MONETARY POLICY ANALYSIS UNDER HEADLINE AND CORE INFLATION TARGETING IN THAILAND

BY

MR. KERKKIAT PHROMMIN

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ECONOMICS
(INTERNATIONAL PROGRAM)
FACULTY OF ECONOMICS
THAMMASAT UNIVERSITY
ACADEMIC YEAR 2015

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was approved as partial fulfillment of the requirements for
the degree of Master of Economics (International Program)
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ABSTRACT

This paper analyzes monetary policy in Thailand under core and headline inflation targeting regimes using a small open economy DSGE model. The model, modified from Adolfson (2007), is based on the New Keynesian framework. We also assume incomplete exchange-rate pass-through. The results are estimated by the Bayesian inference for 2001Q1 to 2015Q4. Our key finding is that the headline inflation targeting regime performs better than the core inflation targeting regime in terms of welfare losses. Intuitively, under the headline inflation targeting regime, the exchange rate channel is more effective, which leads to the lower degree of policy trade-off. In addition, we find no concrete conclusion whether the Bank of Thailand (BOT) welfare by adjusting the policy rate in response to the real exchange rate (RER) movement.

Keywords: Headline inflation, Core inflation, Real exchange rate, New Keynesian, DSGE, Exchange rate pass-through, Policy trade-off, Bayesian inference

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CHAPTER 1
INTRODUCTION

1.1 Statement of the Problem

On May 23, 2000, the Bank of Thailand (BOT) adopted a core inflation targeting regime (CITR) that implements core inflation as the monetary policy target.[1, 2] Since January 6, 2015, the BOT has switched to adopt a headline inflation targeting regime (HITR) that implements headline inflation as the monetary policy target. According to the policy announcements of the BOT, headline inflation is supported to implement as the target because of the following four main rationales. First, in recent years, core inflation has lost its ability to track the underlying inflation.[3] Second, energy and food prices, which account for 27 percent of the CPI basket, become increasingly important components of cost of living; hence, changes in headline inflation become more a concern among households than core inflation. Third, headline inflation

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[1] In Thailand, headline inflation is measured by the overall CPI inflation, and core inflation is measured by the overall CPI inflation, excluding energy and fresh food inflation. Intrinsically, core inflation is sticker than headline inflation.

[2] According to the previous policy announcements of BOT, core inflation is implemented as the target because of the following three main reasons. First, core inflation is a more precise measure of underlying inflationary pressures than headline inflation. Second, headline inflation always suffers from energy price shock, which cannot be monitored and predicted by the BOT. Third, on the basis of historical data, headline inflation converges to core inflation in the long run. Therefore, the stabilization in core inflation is the same as that in headline inflation.

[3] Underlying inflation is the component of inflation in which noise is eliminated to reflect how much inflation is driven by the excess domestic demand and expected inflation.

provides more clear definition than core inflation; therefore, it provides more the understanding of the public, and is commonly used as reference for economic and business decision making. Accordingly, the implementation of HITR particularly will improve the performance of BOT's communication and thus support the monetary policy in anchoring inflation expectations of the public. Fourth, considering that most central banks implement HITR, the BOT prefers to implement HITR to conform in the line with international practices. The summary of characteristics of core and headline inflation is shown in Table 1.1.

Table 1.1

Characteristics of Core and Headline Inflation

Characteristics	Headline Inflation	Core Inflation
Ability to reflex the cost of living	√	×
Ability to communicate with the public	√	×
Ability to reflex the underlying inflation trend	×	√
Having more stability	×	√

Source: Summarized from the policy announcements of BOT

Many economists debate about the issue whether central banks should conduct CITR or HITR. The evidence supporting CITR explained that resource misallocation cause from price stickiness under the New Keynesian (NK) model; thus, the optimal policy is to stabilize sticky prices (Aoki, 2001; Gali and Monacelli, 2005; Dhawan and Jeske, 2007; and Bodenstein et al., 2008).[4] To illustrate, firms in a sticky price sector cannot freely adjust their prices; hence, the overtime average price markup of such firms varies in response to shocks and may differ from an efficient level. As a result, central banks are suggested to stabilize sticky prices so that the overtime average markup price becomes the constant one at the efficient level for anchoring inflation

[4] Aoki (2001), Dhawan and Jeske (2007), and Bodenstein et al. (2008) used a closed economy-based NK model with the complete financial market. While, Gali and Monacelli (2005) used an open economy-based NK model with the complete financial market and ERPT.

expectation over time. The evidence supporting CITR also mentioned that, in practice, headline inflation often suffers from an oil price shock, and HITR implementation likely presents an increased risk to swing out of its target rank. The central implementing HITR would face the difficulty to reach the committed target and lose credibility in anchoring inflation expectations of households; thus, price stability can be damaged in the long term (Mishkin, 2007).

However, the evidence supporting CITR is augured that it relies on the sources of distortion from price stickiness and the restrict assumptions. The assumption of complete financial market is augured that it could mislead decisions of monetary policy authority in emerging countries (Anand and Prasad, 2010). Hence, the incomplete financial market assumption, which presents realistic features of the emerging market, is proposed by Anand and Prasad (2010) for choosing the optimal policy target.[5] Anand and Prasad (2010) found that stabilizing core inflation is no longer equivalent to stabilizing output volatility. The logic is that, in the presence of financial frictions, credit-constrained households cannot insure well their future income against a risk; hence, their demand for goods is insensitive to the policy interest rate and aggressively depends on their current real wages, suffering from the fluctuation in flexible prices. Stabilizing flexible prices is necessary to help monetary policy in stabilizing aggregate demand and output. In other words, the implementation of HITR turns to be the optimal policy. In open economy, under the complete degree of exchange rate pass-through (ERPT), imported good prices are flexible prices, which lead to the law of one price of imported good prices holds. Once this assumption is relaxed so that importing good prices becomes sticky prices, stabilizing a domestic good price would be the suboptimal policy (Monacelli, 2002). In detail, Monacelli (2002) found that the presence of the incomplete degree of ERPT likely change the choice of the optimal monetary policy

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[5] Anand and Prasad (2010) used a closed economy-based NK model that considers the credit constraints of households working in the food sector, the requirements for a minimum subsistence food level to the survival of households, the high share of expenditure on food in the total expenditure of households, and the low price elasticity of household demand for food.

target because of a policy trade off (PTF) between stabilizing inflation and output. Corsetti and Pesenti (2005) further stated that the degree of ERPT affects the degree of PTF via the fluctuation in exporting firm's markup. Moreover, in practice, headline inflation is supported to use as the policy target according to the following reasons. First, it is not appropriate to build a model simply stating that core inflation predicts headline inflation because the model should involve variables such as expected inflation, development in the real economy, and a stance of monetary policy. Second, although headline inflation are volatile, central banks can decide how to respond and headline inflation can be smoothed out by using its annualized one-month change (Bullard, 2011). In the case of Thailand, this debate of whether central banks should conduct CITR or HITR is also examined. Previous empirical studies showed that core inflation has lost appropriate criteria for an optimal policy. In detail, core inflation recently demonstrates less predictive power compared with headline inflation; hence, core inflation becomes a less desirable target (McCauley, 2006), and core inflation presents limitations to capture the underlying inflation during the inflationary risk periods (Tanboon et al., 2009).

Even many studies have examined whether monetary policy should be conducted between CITR and HITR, a consensus has yet to be reached. In Thailand, few theoretical studies have analyzed the performance of monetary policy under CITR and HITR. Therefore, we aim to analyze the performance of monetary policy under CITR and HITR by using a theoretical approach that clearly captures economic frictions. Considering that Thailand is a small open country and the exchange rate adjustment is an important issue, our model presents a small open-economy feature. Therefore, the other interesting issue relates to the real exchange rate (RER) response of BOT. In consideration of the different degrees of ERPT between the monetary policy under CITR and HITR, it would be benefit to indicate how different BOT responds to RER between both regimes. The contributions of the literature indicate that the conclusion can be distorted by the restricted assumptions, which are the complete financial market and the complete ERPT. Moreover, empirical studies found that the degrees of ERPT in Thailand are incomplete (Jitpokkasame, 2007; Wattanakorn, 2013); thus, we introduce the incomplete ERPT assumption into our model.

For parameter estimation, Bayesian inference is suitable estimation method for our dynamic stochastic general equilibrium (DSGE) model compared with alternative estimation methods such as Ordinary Least Squares (OLS), Maximum Likelihood Estimation (MLE), and Generalize Method of Moment (GMM) because of the following reasons. First, OLS needs restrict conditions to ensure unbiasness and efficiency of parameters. Therefore, the estimated parameters from OLS may not conform to the economic theory. Second, different from MLE, Bayesian inference allow us to specify the characteristics of parameters before estimation and thus to avoid strange points at the peak of likelihood function. Third, GMM is inappropriate for our DSGE model because GMM ignores the cross relationship of the estimated parameters in the general equilibrium. Our study uses the observed data to update the prior-to-posterior distribution of the parameter by applying Bayes theorem. Totally, this study uses a small open economy DSGE-based NK model and a real business cycle (RBC) model with the incomplete ERPT and estimates all relevant parameters by using Bayesian inference.

1.2 Objectives of the Study

1. To analyze the performances of monetary policy under CITR and HITR
2. To analyze the performances of monetary policy with and without RER response
3. To indicate Thailand economy characteristics through Bayesian estimation

1.3 Scope of the Study

This study uses a small open economy DSGE model with incomplete ERPT. We estimate all relevant parameters by using Bayesian inference with 15 observable variables: real wage, consumption, investment, effective RER, policy interest rate (RP1), hours worked, GDP, export, import, headline inflation rate, core inflation rate, investment deflator, foreign output, foreign inflation rate, and foreign interest rate. All of these variables are found in the Thai quarterly data between 2001Q1 to 2015Q4, which is the period when inflation targeting is implemented.

CHAPTER 2
LITERATURE REVIEW

This chapter reviews the literature on monetary policy targeting headline and core inflation shown in the following sections. Section 2.1 discusses the theoretical literature about monetary policy targeting headline and core inflation. Section 2.2 discusses the empirical literature about monetary policy targeting headline and core inflation. Section 2.3 discusses the literature of Thailand about monetary policy targeting headline and core inflation. Section 2.4 presents other literature related to the objectives of this study.

2.1 Theoretical Literature about Monetary Policy Targeting Headline and Core Inflation

2.1.1 A Closed-Economy Model about Monetary Policy Targeting Headline and Core Inflation

The theoretical literature regarding the closed-economy model adopted the DSGE based on the RBC and NK frameworks while ignoring the role of exchange rate. The model based on the RBC framework considers that agents have an infinite life, are rational, and optimize their objective subject to the constraints. The model based on the NK framework develops the main belief from the RBC concept and considers price rigidity; hence, monetary and fiscal policies can influence the economy. The model based on the NK framework consists of three key equations: (i) dynamic investment-saving (IS) equation, which explains the relationship between the output gap and the interest rate; (ii) New Keynesian Philips curve (NKPC), which explains the relationship between the output gap and the prices; and (iii) monetary policy rule, which explains how central banks respond to economic changes.

The theoretical literature regarding the closed-economy model in this section adopted the same NK model and object to determine the optimal monetary policy targeting with an alternative type of inflation with different definitions of core and headline inflation. Aoki (2001) analyzed the roles of the central bank responding to the sectorial specific supply shocks and examined the relationship between relative-price changes and inflation. The study constructed a closed-economy DSGE model with the complete financial market; this model consists of a sticky-price sector and a flexible-price sector. In detail, the study defined sticky prices as the core prices, flexible prices as the food and energy prices, and the combination of sticky and flexible prices as the headline prices. The model of this study explains that the relatively flexible prices behave well as a shift parameter of inflation in the sticky-price sector and also assume complete financial markets by introducing no constraints to realize a smooth consumption for households. Therefore, the study concluded that the optimal monetary policy is to target core inflation rather than headline inflation because central banks can stabilize core inflation and output gap with minimal policy trade-off (PTF).

Similarly, Mankiw and Reis (2003) used the same two sectors and closed-economy DSGE model based on the NK framework with complete financial market as described by Aoki (2001). In detail, this model consists of a sticky-price sector and a flexible-price sector. Mankiw and Reis (2003) explored what measure of the inflation rate the central bank should target to stabilize the economy. The study constructed the price index to provide the most feasible case of economic stability, that is, the stability price index. The stability price index allows any indexed price to be selected depending on the optimal weight assigned by the central bank. The results suggest that central banks should stabilize prices with large share, high cyclical sensitivity, high sluggishness of price adjustment, and considerable influence from sectoral shocks. In other words, central banks should target core inflation, excluding oil and food prices, to stabilize the economy. In addition, the study suggests that central banks should add weight on the growth in nominal wages when controlling inflation because nominal wages are more cyclically correlated with economic fluctuation than other prices and wages not responding to idiosyncratic shocks. Therefore, once nominal wages increase faster than other prices, the real wages increase, and targeting the stability price index will require a tighter monetary policy than the traditional inflation targeting (IT).

Dhawan et al. (2007) used the same two-sector DSGE model based on the NK framework with complete financial market, as described by Aoki (2001). However, the model of Dhawan et al. (2007) explicitly introduces the energy sector, durable goods sector, and normal sticky-price sector. Sticky prices are defined as the core prices, and the combination of energy and sticky prices is defined as the headline prices. Dhawan et al. (2007) examined whether central banks should respond to energy inflation and employ core or headline inflation. The finding shows that targeting core inflation outperforms targeting headline inflation in the Taylor rule because the output slightly decreases in CITR when an energy price shock occurs in the economy.

Bodenstein et al. (2008) used the same two-sector DSGE model based on the NK framework with complete financial market, as described by Aoki (2001), and explicitly introduced the energy sector, as reported by Dhawan et al. (2007). By contrast, Bodenstein et al. (2008) analyzed the energy supply shock instead of the energy price shock examined by the traditional works. In detail, Bodenstein et al. (2008) evaluated the efficiency of alternative monetary policy rule in response to energy supply shock by setting up the optimal rule as a benchmark for analysis. Bodenstein et al. (2008) found that the optimal rule suggests that central banks should respond to an adverse energy supply shock in the case that the adverse energy supply shock increases core and headline inflation while decreases nominal wage inflation. Moreover, Bodenstein et al. (2008) found that the policy rate responding to a headline inflation forecast promotes fluctuation in core inflation and output gap when a temporary energy shock occurs. Therefore, the policy rate responding to a core inflation forecast improves the stabilization of macro-economy.

Anand and Prasad (2010) used the same two-sector DSGE model based on the NK framework, as described by Aoki (2001), but assumed an incomplete financial market and introduced both food and non-food sectors. Non-food prices (sticky prices) are defined as the core prices, and the combination of food (flexible prices) and non-food prices as the headline prices. Anand and Prasad (2010) examined the performance between HITR and CITR through welfare comparison. They focused on both emerging and advanced countries; hence, the study distinguished the analyses between emerging and advanced countries by modifying the key characteristics of emerging countries into their model. The key characteristics of emerging countries are, relatively to advanced countries, a high share of expenditure on food in households' total expenditure, low price elasticity of demand for food items, and credit-constrained consumers. For credit-constrained consumers, Anand and Prasad (2010) defined those households in terms of food expenditure as those that cannot access the financial market and have spent all of their wage income in each period. This feature based on an empirical work by Demirguc-Kunt and Klapper (2012) found a low level in the share of population by using formal financial services in emerging countries. The lack of access to financial market causes less response of the demand of credit-constrained households to interest rate. Anand and Prasad (2010) found that in the presence of credit-constrained consumers, central banks should implement the flexible headline IT, especially in emerging countries. Intuitively, once central banks ignore the fluctuation in the flexible price sector, an aggregate demand probably moves in a direction opposite to the intention of central bankers. To determine the desirable outcome on aggregate demand, central banks should focus on a price index in the sectors with credit-constrained consumers. In other words, central banks should target headline inflation. Notably, the results may vary from those of traditional works because of financial frictions.

In summary, Aoki (2001), Mankiw and Reis (2003), Dhawan et al. (2007), and Bodenstein et al. (2008) employed the model based on the NK framework with the complete financial marker assumption and suggested the use of target core inflation rather than target headline inflation. By contrast, Anand and Prasad (2010) employed the model based on the NK framework with the incomplete financial market assumption and suggested the use of target headline inflation rather than target core inflation. Therefore, the conclusion of the theoretical literature regarding the closed-economy model based on the NK framework is sensitive to the assumption of the degree of completeness of the financial market.

2.1.2 An Open-Economy Model about Monetary Policy Targeting Headline and Core Inflation

The theoretical literature regarding the open-economy model extends from the closed-economy model in terms of the role of exchange rate. The roles of exchange rate are explained as follows: (i) the financial market channel depends on the uncovered interest rate parity (UIP) equation and (ii) the goods market channel depends on the degree of ERPT. Two groups of the theoretical literature adopted the open-economy model. The first group is the theoretical literature by Clarida, Gali, and Gertler (2001);

McMcallum and Nelson (2001); and Gali and Monacelli (2005) regarding the open-economy model, which assumes the complete degree of ERPT. The second group is the theoretical literature by Corestti and Pesenti (2000); Adolfson (2002); Smets and Wouters (2002); and Monacelli (2003) regarding the open-economy model, which assumes the incomplete degree of ERPT. However, both groups rely on the complete financial market assumption.

The theoretical literature regarding the open-economy model, which assumes the complete degree of ERPT, concludes that the central bank should stabilize domestic inflation. In detail, the theoretical literature regarding the open-economy model, which assumes the complete degree of ERPT, provides different reasons to support the stabilization of domestic inflation. Gali and Monacelli (2005) analyzed the following alternative policy rules: (i) domestic inflation-based Taylor rule, (ii) consumer price index (CPI)-based Taylor rule, and (iii) an exchange rate peg. The domestic inflation-based Taylor rule is the optimal policy because this rule allows the central bank to reduce the distortion from price rigidity. Moreover, Gali and Monacelli (2005) reported that under the complete degree of ERPT assumption, imported good prices are flexible prices in which the law of one price of imported good prices holds. Once this assumption is relaxed, imported good prices becomes sticky prices, and the law of one price of imported good prices does not hold; thus, stabilization of a domestic good price can be the suboptimal policy.

