emerging economies.

2.5.2. The role of foreign exchange intervention

2.5.2.1. What is forex intervention?

Exchange rates are the ratio that is used to exchange one currency for other currency. It is considered as one of the most important prices in the era of globalization, especially for emerging economies. Besides, there are many economic reasons to manage exchange rates (Menkhoff, 2013). First, changes in exchange rates affect export and thus growth. Second, exchange rates can directly affect inflation through the effect on import price. Third, exchange rate volatility can also affect risk premia.

To manage exchange rate volatility, monetary authorities can use interest rates or foreign exchange intervention. Foreign exchange intervention involves the trade of foreign reserves in the foreign exchange market, which can influence the fluctuation of exchange rates (Neely, 2005). The purchase (sales) of foreign currency can lead to an increase (decrease) in money supply, which reduces (increases) interest rates.

Monetary authorities can conduct sterilization to mitigate or offset the effect of foreign exchange intervention on monetary policy indicators. The sterilization occurs when monetary authorities use domestic bonds to reverse the intervention effect on monetary base and interest rates. Both trading central bank securities and reserve requirements can be applicable tools of sterilization (Rossini et al., 2013). The effect of sterilized actions on money supply or interest rates can be complete or partial. On the other hand, unsterilized interventions do not require the central bank to participate in the bond market to offset the effect of the intervention, thereby money supply, interest rates and prices will change. According to Craig and Humpage (2001), open market operations and unsterilized interventions have similar effects, implying that unsterilized interventions may not be necessary.

The effectiveness of foreign exchange intervention depends on two primary channels: signalling and portfolio balance effect. Firstly, the signalling channel involves

the predictability of the intervention about the future stance or adjustment of monetary policy. The effectiveness of this channel varies according to the transparency of the intervention policy. The more the public can access and evaluate the intention of the intervention, the more effective this channel is. Secondly, the portfolio balance channel involves the effect of the intervention on the supply and demand of assets. The significance of this channel may not accompany with the sterilization effort.

2.5.2.2. The relevance of forex interventions in emerging economies

Foreign exchange intervention is a popular policy to maintain the movement of exchange rates in a desired or expected range. In fact, the frequency of foreign exchange intervention is high in emerging economies such as Turkey and Mexico (Domaç and Mendoza, 2004), Latin America (Chang, 2008; Humala and Rodríguez, 2010; Villamizar-Villegas, 2016; Hansen and Morales, 2019), and Central and Eastern European countries (Sideris, 2008; Krizek and Brcak, 2021). The regime of floating exchange rates does not prevent the frequent adjustment of foreign reserves (Calvo and Reinhart, 2002). In fact, foreign exchange intervention is common under both inflation-targeting and non-inflation-targeting regimes (Adler et al., 2021). In Peru, monetary authorities can apply official interventions in the foreign exchange market (Humala and Rodríguez, 2010). According to Chang (2008), Latin America economies are active in accumulating the official reserves because of their concern about the speculative attack on the domestic currency. Chen and Lin (2019) suggest that emerging economies care about depreciation pressures and favour the accumulation of reserves. Mundaca (2018) has a similar argument for Peru. Monetary authorities in emerging economies concern about domestic competitiveness and thus experience the fear of appreciation, especially during the period of strong economic expansions (Levy-Yeyati and Sturzenegger, 2007).

In emerging economies, foreign exchange interventions can be conditional on the fear of floating that stems from many factors such as dollarization (Rossini et al., 2013; Mundaca, 2018), public foreign-currency borrowing (Dudzich, 2020), the shortage of international liquidity in crises, the high pass-through effect of exchange rates on domestic inflation, the problem of low credibility (Calvo and Reinhart, 2000; Caballero and Krishnamurthy, 2001; Calvo and Reinhart, 2002; Domaç and Mendoza, 2004; Akinci et al., 2006; Chang, 2008), the high degree of financial and real vulnerabilities (Cavoli, 2009), or commodity-orienting export. Akinci et al. (2006) emphasize that inflation-targeting countries have more incentive to intervene in the foreign exchange market when

exchange rate volatility increases inflation volatility. Furthermore, exchange rate appreciations can lead to an increase in the political pressures that require monetary authorities to accumulate foreign reserves to depreciate the exchange rate. Foreign reserve accumulation also works as a buffer against the obligation of international short-term debts, which is of importance to prevent financial crisis stemming from the low accessibility of international funds. According to Chang (2008), foreign exchange intervention is a useful tool to achieve other objectives beyond price stability. Faltermeier et al. (2022) state that increasing international reserves is an optimal policy to deal with a commodity boom in a small and open economy. They also note that the effect of monetary policy is less pronounced than foreign exchange intervention because the former is ineffective to address learning-by-doing externalities.

Foreign exchange intervention can help stabilise exchange rates under inflation targeting, especially during the crisis period. Domaç and Mendoza (2004) apply autoregressive conditional heteroscedasticity models to examine the effectiveness of foreign exchange intervention in Mexico and Turkey and suggest that the intervention of different size and frequency can stabilize the exchange rate movement. However, their study documents the asymmetric effect of the intervention, which favours the sales of the US dollar. Yilmazkuday (2007) investigates the case of Turkey by a calibration analysis and suggests the benefit of the regime of managed floating exchange rates under inflation targeting. Compared to other frameworks, flexible inflation targeting achieves the minimum welfare loss in Turkey. Roger et al. (2009) support that foreign exchange intervention can lead to a smooth movement of exchange rates. They argue that the intervention policy can minimize the welfare loss since it can mitigate the negative effect of volatile exchange rates on economic activity. Sideris (2008) applies Johansen analysis and finds that foreign exchange intervention is a useful policy to achieve exchange rate stability in six Central and East European countries (Bulgaria, Poland, Romania, Russia, Slovenia, and Ukraine). Villamizar-Villegas (2016) argue that Colombian monetary authorities can use both interest rates and foreign exchange intervention to manage exchange rates. They find that the intervention policy is effective to stabilise exchange rates but it has an insignificant effect on exchange rate changes. Berganza and Broto (2012) apply a panel analysis for 37 emerging economies and conduct a comparison between inflation targeting and non-inflation targeting groups. They find that foreign reserves negatively affect exchange rate volatility, especially in the crisis. They also find that the adoption of inflation targeting increases exchange rate volatility but the

intervention, especially sales of foreign reserves, is effective to stabilise exchange rate. Humala and Rodríguez (2010) use the Markov switching GARCH model to investigate regimes of foreign exchange intervention. They find that the intervention is more effective when exchange rates are highly volatile. Blanchard and Adler (2015) consider the effect of capital flows on the relationship between monetary policy and foreign exchange intervention. They use a sample of 35 emerging economies and find that the intervention can reduce the appreciation pressure of gross capital inflows on domestic currency.

However, foreign exchange intervention is found to be less effective in other studies. Guimarães and Karacadag (2004) find that foreign exchange intervention has different, even opposite, effects on the level and volatility of exchange rates in Mexico and Turkey. While the intervention decreases exchange rate volatility in Turkey, it increases the latter in Mexico. Recently, Mundaca (2018) find that foreign exchange intervention cannot mitigate large jumps in the exchange rate in Peru. Under inflation targeting, the intervention can confuse the public about the priority of monetary authorities, thereby twisting the market expectations. The distortion is particularly high when there is low consistence between monetary and exchange rate policy. Minella et al. (2003) argue that increasing the transparency of the intervention policy is useful to prevent the misunderstanding. Hence, the empirical evidence suggests that monetary authorities in emerging economies should be cautious when conducting interventions in the foreign exchange market (Guimarães and Karacadag, 2004). Krizek and Brcak (2021) find the positive effect of foreign exchange intervention on exporting in the case of the Czech Republic. However, they note that such an effect is asymmetric, whereby it is more pronounced in certain exporting sections.

Furthermore, the effect of foreign exchange intervention can be asymmetric with respect to the type of interventions. Sales and purchase of foreign reserves have different effects on exchange rates. Égert and Komárek (2006) use the GARCH(1,1) model and document the asymmetric effect of the intervention in Czech Republic over the period 1997 to 2002. They find that foreign reserve purchases can depreciate the koruna whereas sales intervention is associated with a deprecation rather than an appreciation of the koruna. Akinci et al. (2006) conduct both an event and time-series study for Turkey and conclude that the purchase intervention is more effective. On the other hand, Domaç and Mendoza (2004) and Guimarães and Karacadag (2004) support the effectiveness of the

sales of foreign reserves in Turkey and Mexico respectively. In these countries, sales intervention can appreciate domestic currency whereas purchase interventions cannot counter appreciation pressure. Banerjee et al. (2018) also provide evidence favouring the effectiveness of the sales interventions in Slovakia. Rishad and Gupta (2019) apply the GARCH(1,1) model for India and find that sales intervention is effective to prevent appreciation pressures whereas purchase intervention is not effective to prevent the depreciation. The higher effectiveness of sales intervention may stem from the effort to mitigate the effect of depreciation on domestic prices, which affect the fulfilment of inflation targets. Rakhmad and Handoyo (2020) conduct GARCH regression for Indonesia and find that the purchase and sales of USD have asymmetric effect on exchange rate volatility. While purchase intervention causes exchange rates to be more stable, sales intervention causes the latter to be more volatile.

2.5.2.3. Foreign exchange, intervention, and monetary policy

In emerging economies, monetary authorities cannot neglect the movement of exchange rates when setting monetary policy. In fact, they often reserve the right to intervene in the foreign exchange market when exchange rates deviate from its fundamental value. There are several channels linking foreign exchange intervention and monetary policy. To begin with, the intervention can affect money creation through commercial bank reserves and credit expansion (Ponomarenko, 2019). As noted by Ponomarenko (2019), reserve accumulation has a positive effect on money stock despite of the fact that monetary authorities conduct sterilization to stabilize the movement of interest rates and money supply. In fact, the effect of sterilization is not immediate, implying that it requires time to realize the effect of the sterilization effort on interest rates. The mechanism of this channel is quite simple. When monetary authorities purchase foreign currencies in the foreign exchange market, commercials banks reduce an equal amount of foreign assets in their balance sheet. Since commercial banks cannot completely compensate this reduction, their reserves tend to increase, which promotes the supply of credit to individuals and enterprises. This means that a portion of the intervention moves to the non-banking sector, which suggests an inflow of funds and an increase in money supply. Furthermore, imperfect sterilization can have an indirect effect on credit expansion through a decrease in the interbank interest rate.

Finally, signalling channel establishes the third bridge connecting foreign exchange intervention with monetary policy (Kaminsky and Lewis, 1996; Fatum and

Hutchison, 1999). This channel is conditional on the assumption that monetary authorities have more information than market participants (Akinci et al., 2006). Once the intervention is undertaken, market participants can perceive that there is a misalignment in the exchange rate and thus monetary policy may change to recover the equilibrium, thereby motivating market participants to revise their expectation about the future course of monetary policy. However, it should be noted that the signalling channel weakly works when the intervention is implicitly or secretly undertaken. In this case, new information cannot reach the market. Another situation weakening the signalling channel is that monetary authorities provide an oral intervention as expected by the market.

Although monetary policy and foreign exchange intervention are highly likely to be interrelated, the literature on that relationship is scant, especially for emerging economies. According to Ho and Yeh (2010), monetary authorities can establish a restrictive stance by reducing the stock of foreign reserves while maintaining the current level of the interest rate. Kim (2005) conducts a study for Canada and finds that the intervention reduces the effect of monetary policy on exchange rates, which explains the problem of delayed overshooting. Therefore, the intervention lengthens the appreciation of exchange rates following a monetary policy contraction. Aizenman et al. (2011) analyse the Taylor rule in emerging economies with the augmentation of foreign reserves. They find the significant effect of foreign reserves on interest rates in emerging economies that do not follow the inflation targeting.

2.5.3. Asymmetries in the reaction function of monetary policy

2.5.3.1. Sources of asymmetries

The interest rate rule proposed by Taylor (1993) has established a long-lasting standard for the analysis of monetary policy. The Taylor rule plays a role in solving the problem of time inconsistence in the conduct of monetary policy. Accordingly, monetary policy setting closely links to economic movements. Particularly, interest rates proportionally respond to output and inflation gap, which are deviations of the two from their benchmark levels. In this rule, policymakers consider inflation and output gap equally important. Clarida et al. (1998; 1999; 2000) and Svensson (1997; 1999) noted that interest rate adjustments can stabilise the economy when these adjustments are greater than changes in inflation and are positive in response to output gap. This is referred to as the Taylor principle. Its violation implies that monetary policy destabilises or accommodates shocks.

Following studies suggest some modifications to the linear Taylor rule. Clarida et al. (2000) argue that monetary authorities are proactive and monetary policy decisions depend on the forecast of output and inflation. Forecasting plays an important role to deal with uncertainty and delay in making policy decisions (Svensson, 1997; Svensson, 1999). Many studies support the forward-looking specification of the Taylor rule (Minella et al., 2003; Minella and Souza-Sobrinho, 2013). Another modification is to consider the intention to smooth the interest rate movement (Moura and de Carvalho, 2010). Such a smoothing behaviour can stem from either the dislike of market participants for large jumps or sudden reversals in interest rates or the uncertainty related to the true analysis model and released data (Sack and Wieland, 2000).

Nevertheless, the linear economic underlying and quadratic loss function may be too restrictive to capture the complexity in the practical implementation of monetary policy. Recent studies point out that positive and negative shock of inflation and output gap may not be equally important in the Taylor rule. Moreover, inflationary pressure can be different in recessions and expansions. Briefly, both a nonlinear Phillips curve and an asymmetric preference can lead to the asymmetry or nonlinearity in the Taylor rule.

To begin with, the Phillips curve developed by Phillips (1958) is a useful tool to analyse the trade-off between output gap and inflation. Its shape has crucial implications for monetary policy conduct because it shows disinflation costs. Conventionally, the Phillips curve is linear, implying the constant cost of reducing inflation. The optimization problem of a linear Phillips curve and quadratic loss function has the solution that monetary policy rule puts equal weights on inflation and output gap.

According to McLeay and Tenreyro (2020), a linear New Keynesian Phillips curve can be represented as follows:

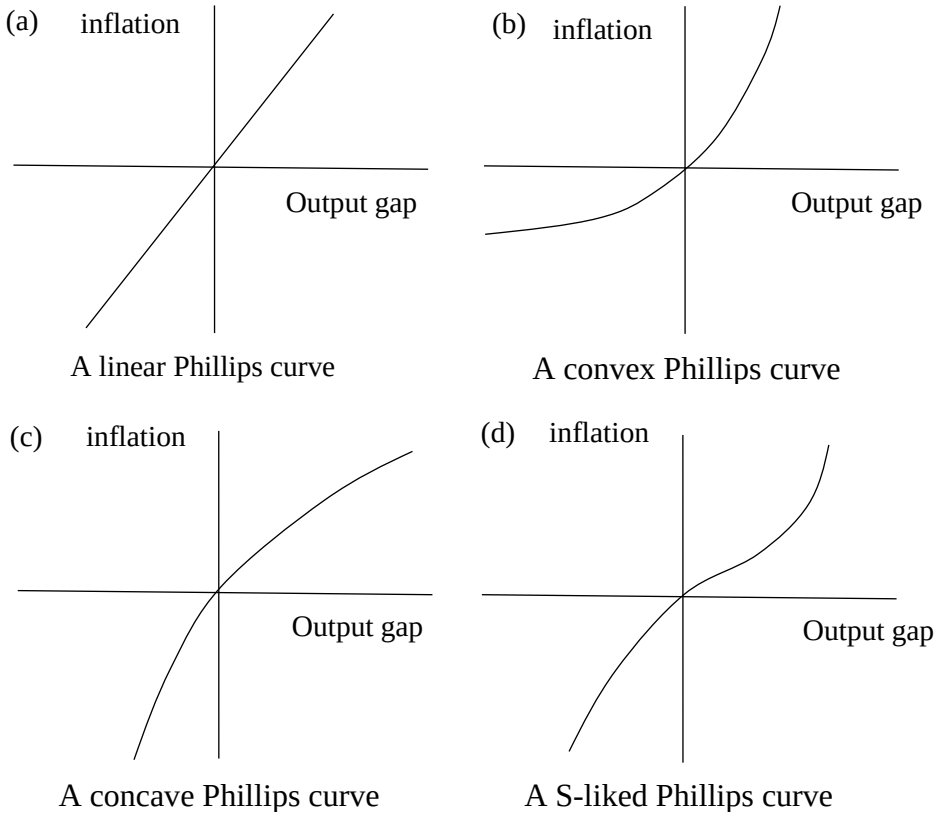
$$\pi_t - \pi_t^* = \beta(\pi_{t+1} - \pi_{t+1}^*) + \kappa y_t + u_t \tag{1}$$

where $\pi_t - \pi_t^*$, namely inflation gap, is the difference between inflation π_t and its target π_t^*. y_t is the output gap, which is the deviation of output from its potential. u_t is the production shock or cost-push shock.

Later works show that there are three other possible shapes (see Figure 2). The Phillips curve can be convex because of price downward rigidity, capacity constraint, menu costs (Ball and Mankiw, 1994; Dotsey et al., 1999), signal extraction (Lucas, 1973), or money illusion problem in low inflationary environment (Akerlof et al., 1996). In this

case, a positive inflation shock accelerates price increases. Once inflation is high, it is costly to reduce it. As a result, monetary authorities show a disinflation bias. On the contrary, the Phillips curve can be concave, though it is less popular in the literature, when monopolistic firms are more willing to decrease prices in times of weak demand to avoid takeover threats (Stiglitz, 1997). The concavity indicates high cost of increasing domestic prices. Another possibility is a hybrid Phillips curve that combines convex and concave parts (Baghli et al., 2007). In summary, a convex (concave) Phillips curve indicates the severity of inflationary pressure caused by a positive (negative) output gap shock and thus monetary policy response to inflation should be more powerful in expansions (recessions) (Dolado et al., 2005). Using dynamic optimization, Schaling (2004) suggests that an asymmetric monetary policy rule is optimal when the Phillips curve is convex.

Figure 2: Possible shapes of the Phillips curve



Source: Author's construction

Another driver of an asymmetric Taylor rule is the asymmetric preference of monetary authorities to a positive and negative shock of output and inflation gap. The asymmetric preference has two implications. On one hand, monetary authorities are reluctant to reduce inflation when facing political heating (Blinder, 1998; Persson and

Tabellini, 1999). In fact, career-concerned policymakers react more forcefully to stimulate the economy when expecting an output contraction (Surico, 2007; Sznajderska, 2014). These support the recession avoidance preference. On the other hand, monetary authorities can be averse to high inflation especially when they concern about the credibility construction in the regime of inflation targeting (Sznajderska, 2014). Therefore, deflationary bias is a necessary condition to fulfil the price stability objective. Relying on the preference of monetary authorities, Cukierman and Muscatelli (2008) indicate that monetary authorities can show a bias to avoid inflation or recession.

2.5.3.2. Empirical studies of asymmetries in the Taylor rule

There are many studies investigating the asymmetry or nonlinearity of monetary policy that is conditional on a nonlinear Phillips curve or an asymmetric preference for advanced economies. Dolado et al. (2005) investigate the effect of the nonlinear Phillips curve in the US and three European countries by adding the interaction between output gap and expected inflation into the traditional Taylor rule. They find that monetary policy strongly reacts to inflation in expansions. The positive value of the interaction coefficient implies that the asymmetric Taylor rule is conditional on a convex Phillips curve. By contrast, a symmetric rule is found for the US. Schaling (2004), however, documents that monetary policy is asymmetric in the US, characterized by a greater inflationary pressure in expansions than in recessions.

Caglayan et al. (2016) investigate the case of the UK and Canada over the period 1883 to 2007. Based on a linex loss function, they add the square of inflation and output volatility into the traditional Taylor rule. They find that the preference is different in these countries. While inflation avoidance is strong in the UK, recession avoidance is strong in Canada. Using a similar approach, Dolado et al. (2004) augment the conditional variance of inflation to investigate the asymmetric preference to inflation in the US from 1970 to 2000. Their results emphasise the inflation avoidance preference. Surico (2007) applies the linex function for both inflation and output gap and suggests that the asymmetry of the Taylor rule can be examined by observing the squared value of inflation and output gap volatility. The GMM estimates show that the Fed puts a greater weight on negative output gaps, implying the fear of recession.

In addition to using a linex loss function, many other studies use threshold models to examine the implication of asymmetric preferences. Bec et al. (2002) use this method to investigate the asymmetric Taylor rule for US, France, and Germany. They find that

monetary authorities in the US and Germany are averse to inflation only in expansions whereas the Bank of France strongly responds to inflation in recessions. Cukierman and Muscatelli (2008) use smooth transition regressions and find evidence for the asymmetric preference in the UK and US. In the UK, recession avoidance dominates in the period prior inflation targeting but inflation avoidance dominates afterwards. In the US, the preference is time-varying. Aguiar and Martins (2008) study the asymmetric preference to inflation, output, and interest rates and find the relevance of the inflation avoidance preference. Particularly, monetary authorities in the Euro area put a weight of double size on the inflation rate above 2 percent. Tawadros (2016) uses a dummy that indicates recessions and expansions to investigate the asymmetric Taylor rule in Australia. The author finds that the monetary policy rule is asymmetric, owing to an asymmetric preference rather than a nonlinear Phillips curve. However, it should be noted that the asymmetry with respect to inflation gap, output gap, or both depends on the measure of inflation. Recently, Tawadros (2020) uses the inflation rate differential as a threshold variable and finds that monetary policy response is strong in the period of low inflation or recessions. Komlan (2013) investigates the case of Canada and finds that monetary policy is more averse to a positive inflation gap.

In contrast to the vast literature for developed countries, little is known about the effect of a nonlinear Phillips curve and an asymmetric preference on the Taylor rule in emerging economies. Aragón et al. (2016) find that in Brazil there is a deflationary bias when the economy is quickly expanding. The finding implies that the asymmetric rule is driven by a convex Phillips curve. On the other hand, Aragón and de Medeiros (2013) argue that monetary policy in Brazil can be asymmetric due to the asymmetric preference. They find evidence for the deflationary aversion in the period prior mid-2003 and inflation aversion afterwards. Sznajderska (2014) uses the threshold model to investigate whether the asymmetric Taylor rule in Poland stems from either an asymmetric preference or a nonlinear Phillips curve. The empirical results indicate that the interest rate response is stronger to a positive inflation gap but is weak to a positive output gap. Kobbi and Gabsi (2019) conduct a similar study for Tunisia. The Taylor rule includes additional variables that capture the effect of two drivers. The empirical results indicate that the asymmetric preference is the main driver of an asymmetric policy rule in Tunisia. While deflationary avoidance dominates the period prior 2011, recession avoidance appears after 2011 only.

Furthermore, there is a dearth of studies conducting a comparative analysis for a group of emerging economies. Vašíček (2012) focuses on Czech Republic, Hungary, and Poland. Observing the interaction term between inflation gap and output gap, the study finds weak evidence for the asymmetry driven by a nonlinear Phillips curve in Czech Republic. To investigate the implication of an asymmetric preference, Vašíček (2012) uses both the square of variables (inflation gap, output gap, or interest rate gap) and threshold models. The study finds that inflation avoidance is visible in Czech Republic and recession avoidance is dominant in Hungary. Klose (2019) conducts a similar study for five Eastern European countries. The study examines the asymmetric Taylor rule by observing the squared value of inflation and output gap in four regimes of output and inflation gap. The evidence is mixed for five countries. Particularly, both recession and inflation avoidance are visible in Poland only and deflationary avoidance appears in other countries. The study also suggests that the asymmetry depends on the state of the economy.

2.6. Summary

Table 1 shows how the existing literature related to the hypothesis 1 to 5. It presents both theoretical and empirical justifications about the indicator as well as identification problem of monetary policy for emerging economies that follow inflation targeting. While the literature for the hypothesis 1 and 2 is primarily based on the analysis of Poole (1970), the literature for hypothesis 3 to 5 is based on the Taylor (1993) rule, its application, and small and open theories.

Table 1: Hypotheses and literature review

Section	Hypothesis	Contributions
2.4.1 2.4.2	1	• Poole 1970 analysis about the role of money supply and interest rates as an indicator of monetary policy • Issues emerge when apply the consensus of Poole 1970 for emerging economies • Empirical studies in advanced and emerging economies
2.4.3	2	• The origin and functions of MCI • The emphasis of MCI as an indicator of monetary policy and its construction
2.5.1	3	• The fear of floating and the necessity of the inclusion of exchange rates in the Taylor rule • Empirical studies about the role of exchange rates in emerging economies
2.5.2	4	• The definition and transmission channels of foreign exchange intervention • The relevance of foreign exchange interventions in emerging economies • The role of the foreign exchange intervention in the conduct of monetary policy
2.5.3	5	• Nonlinear Phillips curve and asymmetric preference as theoretical justifications for potential asymmetries in the Taylor rule • Related empirical studies and its gap

Source: Author's construction

CHAPTER 3: METHODOLOGY AND DATA

3.1. Introduction

Indicator and identification problem involves two primary aspects of monetary policy conduct. While indicator problem refers to the choice of a representative measure of monetary policy, identification problem refers to the construction of a function that can approximate the behaviour of the central bank. To put it differently, to solve the indicator problem, we need to identify a variable that can provide numeric information about changes in the stance of monetary policy. The existing literature show that interest rates are the best measure of monetary policy (Bernanke, 1990a) and many studies conduct monetary policy analysis based on such a prior (Furlani et al., 2010; De Mello and Moccero, 2011; Sánchez-Fung, 2011; Cermeño et al., 2012; Jawadi et al., 2014). However, in practice, monetary authorities in emerging economies rely on other instruments beyond interest rates in the conduct of monetary policy, which questions the relevance of the consensus of Bernanke (1990a). Since there is no consensus about the best measure of monetary policy in emerging economies that follow inflation targeting, the thesis makes a critical contribution to the existing literature by filling this gap.

With respect to the identification problem, it is of importance to characterise and simplify the complexity in the reaction of monetary authorities to changes in economic activities. The interest rate rule developed by Taylor (1993) provides a simple framework to analyse the behaviour of monetary authorities. Accordingly, the Taylor rule assumes that a simple function of interest rates in term of inflation and output gap can capture the majority of information about monetary policy changes. However, monetary authorities in emerging economies are vulnerable to international shocks because of their small size and openness. Therefore, a proper augmented Taylor can provide a better approximation of the reaction function of monetary policy for emerging economies (Yilmazkuday, 2008; Shrestha and Semmler, 2015; Peters, 2016; Caporale et al., 2018) .

Table 2: Hypotheses and methodology

Section	Hypothesis	Methodology
3.2.1; 3.2.2;	1	• Granger causality can examine whether a monetary policy indicator can forecast the movement of inflation.
3.2.3	2	• Forecast error variance decomposition can assess the strength of a monetary policy indicator as a driving force of inflation variation. • Impulse response function identifies the evolution of inflation after a shock of a monetary policy indicator.
3.3.1	3	• Examine both linear and nonlinear effect of exchange rate • Use the crisis dummy to examine the effect of global financial crisis 2007 on the role of exchange rates. • Use the square of exchange rate deviation to examine the presence of the fear of appreciation or fear of depreciation. • Examine the sensitivity of the results to various measures of exchange rate changes.
3.3.2	4	• Use foreign reserves as a proxy for foreign exchange intervention. • Classify foreign reserves into sales and purchase intervention to examine the asymmetric effect of foreign exchange intervention.
3.3.3	5	• Apply the method of Dolado et al. (2005) to investigate whether the asymmetry of Taylor rule is caused by a nonlinear Phillips curve. • Apply the method of Caglayan et al. (2016) to examine whether the nonlinear Taylor rule is caused by the asymmetric preference of monetary authorities.

Source: Author's construction

Table 2 presents how the thesis answers the hypothesis from 1 to 5. First, to deal with the indicator problem, it is of importance to identify the bond between a monetary policy indicator and monetary policy objective. Since the thesis focuses on a sample of emerging economies that follow inflation targeting, the monetary policy objective is inflation. In the thesis, we use Granger causality, impulse response function, and forecast error variance decomposition to examine the strength of the relationship between a monetary policy indicator and inflation. For estimation, we use the VAR model, which is popularly used in the existing literature. Second, to deal with the identification problem, we apply the Taylor rule and make critical modifications that can account for the institutional differences of emerging economies. For estimation, we use the GMM method to deal with the problem of endogeneity, autocorrelation and heteroskedasticity. Third, besides the baseline estimations mentioned above, we also relax the stationarity condition and apply ARDL models as a robustness test. Furthermore, adding a time dummy is of importance to control for the effect of structural breaks.

3.2. Measuring the effectiveness of a monetary policy indicator

This section discusses the methodology that can identify the significance of various indicator of monetary policy, which contributes to solve the hypothesis 1 and 2:

- Hypothesis 1: Interest rates and money supply contain comparable information about changes in monetary policy.
- Hypothesis 2: MCI is a useful indicator of monetary policy in emerging economies.

This thesis compares the performance of monetary policy indicators in emerging economies through the analysis of Granger causality and the impulse response of policy objective variables to shocks of monetary policy indicators (Bernanke and Mihov, 1998). Such an analysis indicates the strength of the linkage between indicators and the objective of monetary policy, which is in line with Atkeson et al. (2007).

To begin with, a scalar variable is an appropriate indicator of monetary policy if it causes changes in the objective of monetary policy. Granger causality test can be considered as a selection device to determine the causality between variables (Handa, 2009). In this thesis, since the sample consists countries that adopt inflation targeting, the Granger causality analysis between monetary policy indicators and inflation is of importance to capture the significance of these indicators as an overall measure of monetary policy.

Furthermore, a measure of monetary policy is more appropriate if it causes inflation to change according to the prediction of monetary theories and explains a greater proportion of inflation variation. In this respect, the absence of the price puzzle (a phenomenon in which inflation shows an increase rather than a decrease after a contraction in monetary policy) provides critical evidence for the effectiveness of a variable as an indicator of monetary policy. In addition, FEVD can indicate whether a monetary policy indicator is a driver of inflation variation.

3.2.1. Granger causality analysis

A monetary policy indicator is effective when it is a predictor for changes in the economic objective. Following Sun and Ma (2004), a monetary policy indicator is effective to control prices/output if it Granger causes prices/output. On the contrary, an indicator is endogenous if there is a statistically significant Granger causality running from prices/output to the indicator. In this thesis, the analysis focuses on how a monetary policy indicator Granger causes inflation.

The thesis examines the Granger causality from money supply and interest rates to inflation by using the augmented Granger test of Toda and Yamamoto (1995) because of the fact that variables under investigation are unlikely to be stationary at the same level. Another reason is to easily compare the results when considering many countries at the same time.

Granger (1969) causality test is a pioneering method for determining whether a variable is useful to forecast the movement of the other variable. Its VAR representation is:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + ... + \beta_p Y_{t-p} + \varepsilon_t \quad (2)$$

where Y_t is a bivariate vector and ε_t is white noise. Since the thesis examines the Granger causality between instruments and inflation, Y_t includes inflation and a monetary policy instrument, which can be either interest rates or monetary aggregates.

Although the VAR model is popular, it needs to satisfy the stability conditions. If there exists integration and cointegration between variables, the standard distribution of the Wald test in the VAR model may be violated. To overcome this issue, Toda and Yamamoto (1995) suggests adding the maximum integration order d into the lag of the standard VAR(p) as specified in Granger (1969). The next step is to estimate the VAR system using the augmented lag $p + d$ and then implement Granger test with lag p. The

VAR representation of the augmented Granger causality test is:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots + \beta_{p+d} Y_{t-p-d} + \varepsilon_t \quad (3)$$

3.2.2. Impulse response analysis and forecast error variance decomposition

According to the existing literature, interest rates and money supply can represent the overall changes in monetary policy. We use a VAR model to investigate the effect of monetary policy indicators on inflation. The lag lengths are selected by the Akaike Information Criterion criteria (AIC). The VAR model consists of four endogenous variables:

$$Y=[DLCPI \quad DLY \quad DLEX \quad POLICY] \quad (4)$$

where DLCPI, DLY, and DLEX are the first difference of the logarithm of consumer price index, industrial production index, and exchange rates respectively. POLICY is the set of monetary policy indicators, including IR, DLM1, and DLM2 that are money market interest rates and the first difference of the logarithm of money supply M1 and M2 respectively. The inclusion of exchange rates is of importance to capture the small and open nature of emerging economies.

The effect of money supply and interest rates on inflation can be investigated through the impulse response function and FEVD. While impulse response function indicates the direction and size of monetary policy effect on inflation, FEVD shows the importance of various indicators of monetary policy as a source of inflation variation.

It should be noted that the VAR model is recursive with the ordering in Equation (4). As shown in Equation (4), one variable shows a contemporaneous response to previous ones whereas it shows a lagged response to the following variables. Accordingly, a policy variable (e.g., interest rate) shows an immediate response to changes in the economic conditions (inflation, output, and exchange rates). Other patterns of the response of the policy variable to inflation, output, and exchange rates are also examined to determine the robustness of the empirical estimates with respect to the specification choices. The analysis of the robustness tests indicates that the empirical results are robust to changes in the order of variables.

Furthermore, we also examine the effectiveness of interest rates and money supply in controlling inflation by using panel data. According to Baltagi (2005), panel data has an advantage over time-series analysis because it can control for country-invariant or time-invariant factors that may affect the implementation of monetary policy in inflation-

targeting emerging economies. Furthermore, another advantage of panel data is that it provides more information, greater variability, less multicollinearity, more degree of freedom, and more efficiency. Therefore, the Panel VAR compliments the traditional time-series VAR. In economic analysis, some studies combined both time-series and panel data analysis. For instance, Tarun Chakravorty (2019) used both methods to investigate the impact of immigration on the UK economy. Other examples are Mallick and Sousa (2013) or Mughal et al. (2021), to name a few.

3.2.3. Construction of MCI and measuring its effectiveness

A proper choice of a monetary policy indicator is of importance to understand the behaviour of monetary authorities and to assess the stance of monetary policy. MCI, which is a weighted average of the deviation of interest rates and exchange rates from their baseline value, can be used as an indicator to evaluate whether monetary policy is contractionary or expansionary. In line with Berument (2007), we focus on the bond between MCI and inflation. Particularly, we emphasize the absence of price puzzle in their impulse response function to investigate the effectiveness of MCI as an overall measure of monetary policy.

Following previous studies (Ericsson et al., 1998; Kesriyeli and Kocaker, 1999; Şıklar and Doğan, 2015; Nucu and Anton, 2018), we use the equation below to determine the MCI:

$$mci = \beta_i (i_t - i_b) + \beta_e (e_t - e_b) * 100 \quad , \quad \beta_i + \beta_e = 1 \tag{5}$$

where e_t is the logarithm of the bilateral exchange rate, which indicates the price of domestic currency in term of the main currencies of international transactions (the euro for European countries and the US dollar for other countries). An increase in e_t reflects the appreciation of the domestic currency. i_t is the short-term interest rates. It is a proxy for the policy interest rates because it is closely linked and quickly responded to the central bank policy rate (Osborne-Kinch and Holton, 2010). i_b and e_b are the value of interest rates and exchange rates in the base period, which are the value in the previous year. Other bases, January 2000 and January 2005, are used as tests for the robustness of empirical results. For Turkey, the base period of interest rates is June 2000 instead of January 2000 because of the reason of data availability. β_i and β_e are estimated parameters that reflect the relative weight of interest rates and exchange rates. Their sum is one. According to Equation 5, an increase in interest rates or an appreciation of

exchange rates indicates higher value of MCI, which suggests the restriction of monetary policy.

As shown in equation (5), the estimation of the weights is of importance to calculate MCI. Since MCI weights reflect the relative importance of the exchange rate and interest rate channel in the transmission mechanism. To put it differently, MCI shows how interest rates and exchange rates influence the objective of monetary policy such as output or inflation (Hyder and Khan, 2007; Şıklar and Doğan, 2015), their estimates require modelling the objective of monetary policy (Qayyum, 2002). This implies that the weights of MCI components can be derived from their relative impact on aggregate demand (Ericsson et al., 1998; Gerlach and Smets, 2000; Knedlik, 2006; Poon, 2010; Majid, 2012; Egan and Leddin, 2016) or prices (Hataiseree, 1998; Kesriyeli and Kocaker, 1999; Qayyum, 2002) or both (Hyder and Khan, 2007). The weight of exchange rates derived from the price equation is greater than the figure derived from aggregate demand equation because the calculation combines the direct effect of exchange rates on import price and its indirect effect on aggregate demand (Kesriyeli and Kocaker, 1999). In addition, the weights can also be the coefficient of variance of monetary policy instruments that the central bank has at their disposal (Egan and Leddin, 2016). According to Peeters (1999), the ratio β_i / β_e depends on the degree of the openness of the economy under investigation. For small and open economies, the weight on exchange rates may be larger than the weight on interest rates, which opposes to large and closed economies where the weight of exchange rates can be negligible (Knedlik, 2006). Since price stability is the primary objective of monetary policy in countries under investigation, we measure the weight of MCI components by the elasticity of inflation to interest rates and exchange rates.

$$\pi_t = \alpha + \alpha_i i_t + \alpha_e \Delta e_t + \alpha_z z_t \tag{6}$$

where z_t is output, which is a control variable.

The existing literature (Batini and Turnbull, 2002; Şıklar and Doğan, 2015) suggests three basic methods to estimate the MCI weights: single equation, trade elasticities equation, and the system of equation through cointegration and VAR models. The first method estimates the MCI weights by coefficients from either price or output equation. The second method estimates the elasticities of trade share (export expressed as the percentage of GDP) to exchange rates and interest rates. The final method extracts

coefficients of exchange rates and interest rates in the corresponding equation in the system.

The thesis uses the vector autoregression model to estimate the elasticity of inflation to interest rates and exchange rate. The choice of the vector autoregression model is of importance to take into account certain issues that emerge in the estimation of the MCI weights: the endogenous relationship between regressors, the problem of simultaneity biasedness, and the lagged effect of exchange rates and interest rates on inflation. In particular, we sum all coefficients that are statistically significant.

β_i and β_e are calculated as follows:

$$\beta_i = \frac{\alpha_i}{\alpha_i + \alpha_e} \tag{7}$$

$$\beta_e = 1 - \beta_i \tag{8}$$

After the MCI construction, following previous studies (Berument, 2007), we focus on the significance of the inflation response to MCI shocks and the absence of the price puzzle in their impulse response function to examine whether MCI is an appropriate indicator of monetary policy. For this purpose, we generate both country and panel evidence by using a VAR model. The endogenous variables are:

$$Y_t = [\text{DLCOM, MCI, DLEX, DLCPI, DLY}]' \tag{9}$$

where DLCOM, DLEX, DLCPI, DLY are the first difference of the logarithm of commodity price, exchange rate, consumer price index, and industrial production index. MCI is the monetary condition index determined by the weighted average of changes in exchange rates and interest rates relative to their value in the base period. The weights are derived from their estimated coefficients in the inflation equation.

It should be noted that the VAR model is recursive with the ordering specified in Equation (9). Such an ordering indicates that MCI has a contemporaneous effect on inflation and other economic variables. On the other hand, inflation, output, and exchange rates have an effect on monetary policy with lags.

In addition to time-series VAR, we also apply the panel VAR to investigate the response of prices to MCI. Contrary to time-series data, panel data is information-rich. It provides a high degree of variability that can mitigate the problem of multicollinearity. Therefore, panel VAR can increase the reliability of parameter estimates in the baseline

analysis of the effectiveness of MCI in measuring the stance of monetary policy in emerging economies that follow inflation targeting.

In this thesis, we focus on the response of monetary policy to MCI shocks. MCI can be considered as a good measure of monetary policy if inflation shows a reduction in response to a positive shock of MCI which represents the contractionary stance of monetary policy.