In the theoretical literature regarding the open-economy model, which assumes the incomplete degree of ERPT, Corestti and Pesenti (2000) mentioned that stabilizing core or domestic inflation is no longer the optimal policy because the incomplete ERPT decreases the effectiveness of the monetary policy transmission (MPT) under the exchange rate channel. Corestti and Pesenti (2000) introduced the predetermined sectors of local and foreign prices, and they found that minimizing the expected value of a CPI overtime-average markup in the domestic price sector is the optimal policy. In addition, Corestti and Pesenti (2000) suggested that the monetary policy in the low degree of ERPT presents constraints to render the economy flexible to price environments. Moreover, Adolfson (2001) employed the open-economy model based on the NK framework with incomplete ERPT assumption. Adolfson (2001) analyzed both cases of low and high degrees of ERPT and found that the low degree of ERPT causes high fluctuation in the exchange rate. However, the monetary policy stabilizing either nominal or real exchange rate does not provide the optimal policy. Additionaly, the key finding implies that the monetary policy stabilizing headline inflation is the optimal one in both cases of low and high degrees of ERPT.

Smets and Wouters (2002) also introduced the incomplete degree of ERPT by allowing the prices of imported goods to become rigidity prices. The findings suggest that central banks should reduce the resource cost of straggered price setting to stabilize the combined prices of domestic and imported goods and become the optimal policy. Notably, Smets and Wouters (2002) reported a conclusion similar to that of Corestti and Pesenti (2000).

2.2 Empirical Literature about Monetary Policy Targeting Headline and Core Inflation

Majority of the empirical literature about monetary policy targeting headline and core inflation objected to examine the desirable criteria of inflation target as follows: (i) ability to reflect the cost of living, (ii) ability to communicate with the public, (iii) ability to reflect the underlying inflation trend, and (iv) increased stability. Armour (2006) evaluated the performance of several measures of inflation in Canada. The criteria of evaluation included unbiasness, low fluctuation, and ability to predict the headline CPI. The results showed that the many traditional measures of core inflation are unbiased and have low fluctuation. However, the traditional measures have high fluctuation and limited predictive power. In summary, the weighted CPI is more fit with the criteria than the other measures. Intuitively, Bullard (2011) argued that previous supporting evidence for using core inflation instead of headline inflation as the target is weak. First, we cannot build a model simply stating that core inflation predicts headline inflation because the model should involve variables such as expected inflation, development in the real economy, and stance of monetary policy. Second, central banks that use the core number will be induced to make a massive change in the policy because of small changes in the core number. Although the headline number is more volatile than the core number, central banks can decide how to respond. Third, an approach is available to smooth the headline number. A simple way is to measure the headline inflation for a one-year period rather than an annualized one-month change.

Gamber et al. (2013) investigated the dynamic relationship between headline and core inflation across monetary policy regimes for both the consumer price index and personal consumption expenditure deflator. They also examined the behavior of convergence of headline and core inflation and the factors inducing headline and core inflation converge together. In addition, Gamber et al. (2013) examined three candidates of core inflation measures: (i) corresponding less inflation for food and energy, (ii) respective weighted median inflation, (iii) trimmed mean inflation. The results showed that the dynamic relationship between core and headline inflation measures varies over time and across different measures of core inflation. Finally, the study determined that the dynamic relationship between the weighted median and trimmed mean CPI inflation rate and the respective headline inflation rate is highly consistent across monetary policy regimes.

2.3 Literature of Thailand about Monetary Policy Targeting Headline and Core Inflation

The empirical literature of Thailand about monetary policy targeting headline and core inflation examined the following desirable criteria of inflation target: (i) ability to reflect the cost of living, (ii) ability to communicate with the public, (iii) ability to reflect the underlying inflation trend, and (iv) increased stability. McCauley (2006) used an empirical method and reviewed the case studies from many central bank experiences, including the Riksbank, Bank of England, and Bank of Korea, to analyze the monetary targeting choice between CITR or HITR in Thailand. In the analysis, he examined many dimensions, including predictive power, alternative core measure, and design of a new inflation target, to select a measure of IT. The study found that core inflation has lost its predictive power to headline inflation. The finding also suggested that central banks should not adopt core inflation as the intermediate target.

Atchana et al. (2009) evaluated the performance of the measure for the underlying inflation of core inflation. The results showed that core inflation cannot reflect the underlying inflation in some situations. For instance, in 2003 to 2005, the

Thai economy faced significant inflation risks because of the rapid economic growth and credit expansion. This situation reduced the ability of core inflation to reflect the underlying inflation. In 2004 to 2008, another evidence for Thailand indicated a persistent huge gap between headline inflation and core inflation because of a distinct trend in the prices of food and energy. This paper concludes that if the Bank of Thailand (BOT) considers only the core inflation, the BOT will not be able to detect accurate inflation pressures because core inflation cannot easily capture the underlying inflation. Furthermore, Atchana et al. (2009) examined the performance of other measures for underlying inflation, including headline inflation, trimmed mean inflation, and Kalman-smoothed inflation. They found that even trimmed mean inflation is more appropriate to reflect the underlying inflation. However, both the trimmed mean inflation and Kalman-smoothed inflation still face problems in communicating with the public.

Similarly, Kushwaha and Stjernberg (2011) examined the underlying inflation indicators as a monetary intermediate target of the BOT under an inflation-targeting regime. The used data cover in both periods before and after the BOT has implemented IT. The findings showed that before the BOT has implemented IT, headline inflation demonstrated higher fluctuation than core inflation, even if both types of inflation presented the same means, namely, standard deviation and skewness. Core inflation was also an unbiased forecaster of headline inflation in both short and medium periods. Conversely, after the BOT has implemented CITR, core inflation is no longer an unbiased forecaster of headline inflation. Consequently, headline inflation can be an appropriate unbiased forecaster of core inflation. Moreover, Kushwaha and Stjernberg (2011) used the Granger causality test to examine the relationship between headline inflation and the other candidate measures of core inflation as follows: (i) the index prices measured by CPI, excluding raw food and energy; (ii) the index prices measured by CPI, excluding raw food energy and house rent; (iii) the index prices measured by CPI with a trimmed mean of 5%; (iv) the index prices measured by CPI filtered by the Hodrick–Prescott filter; and (v) the index prices measured by the 18-month exponentially moving average of CPI inflation. However, none of the above candidate measures of core inflation satisfy the criteria of desirable core inflation target, including an unbiasness to predict headline inflation and ability to reflect the underlying inflation trend. In summary, Kushwaha and Stjernberg (2011) concluded that using core inflation as a measure of underlying headline inflation is currently an inappropriate strategy for Thailand.

2.4 Other Related Literature

Other related literature discuses about the evidence of the Taylor rule and principle in Thailand. Sinthuprasirt (2002) examined the Taylor rule in Thailand by taking three steps of analysis. First, the study adopted a small macroeconomic model and estimated it by using the two-stage least square method.
Second, the study analyzed the Taylor rule derived by the stochastic simulation method. Finally, the study calculated the welfare loss (WFL) and examined the behavior of variables, including the stochastic properties. The results showed that in the Taylor rule, the coefficient of inflation response is 1.36, which indicates that the BOT follows the Taylor principle. Since the beginning of the study in 2002, the BOT has recently changed from monetary targeting to IT, and an exact value of the coefficient of inflation response is difficult to determine.

Pornpattanapaisankul (2010) examined the monetary policy of the BOT under an IT regime by using an empirical method. The study used the Taylor rule as a main strategy by using a cointegration method. The study also considered alternative ways to estimate the potential output and output gap to cope with the uncertainty of estimation. The results showed that the monetary policy in Thailand follows flexible IT principles, indicating that the BOT adjusted the interest rate by responding to inflation and output gap. The cointegration result shows that the interest rate aggressively responds to inflation. This finding implies that the BOT follows the Taylor principle and holds different types of potential output estimation. Furthermore, Pornpattanapaisankul (2010) found that the Taylor rule, which consists of the potential output estimated by quasi-quadratic function, presents no long-term relationship. Hence, Pornpattanapaisankul (2010) concluded that the way to estimate the potential output can change the way to interpret the Taylor rule.

Luengwilai (2011) examined the monetary policy implementation under an IT regime in Thailand. For analysis, the study employed a small open-economy model based on the NK and Bayesian estimation. The key finding shows that the BOT follows the Taylor principle and responds to the exchange rate movement. Some pieces of evidence from international studies have evaluated the Taylor rule in Thailand. Mohanty and Klau (2004), Osawa (2006), and Hsing (2009) concluded that the BOT adopts the Taylor principle because the long-run coefficient of inflation response in the Taylor rule is greater than 1.

CHAPTER 3
A MODEL AND METHODOLOGY

This chapter presents a model and methodology used for this study. Section 3.1 explains the model proposed by Adolfson et al. (2007). Section 3.2 explains the methodology including the welfare loss functions, parameters calibration, parameters estimation, data description and the policy modification.

3.1 A Model

This study employs the open economy DSGE model proposed by Adolfson et al. (2007). In this model, agents consist of domestic firms, importing firms, exporting firms and households. Key frictions of the model are as follows: (i) price and wage rigidities implying that law of one price and wage do not hold, (ii) incomplete exchange rate pass-through implying that an import price cannot fully adjust according to an exchange rate change, (iii) a risk premium for foreign bond holding implying that uncovered interest rate parity does not hold, (iv) costs of capital adjustment implying persistence in a capital price, (v) habit formation implying consumption gradually responding to the policy rate, (vi) working capital channel implying that the policy rate can create a cost push shock and (vii) complete financial market by allowing that households can borrow against the risk in the future income.

3.1.1 Firms

There are three types of firms: domestic, importing and exporting firms. The intermediate domestic goods firms use capital and labor input to produce the intermediate domestic goods and sell ones to the domestic final good firm. The exporting firms buy input from the domestic final firms to produce exported goods and each exporting firm also differentiates exported goods to sell to the foreign sector. The importing firms buy homogenous goods from aboard and each importing firm also differentiates homogenous goods to sell to the domestic households.

3.1.1.1 Domestic (Core) Firms

Specifically, the domestic firms consist of three sub-types of firms which are a labor hiring firm, an intermediate good firm and a final good firm. First, the labor hiring firm buys a differentiated labor (h) from each household and transforms it to be a homogeneous labor input (H). Second, each intermediate good firm buys a homogeneous labor input and rents capital service stock (K) to produce an intermediate good. Third, the final goods firm buys the intermediate goods and transforms them into a homogenous final good. The homogenous final good is sold to the household for consumption and investment. The production function of the final good firm is

$$Y_t = \left[\int_0^1 Y_{i,t}^{\frac{1}{\lambda_{d,t}}} di\right]^{\lambda_{d,t}}, 1 \leq \lambda_{d,t} < \infty \tag{3.1}$$

where $\lambda_{d,t}$ is a stochastic process of the time-varying markup on domestic goods and is given by

$$\lambda_{d,t} = (1-\rho_{\lambda_d})\lambda_d + \rho_{\lambda_d}\lambda_{d,t-1} + \varepsilon_{\lambda_{d,t}}. \tag{3.2}$$

The final goods firm is a price taker and its product prices are set at P_t^{core}. Its profit maximization provides the following optimal condition:

$$\frac{Y_{i,t}}{Y_t} = \left(\frac{P_t^{Core}}{P_{i,t}^{Core}}\right)^{\frac{\lambda_{d,t}}{\lambda_{d,t}-1}} \tag{3.3}$$

where Y_t denotes final domestic output,

P_t^{Core} denotes the domestic (core) goods price.[6]

[6] Notice that we introduce a fixed cost, ϕ, into the production function (3.5) to make sure that the firm's profits are zero in the steady state. Also, the fixed cost is

We combine the equations (3.2) and (3.3) to get the following equation (3.4) which shows how to aggregate the intermediate goods price to be the final goods price:

$$P_t^{Core} = \left[\int_0^1 \left(P_{i,t}^{Core}\right)^{\frac{1}{\lambda_{d,t}}} di\right]^{(1-\lambda_{d,t})}. \tag{3.4}$$

The production function of each intermediate good firm *i* is

$$Y_{i,t} = z_t^{1-\alpha}\epsilon_t K_{i,t}^{\alpha} H_{i,t}^{1-\alpha} - z_t\phi \tag{3.5}$$

where z_t denotes a permanent technology shock,

ϵ_t denotes a covariance stationary technology,

$K_{i,t}$ denotes the capital service stock, which can differ from the physical capital stock ($\bar{K}_t$),

$H_{i,t}$ denotes the homogeneous labor input that is hired by the i^{th} intermediate goods firm and

ϕ denotes a fixed cost.

The process for the permanent technology level, z_t, is

$$\frac{z_t}{z_{t-1}} = \mu_{z,t} \tag{3.6}$$

and

$$\mu_{z,t} = (1-\rho_{\mu_z})\mu_z + \rho_{\mu_z}\mu_{z,t-1} + \varepsilon_{z,t}. \tag{3.7}$$

In the production function (3.5), the covariance stationary technology, ϵ_t, is assumed so that $E(\epsilon_t) = 1$ and $\hat{\epsilon}_t \equiv \frac{(\epsilon_t - 1)}{1}$. An exogenous process for $\hat{\epsilon}_t$ is

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allowed to grow in the steady state by multiplying with z_t. This implies that, in the steady state, the fixed cost's growth equal to the output's growth.

$$\hat{\epsilon}_t = \rho_\varepsilon \hat{\epsilon}_{t-1} + \varepsilon_{\epsilon,t}. \tag{3.8}$$

Each intermediate good firm i minimizes its cost function subject to its production (3.5) by choosing the capital services stock and homogeneous labor input. Then the cost minimization problem of each intermediate good firm is

$$\min_{K_{i,t},H_{i,t}} W_t R_t^f H_{i,t} + R_t^k K_{i,t} + \lambda_t P_{i,t}^{Core} \left[Y_{i,t} - z_t^{1-\alpha} \epsilon_t K_{i,t}^\alpha H_{i,t}^{1-\alpha} + z_t \phi \right] \tag{3.9}$$

where W_t denotes the nominal wage rate per unit of the homogeneous labor input,

R_t^f denotes the gross effective nominal interest rate,

R_t^k denotes the gross nominal rate of capital return,

λ_t denotes the real Lagrangian multiplier.

As a fraction of wage bill is financed in advance by the intermediate firms, the labor cost is $W_t R_t^f H_{i,t}$ at the end of the period. R_t^f is given by

$$R_t^f \equiv \mathrm{v}_t R_{t-1} + 1 - \mathrm{v}_t \tag{3.10}$$

where v_t denotes a fraction of the intermediate firms' wage bill,

R_{t-1} denotes the gross nominal interest rate.

Log-linearizing equation (3.10), we get

$$\hat{R}_t^f = \frac{\mathrm{v}R}{\mathrm{v}R+1-\mathrm{v}} \hat{R}_{t-1} + \frac{\mathrm{v}(R-1)}{\mathrm{v}R+1-\mathrm{v}} \hat{\mathrm{v}}_t \tag{3.11}$$

where $\hat{\mathrm{v}}_t = (\mathrm{v}_t - 1)/1$,

R denotes the gross nominal interest rate at the steady state v denotes a fraction of the intermediate firms' wage bill at the steady state.[7]

The optimal condition for cost minimization w.r.t $H_{i,t}$ is

$$W_t R_t^f = (1-\alpha)\lambda_t P_{i,t}^{Core} z_t^{1-\alpha} \epsilon_t K_{i,t}^{\alpha} H_{i,t}^{-\alpha}. \tag{3.12}$$

The optimal condition for cost minimization w.r.t $K_{i,t}$ is

$$K_{i,t}\ R_t^k = \alpha\lambda_t P_{i,t}^{Core} z_t^{1-\alpha} \epsilon_t K_{i,t}^{\alpha-1} H_{i,t}^{1-\alpha}. \tag{3.13}$$

Following Altig et al. (2003), these variables are stationarized as follows:

$$r_t^k \equiv \frac{R_t^k}{P_t^{Core}}, \qquad \bar{w}_t \equiv \frac{W_t}{z_t P_t^{Core}}, \qquad k_{t+1} \equiv \frac{K_{t+1}}{z_t} \text{ and } \qquad \bar{k}_{t+1} \equiv \frac{\bar{K}_{t+1}}{z_t} \tag{3.14}$$

where $\bar{K}_{t+1}$ is the physical capital stock. [8,9]

We plug equation (3.12) into equation (3.13) and stationarize the result using equation (3.14) to get

$$r_t^k = \frac{\alpha}{1-\alpha} \bar{w}_t \mu_{z,t} R_t^f k_t^{-1} H_t. \tag{3.15}$$

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[7] Note that the equation (3.11) is used to explain how the nominal interest rate affects the gross effective nominal interest rate.

[8] The reason why we stationarize the model is to transform the growth model to the no-growth model.

[9] Notice that we can stationarize the physical capital stock ($\bar{K}_{t+1}$) at time *t+1* with z_t because $\bar{K}_{t+1}$ is assigned at time *t*. Even K_{t+1} is assigned at time *t+1*, we also stationarize it with z_t for simplification.