3.3. Identifying the reaction function of monetary policy

This section discusses methodology that can solve the hypothesis 3, 4, and 5. Following the existing literature, we make crucial modifications to the Taylor rule to shed new light on the decision-making process of monetary authorities in emerging economies that follow inflation targeting. The next three subsections discuss how exchange rates, foreign exchange intervention, and nonlinearity are incorporated into the Taylor rule.

- Hypothesis 3: Exchange rates have a significant effect on monetary policy in emerging economies.
- Hypothesis 4: Foreign reserves have a significant effect on monetary policy in emerging economies.
- Hypothesis 5: Monetary authorities in emerging economies asymmetrically respond to positive and negative inflation and output gap.

3.3.1. The role of exchange rates in the reaction function of monetary policy

The existing literature suggests that there are two methods that can be used to investigate whether monetary authorities indirectly affect exchange rates by adjusting interest rates. The first method is to examine empirical results of the monetary policy equation in a VAR model (Hammermann, 2005; Civcir and Akçağlayan, 2010; Furlani et al., 2010; Granville and Mallick, 2010; Aizenman et al., 2011; Frömmel et al., 2011; Lueangwilai, 2012; Bjørnland and Halvorsen, 2014; Demir, 2014; Dybowski et al., 2018). An advantage of this method is that it takes into account the dynamic relationship between interest rates, exchange rates, and other endogenous variables. The second method involves estimating a Taylor rule with the augmentation of exchange rate changes (Mohanty and Klau, 2005; Sánchez-Fung, 2011; Cermeño et al., 2012; Pontines and Siregar, 2012; Peters, 2016; Caporale et al., 2018). In this thesis, we apply the second method by using the GMM method.

Taylor (1993) provides a theoretical framework for studies on the behaviour of the central bank. A simple specification of the Taylor rule is as follows:

$$\overline{i_t} = \alpha_0 + \alpha_\pi \left(\pi_t - \pi_t^* \right) + \alpha_y y_t + \varepsilon_t \tag{10}$$

where $\bar{\imath}_t$ is policy rate officially stated by monetary authorities. $(\pi_t - \pi_t^*)$ and y_t are inflation gap and output gap respectively. It should be noted that inflation target π_t^* is time-varying in the thesis, which is contrary to the original specification of the Taylor rule. Since the adoption of inflation targeting in 1990s, emerging economies gradually reduced the target of annual inflation rate and ultimately most of them maintained a fixed inflation target of 3 percent and a tolerance bank of 1 percent. As shown in Equation (9), interest rates contemporaneously react to inflation and output gap. To ensure the stabilization effect, the response of interest rates to output and inflation gap should satisfy the Taylor principle, whereby interest rate adjustments should be greater than inflation gap changes and be positive in response to output gap changes. To put it simply, the Taylor principle indicates that the inflation gap coefficient should be greater than one and the output gap coefficient should be positive. A violation of the Taylor principle indicates that monetary policy tends to accommodate rather than stabilize shocks.

Nonetheless, the Taylor (1993) rule copes with the critique when using it to examine the behaviour of monetary authorities in emerging economies. Following studies modify the conventional Taylor rule to account for the complexity in the implementation of monetary policy in these economies. Two important modifications are the augmentation of the smoothing behaviour and forward-looking outlook. In this thesis, we employ the forward-looking specification given by Clarida et al. (1998) to investigate the matter of exchange rates in the reaction function of monetary policy.

$$i_t = \rho i_{t-1} + (1-\rho)\left[\alpha_0 + \alpha_\pi \left(\pi_{t+k} - \pi_{t+k}^* \right) + \alpha_y y_{t+m} + \alpha_e \Delta e_{t+n} + \varepsilon_t \right] \tag{11}$$

where ρ is the smoothing coefficient. A high value of ρ indicates that monetary authorities in emerging economies are likely to conduct gradual adjustments in interest rates. e_{t+n} indicates the expectation of exchange rates. $(\pi_{t+k} - \pi_{t+k}^*)$ and y_{t+m} represent the expectation of inflation and output gap.

For simplicity, equation (10) can be parameterized as follows:

$$i_t = \rho i_{t-1} + \beta_0 + \beta_\pi \left(\pi_{t+k} - \pi_{t+k}^* \right) + \beta_y y_{t+m} + \beta_e \Delta e_{t+n} + \nu_t \tag{12}$$

where $\beta_0 = (1-\rho)\alpha_0$, $\beta_\pi = (1-\rho)\alpha_\pi$, $\beta_y = (1-\rho)\alpha_y$, $\beta_e = (1-\rho)\alpha_e$, and $v_t = (1-\rho)\varepsilon_t$. Accordingly, the response of monetary policy to inflation can be indirectly calculated by the ratio of inflation and output gap coefficients in the Equation (11) and (10), $\alpha_\pi = \beta_\pi/(1-\rho)$. If $\beta_\pi/(1-\rho)$ is greater than one, monetary policy is effective to stabilize inflation in emerging economies. On the other hand, β_y and α_y have the same sign in the Equation (11) and (10), suggesting that a positive value of β_y indicates the stabilizing effect of monetary policy on the real economy.

In this thesis, we implement some departures from the linear or symmetric response of interest rates to exchange rates. Firstly, it is likely that monetary authorities may put a greater emphasis on the exchange rate stability during the Global financial crisis period. To examine this problem, we add the interaction between exchange rate changes and a crisis dummy that takes the value of one for the series after September 2008 (Equation 13).

$$i_t = \rho i_{t-1} + \beta_0 + \beta_\pi\left(\pi_{t+k} - \pi^*_{t+k}\right) + \beta_y y_{t+m} + \beta_e \Delta e_{t+n} + \beta_{ec}\Delta e_{crisis,t+n} + v_t \qquad (13)$$

where $\Delta e_{crisis,t+n} = \Delta e_{t+n} * C_{t+n}$, C is the crisis dummy.

Following Cermeño et al. (2012) and Keefe and Shadmani (2018), we examine the asymmetric response of monetary policy to an appreciation and a deprecation of exchange rates by observing the square of exchange rate changes in the augmented Taylor rule (see Equation 13). If β_{e^2} is negative, monetary authorities show an aversion to an increase in the value of domestic currency, suggesting the fear of appreciation. On the other hand, the positive value of β_{e^2} indicates the fear of depreciation.

$$i_t = \rho i_{t-1} + \beta_0 + \beta_\pi\left(\pi_{t+k} - \bar{\pi}_{t+k}\right) + \beta_y y_{t+m} + \beta_e \Delta e_{t+n} + \beta_{e^2}\Delta e^2_{t+n} + v_t \qquad (14)$$

The choice of the preference value can affect the interpretation about the role of exchange rates in the implementation of monetary policy. In this thesis, we use two benchmarks to calculate exchange rate changes. Accordingly, we use both monthly and yearly changes, indicating whether monetary policy concerns about the exchange rate movement in the last month or year. Furthermore, exchange rate indicators can be effective index, bilateral, nominal, or real. These measures suggest whether monetary authorities closely watch a single currency or a basket of currencies. In sum, we use six measures of exchange rate changes: monthly and yearly changes of the nominal effective, real effective, and bilateral exchange rate.

3.3.2. The role of foreign exchange intervention

Neely (2005) suggests three methodologies to investigate the effect of foreign exchange intervention. First, the most popular method is the time-series analysis, which involves estimating the significance of foreign exchange intervention in a single equation. Event study is the second method that applies to high frequency data such as daily or intraday series. Due to the availability of data, this method often applies for advanced economies. Another obstacle prevents the use of this method for emerging economies is difficulties when defining the event of intervention, which refers to a cluster of intervention actions. The third method is the structural analysis, which emphasises on the simultaneous interaction between variables of interest.

In this thesis, we apply the first method. Accordingly, we use the GMM model and the following specifications to investigate the effect of foreign exchange intervention on monetary policy:

$$i_t = \beta_0 + \rho i_{t-1} + \beta_1 \pi_{t+k} + \beta_2 y_{t+m} + \beta_3 e_{t+n} + \beta_4 I_{t-p} + v_t \quad (15)$$

$$i_t = \beta_0 + \rho i_{t-1} + \beta_1 \pi_{t+k} + \beta_2 y_{t+m} + \beta_3 e_{t+n} + \beta_4 pur_{t-p} + \beta_4 sales_{t-p} + v_t \quad (16)$$

where i_t, π_t, y_t, e_t are four primary variables of the analysis of monetary business cycle. i_t is the short-term interest rate, which is the most popular indicator of monetary policy. π_t is the inflation gap measured by the spread between actual inflation and its target. y_t is the output gap measured by the spread between actual output and the potential derived from the Hodrick-Prescott filter. e_t is the bilateral exchange rates. I_t is the proxy for foreign exchange intervention. Following previous studies (Kim, 2003; Kim, 2005; Sideris, 2008; Berganza and Broto, 2012; Blanchard and Adler, 2015), we use changes in foreign reserves to measure foreign exchange interventions. A positive change in this indicator means that the purchase of foreign reserves is greater than the sales of foreign reserves, which equals the net purchase of foreign reserves. However, it should be noted that foreign reserves are a narrative measure of the foreign exchange intervention (Blanchard and Adler, 2015) because changes in foreign reserves can be a result of either intervention policies or other reasons (Berganza and Broto, 2012). Furthermore, foreign reserve changes and actual interventions can be weakly correlated (Neely, 2000) and foreign reserves have measuring error (Sideris, 2008).

The Taylor rule specified in equation (15) and (16) should follow the Taylor principle to ensure the stabilization effect of monetary policy. In the Taylor principle,

inflation coefficient β_1/ρ should be greater than one and output coefficient β_2 should be greater than zero. Equation (15) and (16) investigate the symmetric and asymmetric effect of foreign exchange intervention on interest rates respectively. In equation (16), pur_{t-p} and $sales_{t-p}$ indicate the purchase and sales of foreign reserves. Comparing the sign, size, and statistically significance of the coefficients of pur_{t-p} and $sales_{t-p}$ provides evidence about the asymmetric effect of the intervention on monetary policy.

3.3.3. Asymmetric reaction function of monetary policy

In this thesis, we depart from the two primary assumptions of the traditional Taylor rule, which are a linear Phillips curve and a quadratic loss function. We discuss the specification that can be used to investigate the relaxation of the two drivers for the interest rate setting.

The thesis investigates the asymmetric Taylor rule that stems from either an asymmetric preference or a nonlinear Phillips curve. Following Dolado et al. (2005), we examine the effect of a nonlinear Phillips curve by interpreting the estimated interaction coefficient (α_3) between expected inflation gap and output gap (Equation 17). If α_3 is positive, monetary policy strongly responds to inflation in expansions and the asymmetry is conditional on a convex Phillips curve. If, however, α_3 is negative, the asymmetric Taylor rule is conditional on a concave Phillips curve.

$$i_t = \alpha_0 + \rho i_{t-1} + \alpha_1 \pi_{t+k} + \alpha_2 y_t + \alpha_3 \pi_{t+k} y_t + \alpha_4 e_t + v_t \quad (17)$$

where i_t is the short-term interest rates, a measure of monetary policy. π_t and y_t are the inflation and output gap respectively, which are the primary explanatory variables of the Taylor rule. e_t is the exchange rates. v_t is the exogenous shock of monetary policy.

On the other hand, we apply the methodology developed by Caglayan et al. (2016) to investigate the effect of an asymmetric preference on interest rates. Accordingly, the preference to inflation or recession avoidance can be investigated by observing the significance and sign of the conditional volatility of inflation ($\sigma^2_{\pi,t}$) and output ($\sigma^2_{y,t}$). As shown in Equation (18), a positive and statistically significant β_3 indicates the inflation avoidance preference whereas a negative and statistically significant β_4 suggests the recession avoidance preference.

$$i_t = \beta_0 + \rho i_{t-1} + \beta_1 \pi_{t+k} + \beta_2 y_t + \beta_3 \sigma^2_{\pi,t} + \beta_4 \sigma^2_{y,t} + \beta_5 e_t + v_t \quad (18)$$

The Taylor rule specified in Equation (17) and (18) shows three extensions into the traditional Taylor rule. Firstly, it incorporates the lag of interest rates to reflect the intention to smooth the interest rate movement. The extension indicates that monetary authorities dislike large adjustments in interest rates. Gradual adjustments of interest rates allow market participants to slowly adapt to monetary policy changes. Secondly, it adds exchange rates to capture the effect of external forces on domestic economy. Thirdly, the Taylor rule is augmented with regressors that measure the effect of a nonlinear Phillips curve or an asymmetric preference on the setting of interest rates.

To estimate the asymmetric Taylor rule, we use several unobserved variables such as output gap, inflation gap, inflation volatility, and output volatility. Furthermore, inflation expectation is not readily available in emerging economies. Therefore, we use the ex-post value of inflation to replace its expectation. This remedy introduces the forecast error, leading to the endogeneity problem. Hence, we apply the GMM method because it can solve the correlation between some regressors and the error term. The GMM method also has the advantage of correcting the problem of autocorrelation and heteroskedasticity. In line with Kobbi and Gabsi (2019), we use the Newey-West procedure to correct the variance-covariance matrix.

In our estimation, inflation gap and output gap are considered as endogenous whereas exchange rates are considered as exogenous. Instruments are lags of endogenous and exogenous variables. Following Sznajderska (2014), we select the specification by observing the statistical significance of coefficients, the suitable signs of variables of interest, and the proper size of Hansen J statistics. The Hansen J statistic is able to confirm the validity of selected instruments. It should be greater than 5 percent to conclude the validity of instruments (Baum et al., 2007).

3.4. Data

We focus on emerging economies that follow inflation targeting. There are several reasons that justify the choice of this sample. Firstly, emerging economies that follow inflation targeting present a major part of the group of emerging economies. Such a representation can be seen through their great size of GDP and export. Secondly, emerging economies that adopted inflation targeting show a great advance in the banking system. This means that interest rates show a significant importance in the conduct of monetary policy while other instruments remain their importance in many occasions.

Such a circumstance raises many questions about the relevance of the consensus that interest rates are the best measure of monetary policy.

Because of data availability, the sample consists twelve emerging economies: Brazil, Chile, Colombia, Mexico, Hungary, Poland, Romania, Turkey, Korea, Philippines, Thailand, and South Africa. As noted by Duttagupta and Pazarbasioglu (2021), there is no official definition of emerging economies. In their paper, they stated that the IMF World Economic Outlook classifies 39 economies as "advanced" and 40 as "emerging market and middle-income". In emerging group, Brazil, Chile, Colombia, Mexico, Hungary, Philippines, Poland, Thailand, Turkey, and South Africa are considered as top emerging economies. Cannavale et al. (2021) summarize different views about the classification of Korea. In their studies, Korea can be considered as developed or emerging economy depending on the classification criteria. In fact, IMF shows no change in the classification of Korea as an emerging market in its reports until 2014 (IMF, 2013; IMF, 2014). Furthermore, according to MSCI (2022), Korea still belongs to the emerging market. In Song (2021), Korea is also considered emerging. In our study, Korea is considered as an emerging economy.

The data are monthly, spanning from January 2000 to June 2018. In other words, there are 222 observations. They are mainly collected from the IMF. We use the money market interest rates, which are derived from the IMF, as a proxy for the short-term interest rates. For most countries, exchange rates are derived from the IMF. For Turkey, Korea, and Thailand, exchange rates are collected from the Bank for International Settlements. In this thesis, exchange rates measure the value of domestic currency in term of the euro (European countries) or US dollar (other countries). Following the existing literature, we use changes in the consumer price index (industrial production index) as a measure of inflation (output).

Table 3 shows the mean and standard deviation of six variables: inflation rate, output growth, money supply (M1, M2) growth, exchange rate change, and short-term interest rates. It can be seen that annual inflation rates are relatively low in most countries, standing in the range 2 – 5%. In Romania and Turkey, the inflation rate is high at 9.08% and 14.28% respectively. Brazil and South Africa have moderate inflation rates, approximately 6.32% and 5.21% respectively.

Table 3: Mean and standard deviation of selected variables

	Inflation	Output growth	Exchange rate change	M1 growth	M2 growth	Interest rate
Brazil	6.32	1.12	-3.26	10.69	12.54	13.70
	(2.5)	(6.51)	(18.37)	(7.89)	(7.13)	(4.44)
Chile	3.14	2.19	-1.11	12.65	10.25	3.89
	(2)	(5.31)	(11.14)	(5.74)	(5.96)	(1.65)
Colombia	4.98	2.32	-2.76	13.19	12.06	6.43
	(1.99)	(5.51)	(13.88)	(6.46)	(4.15)	(2.52)
Mexico	4.52	0.95	-3.63	12.79	10.91	6.95
	(1.51)	(3.78)	(9.33)	(3.71)	(3.08)	(3.57)
Hungary	4.26	3.15	-1.13	11.50	8.21	5.88
	(2.82)	(8.94)	(5.43)	(7.44)	(4.98)	(3.25)
Poland	2.54	5.05	-0.01	11.85	9.25	7.12
	(2.42)	(5.83)	(8.99)	(6.01)	(4.35)	(5.27)
Romania	9.08	4.24	-5.67	22.80	16.09	7.60
	(10.26)	(6.51)	(10.19)	(22.2)	(10.65)	(5.54)
Turkey	14.28	5.17	-12.67	27.52	25.60	20.54
	(12.98)	(8.98)	(18.62)	(17.66)	(16.68)	(33.02)
Korea	2.51	4.87	0.43	9.53	7.29	3.18
	(1.16)	(7.47)	(10.55)	(8.49)	(2.92)	(1.24)
Philippines	3.76	2.92	-1.48	13.74	11.24	5.25
	(1.9)	(10.56)	(7.62)	(4.92)	(6.20)	(1.73)
Thailand	2.08	4.00	0.83	8.29	6.37	2.27
	(1.96)	(9.92)	(6.57)	(4.38)	(3.05)	(1)
South Africa	5.21	0.91	-4.02	10.77	10.48	8.07
	(2.67)	(5.52)	(17.35)	(5.75)	(5.17)	(2.55)

Source: Author's estimation.

Notes: Standard deviation is in the parentheses; otherwise, it is mean.

Output growth is slightly different between emerging economies. Compared with other countries, Brazil, Mexico and South Africa have a relatively low rate of output growth, approximately 1%. Similarly, the growth rate of M1 and M2 is not much different across countries with the exception of Romania and Turkey, of which the figure is twice or three times greater than other countries. It seems that high money growth is an important factor leading to high inflation in Romania and Turkey. Furthermore, the growth rate of exchange rates is negative, indicating the depreciation of the domestic currency in emerging economies.

Table 4 shows presents the stationary status of various variables. As shown, it shows the test statistics of the ADF test (Z(t)), significance level ($^{*}/^{**}/^{***}$), and the order of integration (0/1). For instance, in Brazil, the logarithm of output has the test statistic of –4.37, the significance level of 1 percent, and the integration order of 0. This means that the logarithm of output is stationary at level with the significance level of 1 percent. Overall, the result of the ADF test indicate that most variables are highly likely to be stationary at first difference whereas interest rates are stationary at level in emerging economies. Output is stationary at level in most countries but Poland and Turkey, whereby the series is stationary at first difference. Similarly, exchange rates require no first differencing to be stationary in most emerging economies excepting Mexico, Thailand, and South Africa. Interest rates contain a unit root at level and has the integration order of one in Hungary but it is stationary at level in other economies. However, it should be noted that interest rates are trend stationary in Hungary (results not shown, available upon request). On the other hand, consumer price index satisfies the stationarity condition at first difference in most countries, excepting Mexico, Romania, and Turkey where the variable is stationary at level. In a nutshell, to ensure the stability condition, the simplicity in the estimation as well as the comparability of empirical results, we use the first difference of variables in the VAR model. However, we use the level of interest rates and its inclusion should not lead to the instability of VAR model. In the case of Hungary, interest rate in its level form is included in the VAR model. Such a remedy does not lead to the instability of the VAR estimation.

Table 4: ADF test results

	Y		CPI		M1		M2		EX		IR	
	Z(t)	I	Z(t)	I	Z(t)	I	Z(t)	I	Z(t)	I	Z(t)	I
Brazil	-4.37*	0	-6.41*	1	-9.83*	1	-5.97*	1	-1.39***	0	-2.39*	0
Chile	-1.57***	0	-8.38*	1	-10.06*	1	-6.2*	1	-2.07**	0	-3.48*	0
Colombia	-2.28**	0	-7.73*	1	-11.76*	1	-8.47*	1	-1.53***	0	-3.08*	0
Mexico	-1.77**	0	-3.58**	0	-4.74*	0	-6.98*	1	-8.44*	1	-2.51*	0
Hungary	-1.99**	0	-6.67*	1	-7.25*	1	-11.06*	1	-1.45***	0	-11.1*	1
Poland	-14.12*	1	-8.57*	1	-8.31*	1	-10.64*	1	-2.92*	0	-2.27**	0
Romania	-1.7**	0	-5.64*	0	-5.14*	1	-3.97*	1	-4.27*	0	-1.85**	0
Turkey	-11.64*	1	-4.98*	0	-12.47*	1	-15.3*	1	-1.93**	0	-1.69**	0
Korea	-1.49***	0	-8.66*	1	-6.88*	1	-5.61*	1	-2.64*	0	-1.56***	0
Philippines	-1.52***	0	-6.38*	1	-3.17***	0	-7.82*	1	-1.8**	0	-1.47***	0
Thailand	-2.15**	0	-8.12*	1	-7.57*	1	-8.09*	1	-8.65*	1	-2.7*	0
South Africa	-5.02*	0	-5.42*	1	-9.61*	1	-14.98*	1	-9.56*	1	-2.58*	0

Source: Author's calculation.

Notes: The optimal lag is selected by AIC criterion. *, **, *** indicates the significance at 1%, 5%, and 10% respectively. Integration order I indicates the variable of interest has the integration order of 0 and 1, meaning being stationary at level and first difference respectively.

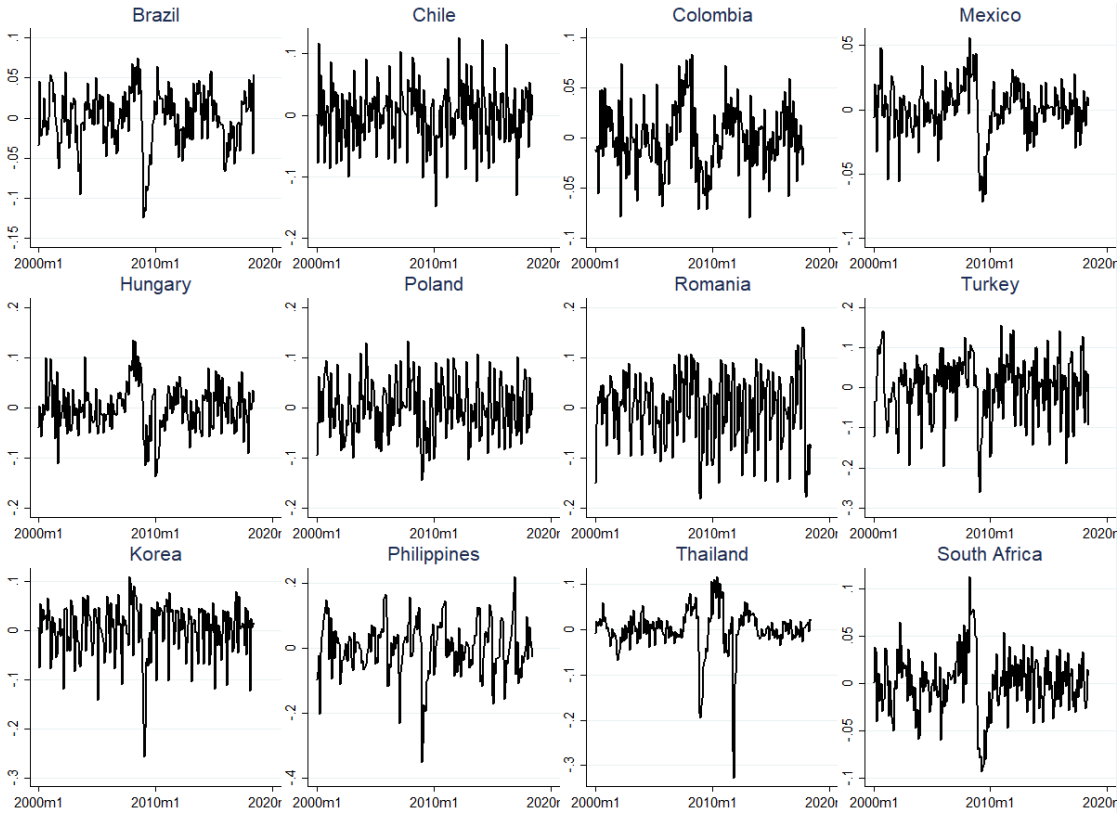
3.4.1. Measuring output gap, inflation gap and their volatility

In this thesis, we use several unobserved variables such as output and inflation gap in the estimation of the linear Taylor rule as well as inflation volatility and output volatility in the estimation of the nonlinear Taylor rule. The output gap measures how far the actual level of output departs from its potential level. Since the output gap is unobservable in practice, its estimation involves the decomposition of the actual values into trend and cyclical component. There are a variety of proxies for the output gap, for instance, the residual of a linear or a quadratic regression (Saxegaard, 2006; Aragón et

al., 2016) and the differential between actual output and its potential figure reported in public reports (Saxegaard, 2006; Surico, 2007; Surico, 2008). Although the calculation of these proxies is simple, their use is limited in the literature of monetary policy analysis. Meanwhile, the most popular approach is to determine the output gap by subtracting the trend value derived from Hodrick–Prescott filter (see, for instance, Komlan, 2013; Ma, 2016; Tawadros, 2016) from the actual output. The thesis uses this approach to measure output gap.

Figure 3 shows changes in the output gap, which is measured by the spread between actual output and the potential output derived from the Hodrick-Prescott filter. Accordingly, emerging economies experienced a strong fluctuation in the output gap over the last decades, especially during the recent Global financial crisis. Furthermore, the pattern of the output gap was clustered, implying that an economic expansion (contraction) was highly likely to be followed by expansions (contractions).

Figure 3: Output gap



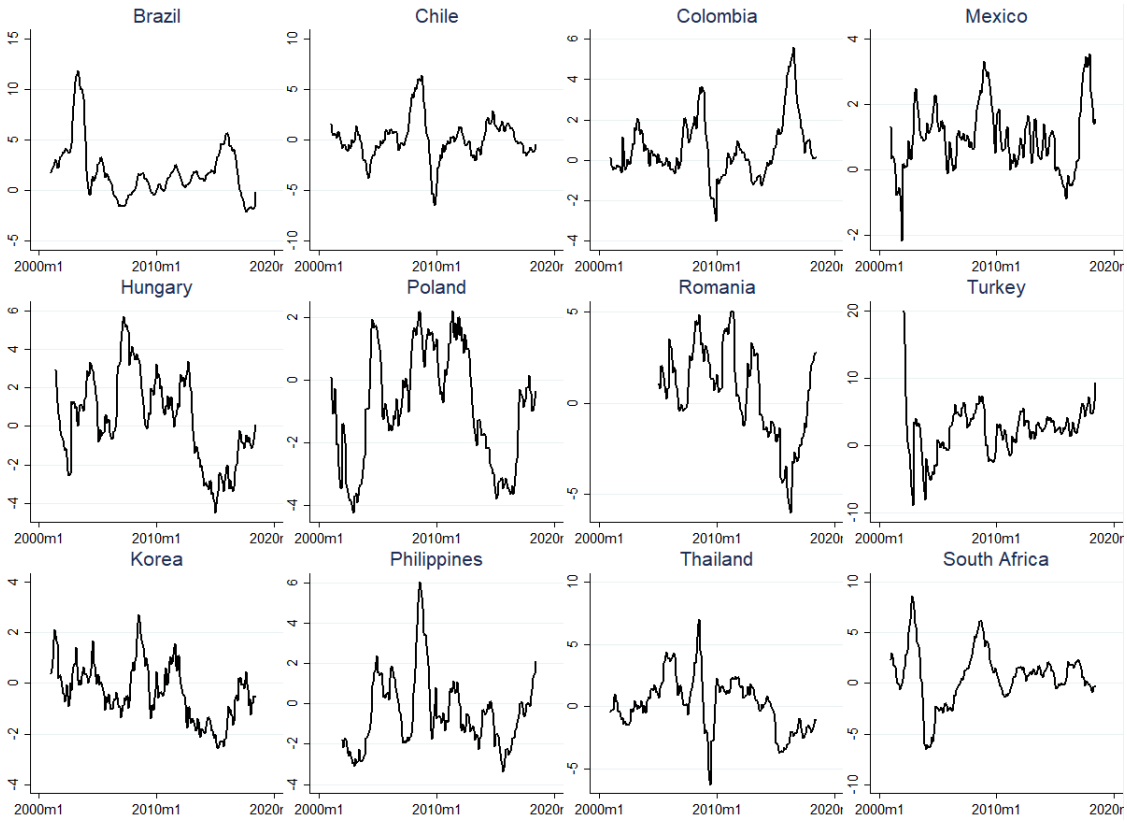
Source: Authors' construction

Inflation gap is the deviation of current inflation from its target. The target inflation can be obtained through the figures published by central banks. Vašíček (2012) suggested that inflation targets can also be obtained through HP filter of actual inflation

target or actual CPI inflation. In this thesis, we measure the inflation gap by the spread between the actual inflation rate and the target proposed by monetary authorities.

Figure 4 shows changes in the inflation gap in twelve inflation-targeting emerging economies over the period from 2000 to 2018. The movement of the inflation gap implies that realized inflation rates often departed from the targets. In most emerging economies, the gap between actual inflation and the target was relatively large, especially during the recent Global financial crisis. After the crisis, the inflation gap reduced significantly due to the disinflation bias of monetary authorities. In fact, it became negative, which led to the slow recovery of many economies. In recent years, the situation had been improving. The inflation gap increased and was above zero. This upward trend was of importance because it signalled emerging economies recovered and grew.

Figure 4: Inflation gap



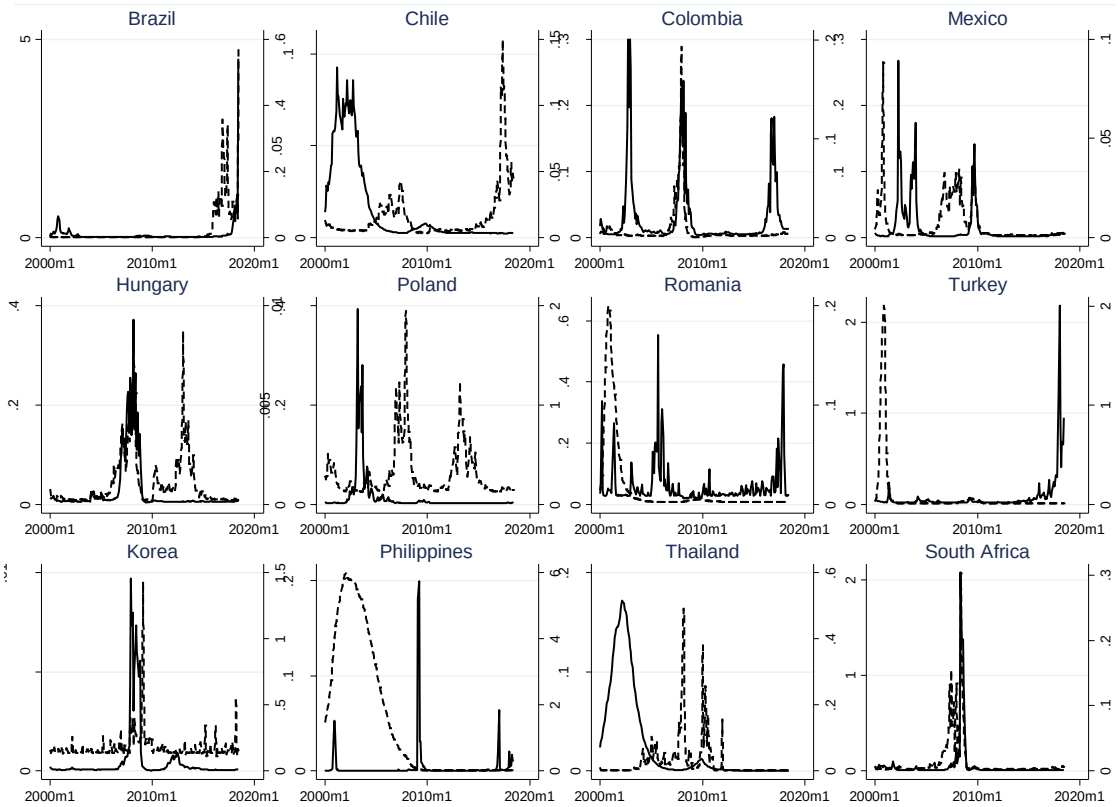
Source: Authors' construction

Although basic statistics determine the volatility of a series by its standard deviation, the method is too simple to deal with the styled movement of macroeconomic series such as the cluster of periods of high and low volatility, the high frequency of large changes, and the tendency of moving back to the long-run level. Provided that the structure of emerging economies has changed over time, it is highly likely that the

volatility of both output and inflation gap are time-varying. In addition, changes in both series may exhibit some of styled behaviour mentioned above. For those reasons, the thesis is going to use the ARCH/GARCH models to identify output volatility and inflation volatility. Particularly, the volatility of output and inflation is the conditional variance derived from the GARCH(1,1) estimation.

Figure 5 indicates the volatility of inflation and output in emerging economies. Short-dashed (solid) line shows changes in the volatility of inflation (output), of which the value is corresponding to left (right) vertical axis. As observed, inflation was highly volatile during the crisis period in most emerging economies excepting for Brazil, Turkey, and Philippines. The pattern of inflation volatility was quite different in Brazil, Turkey, and Philippines, which was conditional on specific economic and political context of the economy. For instance, in Turkey, inflation volatility was dramatically high in the early 2000s due to the economic and financial crisis.

Figure 5: Inflation and output volatility



Source: Authors' construction

Notes: Short dashed line is inflation volatility. Solid line is output volatility. Left (right) vertical line measures inflation (output) volatility.

Table 5: Mean and standard deviation of exchange rate changes in emerging economies

		Monthly change			Yearly change		
		NEER	REER	EX	NEER	REER	EX
Brazil	$\bar{e}$	-0.20	-0.03	-0.33	-2.09	-0.10	-3.39
	σ_e	4.09	4.10	3.83	15.91	14.81	18.80
Chile	$\bar{e}$	-0.03	-0.03	-0.09	-0.40	-0.52	-0.84
	σ_e	2.17	2.08	2.62	7.77	7.08	11.38
Colombia	$\bar{e}$	-0.06	-0.03	-0.18	-0.61	-0.36	-1.91
	σ_e	2.61	2.63	3.02	10.75	10.39	13.74
Mexico	$\bar{e}$	-0.35	-0.17	-0.34	-4.06	-1.99	-3.90
	σ_e	2.30	2.29	2.49	8.40	8.15	9.50
Hungary	$\bar{e}$	-0.07	0.08	-0.11	-0.49	1.28	-1.04
	σ_e	1.87	1.90	1.80	5.70	6.50	5.56
Poland	$\bar{e}$	0.02	0.02	-0.02	0.28	0.13	-0.31
	σ_e	2.07	2.08	2.13	8.51	8.55	9.09
Romania	$\bar{e}$	-0.35	0.10	-0.42	-4.02	0.95	-4.82
	σ_e	1.60	1.49	1.72	9.02	6.12	9.73
Turkey	$\bar{e}$	-1.00	-0.09	-1.03	-11.25	-0.89	-11.88
	σ_e	3.91	3.79	4.09	17.87	12.13	18.72
Korea	$\bar{e}$	0.00	0.03	0.01	-0.23	0.21	0.17
	σ_e	1.97	1.96	2.33	9.63	9.31	10.74
Philippines	$\bar{e}$	-0.15	0.01	-0.12	-1.36	0.50	-0.88
	σ_e	1.38	1.41	1.50	6.22	5.91	7.28
Thailand	$\bar{e}$	0.06	0.07	0.06	0.95	1.02	1.20
	σ_e	1.26	1.26	1.39	5.59	5.66	6.49
South Africa	$\bar{e}$	-0.35	-0.12	-0.35	-3.97	-1.24	-3.53
	σ_e	3.36	3.34	3.95	14.20	13.60	17.64

Source: Authors' calculation

Notes: $\bar{e}$ and σ_e are the mean and standard deviation of exchange rate changes respectively. EX is the bilateral exchange rates, measured by the number of USD/EUR to purchase a unit of domestic currency.

Turning to output volatility, it was dramatically high during time of crisis. Such a pattern was visible in Colombia, Mexico, Hungary, Romania, Korea, Philippines, and South Africa. In some emerging economies such as Chile and Thailand, output moved volatilely during the beginning of the 2000s. On the other hand, output volatility reached a very high level in recent years in Brazil, Colombia, Romania, Turkey, and Philippines. However, there were differences in the pattern of output and inflation volatility.

3.4.2. Exchange rate

Table 5 presents monthly and yearly changes in various indicators of exchange rates in emerging economies. As observed, different measures of exchange rates can provide conflicting interpretation about changes in the value of domestic currency. For instance, in Hungary monthly changes in NEER and bilateral exchange rates have a negative mean, suggesting a depreciation. By contrast, monthly changes in REER have a positive mean, suggesting an appreciation. A similar observation can be found for other countries such as Poland, Romania, Korea, and Philippines. Hence, monetary policy response can be affected when using different indicators of exchange rates. Turning to the standard deviation of exchange rates, monthly figures, when annualized (multiplied by 12), are much greater than yearly ones. This indicates that exchange rates are highly volatile when there is a short-term vision. Meanwhile, exchange rates seem to be more stable when looking at a one-year movement. Consequently, monetary authorities that want to stabilise exchange rates may strongly react to their monthly changes.

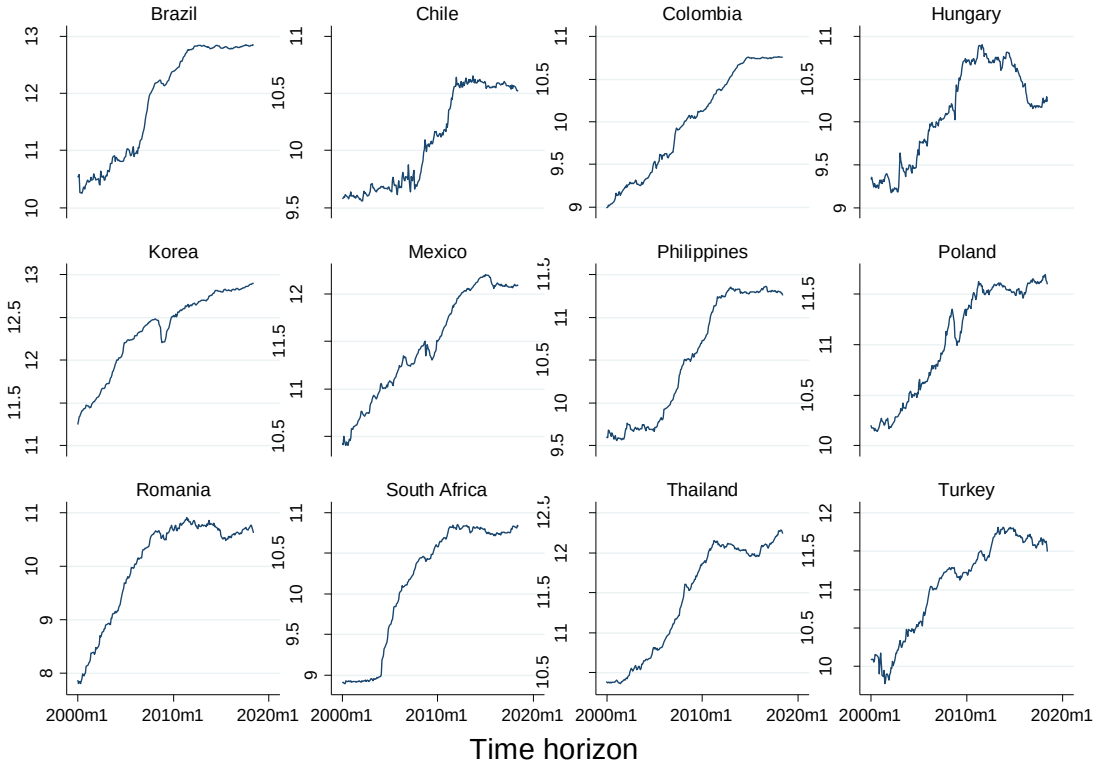
3.4.3. Foreign exchange intervention

Figure 6 indicates the evolution of foreign reserves in twelve emerging economies targeting inflation. As observed, there are two distinct periods. The first period saw an acceleration in the accumulation of foreign reserves, which ended in the Global financial crisis. It should also be noted that the accumulation was rather stable in early 2000s in some economies: Brazil, Chile, Hungary, Philippines, and South Africa. Precautionary motive is a possible explanation for the continuous accumulation of foreign reserves in these economies because it helps resist against the exchange rate appreciation and cope with the sudden stops of capital inflows (Blanchard and Adler, 2015; Ponomarenko, 2019). As pointed out by Cheung and Qian (2009), precautionary motive is high, especially in Asian economies, because monetary authorities do not want to become a target of speculative attack. Furthermore, emerging economies that have an export-oriented growth policy express a preference to reserve accumulation (Johannes and

Sondergaard, 2007). Additionally, the fear of appreciation is of importance to stimulate export (Blanchard and Adler, 2015). However, Ding and Wang (2022) argued that the growth of international reserves can lead to a rise in the impact of foreign exchange intervention, which is likely to cause an increase in inflation.