The Lagrangian multiplier, $\lambda_t P_{i,t}^{Core}$, in the costs minimization problem (3.9) can be interpreted as the nominal marginal cost. Then λ_t equals to the *real* marginal cost for producing the intermediate goods ($mc_t \equiv \lambda_t$). We combine the optimal conditions (3.12) and (3.13) to get the following equation:

$$mc_t = \left(\frac{1}{1-\alpha}\right)^{1-\alpha}\left(\frac{1}{\alpha}\right)^{\alpha}\left(r_t^k\right)^{\alpha}\left(\overline{w}_t R_t^f\right)^{1-\alpha}\frac{1}{\epsilon_t}. \tag{3.16}$$

Following Calvo (1983), each intermediate domestic good firm faces the price setting problem and its probability to reoptimize its own price is $1-\xi_d$. If each intermediate domestic good firm is not allowed to reoptimize its price setting with probability, ξ_d, its price, P^{core}, will be indexed to the last period domestic goods inflation and the inflation target. As a result, in period *t+1*, its price is

$$P_{t+1}^{Core} = (\pi_t^{Core})^{\kappa_d} P_t^{Core}. \tag{3.17}$$

Each intermediate domestic good firm *i* solves the following optimization problem for price setting:

$$\max_{P_{new,t}^{Core}} E_t \sum_{s=0}^{\infty} (\beta\xi_d)^s v_{t+s} \begin{bmatrix} \left((\pi_t^{Core}\pi_{t+1}^{Core} \dots \pi_{t+s-1}^{Core})^{\kappa_d} P_{new,t}^{Core}\right) Y_{i,t+s} \\ -MC_{i,t+s}\left(Y_{i,t+s} + z_{t+s}\phi\right) \end{bmatrix} \tag{3.18}$$

where P_{new}^{Core} is the reoptimized price,

β is the discount factor,

v_{t+s} is the marginal utility of the nominal income for household in period *t+s*,

$MC_{i,t}$ is the nominal marginal cost for the intermediate firms and

$(\beta\xi_d)^s v_{t+s}$ is the stochastic discount factor. [10]

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[10] Note that $P_{new,t}^{Core}$ has no index *i* because we assume that the firm will always reoptimize the same price.

We plug equation (3.2) into equation (3.17) and solve for the price setting problem. The first order condition is as follows:

$$\sum_{s=0}^{\infty}(\beta\xi_d)^s\, v_{t+s}\left(\frac{\left(\frac{P^{Core}_{t+s-1}}{P^{Core}_{t-1}}\right)^{\kappa_d}}{\left(\frac{P^{Core}_{t+s}}{P^{Core}_{t}}\right)}\right)^{-\frac{\lambda_{d,t+s}}{\lambda_{d,t+s}-1}} E_t Y_{t+s} P^{Core}_{t+s}\left[\frac{\left(\frac{P^{Core}_{t+s-1}}{P^{Core}_{t-1}}\right)^{\kappa_d}}{\left(\frac{P^{Core}_{t+s}}{P^{Core}_{t}}\right)}\frac{P^{Core}_{new,t}}{P^{Core}_{t}}-\frac{\lambda_{d,t}MC_{i,t+s}}{P^{Core}_{t+s}}\right]=0. \quad (3.19)$$

We adopt the aggregate price index equation (3.4) and get the average price in period *t* as follows:

$$P^{Core}_t = \left[\left(\int_0^{\xi_d}\left(P^{Core}_{t-1}(\pi^{Core}_{t-1})^{\kappa_d}\right)^{\frac{1}{1-\lambda_{d,t}}} + \int_{\xi_d}^{1}\left(P^{Core}_{new,t}\right)^{\frac{1}{1-\lambda_{d,t}}}\right)di\right]^{1-\lambda_{d,t}} \quad (3.20)$$

$$P^{Core}_t = \left[\xi_d\left(P^{Core}_{t-1}(\pi^{Core}_{t-1})^{\kappa_d}\right)^{\frac{1}{1-\lambda_{d,t}}} + \left(P^{Core}_{new,t}\right)^{\frac{1}{1-\lambda_{d,t}}}\right]^{1-\lambda_{d,t}}. \quad (3.21)$$

We combine equation (3.19) and equation (3.21) and log-linearize the result to get the following aggregate Phillips curve equation:

$$\hat{\pi}^{Core}_t = \frac{\beta}{1+\kappa_d\beta}E_t\hat{\pi}^{Core}_{t+1} + \frac{\kappa_d}{1+\kappa_d\beta}\hat{\pi}^{Core}_{t-1} + \frac{(1-\xi_d)(1-\beta\xi_d)}{\xi_d(1+\kappa_d\beta)}\left(\widehat{mc}_t + \hat{\lambda}_{d,t}\right). \quad (3.22)$$

3.1.1.2 Importing Firms

The importing firms basically buy a homogenous good from the world market and differentiate it for selling to households. Specifically, there are two types of importing firms; one imports the homogenous good and transforms it to be *a differentiated consumption good*, $C^m_{i,t}$, and another imports the homogenous good and transforms it to be *a differentiated investment good*, $I^m_{i,t}$. Both importing firms buy the homogenous good at the price P^*_t. The study assumes that there is incomplete exchange rate pass-through in both the consumption and investment import prices, namely $P^{m,c}_t$ and $P^{m,i}_t$ respectively. This assumption leads to local price stickiness. The importing firm will change their prices only if they face a random price change signal. Each importing firm which produces the consumption goods has a random chance ($1-\xi_{m,c}$) for reoptimization its own price. Also, each importing firm which produces the investment goods has a random chance ($1-\xi_{m,i}$) for reoptimization its own price. If each importing firm is not allowed to reoptimize its price setting with probability, $\xi_{m,j}$ for $j=\{c,i\}$, its price will be indexed to the last period domestic goods inflation and the inflation target. As a result, in period *t+1*, its price is

$$P_{t+1}^{m,j} = \left(\pi_t^{m,j}\right)^{\kappa_{m,j}} P_t^{m,j} \tag{3.23}$$

for $j=\{c,i\}$.[11]

Similarly, if the firm is not allowed to change its price during s periods ahead, its price, in period $t+s$, will be

$$P_{t+s}^{m,j} = (\pi_t^{m,c}\pi_{t+1}^{m,c} \dots \pi_{t+s-1}^{m,c})^{\kappa_{m,c}} P_{new,t}^{m,c} \tag{3.24}$$

for $j = \{c,i\}$.

As a result, the maximization problem for the consumption importing firms is

$$\max_{P_{new,t}^{m,c}} E_t \sum_{s=0}^{\infty} \left(\beta\xi_{m,c}\right)^s v_{t+s} \begin{bmatrix} \left((\pi_t^{m,c}\pi_{t+1}^{m,c} \dots \pi_{t+s-1}^{m,c})^{\kappa_{m,c}} P_{new,t}^{m,c}\right) C_{i,t+s}^m \\ -NER_{t+s}P_{t+s}^{*}\left(C_{i,t+s}^m + z_{t+s}\phi^{m,c}\right) \end{bmatrix} \tag{3.25}$$

for $j=\{c,i\}$.

[11] Note that all importing firms which reoptimize their price will set the same price, so the subscript *i* can be disappeared. Also, the updating scheme allows for the possibility that the importing firms update the CPI inflation target. Since the profit maximization for the importing firms involves its own price relative to an aggregate import price, as well as the firm marginal cost which is $NER_t P_t^*$.

Similarly, the maximization problem for the investment importing firms is

$$\max_{P_{new,t}^{m,i}} E_t \sum_{s=0}^{\infty}\left(\beta\xi_{m,i}\right)^s v_{t+s}\begin{bmatrix}\left(\left(\pi_t^{m,i}\pi_{t+1}^{m,i}\ldots\pi_{t+s-1}^{m,i}\right)^{\kappa_{m,i}}P_{new,t}^{m,i}\right)I_{i,t+s}^m \\ -NER_{t+s}P_{t+s}^*\left(I_{i,t+s}^m+z_{t+s}\phi^{m,i}\right)\end{bmatrix} \tag{3.26}$$

for j=$\{c,i\}$

where $\left(\beta\xi_{m,j}\right)^s v_{t+s}$ is the profits discount factor,

$\phi^{m,j}$ is the fixed cost of the importing firms.

We aggregate the differentiated imported consumption goods to a homogenous imported consumption good by the following CES function:

$$C_t^m=\left[\int_0^1\left(C_{i,t}^m\right)^{\frac{1}{\lambda_t^{m,c}}}di\right]^{\lambda_t^{m,c}},\ 1\leq\lambda_t^{m,c}<\infty. \tag{3.27}$$

Each importing firm *i* faces the following demand function for imported consumption goods:

$$C_{i,t}^m=\left(\frac{P_{i,t}^{m,c}}{P_t^{m,c}}\right)^{-\frac{\lambda_t^{m,c}}{\lambda_t^{m,c}-1}}C_t^m. \tag{3.28}$$

Similarly, we aggregate the differentiated imported investment goods to a homogenous imported investment good by the following CES function:

$$I_t^m=\left[\int_0^1\left(I_{i,t}^m\right)^{\frac{1}{\lambda_t^{m,i}}}di\right]^{\lambda_t^{m,i}},\ 1\leq\lambda_t^{m,i}<\infty. \tag{3.29}$$

Each importing firm *i* faces the following demand function for imported investment goods:

$$I_{i,t}^{m} = \left(\frac{P_{i,t}^{m,i}}{P_t^{m,i}}\right)^{-\frac{\lambda_t^{m,i}}{\lambda_t^{m,i}-1}} I_t^{m}. \tag{3.30}$$

The processes of the time varying markup on imported consumption and investment goods are given by

$$\lambda_t^{m,c} = (1-\rho_{\lambda^{m,c}})\lambda^{m,c} + \rho_{\lambda^{m,c}}\lambda_{t-1}^{m,c} + \varepsilon_{\lambda^{m,c},t}\ , \tag{3.31}$$

$$\lambda_t^{m,i} = \left(1-\rho_{\lambda^{m,i}}\right)\lambda^{m,i} + \rho_{\lambda^{m,i}}\lambda_{t-1}^{m,i} + \varepsilon_{\lambda^{m,i},t}. \tag{3.32}$$

We plug both demand equations for imported consumption goods (3.28) and investment goods (3.30) into the firms' optimization problem. Then, we get the first order condition with respect to the imported consumption goods:

$$E_t \sum_{s=0}^{\infty}\left(\beta\xi_{m,c}\right)^s v_{t+s}\left(\frac{\left(\frac{P_{t+s-1}^{m,c}}{P_{t-1}^{m,c}}\right)^{\kappa_{m,c}}}{\left(\frac{P_{t+s}^{m,c}}{P_t^{m,c}}\right)}\right)^{-\frac{\lambda_{t+s}^{m,c}}{\lambda_{t+s}^{m,c}-1}} \times C_{t+s}^{m} P_{t+s}^{m,c}\left[\frac{\left(\frac{P_{t+s-1}^{m,c}}{P_{t-1}^{m,c}}\right)^{\kappa_{m,c}}}{\left(\frac{P_{t+s}^{m,c}}{P_t^{m,c}}\right)}\frac{P_{new,t}^{m,c}}{P_t^{m,c}} - \frac{\lambda_{t+s}^{m,c} NER_{t+s} P_{t+s}^{*}}{P_t^{m,c}}\right] = 0. \tag{3.33}$$

and to the imported investment goods

$$E_t \sum_{s=0}^{\infty}\left(\beta\xi_{m,i}\right)^s v_{t+s}\left(\frac{\left(\frac{P_{t+s-1}^{m,i}}{P_{t-1}^{m,i}}\right)^{\kappa_{m,i}}}{\left(\frac{P_{t+s}^{m,i}}{P_t^{m,i}}\right)}\right)^{-\frac{\lambda_{t+s}^{m,i}}{\lambda_{t+s}^{m,i}-1}} \times I_{t+s}^{m} P_{t+s}^{m,i}\left[\frac{\left(\frac{P_{t+s-1}^{m,i}}{P_{t-1}^{m,i}}\right)^{\kappa_{m,i}}}{\left(\frac{P_{t+s}^{m,i}}{P_t^{m,i}}\right)}\frac{P_{new,t}^{m,i}}{P_t^{m,i}} - \frac{\lambda_{t+s}^{m,i} NER_{t+s} P_{t+s}^{*}}{P_t^{m,i}}\right]=0. \tag{3.34}$$

We stationarize equations (3.3) and (3.33) and apply them to their aggregate price indices given by

$$P_t^{m,j} = \left[\int_0^1 \left(P_{it}^{m,j}\right)^{\frac{1}{1-\lambda_{d,t}}} di\right]^{1-\lambda_t^{m,j}} \tag{3.35}$$

$$P_t^{m,j} = \left[\xi_{m,j}\left(P_{it}^{m,j}(\pi_{t-1})^{\kappa_{m,j}}\right)^{\frac{1}{1-\lambda_t^{m,j}}} + \left(P_{new,t}^{m,j}\right)^{\frac{1}{1-\lambda_t^{m,j}}}\right]^{1-\lambda_t^{m,j}} \quad (3.36)$$

for $j = \{c, i\}$.

Next, we log-linearize the above equations. Then we get the Phillips curve equation

$$\hat{\pi}_t^{m,j} = \frac{\beta}{1+\kappa_{m,j}\beta} E_t \hat{\pi}_{t+1}^{m,j} + \frac{\kappa_{m,j}}{1+\kappa_{m,j}\beta} \hat{\pi}_{t-1}^{m,j} + \frac{(1-\xi_{m,j})(1-\beta\xi_{m,j})}{\xi_{m,j}(1+\kappa_{m,j}\beta)} \left(\widehat{mc}_t^{m,j} + \hat{\lambda}_t^{m,j}\right) \quad (3.37)$$

for $j = \{c, i\}$ and where $\widehat{mc}_t^{m,j} = \hat{p}_t^* + \widehat{NER}_t - \hat{p}_t^{m,j}$.

3.1.2.3 Exporting Firms

The exporting firms purchase the homogeneous final domestic goods and differentiate them for selling to the households sector in the aboard market. The marginal cost for the exporting firm is the domestic (core) good price P_t^{Core}. Each exporting firm *i* receives the following demand for exported goods

$$\tilde{X}_{i,t} = \left(\frac{P_{i,t}^x}{P_t^x}\right)^{-\frac{\lambda_{x,t}}{\lambda_{x,t-1}}} \tilde{X}_t. \quad (3.38)$$

The process of the time varying markup on exported goods is given by

$$\lambda_{x,t} = \left(1-\rho_{\lambda_x}\right)\lambda_x + \rho_{\lambda_x}\lambda_{x,t-1} + \epsilon_{\lambda_{x,t}}. \quad (3.39)$$

Incomplete exchange rate pass-through in the exported goods market is introduced by assuming the export price stickiness in the foreign currency. Once the exporting firms reoptimize their own prices, they concern about the relative prices of their own price to the aggregate export price and the final domestic good price. If each exporting firm is not allowed to reoptimize its price setting with probability, ξ_x , its price will be indexed to the last period export goods inflation and the inflation target. As a result, in period *t+1*, the exported goods price is

$$P_{t+1}^{x} = (\pi_t^x)^{\kappa_x} P_t^x. \tag{3.40}$$

Similarly, if the firm is not allowed to change its price during s periods ahead, the exported goods price, in period *t+s*, will be

$$P_{t+s}^{x} = (\pi_t^x \pi_{t+1}^x \dots \pi_{t+s-1}^x)^{\kappa_x} P_{new,t}^x. \tag{3.41}$$

As a result, the maximization problem for the exporting firms is

$$\max_{P_{new,t}^x} E_t \sum_{s=0}^{\infty} (\beta \xi_x)^s v_{t+s} \left[\left((\pi_t^x \pi_{t+1}^x \dots \pi_{t+s-1}^x)^{\kappa_x} P_{new,t}^x \right) \tilde{X}_{i,t+s} - \frac{P_{t+s}^{Core}}{NER_{t+s}} \left(\tilde{X}_{i,t+s} + z_{t+s} \phi^{m,i} \right) \right] \tag{3.42}$$

The exporting firms solve the problem in the equation (3.42) subject to the demand for exported goods (3.38). Then they get first order condition for this problem, and they rearrange and log-linearize it. The log-linearized optimal condition is show as follows:

$$\hat{\pi}_t^x = \frac{\beta}{1+\kappa_x \beta} E_t \hat{\pi}_{t+1}^x + \frac{\kappa_x}{1+\kappa_x \beta} \hat{\pi}_{t-1}^x + \frac{(1-\xi_x)(1-\beta \xi_x)}{\xi_x (1+\kappa_x \beta)} \left(\widehat{mc}_t^x + \hat{\lambda}_t^x \right) \tag{3.43}$$

where $\widehat{mc}_t^x = \hat{p}_t + \widehat{NER}_t - \hat{p}_t^x$.

This model assumes that the foreign demand for the aggregate domestic consumption good is a CES function as follow

$$C_t^x = \left(\frac{P_t^x}{P_t^*} \right)^{-\eta_f} C_t^* \tag{3.44}$$

where C_t^x is the exporting consumption,

C_t^* is the foreign consumption,

P_t^x is the price level of exporting consumption and

P_t^* is the price level of foreign consumption.[12]

Also, the foreign demand for the aggregate domestic investment good is a CES function as follows:

$$I_t^x = \left(\frac{P_t^x}{P_t^*}\right)^{-\eta_f} I_t^* \qquad (3.45)$$

where I_t^x is the exporting investment,

I_t^* is the foreign investment.[13]

3.1.2 Households

This model assumes that the households are indexed by $j\epsilon(0,1)$. Each j^{th} household obtains the utility by consumption, working hours and cash balances. The j^{th} household's preferences function is given by

$$E_0^j \sum_{t=0}^{\infty} \beta^t \left[\zeta_t^c \ln\left(C_{j,t} - bC_{j,t-1}\right) - \zeta_t^h A_L \frac{\left(h_{j,t}\right)^{1+\sigma_L}}{1+\sigma_L} + A_q \frac{\left(\frac{Q_{j,t}}{z_t P_t^{Core}}\right)^{1-\sigma_q}}{1-\sigma_q}\right] \qquad (3.46)$$

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[12] Note that the equation (3.44) does not satisfy the law of one price because of the export price stickiness in terms of the local currency.