The second period happened after the Global financial crisis. During this period, foreign reserves were more stable and remained at high level, which is of importance to maintain a strong buffer against external shocks. In summary, changes in foreign reserves may be considered as a signal for the relaxation of the basic principle of the strict inflation targeting.

Figure 6: Foreign exchange intervention in emerging economies



Notes: Authors' construction

3.5. Estimation methods

3.5.1. VAR

VAR model constructs the regression of a variable by the past value of its own and other variables. In theory, the VAR model can use all or relevant past values. Since its introduction, the VAR model regains popularity in the existing literature about empirical finance (Chris, 2002).

According to Chris (2002), the VAR model is superior over other models such as univariate time series models or simultaneous equations models. To begin with, an important feature of the VAR model is its flexibility and the high ability of generalization. Using the VAR model, we can represent a dynamic relationship between two or more variables. Secondly, there is no need to distinguish between exogenous and endogenous variables since all regressors are considered as endogenous. Therefore, all equations in the VAR model are identified. Thirdly, the flexibility of the VAR model is conditional on the regression of a variable by the lag of its own and other variables or combinations of white noise terms. Because of this, the VAR model can summarize more information about the data. Fourthly, the VAR model is able to provide a good forecast. However, according to Sims (1980), large-scale structural models badly perform in case of out-of-sample forecast.

Despite of these advantages, the VAR model comes with some drawbacks. Firstly, its flexibility requires less restrictions and thus it is less likely to be suitable for theoretical analysis or policy prescriptions. Moreover, it is not clear how to interpret the VAR coefficient estimates. Furthermore, the choice of the lag length is of importance to remain a proper degree of freedom as well as the amount of lost information.

A VAR model with a lag length p can be written as follows:

$$Y_t = c + \Pi_1 Y_{t-1} + \Pi_1 Y_{t-2} + ... + \Pi_1 Y_{t-p} + \varepsilon_t \tag{19}$$

where Π_i are matrices of coefficients with dimension (nxn) and ε_t is a (nx1) vector of zero mean white noise. In the VAR model, the covariance matrix is time invariant.

The VAR model can also be represented in the lag operator notation:

$$\Pi(L)Y_t = c + \varepsilon_t \tag{20}$$

where $\Pi(L)Y_t = I_n - \Pi_1 L - \Pi_2 L^2 - ... - \Pi_p L^p$.

According to Zivot and Wang (2007), VAR(p) satisfies a stable and stationary process if the roots of the determinant of the following matrix lie outside the complex unit circle.

$$\det(I_n - \Pi_1 z - \Pi_2 z^2 - ... - \Pi_p z^p) = 0 \tag{21}$$

In practice, we often use information criteria to select a proper order of the past values. The information criteria are devices to select a model or specification. In general, we will choose the lag length p that minimises a certain model selection criterion. There

are three basic information criteria: Akaike (AIC), Schwarz-Bayesian (BIC) and Hannan-Quinn (HQ). While AIC is preferred for prediction since it asymptotically overestimates the order given positive probability, BIC and HQ are preferred for explanation since they provide a consistent estimation of the underlying process of data generating.

In this thesis, we use the AIC criterion. Since AIC gives an estimate of the lost information in a model, a lower value of AIC means a high quality of the model. The VAR model should also meet the stability condition. This means that the roots of the determinant specified in Equation 21 lie outside the complex unit circle. Furthermore, the VAR model should have no autocorrelation in the error.

It should be noted that the VAR model is recursive with the ordering in Equation (4) and (9). The ordering implies that policy rates affect inflation, output, and exchange rates with lags whereas economic variables contemporaneously influence policy interest rates. Such a recursive ordering suggests minimum assumptions about the structure of the VAR model.

3.5.2. GMM

From empirical perspectives, it is not easy to have data of the expected value of variables of interest. Therefore, we use the ex-post value to replace the expected value. In this case, there is forecast errors, which incorporates into the error term. This leads to the fact that there will be a relationship between an explanatory variable and the error term, which is termed as the endogeneity problem.

The existing literature suggests many methods to solve the problem of endogeneity in the regression. In this thesis, we use the GMM method to estimate the reaction function specified in the section 3.3. The GMM estimator resolves the endogeneity problem by constructing a vector of instrumental variables that contains some or all of the elements of explanatory variables. Then, it solves for unknown parameters by using orthogonality conditions (see Equation 24), of which the idea is to match the sample moments $g_t(w_t, \beta)$ with the population moments $E[z_t \varepsilon_t]$=0:

$$E[g_t(w_t, \beta)] = E[z_t \varepsilon_t] = E[z_t(y_t - x_t^{'}\beta)] = 0 \quad (22)$$

Here, w_t is the nonconstant vector comprising response variable (y_t), explanatory variables (x_t), and instrumental variables (z_t).

Such a construction (Equation 22) refers to as the method of moment and the GMM model could be considered as a semiparametric estimation. According to Greene (2011), the semiparametric estimation has at least two advantages over the parametric estimation. Firstly, it is undertaken under fewer assumptions than the parametric estimation. The primary reason is that the removal of the distributional assumption of the former methodology. Secondly, the semiparametric estimation has a greater degree of robustness, meaning that it can remain the consistence across a wider range of specifications than the parametric estimation. For instance, the least squared estimation is robust whenever the data is well behaved and there is no relation between the regressors and disturbances. Moreover, the robustness of the least squared estimation accompanies with the asymmetric but nonnormal disturbance.

However, the semiparametric estimation achieves a high degree of robustness with a cost. The reason is that the distributional assumption is the main factor of an efficient estimation. Greene (2011) confirmed the inferiority of the best robust estimation over the parametric estimation in its class when the distributional assumption is correct.

The estimation of unknown parameters β is conditional on the order condition that the number of instruments (L) is equal to or greater than the number of explanatory variables (K). In justified case (L=K), the solution of β is unique under suitable regularity conditions. In over-justified case (L>K), there is no unique solution for β and the GMM solves the problem by minimizing the weighted sum of squares.

$$\hat{\beta}(W) = \arg\min_{\beta} g_n^{'} W g_n \tag{23}$$

where W is the weighting matrix, which is symmetric and positive definite.

The asymptotic variance-covariance matrix by GMM is:

$$V = (\Sigma_{xz}^{'} W \Sigma_{xz})^{-1} \Sigma_{xz}^{'} WSW \Sigma_{xz} (\Sigma_{xz}^{'} W \Sigma_{xz})^{-1} \tag{24}$$

In the case of under-identified case (L<K), it is impossible to find a unique solution for the equation (20).

Furthermore, the inflation expectation is not readily available in emerging economies. Therefore, we use the ex-post value of inflation to replace its expectation. This remedy introduces the forecast error, leading to the endogeneity problem. Hence, we apply the GMM method because it can solve the correlation between some regressors and the error term. The GMM method also has the advantage of correcting the problem of

autocorrelation and heteroskedasticity. In line with Kobbi and Gabsi (2019), we use the Newey-West procedure to correct the variance-covariance matrix.

In our estimation, inflation and output gap are considered as endogenous whereas exchange rates are considered as exogenous. Instruments are lags of endogenous and exogenous variables. Following Sznajderska (2014), we use the statistical significance of coefficients, the suitable signs of variables of interest, and the proper size of Hansen J statistics. The Hansen J statistic is used to test the validity of selected instruments. It should be large enough (greater than 5%) to support the validity of the instruments (Baum et al., 2007).

3.6. Structural breaks and stationarity

Since 2000, many events have led to disruptions in the operation of the world economy, which can cause changes in the behaviour of both economic participants and policymakers. Among others, the Great recession and the emergence of Coronavirus disease are remarkable events. In fact, the Global financial crisis seriously affected the international banking system, especially from 2007 to early 2009, which then put a damper on other activities of the economy in many countries. It took years for many countries to recover economic performance. In 2019, Coronavirus disease appeared and quickly spread over the world. It caused another disruption in the operation of the world economy. Many restrictions on citizen mobility are introduced to prevent the freely movement of people between areas in a country or from one country to other country. Although these policies could mitigate the infection, they affected the smooth flow of goods, labours, and finance, which in turn led to a reduction in production and a rise in the demand for daily products. Monetary authorities also need modifications in their implementation of monetary policy. In fact, Covid-19 pandemic still remained its negative effects until now. These structural breaks should be under consideration when conducting monetary policy analysis. However, data availability prevents the thesis from updating the analysis for the period after 2019. As a result, we keep the topic for future researches and put the emphasis on the effect of the Global financial crisis.

Regarding the effect of structural breaks, they can lead to sudden changes in economic variables such as output, inflation, or interest rates. Therefore, a stationarity test that can control for structural breaks is of importance to have a glance at the properties of time series and the necessity of robustness tests on structural break effects. Table 6 presents the results of the unit root test proposed by Andrews and Zivot (1992; 2002),

hereafter called ZA test. The results have two parts. While the first part indicates test statistic, significance level (star) and the order of integration in brackets ([]), the second part standing below shows the timing of the potential structural break. For instance, output in Brazil has the t statistic of -7.8. As shown, there is only one star (*), indicating the rejection of the null hypothesis of unit root at 1 percent. The number in the brackets suggest that output is stationary at level or its order of integration is zero. The next result indicates that output movement shows a sudden drift in March 2020.

Overall, the ZA test results indicate that variables have different order of integration, which can be represented by a mixture of I(0) and I(1) series. However, it should be noted that first differencing ensures the stationarity of all variables. Regarding the timing of structural breaks, it is apparent that the recent Global financial crisis has a significant impact on economic activities and the conduct of monetary policy in inflation-targeting emerging economies. Accordingly, variables show a sudden and permanent changes in their movement after 2008 although the specific time varies between countries and variables.

We also conducted another unit root test proposed by Clemente et al. (1998), hereafter referred to as CML test. This test complements the ZA test by allowing one or two breaks in the variable. For brevity, CML test results are put in the appendices section (appendix 15 to 18). In case of one structural break, the results show that variables have the integration order of 1 in most cases. Regarding interest rates, there are two groups. It is stationary at level in Brazil, Chile, Colombia, Turkey, Philippines, and Thailand whereas it requires first differencing to be stationary in other countries. As shown in Appendix 15 and 16, the Global financial crisis leads to the break in many variables in inflation-targeting emerging economies. Such findings are highly consistent with ZA test results.

When assuming two breaks, CML test results show that the period from the first to second break to a greater extent overlaps the Global financial crisis that occurred between 2007 and 2009. However, second differencing are needed to achieved stationarity in a few cases. Because of this, we are reluctant to relax the assumption of one structural break and conduct the analysis with double breaks.

Table 6: ZA test results

	Output	Price	M1	M2	Exchange rate	Interest rate
Brazil	-7.8*[0]	-7.84*[1]	-5.09**[0]	-7.55*[1]	-10.45*[1]	-4.9***[0]
	(2010m3)	(2003m3)	(2010m8)	(2009m1)	(2002m11)	(2014m11)
Chile	-5.21**[0]	-9.82*[1]	-5.47**[0]	-8.05*[1]	-10.7*[1]	-10.89*[1]
	(2008m5)	(2008m11)	(2009m12)	(2003m12)	(2004m2)	(2009m1)
Colombia	-7.37*[0]	-8.72*[1]	-6*[0]	-11.4*[1]	-10.03*[1]	-5.04***[1]
	(2006m5)	(2015m1)	(2005m12)	(2004m11)	(2014m8)	(2008m9)
Mexico	-6.65*[0]	-5.21**[0]	-6.12*[0]	-5.29**[0]	-9.85*[1]	-12.83*[1]
	(2008m11)	(2008m6)	(2008m1)	(2008m12)	(2009m4)	(2005m6)
Hungary	-6.65*[0]	-11.42*[1]	-9.79*[1]	-16.92*[1]	-6.10*[0]	-16.8*[1]
	(2008m12)	(2012m5)	(2008m4)	(2009m4)	(2008m10)	(2003m3)
Poland	-6.7*[0]	-10.56*[1]	-9.70*[1]	-20.42*[1]	-9.81*[1]	-5.05***[0]
	(2006m3)	(2003m9)	(2008m8)	(2003m5)	(2004m3)	(2003m2)
Romania	-18.61*[1]	-6.05*[0]	-5.08**[0]	-5.49**[0]	-11.53*[1]	-5.31**[0]
	(2013m9)	(2015m6)	(2006m12)	(2007m11)	(2007m8)	(2004m7)
Turkey	-7.09*[0]	-4.91***[0]	-7.32*[0]	-13.24*[0]	-10.04*[1]	-8.6*[0]
	(2008m8)	(2002m11)	(2005m12)	(2005m12)	(2003m2)	(2004m11)
Korea	-6.11*[0]	-5.03***[0]	-8.08*[1]	-7.79*[1]	-4.97***[0]	-6.99*[1]
	(2010m3)	(2010m12)	(2008m4)	(2010m7)	(2008m3)	(2008m9)
Philippines	-6.96*[0]	-7.76*[1]	-5.26**[0]	-4.91***[0]	-11.66*[1]	-10.01*[1]
	(2008m11)	(2008m8)	(2011m3)	(2013m6)	(2008m2)	(2002m12)
Thailand	-5.4**[0]	-10.99*[1]	-5.11**[0]	-7.68*[1]	-10.22*[1]	-5.86*[1]
	(2008m9)	(2008m7)	(2003m10)	(2010m9)	(2008m4)	(2006m8)
South	-8.5*[0]	-10.42*[1]	-13.23*[1]	-5.37**[0]	-11.44*[1]	-5.28**[1]
Africa	(2008m12)	(2002m12)	(2008m2)	(2009m6)	(2004m1)	(2008m8)

Source: Author's estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. [] indicates the order of integration, which can be 0 or 1. () indicates the timing of the structural break.

Two methods can be used to deal with the effect of the crisis in the baseline models. One is the sub-sample method that involves dividing the research sample into pre- and post-crisis subsample. The other method is adding time dummies into the benchmark analysis model. The first method can separately analyse the dynamic in the

relationship of concern under different scenarios. However, the conduct of this method is at the expense of losing information and degree of freedom. The time-dummy method can account for the effect of structural breaks while remaining the sample unchanged. For instance, Shambaugh (2004) used this method to control for common shocks in the analysis of the relationship between monetary policy and fixed exchange rate. Similarly, Juurikkala et al. (2011) used a set of time dummies when examining the role of banks in the transmission of monetary policy in Russia. The second method is more preferred in this thesis as the sample length is moderate, which is not long enough to apply the sub-sample method.

ARDL model is a proper choice to avoid loss of information and degree of freedom because it does not require all variables to be stationary before estimation such as GMM and VAR model do. In the ARDL model, variables can be purely I(1) or purely I(0) or a mixture of both. However, when variables are integrated at different level, they should be cointegrated, implying that they are bound together because of equilibrium forces. The existence of cointegration is examined by the bounds test proposed by Pesaran et al. (2001). Accordingly, a relatively high F statistic, which is greater than the critical value of F statistic at 5 percent, is more preferred. The thesis applied this method as another robustness test for the baseline models. There are several justifications for this choice. Firstly, the ARDL model can conduct estimations without first differencing; therefore, there is no loss in information or degree or freedom. Secondly, adding the time dummy into the ARDL model can also control for the effect of the structural break. Thirdly, it is likely that economic variables are influenced by their lags and the current and past values of other variables. For instance, current inflation is affected by its lagged values due to inertia and changes in policy interest rates or money supply in previous months. A ARDL model with an appropriate choice of lags can capture the dynamic relationship between monetary policy and economic variables. As noted by Gujarati (2014), the selection criteria of lag length can be Akaike, which is used in the thesis, or a similar information criterion.

CHAPTER 4: MEASURING MONETARY POLICY

4.1. Introduction

This chapter shows the empirical results related to the hypothesis 1 and 2. The first section discusses how and why money supply and interest rates contain equivalent power in explaining changes in monetary policy. The second section provides evidence for the role of MCI in the conduct of monetary policy in emerging economies that follow inflation targeting.

- Hypothesis 1: Interest rates and money supply contain comparable information about changes in monetary policy.
- Hypothesis 2: MCI is a useful indicator of monetary policy in emerging economies.

4.2. Money supply and interest rates as a measure of monetary policy

This section starts by discussing whether money supply and interest rates are useful to predict the evolution of inflation in emerging economies that follow inflation targeting. Then, it shows the result of impulse response function that can indicate the response of inflation to a positive shock of either money supply or interest rates. Finally, it indicates how strong money supply and interest rates can drive the variation of inflation.

4.2.1. Granger causality analysis

This section discusses how money supply and interest rates Granger cause inflation in inflation-targeting emerging economies. The Granger causality analysis is of importance because it indicates whether changes in monetary policy indicators can predict changes in inflation. It also complements the disadvantage of the correlation analysis in previous studies. However, it should be noted that the Granger causality analysis cannot specify the direction of changes in monetary policy objectives such as inflation after a decision of monetary authorities. Therefore, Granger causality evidence works as a supplement for the analysis of the impulse response function in the next section.

Table 7: Granger causality between monetary policy indicators and inflation

	$i \rightarrow \pi$	$\pi \rightarrow i$	$M1 \rightarrow \pi$	$\pi \rightarrow M1$	$M2 \rightarrow \pi$	$\pi \rightarrow M2$
Brazil	26.43*	18.17***	30*	42.51*	34.17*	27.17*
	(10-1)	(10-1)	(12-1)	(12-1)	(10-1)	(10-1)
Chile	5.79	51.9*	35.63*	32*	25.79*	20.66**
	(8-0)	(8-0)	(12-1)	(12-1)	(11-1)	(11-1)
Colombia	17.56	37.46*	42.19*	48.51*	38.9*	28.57*
	(12-0)	(12-0)	(12-1)	(12-1)	(12-1)	(12-1)
Mexico	26.09*	20.16**	67.26*	26.12**	19.1**	14.6***
	(9-0)	(9-0)	(12-1)	(12-1)	(8-1)	(8-1)
Hungary	15.97***	25.67*	30.35*	27.98*	23.34**	34.72*
	(9-1)	(9-1)	(12-1)	(12-1)	(12-0)	(12-0)
Poland	22.37*	27.35*	20.61***	31.17*	21.99**	12.64
	(8-0)	(8-0)	(12-1)	(12-1)	(12-1)	(12-1)
Romania	2.07	7.67**	17.17**	9.37	33.2*	32.1*
	(2-1)	(2-1)	(7-1)	(7-1)	(12-0)	(12-0)
Turkey	66.27*	49.11*	42.74*	7	23.98*	7.08
	(12-1)	(12-1)	(7-0)	(7-0)	(7-0)	(7-0)
Korea	5.02	8.78***	20.32***	32.51*	5.53	8.61***
	(4-1)	(4-1)	(12-1)	(12-1)	(4-1)	(4-1)
Philippines	15.42**	3.13	32.47*	14.83	21.68*	17.31**
	(6-1)	(6-1)	(12-1)	(12-1)	(7-1)	(7-1)
Thailand	3.68	94.85*	13.16	32.84*	26.06*	31.35*
	(7-1)	(7-1)	(12-1)	(12-1)	(8-1)	(8-1)
South Africa	11.93*	2.46	20.34**	51.08*	0.14	1.52
	(3-1)	(3-1)	(9-1)	(9-1)	(2-1)	(2-1)

Source: Author's estimation.

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. The optimal lag and maximum integration order are in the parentheses, respectively.

To account for the fact that variables are integrated at different levels, we use the augmented Granger causality test proposed by Toda and Yamamoto (1995). Table 7,shows that the maximum order of integration is one in most cases and the optimal lag selected by the AIC criterion varies across specifications. Overall, the results show that the causal relationship between monetary policy indicators and inflation is strong. Interest rates have a bidirectional Granger causality with inflation in most countries. The Granger causality from interest rates to inflation is statistically significant in many countries excepting Chile, Colombia, Romania, Korea, and Thailand. The reverse Granger causality is statistically significant in ten out of twelve countries. Regarding M1, it has a bidirectional causality with inflation in most countries. While it does not lead to changes in inflation in Thailand, the reverse causality does not hold for Romania, Turkey, and the Philippines. Turning to M2, it does not cause inflation in South Africa and Korea. On the contrary, inflation is useful to forecast changes in M2 in most countries excepting Poland, Turkey, and South Africa. According to the conventional theory, it is likely that a rise in the money supply can lead to a rise in inflation. In reverse, changes in inflation can cause changes in the money supply. One channel happens through changes in wages. Higher inflation can cause a rise in wages, which leads to a rise in production costs and a reduction in production. To avoid the contraction in the production and related economic activities, monetary authorities can increase the money supply. Another channel is the inflation expectation. In times of high inflation, the public can establish a high level of inflation expectation, which calls for a contraction in the supply of money.

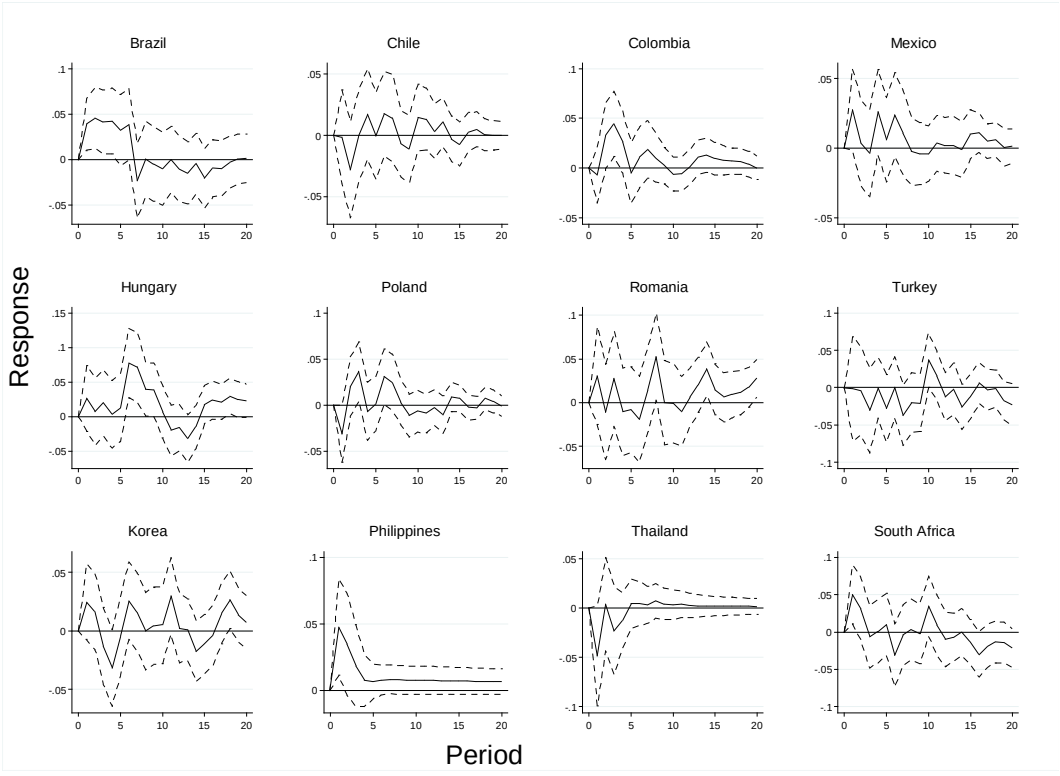
4.2.2. Impulse response function analysis

We proceed by separately investigating the effect of interest rates and money supply on inflation. Figure 7 shows that interest rates weakly affect inflation in emerging economies. Such a finding is in line with Acosta-Ormaechea and Coble (2011) in the sense that monetary policy weakly transmits through the traditional interest rate channel in emerging economies. A low degree of monetization, underdeveloped financial markets, and capital controls are factors that can lower the effectiveness of the interest rate policy in emerging economies.

Furthermore, interest rates have a positive effect on inflation in most economies, which has been termed as the price puzzle (Sims, 1992). For Poland and Thailand, interest rates negatively affect inflation in the first few months, which is consistent with the findings for advanced economies and most theoretical models. The presence of the price

puzzle has some possible interpretations. Firstly, interest rates are weak in representing the stance of monetary policy in emerging economies. To put it differently, a rise in interest rates cannot fully capture the expansionary and contractionary stance of monetary policy in emerging economies. Other variables such as money supply can play a role in measuring monetary policy. This problem is likely to emerge because monetary authorities in emerging economies use multiple instruments to achieve many objectives, including price stability, output growth, financial stability, exchange rate stability, and the adequacy of international reserves. Furthermore, the segmentation of credit markets can also reduce the representation of interest rates as an indicator of monetary policy in emerging economies. In summary, it is crucial to consider information from other indicators such as money supply when measuring the stance of monetary policy for emerging economies.

Figure 7: Response of inflation to positive interest rate shocks



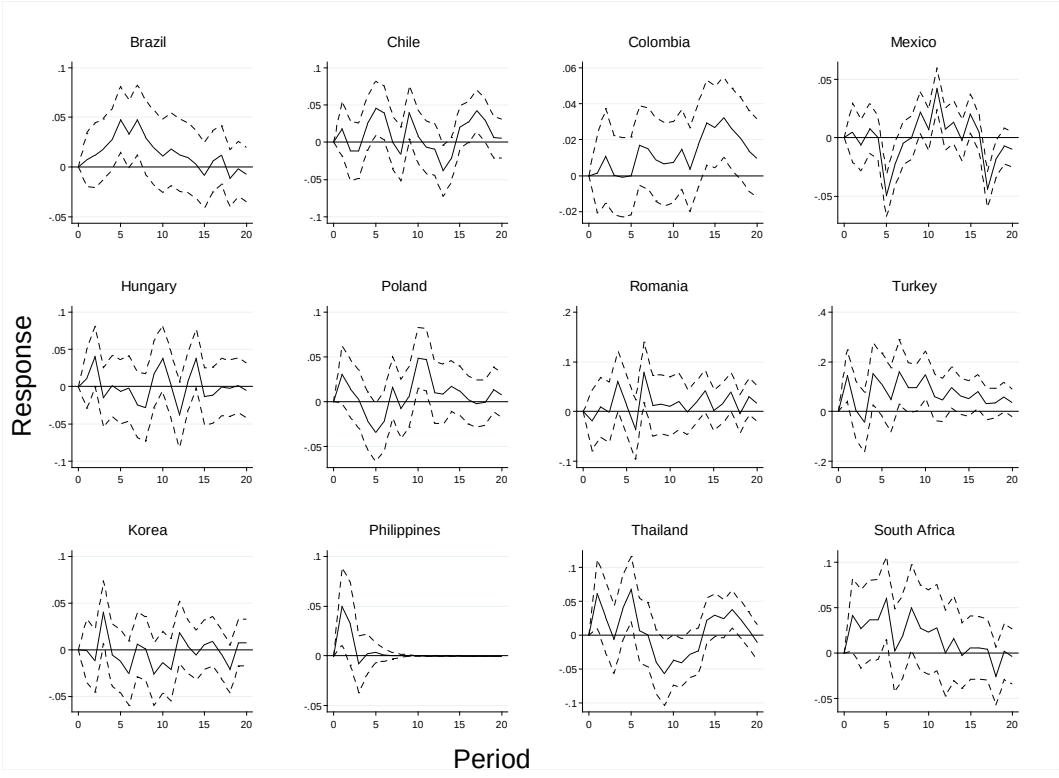
Source: Authors' construction

Secondly, the presence of the price puzzle can stem from the specification bias. The small-scaled nature of VAR model may lead to the exclusion of important information for inflation forecast (Sims, 1992; Bernanke and Mihov, 1998). Therefore, a remedy to solve the price puzzle is to add variables such as commodity or oil prices (Sims, 1992; Bernanke and Mihov, 1998). However, the robustness tests do not support the

speculation that the price puzzle is conditional on the misspecification.

Thirdly, the price puzzle can result from other reasons. One is the influence of monetary policy on the supply side of the economy (Barth and Ramey, 2001). Changes in interest rates can affect borrowing costs and then lead to changes in prices. If the effect of monetary policy on production costs dominates the effect on aggregate demand, prices are likely to increase rather than decrease following a monetary policy contraction. Moreover, information asymmetry can also lead to the price puzzle. Imperfect information may cause monetary policy responses to be insufficient or too late to control inflation. As a result, raising interest rates will increase rather than decrease inflation (Walsh, 2010). Furthermore, high inflation expectation can lead to the weak response of inflation to a monetary policy restriction and lengthen the period of disinflation (Mackiewicz-Łyziak, 2016).

Figure 8: Response of inflation to positive shocks of money supply M1

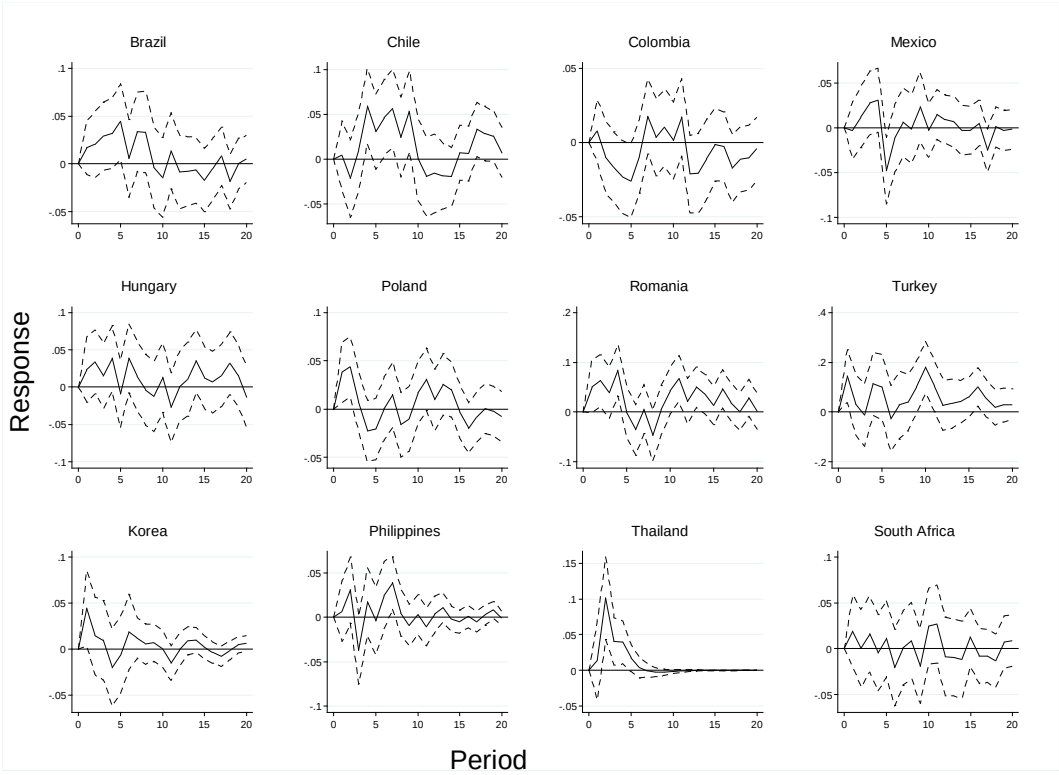


Source: Authors' construction

Turning to M1 and M2, Figure 8 and Figure 9 show that inflation positively reacts to positive shocks of M1 and M2 in most emerging economies. Such a positive effect shows a quick reduction and becomes neutral in the medium term. The finding is in line with the traditional conceptualization. However, it should be noted that the results are

quite different for Romania and Korea, whereby M1 has a negative effect on inflation. M2 has a quite similar pattern of impulse response function. Last but not least, the effect of monetary aggregates on inflation is statistically insignificant in most emerging economies. This finding suggests that changes in money supply can contain information about changes in monetary policy, but this role seems to be weak.

Figure 9: Response of inflation to positive shocks of money supply M2



Source: Authors' construction

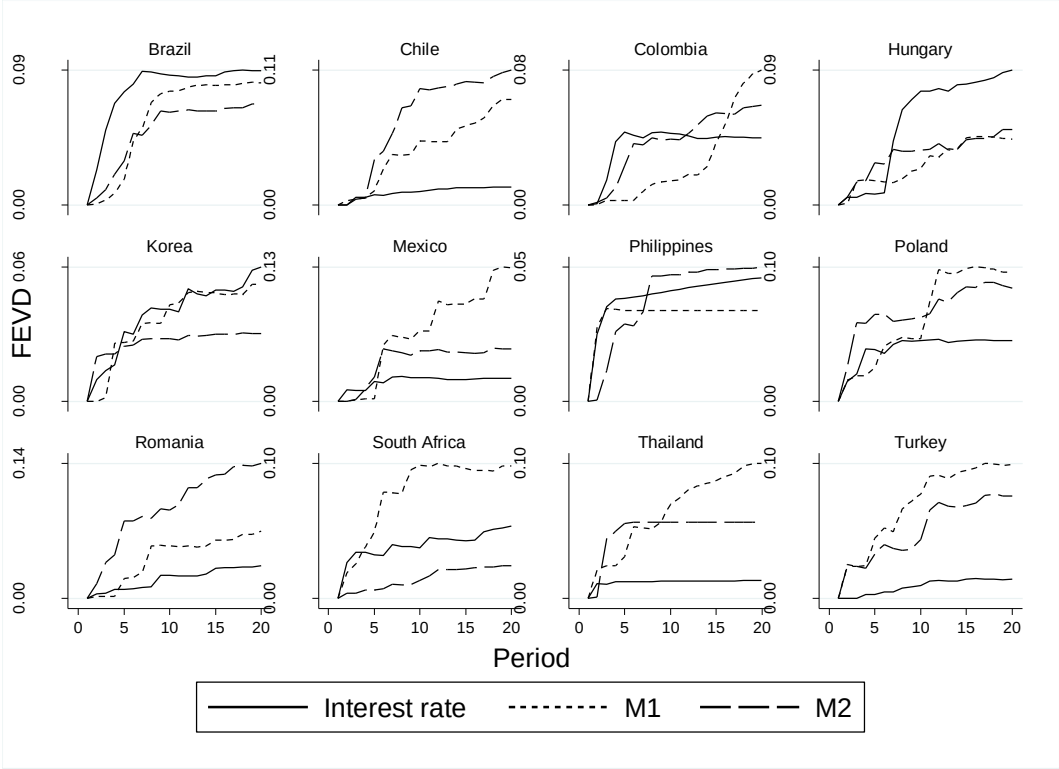
4.2.3. Forecast error variance decomposition analysis

This section presents the contribution of monetary policy indicators to inflation variation (see Figure 10). It can be seen that interest rates explain a greater part of the variation of inflation than money supply does in a few countries: Brazil or Hungary. In many countries, M1 and M2 explain more about the inflation variation than interest rates do. In Brazil, Colombia, Korea, Philippines, and Poland, interest rates and M2 have similar explanatory power on the inflation variation. Overall, money supply has a stronger power in explaining the inflation variation than interest rate.

In summary, the country evidence about the response of inflation to both money supply and interest rates suggests some interpretations. One, the misspecification causes difficulties in distinguishing the endogenous and exogenous components of monetary

policy changes. However, the robustness tests below show that this is less likely to happen. Two, neither interest rates nor money supply can fully capture the stance of monetary policy. The empirical results, especially Granger causality and FEVD, are supportive of the speculation that monetary policy is not fully captured by using a single indicator.

Figure 10: FEVD contribution of monetary policy indicators to inflation



Source: Authors' construction

4.2.4. Panel evidence

Furthermore, we also conducted panel analysis. To begin with, we perform the Dumitrescu and Hurlin (2012) test to determine whether monetary policy indicators Granger cause inflation. As observed, the panel VAR evidence is to some degree consistent with the country evidence (see Table 8). Monetary aggregates are useful to predict the inflation movement. However, interest rates are not a useful predictor of inflation. However, it should be noted that the results of panel Granger causality examine the causal relationship on the average basis rather than individual country. To put it differently, the panel data analysis indicates that the causal relationship between monetary policy indicators and inflation is highly likely to happen in group of inflation-targeting emerging economies.

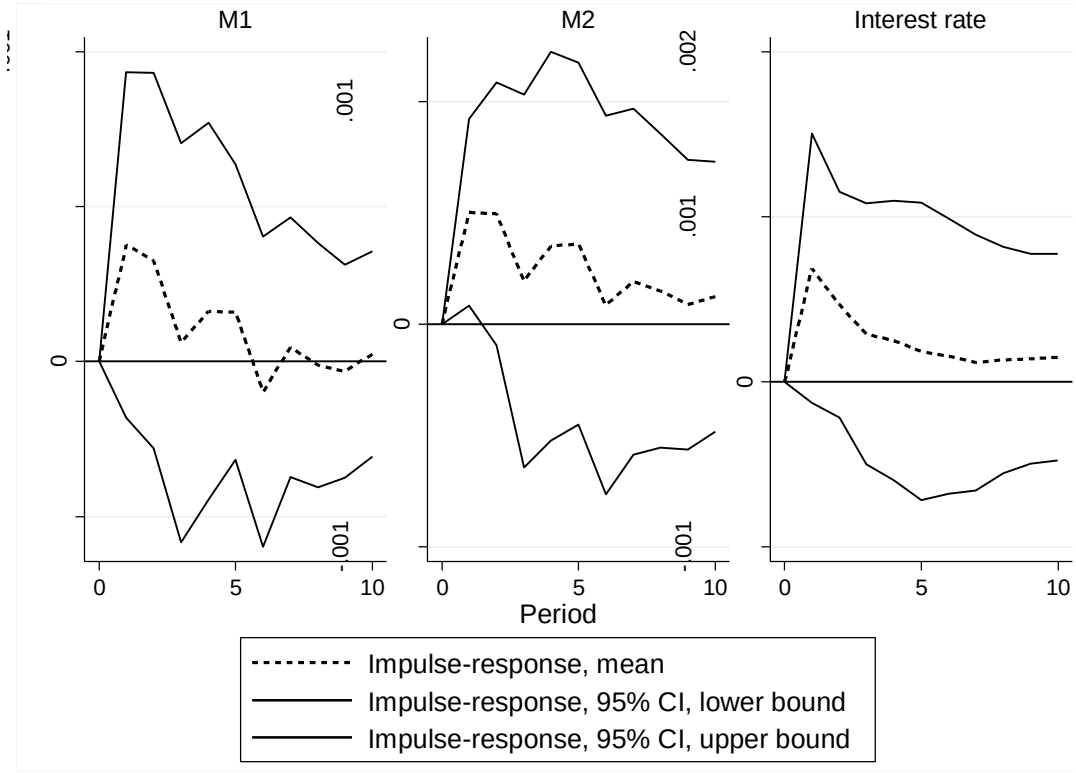
Table 8: The causal effect of monetary policy indicators on inflation

	$\bar{W}$	$\bar{Z}$	$\bar{Z}$ p-value
Interest rate	58.72	-0.38	0.70
M1	30.20	-2.92	0.00
M2	33.00	-2.67	0.01

Source: Authors' calculation

Figure 11 indicates the response of inflation to positive shocks of interest rates and money supply. Accordingly, interest rates have a temporary and positive effect on inflation, which is in line with the country evidence. However, the effect of interest rates is statistically insignificant, which is consistent with the time-series results for most of emerging economies. With respect to money supply, both M1 and M2 have a positive effect on inflation, which is in line with the theory. However, it should be noted that the response of inflation to shocks of M2 is statistically significant in the short run. The finding implies finance development can make a significant contribution to the implementation of monetary policy in inflation-targeting emerging economies.

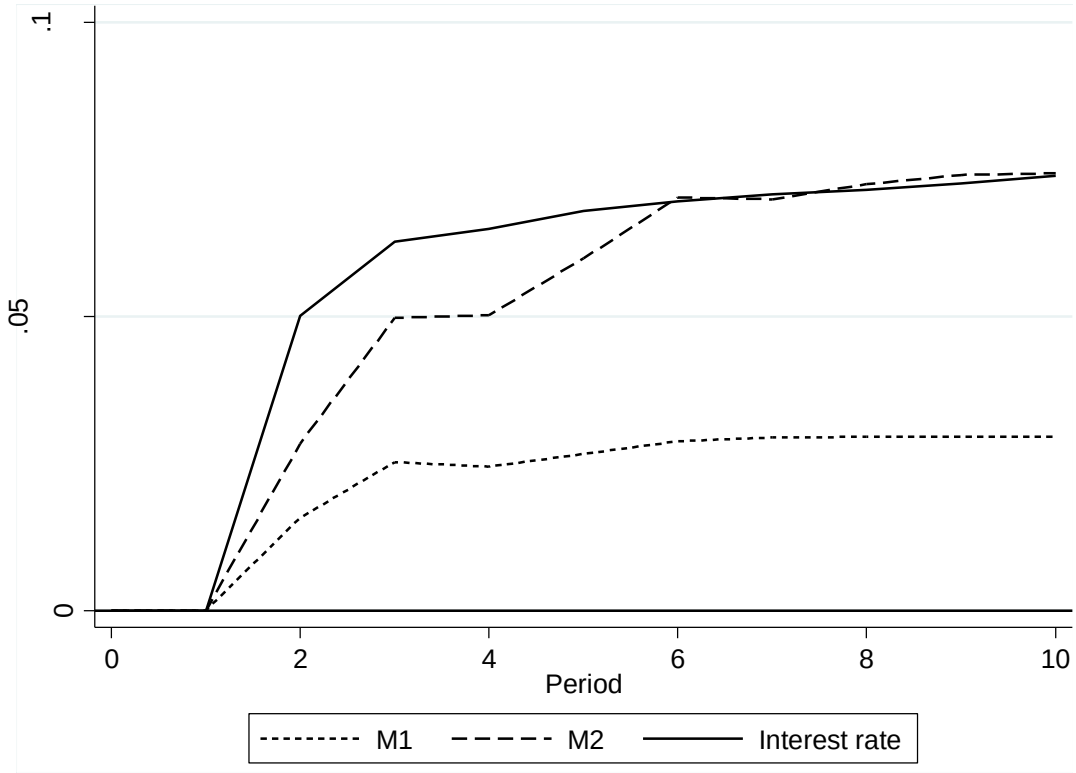
Figure 11: Response of inflation to positive shocks of monetary policy indicators



Source: Authors' construction

Figure 12 indicates the contribution of monetary policy indicators to inflation variation. Among indicators, interest rates make the greatest contribution, which doubles in size when comparing with M1. On the other hand, money supply explains a smaller percentage of the inflation variation. Since the line of M2 stands above the line of M1 over the study period, M2 explains more about the inflation variation than M1. This finding implies that finance development has a positive effect on the contribution of the money supply to the inflation variation.

Figure 12: FEVD of inflation to monetary policy indicators



Source: Authors' construction

Overall, the panel evidence, to a certain degree, supports the country evidence. The results of impulse response and FEVD indicate that it is not possible to determine the superiority of interest rates in measuring the stance of monetary policy in inflation-targeting emerging economies.

4.2.5. Robustness tests

Since the price puzzle may happen because of the exclusion of important information for inflation forecasts (Sims, 1992; Bernanke and Mihov, 1998). Therefore, an important robustness test of equation 4 is to add variables that can influence inflation expectation, such as commodity or oil prices. Since emerging economies are small and

open, they are considered price takers. Therefore, commodity or oil prices are considered as exogenous, and thus, they stay before other domestic variables in equation (4). To preserve the degree of freedom, we include these variables one at a time. The results (not shown) indicate that inflation response is similar to those shown in previous sections. Particularly, the price puzzle is still present. Money supply has a positive effect on inflation, which is consistent with the theories. Hence, the analysis indicates that the price puzzle does not stem from the failure of the VAR model in capturing important information in forecasting inflation. In other words, the price puzzle may be conditional on other factors such as the low representative power of interest rates in measuring the stance of monetary policy.

Following Acosta-Ormaechea and Coble (2011), we use the differential between domestic inflation and US inflation to replace the original measure of inflation in the equation (4). Since domestic prices are influenced by the movement of prices in large economies such as the US, the use of inflation differential can help isolate domestic inflation from external inflation. Another reason for the selection of the US inflation is that the US dollar is considered as an anchor currency and the US has a significant impact on emerging economies. The results indicate that the effectiveness of this solution is quite limited. The price puzzle does not disappear. Moreover, the empirical evidence is not supportive of the superiority of either interest rates or money supply.

Another robustness test refers to the effect of the structural break. Since 2000, the world has experienced common shocks that led to many changes in the behaviour of economic participants as well as the reaction of monetary authorities. Among others, the remarkable event is the occurrence of the Global financial crisis that seriously affected the world banking system, especially from 2007 to early 2009. In 2019, the world coped with another disruption caused by the widespread infection of the Coronavirus disease (COVID-19). The effect of the Covid-19 pandemic lasts until now. These structural breaks should get high attention. However, data availability prevents the thesis from updating the analysis for the period after 2019. As a result, we mainly focus on the effect of the Global financial crisis.

We used two methods to deal with the existence of structural breaks in the baseline models. One is to divide the research sample into pre- and post-crisis subsample and the other is to add time dummies in the analysis model. The first method can show separate pictures about the research problems at the cost of losing some information and degree of

freedom. The time-dummy method can account for the effect of the structural break while remaining the sample unchanged. The results of these methods are presented in the appendices section.

Appendix 1 and 2 presents how monetary policy indicators act as a predictor of inflation in inflation-targeting emerging economies during the pre- and post-crisis period. Accordingly, there are some changes in the causal relationship between inflation and indicators such as interest rate, M1 and M2. For instance, M1 changes can precede inflation before crisis in Brazil. However, this causal direction does not appear after the crisis in this country. A similar observation is found for the causality from inflation to M2 in Brazil. On the contrary, Brazil shows no changes in other causalities. Furthermore, it is apparent that the causal evidence cannot conclude the superiority of either interest rates or monetary aggregates in measuring monetary policy in Brazil. Similar observations happen in other countries, whereby both interest rates and money supply can be considered as a useful predictor of inflation in inflation-targeting economies. In a nutshell, the findings of the sub-sample analysis are highly consistent with those of the baseline analysis, section 4.2.1.

Nevertheless, there are no improvements regarding the presence of the price puzzle in the impulse response function of interest rates in the sub-sample analysis (Appendix 3). The price puzzle still exists in both pre- and post-crisis period. Regarding M1 and M2, they exhibit a positive effect on inflation, implying that their increases cause a rise in inflation (Appendix 4 and 5). Such an impulse response function resembles those of the baseline analysis and is consistent with monetary theories.

Turning to the second method, there are no changes in the general consensus about the superiority of either money supply and interest rates in measuring the stance of monetary policy (Appendix 6 to 9). Adding the time dummy does not solve the price puzzle in the response of inflation to a positive shock of interest rates. By contrast, inflation increases after a rise in money supply but its response is statistically insignificant in most economies. These findings are in line with the analysis in section 4.2.2.

Nevertheless, the FEVD results of the sub-sample and time-dummy method indicate that both money supply and interest rates are important drivers of inflation variation in emerging economies (appendix 10, 11, and 12). Despite these, there are some minor differences between the results of the baseline and these two methods. For instance, using FEVD of Figure 10 as a benchmark, it indicates that interest rates, M1, and M2

show equivalent contribution to the inflation variation in Brazil. However, the sub-sample analysis points out that money supply has greater explanatory power about the inflation variation before the Global financial crisis whereas interest rates make a greater contribution after the crisis. In Turkey, interest rates also become more important after the crisis. On the contrary, in Philippines, the contribution of M1 to the inflation variation is much greater than that of M2 or interest rates during the pre-crisis period while all monetary policy indicators show a comparable contribution during the post-crisis period, which is more in line with the results presented in the benchmark method. Furthermore, adding the time dummy does not change the general conclusion about how interest rates, M1, and M2 drive the inflation variation in inflation-targeting emerging economies.

The results of both sub-sample and time-dummies analysis implies the robustness of the empirical findings to the structural break. The occurrence of the crisis does not affect the general consensus that both money supply and interest rates contain comparable information about changes in monetary policy in inflation-targeting emerging economies. Furthermore, these tests provide more evidence that the price puzzle does not stem from the misspecification of the VAR model. The practice of using multiple instruments suggest that other instruments can contain important information about the intention of monetary policy. In other words, interest rates may not fully reflect any changes in the stance of monetary policy in inflation-targeting emerging economies.

The analysis proceeds by relaxing the stationarity conditions. Particularly, the ARDL models are used because they can apply for variables that are purely I(1), purely I(0), or the mixture of both. As shown in the last column of Table 9, the results of bounds test proposed by Pesaran et al. (2001) provide a relatively high F statistics, which are greater than the critical value of the F statistic at 5 percent (3.79) in all economies. The finding implies a long-run relationship exists between variables. Furthermore, the coefficient of error correction (EC) is negative and significant, suggesting short-term unbalance in inflation will slowly adjust toward its equilibrium state. The higher the absolute value of the error correction coefficient is, the faster the movement of inflation toward the long-run equilibrium. It seems that the adjustment is speedy in Turkey whereas it is moderate in other emerging economies.

Turning to the bond between inflation and monetary policy indicators, both interest rates and M2 have a significant effect on inflation in Brazil, Chile, Colombia, Turkey, and Thailand. M2 plays a more pronounced role in the evolution of inflation in

Mexico, Hungary, Korea, Philippines, and South Africa. In these emerging economies, an increase in the stock of money leads to a rise in inflation, which is as expected and consistent with monetary theories.

Table 9: ARDL estimates of the long-run inflation effect of monetary policy indicators

	EC	Y	IR	M2	EX	T	F
Brazil	-0.035*	0.136	0.008**	0.446*	-0.215*	-0.050	5.60
	(0.008)	(0.134)	(0.003)	(0.033)	(0.052)	(0.034)	
Chile	-0.047**	-0.032	-0.007***	0.330*	0.035	-0.066	4.30
	(0.022)	(0.147)	(0.004)	(0.059)	(0.100)	(0.058)	
Colombia	-0.026*	0.797*	-0.012*	0.126*	-0.284*	0.029	6.77
	(0.006)	(0.184)	(0.004)	(0.046)	(0.059)	(0.032)	
Mexico	-0.048**	0.379	0.001	0.235**	-0.179***	0.064	4.49
	(0.023)	(0.308)	(0.003)	(0.101)	(0.105)	(0.040)	
Hungary	-0.029*	-0.027	0.009	0.380*	-0.572**	0.016	6.41
	(0.008)	(0.115)	(0.007)	(0.086)	(0.253)	(0.049)	
Poland	-0.034*	0.580*	0.007***	-0.149	-0.281**	0.109*	5.24
	(0.010)	(0.194)	(0.004)	(0.120)	(0.124)	(0.039)	
Romania	-0.025***	-0.165	-0.000	0.117	-0.162	0.063	16.13
	(0.013)	(0.189)	(0.007)	(0.128)	(0.232)	(0.100)	
Turkey	-0.067*	0.317*	0.005**	0.154*	-0.513*	0.084**	17.23
	(0.012)	(0.117)	(0.002)	(0.043)	(0.064)	(0.035)	
Korea	-0.078*	0.278*	-0.000	0.139*	-0.022	0.013	3.95
	(0.021)	(0.078)	(0.005)	(0.053)	(0.058)	(0.019)	
Philippines	0.008	0.023	0.022	0.322**	1.160	0.024	1.03
	(0.010)	(0.363)	(0.053)	(0.155)	(1.181)	(0.200)	
Thailand	-0.133*	0.130*	0.008**	0.203*	0.141**	0.027***	5.83
	(0.031)	(0.023)	(0.003)	(0.015)	(0.056)	(0.014)	
South	-0.028*	-0.374**	0.003	0.309*	-0.283*	0.160*	9.89
Africa	(0.006)	(0.159)	(0.007)	(0.044)	(0.043)	(0.045)	

Source: Author's estimation

Notes: *, **, *** indicates the significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses. T denotes the time dummy.

Meanwhile, interest rate coefficients are positive but insignificant, which is in line with the finding of the price puzzle in the baseline models. Nevertheless, the interest rate effect is significant in Poland whereas both indicators have an insignificant effect in Romania. In Chile and Romania, the interest rate effect is negative, which to certain extent resembles the impulse response function results of the baseline models. In a nutshell, the ARDL results are supportive of the finding of the baseline models that both interest rates and money supply contain comparable information about changes in the stance of monetary policy.

In summary, there is robust evidence supporting the argument that the price puzzle is not conditional on the misspecification. Since both interest rates and money supply have comparable power in explaining the movement of inflation in emerging economies, it is likely that the price puzzle stems from the low representation of interest rates in measuring the stance of monetary policy. Hence, a composite index may be better than any single indicator in measuring monetary policy. There are several ways to construct this composite index. One example is the monetary condition index which is the weighted average of changes in exchange rates and interest rates relative to a benchmark level (Batini and Turnbull, 2002; Qayyum, 2002). Another example is to use the component derived from the Principal component analysis of various monetary policy instruments (Memon and Jabeen, 2018).

4.2.6. Conclusion

What should be the representative indicator of monetary policy: interest rates or money supply? While the literature is vast for advanced economies, it is quite limited for emerging economies. This section attempts to investigate how money supply and interest rates act as a measure of monetary policy through the analysis of Granger causality, impulse response function, and forecast error variance decomposition. The empirical results indicate that both money supply and interest rates have a significant causal effect on inflation. Moreover, both have a comparable power in explaining the inflation variation. However, in most emerging economies, the inflation response to interest rates is weak and of unexpected sign whereas money supply has a positive and expected effect on inflation.

The existence of the price puzzle when measuring monetary policy by interest rates suggests some explanations and policy recommendations. One, interest rates cannot fully capture the stance of monetary policy. This means that part of monetary policy

intention is included in the change of other monetary policy instruments. It is highly likely to happen in emerging economies where monetary authorities use multiple instruments, which stems from the influence of other objectives than price stability and the incomplete knowledge about the structure of the economy. Since both money supply and interest rates contain information about changes in monetary policy, a composite indicator can be a better measure of monetary policy. Another suggestion is to explicitly consider the influence of money supply in the interest rate reaction function.

Two, interest rate policies may have a limited impact on inflation. To increase the effectiveness of the interest rate policy, monetary authorities should put emphasis on the objective of price stability. This requires greater independence of the central bank, and thus more reforms should be implemented in the financial system. Future reforms should allow monetary authorities to have more power in determining objectives and instruments of monetary policy as well as specify penalties when not fulfilling inflation targets. Another suggestion is to improve the forecast of inflation. The reason is that underestimating inflation expectation reduces the response of interest rates to inflation, leading to the fact that a rise in interest rates is not high enough to reduce inflation. Therefore, the performance of inflation forecast is crucial to improve interest rate policies. There are several tools to obtain a better forecast of inflation: (1) understanding the drivers of inflation and the structure of the Phillips curve and (2) using forward guidance to improve the transparency of monetary policy (Mackiewicz-Łyziak, 2016). Finally, improvements in the financial system can contribute to the effective implementation of monetary policy. A greater volume of financial instruments and a higher level of financial development can improve the transmission of the interest rate channel.

4.3. MCI as a measure of monetary policy

This section provides empirical results for hypothesis 2, which involves the role of MCI in measuring the stance of monetary policy for emerging economies that follow inflation targeting. To begin with, it shows discussions about the construction of MCI through the VAR model. Then, it provides evidence for the importance of MCI by emphasizing on the absence of the price puzzle.

- Hypothesis 2: MCI is a useful indicator of monetary policy in emerging economies.

4.3.1. Empirical results

This section starts by presenting the empirical results about the construction of MCI for emerging economies. As MCI components, interest rates and exchange rates, require time to realize their effect on inflation, the VAR model is a proper choice to estimate the inflation equation. In addition to this, the VAR model can capture the simultaneous interaction between variables in the model, which is termed as the endogeneity problem.

As shown in Table 10, the lagged values of exchange rates and interest rates are useful indicators of inflation. It should be noted that Table 10 puts the emphasis on the statistically significant coefficients of MCI components. Accordingly, although these variables exhibit a lagged effect on inflation, a few coefficients are statistically significant. For instance, in Brazil, four lags of exchange rates have significant effect on inflation: 1, 7, 8, and 9. Regarding interest rates, lag 1, 4, 9, and 11 have a significant effect on inflation. For Chile, the relationship shows a different pattern. In Chile, exchange rates realise their impact on inflation at lag 1, 2, 3, 5, 11, and 18. Concerning interest rates, they show a statistically significant effect on inflation only at lag 11 and 13. In other countries, inflation also show a quite similar pattern of the inflation response to exchange rates and interest rates.

Table 11 presents the relative significance of interest rates and exchange rates in the construction of MCI. It should be noted that the focus is on the statistically significant coefficients of MCI components (Table 10) that are shown in the inflation equation in the VAR model (Equation 6: $\pi_t = \alpha + \alpha_i i_t + \alpha_e \Delta e_t + \alpha_z z_t$). As observed, exchange rates play a relatively important role. The weight of exchange rates has a significant size in emerging economies such as Mexico, Hungary, Poland, Romania, and Thailand. In these economies, exchange rates have a high weight, greater than 0.10. In other emerging economies, exchange rates play a non-trivial role, fluctuating in the range from 0.05 to 0.09. Nevertheless, they play an insignificant role in Korea, Brazil, and South Africa, being under 0.05.

Overall, the weight of exchange rates is less than that of interest rates in emerging economies. Such a finding is consistent with Ericsson et al. (1998) and Hyder and Khan (2007), whereby the weight of MCI components is derived from the inflation equation. It is contrast with the empirical estimates derived from the output equation in Hyder and Khan (2007). The importance of exchange rates in these countries suggest that it is a good

choice to use the MCI to measure changes in the stance of monetary policy. The significance of exchange rates can also support the relevance of the MCI and its ignorance would increase the volatility of monetary condition (Knedlik, 2006). However, it should also be noted that the small weight of exchange rates implies that the MCI may have little use in Korea, Brazil, and South Africa.

We further investigate the significance of MCI as an indicator of monetary policy in emerging economies by observing the response of inflation to a positive shock of MCI. As shown in Figure 13, inflation shows a negative and significant response to MCI shocks in most emerging economies. To begin with, inflation shows an immediate reduction following a monetary policy contraction (a positive MCI shock) in Chile and Colombia. In other emerging economies, the negative response of inflation is visible in the very short run, from the one-month ahead. In Philippines, inflation shows a negative response to MCI shocks but such a response is not statistically significant.

The absence of the price puzzle when using MCI as a measure of monetary policy in most emerging economies provides supportive evidence for the argument in the section 4.2 that a composite index can better measure the stance of monetary policy than any single indicator does in inflation-targeting emerging economies. In fact, the section 4.2 shows empirical results about the relative significance of interest rates and monetary aggregates as a monetary policy indicator by using a pallet of methods such as Granger causality test, impulse response function, and forecast error variance decomposition. Accordingly, it shows that the price puzzle appears after a contractionary shock of interest rate. The robustness analysis also suggest that interest rates cannot fully reflect changes in the stance of monetary policy and more information about monetary policy stance stems from the use of other instruments. Therefore, the finding about the superiority of MCI in mitigating the price puzzle problem sheds light on how to measure monetary policy in inflation-targeting emerging economies.

Furthermore, the stabilizing effect of MCI on inflation is in line with Berument (2007). However, it should be noted that the spread constructed by Berument (2007) implies that that interest rates and exchange rates are equally important. In this thesis, exchange rates have a smaller weight. Therefore, they may show a reduction in its importance since the crisis in the early 2000s in Turkey.

Table 10: Coefficients on interest rates and exchange rates

Country	Exchange rate	Interest rate
Brazil	[1].165*; [7]-.344*; [8].459*; [9]-.244***	[1]-.013*; [4]-.015*; [9]-.011**; [11]-.01***
Chile	[1].224***; [2]-.469***; [3].426***; [5]-.108***; [11].089***; [18]-.091*	[11]-.025**; [13]-.022**
Colombia	[4]-.182***	[1]-.021*; [3]-.018*; [4].014*; [5]-.025*; [6].016*; [7]-.018*; [8].017*; [9]-.015**; [11]-.023*; [12].014**; [13]-.011**; [14].012**
Mexico	[12].088***	[2]-.016**; [3].015***; [13].018**
Hungary	[6].109**; [8]-.097**	[3]-.035**; [5]-.045*; [6]-.03***; [7]-.034**
Poland	[1]-.084**; [2].143*; [4]-.092***; [6].094**; [8]-.065***	[1]-.023**; [4]-.016***; [5]-.018***
Romania	[9]-.118**	[1]-.05**; [11].062**
Turkey	[6].092***; [7]-.107***; [8].091***; [10].133*; [11]-.124*	[4]-.051*; [8]-.026***
Korea	[12]-.756***	[11]-.021***; [17]-.029*
Philippines	[1].174***; [2]-.274***; [15].199***; [16]-.138**	[2].033**
Thailand	[9]-.502***	[2].076*; [4].055**; [5]-.076*; [6].065**; [9]-.067**
South Africa	[1].373**; [7].411***; [11]-.467**	[1]-.014**; [4]-.016**; [7]-.019*; [13]-.014**

Source: Author's estimation.

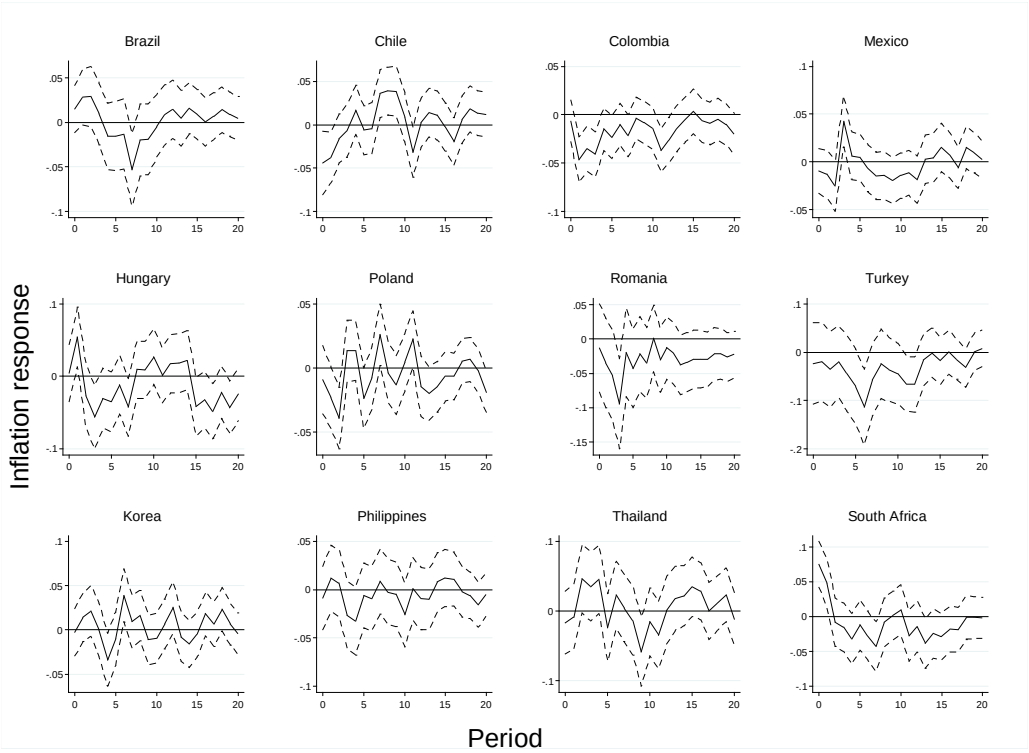
Notes: The lag order of statistically significant coefficients is in parentheses. ***, **, * denote significance at 10%, 5%, and 1%, respectively.

Table 11: Weights on exchange rates and interest rates in MCI

	Lag	β_e	β_i
Brazil	12	0.03	0.97
Chile	18	0.05	0.95
Colombia	14	0.07	0.93
Mexico	14	0.13	0.87
Hungary	8	0.19	0.81
Poland	8	0.11	0.89
Romania	12	0.11	0.89
Turkey	13	0.06	0.94
Korea	19	0.01	0.99
Philippines	16	0.08	0.92
Thailand	10	0.12	0.88
South Africa	13	0.03	0.97

Source: Author's estimation

Figure 13: Response of inflation to positive innovations of MCI



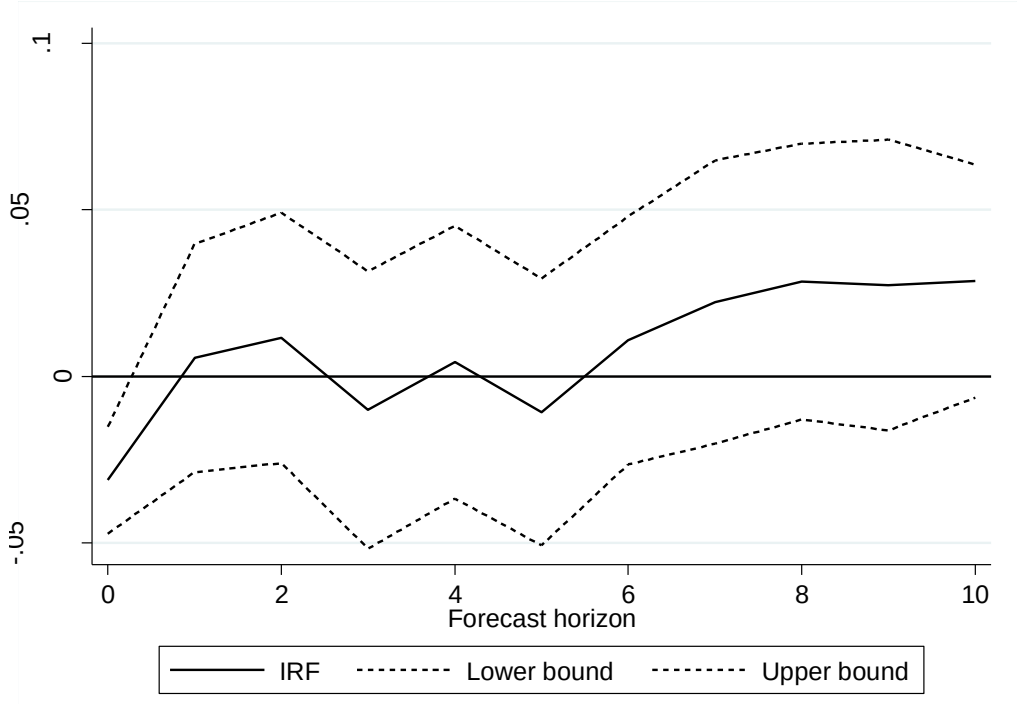
Source: Author's construction

The findings have some implications. As aforementioned, inflation reduces after a contractionary shock of monetary policy represented by a positive shock of MCI. Such a finding implies that MCI can be considered as a useful indicator of monetary policy in emerging economies that follow inflation targeting. Furthermore, the fact that MCI mitigates the price puzzle problem provides supportive empirical evidence for the argument that interest rates may not fully capture changes in the stance of monetary policy in those economies. It also suggests that a composite index can be a good choice to solve the problem of price puzzle in the analysis of monetary policy.

4.3.2. Panel evidence

In addition, a panel analysis is conducted since it has some advantages over time-series data. According to Baltagi (2005), it contains more information, which can increase the variability of data and reduce the problem of multicollinearity that usually happens in the time-series analysis. As shown in Figure 14, a positive shock of MCI has a negative and statistically significant effect on the movement of inflation in emerging economies, which is consistent with most theoretical models. As observed, MCI shows a negative effect on impact. However, the effect of MCI bounces back and fades out quickly. Such an economic meaningful response of inflation indicates the usefulness of MCI as an indicator of monetary policy in inflation-targeting emerging economies.

Figure 14: Panel evidence about the inflation response to MCI



Source: Authors' construction

4.3.3. Robustness tests

The thesis conducted a series of tests to ensure the robustness of the empirical results. To begin with, the VAR estimation is performed with different lag orders, ranging from 3 to 18. Stability and autocorrelation tests are applied to all regressions. The results (not shown) show that there is no change in the general conclusion about the role of MCI. In fact, the price puzzle does not emerge in most emerging economies. Another robustness test involves changing the base value of exchange rates and interest rates specified in equation 5. For robustness test, we select the value of exchange rates and interest rates in January 2000 and January 2005 as new base values. Accordingly, the impulse response function shows similar patterns to those derived from baseline models.

Furthermore, the Global financial crisis has a considerable impact many economies. It led to changes in the implementation of monetary policy. The thesis considered such an impact on the role of MCI by adding a time dummy, which can control for the potential effect of the crisis.

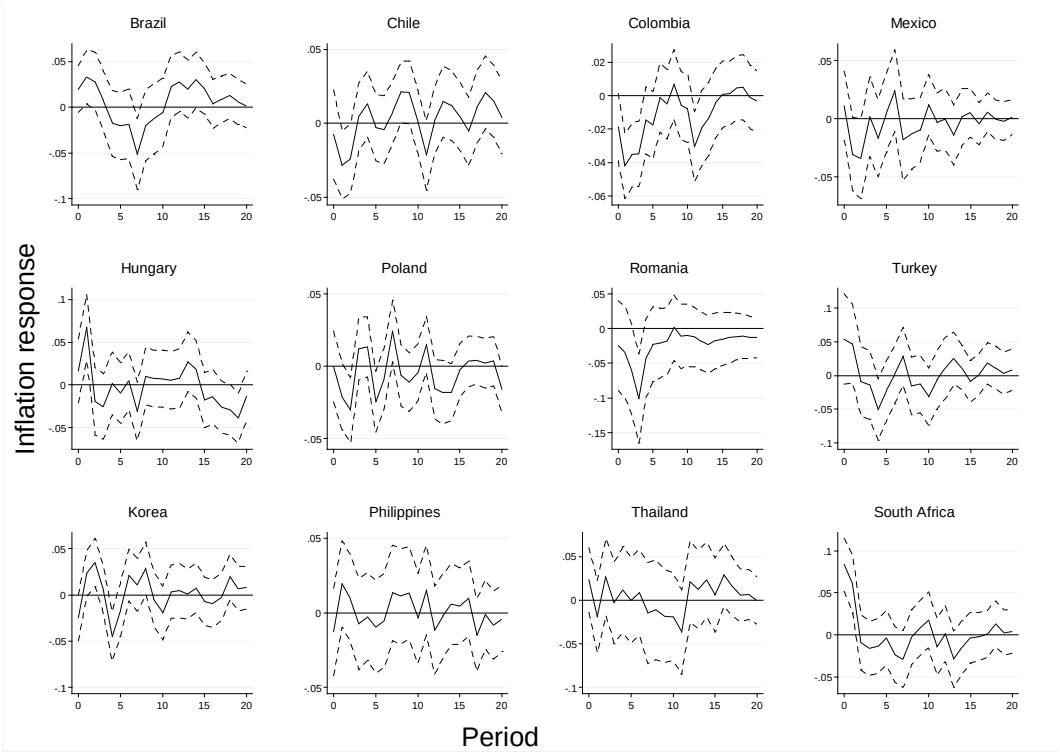
Figure 15 indicates that inflation shows an immediate reduction after a contraction in monetary policy, represented by a positive shock of MCI, in Chile, Colombia, Poland, Romania, and Korea. Furthermore, interest rates quickly realise the negative effect on inflation in other countries: Brazil, Mexico, Hungary and Turkey. In the remaining countries, there is no sign of price puzzle. The absence of price puzzle is highly consistent with the finding of the baseline model. Therefore, it implies the robustness of empirical results to the structural break.

The analysis proceeds by conducting ARDL estimations with the inclusion of variables in the baseline models, M2 and a time dummy. M2 is included because it contains important information about changes in monetary policy. Including the time dummy is of importance to control for the effect of the Global financial crisis. It should be noted variables are the mixture of I(1) and I(0) series and Table 12 indicates that they are cointegrated. The F statistics are greater than the critical value at 5% (4.01), excepting for Mexico of which the F statistic is 3.78 and greater than the critical value at 10% (3.52).

The coefficient of error correction (EC) is negative and significant in all emerging economies, suggesting the gradual movement of inflation toward its long-run equilibrium. The figure is high in Chile, Korea, and Thailand, which is greater than 10%. This indicates quick adjustment of inflation in these economies.

Regarding the MCI, it does not have a significant effect on inflation in the long run in most inflation-targeting emerging economies, excepting for Chile and South Africa. It suggests that MCI is not useful to predict or adjust inflation in the long run. This phenomenon is conditional on the construction of MCI, which cause difficulties in the interpretation of its effect on inflation, especially when there is inverse relationship between interest rates and exchange rate. Another problem is changes in the weight of its components. On the other hand, a rise in MCI leads to a fall in inflation in many countries in the short run, which is as expected and in line with monetary theories. Such a finding is also consistent with the finding of baseline model (section 4.3.1).

Figure 15: Response of inflation to positive innovations of MCI (time dummy is included)



Source: Author's construction

Table 12: Short- and long-run response of inflation to MCI (ARDL estimation)

	EC[(a)]	Long run	Short run					
			D[(b)]	LD	L2D	L3D	L4D	F[(c)]
Brazil	-0.023*	0.005	0.0008***	-0.0004	0.0001	0.0003	-0.0009**	4.51
	(0.006)	(0.004)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0004)	
Chile	-0.116*	0.002***	0.0003***					7.00
	(0.029)	(0.001)	(0.0001)					
Colombia	-0.041*	-0.001	-0.0001	0.0001	0.0001	0.0003		7.77
	(0.009)	(0.003)	(0.0004)	(0.0003)	(0.0003)	(0.0003)		
Mexico	0.031	0.009	-0.0000	0.0001	-0.0003	0.0003	-0.0002	3.78
	(0.039)	(0.008)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	
Hungary	-0.076*	0.011*	0.0004	-0.0004	-0.0007**	-0.0006***		8.03
	(0.013)	(0.003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)		
Poland	-0.079*	0.002	-0.0001	-0.0009*	-0.0007**			10.67
	(0.015)	(0.002)	(0.0003)	(0.0003)	(0.0003)			
Romania	-0.059*	-0.002	-0.0001					5.57
	(0.017)	(0.002)	(0.0001)					
Turkey	-0.074*	0.001	0.0001	-0.0005*				12.77
	(0.014)	(0.001)	(0.0001)	(0.0001)				
Korea	-0.130*	0.004	0.0003	0.0016	0.0012	-0.0003	-0.0033**	9.93
	(0.025)	(0.003)	(0.0016)	(0.0018)	(0.0018)	(0.0018)	(0.0015)	
Philippines	-0.058*	-0.002	0.0003	0.0007	-0.0011***	-0.0012***	-0.0012***	9.11
	(0.013)	(0.008)	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(0.0006)	
Thailand	-0.246*	-0.000	0.0002	-0.0019**				14.85
	(0.029)	(0.001)	(0.0009)	(0.0009)				
South	-0.041*	0.012**	0.0022*	0.0016**				17.71
Africa	(0.006)	(0.005)	(0.0008)	(0.0007)				

Source: Author's estimation. Note: *, **, ** denote significance at 1, 5, and 10% respectively. Standard errors in the parentheses. (a), (b), and (c) imply the error correction, distributed lags, and F statistic of Pesaran et al. (2001) bounds test.

4.3.4. Conclusion

Measuring monetary policy is the first step to analyse the effect and transmission of monetary policy. However, the significance of the exchange rate channel questions the

relevance of MCI, which is the weighted average of the deviation of exchange rates and interest rates from their baseline value, as an indicator of monetary policy in emerging economies. The objective of this thesis is to investigate whether MCI can capture changes in the stance of monetary policy in emerging economies that following inflation targeting.

The empirical results show that inflation shows a negative and statistically significant response to a positive MCI shock, a proxy for a contraction in monetary policy, in most emerging economies. Such an impulse response is of expected sign, economic meaningful, and consistent with most theoretical models. Therefore, MCI can be considered as a useful indicator of monetary policy and it can be used to predict the movement of inflation. However, this does not mean that MCI should be used as an operational target, especially when there is a systematic negative interaction between interest rates and exchange rates (Engelbrecht and Loomes, 2002). Furthermore, using MCI as an operational target is difficult due to the consideration of adjustment timing and additional information (Ericsson et al., 1998).

The empirical results provide crucial policy implications. Firstly, it provides supportive evidence for the argument that interest rates can capture only a part of information about change in the stance of monetary policy in emerging economies that follow inflation targeting. In other words, a composite index such as MCI can better indicate whether monetary policy is easing or tightening. However, it should be noted that MCI is not a recommendation as an operational target in the conduct of monetary policy. Secondly, the importance of MCI also implies that both interest rates and exchange rates are active transmission channels in inflation-targeting emerging economies. Since exchange rates play an important role in emerging economies, the market participants should consider it when analysing the intention of the central bank in inflation-targeting emerging economies. Finally, the public can use MCI to have a more accurate assessment of changes in the stance of monetary policy. They can also incorporate information of MCI into that of other instruments at their disposal when analysing the expected movement of inflation.

It should also be noted that the construction of MCI in the thesis copes with some limits. Firstly, to interpret the monetary conditions, it is better to observe the movement rather than the value of MCI, which is in line with the finding and suggestion of Nucu and Anton (2018). Such a weakness prevents the use of MCI as a technical instrument through which monetary authorities can make a decision. Secondly, the public copes with

difficulties when predicting the effect of MCI on inflation when there is an inverse relationship between interest rates and exchange rates (Engelbrecht and Loomes, 2002). Finally, the thesis does not consider the time-varying characteristic of the weight of MCI components. Since the later 1990s, the implementation of financial reforms and the adoption of inflation targeting leads to an improvement in the interest rate channel as well as a reduction in the importance of exchange rates. Therefore, time-varying weights deserve further investigations in future studies.

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CHAPTER 5: REACTION FUNCTION OF MONETARY POLICY

5.1. Introduction

This chapter shows the empirical results for the hypothesis 3, 4, and 5, which are related to the identification of the reaction function of monetary policy for emerging economies that follow inflation targeting.