[13] We assume that both foreign demand functions for the domestic consumption (3.44) and investment (3.45) goods have the same elasticity of substitution (η_f). This is because we define the foreign output as a function of the demand variable following the formula ($Y_t^* = C_t^* + I_t^*$). Hence, we do not need to specify the amount of the exporting goods that are used to consume and to invest by foreigners.

where $C_{j,t}$ is the level of aggregate consumption for the j^{th} household,

$h_{j,t}$ is the level of working hours for the j^{th} households,

$\frac{Q_{j,t}}{P_t^{core}}$ is real cash balances held by households in a non-interest bearing form,

ζ_t^c is a consumption preference shock,

ζ_t^h is a labor supply shock,

b is the habit formation coefficient,

A_L is the labor disutility function,

A_q is the cash to money ratio, measured by *M1/M3*,

σ_L is the inverse of the elasticity of work effort with respect to the real wage and

σ_q is the curvature parameter related to money demand.

The real balance is also scaled by z_t to be the stationary variable. This model also introduces the habit persistence in the household's utility function by including $bC_{j,t-1}$.[14] We assume that the consumption preference and labor supply shock processes are given by

$$\hat{\zeta}_t^c = \rho_{\zeta^c}\hat{\zeta}_{t-1}^c + \varepsilon_{\zeta^c,t}, \tag{3.47}$$

$$\hat{\zeta}_t^h = \rho_{\zeta^h}\hat{\zeta}_{t-1}^h + \varepsilon_{\zeta^h,t}, \tag{3.48}$$

where $\varepsilon_{\zeta^c,t}$ is the disturbances of the consumption preference shocks and

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[14] We introduce the habit formation in order to capture hamp-sharped behavior in consumption. The habit formation is a preference specification according to which the period utility function depends on quasi-difference of consumption or related to consumption in a part. For an economic sense means that with habit persistence, increasing in present consumption decrease the marginal utility of consumption in the present period and increases it in the next period. Its common sense is that the more the consumer eats today, the hungrier he wakes up tomorrow. See Fuhrer, Jeffrey C. (2000) for more detail about the habit formation.

$\varepsilon_{\zeta^{h},t}$ is the disturbances of the labor supply shocks. [15]

The CES function of the aggregate consumption is indexed by the CES of domestic and imported consumption goods as follows:

$$C_t = \left[(1-\omega_c)^{1/\eta_c}\left(C_t^d\right)^{(\eta_c-1)/\eta_c} + \omega_c{}^{1/\eta_c}(C_t^m)^{(\eta_c-1)/\eta_c}\right]^{\eta_c/(\eta_c-1)} \tag{3.49}$$

where C_t^d and C_t^m are the domestic and imported consumption goods, respectively,

ω_c denotes the share of imported goods in the aggregate consumption,

η_c denotes the elasticity of substitution between domestic and imported consumption goods.

Each j^{th} household maximizes the aggregate consumption equation (3.49) subject to the budget constraint:

$$P_t^{Core}C_t^d + P_t^{m,c}C_t^m = P_t^{HL}C_t. \tag{3.50}$$

Then, we get the following consumption demand function for domestic goods

$$C_t^d = (1-\omega_c)\left[\frac{P_t^{Core}}{P_t^{HL}}\right]^{-\eta_c} C_t \tag{3.51}$$

and demand function for imported goods

$$C_t^m = \omega_c\left[\frac{P_t^{m,c}}{P_t^{HL}}\right]^{-\eta_c} C_t\ . \tag{3.52}$$

The aggregate price index or CPI price index is as follows:

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[15] We assume that $E\left(\zeta_t^i\right) = 1$ and $\hat{\zeta}_t^i = \frac{(\zeta_t^i - 1)}{1}$ for $i = \{c, h\}$.

$$P_t^{HL} = [(1-\omega_c)(P_t^{Core})^{1-\eta_c} + \omega_c(P_t^{m,c})^{1-\eta_c}]^{1/(1-\eta_c)}. \tag{3.53}$$

The CES function of the aggregate investment is indexed by CES of domestic and imported investment goods as follows:

$$I_t = \left[(1-\omega_i)^{1/\eta_i}\left(I_t^d\right)^{(\eta_i-1)/\eta_i} + {\omega_i}^{1/\eta_i}(I_t^m)^{(\eta_i-1)/\eta_i}\right]^{\eta_i/(\eta_i-1)} \tag{3.54}$$

where ω_i denotes the share of imported investment goods in the aggregate investment goods,

η_c denotes the elasticity of substitution between domestic and imported investment goods.

Each j^{th} household maximizes the aggregate investment equation (3.54) subject to the budget constraint:

$$P_t^i I_t = P_t^{Core} I_t^d + P_t^{m,i} I_t^m. \tag{3.55}$$

Then, we get the following consumption demand function for domestic investment goods

$$I_t^d = (1-\omega_i)\left[\frac{P_t^{Core}}{P_t^i}\right]^{-\eta_i} I_t \text{ ,} \tag{3.56}$$

and demand function for imported investment goods

$$I_t^m = \omega_i \left[\frac{P_t^{m,i}}{P_t^i}\right]^{-\eta_i} I_t \text{ .} \tag{3.57}$$

The aggregate investment price is given by

$$P_t^i = \left[(1-\omega_i)(P_t^{Core})^{1-\eta_i} + \omega_i\left(P_t^{m,i}\right)^{1-\eta_i}\right]^{1/(1-\eta_i)}. \tag{3.58}$$

The law of motion for the physical capital stock, $\bar{K}_t$, is given by

$$\bar{K}_{t+1} = (1-\delta)\bar{K}_t + \Upsilon_t F(I_t, I_{t-1}) + \Delta_t \qquad (3.59)$$

where Υ_t denote a stationary investment-specific technology shock.[16]

We assume that the process of $\hat{\Upsilon}_t$ is the following equation:

$$\hat{\Upsilon}_t = \rho_\Upsilon \hat{\Upsilon}_{t-1} + \varepsilon_{\Upsilon,t} \qquad (3.60)$$

where $\hat{\Upsilon}_t = \frac{(\Upsilon_t - 1)}{1}$.

According to Christiano et al. (2005), $F(I_t, I_{t-1})$ is a function that converts investment to physical capital as follows:

$$F(I_t, I_{t-1}) = (1-\tilde{S}(I_t/I_{t-1}))I_t \qquad (3.61)$$

where $\tilde{S}(I_t/I_{t-1}) = \frac{\xi^I}{2}\left(\frac{I_t}{I_{t-1}} - \mu_z\right)^2$

ξ^I is the investment adjustment cost parameter and $\xi^I > 0$.[17]

Note that only the parameter $\tilde{S}''$ is identified and will appear in the log-linearized model. Then we obtain that $F(I_t, I_{t-1})$ from equation (3.47) has two following properties:

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[16] We introduce the variable Δ_t in order to imply that household can access to a capital market. If households want to sell $\bar{K}_{t+1}$, they will be the suppliers in this market. If households want to purchase $\bar{K}_{t+1}$, they will be the source of demand in this market. Because we assume that all households are identical, the equilibrium will occur if and only if $\Delta_t = 0$.

[17] Note that, in the simple case, ξ^I=0 then $\tilde{S}(I_t/I_{t-1})$=0, and then $F(I_t, I_{t-1})$=I_t.

$$F_1(I_t, I_{t-1}) \equiv \frac{\partial F(I_t, I_{t-1})}{\partial I_t} = -\tilde{S}'(I_t/I_{t-1})\frac{I_t}{I_{t-1}} + (1 - \tilde{S}(I_t/I_{t-1})), \tag{3.62}$$

$$F_2(I_t, I_{t-1}) \equiv \frac{\partial F(I_t, I_{t-1})}{\partial I_{t-1}} = \tilde{S}'(I_t/I_{t-1})\left(\frac{I_t}{I_{t-1}}\right)^2. \tag{3.63}$$

In the steady state, we get

$$F_1(I, I) = -\tilde{S}'(\mu_z)\mu_z + (1 - \tilde{S}(\mu_z)) = 1, \tag{3.64}$$

$$F_2(I, I) = \tilde{S}'(\mu_z){\mu_z}^2 = 0, \tag{3.65}$$

where $\tilde{S}(\mu_z)$=$\tilde{S}'(\mu_z)$ =0, and $\tilde{S}''(\mu_z) = \tilde{S}'' > 0$.[18]

Each household is a monopoly supplier and can set its wage rate. The household faces two types of uncertainty: one is aggregate uncertainty generated from aggregate shocks, and another is idiosyncratic uncertainty. This model restricts the analysis to make sure that any friction does not generate by the household heterogeneity. As a result, the households are allowed to buy the appropriate portfolio of securities against the outcomes of the frictions. This assumption implies that domestic financial markets are complete. Therefore, the identical budget constraint of each household is

$$M_{j,t+1} + NER_t B^*_{j,t+1} + P^{HL}_t C_{j,t}(1 + \tau^c_t) \quad + \quad P^i_t I_{j,t} + P^{Core}_t\left(a(u_{j,t})\overline{K}_{j,t} + P_{k',t}\Delta_t\right) =$$
$$R_{t-1}\left(M_{j,t} - Q_{j,t}\right) + Q_{j,t} + \left(1 - \tau^k_t\right)\prod\nolimits_t + \left(1 + \tau^y_t\right)\frac{W_{j,t}}{1+\tau^w_t}h_{j,t} + \left(1 - \tau^k_t\right)R^k_t u_{j,t}\overline{K}_{j,t} +$$
$$R^*_{t-1}\Phi\left(\frac{A_{t-1}}{z_{t-1}}, \widetilde{\Phi}_{t-1}\right)NER_t B^*_{j,t} - \tau^k_t\Big[(R_{t-1} - 1)\left(M_{j,t} - Q_{j,t}\right) +$$
$$\left(R^*_{t-1}\Phi\left(\frac{A_{t-1}}{z_{t-1}}, \widetilde{\Phi}_{t-1}\right) - 1\right)NER_t B^*_{j,t} + B^*_{j,t}(NER_t - NER_{t-1})\Big] + TR_t + D_{j,t} \tag{3.66}$$

---

[18] Note that $I_t/I_{t-1} = z_t i_t / z_{t-1} i_{t-1}$ where $\frac{z_t}{z_{t-1}} = \mu_{z,t}$. In the steady state, we get $\mu_{z,t} = \mu_z$,$i_t = i_{t-1} = i$ and then$I_t/I_{t-1} = \frac{\mu_{z,t} i_t}{i_{t-1}} \rightarrow \frac{\mu_z i}{i} = \mu_z$.

where NER_t is the nominal exchange rate,

$B^*_{j,t+1}$ is the foreign bonds that each household decide to hold from period *t* to *t+1*,

$I_{j,t}$ is investment goods,

P^i_t is the nominal price of investment goods measured by an investment deflator,

$a(u_{j,t})$ is the utilization cost function,

$u_{j,t}$ is the utilization rate formulated by $u_t = K_t/\overline{K}_t$,

$P_{k',t}\Delta_t$ is the variable that allows us to compute the price of capital in the model,

$M_{j,t}$ is the money balance that appears during period *t-1* to *t*,

$Q_{j,t}$ is the nominal cash balance that each household decides to hold at period *t* with giving no interest,

$\prod_t$ is the profit from the domestic firms ownership,

$W_{j,t}$ is the nominal wage rate per unit of the differentiated labor supply, $h_{j,t}$,

A_t is the real aggregate net foreign asset position in the domestic economy formulated by $A_t \equiv \frac{NER_t B^*_{t+1}}{P^{Core}_t}$,

$\widetilde{\Phi}_{t-1}$ is a time varying shock to the risk premium,

τ^k_t is a capital-income tax rate,

τ^c_t is a consumption tax rate,

τ^y_t is a labour-income tax rate,

τ^w_t is a pay-roll tax rate,

TR_t is lump-sum transfers by the government,

$D_{j,t}$ is the net cash income of the household by holding state contingent securities in period t.[19,20]

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[19] Note that all interest rate variables are gross rate (i.e. $R_t = 1 + r_t$).

[20] Note that $a(u)$ is the utilization cost function, which has the following properties: first, $a(1) = 0$ when $u = 1$, second, $a' = (1 - \tau^k)\tau^k$ in the steady state and third, $a'' \geq 0$.

Note that the variables that have the subscript *j* are the choice variables for each household j^{th} and the variables without the subscript are determined on their markets. There are three types of financial assets that households decide to hold: one is cash balances, another is domestic bank deposits and the other is foreign bonds. Households obtain returns from the nominal domestic assets which are treated as non-cash, i.e. $M_{j,t} - Q_{j,t}$. Households are allowed to decide to hold foreign bonds, hence they earn a foreign interest rate, R^*_{t-1}, and face a risk premium, $\Phi\left(\frac{A_{t-1}}{z_{t-1}}, \widetilde{\Phi}_{t-1}\right)$, for holding foreign bonds, which affects the real aggregate net foreign asset position in the domestic economy

$$A_t \equiv \frac{NER_t B^*_{t+1}}{P^{Core}_t}.\quad (3.67)$$

[21,22]

By following this mechanism, if the domestic economy as a whole becomes a net borrower, which means $B^*_{t+1} < 0$, the domestic households will pay a premium on the foreign interest rate. Conversely, if the domestic economy become a net lender, which means $B^*_{t+1} > 0$, the households will obtain a lower return on their saving. Because households are the physical capital stock owners, they pay a cost of capital adjustment. As a result, we introduce $a(u_{j,t})P^{Core}_t$ in the household's budget constrain.

Household decide to hold Δ_t .By following this mechanism, if the variable, Δ_t, is positive, it means that each household buys more new installed capital, $\overline{K}_{t+1}$, in period *t*. Conversely, If the variable Δ_t is positive, it means that each household sells new installed capital,$\overline{K}_{t+1}$, in period *t*. We setup the following Lagrangian problem by using the preference equation (3.46), the law of motion for the physical capital stock (3.59) and the budget constraint (3.66):

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[21] This model assumes that the function $\Phi\left(\frac{A_{t-1}}{z_{t-1}}, \widetilde{\Phi}_{t-1}\right)$ is strictly decreasing in A_t and that$\Phi(0,0) = 1$.

[22] Equation (3.67) implies imperfect integration in the international financial markets.

$$\max_{C_{j,t},M_{j,t+1},\Delta_t,\bar{K}_{j,t+1},I_{j,t},u_{j,t},Q_{j,t},B^*_{j,t+1},h_{j,t}} E_0^j \sum_{t=0}^{\infty} \beta^t [\tilde{L}_t] = \vartheta,$$

$$\tilde{L}_t = \left\{ \begin{array}{c} \zeta_t^c ln\left(C_{j,t} - bC_{j,t-1}\right) - \zeta_t^h A_L \dfrac{\left(h_{j,t}\right)^{1+\sigma_L}}{1+\sigma_L} + A_q \dfrac{\left(\dfrac{Q_{j,t}}{z_t P_t^{Core}}\right)^{1-\sigma_q}}{1-\sigma_q} \\ +v_t \left[\begin{array}{c} R_{t-1}\left(M_{j,t} - Q_{j,t}\right) + Q_{j,t} + \left(1-\tau_t^k\right)\prod_t + \left(1-\tau_t^y\right)\dfrac{W_{j,t}}{1+\tau_t^w} h_{j,t} \\ +\left(1-\tau_t^k\right)R_t^k u_{j,t}\bar{K}_{j,t} + R_{t-1}^*\Phi\left(\dfrac{A_{t-1}}{z_{t-1}}, \tilde{\Phi}_{t-1}\right) NER_t B_{j,t}^* - \\ \tau_t^k \left[\begin{array}{c} (R_{t-1}-1)\left(M_{j,t} - Q_{j,t}\right) \\ + \left(R_{t-1}^*\Phi\left(\dfrac{A_{t-1}}{z_{t-1}}, \tilde{\Phi}_{t-1}\right) - 1\right) NER_t B_{j,t}^* \\ +B_{j,t}^*(NER_t - NER_{t-1}) \end{array} \right] \\ +TR_t + D_{j,t} \\ -\left(\begin{array}{c} M_{j,t+1} + NER_t B_{j,t+1}^* + P_t^{HL} C_{j,t}(1+\tau_t^c) + P_t^i I_{j,t} \\ +P_t^{Core}\left(a\left(u_{j,t}\right)\bar{K}_{j,t} + P_{k',t}\Delta_t\right) \end{array} \right) \end{array} \right] \\ +\omega_t\left[(1-\delta)\bar{K}_{j,t} + \Upsilon_t F(I_t, I_{t-1}) + \Delta_t - \bar{K}_{j,t+1}\right] \end{array} \right\}$$

Since we consider the stationary first- order condition, all variables are stationarized by dividing with z_t.[23] We also define more three types of Lagrangian multiplier notions. First, the real and stationary Lagrangian multiplier is denoted by v_t. Second, the nominal and stationary Lagrangian multiplier is denoted by $\psi_t \equiv P_t^{Core} v_t$. Third, the nominal and non-stationary Lagrangian multiplier is denoted by $\psi_{z,t} = z_t \psi_t$. After we stationarize all variables as mentioned earlier, we get the first-order conditions by finding partial differentiation with respect to these choice variables as follows:

$$\frac{\partial \vartheta}{\partial c_t}: \quad \frac{\zeta_t^c}{c_t - bc_{t-1}\frac{1}{\mu_{z,t}}} - \beta b E_t \frac{\zeta_{t+1}^c}{c_{t+1}\mu_{z,t+1} - bc_t} - \psi_{z,t} \frac{P_t^{HL}}{P_t^{Core}}(1+\tau_t^c) = 0, \tag{3.68}$$

$$\frac{\partial \vartheta}{\partial m_{t+1}}: \; -\psi_{z,t} + \beta E_t \left[\frac{\psi_{z,t+1}}{\mu_{z,t+1}} \frac{R_t}{\pi_{t+1}^{HL}} - \frac{1}{\mu_{z,t+1}} \frac{\psi_{z,t+1}}{\pi_{t+1}^{HL}} \tau_{t+1}^k (R_t - 1) \right] = 0, \tag{3.69}$$

[23] Note that the small letters are the stationarized variables.