- Hypothesis 3: Exchange rate shocks have a significant influence on monetary policy in emerging economies.
- Hypothesis 4: Foreign reserves shocks have a significant influence on monetary policy in emerging economies.
- Hypothesis 5: Monetary authorities in emerging economies asymmetrically respond to positive and negative inflation gap and output gap.

Studying the behaviour of the central bank is an ongoing controversial issue in the analysis of monetary policy. To better understanding the conduct of monetary policy, it is of interest to study how to simply approximate the process of making a policy decision by monetary authorities. Taylor (1993) suggests that the rule of interest rate setting can be formulated by optimizing the policy objective function, which is expressed as a quadratic function, within the constraint of a linear economic system. On the one hand, the quadratic function puts the same weight on objective variables such as output or inflation. It implies the equal weight of inflation and output gap in the reaction function of monetary policy. Therefore, monetary authorities show indifference to the positive and negative shock of inflation and output gap.

On the other hand, a linear economic system implies the evolution of aggregate demand and aggregate supply are linear functions. Compared to aggregate demand, the properties of aggregate supply play an important role in the conduct of monetary policy. Aggregate supply defines crucial explanatory variables that explain the evolution of prices or inflation. In the framework of inflation targeting, price stability is the primary objective of monetary policy, thereby the shape of aggregate supply has a significant effect on the setting of interest rate.

The literature based on the seminal work of Taylor (1993) is vast for advanced economies. The Taylor (1993) rule becomes the foundation for approximating the actual

behaviour of monetary authorities. Following studies make certain modifications to better capture the behaviour of monetary authorities in small and open economies. Forward-looking specification, exchange rates, and smoothing behaviour are three important extensions into the conventional Taylor rule.

Nevertheless, studies on these problems are scant for emerging economies, especially those in Asia and Latin America. The objective of thesis is to fill this gap. The thesis makes three extensions into the conventional Taylor rule. One, it focuses on emerging economies and thus the inclusion of exchange rates is of importance to capture the small and open nature of these economies. In fact, we examine how exchange rates should appear in the Taylor rule. Two, we investigate how foreign exchange intervention influences the setting of interest rates. Three, we depart from the linear-quadratic framework to capture the nonlinearity or asymmetry of monetary policy rule. In this thesis, we allow the aggregate supply to be nonlinear and the preference to be asymmetric. These relaxations have important policy implications. A nonlinear aggregate supply means that positive and negative shocks of output gap have asymmetric effects on inflation or prices. To put it differently, the cost of reducing inflation is not constant, but depending on the shape of the Phillips curve. On the other hand, asymmetric preference leads to the fact that inflation and output gap weight differently in the conventional Taylor rule.

5.2. The role of exchange rates

This section presents how exchange rates affect the conduct of monetary policy in emerging economies that follow inflation targeting. It indicates whether the hypothesis 4 can or cannot be rejected.

5.2.1. Fear of floating

Table 13 presents the estimates of the effect of yearly changes in NEER in the Taylor rule. As observed, its effect on interest rates is negative and statistically significant in most emerging economies, suggesting that monetary policy is expansionary in response to appreciation pressure. Such evidence for the fear of floating is consistent with most of previous studies (Hammermann, 2005; Mohanty and Klau, 2005; Yilmazkuday, 2008; Furlani et al., 2010; Aizenman et al., 2011; Cermeño et al., 2012; Lueangwilai, 2012; Bjørnland and Halvorsen, 2014; Peters, 2016; Dybowski et al., 2018) but is contrast with Caporale et al. (2018), Minella et al. (2003), and Sánchez-Fung (2011). On the other hand, the positive effect of exchange rates is documented for Chile and Korea, implying

that interest rates increase when expecting a rise in the value of domestic currency. Hence, monetary policy accommodates rather than stabilizes the exchange rate movement in the two countries. In Colombia and Poland, exchange rates matter, which is not consistent with the empirical results in other studies (Hammermann, 2005; Yilmazkuday, 2008). Turning to the classical coefficients of the Taylor rule, the response of interest rates to output and inflation gap satisfies the Taylor principle. To begin with, interest rates positively react to output gap, suggesting that monetary policy can stabilize the real economy. Moreover, the response to inflation calculated by the ratio $\beta_\pi /(1-\rho)$ is greater than unity, thereby monetary policy is useful to achieve price stability.

We further investigate the sensitivity of the interest rate elasticity to various measures of exchange rate changes. In this thesis, we use both monthly and yearly changes in NEER, REER, and bilateral exchange rate. Therefore, there are six possible specifications for each emerging economy. As shown in Table 14, the matter of exchange rates copes with the problem of measurement sensitivity. Firstly, the choice of an exchange rate indicator and reference value can affect the interpretation about the role of exchange rates in the implementation of monetary policy. For instance, in Brazil monetary policy shows an accommodating response when observing monthly changes in NEER and REER whereas it shows a countering response for other cases. For Chile, we can come up with a conclusion that REER plays no role in the implementation of monetary policy. In this country, the fear of floating appears with NEER or bilateral exchange rate. In other countries, a similar situation happens.

Secondly, yearly coefficients are very small whereas monthly coefficients are large. This implies that monetary policy is more responsive to the monthly movement of exchange rates whereas the effect of the yearly movement can be negligible. Such a finding is in line with the descriptive statistics of exchange rate changes presented in section 3.4, whereby exchange rates seem to be volatile if observing monthly changes.

Despite of above generalization, there is slight difference in the matter of exchange rates between inflation-targeting emerging economies. Although exchange rates exhibit a negative effect on interest rates in most emerging economies, its positive effect or statistical insignificant effect is visible in other economies. This heterogeneity is conditional on the country-specific factors such as the relevant importance of tradable and non-tradable goods in the product basket of a country. For instance, Edwards and Cabezas (2022) argue that the effect of exchange rates is higher for tradable goods than

non-tradable goods in Iceland. Therefore, monetary authorities that mainly export these goods require strong responses to maintain the price stability. Furthermore, the heterogeneity can stem from the stock of foreign reserves in these emerging economies. Ahmad and Pentecost (2020) found evidence for the fear of floating in the regime of high reserves.

Table 13: Exchange rate effect in the Taylor rule

	β_0	i_{t-1}	$(\pi_{t+k} - \pi^*_{t+k})$	y_{t+m}	Δe_{t+n}
Brazil	-0.049	0.991*	0.076*	0.094*	-0.008**
	(0.098)	(0.009)	(0.018)	(0.012)	(0.003)
Chile	0.135***	0.966*	0.053*	0.004	0.011**
	(0.074)	(0.020)	(0.019)	(0.022)	(0.005)
Colombia	0.266*	0.945*	0.078*	0.040*	0.001
	(0.064)	(0.012)	(0.020)	(0.011)	(0.003)
Mexico	0.182	0.934*	0.173*	0.142*	-0.009***
	(0.117)	(0.024)	(0.050)	(0.036)	(0.005)
Hungary	0.011	0.977*	0.036***	0.012	-0.030***
	(0.067)	(0.015)	(0.021)	(0.020)	(0.015)
Poland	0.172**	0.952*	0.037*	0.016***	-0.001
	(0.078)	(0.019)	(0.013)	(0.010)	(0.004)
Romania	0.168**	0.953*	0.073	0.040***	-0.028**
	(0.070)	(0.011)	(0.067)	(0.021)	(0.013)
Turkey	-0.002	0.974*	0.044**	0.027**	-0.026*
	(0.095)	(0.005)	(0.018)	(0.013)	(0.008)
Korea	0.003	0.999*	0.025*	0.006**	0.006*
	(0.020)	(0.006)	(0.010)	(0.003)	(0.001)
Philippines	0.003	0.995*	0.006	0.007***	-0.008*
	(0.023)	(0.005)	(0.008)	(0.004)	(0.002)
Thailand	0.143*	0.931*	0.044*	-0.012*	0.004***
	(0.027)	(0.014)	(0.006)	(0.003)	(0.002)
South Africa	0.026	0.993*	0.012***	0.059*	-0.004**
	(0.061)	(0.008)	(0.007)	(0.009)	(0.002)

Source: Authors' calculation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses. Δe_{t+n} is the yearly change of NEER.

Table 14: Interest rate responses to different measures of exchange rate changes

	Yearly changes			Monthly changes		
	NEER	REER	EX	NEER	REER	EX
Brazil	-0.008**	-0.009**	-0.008*	0.121***	0.118***	-0.042**
	(0.003)	(0.003)	(0.003)	(0.066)	(0.069)	(0.016)
Chile	0.011**	0.010	0.009*	0.061**	-0.172	-0.156***
	(0.005)	(0.009)	(0.003)	(0.030)	(0.295)	(0.084)
Colombia	0.001	0.002	0.003***	-0.097**	-0.098**	-0.067**
	(0.003)	(0.003)	(0.002)	(0.047)	(0.048)	(0.027)
Mexico	-0.009***	-0.008***	-0.007***	0.118***	0.124**	0.121***
	(0.005)	(0.004)	(0.004)	(0.060)	(0.062)	(0.065)
Hungary	-0.030***	-0.020***	-0.027**	0.079	-0.036	0.001
	(0.015)	(0.011)	(0.011)	(0.075)	(0.044)	(0.051)
Poland	-0.001	-0.000	0.006	-0.044	-0.040	-0.161***
	(0.004)	(0.004)	(0.007)	(0.036)	(0.035)	(0.083)
Romania	-0.028**	-0.020***	-0.028**	-0.238***	-0.133	0.140
	(0.013)	(0.011)	(0.012)	(0.137)	(0.137)	(0.128)
Turkey	-0.026*	-0.026*	-0.015*	0.205**	0.426*	0.157**
	(0.008)	(0.008)	(0.005)	(0.084)	(0.134)	(0.068)
Korea	0.006*	0.004**	0.004*	-0.080***	-0.087***	-0.080**
	(0.001)	(0.002)	(0.001)	(0.041)	(0.046)	(0.040)
Philippines	-0.008*	-0.008*	-0.005***	0.049**	0.057**	0.105***
	(0.002)	(0.002)	(0.003)	(0.023)	(0.022)	(0.060)
Thailand	0.004***	0.004***	0.000	0.098***	-0.090***	-0.058***
	(0.002)	(0.003)	(0.002)	(0.057)	(0.051)	(0.034)
South Africa	-0.004**	-0.004**	-0.002***	-0.032***	-0.031***	0.022***
	(0.002)	(0.002)	(0.001)	(0.017)	(0.017)	(0.013)

Source: Authors' calculation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

5.2.2. The effect of crisis

Table 15 presents the effect of yearly changes in NEER after the Global financial crisis. As observed, the normal-time coefficients are negative and statistically significant in most economies, suggesting that monetary policy aim to counter the effect of exchange rate movement. However, the post-crisis coefficients are positive and statistically significant in all emerging economies but Colombia, Romania and Thailand. Since the

post-crisis coefficients have opposite signs and greater size than normal-time coefficients, there is a reversal in the response of monetary policy to exchange rates during the post-crisis period. Furthermore, it should be noted that the sum of normal and post-crisis coefficients is very small, suggesting the effect of the yearly movement of NEER can be negligible.

The analysis proceeds by further investigating the problem of measurement sensitivity. For brief description, Table 16 presents only the post-crisis effect of exchange rate changes. As observed, the results provide evidence for the measurement sensitivity. Particularly, yearly and monthly coefficients have different signs in most emerging economies (Brazil, Chile, Mexico, Hungary, Poland, Turkey, and South Africa). While yearly coefficients are positive in most cases, monthly coefficients are negative in most cases. Therefore, monetary policy is likely to counter or postpone the exchange rate movement if policymakers care about the foreign exchange market in the last month during the post-crisis period. Moreover, monthly coefficients are much greater than yearly coefficients, implying that monetary policy still put a greater emphasis on monthly changes in the exchange rate. Furthermore, there is a great consistence when using either yearly or monthly changes of the exchange rate. These also imply that the interpretation about the exchange rate matter is not robust to the selection of the benchmark value.

Since the post-crisis coefficients of exchange rates are statistically significant in most emerging economies, it suggests some implications. On one hand, exchange rates show a rise in its importance in emerging economies after the Great crisis. A rise in the fear of floating is conditional on many factors such as large and sudden changes in the exchange rate, the high frequent occurrences of international shocks such as a rise in crude oil or golds. Monitoring the exchange rate movement is a key policy to maintain the stability of the domestic economy. On the other hand, the fact that exchange rates become more important after crisis also stems from the ineffectiveness of other policies. As argued by Montes and Ferreira (2020), although monetary policy credibility can reduce or prevent the intervention of monetary authorities, its effect shows a reduction after the crisis.

Table 15: The effect of exchange rates during the post-crisis period

	β_0	i_{t-1}	$(\pi_{t+k} - \pi^*_{t+k})$	y_{t+m}	Δe_{t+n}	$\Delta e_{**risis,t+n}$
Brazil	0.091	0.983*	0.064*	0.094*	-0.026*	0.027*
	(0.104)	(0.009)	(0.022)	(0.013)	(0.006)	(0.008)
Chile	0.138	0.967*	0.127*	0.036***	-0.040**	0.115*
	(0.151)	(0.045)	(0.045)	(0.019)	(0.018)	(0.038)
Colombia	0.379*	0.921*	0.083*	0.032*	0.021***	-0.030***
	(0.074)	(0.015)	(0.019)	(0.012)	(0.011)	(0.015)
Mexico	0.400*	0.911*	0.084	0.078*	-0.074**	0.093**
	(0.153)	(0.028)	(0.069)	(0.030)	(0.037)	(0.046)
Hungary	0.052	0.974*	0.037***	0.030	-0.030	0.022
	(0.076)	(0.024)	(0.022)	(0.025)	(0.051)	(0.095)
Poland	0.293*	0.934*	0.079*	0.017**	-0.014***	0.027**
	(0.089)	(0.021)	(0.022)	(0.009)	(0.008)	(0.013)
Romania	-0.030	0.965*	0.304**	0.009	0.016	-0.163***
	(0.130)	(0.014)	(0.153)	(0.016)	(0.031)	(0.085)
Turkey	0.093	0.961*	0.063*	0.030**	-0.058*	0.033
	(0.176)	(0.009)	(0.022)	(0.015)	(0.019)	(0.027)
Korea	0.019	0.995*	0.055*	0.009	-0.006	0.024*
	(0.039)	(0.011)	(0.021)	(0.006)	(0.006)	(0.009)
Philippines	0.056	0.987*	0.023***	-0.006	-0.014**	0.023
	(0.038)	(0.007)	(0.014)	(0.004)	(0.006)	(0.016)
Thailand	0.417**	0.802*	0.073*	0.011***	0.047***	-0.087***
	(0.205)	(0.100)	(0.024)	(0.006)	(0.027)	(0.048)
South Africa	0.125***	0.980*	0.016**	0.058*	-0.011*	0.017**
	(0.071)	(0.010)	(0.008)	(0.012)	(0.003)	(0.007)

Source: Authors' calculation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

Table 16: Sensitivity of the post-crisis effect of the exchange rate

	Yearly change			Monthly change		
	NEER	REER	EX	NEER	REER	EX
Brazil	0.027*	0.053*	0.062*	-0.166**	-0.158**	-0.161*
	(0.008)	(0.015)	(0.013)	(0.074)	(0.078)	(0.047)
Chile	0.115*	0.047***	0.008	-0.126**	-0.220**	-0.211*
	(0.038)	(0.027)	(0.013)	(0.058)	(0.088)	(0.063)
Colombia	-0.030***	-0.064***	-0.018***	-0.197**	-0.073***	-0.108**
	(0.015)	(0.037)	(0.011)	(0.091)	(0.041)	(0.045)
Mexico	0.093**	0.039***	0.067***	-0.192**	-0.167**	-0.152***
	(0.046)	(0.022)	(0.038)	(0.078)	(0.084)	(0.091)
Hungary	0.022	-0.058	0.059	-0.367***	-0.517***	-0.611***
	(0.095)	(0.088)	(0.104)	(0.215)	(0.292)	(0.319)
Poland	0.027**	0.047*	0.035***	-0.093	-0.065	-0.342**
	(0.013)	(0.016)	(0.018)	(0.091)	(0.085)	(0.159)
Romania	-0.163***	-0.148**	-0.096	-0.133	0.064	0.252
	(0.085)	(0.066)	(0.073)	(0.278)	(0.466)	(0.289)
Turkey	0.033	0.008	0.031	-0.333***	-0.355**	-0.342**
	(0.027)	(0.022)	(0.019)	(0.184)	(0.161)	(0.137)
Korea	0.024*	0.021*	0.018*	0.036	-0.023	0.060**
	(0.009)	(0.005)	(0.005)	(0.057)	(0.117)	(0.027)
Philippines	0.023	-0.058**	0.036*	0.222**	-0.016	0.046
	(0.016)	(0.023)	(0.010)	(0.106)	(0.127)	(0.054)
Thailand	-0.087***	-0.096***	0.024**	-0.075***	-0.104**	-0.230*
	(0.048)	(0.053)	(0.010)	(0.044)	(0.043)	(0.059)
South Africa	0.017**	0.016**	0.016*	-0.081**	-0.112*	-0.075*
	(0.007)	(0.008)	(0.004)	(0.034)	(0.038)	(0.025)

Source: Authors' calculation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

5.2.3. Fear of deprecation or appreciation

This section investigates the asymmetry in the response of monetary policy to exchange rates. As shown in Table 17, monetary authorities differently weight an appreciation and a depreciation when making monetary policy decisions. It should be noted that we present only the coefficient on the squared term of exchange rate changes specified in Equation (14). To begin with, the coefficients pertaining to yearly changes of REER have different effect in emerging economies. While it is positive and statistically significant in Brazil, Chile, Philippines and South Africa, it is negative and statistically significant in Mexico, Turkey, Korea, and Thailand. With respect to NEER or bilateral exchange rate, there are more negative and statistically significant cases.

Turning to monthly effects, there are even more statistically significant and negative coefficients, especially the bilateral exchange rate. Moreover, the empirical results show that monthly coefficients are greater than yearly coefficients, suggesting that the high relevance of the fear of appreciation when monetary authorities concern about monthly deviation of exchange rate. On the other hand, since the quantitative effect of yearly changes in exchange rates is small and negligible, we can ignore them and conclude that the fear of appreciation does not emerge in the long run.

These findings suggest some important implications. Firstly, emerging economies exhibit a close watch on the monthly appreciation of domestic currency against the main currencies of international transactions. Obviously, the US dollar is the main currency for international transactions around the world, especially in Asia, Latin America, and certain parts of Africa. For European countries, the euro is of importance because it is the official currency in the European Union. As a result, an expected appreciation requires an interest rate cut to maintain the competitiveness of the economy. The fear of appreciation may suggest that emerging economies still emphasize on export as an important driver of economic growth and they concern about the loss of competitiveness caused by an appreciation. The evidence for the fear of appreciation is in line with Keefe and Shadmani (2018) but is contrast with Cermeño et al. (2012). The difference between our findings and those of Cermeño et al. (2012) can be attributable to changes in the exchange rate effect during the post-crisis period, which is not considered by Cermeño et al. (2012).

Table 17: Asymmetric response of interest rates to exchange rate changes

	Yearly change			Monthly change		
	NEER	REER	EX	NEER	REER	EX
Brazil	0.0005*	0.0004*	0.0002***	0.0108**	0.0078**	0.0220*
	(0.0001)	(0.0002)	(0.0001)	(0.0046)	(0.0034)	(0.0084)
Chile	0.0049**	0.0046***	-0.0010**	-0.0155***	-0.0348***	-0.0147***
	(0.0025)	(0.0027)	(0.0004)	(0.0093)	(0.0202)	(0.0083)
Colombia	0.0001	0.0001	-0.0003**	-0.0127**	-0.0132**	-0.0057***
	(0.0001)	(0.0002)	(0.0001)	(0.0054)	(0.0055)	(0.0030)
Mexico	-0.0010***	-0.0031***	0.0001	-0.0105***	-0.0100***	-0.0098***
	(0.0006)	(0.0018)	(0.0006)	(0.0056)	(0.0057)	(0.0055)
Hungary	-0.0005	0.0007	-0.0001	0.0221**	0.0222**	0.0199***
	(0.0022)	(0.0024)	(0.0021)	(0.0102)	(0.0106)	(0.0109)
Poland	-0.0017*	-0.0010	-0.0010**	0.0022	-0.0217***	-0.0114***
	(0.0004)	(0.0008)	(0.0005)	(0.0121)	(0.0124)	(0.0063)
Romania	-0.0042*	0.0004	-0.0023**	0.0932***	0.1226**	-0.0817***
	(0.0014)	(0.0013)	(0.0011)	(0.0497)	(0.0550)	(0.0485)
Turkey	-0.0017**	-0.0015*	-0.0010**	0.0092	0.0141**	-0.0338**
	(0.0008)	(0.0004)	(0.0004)	(0.0131)	(0.0071)	(0.0171)
Korea	-0.0002**	-0.0002***	-0.0003*	-0.0068*	-0.0072*	-0.0062*
	(0.0001)	(0.0001)	(0.0001)	(0.0017)	(0.0018)	(0.0019)
Philippines	-0.0017**	0.0012**	-0.0008**	-0.0409*	-0.0319**	-0.0253**
	(0.0007)	(0.0006)	(0.0004)	(0.0110)	(0.0159)	(0.0118)
Thailand	-0.0011***	-0.0014*	-0.0010*	-0.0203**	-0.0200***	-0.0589***
	(0.0006)	(0.0005)	(0.0003)	(0.0091)	(0.0106)	(0.0335)
South Africa	0.0002***	0.0002**	0.0001	-0.0046***	-0.0050***	0.0002
	(0.0001)	(0.0001)	(0.0001)	(0.0025)	(0.0026)	(0.0009)

Source: Authors' calculation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

5.2.4. Structural breaks and stationarity

We further investigate the robustness of the fear of floating to structural breaks that may happen. Accordingly, we add a time dummy into the baseline model used in the section "fear of floating". As shown in Table 18, the Global financial crisis does not prevent monetary authorities from managing the yearly changes in the exchange rate. When comparing the results of the time-dummy models and baseline models, exchange rates show minor differences in the size and direction of the effect on interest rates in inflation-targeting emerging economies. For instance, in Brazil, NEER coefficient is -0.010 in the time-dummy model whereas it is -0.008 in the baseline model. In addition, the coefficients are significant at 1 and 5% respectively. Obviously, the difference is trivial. In Chile, NEER coefficients are roughly equal, suggesting a negligible disparity. Similar observations emerge with other variables and other countries. These imply that monetary authorities are reluctant to allow the free movement of exchange rates in inflation-targeting emerging economies.

Table 19 indicates how interest rates respond to monthly changes of exchange rates in inflation-targeting emerging economies. It is apparent that there is no change in the general consensus on the matter of exchange rates in the conduct of monetary policy. Therefore, the fear of floating is robust even though there are fundamental breaks in emerging economies that aim at price stability. Furthermore, monthly coefficients are much greater than yearly coefficients when comparing the results presented in Table 18 and Table 19. The greater magnitude of monthly-change effect is in line with the exchange rate statistics in section Data of Chapter 3. Such a finding also suggests that monetary authorities may have a close look at the exchange rate movement in the last month.

We proceed by discussing the asymmetric effect of exchange rates on the conduct of monetary policy in inflation-targeting emerging economies. When adding the time dummy, the empirical results (appendix 13 and 14) show that there are negligible changes in the coefficient on the square of exchange rate changes. Exceptional cases are Chile, Colombia, Romania, and Philippines, where the square of monthly bilateral exchange rate changes become statistically insignificant. However, it should be noted that there are no changes in the other measures of exchange rate changes in these countries. This indicates that they may consider other currencies beyond US dollar or euro in the last month when

setting interest rate. In other cases, the results of the time-dummy analysis resemble those of the baseline analysis in section “Fear of depreciation or appreciation”.

Table 18: Fear of floating for yearly changes of exchange rate

	NEER		REER		EX	
	Time	Base	Time	Base	Time	Base
Brazil	-0.010*	-0.008**	-0.009**	-0.009**	-0.008**	-0.008*
	(0.004)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
Chile	0.011**	0.011**	0.010	0.010	0.010*	0.009*
	(0.005)	(0.005)	(0.009)	(0.009)	(0.003)	(0.003)
Colombia	0.003	0.001	0.003	0.002	0.005*	0.003***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
Mexico	-0.007	-0.009***	-0.006	-0.008***	-0.006	-0.007***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Hungary	-0.034**	-0.030***	-0.026**	-0.020***	-0.032*	-0.027**
	(0.015)	(0.015)	(0.011)	(0.011)	(0.011)	(0.011)
Poland	-0.001	-0.001	-0.000	-0.000	0.007	0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)
Romania	-0.073*	-0.028**	-0.079*	-0.020***	-0.067*	-0.028**
	(0.021)	(0.013)	(0.019)	(0.011)	(0.020)	(0.012)
Turkey	-0.035*	-0.026*	-0.029*	-0.026*	-0.020*	-0.015*
	(0.008)	(0.008)	(0.007)	(0.008)	(0.005)	(0.005)
Korea	0.006*	0.006*	0.005*	0.004**	0.005*	0.004*
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
Philippines	-0.005**	-0.008*	-0.005**	-0.008*	-0.000	-0.005***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Thailand	0.004***	0.004***	0.004	0.004***	0.000	0.000
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)
South Africa	-0.001	-0.004**	-0.002	-0.004**	-0.001	-0.002***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)

Source: Author’s estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses. Time and Base mean the time-dummy models and baseline models.

Table 19: Fear of floating for monthly changes of exchange rate

	NEER		REER		EX	
	Time	Base	Time	Base	Time	Base
Brazil	0.112***	0.121***	0.112***	0.118***	-0.050*	-0.042**
	(0.063)	(0.066)	(0.066)	(0.069)	(0.018)	(0.016)
Chile	0.057**	0.061**	-0.171	-0.172	-0.151**	-0.156***
	(0.029)	(0.030)	(0.294)	(0.295)	(0.074)	(0.084)
Colombia	-0.070***	-0.097**	-0.072***	-0.098**	-0.054**	-0.067**
	(0.041)	(0.047)	(0.041)	(0.048)	(0.022)	(0.027)
Mexico	0.100***	0.118***	0.103***	0.124**	0.103***	0.121***
	(0.056)	(0.060)	(0.057)	(0.062)	(0.060)	(0.065)
Hungary	0.063	0.079	-0.046	-0.036	-0.010	0.001
	(0.077)	(0.075)	(0.041)	(0.044)	(0.048)	(0.051)
Poland	-0.069***	-0.044	-0.063***	-0.040	-0.216**	-0.161***
	(0.038)	(0.036)	(0.038)	(0.035)	(0.092)	(0.083)
Romania	-0.095	-0.238***	-0.033	-0.133	0.199	0.140
	(0.125)	(0.137)	(0.133)	(0.137)	(0.143)	(0.128)
Turkey	0.236**	0.205**	0.435*	0.426*	0.181**	0.157**
	(0.098)	(0.084)	(0.137)	(0.134)	(0.082)	(0.068)
Korea	-0.097*	-0.080***	-0.109*	-0.087***	-0.076*	-0.080**
	(0.035)	(0.041)	(0.040)	(0.046)	(0.027)	(0.040)
Philippines	0.039***	0.049**	0.047**	0.057**	0.085	0.105***
	(0.022)	(0.023)	(0.021)	(0.022)	(0.055)	(0.060)
Thailand	0.100***	0.098***	-0.093***	-0.090***	-0.066**	-0.058***
	(0.058)	(0.057)	(0.053)	(0.051)	(0.033)	(0.034)
South Africa	-0.021	-0.032***	-0.020	-0.031***	0.008	0.022***
	(0.014)	(0.017)	(0.014)	(0.017)	(0.012)	(0.013)

Source: Author's estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses. Time and Base mean the time-dummy models and baseline models.

The next analysis involves using variables at level for estimations, which is believed to reserve important information, especially when there exists a long-run relationship between non-stationary variables. The ARDL model is a proper choice to deal with the inclusion of a mixture of I(1) and I(0) variables, which is highly likely to happen in the thesis. Furthermore, including commodity prices and a time dummy can account for the exposure of inflation-targeting emerging economies to international shocks and structural breaks respectively. As shown in Table 20, the F statistic of the bound test is greater than 4.35, suggesting that variables are bound together in the long term. Furthermore, the correction coefficient is negative and significant, implying that unbalanced interest rates gradually move toward its equilibrium.

As expected, Table 20 indicates that bilateral exchange rates matter in the implementation of monetary policy in most emerging economies that follow inflation targeting in both short and long run. Particularly, its effect is negative and significant in Chile, Mexico, Hungary, Romania, Turkey, and South Africa. The finding suggests that monetary authorities tend to reduce interest rates when domestic currency shows an appreciation against the US dollar or euro. By contrast, interest rates show a rise after an appreciation in Korea. Regarding short-run coefficient, it is significant in many emerging economies.

It is apparent that ARDL estimates are highly consistent with those of baseline models (section 5.2.1). Both indicates that monetary authorities take the movement of exchange rates into consideration when making a policy decision. In fact, the ARDL estimates clarify how the exchange rate effect found in the baseline analysis is in the short and long run. As an illustration, in Chile, the baseline models indicate that a cut in interest rates emerges after a rise the value of the Peso whereas the ARDL models suggest that interest rates cut only occurs in the long run and interest rates can increase in the short run. Furthermore, it should be noted that ARDL results are supportive for the fear of floating in inflation-targeting emerging economies when using other exchange rate indicators such as nominal or real effective exchange rates (appendix 19).

Table 20: Short- and long-run effect of bilateral exchange rates on interest rate setting

	F	Error correction	Long run	Short run			
				Δe_t	Δe_{t-1}	Δe_{t-2}	Δe_{t-3}
Brazil	8.33	-0.053*	-0.259	-0.001	0.010	0.013**	
		(0.013)	(0.172)	(0.005)	(0.006)	(0.005)	
Chile	8.18	-0.169*	-0.347**	0.018	0.038***		
		(0.031)	(0.176)	(0.021)	(0.022)		
Colombia	5.41	-0.045*	-0.019	-0.011***			
		(0.010)	(0.157)	(0.006)			
Mexico	7.97	-0.049*	-0.898**	-0.044*			
		(0.014)	(0.438)	(0.016)			
Hungary	5.09	-0.134*	-0.986***	0.023	0.130**	0.159*	0.122**
		(0.034)	(0.582)	(0.026)	(0.063)	(0.059)	(0.054)
Poland	10.68	-0.058*	0.261	0.015			
		(0.013)	(0.273)	(0.016)			
Romania	5.35	-0.038*	-9.798*	-0.060	0.228*	0.212*	
		(0.012)	(3.084)	(0.053)	(0.065)	(0.053)	
Turkey	10.67	-0.037*	-2.730*	-0.019	0.035**		
		(0.008)	(0.840)	(0.017)	(0.017)		
Korea	11.50	-0.023**	0.570***	0.000			
		(0.009)	(0.324)	(0.003)			
Philippines	7.24	-0.068*	-0.431	-0.005	0.021***		
		(0.018)	(0.286)	(0.011)	(0.011)		
Thailand	8.49	-0.061*	0.012	0.001			
		(0.014)	(0.112)	(0.007)			
South Africa	4.38	-0.036*	-0.255***	-0.001			
		(0.011)	(0.138)	(0.003)			

Source: Author's estimation. Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses. Short run coefficients Δe_{t-k} with k greater than 3 are not provided.

Table 21: ARDL estimates of the asymmetric effect of exchange rates on interest rate

		EC	Long run	Short run				
				Δe_t	Δe_{t-1}	Δe_{t-2}	Δe_{t-3}	Δe_{t-4}
Brazil	7.70	-0.056*	0.022***	0.001***				
		(0.013)	(0.013)	(0.001)				
Chile	7.04	-0.124*	-0.198*	0.001	0.029*	0.033*	0.032*	0.026*
		(0.028)	(0.075)	(0.003)	(0.006)	(0.006)	(0.006)	(0.005)
Colombia	5.34	-0.035*	-0.058	-0.000				
		(0.010)	(0.048)	(0.001)				
Mexico	6.47	-0.042*	-0.083	-0.004***				
		(0.014)	(0.062)	(0.002)				
Hungary	3.71	-0.130*	0.151***	0.002				
		(0.034)	(0.079)	(0.008)				
Poland	11.16	-0.046*	-0.445*	-0.011*				
		(0.012)	(0.166)	(0.004)				
Romania	5.04	-0.039*	1.173**	-0.002	-0.056*	-0.066*		
		(0.012)	(0.579)	(0.014)	(0.014)	(0.011)		
Turkey	9.94	-0.042*	0.371*	-0.002	-0.005**			
		(0.008)	(0.095)	(0.003)	(0.002)			
Korea	4.86	-0.015	-0.129	-0.001	-0.001	-0.001	-0.002*	-0.002*
		(0.009)	(0.101)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Philippines	5.81	-0.077*	0.008	0.001				
		(0.018)	(0.046)	(0.004)				
Thailand	7.87	-0.059*	0.268**	-0.000	-0.014*	-0.009**		
		(0.013)	(0.135)	(0.004)	(0.005)	(0.004)		
South Africa	8.26	-0.053*	-0.006	-0.000				
		(0.012)	(0.008)	(0.000)				

Source: Author's estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses. EC denotes error correction term. Short run coefficients Δe_{t-k} with k greater than 4 are not provided.

The next analysis involves the potential asymmetries in the effect of exchange rates on interest rates in inflation-targeting emerging economies. As shown in Table 21, the square of the bilateral exchange rate changes is negative and significant in the short run in Mexico, Poland, Romania, Turkey, Korea, and Thailand. In Colombia and South Africa, the figure is negative but too small and insignificant. In Chile, the fear of appreciation appears in the long run whereas fear of depreciation is visible in the short run. Hungary and Colombia are exceptional cases where monetary authorities are reluctant to allow a fall in the value of their domestic currency. Furthermore, it should be noted that changing exchange rate indicators does not affect the general conclusion about the existence of fear of appreciation in most economies (appendix 20 for long-run asymmetries). In summary, ARDL results are consistent with the baseline analysis.

5.2.5. Conclusion

Although the literature about the matter of exchange rates is vast for advanced economies, the empirical evidence is limited and mixed for emerging economies. The thesis used the GMM method to examine crucial questions about the matter of exchange rates in twelve emerging economies that follow inflation targeting. Firstly, do exchange rates matter under inflation targeting? Secondly, do exchange rates play a different role during the post-crisis period? Thirdly, is the fear of appreciation or depreciation significant in emerging economies? Fourthly, are empirical results sensitive to monthly and yearly changes in various indicators of exchange rates?

The empirical results provided evidence for the matter of exchange rates in the reaction function of monetary policy in emerging economies that are inflation targeting adopters. Particularly, the fear of floating emerges in most emerging economies and it is more pronounced during the post-crisis period. Furthermore, there is strong evidence for the fear of appreciation, especially against the main currencies of international transactions such as the US dollar or the euro. Finally, the measurement sensitivity analysis suggests that the fear of floating or appreciation is more pronounced when observing the monthly deviation of the bilateral exchange rates.

Our findings suggest some important policy implications. Firstly, the fear of appreciation is consistent with the continuous accumulation of international reserves in emerging economies as well as the dependence of these economies on exporting. Moreover, the tolerance of depreciation forces monetary authorities to face difficulties in achieving the objective of price stability. Secondly, since the monthly deviation of

exchange rates has a stronger effect on interest rates than the yearly deviation, monetary policy is likely to adjust more frequently. This can confuse the expectation of market participants and increase the uncertainty of the financial market. As suggested by Montes and Ferreira (2020), monetary policy credibility can be a cure to ease the fear of floating. A rise in the credibility of monetary policy can lead to a reduction in the exchange rate pass-through (Kabundi and Mlachila, 2019), which causes a fall in the matter of exchange rates in the conduct of monetary policy. The reason is that the public expect less interventions by monetary authorities when the credibility of these policy makers is high (Montes and Ferreira, 2019; Montes and Ferreira, 2020).

5.3. Foreign exchange intervention and monetary policy

This section presents how foreign exchange intervention influences the conduct of monetary policy in emerging economies that follow inflation targeting, which indicate whether the hypothesis 4 can or cannot be rejected.

5.3.1. Monetary policy response to foreign exchange intervention

This section investigates the linear response of monetary policy to foreign exchange intervention. Table 22 indicates that foreign exchange intervention shows a statistically significant effect on the setting of interest rates in most emerging economies. However, the sign of the effect is not consistent between emerging economies. Firstly, interest rates show a reduction in response to a rise in the stock of foreign reserves in Mexico, Philippines, and Thailand. Such a response is consistent with Kim (2003) and Aizenman et al. (2011). The finding implies that the effect of foreign exchange intervention can be partially sterilized.

Secondly, interest rates show a positive response to changes in foreign reserves in Colombia, Poland, Turkey, Korea, and South Africa. This means that interest rates increase following a rise in foreign reserves, suggesting that the response of monetary policy is to counter or mitigates the effect of foreign exchange interventions on the exchange rate. Such a finding may be conditional on the focus of these countries on the price stability. General speaking, a rise in the stock of foreign reserves indicates an increase in money supply, a reduction in interest rate, and a depreciation of domestic currency that may cause a rise in inflation. Therefore, monetary authorities can increase interest rates to counter the inflationary pressure of a depreciation. In other words, the positive effect of the intervention suggests that monetary authorities are cautious about the price stability in Colombia, Poland, Turkey, Korea, and South Africa. Thirdly, in other

countries such as Brazil, Chile, Hungary, interest rates show an insignificant response to foreign exchange intervention.

Table 22: GMM estimate of monetary policy response to foreign exchange interventions

	β_0	i_{t-1}	π_{t+k}	y_{t+m}	e_{t+n}	I_{t+p}	$J^{(a)}$
Brazil	-0.121	0.979*	0.102***	0.038	-0.107***	0.119	0.26
	(0.232)	(0.035)	(0.055)	(0.050)	(0.057)	(0.198)	
Chile	0.276**	0.930*	0.062**	-0.040	-0.056***	-0.025	0.74
	(0.123)	(0.034)	(0.027)	(0.028)	(0.031)	(0.031)	
Colombia	0.157***	0.954*	0.070*	0.053*	-0.063**	0.058***	0.98
	(0.083)	(0.016)	(0.024)	(0.015)	(0.028)	(0.035)	
Mexico	0.315*	0.929*	0.125**	0.073*	-0.019	-0.056***	0.58
	(0.121)	(0.025)	(0.052)	(0.027)	(0.043)	(0.031)	
Hungary	0.106	0.968*	0.038***	0.009	0.027	-0.002	0.42
	(0.069)	(0.016)	(0.022)	(0.019)	(0.054)	(0.026)	
Poland	0.176**	0.938*	0.039**	0.038**	-0.062	0.060***	0.77
	(0.085)	(0.018)	(0.019)	(0.017)	(0.068)	(0.032)	
Romania	0.336	0.969*	0.797***	0.036	0.383	-0.138	0.14
	(0.348)	(0.022)	(0.429)	(0.044)	(0.355)	(0.421)	
Turkey	0.210	0.965*	0.123**	-0.003	0.369*	0.169***	0.82
	(0.260)	(0.012)	(0.052)	(0.053)	(0.134)	(0.096)	
Korea	0.020	0.982*	0.001	0.024*	-0.037**	0.030**	0.18
	(0.037)	(0.011)	(0.013)	(0.008)	(0.015)	(0.013)	
Philippines	0.071	0.990*	0.020***	0.002	0.085	-0.030***	0.20
	(0.062)	(0.011)	(0.010)	(0.005)	(0.073)	(0.017)	
Thailand	0.084**	0.972*	0.031*	0.006	-0.095***	-0.015***	0.90
	(0.039)	(0.017)	(0.009)	(0.006)	(0.051)	(0.009)	
South Africa	-0.011	0.989*	0.038**	0.035**	-0.054**	0.040***	0.19
	(0.098)	(0.014)	(0.016)	(0.015)	(0.026)	(0.021)	

Source: Authors' estimation

Notes: (a): p-value of Hansen J test. *, **, *** denote the significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

5.3.2. Asymmetric effect of foreign exchange intervention

We proceed by investigating whether foreign exchange intervention has asymmetric effects on interest rates in emerging economies that follow inflation targeting. As shown in Table 23, the effect of sales and purchase intervention is different and not consistent between economies. Remarkably, sales and purchase intervention are not statistically significant at the same time. The finding is evidence for the asymmetric effect of foreign exchange intervention on the conduct of monetary policy in inflation-targeting economies. Such an asymmetry is consistent with previous studies (Domaç and Mendoza, 2004; Guimarães and Karacadag, 2004; Akinci et al., 2006; Égert and Komárek, 2006; Banerjee et al., 2018).

In fact, there are two distinct groups. Purchase intervention exhibits a statistically significant effect on monetary policy in many countries: Colombia, Hungary, Philippines, Thailand, and South Africa. However, the sign of purchase intervention effect varies between countries. While purchase intervention shows a negative effect in Philippines and Thailand, they show a positive effect in Colombia, Hungary, and South Africa. The statistical significant and positive coefficients of purchase intervention, which is likely to realize a depreciation, is in line with the finding of Keefe and Shadmani (2020) that find strong response of monetary policy during periods of depreciations. In other countries, purchase intervention shows an insignificant effect on monetary policy.

On the other hand, the effect of sales intervention is statistically significant in Brazil, Chile, Mexico, Poland, Romania, Turkey, and Korea. In this group, a positive shock of sales intervention leads to a reduction in interest rates in all countries but Korea where sales interventions are positively related to interest rate changes. Such a negative linkage is consistent with most theoretical models and it also suggests that sales intervention is likely to be strongly sterilized.

Table 23: GMM estimate of the effect of sales and purchase interventions on interest rate

	β_0	i_{t-1}	π_{t+k}	y_{t+m}	e_{t+n}	pur_{t-p}	$sales_{t-p}$	J
Brazil	0.044	0.971*	0.128*	0.053*	-0.033***	0.021	-0.094***	0.10
	(0.120)	(0.015)	(0.022)	(0.015)	(0.019)	(0.028)	(0.053)	
Chile	0.327**	0.854*	0.058**	0.005	-0.106***	0.077	-0.128**	0.58
	(0.152)	(0.059)	(0.030)	(0.031)	(0.063)	(0.052)	(0.062)	
Colombia	0.132	0.954*	0.068*	0.055*	-0.071*	0.076**	0.024	0.93
	(0.084)	(0.019)	(0.026)	(0.014)	(0.027)	(0.035)	(0.089)	
Mexico	0.175***	0.923*	0.126*	0.056**	-0.077**	0.040	-0.124**	0.62
	(0.092)	(0.023)	(0.049)	(0.025)	(0.035)	(0.043)	(0.059)	
Hungary	-0.116	0.964*	0.044***	0.021	-0.005	0.068***	-0.080	0.38
	(0.132)	(0.017)	(0.024)	(0.018)	(0.065)	(0.041)	(0.062)	
Poland	0.710**	0.966*	0.149**	0.036	-0.134	-0.210	0.172***	0.67
	(0.305)	(0.022)	(0.062)	(0.030)	(0.151)	(0.138)	(0.101)	
Romania	-1.370**	0.982*	-0.264***	-0.044	-0.093	0.326	-0.687**	0.47
	(0.621)	(0.017)	(0.149)	(0.050)	(0.253)	(0.222)	(0.310)	
Turkey	-0.315	0.983*	0.148*	-0.048***	0.100*	0.002	-0.183***	0.90
	(0.237)	(0.010)	(0.029)	(0.028)	(0.034)	(0.093)	(0.110)	
Korea	0.049	0.981*	0.006	0.020*	-0.036**	0.014	0.066***	0.16
	(0.046)	(0.011)	(0.014)	(0.006)	(0.016)	(0.029)	(0.034)	
Philippines	0.046	0.998*	0.012***	0.009**	0.052	-0.044**	-0.019	0.67
	(0.040)	(0.006)	(0.007)	(0.003)	(0.032)	(0.018)	(0.037)	
Thailand	0.125***	0.974*	0.033*	0.010**	0.006	-0.046***	0.026	0.72
	(0.067)	(0.014)	(0.008)	(0.005)	(0.026)	(0.023)	(0.051)	
South	0.123	0.964*	0.040*	0.059*	0.031***	0.072**	-0.043	0.63
Africa	(0.119)	(0.012)	(0.009)	(0.011)	(0.016)	(0.029)	(0.078)	

Source: Authors' estimation

Notes: (a): p-value of Hansen J test. *, **, *** denote the significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

5.3.3. Structural breaks and stationarity

In this section, we conducted analysis about the role of interventions when a time dummy is added into the baseline models. This modification is of importance to control for the effect of the Global financial crisis. Table 24 has two parts. The one named "Intervention effect" compares the results of the time-dummy and baseline models presented in section 5.3.1. The one named "Asymmetric intervention effect" indicates how adding the time dummy leads to changes in the asymmetric effect of foreign exchange intervention on the conduct of monetary policy in inflation-targeting emerging economies.

Overall, the structural break does not change the consensus that foreign exchange intervention has an asymmetric effect on interest rates in inflation-targeting emerging economies. The empirical results remained unchanged in most economies, implying that they are to a greater degree robust to the structural break. However, there are still some exceptional cases. Adding the time dummy causes changes in the significance of intervention in a few economies, becoming significant in Brazil but turning to be insignificant in Colombia, Philippines, and South Africa. The asymmetries change in some countries: Brazil, Colombia, Romania, Turkey, and South Africa. Since structural breaks still have some minor influences on the matter of intervention, their potential effects deserve a more rigorous study in the future.

Table 25 shows the estimate of the foreign exchange intervention effect in short- and long-run by using ARDL models with the inclusion of the time dummy. Accordingly, a rise in foreign reserves leads to a fall in interest rate, at least in the short run, in many inflation-targeting emerging economies: Brazil, Mexico, Hungary, Romania, Turkey, the Philippines, and South Africa. Conventionally, as monetary authorities decide to accumulate foreign reserves, the stock of domestic currency tends to increase even though the intervention is sterilized. High liquidity causes banks to reduce interest rates for new credit. In this case, monetary authorities further reduce interest rates as a response to a rise in the stock of foreign reserves. As a result, interest rates fall deeper. On the contrary, an increase in foreign reserves is followed by an increase in interest rates in some economies (Poland, Korea, and Thailand), suggesting that monetary authorities want to postpone or mitigate the effect of intervention on market interest rate.

Table 24: Intervention effect in time-dummy analysis

	Intervention effect		Asymmetric intervention effect			
	Time	Base	Time		Base	
			Purchase	Sales	Purchase	Sales
Brazil	-0.276***	0.119	-0.009	-0.079	0.021	-0.094***
	(0.160)	(0.198)	(0.038)	(0.062)	(0.028)	(0.053)
Chile	-0.027	-0.025	0.067	-0.129**	0.077	-0.128**
	(0.032)	(0.031)	(0.042)	(0.065)	(0.052)	(0.062)
Colombia	0.041	0.058***	0.033	0.076	0.076**	0.024
	(0.032)	(0.035)	(0.033)	(0.091)	(0.035)	(0.089)
Mexico	-0.063**	-0.056***	0.054	-0.131**	0.040	-0.124**
	(0.030)	(0.031)	(0.040)	(0.060)	(0.043)	(0.059)
Hungary	0.004	-0.002	0.075***	-0.091	0.068***	-0.080
	(0.026)	(0.026)	(0.038)	(0.060)	(0.041)	(0.062)
Poland	0.054***	0.060***	-0.196	0.174***	-0.210	0.172***
	(0.033)	(0.032)	(0.129)	(0.098)	(0.138)	(0.101)
Romania	0.575	-0.138	0.374***	-0.706**	0.326	-0.687**
	(0.416)	(0.421)	(0.213)	(0.343)	(0.222)	(0.310)
Turkey	0.166***	0.169***	-0.035	-0.162	0.002	-0.183***
	(0.100)	(0.096)	(0.096)	(0.110)	(0.093)	(0.110)
Korea	0.027**	0.030**	-0.000	0.073**	0.014	0.066***
	(0.013)	(0.013)	(0.026)	(0.031)	(0.029)	(0.034)
Philippines	-0.023	-0.030***	-0.037**	-0.020	-0.044**	-0.019
	(0.018)	(0.017)	(0.017)	(0.035)	(0.018)	(0.037)
Thailand	-0.017**	-0.015***	-0.047**	0.027	-0.046***	0.026
	(0.008)	(0.009)	(0.023)	(0.050)	(0.023)	(0.051)
South Africa	0.022	0.040***	0.038	-0.037	0.072**	-0.043
	(0.020)	(0.021)	(0.023)	(0.062)	(0.029)	(0.078)

Source: Authors' estimation

Notes: *, **, *** denote the significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

Table 25: Short- and long-run effect of foreign exchange intervention

	Error correction	Long run	Short run	
		I_{t-1}	ΔI_t	ΔI_{t-1}
Brazil	-0.080*	-6.825*	-0.547*	
	(0.014)	(1.473)	(0.131)	
Chile	-0.144*	0.241	0.035	
	(0.032)	(2.179)	(0.313)	
Colombia	-0.041*	-1.955	-0.080	
	(0.012)	(2.033)	(0.091)	
Mexico	-0.077*	-5.221*	-3.566**	
	(0.019)	(1.881)	(1.503)	
Hungary	-0.148*	-2.495	0.141	-2.665*
	(0.036)	(1.896)	(0.798)	(0.803)
Poland	-0.037*	11.678	1.601	2.472**
	(0.014)	(10.613)	(0.981)	(0.982)
Romania	-0.062*	-23.702*	-6.163*	-4.539**
	(0.019)	(3.823)	(1.793)	(1.855)
Turkey	-0.023**	-8.494	1.291	-5.095*
	(0.009)	(9.644)	(1.349)	(1.324)
Korea	-0.046*	-2.118*	0.314	0.982**
	(0.013)	(0.712)	(0.424)	(0.413)
Philippines	-0.109*	-1.702*	-0.186**	
	(0.023)	(0.627)	(0.086)	
Thailand	-0.058*	1.588	0.659***	
	(0.013)	(1.146)	(0.380)	
South Africa	-0.035*	-4.814	-0.167***	
	(0.011)	(3.090)	(0.099)	

Source: Author's estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

Table 26: Asymmetric effect of intervention in the short and long run

	Correction	Long run			
		y_{t-1}	π_{t-1}	$sales_{t-1}$	pur_{t-1}
Brazil	-0.061*	0.064	0.455*	-0.258	-0.295
Chile	-0.149*	0.154	0.600*	-0.045	0.053
Colombia	-0.034*	0.130	1.650*	1.209	-0.459
Mexico	-0.043*	1.197**	-0.235	-0.458	-0.991
Hungary	-0.080*	-0.033	0.929*	0.244	-0.499***
Poland	-0.066*	0.832*	2.235*	2.244*	0.001
Romania	-0.008	4.232	-23.311	-17.395	-18.379
Turkey	-0.023*	0.981*	1.898**	-0.920	-2.115
Korea	-0.026**	0.472**	0.305	2.250**	0.002
Philippines	-0.072*	0.050***	0.444*	0.135	-0.137
Thailand	-0.057*	0.014	0.183	0.473	-0.057
South Africa	-0.057*	0.025	0.867*	-0.180	0.074
		Short run			
	$\Delta sales_t$	$\Delta sales_{t-1}$	Δpur_t	Δpur_{t-1}	Δpur_{t-2}
Brazil	-0.003		-0.003	0.023*	
Chile	-0.007		0.008		
Colombia	0.001		-0.016		
Mexico	-0.020		-0.010	0.063***	0.052***
Hungary	0.020		-0.001		
Poland	0.030***	-0.058**	0.000		
Romania	-0.131*		-0.044	0.032	0.020
Turkey	-0.021		0.047**		
Korea	0.014***		0.000		
Philippines	0.010		-0.017***		
Thailand	0.008	-0.036***	-0.003		
South Africa	-0.010		0.004		

Source: Author's estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses. Short-term results are not included for those from 2nd lag of sales changes and 3rd lag of purchase changes.

Table 26 provides the ARDL estimates of the asymmetric effect of the foreign exchange intervention in inflation-targeting emerging economies. It should be noted that commodity prices and the time dummy are included. Accordingly, it is apparent that the ARDL estimation provides a negative correction coefficient, which implies a gradual adjustment of interest rates toward its equilibrium state. Furthermore, foreign exchange intervention has an asymmetric effect on interest rate, depending whether it is a purchase or sales of foreign reserves. In the long term, the asymmetry is visible in Hungary, Poland and Korea. While sales intervention effect is positive and significant in Poland and Korea, purchase intervention effect is negative in Hungary. Such effects are in line with monetary theories.

Regarding the short run, the asymmetry emerges in most emerging economies excepting for Chile, Colombia, Hungary, and South Africa. The effect of both purchase and sales intervention on interest rates is mixed, varying between countries. As an illustration, sales intervention effect is positive in Korea whereas it is negative in Romania and Thailand. In Poland, the situation is more complicated, whereby current sales intervention leads to a rise in interest rates on impact but causes a fall in interest rates in the next period. Turning to purchase intervention, its effect shows a similar pattern.

In summary, ARDL results support the consensus of the baseline model that foreign exchange intervention has asymmetric effect on the conduct of monetary policy. However, it should be noted that the properties of asymmetry remained unchanged in a few countries in the ARDL models. Particularly, sales intervention effect is positive and significant in Korea whereas purchase intervention effect is negative and significant in Philippines in the baseline analysis. The asymmetry appeared in these economies remained unchanged in the short run in the ARDL models. In other economies, ARDL models also indicate the existence of the asymmetry but its properties are different. As an illustration of this, the baseline models show that sales intervention has a negative and significant effect in Brazil whereas the ARDL models indicate that the asymmetry only occurs in the short run with the positive effect of the purchase intervention in this Latin America economies. Similar observations are visible in other emerging economies.

The disparity of the asymmetry results and the high consistence of the ARDL estimate of the overall significance of foreign exchange intervention with the baseline models may indicate that foreign reserves are not a good enough proxy for foreign exchange intervention. Particularly, foreign reserves can better measure changes in the

intervention as the whole but it cannot distinguish which change is the purchase or sales of foreign reserves. These findings also support the argument of Blanchard and Adler (2015) that foreign reserves are a narrative measure of foreign exchange intervention. Changes in foreign reserves can capture changes in either intervention policies or other reasons (Berganza and Broto, 2012). Therefore, future studies should use a better measure of foreign exchange intervention. Event studies are recommended since it involves the definition of which events refer to the purchase or sales of foreign reserves. However, such a method requires a huge amount of information and depends much on the transparency of monetary policy conduct in emerging economies.

5.3.4. Conclusions

While there is vast literature on the effectiveness of the foreign exchange intervention in stabilizing the volatility of exchange rates, much less evidence on the linkage between monetary policy and foreign exchange intervention is available for emerging economies. The thesis used the GMM model to examine how foreign exchange interventions affect the setting of interest rates in emerging economies that follow inflation targeting. The analysis started with the linear response of monetary policy to the intervention. Then, it proceeded by investigating the asymmetric effect of sales and purchase interventions. The thesis found that the intervention plays a significant role in the conduct of monetary policy. However, sales and purchase intervention asymmetrically affect the movement of interest rates.

These findings suggest crucial implications. Firstly, market participants should consider the effect of foreign exchange interventions when analysing the behaviour of the central bank in emerging economies. Since foreign exchange interventions play a role in predicting the future course of monetary policy, its augmentation in the Taylor rule is crucial to have a better forecast of interest rates. Secondly, the intervention can provide misleading information about the priority in the conduct of monetary policy in emerging economies that follow inflation targeting. This may lead to a reduction in the creditability of the central bank. Monetary authorities can deal with such a problem by increasing the transparency in the conduct of foreign exchange interventions or by fostering the development of domestic financial system, which can reduce the exposure of the country to external risks.

The disparity between ARDL and baseline models about the asymmetry of the intervention effect suggests that foreign reserves are not good enough to measure the

intervention. In particular, it may fail to distinguish what changes are purchase or sales interventions. Therefore, the use of foreign reserves, which is a narrative measure of foreign exchange intervention (Blanchard and Adler, 2015), is a limitation of the thesis.

5.4. Asymmetries in the monetary policy rule

This section presents the empirical results about the hypothesis 5, which questions about the asymmetry of the function of monetary policy. It shows whether the asymmetric rule of monetary policy is conditional on a nonlinear Phillips curve or an asymmetric preference or both.

The thesis is one of few studies that provide comparative evidence for the asymmetric Taylor rule between emerging economies targeting inflation. It provides two sets of empirical results. Firstly, it investigates the preliminary results of a nonlinear Phillips curve and its implication for the asymmetric Taylor rule. Secondly, it investigates whether monetary authorities in emerging economies have an asymmetric preference to the sign of inflation and output gap.

5.4.1. Preliminary analysis of the nonlinear Phillips curve

This session preliminarily examines the nonlinearity of the Phillips curve, which indicates the inflationary pressure caused by output changes. Table 27 presents the estimation of a simple specification of a nonlinear Phillips curve, $\pi_t = c_0 + c_1\pi_{t-1} + c_2 y_k + c_3 y_k^2 + v_t$. The main interest is to investigate the sign and significance of the squared output gap coefficient. If $c_3 > 0$, the Phillips curve is convex. In this case, the inflationary pressure in expansions will be larger than what is implied by a linear Phillips curve. By contrast, if $c_3 < 0$, the Phillips curve is concave and thus the inflationary pressure in expansions will be lower than the linear case.

As shown in Table 27, the Phillips curve is not linear in inflation-targeting emerging economies. The Phillips curve is concave in ten out of twelve emerging economies. The finding supports the argument of Stiglitz (1997) about the downward flexibility of prices. In emerging economies, the monopoly encourages firms to reduce prices in time of recessions and thus monetary policy response should be stronger when output gap is negative. On the other hand, the Phillips curve is convex in Poland and Philippines. It suggests that in these economies, the monetary policy response should be strong in expansions. In brief, the strong evidence for the concavity suggests that the monetary policy response to inflation is stronger when facing recession pressures.

Table 27: Estimation of the nonlinear Phillips curve in emerging economies

	k	α_0	π_{t-1}	y_k	y_k^2
Brazil	6	0.194*	0.647*	-0.001	-0.001***
		(0.031)	(0.046)	(0.005)	(0.001)
Chile	3	0.185*	0.464*	0.018**	-0.002***
		(0.039)	(0.092)	(0.007)	(0.001)
Colombia	9	0.466*	0.436*	0.060	-0.024***
		(0.170)	(0.130)	(0.045)	(0.014)
Mexico	8	0.246*	0.491*	0.000	-0.012***
		(0.045)	(0.107)	(0.024)	(0.007)
Hungary	7	0.195*	0.502*	0.007	-0.003***
		(0.068)	(0.128)	(0.011)	(0.002)
Poland	12	-0.415	1.084*	-0.013	0.014***
		(0.264)	(0.322)	(0.019)	(0.007)
Romania	1	0.210*	0.746*	-0.004	-0.002***
		(0.071)	(0.061)	(0.007)	(0.001)
Turkey	12	0.945*	0.974*	-0.123*	-0.016*
		(0.255)	(0.167)	(0.042)	(0.006)
Korea	4	0.265*	0.738**	-0.104*	-0.008*
		(0.071)	(0.291)	(0.037)	(0.003)
Philippines	11	-0.068	0.439**	0.026***	0.004**
		(0.112)	(0.183)	(0.014)	(0.002)
Thailand	12	0.180*	0.386*	-0.024**	-0.003***
		(0.048)	(0.149)	(0.011)	(0.002)
South Africa	11	0.397**	0.443**	0.108**	-0.015***
		(0.159)	(0.216)	(0.050)	(0.009)

Source: Authors' estimation.

Notes: *, **, *** denote the significance at 1%, 5%, and 10% respectively. Standard error is in the parentheses.

In sum, there is strong evidence supporting for the asymmetric response of inflation to output gap shocks. However, the direction of the asymmetry is different across emerging economies. This suggests that monetary authorities may put different weights on future inflationary pressure caused by a positive output gap.

5.4.2. Nonlinear Phillips curve and monetary policy reaction function

Table 28 presents the asymmetry caused by a nonlinear Phillips curve. The coefficient on the interaction between expected inflation and output gap is the focus of the analysis and discussion. As observed, the interaction coefficient is statistically significant in most emerging economies. This gives strong evidence for the asymmetric Taylor rule in emerging economies. For Turkey, the Taylor rule seems to be symmetric.

Furthermore, the sign of the interaction coefficients varies between emerging economies. While the interaction coefficient is negative in most emerging economies, it is positive in few economies (Brazil, Poland, and Philippines). Such a finding strongly supports the asymmetry driven by a concave Phillips curve, which is strongly connected with the preliminary results of a nonlinear Phillips curve in the previous section. Accordingly, monetary policy strongly responds to inflation in recessions. This finding is contrast with the positive interaction term in Dolado et al. (2005) and Aragón et al. (2016) or the insignificant interaction term in Vašíček (2012).

Turning to other variables, their sign is strongly consistent with most monetary models. Firstly, the smoothing coefficient is statistically significant in all cases, suggesting the reluctance of monetary authorities to allow large changes in interest rates. Such a behaviour is widely documented in previous studies (Clarida et al., 2000; Dolado et al., 2005). However, the smoothing coefficient is very close to one, which can stem from the bias of omitting important explanatory variables (Rudebusch, 2006). Therefore, it is cautious to interpret the smoothing parameter.

Secondly, the effect of output gap is positive and statistically significant in most emerging economies. Moreover, the size of the inflation expectation coefficient ($\alpha_1/(1-\rho)$) is greater than unity, which obeys the Taylor rule principle. The stabilizing effect of monetary policy is consistent with Dolado et al. (2005).

Table 28: The effect of nonlinear Phillips curve on the Taylor rule

	k	α_0	i_{t-1}	π_{t+k}	y_t	$\pi_{t+k}y_t$	e_t
Brazil	1	-0.097	0.992*	0.129*	0.040**	0.037**	-0.000
		(0.113)	(0.009)	(0.024)	(0.018)	(0.015)	(0.009)
Chile	1	0.385*	0.904*	0.086*	0.033***	-0.016**	0.005
		(0.088)	(0.023)	(0.020)	(0.017)	(0.008)	(0.014)
Colombia	2	0.234*	0.953*	0.067*	0.069*	-0.013***	-0.002
		(0.061)	(0.011)	(0.017)	(0.017)	(0.008)	(0.006)
Mexico	3	0.063	0.959*	0.146**	0.338**	-0.130***	-0.027
		(0.151)	(0.028)	(0.070)	(0.158)	(0.076)	(0.018)
Hungary	1	0.108***	0.968*	0.042**	0.040**	-0.013***	0.026
		(0.064)	(0.015)	(0.021)	(0.017)	(0.007)	(0.018)
Poland	1	0.140**	0.957*	0.026**	0.003	0.012***	0.026**
		(0.067)	(0.017)	(0.013)	(0.008)	(0.006)	(0.011)
Romania	6	0.399*	0.895*	0.147*	-0.019	-0.011***	0.037
		(0.150)	(0.032)	(0.055)	(0.017)	(0.006)	(0.044)
Turkey	1	-0.000	0.979*	0.076*	0.015	-0.005	-0.032**
		(0.093)	(0.005)	(0.015)	(0.014)	(0.004)	(0.013)
Korea	6	0.023	0.994*	0.025***	0.014*	-0.008**	0.007
		(0.031)	(0.009)	(0.014)	(0.004)	(0.004)	(0.005)
Philippines	1	-0.011	1.001*	-0.002	0.005***	0.003**	0.008
		(0.024)	(0.005)	(0.007)	(0.003)	(0.001)	(0.009)
Thailand	1	0.071*	0.968*	0.033*	0.005**	-0.003**	0.009
		(0.022)	(0.010)	(0.005)	(0.003)	(0.001)	(0.006)
South Africa	5	0.064	0.990*	0.017**	0.064*	-0.005***	-0.000
		(0.056)	(0.008)	(0.008)	(0.012)	(0.003)	(0.004)

Source: Authors' estimation

Notes: *, **, *** denote the significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

5.4.3. Asymmetric preferences and the Taylor rule

This section provides further evidence about the asymmetry driven by an asymmetric preference. As shown in Table 29, the evidence for this asymmetry is mixed. To begin with, inflation asymmetry ($\sigma^2_{\pi,t}$) is visible in most emerging economies and it can be classified into two groups. The first group includes Brazil, Colombia, Hungary, Philippines, and South Africa. In this group, monetary policy is more aggressive to the inflation rate above the target. The evidence for the disinflation bias is in line with previous studies (Aguiar and Martins, 2008; Vašíček, 2012; Aragón and de Medeiros, 2013; Komlan, 2013; Sznajderska, 2014; Caglayan et al., 2016; Tawadros, 2016). On the other hand, monetary policy in Chile, Romania, Korea, and Thailand strongly responds to the inflation rate below the target. This supports the tendency to keep the pace of growth in the economy. The response is in line with Tawadros (2020) or Kobbi and Gabsi (2019).

Turning to output asymmetry ($\sigma^2_{y,t}$), it is negative and statistically significant in many emerging economies: Brazil, Chile, Colombia, Hungary, Turkey, Philippines, Thailand, and South Africa. Accordingly, monetary policy shows a stronger response to a negative output gap than to a positive output gap. This indicates the preference to avoid recession, which is consistent with Surico (2007), Vašíček (2012), Caglayan et al. (2016), and Kobbi and Gabsi (2019). The fear of economic contraction has some important implications. First, in emerging economies the central bank has little independence and thus political pressure has certain impacts on the decision of monetary authorities (Blinder, 1998; Persson and Tabellini, 1999). For Poland, the output volatility coefficient is positive, thereby monetary policy is more responsive to economic booms. The finding for Poland is not consistent with Klose (2019).

Coming to the standard coefficients of the traditional Taylor rule, expected inflation and output gap have an expected effect on interest rates in emerging economies. An increase in these variables leads to a rise in interest rates. The response also obeys the Taylor principle, implying that monetary policy can stabilise inflation and output. The finding is in line with Klose (2019). The results of other variables resemble those specified in section 5.4.2. The smoothing coefficient is significant and close to unity. Furthermore, exchange rate changes do not have a significant effect on interest rates. The finding has two explanations. First, nominal effective exchange rates have a trivial effect on monetary policy in inflation-targeting emerging economies. Second, monetary

authorities may respond to other measures of exchange rate changes such as the real effective or bilateral exchange rates. For instance, Latin America economies may strongly respond to the exchange rate against the US dollar whereas those in Europe area may strongly respond to the exchange rate against the euro.

Table 29: The effect of asymmetric preference on the Taylor rule

	k	β_0	i_{t-1}	π_{t+k}	y_t	$\sigma^2_{\pi,t}$	$\sigma^2_{y,t}$	e_t
Brazil	7	-0.127	0.994*	0.138*	0.062*	0.135**	-18.344***	0.015**
		(0.083)	(0.007)	(0.015)	(0.012)	(0.057)	(11.074)	(0.007)
Chile	1	0.321*	0.934*	0.047*	0.009	-1.969**	-2.375*	0.012
		(0.089)	(0.022)	(0.012)	(0.015)	(0.768)	(0.826)	(0.009)
Colombia	2	0.254*	0.943*	0.097*	0.017	1.245***	-0.681***	0.002
		(0.047)	(0.010)	(0.017)	(0.013)	(0.647)	(0.386)	(0.006)
Mexico	1	0.217**	0.933*	0.145*	0.094*	-0.148	4.196	-0.026***
		(0.084)	(0.019)	(0.040)	(0.022)	(0.816)	(4.555)	(0.016)
Hungary	12	0.123	0.957*	0.101***	0.054**	1.892***	-3.277***	0.032***
		(0.101)	(0.021)	(0.057)	(0.028)	(1.094)	(1.944)	(0.018)
Poland	1	0.247*	0.930*	0.053*	-0.003	5.380	0.286**	0.030**
		(0.074)	(0.020)	(0.016)	(0.008)	(14.775)	(0.118)	(0.013)
Romania	1	0.688**	0.953*	0.071**	-0.021	-65.435***	1.137	-0.008
		(0.306)	(0.031)	(0.029)	(0.030)	(35.764)	(1.674)	(0.043)
Turkey	7	-0.239	0.980*	0.130*	0.021***	5.584	-0.894**	-0.012
		(0.223)	(0.009)	(0.034)	(0.013)	(5.028)	(0.445)	(0.013)
Korea	10	0.107**	0.984*	0.051***	0.010***	-41.175***	0.015	0.004
		*	(0.013)	(0.026)	(0.005)	(23.548)	(0.061)	(0.005)
		(0.060)						
Philippines	1	0.085	0.976*	0.023**	0.001	0.825***	-0.046**	0.008
		(0.058)	(0.016)	(0.011)	(0.004)	(0.475)	(0.019)	(0.011)
Thailand	1	0.105*	0.958*	0.038*	0.005***	-1.264*	-0.170**	0.008
		(0.022)	(0.010)	(0.005)	(0.003)	(0.328)	(0.066)	(0.006)
South Africa	1	0.077	0.987*	0.011***	0.058*	0.208**	-2.258*	0.000
		(0.063)	(0.009)	(0.006)	(0.008)	(0.099)	(0.553)	(0.004)

Source: Authors' estimation.

Notes: *, **, *** denote the significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

5.4.4. Structural breaks and stationarity

This section proceeds by discussing the potential effect of the Global financial crisis on the existence of asymmetries in the reaction function of monetary policy in inflation-targeting emerging economies. As discussed in the methodology chapter, we introduce a time dummy into the baseline model to control the effect of the crisis. Table 30 shows the comparison of the empirical results with and without the time dummy. As expected, there is no change in the consensus that monetary authorities show asymmetric responses to output and inflation gap, which is caused by the existence of a nonlinear Phillips curve and asymmetric preferences.

However, there are some differences even though they are small and can be negligible in some cases. Regarding the asymmetry caused by the nonlinear Phillips curve, the interaction between expected inflation and output gap is still negative but becomes insignificant in Colombia, Mexico, and Hungary. However, it should be noted that the interaction has the significance level of 10% in the baseline models, indicating that a minor change can cause it to become insignificant. In fact, the difference is trivial between two estimation methods in these countries. Similar observations and conclusions come with the results of both time-dummy and baseline models about the asymmetry caused by the asymmetric preferences of policymakers. While output and inflation asymmetry are stable in most countries, minor differences are visible in Brazil, Korea, the Philippines, and South Africa. In summary, the empirical findings about asymmetries are robust to structural breaks.

The next analysis involves the relaxation of the stationarity condition, meaning that variables of interest are estimated at its level. ARDL models are a proper choice to solve this problem as variables are integrated at different level, I(0) and I(1). It should be noted that the time dummy is included to control for the effect of the structural beak. Other control variables are commodity price, exchange rate, and money supply. To begin with, ARDL estimation (appendix 21) shows that the Phillips curve is concave in the short run in many inflation-targeting emerging economies: Chile, Colombia, Mexico, Hungary, Poland, and Korea. It is concave in the long run in Brazil and Turkey whereas it is convex in the Philippines. In summary, ARDL estimation is highly consistent with the preliminary analysis of the Phillips curve shape in the section 5.4.1.

Table 30: Asymmetric Taylor rule and structural breaks

	Nonlinear Phillips curve		Asymmetric preferences			
	Time	Base	Time		Base	
	$\pi_{t+k}y_t$	$\pi_{t+k}y_t$	$\sigma^2_{\pi,t}$	$\sigma^2_{y,t}$	$\sigma^2_{\pi,t}$	$\sigma^2_{y,t}$
Brazil	0.038**	0.037**	0.107***	-16.413	0.135**	-18.344***
	(0.017)	(0.015)	(0.064)	(10.447)	(0.057)	(11.074)
Chile	-0.016**	-0.016**	-2.065*	-3.046*	-1.969**	-2.375*
	(0.008)	(0.008)	(0.760)	(0.934)	(0.768)	(0.826)
Colombia	-0.008	-0.013***	1.168***	-0.760***	1.245***	-0.681***
	(0.008)	(0.008)	(0.699)	(0.426)	(0.647)	(0.386)
Mexico	-0.126	-0.130***	-0.214	-0.265	-0.148	4.196
	(0.077)	(0.076)	(0.834)	(4.601)	(0.816)	(4.555)
Hungary	-0.010	-0.013***	2.021**	-3.572**	1.892***	-3.277***
	(0.007)	(0.007)	(1.024)	(1.760)	(1.094)	(1.944)
Poland	0.011***	0.012***	0.820	0.233**	5.380	0.286**
	(0.006)	(0.006)	(14.936)	(0.116)	(14.775)	(0.118)
Romania	0.014	0.012	5.589**	-4.404	5.526**	-2.104
	(0.034)	(0.034)	(2.360)	(3.920)	(2.147)	(2.926)
Turkey	-0.005	-0.005	4.558	-0.970**	5.584	-0.894**
	(0.004)	(0.004)	(4.658)	(0.448)	(5.028)	(0.445)
Korea	-0.008**	-0.008**	-33.248	-0.020	-41.175***	0.015
	(0.004)	(0.004)	(21.260)	(0.065)	(23.548)	(0.061)
Philippines	0.002**	0.003**	0.509	-0.045*	0.825***	-0.046**
	(0.001)	(0.001)	(0.563)	(0.017)	(0.475)	(0.019)
Thailand	-0.003*	-0.003**	-1.273*	-0.267*	-1.264*	-0.170**
	(0.001)	(0.001)	(0.345)	(0.085)	(0.328)	(0.066)
South Africa	-0.005***	-0.005***	0.096	-0.795	0.208**	-2.258*
	(0.003)	(0.003)	(0.096)	(0.635)	(0.099)	(0.553)

Source: Authors' estimation

Notes: *, **, *** denote the significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses. Time and Base mean the estimation with and without the time dummy.

Table 31 indicates that the nonlinear Phillips curve leads to the existence of the asymmetry in the reaction function of monetary policy in inflation-targeting emerging economies. Specifically, monetary authorities strongly respond to inflation when there is a negative shock of output gap in the short run in most economies. This implies that policymakers perceive that it is costly to increase inflation when inflation reaches low level. Such a finding is in line with the baseline analysis of the Phillips curve shape and the asymmetric Taylor rule caused by the nonlinear Phillips curve. In some economies (Brazil, Poland, Korea, and South Africa), monetary authorities may believe that the cost of reducing inflation is high if allowing a significant increase in prices in the long run.

Table 32 provides the ARDL estimate of the asymmetry caused by the asymmetric preference of monetary authorities in the short and long run. Accordingly, the short-run output volatility coefficient is negative and significant in Brazil, Mexico, and Romania. In Hungary, figure can be negative or positive in the short-run, depending on the lag length. However, it should be noted the negative effect is more pronounced in this country. In Chile, Colombia, and Thailand, the negative effect of output volatility is not greater than that of positive effect. On the other hand, in the long run, the asymmetry emerges in fewer economies, whereby recession avoidance is visible in Hungary and Romania. In summary, the evidence for recession avoidance preference is visible in the short-run in most emerging economies, which is highly consistent with the finding of the baseline analysis.

Turning to inflation asymmetry, the short-run inflation preference falls into two group. Inflation avoidance appears in Colombia, Hungary, Poland, Korea, and South Africa. By contrast, low-inflation avoidance emerges in Brazil, Mexico, and Romania. Overall, there is a high similarity between the ARDL and baseline analysis. However, minor differences are documented. As an illustration of this, Brazil tends to avoid high inflation in the baseline analysis whereas ARDL analysis indicates that it prefers to avoid too low inflation in the short run.

Table 31: Short- and long-run asymmetry caused by the nonlinear Phillips curve

	Correction	Long run	Short run			
			ΔITR_t	ΔITR_{t-1}	ΔITR_{t-1}	ΔITR_{t-1}
Brazil	-0.048*	0.283*	0.006*	-0.010*	-0.006*	-0.005*
	(0.013)	(0.091)	(0.001)	(0.002)	(0.002)	(0.002)
Chile	-0.363*	-0.016	-0.006			
	(0.042)	(0.014)	(0.005)			
Colombia	-0.048*	-0.026	0.002	-0.004***		
	(0.012)	(0.084)	(0.003)	(0.002)		
Mexico	-0.066*	-0.228	-0.015			
	(0.019)	(0.158)	(0.011)			
Hungary	-0.155*	-0.008	-0.001			
	(0.038)	(0.019)	(0.003)			
Poland	-0.043*	0.263**	0.005			
	(0.014)	(0.119)	(0.003)			
Romania	-0.165*	-0.231	-0.009	0.022	0.006	0.006
	(0.030)	(0.140)	(0.009)	(0.021)	(0.017)	(0.014)
Turkey	-0.056*	-0.005	-0.004***			
	(0.013)	(0.047)	(0.002)			
Korea	-0.049*	0.074**	0.004*			
	(0.013)	(0.030)	(0.001)			
Philippines	-0.083*	0.018	-0.000			
	(0.026)	(0.012)	(0.001)			
Thailand	-0.036**	-0.005	-0.006*	-0.004*		
	(0.015)	(0.034)	(0.001)	(0.001)		
South Africa	-0.034*	0.074*	0.001**	-0.001**		
	(0.011)	(0.028)	(0.001)	(0.001)		

Source: Authors' estimation

Notes: *, **, *** denote the significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses. $ITR_t = \pi_{t+1} y_t$. ΔITR_{t-k} with k greater than 3 is not included.

Table 32: Short- and long-run asymmetry caused by asymmetric preferences

	Correction	Long run		Short run	
		$\sigma^2_{y,t-1}$	$\sigma^2_{\pi,t-1}$	$\Delta y^2_{\pi,t-k}$	$\Delta\sigma^2_{\pi,t-k}$
Brazil	-0.034**	166.560	-1.751	[2]-9.882**; [3]-8.054***; [5]-5.865***	[2]0.153**
Chile	-0.257*	3.196	-9.456	[0]-18.594***; [1]27.651**	
Colombia	-0.054*	-20.714	126.642*	[0]-1.865**; [3]2.174**	[0]6.916*; [1]-5.982*; [3]-6.330*; [4]-3.153**
Mexico	-0.015	1714.566	-40.811	[1]-48.925*; [4]-58.271*	[1]7.306**; [6]5.470**
Hungary	-0.164*	-28.281**	-25.826***	[0]-5.788**; [1]9.065*; [4]-6.703*; [5]-7.430*	[1]-225.524*
Poland	-0.042*	3.163	1060.210		[1]-103.879**
Romania	-0.162*	-189.993*	57.128*	[0]-11.712**	[0]9.269*
Turkey	-0.024**	21.770	377.300		
Korea	-0.016	-4.548	2500.507		[1]-33.310*
Philippines	-0.069*	-0.416	0.767		
Thailand	-0.072*	-0.515	-8.855	[1]9.275*; [5]9.621*; [6]-6.091**	
South Africa	-0.057*	104.369*	12.116	[0]2.884**	[0]-7.540***

Source: Authors' estimation

Notes: *, **, *** denote the significance at 1%, 5%, and 10% respectively. Only significant short-run coefficients are included.

5.4.5. Conclusion

In this thesis, we searched for the asymmetry in the reaction function of monetary policy in twelve emerging economies targeting price stability. Unlike previous studies, we simultaneously investigated the effect of two primary drivers of the asymmetry: nonlinear Phillips curve and asymmetric preference. The empirical results suggested that both have important implications for the asymmetric setting of monetary policy in

emerging economies that follow inflation targeting. In general, the monetary policy response to inflation is stronger in recessions than in expansions. Furthermore, the recession avoidance preference is strong and consistent in emerging economies whereas the inflation avoidance preference varies between economies.