$$\frac{\partial\vartheta}{\partial\Delta_t}: \quad \Delta_t: -\psi_t P_{k',t} + \omega_t = 0 \tag{3.70}$$

$$\frac{\partial\vartheta}{\partial\bar{k}_{t+1}}: -P_{k',t}\psi_{z,t}, +\beta E_t\left[\frac{\psi_{z,t+1}}{\mu_{z,t+1}}\begin{pmatrix} (1-\delta)P_{k',t+1} \\ +(1-\tau_{t+1}^k)r_{t+1}^k u_{t+1} - a(u_{t+1}) \end{pmatrix}\right] = 0, \tag{3.71}$$

$$\frac{\partial\vartheta}{\partial i_t}: \quad -\psi_{z,t}\frac{P_t^i}{P_t^{Core}} + P_{k',t}\psi_{z,t}\Upsilon_t F_1(i_t, i_{t-1}, \mu_{z,t}) + \beta E_t\left[P_{k',t+1}\frac{\psi_{z,t+1}}{\mu_{z,t+1}}\Upsilon_{t+1}F_2(i_{t+1}, i_t, \mu_{z,t+1})\right] = 0 \tag{3.72}$$

$$\frac{\partial\vartheta}{\partial u_t}: \quad \psi_{z,t}\left((1-\tau_t^k)\tau_t^k - a'(u_t)\right) = 0, \tag{3.73}$$

$$\frac{\partial\vartheta}{\partial q_t}: \quad \zeta_t^q A_q {q_t}^{-\sigma_q} - (1-\tau_t^k)\psi_{z,t}(R_{t-1}-1) = 0, \tag{3.74}$$

$$\frac{\partial\vartheta}{\partial b_{t+1}^*}: -\psi_{z,t}NER_t + \beta E_t\begin{bmatrix} \frac{\psi_{z,t+1}}{\mu_{z,t+1}\pi_{t+1}}(NER_{t+1}R_t^*)\Phi(a_t, \widetilde{\Phi}_t) \\ -\tau_{t+1}^k NER_{t+1}(R_t^*\Phi(a_t, \widetilde{\Phi}_t) - 1) - \tau_{t+1}^k(NER_{t+1} - NER_t) \end{bmatrix} = 0. \tag{3.75}$$

We combine the first order-condition for domestic bond in equation (3.69) and foreign bond in equation (3.75) in order to setup the modified uncovered interest rate parity (UIP) condition:

$$\hat{R}_t - \hat{R}_t^* = E_t\Delta\widehat{NER}_{t+1} - \widetilde{\Phi}_a\hat{a}_t + \hat{\widetilde{\Phi}}_t\ . \tag{3.76}$$

The present of the risk-premium for holding the foreign bond imply the imperfect integration in the global financial markets.[24] Note that the net foreign asset, $\hat{a}_t$, of the domestic economy relate to the interest rate parity condition.

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[24] Note that the risk-premium for holding foreign bonds follows the equation: $\Phi(a_t, \widetilde{\Phi}_t) = exp(-\tilde{\phi}_a(a_t - \bar{a}) + \tilde{\phi}_t)$.

3.1.2.1 Wage Setting Equation

Following Erceg et al. (2000) and Christiano et al. (2005), each household is a monopoly labor supplier and provides a differentiated labor service to the intermediate domestic goods firms. The differentiated labor service is transformed to a homogeneous labor input good by the following CES function:

$$H_t = \left[\int_0^1 \left(h_{j,t}\right)^{\frac{1}{\lambda_w}} dj\right]^{\lambda_w}, 1 \leq \lambda_w < \infty \tag{3.77}$$

where λ_w is the wage markup,

$h_{j,t}$ is differentiated labor service,

H_t is a homogeneous labor input good.

The domestic firm is the input price taker for the j^{th} differentiated labor input, which is the homogenous labor service. There is the labor demand derived from intermediate domestic goods firm's maximization. This labor demand is as follows:

$$h_{j,t} = \left[\frac{W_{j,t}}{W_t}\right]^{\frac{\lambda_w}{1-\lambda_w}} H_t. \tag{3.78}$$

Each household treats this labor demand as a constraint of the wage setting problem. Each household sets randomly its wage with probability $(1-\xi_w)$. If each household cannot reoptimize its own wage, its own wage will be indexed to the previous period CPI inflation rate, the current inflation target and the technology growth factor. As a result, in period *t+1*, its wage is

$$W_{j,t+1} = (\pi_t^{HL})^{\kappa_w} \mu_{z,t+1} W_{j,t}, \tag{3.79}$$

where $\mu_{z,t+1} = \frac{z_{t+1}}{z_t}$.

Similarly, if the j^{th} household is not allowed to change its wage during *s* periods ahead, its wage, in period t+*s*, will be

$$W_{j,t+s} = (\pi_t^{HL} \dots \pi_{t+s-1}^{HL})^{\kappa_w}\left(\mu_{z,t+1} \dots \mu_{z,t+s}\right)W_{j,t}^{new} . \tag{3.80}$$

As a result, the wage setting problem for the j^{th} household is

$$\max_{W_{j,t}^{new}} E_t \sum_{s=0}^{\infty}(\beta\xi_w)^s \begin{bmatrix} -\zeta_{t+s}^h A_L \frac{\left(h_{j,t+s}\right)^{1+\sigma_L}}{1+\sigma_L} \\ +\upsilon_{t+s}\frac{(1-\tau_{t+s}^y)}{(1+\tau_{t+s}^w)}\left((\pi_t^{HL}\pi_{t+1}^{HL} \dots \pi_{t+s-1}^{HL})^{\kappa_w}W_{j,t}^{new}\right)h_{j,t+s} \end{bmatrix}. \tag{3.81}$$

Hence, the first order condition for the wage setting is

$$E_t \sum_{s=0}^{\infty}(\beta\xi_w)^s h_{j,t+s} \begin{bmatrix} -\zeta_{t+s}^h A_L\left(h_{j,t+s}\right)^{\sigma_L} \\ +\frac{W_t^{new}}{z_t P_t^{Core}}\frac{z_{t+s}\upsilon_{t+s}P_{t+s}^{Core}}{\lambda_w}\frac{(1-\tau_{t+s}^y)}{(1+\tau_{t+s}^w)}\frac{\left(\frac{P_{t+s-1}^{HL}}{P_{t-1}^{HL}}\right)^{\kappa_w}}{\left(\frac{P_{t+s}^{Core}}{P_t^{Core}}\right)} \end{bmatrix} = 0.^{25} \tag{3.82}$$

In the case of fully flexible wages ($\xi_w = 0$), the first order condition is the following equation:

$$-\zeta_t^h A_L H_t^{\sigma_L} + \left(1-\tau_t^y\right)\frac{\psi_{z,t}}{\lambda_w}\frac{\overline{w}_{j,t}}{1+\tau_t^w} = 0. \tag{3.83}$$

3.1.3 A Government

The government budget constraint is

$$P_t^{Core}G_t + TR_t = R_{t-1}(M_{t+1} - M_t) + \tau_t^c P_t^{HL}C_t + \frac{\left(\tau_t^y + \tau_t^w\right)W_t}{1+\tau_t^w}H_t +$$
$$\tau_t^k\left[(R_{t-1}-1)(M_t - Q_t) + R_t^k u_t \overline{K}_t + \left(R_{t-1}^*\Phi\left(a_{t-1},\widetilde{\Phi}_{t-1}\right) - 1\right)NER_t B_t^* + \textstyle\prod_t\right]. \tag{3.84}$$

---

[25] Note that $-\zeta_{t+s}^h A_L\left(h_{j,t+s}\right)^{\sigma_L}$ is the marginal disutility of labour.

Importantly, the exogenous processes of the government expenditures and all tax-rates are

$$\Gamma_0 \tau_t = \Gamma(L)\tau_{t-1} + \varepsilon_{\tau,t}, \qquad \varepsilon_{\tau,t} \sim N(0, \Sigma_t) \tag{3.85}$$

where $\tau_t = [\hat{\tau}_t^k \quad \hat{\tau}_t^y \quad \hat{\tau}_t^c \quad \hat{\tau}_t^w \quad \tilde{G}_t]$,

$\tilde{G}_t$ is the detrended (HP-filtered) government expenditures data.[26]

3.1.4 Relative Prices

We define two types of domestic (core) relative prices: one is the imported consumption goods price relative to the domestic goods price and another is the imported investment goods price relative to the domestic goods price. The domestic agents experience the imported consumption goods price as follows:

$$\gamma_t^{mc,Core} \equiv \frac{P_t^{m,c}}{P_t^{Core}} \tag{3.86}$$

and the imported investment goods price as follows:

$$\gamma_t^{mi,Core} \equiv \frac{P_t^{m,i}}{P_t^{Core}}. \tag{3.87}$$

These two types of relative prices are considered when the domestic agents want to choose their consumption as follows:

$$\gamma_t^{HL,Core} \equiv \frac{P_t^{HL}}{P_t^{Core}} \tag{3.88}$$

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[26] Note that all tax rates in the equation (3.85) are the demean data, i.e. $\hat{\tau}_t^i = (\tau_t^i - \bar{\tau}^i)/\bar{\tau}^i \quad , \forall\, i = y, c$.

and investment as follows:

$$\gamma_t^{i,Core} \equiv \frac{P_t^i}{P_t^{Core}}. \tag{3.89}$$

Also, the relative price between the exported domestic goods price and the foreign goods price are observed by the domestic exporters and the foreign agents as follows:

$$\gamma_t^{x,*} \equiv \frac{P_t^x}{P_t^*}. \tag{3.90}$$

The marginal cost of the domestic exporters, which is allowed to unhold the law of one price, is as follows:

$$mc_t^x = \frac{P_t^{Core}}{NER_t P_t^x}. \tag{3.91}$$

In addition, the above relative prices are defined as follow:

$$\gamma_t^f \equiv \frac{P_t^{Core}}{NER_t P_t^*} = mc_t^x \gamma_t^{x,*}, \tag{3.92}$$

$$mc_t^{m,c} = \frac{NER_t P_t^*}{P_t^{m,c}} = \frac{1}{\left(\gamma_t^f\right)\left(\gamma_t^{mj,d}\right)} = \frac{1}{\left(mc_t^x \gamma_t^{x,*}\right)\left(\gamma_t^{mc,d}\right)}, \tag{3.93}$$

$$mc_t^{m,i} = \frac{NER_t P_t^*}{P_t^{m,i}} = \frac{1}{\left(\gamma_t^f\right)\left(\gamma_t^{mi,d}\right)} = \frac{1}{\left(mc_t^x \gamma_t^{x,*}\right)\left(\gamma_t^{mi,d}\right)}. \tag{3.94}$$

3.1.5 A Central Bank

Following Smets and Wouters (2003), we adopt an instrument rule in order to examine the behavior of the central bank. To compare the performance of using headline and core inflation as the policy target, we then define the alternative Taylor rules that are

$$\hat{R}_t = \rho_R \hat{R}_{t-1} + (1-\rho_R)\left(r_\pi \hat{\pi}_{t-1}^{cpi} + r_y \hat{y}_{t-1} + r_{RER}\widehat{RER}_{t-1}\right) + \varepsilon_{R,t}, \tag{3.95}$$

for $cpi = \{HL, Core\}$

where $\hat{R}_t$ is a policy rate,

$\hat{R}_{t-1}$ is an interest smoother,

$\hat{\pi}_{t-1}^{cpi}$ is the deviation of CPI inflation from the inflation target,

$\hat{y}_{t-1}$ is the output gap,

$\widehat{RER}_{t-1}$is the real exchange rate,

$\varepsilon_{R,t}$ is a policy interest rate shock.

The log-linearized real exchange rate is given by

$$\widehat{RER}_t = \widehat{NER}_t + \hat{P}_t^* - \hat{P}_t^{HL}. \tag{3.96}$$

The output gap in this model is measured as the output that differs from its trend. The headline CPI inflation rate ($\hat{\pi}_t^{HL}$) is also measured as follows:

$$\hat{\pi}_t^{HL} = \left((1-\omega_c)(\gamma^{Core,HL})^{(1-\eta_c)}\right)\hat{\pi}_t^{Core} + \left(\omega_c(\gamma^{mc,HL})^{(1-\eta_c)}\right)\hat{\pi}_t^{m,c}. \tag{3.97}$$

3.1.6 Market Clearing Conditions

To get the equilibrium of the model, we need to clear these three markets. First, the final goods market will clear if the production of the final good firm meets all demand from the households, the government and the foreign sector. Second, the foreign bond market will clear if the positions of the exporting and importing firms equal to the amount of foreign bonds held by the domestic households. Third, the loan market will clear if the amount of deposits supplied by the domestic households plus the monetary injection by the central bank equal to the demand for liquidity from the firms financing their wage bills.

3.1.6.1 The Aggregate Resource Constraint

The equilibrium of the aggregate resource constraint satisfies the following equation:

$$C_t^d + I_t^d + G_t + C_t^x + I_t^x \leq \epsilon_t z_t^{1-\alpha} K_t^\alpha H_t^{1-\alpha} - z_t\phi - a(u_t)\bar{K}_t. \tag{3.98}$$

We stationarize the equilibrium equation (3.99) by substituting (3.44), (3.45), (3.51) and (3.56) into (3.98) then we get

$$(1-\omega_c)\left[\frac{P_t^{HL}}{P_t^{Core}}\right]^{\eta_c} c_t + (1-\omega_i)\left[\frac{P_t^{i}}{P_t^{Core}}\right]^{\eta_i} i_t + g_t + \left[\frac{P_t^{x}}{P_t^{*}}\right]^{-\eta_f} y_t^* \frac{z_t^*}{z_t}$$
$$\leq \epsilon_t \left(\frac{1}{\mu_{z,t}}\right)^\alpha k_t^\alpha H_t^{1-\alpha} - \phi - a(u_t)\bar{k}_t \frac{1}{\mu_{z,t}} \tag{3.99}$$

where $Y_t^* = C_t^* + I_t^*$.

The real variables are stationarized by z_t. Then, Y_t^* is stationarized by dividing with z_t^* which is a permanent technology shock in a foreign production function.[27] We formulate a new variable, $\tilde{z}_t^* = \frac{z_t^*}{z_t}$, where $\tilde{z}_t^*$ denotes a stationary shock that measures the degree of asymmetry between the technological process in the domestic and foreign economies. The technology levels of both the domestic and foreign economies will be

[27] Note that z_t^* has the same exogenous process as z_t, and then $\mu_z = \mu_z^*$ in the steady state.

the same ($z^* = z$) in the steady state. This assumption implies that $\tilde{z}^* = 1$ in the steady state. Hence, the log-linearized asymmetric technology process is assumed as follows:

$$\hat{\tilde{z}}^*_{t+1} = \rho_{\tilde{z}^*}\hat{\tilde{z}}^*_t + \varepsilon_{\tilde{z}^*,t+1}. \tag{3.100}$$

To find the steady state value of the stationary aggregate resource constraint (3.99), we have to follow these steady state conditions shown below:

$$\left(\frac{1}{\mu_{z,t}}\right)^{\alpha} k_t^{\alpha} H_t^{1-\alpha} = y + \phi = y + (\lambda_d - 1)y = \lambda_d y, \tag{3.101}$$

$$\Upsilon^{x,*} = 1, \tag{3.102}$$

$$a(u) = 0, \tag{3.103}$$

$$a^{'}(u) = (1 - \tau^k)\tau^k, \tag{3.104}$$

$$\hat{\hat{u}}_t = du_t = \hat{k}_t - \hat{\bar{k}}_t, \tag{3.105}$$

$$d\epsilon_t = \hat{\epsilon}_t. \tag{3.106}$$

After we get the steady state value of the stationary aggregate resource constraint (3.99), we get the log-linearized resource constraint as follows:

$$\begin{aligned}
&\lambda_d\left(\hat{\epsilon}_t + \alpha\left(\hat{k}_t - \hat{\mu}_{z,t}\right) + (1-\alpha)\hat{H}_t\right) - (1-\tau^k)\tau^k \frac{\bar{k}}{y}\frac{1}{\mu_z}\left(\hat{k}_t - \hat{\bar{k}}_t\right) = \\
&(1-\omega_c)(\Upsilon^{HL,Core})^{\eta_c}\frac{c}{y}\left(\hat{c}_t + \eta_c\hat{\gamma}_t^{HL,Core}\right) + (1-\omega_i)\left(\Upsilon^{i,Core}\right)^{\eta_i}\frac{i}{y}\left(\hat{\imath}_t + \eta_i\hat{\gamma}_t^{i,Core}\right) \\
&+\frac{g}{y}\hat{g}_t + \frac{y^*}{y}\left(\hat{y}_t^* - \eta_f\hat{\gamma}_t^{x,*} + \hat{\tilde{z}}_t^*\right).
\end{aligned} \tag{3.107}$$

3.1.6.2 Evolution of Net Foreign Assets

The evolution of net foreign assets at the aggregate level is as follows:

$$NER_t B^*_{t+1} = NER_t P^x_t (C^x_t + I^x_t) - NER_t P^*_t (C^m_t + I^m_t) + R^*_{t+1} \phi\left(a_{t-1}, \tilde{\phi}_{t-1}\right) NER_t B^*_t \tag{3.108}$$

where $R^*_{t+1}\phi\left(a_{t-1}, \tilde{\phi}_{t-1}\right)$ denotes the risk-adjusted gross nominal interest rate.