In detail, monetary authorities in emerging economies show a greater aversion to deflation pressure caused by a reduction in the output gap. Secondly, the asymmetric preference evidence is mixed. In Brazil, Colombia, Hungary, Philippines, and South Africa, monetary authorities aggressively reduce inflation when it is above the target. On the other hand, in Chile, Romania, Korea, and Thailand, policymakers are reluctant to keep low inflation because it can destabilize the economy. With respect to output preference, recession avoidance is visible in most emerging economies. In Poland, expansion avoidance preference is dominant.

Both output and inflation preference are consistent with the counter-procyclical properties of monetary policy. On one hand, recession avoidance is in line with the high concern of emerging economies about economic growth, which can reduce the gap between them and advanced economies. On the other hand, the existence of inflation avoidance and strong reaction to inflation caused by negative output gaps imply that monetary authorities are reluctant to maintain a low inflation rate and prefer to have a moderate and stable inflation rate. To put it differently, monetary authorities may care about the pace of economic growth. Therefore, if the economy grows rapidly (slowly), inflation can be too high (low), monetary policy should be tightening (easing) to reduce (increase) economic growth and inflation.

The strong evidence for the asymmetries suggests important policy implications. Firstly, it causes difficulties for market participants in predicting the behaviour of the central bank. In this case, clear and understandable communication plays an important role to avoid the loss of credibility in the implementation of inflation targeting in emerging economies. Secondly, market participants should account for the asymmetry of the Taylor rule to improve the forecast of the interest rate movement. Finally, to increase the performance of inflation targeting, it is still advisable to implement monetary policy in a symmetric manner.

CHAPTER 6: MAIN CONCLUSIONS AND IMPLICATIONS

6.1. Main conclusions

The study of monetary policy copes with ongoing debates about the choice of the most proper measure and the development of a simple function that can approximate the behaviour of the central bank. While the first problem refers to as the indicator problem, the second problem is called identification problem. In emerging economies, these problems became more serious. The vast literature for advanced economies jumps to a consensus that interest rates are the best measure of monetary policy and Taylor rule is the simplest and the most appropriate function of monetary policy (e.g., Bernanke and Mihov, 1998; Howells and Bain, 2003; Acosta-Ormaechea and Coble, 2011; Phiromswad, 2015; Peters, 2016).

In the late 1980s and early 1990s, emerging economies experienced a period of recessions and high inflation. Such a declining economy is conditional on many factors of which the primary one is the weak framework of monetary policy. The use of money supply and high emphasis on economic growth cause problem in the conduct of monetary policy. Therefore, many economies decided to follow the framework of inflation targeting whose primary principles are the emphasis on remaining price stability and using interest rates as the primary instrument. However, institutions prevent emerging economies from strictly following the primary principles of the inflation targeting. Firstly, the low level of finance development, the high level of uncertainty, or the low level of central bank independence leads to the fact that monetary authorities in emerging economies use a pallet of monetary policy instruments, which is of importance to achieve a range of objectives. An underdeveloped financial system can interrupt the smooth transmission from a change in policy interest rates to economic activities, which restricts the effectiveness of the interest rate instrument. Since monetary policy instruments are different in nature, using a pallet of them is highly likely to increase the performance of monetary policy conduct in the circumstance of high uncertainty. Despite of these advantages, the multiple-instrument framework causes difficulties in the study of monetary policy. It suggests that no single indicator can fully capture changes in monetary policy. In other words, interest rates may capture a proportion of information and the rest of information comes from other instruments such as changes in exchange rates or money

reserves. Therefore, it is of importance to have a rigorous study about the relative significance of various monetary policy indicators as well as the application of a composite measure in emerging economies that follow inflation targeting.

Secondly, the basic Taylor rule is less likely to capture the process of policy making in emerging economies. The primary reason is that monetary authorities in emerging economies have more things under considerations than their counter partners in advanced economies. This means that to better understand the behaviour of monetary authorities in emerging economies, the Taylor rule should add more variables that indicate the difference in the institutions of these economies. To begin with, adding exchange rates is of importance. Since emerging economies are small and open, they have high level of external exposure. Therefore, remaining a stable exchange rate has a significant contribution to the protection and development of certain industries such as agriculture, commodities, or infant industries. A stable exchange rate can also maintain or increase the competitive advantage of emerging economies. Beside exchange rates, the intervention in the foreign exchange market should be under consideration. Last but not least, monetary authorities in emerging economies can depart from the conventional model of monetary policy studies. For instance, the low level of the central bank independence leads to the fact that monetary authorities in emerging economies cope with high political pressures in the implementation of monetary policy. In times of recessions, the political pressure is heating and monetary authorities are likely to put a high priority on output growth rather than price stability. This suggest that a linear monetary policy rule may not be a proper choice to study the behaviour of monetary authorities in emerging economies that follow inflation targeting. To put it differently, the behaviour of monetary authorities should be represented by an asymmetric rule.

While there is a vast literature about the indicator and identification problem for advanced economies, there is a few empirical evidence about these problems for emerging economies that follow inflation targeting. In fact, the existing literature remains some critical gaps that need a rigorous study. First, the indicator problem raises questions about the representativeness of interest rates as an overall measure of monetary policy for emerging economies that follow inflation targeting. Therefore, the first objective of the thesis is to identify the contribution of money supply and interest rates to explain the movement of inflation and examine the role of monetary conditions index as an overall measure of monetary policy. We achieve this objective by analysing empirical results

derived from Granger causality test, impulse response function, and forecast error variance decomposition. We further investigate the indicator problem by evaluating the role of MCI in the conduct of monetary policy. Secondly, we augmented the Taylor rule with exchange rates and foreign reserves to investigate the presence of the fear of floating and the effect of foreign exchange intervention in the conduct of monetary policy in inflation-targeting emerging economies. We also depart from the linear analysis by investigating whether the Taylor rule is asymmetric and such an asymmetry is conditional on the presence of a nonlinear Phillips curve or an asymmetric preference.

Specifically, the results can be summarized as follows:

Table 33: Hypotheses and Conclusions

Hypothesis	Conclusion
Hypothesis 1: Interest rates and money supply contain comparable information about changes in monetary policy	Not rejected
Hypothesis 2: MCI is a useful indicator of monetary policy in emerging economies.	Not rejected
Hypothesis 3: Foreign exchange has a significant influence on monetary policy in emerging economies.	Not rejected
Hypothesis 4: Foreign reserves have significant influence on monetary policy in emerging economies.	Not rejected
Hypothesis 5: Monetary authorities in emerging economies asymmetrically respond to positive and negative inflation and output gap.	Not rejected

Source: Author's construction

The empirical results show critical findings. Firstly, the hypothesis 1 cannot be rejected. This means that money supply contains a significant information about changes in monetary policy in emerging economies that follow inflation targeting. Although interest rates contain information about the stance of monetary policy, their role seems to be weaker than that in advanced economies. The price puzzle still happens after a contraction shock caused by interest rates. There are several justifications for this phenomenon. One is the model misspecification. However, the robustness tests indicate that it is less likely to happen. On the contrary, the phenomenon that inflation rises after

an increase in interest rates is highly likely to be conditional on the fact that there is a strong increase in the stock of money reserves. Conflict changes in the money stock is likely to happen when the central bank has a low degree of independence.

Secondly, MCI that is a weighted average of changes in interest rates and exchange rates relative to a benchmark level makes a critical contribution to the conduct of monetary policy in inflation-targeting emerging economies. The empirical results show that inflation negatively responds to a contraction shock of MCI. Such an impulse response function is of expected and consistent with monetary theories. Therefore, MCI can be considered as a useful indicator of monetary policy.

Thirdly, exchange rates play a critical role in the process of decision making of monetary policy in inflation-targeting emerging economies. To begin with, monthly changes in exchange rates matter more in the Taylor rule, which suggests a close look of monetary authorities on the monthly evolution of the exchange rate market. Moreover, interest rates show an asymmetric response to exchange rate changes. During the post-crisis period, the exchange rate effect is more pronounced, which is consistent with changes in the exchange rate policy in many countries such as Hungary or Poland. Furthermore, there is strong evidence for the fear of appreciation, which is consistent with the behaviour of accumulating foreign reserves in emerging economies.

Fourthly, exchange rate intervention matters and a Taylor rule augmented by foreign reserves can better approximate the behaviour of monetary authorities in emerging economies that are inflation targetters. However, it should be noted that the direction of interest rate changes is different among countries. Interest rates show a negative response in Mexico, Philippines, and Thailand; a positive response in Colombia, Poland, Turkey, Korea, and South Africa; and an insignificant response in other countries. Furthermore, the effect of sales and purchase interventions are asymmetric.

Finally, monetary authorities show a departure from the symmetric reaction to output and inflation, suggesting that their behaviour should be captured by an asymmetric Taylor rule. The empirical results show that there is a great aversion to deflation pressure caused by a contraction in output. Such a finding is in line with the fact that the Phillips curve is concave in most emerging economies. Furthermore, there is evidence for the asymmetry caused by the asymmetric preference of monetary authorities to changes in output and inflation. While inflation avoidance is pronounced in Brazil, Colombia, Hungary, Philippines, and South Africa, deflation avoidance is pronounced in other

emerging economies. With respect to output preference, recession avoidance is supportive in most emerging economies.

6.2. Policy implications

6.2.1. Hypothesis 1

The empirical results suggest critical implications for the implementation of monetary policy in inflation-targeting emerging economies. Firstly, regarding the empirical results for hypothesis 1, they suggest that interest rates may not be the best measure of monetary policy and money supply contains significant information about changes in monetary policy. The problem of the price puzzle provides important implications about the interest rate policy. One, interest rates contain part of information about the stance of monetary policy and a composite measure can be a better measure of monetary policy. Two, the interest rate policy has limited impact on inflation. There are several reasons for the low effectiveness of the interest rate policy. The use of multiple instruments in emerging economies that follow inflation targeting reduces the role of interest rates in driving the evolution of inflation. In other words, a significant part of information about changes in monetary policy comes from other instruments beyond interest rates such as money reserves or exchange rate. Other reason may come from the effect of monetary policy on the supply side of the economy. According to Barth and Ramey (2001), an increase in interest rates can lead to a rise in borrowing costs, which can affect the production cost as well as the spending of the consumers. If the contraction effect on production is greater than that on aggregate demand, there will be an increase in the price and inflation. Hence, the presence of the cost channel is a driver of price puzzle. Another reason for the price puzzle comes from the existence of information asymmetry. An increase in inflation follows a rise in interest rates because monetary authorities do not have sufficient information and they cannot make policy decisions in time.

Therefore, to increase the effectiveness of interest rate policy, it requires several reforms. To begin with, it is of importance to restrict the use of other instruments beyond interest rates and increasing the focus on the price stability. In practice, the government has a significant impact on the conduct of monetary policy in inflation-targeting emerging economies. Political pressures are typically high during times of recessions, which can foster career-concerned monetary authorities to focus more on economic growth rather than price stability. Economic growth, competitiveness, the protection of infant

industries, and many other factors stimulate monetary authorities to maintain a stable exchange rate and accumulate the stock of foreign reserves. Therefore, increasing the effectiveness of interest rate policy is conditional on a higher level of the central bank independence, which allows the central bank a higher degree of freedom in determining the tools and objective of monetary policy. Such a reform can be coped with the political conflict between the government and monetary authorities. Furthermore, a high central bank independence should accompany with the high accountability, transparency, and efficient public communication (Christoffersen et al., 2001).

Moreover, accelerating the speed of finance development can contribute to increase the effectiveness of the interest rate channel. For instance, a greater number of financial instruments provide more rooms for monetary authorities to cope with the uncertainty in emerging economies because financial instruments vary in nature and they can be effective in different situations. Therefore, whenever monetary authorities alter policy interest rate, it is highly likely that other types of interest rates change, which then affect investing and consuming. Furthermore, finance development that is characterized by increased indirect finance (Duggal, 1995) can also contribute to reduce the problem of information asymmetry through the third-party verification (Sheng et al., 2021). This allows investors to reduce risks and actively react to changes in the interest rate policy.

6.2.2. Hypothesis 2

Concerning the hypothesis 2, MCI is a useful indicator of monetary policy because there is an absence of the price puzzle following a contraction of monetary policy (a positive shock of MCI). However, it should be cautious for both policymakers and market participants when using MCI as a monetary policy instrument because there are difficulties in monitoring changes in the components of MCI and their weights. It should be noted that the weight of interest rates and exchange rates remains constant in the thesis. Such a time-invariant characteristic is a limitation of the thesis and need further studies that relax this constrain. In comparison with interest rate, MCI has a lower level of observability by the public. For this reason, MCI shows a disadvantage to interest rates. Furthermore, to interpret the monetary conditions, it is better to observe the movement rather than the value of MCI, which is in line with the finding and suggestion of Nucu and Anton (2018). Such a weakness prevents the use of MCI as a technical instrument through which monetary authorities can make a decision. Finally, the public copes with

difficulties when predicting the effect of MCI on inflation when there is an inverse relationship between interest rates and exchange rates (Engelbrecht and Loomes, 2002).

6.2.3. Hypothesis 3

Regarding to the hypothesis 3, the empirical results provide some crucial implications. The evidence for the matter of exchange rates suggests that a Taylor rule augmented by exchange rates can better capture the behaviour of the central bank. Such a result implies the presence of the fear of floating, which may stem from the small and open nature of emerging economies, their concern about the competitive advantage in the global market, and the care about the development of infant industries. Given the status of the development of emerging economies, there are many obstacles for eliminating the fear of floating. The fear of appreciation is also consistent with the accumulation of foreign reserves in emerging economies. Furthermore, the statistical significance of the monthly coefficient of exchange rate changes implies a high frequency of changes in monetary policy.

To reduce the exchange rate effect, it needs a combined actions in many areas. It needs to reduce the dependence on low-valued products (agriculture or commodities) and increase the production of high-value products (high technology). It also requires the maturity of new and infant industries, which consumes a great amount of time. Changes in the competitive advantage of the country is of importance for emerging economies that follow inflation targeting. A focus on durable products or long-term assets can be a choice since it can prevent the monitoring of the short-run movement of exchange rates.

6.2.4. Hypothesis 4

Turning to the hypothesis 4, the empirical results show that foreign reserves matter for the conduct of monetary policy in inflation-targeting emerging economies. Therefore, market participants should consider the effect of the exchange rate intervention when analysing the stance of monetary policy because changes in foreign reserves is useful in predicting the future course of monetary policy. However, it should be noted that the significance of foreign reserves can provide misleading information about the priority of monetary policy, which can cause a reduction in the credibility of the central bank. To avoid these problems, monetary authorities should increase the transparency in the conduct of foreign exchange interventions and foster finance development.

6.2.5. Hypothesis 5

Regarding the hypothesis 5, the asymmetries in the Taylor rule implies that the Phillips curve is nonlinear and monetary authorities show an asymmetric preference. Such asymmetries cause difficulties for both market participants and policymakers in analysing the behaviour of the central bank in emerging economies that follow inflation targeting. For this reason, clear and understandable communication is of importance to improve the observability and performance of the conduct of monetary policy. Furthermore, accounting for these asymmetries can improve the forecast of the movement of the interest rate.

6.3. Limitations

It should be noted that the thesis focuses on the period from January 2000 to June 2018. Data availability is the main reason that prevents the inclusion of the data of recent years. The period after 2019 is characterized by the introduction and spread of Coronavirus disease over the world, which can refer to as the post-covid era. Therefore, it is not clear about the impact of the covid pandemic on the conduct of monetary policy in inflation-targeting emerging economies. Consequently, both monetary authorities and market participants should be cautious when applying the findings in the thesis. Furthermore, the ignorance is a limitation of the thesis and needs further studies in the future. It is recommended that future studies should investigate the effect of the covid pandemic on the conduct of monetary policy in inflation-targeting emerging economies.

Another shortcoming is the possibility of structural breaks in the last two decades. Over the last two decades, there are changes in institutions in emerging economies that follow inflation targeting. Firstly, the adoption of inflation targeting leads to radical changes in the framework of monetary policy. Price stability becomes the key target whereas interest rates become the primary instrument. Secondly, the Great recession also puts pressures on the implementation of monetary policy in many countries. For instance, the introduction of quantitative easing may affect the effectiveness of the interest rate channel. Finally, the outbreak of Coronavirus disease in 2019 and its spread lead to sudden changes in the global economy like mobility disruptions or market demand. Obviously, the thesis accounted for these possible breaks to a limited degree. It extended the baseline study by adding a time dummy into the baseline as well as ARDL models, which can control for the effect of the structural break. However, it remains ambiguous about the possible effect of structural breaks on the indicator and identification problem

of monetary policy analysis. Therefore, it is of importance to have a more rigorous study about these problems.

Another drawback is the ignorance of the time-varying characteristic of variables of interest. To begin with, the most common speculation is that the role of interest rates was increasing whereas that of money supply or exchange rates was declining after the adoption of inflation targeting in emerging economies. Finance development made a great contribution to this trend. The introduction and development of stock market, the banking restructuring and market liberalization are factors that lead to changes in the effectiveness of the interest rate policy. Second, exchange rates may show a variation in its importance over time. In some occasions, policymakers should closely monitor the movement of the exchange rate, especially in times of financial turmoil. In most of the time, exchange rates can freely move in a specific range. Finally, the asymmetries may change over time. This stems from many factors such as the arrival of a new policy committee, economic crises, or government changes. Therefore, it is of importance to have a rigorous study about time-varying characteristic in both indicator and identification problem.

Furthermore, some disparities appear with the estimate of the asymmetry of foreign exchange intervention effect by ARDL and baseline models. This implies that it is unable to extract purchase and sales intervention from foreign reserves because they are a narrative measure of foreign exchange intervention (Blanchard and Adler, 2015). Therefore, future studies should use a better measure of foreign exchange intervention. A recommendation is event studies, which involve the definition of which events refer to the purchase or sales of foreign reserves. However, such a method requires a huge amount of information and a high degree of transparency in the implementation of monetary policy in emerging economies.

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APPENDICES

Appendix 1: Causal effect of monetary policy on inflation during pre-crisis period

	$i \rightarrow \pi$	$\pi \rightarrow i$	$M1 \rightarrow \pi$	$\pi \rightarrow M1$	$M2 \rightarrow \pi$	$\pi \rightarrow M2$
Brazil	7.38***	12.7*	39.16*	27.57*	37.35*	21.86*
	(3-1)	(3-1)	(12-1)	(12-1)	(8-1)	(8-1)
Chile	5	30.11*	28.71*	34.66*	26.24*	3.22
	(6-0)	(6-0)	(12-1)	(12-1)	(6-1)	(6-1)
Colombia	22.36*	16.97**	49.21*	45.03*	35.54*	21.39**
	(9-0)	(9-0)	(12-1)	(12-1)	(12-1)	(12-1)
Mexico	17.19**	15.82***	75.34*	20.89***	29.61*	36.17*
	(9-0)	(9-0)	(12-1)	(12-1)	(12-1)	(12-1)
Hungary	1.33	0	31.8*	30.98*	16.26**	32.71*
	(1-1)	(1-1)	(12-1)	(12-1)	(6-0)	(6-0)
Poland	37*	17.3***	29.29*	18.04	7.11***	2.26
	(10-0)	(10-0)	(12-1)	(12-1)	(3-1)	(3-1)
Romania	2.46	7.81**	0.21	0.77	37.17*	39.05*
	(2-1)	(2-1)	(1-1)	(1-1)	(12-0)	(12-0)
Turkey	82.23*	40.41*	2.98	0.15	4.33	0.18
	(12-1)	(12-1)	(3-0)	(3-0)	(3-0)	(3-0)
Korea	19.46***	25.63*	30.63*	44.86*	8.33***	3.63
	(11-1)	(11-1)	(12-1)	(12-1)	(4-1)	(4-1)
Philippines	8.63**	0.8	28.03*	13.95	3.4	10.91*
	(2-1)	(2-1)	(12-1)	(12-1)	(2-1)	(2-1)
Thailand	1.8	29.5*	1.68	2.37	6.7***	1.34
	(8-1)	(8-1)	(2-1)	(2-1)	(3-1)	(3-1)
South Africa	30.09*	8.94**	11.27**	22.93*	9.94**	14.44*
	(3-1)	(3-1)	(4-1)	(4-1)	(4-1)	(4-1)

Source: Author's estimation

Notes: *Notes*: *, **, *** denotes significance at 1%, 5%, and 10% respectively. The optimal lag and maximum integration order are in the parentheses.

Appendix 2: Causal effect of monetary policy on inflation during post-crisis period

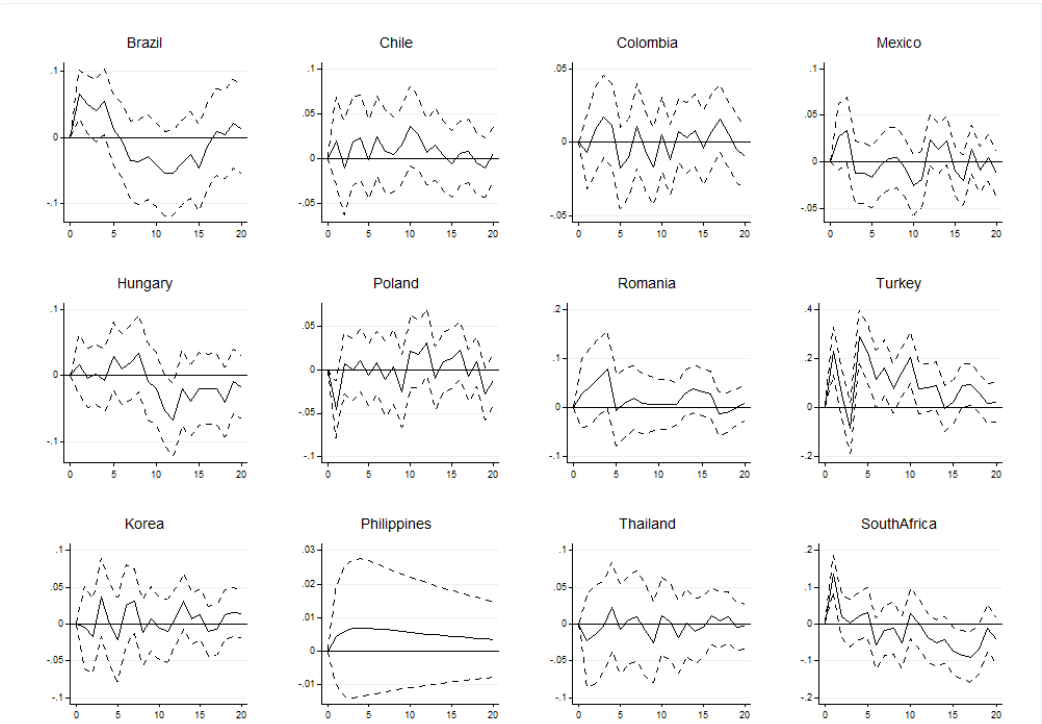
	$i \rightarrow \pi$	$\pi \rightarrow i$	$M1 \rightarrow \pi$	$\pi \rightarrow M1$	$M2 \rightarrow \pi$	$\pi \rightarrow M2$
Brazil	34.21*	29.89*	13.91	27.53*	6.4**	0.2
	(10-1)	(10-1)	(12-1)	(12-1)	(2-1)	(2-1)
Chile	29.55*	66.05*	29.75*	31.07*	2.33	26.17*
	(11-0)	(11-0)	(11-1)	(11-1)	(4-1)	(4-1)
Colombia	14.43	26.92*	31.91*	29.6*	31.98*	23.02**
	(12-0)	(12-0)	(12-1)	(12-1)	(12-1)	(12-1)
Mexico	33.75*	11.88	44.7*	20.08***	18.89*	10.78
	(7-0)	(7-0)	(12-1)	(12-1)	(7-1)	(7-1)
Hungary	18.15***	29.21*	4.31	21.03*	2.38	13.02**
	(11-1)	(11-1)	(6-1)	(6-1)	(4-0)	(4-0)
Poland	3.71	21.82*	17.94	58.38*	12.46**	33.03*
	(6-0)	(6-0)	(12-1)	(12-1)	(5-1)	(5-1)
Romania	1.45	0.09	19.21**	28.06*	0.42	0.62
	(1-1)	(1-1)	(8-1)	(8-1)	(1-0)	(1-0)
Turkey	2.64	27.46*	40.81*	22.19*	6.91	15.02**
	(5-1)	(5-1)	(4-0)	(4-0)	(5-0)	(5-0)
Korea	8.33***	9.03***	26.46*	14.38***	7.46	4.72
	(4-1)	(4-1)	(8-1)	(8-1)	(5-1)	(5-1)
Philippines	19.31***	40.7*	7.8***	3.61	23.32*	21.56*
	(12-1)	(12-1)	(3-1)	(3-1)	(7-1)	(7-1)
Thailand	6.83	115.86*	8.65	52.54*	12.26*	2.73
	(7-1)	(7-1)	(12-1)	(12-1)	(3-1)	(3-1)
South Africa	4.87	2.9	36.52*	35.65*	33.22*	25.27**
	(3-1)	(3-1)	(9-1)	(9-1)	(12-1)	(12-1)

Source: Author's estimation

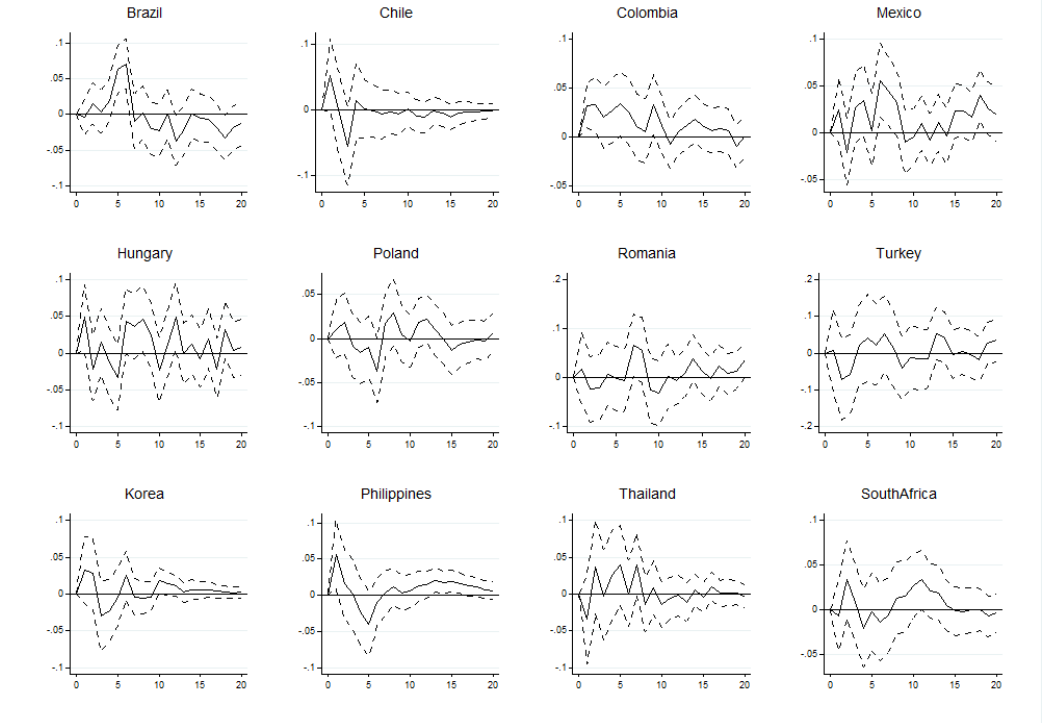
Notes: *Notes*: *, **, *** denotes significance at 1%, 5%, and 10% respectively. The optimal lag and maximum integration order are in the parentheses.

Appendix 3: Interest rate effect on inflation during the pre- and post-crisis

Panel A: Pre-crisis period



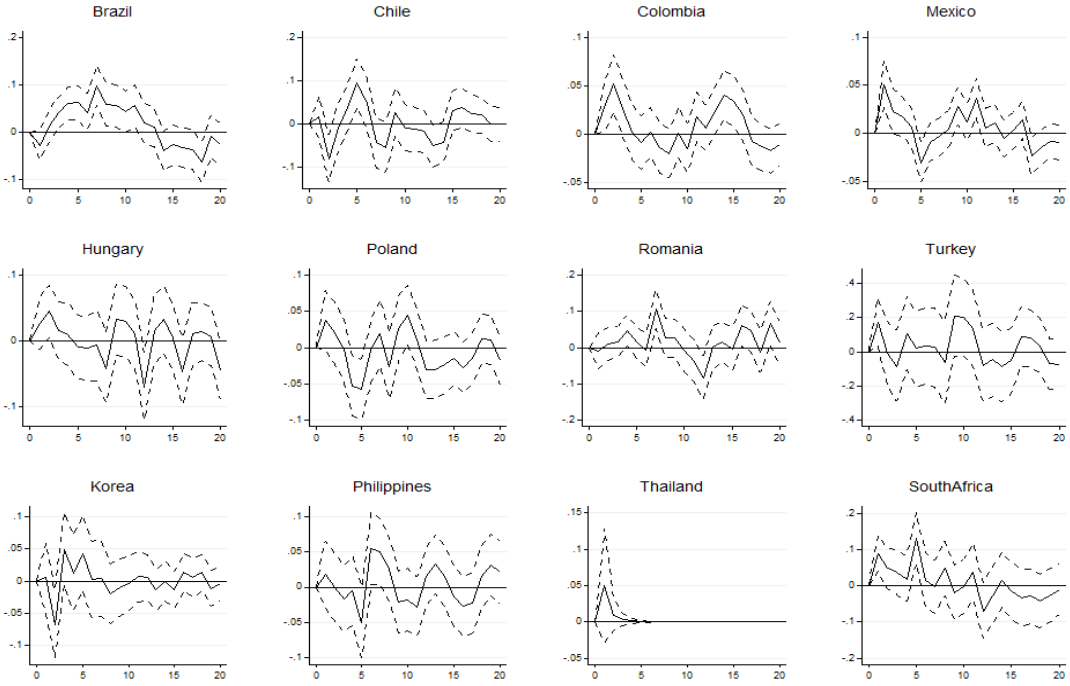
Panel B: Post-crisis period



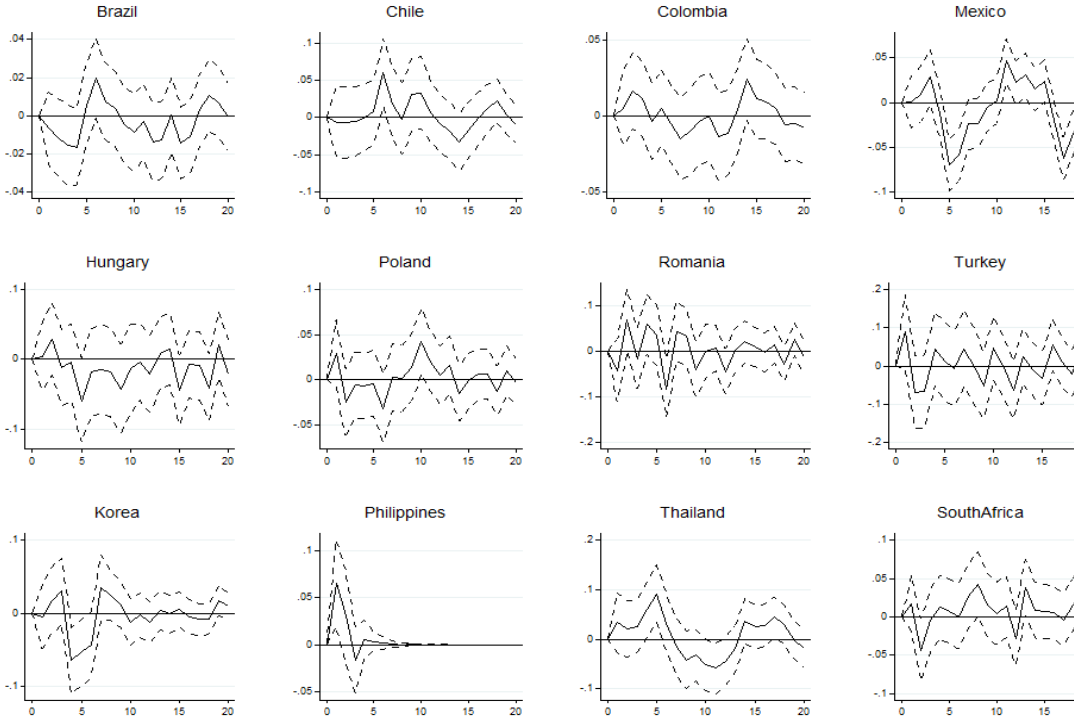
Source: Author's construction

Appendix 4: Inflation effect of M1 during the pre- and post-crisis

Panel A: Pre-crisis period



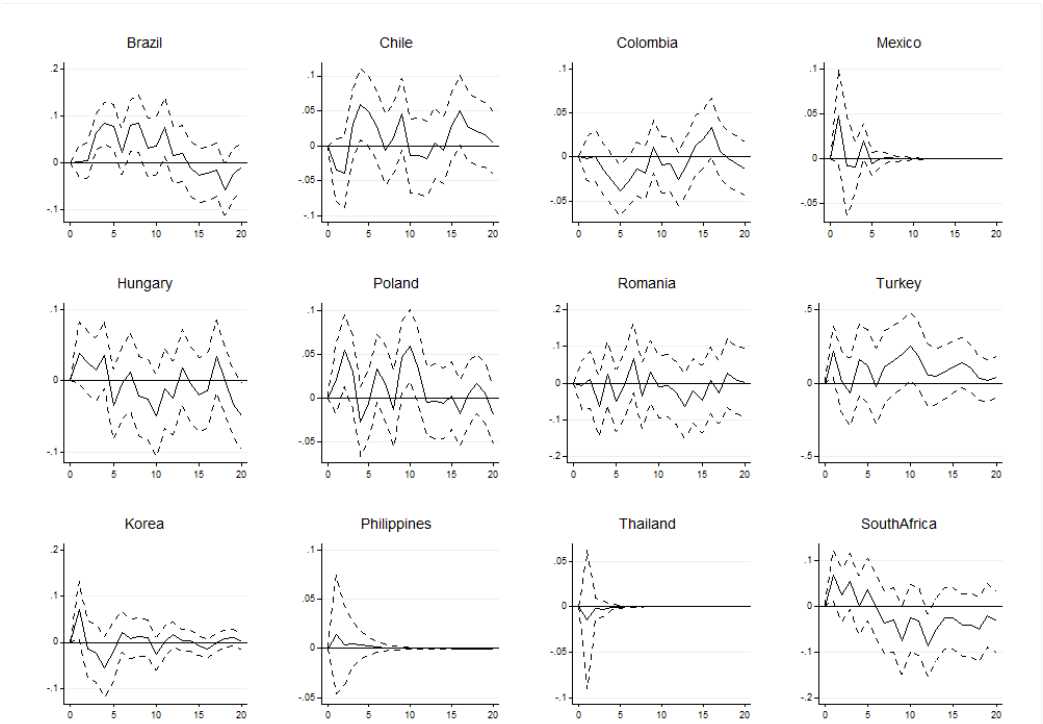
Panel B: Post-crisis period



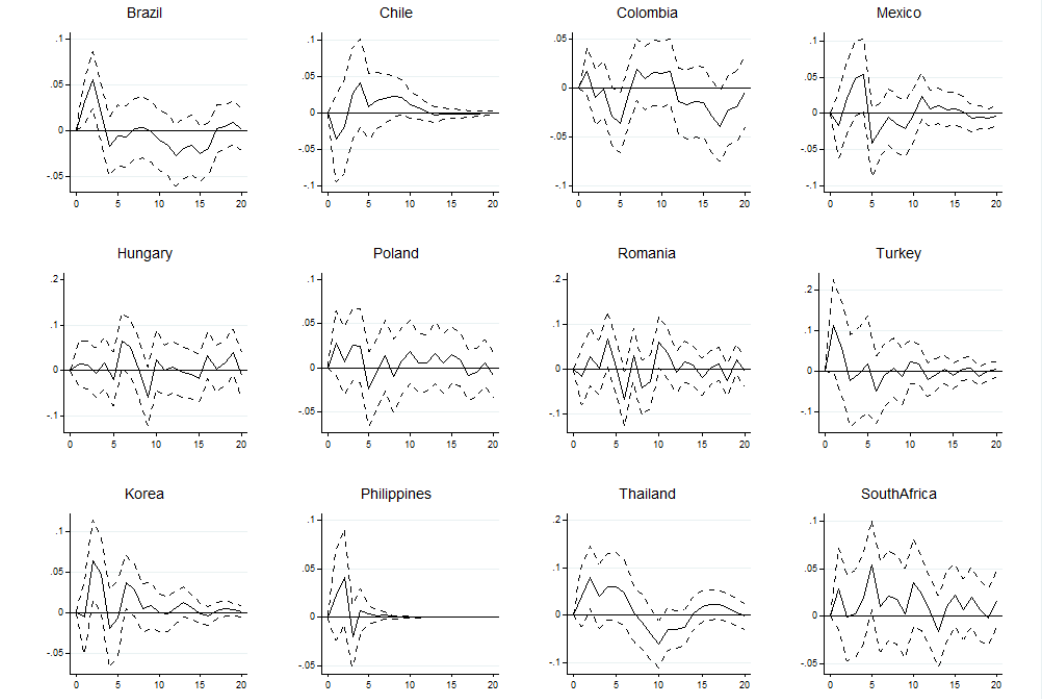
Source: Author's construction

Appendix 5: Inflation effect of M2 during the pre- and post-crisis

Panel A: Pre-crisis period



Panel B: Post-crisis period



Source: Author's construction

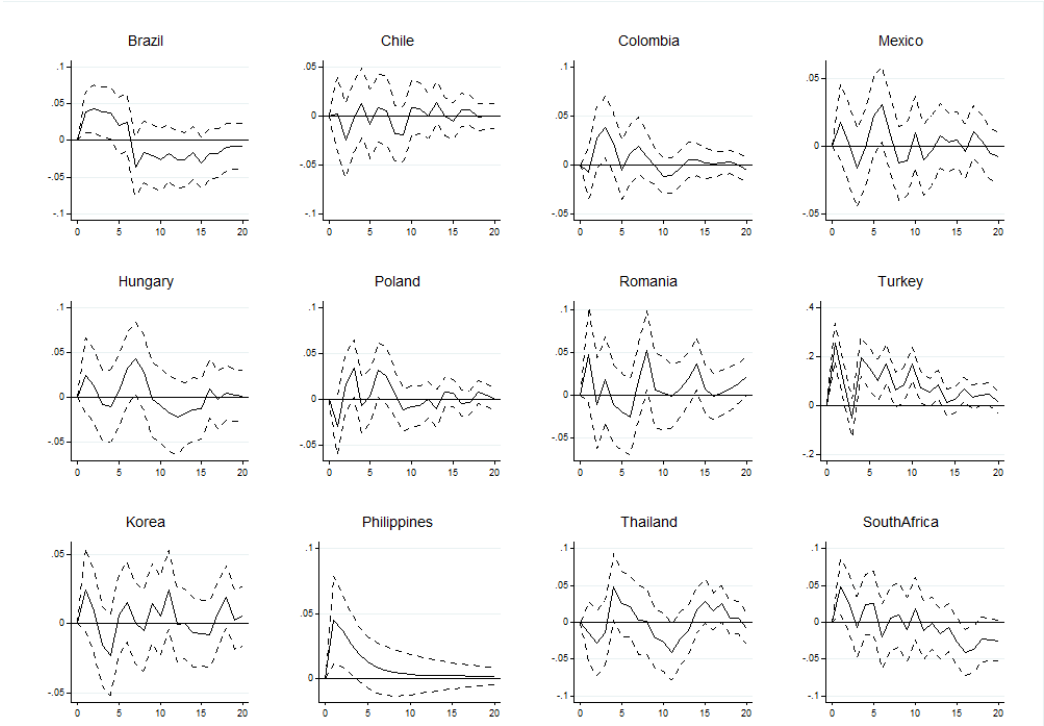
Appendix 6: Granger causality from monetary policy to inflation when adding time dummies

	$i \rightarrow \pi$	$\pi \rightarrow i$	$M1 \rightarrow \pi$	$\pi \rightarrow M1$	$M2 \rightarrow \pi$	$\pi \rightarrow M2$
Brazil	7.4***	22.37*	38.74*	49.64*	6.56**	5.1***
	(3-1)	(3-1)	(12-1)	(12-1)	(2-1)	(2-1)
Chile	6.57	44.82*	31.44*	30.19*	1.92	1.19
	(8-1)	(8-1)	(12-1)	(12-1)	(2-1)	(2-1)
Colombia	24.68*	11.9***	51.72*	53.4*	40*	27.52*
	(6-1)	(6-1)	(12-1)	(12-1)	(12-1)	(12-1)
Mexico	21.97*	26.45*	68.73*	33.12*	22.69**	25.12**
	(9-1)	(9-1)	(12-1)	(12-1)	(12-1)	(12-1)
Hungary	1.35	2.74	33.02*	35.17*	7.13**	7.56**
	(2-1)	(2-1)	(12-1)	(12-1)	(2-1)	(2-1)
Poland	21.59*	23.29*	28.71*	26.46*	11.9*	0.07
	(6-1)	(6-1)	(12-1)	(12-1)	(2-1)	(2-1)
Romania	1.52	3.92	0	0.12	6.53**	0.74
	(2-1)	(2-1)	(1-1)	(1-1)	(2-1)	(2-1)
Turkey	71.99*	57.63*	10.18*	1.3	6.61**	0.63
	(12-1)	(12-1)	(2-1)	(2-1)	(2-1)	(2-1)
Korea	12.87	15.54	38.14*	35.54*	4.95	7.77
	(12-1)	(12-1)	(12-1)	(12-1)	(4-1)	(4-1)
Philippines	17.65*	3.03	36.18*	14.14	22.41*	18.72*
	(6-1)	(6-1)	(12-1)	(12-1)	(7-1)	(7-1)
Thailand	8.12	52.26*	12.92	41.95*	25.93**	42.21*
	(12-1)	(12-1)	(12-1)	(12-1)	(12-1)	(12-1)
South Africa	18.68*	0.79	13.77*	16.8*	0.48	2.35
	(2-1)	(2-1)	(4-1)	(4-1)	(2-1)	(2-1)

Source: Author's estimation

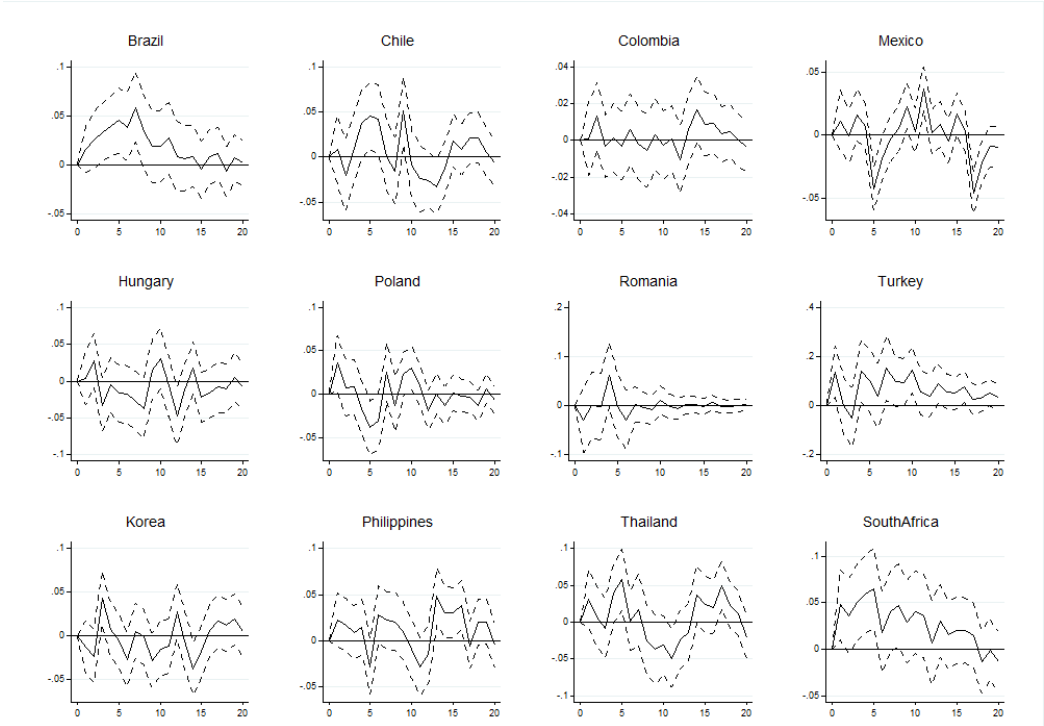
Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. The optimal lag and maximum integration order are in the parentheses.

Appendix 7: Interest rate effect on inflation (time-dummy method)



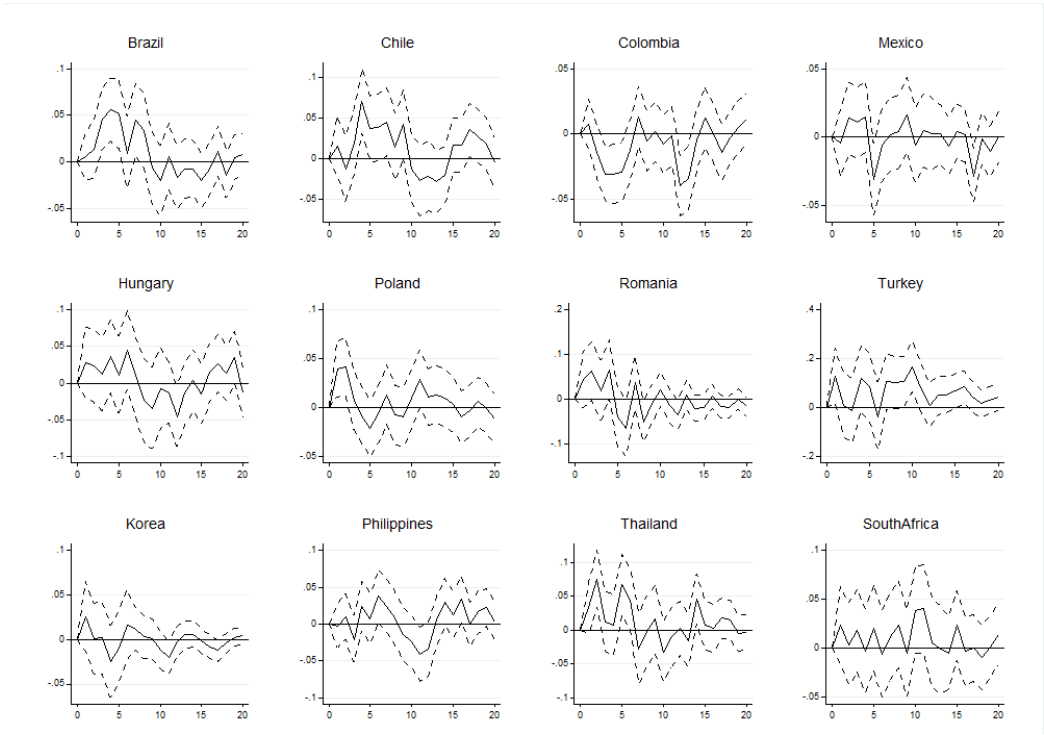
Source: Author's construction

Appendix 8: M1 effect on inflation (time-dummy method)



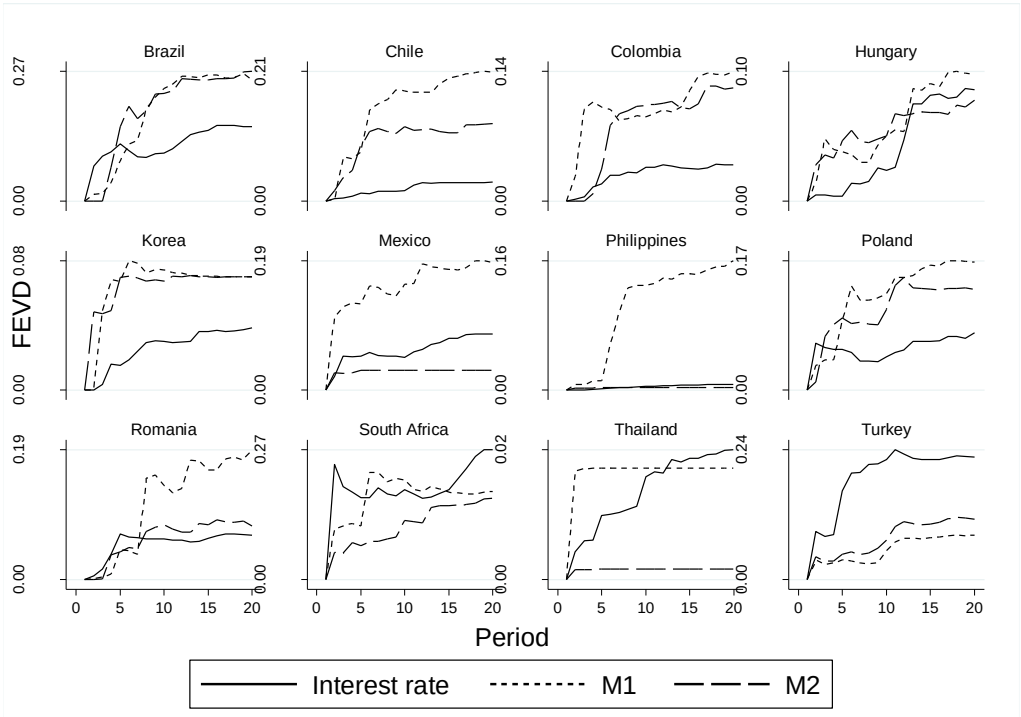
Source: Author's construction

Appendix 9: M2 effect on inflation (time-dummy method)



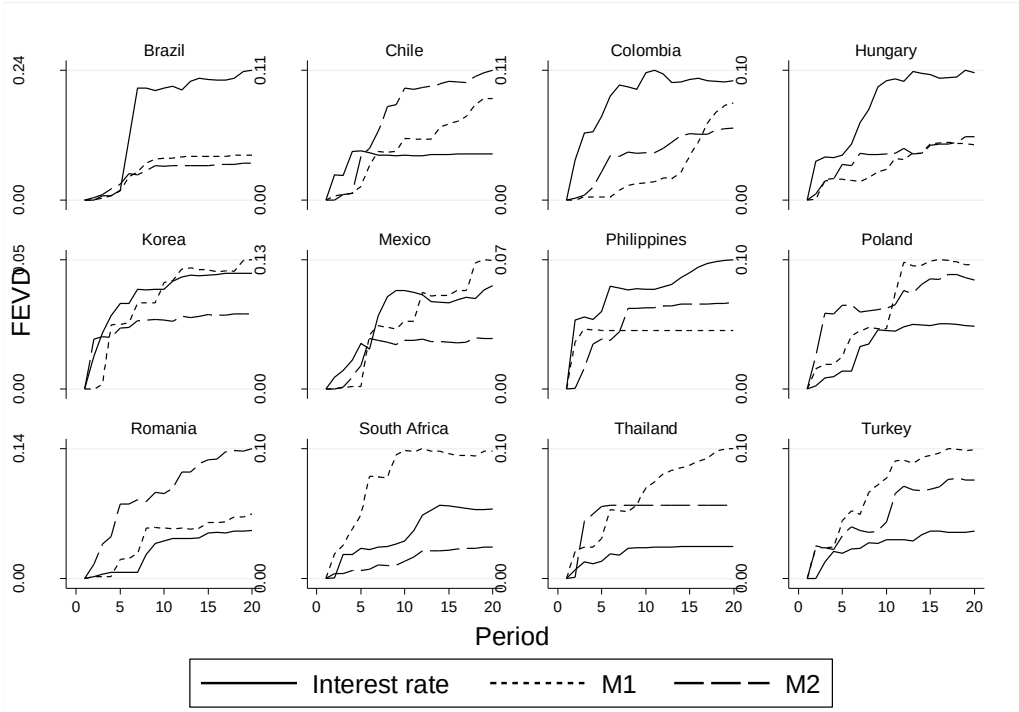
Source: Author's construction

Appendix 10: Monetary policy indicators and inflation variation during pre-crisis period



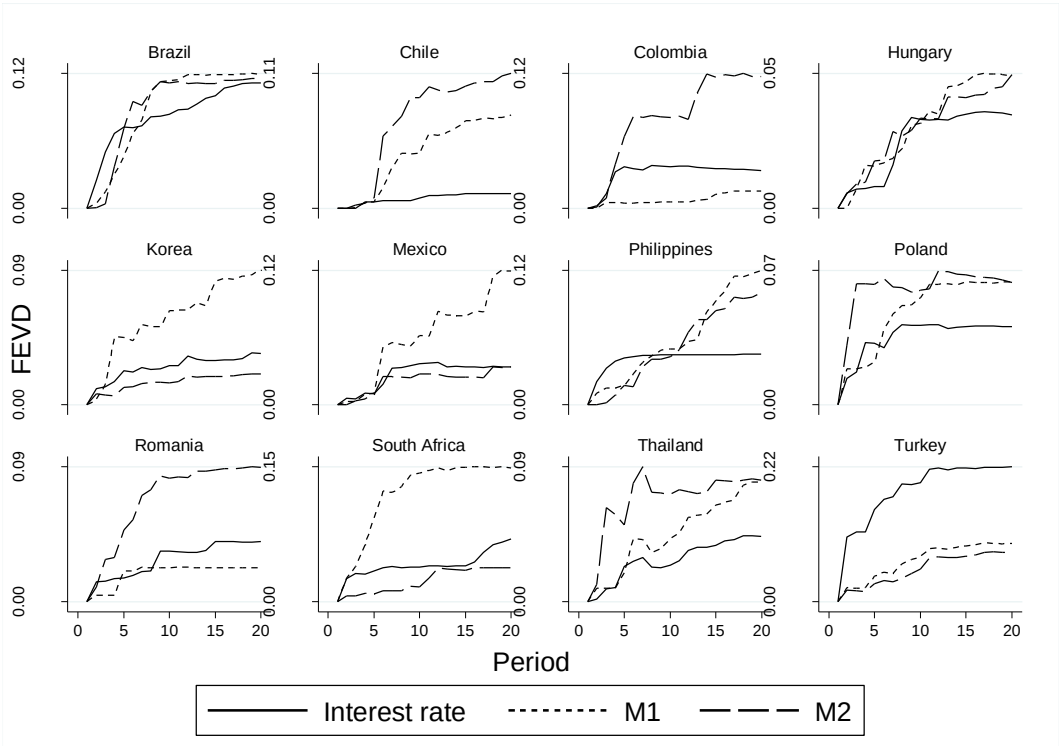
Source: Author's construction

Appendix 11: Monetary policy indicators and inflation variation during post-crisis period



Source: Author's construction

Appendix 12: Monetary policy indicators and inflation variation (with time dummy)



Source: Author's construction

Appendix 13: Asymmetric effect of exchange rates in the time-dummy model (yearly)

	NEER		REER		EX	
Model	Time	Base	Time	Base	Time	Base
Brazil	0.0004*	0.0005*	0.0004**	0.0004*	0.0002***	0.0002***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
Chile	0.0049**	0.0049**	0.0045***	0.0046***	-0.0010**	-0.0010**
	(0.0024)	(0.0025)	(0.0026)	(0.0027)	(0.0004)	(0.0004)
Colombia	-0.0000	0.0001	-0.0001	0.0001	-0.0004*	-0.0003**
	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)
Mexico	-0.0003	-0.0010***	-0.0029	-0.0031***	0.0016	0.0001
	(0.0006)	(0.0006)	(0.0018)	(0.0018)	(0.0010)	(0.0006)
Hungary	0.0008	-0.0005	0.0026	0.0007	0.0015	-0.0001
	(0.0024)	(0.0022)	(0.0024)	(0.0024)	(0.0022)	(0.0021)
Poland	-0.0018*	-0.0017*	-0.0010	-0.0010	-0.0010**	-0.0010**
	(0.0004)	(0.0004)	(0.0008)	(0.0008)	(0.0005)	(0.0005)
Romania	-0.0041*	-0.0042*	0.0007	0.0004	-0.0029*	-0.0023**
	(0.0014)	(0.0014)	(0.0013)	(0.0013)	(0.0011)	(0.0011)
Turkey	-0.0020**	-0.0017**	-0.0016*	-0.0015*	-0.0010**	-0.0010**
	(0.0008)	(0.0008)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Korea	-0.0003*	-0.0002**	-0.0003**	-0.0002***	-0.0003*	-0.0003*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Philippines	-0.0018*	-0.0017**	0.0009	0.0012**	-0.0006**	-0.0008**
	(0.0006)	(0.0007)	(0.0006)	(0.0006)	(0.0003)	(0.0004)
Thailand	-0.0012***	-0.0011***	-0.0014*	-0.0014*	-0.0010*	-0.0010*
	(0.0007)	(0.0006)	(0.0005)	(0.0005)	(0.0003)	(0.0003)
South Africa	0.0002**	0.0002***	0.0001	0.0002**	0.0001	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)

Source: Author's estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

Appendix 14: Asymmetric effect of exchange rates in the time-dummy model (monthly)

	NEER		REER		EX	
Model	Time	Base	Time	Base	Time	Base
Brazil	0.0112**	0.0108**	0.0075**	0.0078**	0.0203*	0.0220*
	(0.0045)	(0.0046)	(0.0032)	(0.0034)	(0.0078)	(0.0084)
Chile	-0.0153***	-0.0155***	-0.0356***	-0.0348***	-0.0118	-0.0147***
	(0.0093)	(0.0093)	(0.0202)	(0.0202)	(0.0082)	(0.0083)
Colombia	-0.0110**	-0.0127**	-0.0111**	-0.0132**	-0.0042	-0.0057***
	(0.0054)	(0.0054)	(0.0054)	(0.0055)	(0.0027)	(0.0030)
Mexico	-0.0100***	-0.0105***	-0.0094***	-0.0100***	-0.0101***	-0.0098***
	(0.0052)	(0.0056)	(0.0053)	(0.0057)	(0.0053)	(0.0055)
Hungary	0.0249**	0.0221**	0.0226**	0.0222**	0.0236**	0.0199***
	(0.0109)	(0.0102)	(0.0111)	(0.0106)	(0.0117)	(0.0109)
Poland	0.0092	0.0022	-0.0176	-0.0217***	-0.0111***	-0.0114***
	(0.0121)	(0.0121)	(0.0114)	(0.0124)	(0.0063)	(0.0063)
Romania	0.1255**	0.0932***	0.1568*	0.1226**	-0.0761	-0.0817***
	(0.0572)	(0.0497)	(0.0594)	(0.0550)	(0.0465)	(0.0485)
Turkey	0.0107	0.0092	0.0142**	0.0141**	-0.0346***	-0.0338**
	(0.0136)	(0.0131)	(0.0071)	(0.0071)	(0.0179)	(0.0171)
Korea	-0.0052*	-0.0068*	-0.0058*	-0.0072*	-0.0056**	-0.0062*
	(0.0015)	(0.0017)	(0.0013)	(0.0018)	(0.0023)	(0.0019)
Philippine	-0.0386*	-0.0409*	-0.0277***	-0.0319**	-0.0141	-0.0253**
s	(0.0106)	(0.0110)	(0.0156)	(0.0159)	(0.0118)	(0.0118)
Thailand	-0.0204**	-0.0203**	-0.0199***	-0.0200***	-0.0589***	-0.0589***
	(0.0091)	(0.0091)	(0.0106)	(0.0106)	(0.0333)	(0.0335)
South	-0.0036***	-0.0046***	-0.0043***	-0.0050***	0.0010	0.0002
Africa	(0.0020)	(0.0025)	(0.0023)	(0.0026)	(0.0007)	(0.0009)

Source: Author's estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

Appendix 15: CML results in case of one structural break (additive outlier model)

	Y	CPI	M1	M2	EX	IR
Brazil	-3.12*[1]	-3.22*[1]	-2.43*[1]	-3.4*[1]	-9.09*[1]	-3.99**[0]
	(2008m10)	(2002m9)	(2007m10)	(2011m10)	(2008m8)	(2007m10)
Chile	-4*[1]	-2.61*[1]	-3.62*[1]	-4.69*[1]	-10.19*[1]	-3.89**[0]
	(2016m12)	(2008m12)	(2003m5)	(2003m6)	(2008m8)	(2001m2)
Colombia	-4.25*[1]	-2.64*[1]	-3.9*[1]	-2.34*[1]	-6.17*[1]	-4.24**[0]
	(2007m11)	(2007m12)	(2001m10)	(2004m10)	(2008m7)	(2009m9)
Mexico	-3.18*[1]	-4.13*[1]	-3.54*[1]	-4.33*[1]	-4.83*[1]	-4.99*[1]
	(2008m12)	(2016m11)	(2008m10)	(2008m10)	(2008m8)	(2003m3)
Hungary	-3.58*[1]	-3.4*[1]	-2.98*[1]	-3.65*[1]	-6.78*[1]	-4.71*[1]
	(2009m11)	(2011m11)	(2012m2)	(2007m12)	(2008m8)	(2002m12)
Poland	-2.77*[1]	-2.16*[1]	-3.51*[1]	-2.58*[1]	-3.35***[0]	-5.46*[1]
	(2008m11)	(2001m3)	(2007m10)	(2004m8)	(2009m4)	(2001m10)
Romania	-2.56*[1]	-3.67**[0]	-3.58*[1]	-3.54*[1]	-3.37***[0]	-6.56*[1]
	(2008m10)	(2010m7)	(2006m11)	(2007m10)	(2008m12)	(2003m1)
Turkey	-2.92*[1]	-3.26***[0]	-4.41*[1]	-7.29*[1]	-4.6*[1]	-4.72*[0]
	(2005m11)	(2011m10)	(2005m10)	(2005m10)	(2001m2)	(2003m7)
Korea	-3.53*[1]	-3.73*[1]	-3.36*[1]	-7.36*[1]	-4.43*[1]	-9.36*[1]
	(2008m11)	(2011m6)	(2007m1)	(2010m4)	(2008m8)	(2008m9)
Philippines	-4.41*[1]	-2.95*[1]	-3.97*[1]	-2.95*[1]	-4.49*[1]	-3.48***[0]
	(2008m11)	(2008m4)	(2006m10)	(2007m10)	(2000m12)	(2008m6)
Thailand	-7.74*[1]	-2.4*[1]	-2.44*[1]	-2.41*[1]	-3.61**[0]	-3.71*[1]
	(2011m8)	(2008m8)	(2003m9)	(2002m7)	(2007m8)	(2008m10)
South	-4*[1]	-2.82*[1]	-4.27*[1]	-3.95*[1]	-3.38***[0]	-3.77*[1]
Africa	(2008m10)	(2003m9)	(2008m2)	(2008m9)	(2014m3)	(2003m7)

Source: Author's estimation

Notes: *, **, *** denote the significance at 1, 5, and 10% respectively. [] indicates the order of integration. () shows the timing of the structural break.

Appendix 16: CML results in case of one structural break (innovational outlier model)

	Y	CPI	M1	M2	EX	IR
Brazil	-3.72*[1]	-4.89*[1]	-3.91*[1]	-3.74*[1]	-6.57*[1]	-6.4*[1]
	(2008m11)	(2002m10)	(2007m11)	(2011m11)	(2002m9)	(2002m12)
Chile	-5.25*[1]	-2.93*[1]	-4.11*[1]	-5.3*[1]	-11.64*[1]	-3.95***[0]
	(2017m1)	(2009m1)	(2000m11)	(2003m7)	(2008m9)	(2008m11)
Colombia	-3.83*[1]	-2.77*[1]	-2.72*[1]	-2.47*[1]	-5.68*[1]	-5.21*[0]
	(2001m2)	(2003m3)	(2001m11)	(2004m11)	(2008m8)	(2009m1)
Mexico	-4.17*[1]	-4.24*[1]	-3.8*[1]	-5.09*[1]	-12.67*[1]	-4.2***[0]
	(2009m1)	(2016m12)	(2003m11)	(2008m11)	(2008m9)	(2008m11)
Hungary	-3.63*[1]	-3.73*[1]	-2.9*[1]	-3.86*[1]	-6.78*[1]	-5.24*[1]
	(2009m12)	(2011m12)	(2012m3)	(2008m1)	(2008m9)	(2003m1)
Poland	-3.67*[1]	-3.52*[1]	-4.22*[1]	-2.71*[1]	-4.15***[0]	-6.36*[0]
	(2008m12)	(2011m2)	(2007m11)	(2004m9)	(2008m6)	(2001m1)
Romania	-3.29*[1]	-3.16*[1]	-4.09*[1]	-4.06*[1]	-5.46*[0]	-5.29*[0]
	(2008m11)	(2003m12)	(2006m12)	(2007m11)	(2007m6)	(2001m2)
Turkey	-3.55*[1]	-7.69*[1]	-5.61*[1]	-10.95*[1]	-4.99*[0]	-5*[0]
	(2001m2)	(2001m12)	(2005m11)	(2005m11)	(2013m4)	(2003m4)
Korea	-6.53*[1]	-4.38*[1]	-3.25*[1]	-3.48*[1]	-6.6*[1]	-4.81**[0]
	(2008m12)	(2011m7)	(2007m2)	(2010m5)	(2008m9)	(2008m7)
Philippines	-5.41*[1]	-4.06*[1]	-4.15*[1]	-3.11*[1]	-10.97*[1]	-3.42*[1]
	(2008m12)	(2008m5)	(2006m11)	(2007m11)	(2008m9)	(2001m5)
Thailand	-5.99*[1]	-3.33*[1]	-4.14***[0]	-2.99*[1]	-3.93***[0]	-4.26*[1]
	(2011m9)	(2008m9)	(2009m6)	(2002m8)	(2005m11)	(2008m11)
South	-3.77*[1]	-3.17*[1]	-3.86*[1]	-4.15*[1]	-11.99*[1]	-4.04***[0]
Africa	(2008m11)	(2003m10)	(2008m3)	(2007m7)	(2001m11)	(2008m10)

Source: Author's estimation

Notes: *, **, *** denote the significance at 1, 5, and 10% respectively. [] indicates the order of integration. () shows the timing of the structural break.

Appendix 17: CML test results in case of 2 structural breaks (additive outlier model)

	Output			Inflation			Exchange rate		
	IT	TB1	TB2	IT	TB1	TB2	IT	TB1	TB2
Brazil	[2]*	2009m1	2010m1	[2]*	2002m9	2003m7	[0]**	2005m10	2015m4
Chile	[1]**	2010m1	2010m12	[0]**	2008m12	2014m12	[0]**	2005m1	2015m2
Colombia	[1]**	2003m11	2007m11	[2]*	2001m3	2016m11	[0]*	2007m7	2015m4
Mexico	[1]*	2008m10	2008m12	[1]**	2011m3	2016m11	[0]*	2009m4	2016m3
Hungary	[1]**	2008m10	2009m11	[0]**	2006m9	2010m10	[0]***	2009m4	2011m12
Poland	[1]***	2007m8	2008m11	[0]**	2007m6	2011m5	[0]*	2007m6	2009m3
Romania	[1]**	2008m10	2014m6	[0]***	2005m4	2010m7	[0]*	2002m8	2009m3
Turkey	[2]*	2015m11	2016m11	[1]*	2001m11	2003m1	[1]*	2001m8	2002m5
Korea	[1]**	2008m8	2009m1	[1]**	2003m1	2011m6	[0]**	2005m1	2008m12
PLP	[1]**	2008m11	2014m11	[1]***	2008m2	2008m4	[0]**	2007m8	2016m3
Thailand	[0]*	2003m6	2006m8	[2]*	2005m9	2008m6	[0]**	2007m8	2015m10
S. Africa	[1]***	2002m10	2008m10	[2]*	2001m11	2003m11	[0]**	2003m5	2013m7
	M1			M2			Interest rate		
	IT	TB1	TB2	IT	TB1	TB2	IT	TB1	TB2
Brazil	[2]*	2007m10	2008m1	[2]*	2007m10	2008m2	[0]**	2004m2	2007m10
Chile	[2]*	2007m2	2007m5	[1]*	2003m9	2009m1	[0]**	2001m2	2005m10
Colombia	[2]*	2004m10	2005m10	[2]*	2001m10	2015m11	[0]***	2009m9	2016m9
Mexico	[1]**	2003m10	2008m10	[1]*	2006m10	2008m10	[0]**	2009m5	2016m12
Hungary	[1]***	2007m10	2012m6	[1]**	2002m10	2008m10	[0]***	2009m5	2013m11
Poland	[1]**	2004m11	2008m8	[2]*	2001m9	2004m8	[1]*	2001m8	2002m9
Romania	[0]**	2006m9	2014m12	[2]*	2003m1	2006m10	[0]**	2003m1	2005m5
Turkey	[0]***	2005m9	2012m12	[1]*	2001m5	2005m10	[0]*	2003m6	2009m1
Korea	[1]***	2007m1	2007m6	[1]*	2006m4	2010m4	[1]***	2008m6	2009m3
Philippines	[1]**	2003m10	2006m10	[1]***	2013m3	2014m1	[0]**	2008m1	2013m2
Thailand	[2]*	2002m10	2003m9	[1]***	2009m5	2013m3	[0]***	2005m12	2008m7
S. Africa	[1]*	2004m3	2008m2	[1]**	2008m9	2010m4	[1]***	2003m7	2003m9

Source: Author's estimation.

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. IT denotes order of integration. TB1 and TB2 mean the timing of the first and second structural break. S. Africa: South Africa.

Appendix 18: CML test results in case of 2 structural breaks (innovational outlier model)

	Output			Inflation			Exchange rate		
	IT	TB1	TB2	IT	TB1	TB2	IT	TB1	TB2
Brazil	[2]*	2009m2	2010m2	[1]*	2002m9	2002m12	[0]***	2005m2	2014m6
Chile	[0]***	2004m1	2011m1	[1]*	2007m1	2008m9	[0]**	2004m7	2014m6
Colombia	[1]**	2003m12	2007m12	[2]*	2007m12	2016m12	[0]*	2006m5	2014m7
Mexico	[1]*	2008m10	2009m1	[2]*	2010m3	2016m12	[0]*	2008m7	2014m10
Hungary	[1]***	2008m11	2009m12	[0]***	2003m7	2006m7	[0]*	2008m6	2011m6
Poland	[1]***	2008m9	2009m2	[0]***	2003m7	2007m7	[0]**	2007m8	2008m6
Romania	[2]*	2008m11	2009m11	[1]**	2001m12	2011m3	[0]*	2002m1	2008m7
Turkey	[2]*	2015m12	2016m12	[1]*	2001m12	2003m2	[0]*	2008m8	2013m4
Korea	[0]*	2003m8	2009m1	[1]**	2003m2	2011m7	[0]*	2004m9	2008m1
Philippines	[1]*	2008m12	2014m12	[0]***	2004m3	2007m10	[0]**	2006m5	2015m6
Thailand	[1]*	2008m11	2011m9	[2]*	2008m7	2009m4	[0]***	2005m11	2015m3
S. Africa	[2]*	2002m11	2003m11	[2]*	2001m12	2003m12	[1]*	2001m11	2008m9
	M1			M2			Interest rate		
	IT	TB1	TB2	IT	TB1	TB2	IT	TB1	TB2
Brazil	[2]*	2007m11	2008m3	[0]**	2004m3	2008m1	[1]*	2003m5	2003m11
Chile	[1]***	2001m6	2003m6	[0]**	2003m10	2010m11	[0]**	2008m11	2010m5
Colombia	[2]*	2001m11	2002m3	[0]***	2004m9	2010m9	[0]*	2009m1	2015m8
Mexico	[2]*	2001m3	2002m11	[1]*	2006m11	2008m11	[0]*	2001m1	2008m11
Hungary	[2]*	2001m11	2002m3	[1]***	2002m11	2008m11	[0]**	2008m12	2012m12
Poland	[1]**	2001m4	2007m11	[1]***	2004m9	2008m11	[0]*	2001m10	2012m10
Romania	[1]*	2006m12	2007m11	[0]***	2004m4	2015m11	[0]*	2001m3	2008m9
Turkey	[1]*	2005m10	2006m2	[1]*	2001m2	2005m11	[0]*	2003m4	2008m11
Korea	[2]*	2007m2	2007m5	[1]**	2005m9	2010m5	[0]*	2008m7	2014m6
Philippines	[1]***	2002m11	2006m11	[1]**	2013m4	2013m11	[1]*	2001m3	2002m2
Thailand	[0]**	2002m9	2009m6	[0]***	2005m6	2010m7	[0]*	2005m2	2008m8
S. Africa	[1]**	2004m4	2008m3	[0]***	2004m6	2013m1	[0]**	2003m4	2008m10

Source: Author's estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. IT denotes order of integration. TB1 and TB2 mean the timing of the first and second structural break. S. Africa: South Africa

Appendix 19: Long-run effect of exchange rates on interest rates

	Yearly change			Monthly change		
	NEER	REER	EX	NEER	REER	EX
Brazil	0.055***	0.035	0.015	-0.606	-0.595	-0.259
	(0.028)	(0.025)	(0.022)	(0.373)	(0.371)	(0.172)
Chile	0.097	0.080	0.298***	-0.535***	-0.531***	-0.347**
	(0.066)	(0.063)	(0.171)	(0.296)	(0.301)	(0.176)
Colombia	-0.277***	-0.302***	-0.161***	-0.040	-0.051	-0.019
	(0.153)	(0.173)	(0.095)	(0.280)	(0.280)	(0.157)
Mexico	-0.124	-0.165	-0.017	-0.742**	-1.125**	-0.898**
	(0.156)	(0.148)	(0.078)	(0.336)	(0.541)	(0.438)
Hungary	-0.181**	-0.162**	-0.237*	-1.038	-0.545	-0.986***
	(0.071)	(0.075)	(0.068)	(0.660)	(0.803)	(0.582)
Poland	0.073	0.092	0.053	1.470	1.486	0.261
	(0.094)	(0.092)	(0.127)	(0.963)	(0.957)	(0.273)
Romania	-0.725*	-0.464	-0.632*	-10.525*	-20.024***	-9.798*
	(0.129)	(0.365)	(0.141)	(2.971)	(12.032)	(3.084)
Turkey	-0.517*	-0.709**	-0.398*	-3.679*	-4.313*	-2.730*
	(0.129)	(0.277)	(0.105)	(1.062)	(1.513)	(0.840)
Korea	0.039	0.041	0.021	0.889***	0.881***	0.570***
	(0.050)	(0.052)	(0.036)	(0.531)	(0.519)	(0.324)
Philippines	-0.117**	-0.117**	0.006	-0.717**	-0.710**	-0.431
	(0.057)	(0.058)	(0.055)	(0.323)	(0.314)	(0.286)
Thailand	-0.029	-0.006	-0.064***	-0.156	-0.009	0.012
	(0.052)	(0.049)	(0.034)	(0.356)	(0.162)	(0.112)
South Africa	-0.052***	-0.052***	-0.017	-0.222***	-0.204***	-0.255***
	(0.030)	(0.029)	(0.020)	(0.113)	(0.110)	(0.138)

Source: Author's estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

Appendix 20: Asymmetries in the long-run effect of exchange rates on interest rates

	Yearly change			Monthly change		
	NEER	REER	EX	NEER	REER	EX
Brazil	-0.005***	-0.006	0.001	0.023	0.021	0.022***
	(0.003)	(0.004)	(0.001)	(0.020)	(0.020)	(0.013)
Chile	-0.013***	-0.005	-0.015*	-0.284**	-0.268**	-0.198*
	(0.007)	(0.008)	(0.005)	(0.111)	(0.111)	(0.075)
Colombia	0.007	0.004	0.003	-0.004	-0.005	-0.058
	(0.007)	(0.006)	(0.004)	(0.048)	(0.048)	(0.048)
Mexico	-0.014	-0.015	-0.009	-0.037	-0.038	-0.083
	(0.014)	(0.015)	(0.009)	(0.046)	(0.046)	(0.062)
Hungary	-0.014	-0.010	-0.009	0.197**	0.194**	0.151***
	(0.018)	(0.010)	(0.010)	(0.089)	(0.085)	(0.079)
Poland	-0.042**	-0.016***	-0.015**	-0.560*	-0.587*	-0.445*
	(0.019)	(0.009)	(0.007)	(0.195)	(0.209)	(0.166)
Romania	-0.011	0.036	-0.028	1.067	0.214	1.173**
	(0.018)	(0.033)	(0.019)	(0.677)	(0.743)	(0.579)
Turkey	0.018*	-0.063**	0.016*	0.405*	0.520*	0.371*
	(0.006)	(0.025)	(0.005)	(0.107)	(0.095)	(0.095)
Korea	-0.009	-0.011	-0.005***	-0.249	-0.255	-0.129
	(0.008)	(0.009)	(0.002)	(0.228)	(0.250)	(0.101)
Philippines	-0.015***	-0.009	-0.012**	-0.090	-0.027	0.008
	(0.008)	(0.007)	(0.006)	(0.122)	(0.109)	(0.046)
Thailand	-0.010	-0.012	0.003	0.015	-0.082	0.268**
	(0.008)	(0.010)	(0.003)	(0.058)	(0.068)	(0.135)
South Africa	0.003*	0.004*	0.002***	0.032	0.035	-0.006
	(0.001)	(0.001)	(0.001)	(0.025)	(0.025)	(0.008)

Source: Author's estimation

Notes: *, **, *** denotes significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses.

Appendix 21: Shapes of Philipps curve in the short and long run

	Correction	Long run	Short run			
		y_{t-1}	Δy_t^2	Δy_{t-1}^2	Δy_{t-2}^2	Δy_{t-3}^2
Brazil	-0.03205*	-0.00023***	-0.00000	-0.00000		
	(0.005)	(0.000)	(0.000)	(0.000)		
Chile	-0.08307*	0.00067***	0.00000	-0.00004**	-0.00004**	-0.00005*
	(0.022)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Colombia	-0.01760*	0.00133**	0.00000	-0.00002*	-0.00002*	
	(0.006)	(0.001)	(0.000)	(0.000)	(0.000)	
Mexico	-0.07943*	-0.00064**	-0.00003**	0.00007*	0.00005*	
	(0.021)	(0.000)	(0.000)	(0.000)	(0.000)	
Hungary	-0.04260*	0.00028	-0.00000	-0.00002*	-0.00001**	
	(0.010)	(0.000)	(0.000)	(0.000)	(0.000)	
Poland	-0.05305*	0.00055**	0.00001	-0.00001**		
	(0.014)	(0.000)	(0.000)	(0.000)		
Romania	-0.04407*	0.00032	0.00000			
	(0.015)	(0.000)	(0.000)			
Turkey	-0.07381*	-0.00036**	-0.00001	0.00003*	0.00001***	
	(0.012)	(0.000)	(0.000)	(0.000)	(0.000)	
Korea	-0.11317*	0.00038*	-0.00001	-0.00004*	-0.00003*	-0.00002*
	(0.024)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Philippines	-0.06374*	0.00006**	0.00000**			
	(0.011)	(0.000)	(0.000)			
Thailand	-0.08719*	-0.00006	-0.00001			
	(0.016)	(0.000)	(0.000)			
South	-0.02445*	0.00016	-0.00000			
Africa	(0.005)	(0.000)	(0.000)			

Source: Authors' estimation

Notes: *, **, *** denote the significance at 1%, 5%, and 10% respectively. Standard errors in the parentheses. Δy^2 after lag 3 are not included.