The net foreign assets, a_t, is given by

$$a_t \equiv \frac{NER_t B^*_{t+1}}{P^{Core}_t z_t}. \tag{3.109}$$

We time (3.109) with $\frac{1}{P^{Core}_t z_t}$,and use $\frac{C^x_t}{z_t} + \frac{I^x_t}{z_t} = \left[\frac{P^x_t}{P^*_t}\right]^{-\eta_f} \frac{Y^*_t}{z^*_t} \frac{z^*_t}{z_t}$. Hence, another formula of the net foreign assets is

$$a_t = (mc^x_t)^{-1} (\gamma^{x,*}_t)^{-\eta_f} y^*_t \tilde{z}^*_t - \left(\gamma^f_t\right)^{-1} (c^m_t + i^m_t) + R^*_{t-1} \phi\left(a_{t-1}, \tilde{\phi}_{t-1}\right) \frac{a_{t-1}}{\pi_t \mu_{z,t}} \frac{NER_t}{NER_{t-1}}. \tag{3.110}$$

The steady state value of the net foreign assets, a_t, equals zero.[28] Then, we derive the linearized version for the net foreign assets as follows:

$$\begin{aligned} \hat{a}_t = & -y^* \widehat{mc}^x_t - \eta_f y^* \hat{\gamma}^{x,*}_t + y^* \hat{y}^*_t + y^* \hat{\tilde{z}}^*_t + (c^m + i^m) \hat{\gamma}^f_t \\ & - c^m \left(-\eta_c (1-\omega_c) (\gamma^{HL,Core})^{-(1-\eta_c)} \hat{\gamma}^{HL,Core}_t + \hat{c}_t\right) \\ & + i^m \left(-\eta_i (1-\omega_i) \left(\gamma^{i,Core}\right)^{-(1-\eta_i)} \hat{\gamma}^{mi,Core}_t + \hat{\imath}_t\right) + \frac{R}{\pi^{Core} \mu_z} \hat{a}_{t-1}. \end{aligned} \tag{3.111}$$

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[28] When $a = 0$, it is implied that in the steady state $\phi(0,0) = 1, R^* = R$, $\frac{\widehat{NER}_t}{\widehat{NER}_{t-1}} = 1, \gamma^f = \frac{P^{Core}}{NER \times P^*} = 1$, $mc^x = \frac{P^{Core}}{NER \times P^x} = \frac{P^{core}}{NER \times (P^{core}/NER)} = 1$, and $\gamma^{x,*} = \frac{P^x}{P^*} = \frac{P^{Core}}{NER \times P^*} = 1$.

3.1.6.3 Loan Market Clearing

The money market clearing condition is the following equation:

$$\mathrm{v}W_t H_t = \mu_t M_t - Q_t. \tag{3.112}$$

We stationarize equation (3.112) to be

$$\mathrm{v}\bar{w}_t H_t = \frac{\mu_t \bar{m}_t}{\pi_t^{Core} \mu_{z,t}} - q_t. \tag{3.113}$$

3.1.7 A Foreign Economy

We assume that the foreign inflation, output and interest rate are exogenous variables. It is given that the vector $X_t^* = [\pi_t^* \quad \hat{y}_t^* \quad R_t^*]'$. Note that π_t^* is the quarterly foreign inflation, R_t^* is the quarterly foreign interest rate and $\hat{y}_t^*$ is the quarterly foreign output applied with HP-filter. These three foreign economy variables are exogenously determined by the following VAR process

$$F_0 X_t^* = F(L) X_{t-1}^* + \varepsilon_{x^*,t} \qquad \varepsilon_{x^*,t} \sim N(0, \Sigma_{x^*}). \tag{3.114}$$

The above matrix F_0 implies the assuming predetermined expectation in the Phillips curve. Furthermore, we show the solution of the steady state in appendix A. The log-linearized model, concluding of key equations, is shown in appendix B.

3.2 Methodology

This section discusses the methodology of the study. Section 3.2.1 explains about the welfare loss function used to evaluate the monetary policy performance under headline and core inflation targeting. Section 3.2.2 explains about parameter calibration. Section 3.2.3 explains about parameter estimation. Section 3.2.5 explains about data description and section 3.2.5 explains about the policy rule modification.

3.2.1 Welfare Loss Function

We evaluate the performance of headline and core inflation targeting by using the welfare loss function proposed by Adolfson (2001). The welfare loss function is as follows:

$$W = E_t \sum_{k=0}^{\infty} \beta^k \left[L_{t+k}^{cpi}\right] \tag{3.115}$$

where $L_t^{cpi} = \hat{\pi}_{t-1}^{cpi\,2} + \lambda^S \hat{y}_{t-1}^2$ for $cpi = \{HL, Core\}$,

λ^S denotes the weight on output- gap stabilization relative to inflation stabilization.

Taking unconditional expectations on the welfare loss function (3.116) and giving that β goes to 1, the welfare loss function can be written in terms of the variances of inflation deviation from its target and output gap. We further modify the welfare losses as the functions of core and headline inflation as follow:

$$WFL^C = Var(\hat{\pi}_t^{Core}) + 0.5Var(\hat{y}_t) \tag{3.116}$$

and

$$WFL^H = Var(\hat{\pi}_t^{HL}) + 0.5Var(\hat{y}_t). \tag{3.117}$$

3.2.2 Parameter Calibration

This study obtains some fixed parameters following Fagan et al. (2001), Adolfson et al. (2007) and Tanboon (2008). Note that we use the same value of calibrated parameters under both headline and core inflation targeting. These calibrated parameters relate to the steady state value of the observed variables shown in appendix A. The summary of the specification of calibrated parameters is shown in Table 3.1

Table 3.1

The Specification of Calibrated Parameters

Parameter	Name	Value	Source
λ^S	The weight on output- gap stabilization relative to inflation stabilization	0.5	Adolfson (2001)
A_L	A constant in the labor disutility function	7.5	Adolfson et al. (2007)
v	A steady state value of the fraction of the intermediate firms' wage bill	0.95	Adolfson et al. (2007)
η_c	A substitute elasticity consumption	5	Adolfson et al. (2007)
σ_a	the cost of varying the capital utilization rate	0.49	Adolfson et al. (2007)
ρ_{τ^k}	A persistence coefficient in AR(1) process for a capital income tax rate	0.9	Adolfson et al. (2007)
ρ_{τ^w}	A persistence coefficient in AR(1) process for a pay- roll tax	0.9	Adolfson et al. (2007)
λ_W	A steady state value of a markup in the wage setting	1.05	Adolfson et al. (2007)
σ_q	Curvature parameter for money demand	10.62	Adolfson et al. (2007)
β	Discount factor coefficient	0.9926	Tanboon (2008)
α	A share of capital in the production	0.3	Tanboon (2008)
σ_L	A labor supply elasticity	1	Tanboon (2008)

Table 3.1 (Continued)

Parameter	Name	Value	Source
μ	A steady state value of a money growth rate	1.0179	Calculated by author: The sample mean of growth rate of *M3*
μ_z	A steady state value of technology growth	1.01	Calculated by author: A common quarterly trend growth rate of real GDP
π^{HL}	A steady state value of inflation	1.0078	Calculated by author: $\pi^{HL} = \frac{\mu}{\mu_z}$
R	A steady state value of gross nominal economy wide interest rate	1.0283	Calculated by author: $R = \frac{\pi\mu_z - \tau^k\beta}{(1-\tau^k)\beta}$
τ^y	A steady state value of a labour –income tax	0.107	Calculated by author: Sample mean of $\frac{\text{Personal income tax+coperate tax}}{\text{Disposable Income}}$
τ^c	A steady state value of a consumption-income tax	0.07	Value added tax 7% in Thailand
τ^k	A steady state value of a capital income tax rate	0.2	Capital income tax 20% in Thailand

Source: Adopted from Fagan et al. (2001), Adolfson et al. (2007) and Tanboon (2008).

3.2.3 Parameter Estimation

To capture the different economic characteristic and monetary policy transmission under both headline and core inflation targeting, we separately estimate the sets of parameters under both headline and core inflation targeting.

3.2.3.1 Bayesian Estimation Concept

Following Adolfson et al. (2007), we estimate all relevant parameters by Bayesian estimation. The Bayesian estimation is a mix of calibration and maximum likelihood by specifying prior information and applying to the model with data. Note that prior information is equivalent to the weight on the likelihood function. Bayesian estimation is based on the Bayes formula given by

$$p(\theta|Y,M) = \frac{L(Y|\theta,M)p(\theta|M)}{p(M|Y)} \tag{3.118}$$

where Y is a set of observable data over a sample period,

M is the model,

θ is the a set of the model parameters,

$p(\theta|Y,M)$ is the posterior density function,

$p(\theta|M)$ is the prior density function,

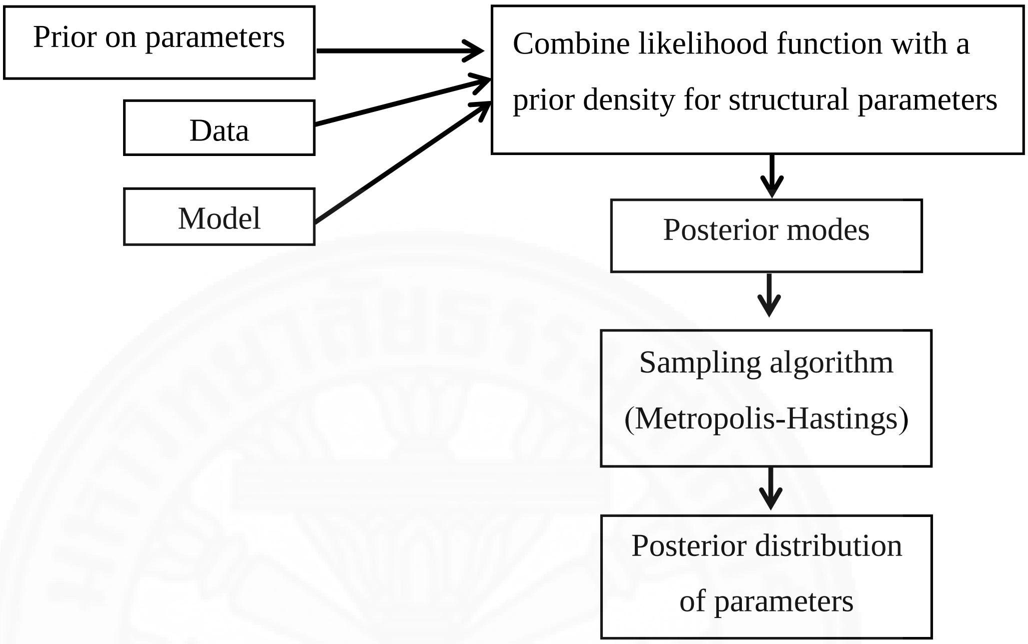
$p(M|Y)$ is the marginal data density function and

$L(Y|\theta,M)$ is the likelihood function.

Bayesian estimation is based on the assumption that both data and parameters are random variables. Basically, we combine the information on the set of parameters with the data by using a prior distribution ($p(\theta|M)$). Also, we scale the combination of the prior *($p(\theta|M)$)* by marginal data density *($p(Y|M)$)* and maximize the likelihood function *($L(Y|\theta,M)$)* to get the posterior density function *($p(\theta|Y,M)$)*. Finally, we apply this posterior density function to Markov-Chain-Monte-Carlo method in order to get θ and the posterior distribution of parameters. Typically, Bayesian estimation method is used with a DSGE-type model. Bayesian estimation can solve the limitation of both calibration and maximum likelihood methods because the prior avoids the posterior distribution peaking at weird points in the likelihood peaks. In other words, the prior helps explicitly identifying parameters in the case of the flat likelihood function which generates invalid results in the case of using the maximum likelihood estimation. We summarize the process of Bayesian estimation in Figure 3.1.

Figure 3.1

Bayesian Estimation Process



Source: Pongsaparn (2008)

3.2.3.2 Choice of the Prior Distribution

The merit of Bayesian inference allows us to specify the characteristics of parameters before estimation. The study uses the observed data to update the prior distribution to be the posterior distribution of the parameter by applying Bayes theorem. The prior distributions of the 47 parameters are specified by adopting the findings of Cooley and Hansen (1995), Chari et al. (2002), Altig et al. (2003), Linde et al. (2003), Smets et al. (2003) and Adolfson et al. (2007).

The prior mean of parameters under beta distribution are bounded between 0 and 1, including Calvo prices stickiness parameters, prices indexation parameters, habit formation parameter and all persistent parameters. The prior means of wages (ξ_w) and domestic (core) price (ξ_d) stickiness parameters are set to 0.675 and their prior standard deviations (S.D.) are set to 0.05. While the prior means of import (ξ_m) and export prices (ξ_x) stickiness parameters are set to 0.5, which are lower than the prior mean of domestic price because of the assumption of incomplete exchange rate pass-through.

The prior S.D. of import and export prices stickiness parameters are set to 0.1, which are twice as high as the stickiness parameters of domestic prices because of the assumption of exchange rate uncertainty. Following Chari et al. (2002), the prior means and S.D. of all indexation parameters (κ) are set to 0.5 and 0.15, respectively. The prior mean and S.D. of habit formation (b) are set to 0.65 and 0.1, respectively. Moreover, the prior means and S.D of all persistent parameters (ρ) in all shock processes are set to 0.85 and 0.1, respectively.

The prior mean of parameters under the inverse gamma distribution are set to be positive, including the markup prices parameters, the elasticities of substitution, risk premium parameters and the standard deviation of shock jumpers. The prior mean and S.D. of markup prices of domestic (λ_d), imported consumption goods ($\lambda_{m,c}$) and imported investment goods ($\lambda_{m,i}$) are set to 1.2 and 2, respectively. For monopolistic firms, their elasticities of substitution and markup prices are assumed to be gather than 1. The prior mean and S.D. of The elasticity of substitution between domestic and imported investment goods (η_i) and The elasticity of substitution among goods in the foreign economy (η_f) are set to 1.5 and 4, respectively. Following Linde et al. (2003), the prior mean of the risk premium parameter related to net foreign assets, $\tilde{\phi}$, is set to 0.01 and the prior S.D. of the size of the risk premium shock ($\sigma_{\tilde{\phi}}$) is set to 0.05. Moreover, the prior S.D of the standard deviations of all shock jumpers in all shock process are set to 2. Following Altig et al. (2003), the prior mean of the standard deviation in a monetary policy shock (σ_R) is set to 0.15. The prior means of S.D. in a unit root technology shock (σ_z), an investment specific technology shock (σ_γ) a consumption preference shock (σ_{ξ_c}) and a labour supply shock (σ_{ξ_h}) are equally set to 0.2. The prior means of the standard deviation in all markup price shocks are equally set to 0.3. Following the statistic finding from Smet and Wouters (2003), the prior means of the standard deviation in an asymmetric technology shock ($\sigma_{\tilde{z}^*}$) is set to 0.4, which obtain from the residuals of a first-order auto-regression of the series generated by the different value between the HP-trend in domestic output and foreign output. The prior means of the standard deviation in a stationary technology shock (σ_ε) is set to 0.7.

The parameters under the normal distribution include investment adjustment cost, technology growth and all monetary policy response parameters. The prior mean and S.D. of investment adjustment cost parameter ($\tilde{S}^*$) is set to 7.694 and 1.5, respectively. We assume that the steady state quarterly gross growth rate (μ_z) is 1.006, which implies its prior mean. Note that because the steady state quarterly gross growth rate is calculated from GDP data, it is a component between productivity growth and population growth. Also the prior S.D. of technology growth is set to 0.0005. The prior mean of the inflation response coefficient (r_π), the output gap response coefficient (r_y) and the real exchange rate response (r_x) are set to 1.7, 1.25 and 0, respectively. The prior S.D. of the inflation coefficient (r_π), the output gap response coefficient (r_y) and the real exchange rate response (r_x) are set to 0.1, 0.05 and 0.05, respectively. Finally, we summarize all the prior distribution in Table 3.2

Table 3.2

Prior Specification

Parameter	Description	Distri-bution	S.D.	Mean
ξ_w	Calvo wages	Beta	0.050	0.675
ξ_d	Calvo domestic (core) prices	Beta	0.050	0.675
$\xi_{m,c}$	Calvo import consumption prices	Beta	0.100	0.500
$\xi_{m,i}$	Calvo import investment price	Beta	0.100	0.500
ξ_x	Calvo export prices	Beta	0.100	0.675
κ_w	Indexation wage	Beta	0.150	0.500
κ_d	Indexation domestic (core) price	Beta	0.150	0.500
$\kappa_{m,c}$	Indexation import consumption prices	Beta	0.150	0.500
$\kappa_{m,i}$	Indexation import investment price	Beta	0.150	0.500
κ_x	Indexation export prices	Beta	0.150	0.500
λ_d	Markup domestic (core) prices	Inverse gamma	2	1.200
$\lambda_{m,c}$	Markup import consumption prices	Inverse gamma	2	1.200

Table 3.2 (Continued)

Parameter	Description	Distri-bution	S.D.	Mean
$\lambda_{m,i}$	Markup import investment price	Inverse gamma	2	1.200
ξ^I	Investment adjustment cost	Normal	1.500	7.694
b	Habit formation	Beta	0.100	0.650
η_i	The elasticity of substitution between domestic and imported investment	Inverse gamma	4	1.500
η_f	The elasticity of substitution among goods in the foreign economy	Inverse gamma	4	1.500
μ_z	Technology growth rate	Normal	0.0005	1.006
τ_w	A labour pay-roll tax	Beta	0.050	0.120
τ_y	A labour-income tax	Beta	0.050	0.180
$\tilde{\phi}$	Risk premium	Beta	0.100	0.200
ρ_{μ_z}	Persistence of unit root technology shock	Beta	0.100	0.850
ρ_{ε}	Persistence of stationary technology shock	Beta	0.100	0.850
ρ_{Υ}	Persistence of investment specific technology shock	Beta	0.100	0.850
$\rho_{\tilde{z}^*}$	Persistence of asymmetric technology shock	Beta	0.100	0.850
ρ_{ξ_c}	Persistence of the consumption preferences shock	Beta	0.100	0.850
ρ_{ξ_h}	Persistence of the leisure preferences shock	Beta	0.100	0.850
$\rho_{\tilde{\phi}}$	Persistence of the risk premium shock	Beta	0.100	0.850
$\rho_{\lambda_{m,c}}$	Persistence of the markup in the imported consumption goods shock	Beta	0.100	0.850
$\rho_{\lambda_{m,i}}$	Persistence of the markup in the imported investment goods shock	Beta	0.100	0.850

Table 3.2 (Continued)

Parameter	Description	Distri-bution	S.D.	Mean
ρ_{λ_x}	Persistence of the markup in the export goods shock	Beta	0.100	0.850
σ_{μ_z}	Standard deviation the permanent technology shock	Inverse gamma	2	0.200
σ_{ε}	Standard deviation of the covariance stationary technology shock	Inverse gamma	2	0.700
σ_{Υ}	Standard deviation of the stationary investment-specific technology shock	Inverse gamma	2	0.200
σ_{ξ_c}	Standard deviation of the consumption preferences shock	Inverse gamma	2	0.200
σ_{ξ_h}	Standard deviation of the leisure preferences shock	Inverse gamma	2	0.200
$\sigma_{\tilde{\phi}}$	Persistence of the risk premium shock	Inverse gamma	2	0.050
σ_{λ_d}	Standard deviation of the markup in the domestic goods shock	Inverse gamma	2	0.300
$\sigma_{\lambda_{m,c}}$	Standard deviation of the markup in the imported consumption goods shock	Inverse gamma	2	0.300
$\sigma_{\lambda_{m,i}}$	Standard deviation of the markup in the imported investment goods shock	Inverse gamma	2	0.300
σ_{λ_x}	Standard deviation of the markup in the export goods shock	Inverse gamma	2	0.300
σ_R	Standard deviation for the monetary policy shock	Inverse gamma	2	0.150
$\sigma_{\tilde{z}^*}$	Standard deviation of the asymmetric technology shock	Inverse gamma	2	0.400

Table 3.2 (Continued)

Parameter	Description	Distri-bution	S.D.	Mean
ρ_R	Interest rate smoothing parameter	Beta	0.050	0.800
r_π	Inflation response	Normal	0.100	1.700
r_y	Output gap response	Normal	0.050	0.125
r_{RER}	Real exchange rate response	Normal	0.050	0.000

Source: Adopted from Cooley and Hansen (1995), Chari et al. (2002), Altig et al. (2003), Linde et al. (2003), Smets et al. (2003) and Adolfson et al. (2007)

3.2.4. Data Description

To estimate the model, this study use Thai quarterly data between 2001Q1 to 2015Q4, which is the period of implementing inflation targeting. We choose the set of fifteen observable variables, namely a real wage, consumption, investment, RER, the policy interest rate (RP1), working hours, GDP, exports, imports, a headline inflation rate, a core inflation rate, an investment deflator, a foreign output, a foreign inflation rate and a foreign interest rate. All data are seasonally adjusted by X-12-ARIMA method. The sources of data consist of National Economic and Social Development Board (NESDB), National Statistical Office (NSO), Bank of Thailand (BOT), Minister of Commerce (MOC), U.S. Bureau of Economic Analysis (BEA), and U.S. Federal Reserve System (FED). In addition, measurement issues are explained in appendix C. We summarize specification of the data and proxies in Table 3.3

Table 3.3

Specification of the Data and Proxies

Variable	Name	Proxy	Unit	Source
Y_t	Real GDP	Real gross domestic product (Reference year = 2002)	Millions of Baht	NESDB
C_t	Real consumption expenditure	Real private consumption expenditure (Reference year = 2002)	Millions of Baht	NESDB

Table 3.3 (Continued)

Variable	Name	Proxy	Unit	Source
I_t	Real investment	Total investment expenditure (Reference year = 2002)	Millions of Baht	NESDB
$\tilde{X}_t$	Real export	Exports of goods and services (Reference year = 2002)	Millions of Baht	NESDB
$\tilde{M}_t$	Real import	Imports of goods and services (Reference year = 2002)	Millions of Baht	NESDB
H_t	Hours worked	Average hours worked per week	Thousand hours	NSO
RER_t	Real exchange rate (RER)	RER= NER× $\frac{Thai\ headline\ CPI}{U.S.headline\ CPI}$	Bath per U.S. dollar	Author's Calcula-tion
R_t	Nominal interest rate	Policy rate: RP1 day	% per annum	BOT
W_t	Nominal wages	Average monthly wages	Bath	BOT
P_t^{Core}	Core CPI	Core CPI (Based year 2011=100)	Index	MOC
P_t^{HL}	Headline CPI	Headline CPI (Based year 2011=100)	Index	MOC
$P_t^{def,i}$	Investment deflator	$\frac{\text{Nonimal Investment}}{\text{Real Investment(reference year = 2002)}}$ x100	Index	Author's Calcula-tion
Y_t^*	Foreign GDP	Real GDP USA (reference year = 2009)	USD bn.	BEA
P_t^*	Foreign inflation	U.S. CPI (Based year 2010=100)	Index	BEA
R_t^*	Foreign interest rate	Policy rate Fed Funds rate	% per annum	FED

Source: Adopted from Adolfson et al. (2007)

3.2.5 Policy Modification

We modify the policy rules representing for CITR and HITR. To modify the policy rule under CITR, we estimate the model where BOT targets core inflation during the time periods from 2001Q1 to 2014Q4 to obtain the following policy rule:

$$\hat{R}_t = \rho_{R,C1}\hat{R}_{t-1} + \left(1 - \rho_{R,C1}\right)\left[r_{\pi,C1}\hat{\pi}_{t-1}^{Core} + r_{y,C1}\hat{y}_{t-1} + r_{RER,C1}\widehat{RER}_{t-1}\right] + \varepsilon_{R,t}. \quad \text{(C.1)}$$

The problem of modifying the policy rule under HITR is that the time periods of HITR have only 4 observations since BOT start implementing HITR on 6 January 2015. We then solve the problem by adopting these four approaches. The first approach is to modify the policy rule under HITR by using the same estimated parameter values as the policy rule (C.1) because we assume that BOT responds to all variables in Taylor rule under HITR with the same degree as under CITR. Therefore, we obtain the following policy rule:

$$\hat{R}_t = \rho_{R,C1}\hat{R}_{t-1} + \left(1 - \rho_{R,C1}\right)\left[r_{\pi,C1}\hat{\pi}_{t-1}^{HL} + r_{y,C1}\hat{y}_{t-1} + r_{RER,C1}\widehat{RER}_{t-1}\right] + \varepsilon_{R,t}. \quad \text{(H.1)}$$

The second approach is to estimate the policy rule under HITR during the time periods from 2001Q1 to 2015Q4 because we assume that BOT began implementing HITR since 2001Q1. Therefore, we obtain the following policy rule:

$$\hat{R}_t = \rho_{R,H2}\hat{R}_{t-1} + \left(1 - \rho_{R,H2}\right)\left[r_{\pi,H2}\hat{\pi}_{t-1}^{HL} + r_{y,H2}\hat{y}_{t-1} + r_{RER,H2}\widehat{RER}_{t-1}\right] + \varepsilon_{R,t}. \quad \text{(H.2)}$$

The third approach is to estimate the policy rule under HITR during the time periods from 2015Q1 to 2015Q4, which is the actual periods of the monetary policy under HITR. Because 4 observations probably provide inaccurate estimation results, we setup the new prior information of the Bayesian estimation by using the posterior information from the policy rule (C.1). This approach of modification can be interpreted that BOT implements the monetary under CITR from 2001Q1 to 2014Q4 and switch to implements the monetary under HITR from 2015Q1 to 2015Q4 as the same as the actual economy envelopment. Therefore, we obtain the following policy rule:

$$\hat{R}_t = \rho_{R,H3}\hat{R}_{t-1} + (1-\rho_{R,H3})\left[r_{\pi,H3}\hat{\pi}^{HL}_{t-1} + r_{y,H3}\hat{y}_{t-1} + r_{RER,H3}\widehat{RER}_{t-1}\right] + \varepsilon_{R,t}. \quad \text{(H.3)}$$

The fourth approach is to estimate the policy rule under HITR during the time periods from 2015Q1 to 2015Q4, which is the actual periods of the monetary policy under HITR. Because 4 observations probably provide inaccurate estimation results, we setup the new prior information of the Bayesian estimation. The fourth approach is similar to the third approach but we find the alternative way to setup the new prior information. We use the posterior information from the policy rule under HITR estimated with the time periods from 2001Q1 to 2014Q4 to be the alternative prior information for the fourth approach' s the modification. Therefore, we obtain the following policy rule:

$$\hat{R}_t = \rho_{R,H4}\hat{R}_{t-1} + (1-\rho_{R,H4})\left[r_{\pi,H4}\hat{\pi}^{HL}_{t-1} + r_{y,H4}\hat{y}_{t-1} + r_{RER,H4}\widehat{RER}_{t-1}\right] + \varepsilon_{R,t}. \quad \text{(H.4)}$$

To analyse the policy rules with and without RER response, we further modify the policy rules without RER as follows:

$$\hat{R}_t = \rho_{R,C1Nx}\hat{R}_{t-1} + (1-\rho_{R,C1Nx})\left[r_{\pi,C1Nx}\hat{\pi}^{Core}_{t-1} + r_{y,C1Nx}\hat{y}_{t-1}\right] + \varepsilon_{R,t}, \quad \text{(C.1.Nx)}$$

$$\hat{R}_t = \rho_{R,C1Nx}\hat{R}_{t-1} + (1-\rho_{R,C1Nx})\left[r_{\pi,C1Nx}\hat{\pi}^{HL}_{t-1} + r_{y,C1Nx}\hat{y}_{t-1}\right] + \varepsilon_{R,t}, \quad \text{(H.1.Nx)}$$

$$\hat{R}_t = \rho_{R,H2Nx}\hat{R}_{t-1} + (1-\rho_{R,H2Nx})\left[r_{\pi,H2Nx}\hat{\pi}^{HL}_{t-1} + r_{y,H2Nx}\hat{y}_{t-1}\right] + \varepsilon_{R,t}, \quad \text{(H.2.Nx)}$$

$$\hat{R}_t = \rho_{R,H3Nx}\hat{R}_{t-1} + (1-\rho_{R,H3Nx})\left[r_{\pi,H3Nx}\hat{\pi}^{HL}_{t-1} + r_{y,H3Nx}\hat{y}_{t-1}\right] + \varepsilon_{R,t}, \quad \text{(H.3.Nx)}$$

$$\hat{R}_t = \rho_{R,H4Nx}\hat{R}_{t-1} + (1-\rho_{R,H4Nx})\left[r_{\pi,H4Nx}\hat{\pi}^{HL}_{t-1} + r_{y,H4Nx}\hat{y}_{t-1}\right] + \varepsilon_{R,t}. \quad \text{(H.4.Nx)}$$

CHAPTER 4
ESTIMATION RESULTS AND MONETARY POLICY PERFORMANCE ANALYSIS

This chapter presents the estimation results and monetary policy performance analysis of both core inflation targeting regime (CITR) and headline inflation targeting regime (HITR). Section 4.1 presents estimated parameters of the model under CITR and HITR. Monetary policy performance analysis is discussed in Section 4.2.

4.1 Estimation Results

To estimate the remaining 47 parameters, this study employs the Bayesian inference which is a mix of calibration and maximum likelihood by specifying prior information and applying to the model with the data. Table 4.1 shows prior information and the posterior means of non- parameters in the policy rules (C.1), (H.1), (H.2), (C.1.Nx), (H.1.Nx) and (H.2.Nx). Table 4.2 shows prior information and the posterior means of policy parameters in the policy rules (C.1), (H.1), (H.2), (C.1.Nx), (H.1.Nx) and (H.2.Nx). Table 4.3 shows prior information and posterior means of non-policy parameters in the policy rules (H.3), (H.3.Nx), (H.4) and (H.4.Nx). Table 4.4, Table 4.5, Table 4.6 and Table 4.7 shows prior information and posterior means of policy parameters in the policy rules (H.3), (H.3.Nx), (H.4) and (H.4.Nx), respectively.

Table 4.1

Non-Policy Estimated Parameters in the Policy Rules (C.1), (H.1), (C.1.Nx), (H.1.Nx), (H.2) and (H.2.Nx)

Description	Para-meter	Prior Information			Posterior Mean			
		Distribution	S.D.	Mean	C.1 &H.1	C.1.Nx &H.1.Nx	H.2	H.2.Nx
Calvo wages stickiness	ξ_w	Beta	0.050	0.675	0.660	0.751	0.679	0.647
Calvo core prices stickiness	ξ_d	Beta	0.050	0.675	0.778	0.720	0.890	0.678
Calvo import consumption prices stickiness	$\xi_{m,c}$	Beta	0.100	0.500	0.472	0.310	0.498	0.434
Calvo import investment prices stickiness	$\xi_{m,i}$	Beta	0.100	0.500	0.202	0.164	0.187	0.466
Calvo export prices stickiness	ξ_x	Beta	0.100	0.675	0.526	0.354	0.487	0.492
Indexation wages	κ_w	Beta	0.150	0.500	0.366	0.516	0.775	0.551
Indexation core prices	κ_d	Beta	0.150	0.500	0.498	0.508	0.259	0.434
Indexation import consumption prices	$\kappa_{m,c}$	Beta	0.150	0.500	0.389	0.368	0.398	0.445
Indexation import investment prices	$\kappa_{m,i}$	Beta	0.150	0.500	0.257	0.245	0.835	0.555
Indexation export prices	κ_x	Beta	0.150	0.500	0.430	0.423	0.535	0.459
Markup core prices	λ_d	Inv.gamma	2	1.200	3.553	7.239	3.967	1.430
Markup import consumption prices	$\lambda_{m,c}$	Inv.gamma	2	1.200	1.320	1.195	1.442	0.755
Markup import investment prices	$\lambda_{m,i}$	Inv.gamma	2	1.200	1.402	1.672	3.520	1.792
Investment adjustment costs	ξ^I	Normal	1.500	7.694	0.506	0.181	1.951	7.347

Table 4.1 (Continued)

Description	Para-meter	Prior Information			Posterior Mean			
		Distribution	S.D.	Mean	C.1 &H.1	C.1.Nx &H.1.Nx	H.2	H.2.Nx
Habit formation	b	Beta	0.100	0.650	0.721	0.769	0.877	0.630
Elasticity of substitution investment	η_i	Inv.gamma	4	1.500	0.393	0.476	0.559	0.195
Elasticity of substitution foreign	η_f	Inv.gamma	4	1.500	2.874	1.535	3.032	1.772
Technology growth	μ_z	Normal	0.0005	1.006	1.011	1.011	1.011	1.011
A labour pay-roll tax	τ_w	Beta	0.050	0.120	0.236	0.124	0.214	0.140
A labour-income tax	τ_y	Beta	0.050	0.180	0.254	0.188	0.076	0.195
Risk premium	$\tilde{\phi}$	Beta	0.100	0.010	0.269	0.663	0.341	0.001
The persistence of a unit root technology shock	ρ_{μ_z}	Beta	0.100	0.850	0.365	0.360	0.156	0.786
The persistence of a stationary technology shock	ρ_{ε}	Beta	0.100	0.850	0.882	0.914	0.902	0.715
The persistence of an invest. specific tech. shock	ρ_{Υ}	Beta	0.100	0.850	0.787	0.825	0.657	0.951
The persistence of an asymmetric technology shock	ρ_{z^*}	Beta	0.100	0.850	0.998	0.987	0.992	0.809
The persistence of a consumption preference shock	ρ_{ξ_c}	Beta	0.100	0.850	0.698	0.889	0.569	0.781
The persistence of a leisure preference shock	ρ_{ξ_h}	Beta	0.100	0.850	0.962	0.968	0.928	0.876
The persistence of a risk premium shock	$\rho_{\tilde{\phi}}$	Beta	0.100	0.850	0.962	0.956	0.978	0.889
The persistence of an imported consumption shock	$\rho_{\lambda_{m,c}}$	Beta	0.100	0.850	0.912	0.989	0.505	0.880

Table 4.1 (Continued)

Description	Para-meter	Prior Information			Posterior Mean			
		Distribution	S.D.	Mean	C.1 &H.1	C.1.Nx &H.1.Nx	H.2	H.2.Nx
The persistence of an imported investment shock	$\rho_{\lambda_{m,i}}$	Beta	0.100	0.850	0.819	0.996	0.950	0.856
The persistence of an export markup shock	ρ_{λ_x}	Beta	0.100	0.850	0.941	0.970	0.938	0.760
S.D. of the unit root technology shock	σ_z	Inv.gamma	2	0.200	2.551	2.754	2.385	0.672
S.D. of the stationary technology shock	σ_ε	Inv.gamma	2	0.700	0.663	0.658	0.904	0.512
S.D. of the investment-specific technology shock	σ_Υ	Inv.gamma	2	0.200	13.659	3.467	23.538	1.928
S.D. of the asymmetric technology shock	$\sigma_{\tilde{z}^*}$	Inv.gamma	2	0.400	2.783	2.741	2.591	0.559
S.D. of the shock to consumption preferences	σ_{ξ_c}	Inv.gamma	2	0.200	13.236	9.070	13.698	1.378
S.D. of the shock to leisure preferences	σ_{ξ_h}	Inv.gamma	2	0.200	2.527	3.848	10.848	0.548
S.D. of the shock to risk premium	$\rho_{\tilde{\phi}}$	Inv.gamma	2	0.050	0.773	0.538	0.596	0.200
S.D. of the shock to the markup in the goods market	σ_{λ_d}	Inv.gamma	2	0.300	3.702	3.495	12.690	0.803
S.D. of the markup in imported consumption shock	$\sigma_{\lambda_{m,c}}$	Inv.gamma	2	0.300	8.227	2.677	5.516	2.355
S.D. of the markup in imported investment shock	$\sigma_{\lambda_{m,i}}$	Inv.gamma	2	0.300	9.674	10.641	14.960	1.276
S.D. of the markup in export goods shock	σ_{λ_x}	Inv.gamma	2	0.300	10.251	7.892	6.005	1.176
S.D. of the monetary policy shock	σ_R	Inv.gamma	2	0.150	0.092	0.080	0.089	0.080

Source: Author's estimation based on Bayesian Inference

Table 4.2

Policy Estimated Parameters in the Policy Rules (C.1), (H.1), (C.1.Nx), (H.1.Nx), (H.2) and (H.2.Nx)

Description	Parameter	Prior Information			Posterior Mean			
		Distribution	S.D.	Mean	C.1 &H.1	C.1.Nx &H.1.Nx	H.2	H.2.Nx
Interest rate smoothing	ρ_R	Beta	0.050	0.800	0.890	0.901	0.901	0.835
Inflation response	r_π	Normal	0.100	1.700	1.751	1.668	1.681	1.682
Output gap response	r_y	Normal	0.050	0.125	0.062	0.072	0.042	0.075
RER response	r_{RER}	Normal	0.050	0.000	-0.0026	-	0.0390	-

Source: Author’s estimation based on Bayesian Inference

Table 4.3

Non-Policy Estimated Parameters in the Policy Rules (H.3), (H.3.Nx), (H.4) and (H.4.Nx)

Description	Para-meter	Prior Information			Posterior Mean			
		Distribution	S.D.	Mean	H.3	H.3.Nx	H.4	H.4.Nx
Calvo wages stickiness	ξ_w	Beta	0.050	0.675	0.718	0.631	0.705	0.633
Calvo core prices stickiness	ξ_d	Beta	0.050	0.675	0.687	0.653	0.657	0.599
Calvo import consumption prices stickiness	$\xi_{m,c}$	Beta	0.100	0.500	0.708	0.581	0.647	0.498
Calvo import investment prices stickiness	$\xi_{m,i}$	Beta	0.100	0.500	0.473	0.297	0.455	0.343
Calvo export prices stickiness	ξ_x	Beta	0.100	0.675	0.611	0.629	0.551	0.588
Indexation wages	κ_w	Beta	0.150	0.500	0.715	0.338	0.271	0.072
Indexation core prices	κ_d	Beta	0.150	0.500	0.345	0.582	0.385	0.622
Indexation import consumption prices	$\kappa_{m,c}$	Beta	0.150	0.500	0.500	0.450	0.558	0.464
Indexation import investment prices	$\kappa_{m,i}$	Beta	0.150	0.500	0.545	0.462	0.592	0.465
Indexation export prices	κ_x	Beta	0.150	0.500	0.400	0.468	0.575	0.437
Markup core prices	λ_d	Inv.gamma	2	1.200	0.962	0.361	0.916	0.303
Markup import consumption prices	$\lambda_{m,c}$	Inv.gamma	2	1.200	0.777	0.768	0.784	0.806
Markup import investment prices	$\lambda_{m,i}$	Inv.gamma	2	1.200	1.850	2.980	2.109	6.559
Investment adjustment costs	ξ^I	Normal	1.500	7.694	9.709	5.359	7.162	9.048
Habit formation	b	Beta	0.100	0.650	0.748	0.808	0.737	0.622

Table 4.3 (Continued)

Description	Para-meter	Prior Information			Posterior Mean			
		Distribution	S.D.	Mean	H.3	H.3.Nx	H.4	H.4.Nx
Elasticity of substitution investment	η_i	Inv.gamma	4	1.500	0.529	1.460	0.545	1.238
Elasticity of substitution foreign	η_f	Inv.gamma	4	1.500	0.841	0.799	0.820	0.699
Technology growth	μ_z	Normal	0.0005	1.006	1.008	1.008	1.008	1.009
A labour pay-roll tax	τ_w	Beta	0.050	0.120	0.188	0.182	0.212	0.203
A labour-income tax	τ_y	Beta	0.050	0.180	0.147	0.174	0.178	0.158
Risk premium	$\tilde{\phi}$	Beta	0.100	0.010	0.024	0.015	0.017	0.066
The persistence of a unit root technology shock	ρ_{μ_z}	Beta	0.100	0.850	0.623	0.741	0.606	0.823
The persistence of a stationary technology shock	ρ_{ε}	Beta	0.100	0.850	0.925	0.922	0.791	0.973
The persistence of an invest. specific tech. shock	ρ_{Υ}	Beta	0.100	0.850	0.872	0.830	0.912	0.831
The persistence of an asymmetric technology shock	ρ_{z^*}	Beta	0.100	0.850	0.927	0.838	0.881	0.852
The persistence of a consumption preference shock	ρ_{ξ_c}	Beta	0.100	0.850	0.938	0.871	0.913	0.856
The persistence of a leisure preference shock	ρ_{ξ_h}	Beta	0.100	0.850	0.826	0.866	0.873	0.924
The persistence of a risk premium shock	$\rho_{\tilde{\phi}}$	Beta	0.100	0.850	0.746	0.880	0.928	0.774
The persistence of an imported consumption shock	$\rho_{\lambda_{m,c}}$	Beta	0.100	0.850	0.844	0.819	0.812	0.925
The persistence of an imported investment shock	$\rho_{\lambda_{m,i}}$	Beta	0.100	0.850	0.969	0.956	0.982	0.908

Table 4.3 (Continued)

Description	Para-meter	Prior Information			Posterior Mean			
		Distribution	S.D.	Mean	H.3	H.3.Nx	H.4	H.4.Nx
The persistence of an export markup shock	ρ_{λ_x}	Beta	0.100	0.850	0.891	0.679	0.861	0.841
S.D. of the unit root technology shock	σ_z	Inv.gamma	2	0.200	0.582	0.217	0.445	0.136
S.D. of the stationary technology shock	σ_ε	Inv.gamma	2	0.700	0.936	2.641	0.686	2.877
S.D. of the investment-specific technology shock	σ_Υ	Inv.gamma	2	0.200	14.061	6.193	10.604	0.182
S.D. of the asymmetric technology shock	$\sigma_{\tilde{z}^*}$	Inv.gamma	2	0.400	0.300	0.278	0.269	0.295
S.D. of the shock to consumption preferences	σ_{ξ_c}	Inv.gamma	2	0.200	0.290	0.184	0.162	0.216
S.D. of the shock to leisure preferences	σ_{ξ_h}	Inv.gamma	2	0.200	0.164	0.158	0.129	0.145
S.D. of the shock to risk premium	$\rho_{\tilde{\phi}}$	Inv.gamma	2	0.050	0.050	0.042	0.036	0.035
S.D. of the shock to the markup in the goods market	σ_{λ_d}	Inv.gamma	2	0.300	1.329	0.298	1.839	0.261
S.D. of the markup in imported consumption shock	$\sigma_{\lambda_{m,c}}$	Inv.gamma	2	0.300	1.495	1.432	2.447	2.458
S.D. of the markup in imported investment shock	$\sigma_{\lambda_{m,i}}$	Inv.gamma	2	0.300	14.712	10.642	14.043	11.904
S.D. of the markup in export goods shock	σ_{λ_x}	Inv.gamma	2	0.300	2.120	3.901	2.005	2.743
S.D. of the monetary policy shock	σ_R	Inv.gamma	2	0.150	0.095	0.100	0.086	0.096

Source: Author’s estimation based on Bayesian Inference

Table 4.4

Policy Estimated Parameters in the Policy Rules (H.3)

Description	Parameter	Prior Information			Posterior Mean
		Distribution	S.D.	Mean	H.3
Interest rate smoothing	ρ_R	Beta	0.009	0.890	0.926
Inflation response	r_π	Normal	0.012	1.751	1.740
Output gap response	r_y	Normal	0.005	0.062	-0.001
RER response	r_{RER}	Normal	0.005	-0.0026	0.0070

Source: Author's estimation based on Bayesian Inference

Table 4.5

Policy Estimated Parameters in the Policy Rules (H.3.Nx)

Description	Parameter	Prior Information			Posterior Mean
		Distribution	S.D.	Mean	H.3.Nx
Interest rate smoothing	ρ_R	Beta	0.001	0.901	0.911
Inflation response	r_π	Normal	0.010	1.668	1.537
Output gap response	r_y	Normal	0.006	0.0720	-0.0010
RER response	r_{RER}	-	-	-	-

Source: Author's estimation based on Bayesian Inference

Table 4.6

Policy Estimated Parameters in the Policy Rules (H.4)

Description	Parameter	Prior Information			Posterior Mean
		Distribution	S.D.	Mean	H.4
Interest rate smoothing	ρ_R	Beta	0.013	0.886	0.926
Inflation response	r_π	Normal	0.024	1.460	1.451
Output gap response	r_y	Normal	0.006	0.051	0.066
RER response	r_{RER}	Normal	0.005	0.0022	-0.0519

Source: Author's estimation based on Bayesian Inference

Table 4.7

Policy Estimated Parameters in the Policy Rules (H.4.Nx)

Description	Parameter	Prior Information			Posterior Mean
		Distribution	S.D.	Mean	H.4.Nx
Interest rate smoothing	ρ_R	Beta	0.023	0.791	0.780
Inflation response	r_π	Normal	0.017	1.693	1.653
Output gap response	r_y	Normal	0.008	0.1030	0.0000
RER response	r_{RER}	-	-	-	-

Source: Author's estimation based on Bayesian Inference

4.1.1 Policy Parameters Analysis

Table 4.1 shows the policy parameters under both CITR and HITR in the Policy rules (C.1), (H.1), (C.1.Nx), (H.1.Nx), (H.2) and (H.2.Nx). The values of the policy parameters relevant to theory and the finding from Lueangwilai K. (2011). Note that Lueangwilai K. (2011) examined whether BOT respond to the exchange rate and the term of trade or RER and estimates the Taylor rule by using Bayesian method with monthly data from June 2000 to June 2011. For the policy rule (C.1), interest rate smoothing parameter (ρ_R) is 0.89. Inflation response parameter (r_π) is 1.751 and greater than one implying the Taylor principle adopted by BOT. Taylor principle states that the central bank should raise the nominal interest rate by gather than one percent in response to one present increase in inflation in order to raise the real interest rate. In theory, r_π is greater than one, which implies that when inflation increase 1%, BOT will increase the nominal policy rate more than 1% to make the real inter rate increase and eventually the economy brings back to its steady state. Output gap response parameter (r_y) is 0.062, implying that when output gap increase or overgrowing economy, BOT will raise the nominal interest rate to increase cost of loan and to slow down an economic activity. RER response parameter (r_{RER}) is -0.0026, corresponding to theory. The theory mention that an increase in RER imply an increase in purchasing power of home country. As the result, there is expenditure switching to foreign country, import goods increase, export goods decrease, domestic outputs decrease and eventually inflation decrease.

For the policy rule (H.2), interest rate smoothing parameter (ρ_R) is 0.901. Inflation response parameter (r_π) is 1.661 and greater than one implying the Taylor principle adopted by BOT. Output gap response parameter (r_y) is 0.072. RER response parameter (r_{RER}) is 0.039, which contracts to theory. For the policy rule (C.1.Nx), interest rate smoothing parameter (ρ_R) is 0.901. Inflation response parameter (r_π) is 1.668 and greater than one implying the Taylor principle adopted by BOT. Output gap response parameter (r_y) is 0.072. RER response parameter (r_{RER}) is 0. For the policy rule (H.2.Nx), interest rate smoothing parameter (ρ_R) is 0.835. Inflation response parameter (r_π) is 1.682 and greater than one implying the Taylor principle adopted by

BOT. Output gap response parameter (r_y) is 0.075. RER response parameter (r_{RER}) is 0.

Table 4.4, Table 4.5, Table 4.6 and Table 4.7 shows the policy parameters under HITR in the Policy rules (H.3), (H.3.Nx), (H.4) and (H.4.Nx), respectively. For the policy rule (H.3), interest rate smoothing parameter (ρ_R) is 0.926. Inflation response parameter (r_π) is 1.740 and greater than one implying the Taylor principle adopted by BOT. Output gap response parameter (r_y) is -0.001, which contracts to the theory. RER response parameter (r_{RER}) is 0. For the policy rule (H.3.Nx), interest rate smoothing parameter (ρ_R) is 0.911. Inflation response parameter (r_π) is 1.537 and greater than one implying the Taylor principle adopted by BOT. Output gap response parameter (r_y) is -0.001. RER response parameter (r_{RER}) is 0. For the policy rule (H.4), interest rate smoothing parameter (ρ_R) is 0.926. Inflation response parameter (r_π) is 1.460 and greater than one implying the Taylor principle adopted by BOT. Output gap response parameter (r_y) is 0.051. RER response parameter (r_{RER}) is -0.0519. For the policy rule (H.4.Nx), interest rate smoothing parameter (ρ_R) is 0.780. Inflation response parameter (r_π) is 1.653 and greater than one implying the Taylor principle adopted by BOT. Output gap response parameter (r_y) is 0. RER response parameter (r_{RER}) is 0.

4.1.2 Analysis of Policy Parameters between CITR and HITR

This section analyses policy parameters between CITR and HITR by comparing the policy parameters in the policy rules (C.1) and (H.2). We find that the interest rate smoothing parameter (ρ_R) in (C.1), which is 0.89, is slightly less than in (H.2), which is 0.901. This result reflexes that BOT adjusts the policy rate slightly more under CITR than under HITR. Inflation response parameter (r_π) in (C.1), which is 1.751, is gather than in (H.2), which is 1.681. This result reflexing that BOT considers more on core inflation than headline inflation because the time periods of observation cover more the monetary policy under CITR than under HITR. Output gap response parameter (r_y) in (C.1), which is 0.062, is gather than in (H.2), which is 0.042. This result reflexes that BOT responds more on output gap change under CITR than under HITR because output gap has more strong positive relationship to core inflation through new Keynesian Phillips curve (NKPC) than headline inflation. The absolute value of r_{RER} in (C.1), which is |-0.0026|, is less than in (H.2), which is |0.039|. This reflexes that BOT responds less on RER shock under CITR than under HITR because RER has more strong effect to headline inflation through import prices than core inflation.

Next, we analyze policy parameters between CITR and HITR by comparing the policy parameters in the policy rules (C.1) and (H.3). We find that the interest rate smoothing parameter (ρ_R) in (C.1), which is 0.89, is slightly less than in (H.3), which is 0.926. This result reflexes that BOT adjusts the policy rate slightly more under CITR than under HITR. Inflation response parameter (r_π) in (C.1), which is 1.751, is gather than in (H.2), which is 1.740. This result reflexing that BOT considers more on core inflation than headline inflation because the time periods of observation cover more the monetary policy under CITR than under HITR. The absolute value of output gap response parameter (r_y) in (C.1), which is 0.062, is gather than in (H.2), which is |-0.001|. This result reflexes that BOT responds more on output gap change under CITR than under HITR because output gap has more strong positive relationship to core inflation through new Keynesian Phillips curve (NKPC) than headline inflation. The absolute value of r_{RER} in (C.1), which is |-0.0026|, is less than in (H.2), which is 0.0070. This reflexes that BOT responds less on RER shock under CITR than under HITR because RER has more strong effect to headline inflation through import prices than core inflation.

Next, we analyze policy parameters between CITR and HITR by comparing the policy parameters in the policy rules (C.1) and (H.4). We find that the interest rate smoothing parameter (ρ_R) in (C.1), which is 0.89, is less than in (H.4), which is 0.926. This result reflexes that BOT adjusts the policy rate slightly more under CITR than under HITR. Inflation response parameter (r_π) in (C.1), which is 1.751, is gather than in (H.2), which is 1.451. This result reflexing that BOT considers more on core inflation than headline inflation because the time periods of observation cover more the monetary policy under CITR than under HITR. Output gap response parameter (r_y) in (C.1), which is 0.062, is slightly less than in (H.2), which is 0.066. This result reflexes that BOT responds less on output gap change under CITR than under HITR. The absolute value of r_{RER} in (C.1), which is |-0.0026|, is less than in (H.2), which is |-

$0.0519|$. This reflexes that BOT responds less on RER shock under CITR than under HITR because RER has more strong effect to headline inflation through import prices than core inflation.

We robustly analyses policy parameters between CITR and HITR by comparing the policy parameters in the policy rules $(\mathrm{C.1.Nx})$ and $(\mathrm{H.2.Nx})$. We find that the interest rate smoothing parameter (ρ_R) in $(\mathrm{C.1.Nx})$, which is 0.901, is gather than in $(\mathrm{H.2.Nx})$, which is 0.835. This result reflexes that BOT adjusts the policy rate less under CITR than under HITR in the case of the monetary policy rule without RER response. Inflation response parameter (r_π) in (C.1.Nx), which is 1.668, is less than in (H.2.Nx), which is 1.682. This result reflexes that BOT considers less on core inflation than headline inflation in the case of the monetary policy rule without RER response. Output gap response parameter (r_y) in (C.1.Nx), which is 0.072, is slightly less than in (H.2.Nx), which is 0.075 in the case of the monetary policy rule without RER response.

Moreover, we compare the policy parameters in the policy rules $(\mathrm{C.1.Nx})$ and $(\mathrm{H.3.Nx})$. We find that the interest rate smoothing parameter (ρ_R) in $(\mathrm{C.1.Nx})$, which is 0.901, is less than in (H.3.Nx), which is 0.911. This result reflexes that BOT adjusts the policy rate more under CITR than under HITR in the case of the monetary policy rule without RER response. Inflation response parameter (r_π) in $(\mathrm{C.1.Nx})$, which is 1.668, is less than in (H.3.Nx), which is 1.537. This result reflexes that BOT considers more on core inflation than headline inflation in the case of the monetary policy rule without RER response. Output gap response parameter (r_y) in (C.1.Nx), which is 0.072, is gather than in $(\mathrm{H.3.Nx})$, which is -0.001 in the case of the monetary policy rule without RER response.

In addition, we compare the policy parameters in the policy rules (C.1.Nx) and $(\mathrm{H.4.Nx})$. We find that the interest rate smoothing parameter (ρ_R) in $(\mathrm{C.1.Nx})$, which is 0.901, is gather than in $(\mathrm{H.4.Nx})$, which is 0.780. This result reflexes that BOT adjusts the policy rate more under CITR than under HITR in the case of the monetary policy rule without RER response. Inflation response parameter (r_π) in (C.1.Nx), which is 1.668, is gather than in $(\mathrm{H.2.Nx})$, which is 1.653. This result reflexes that BOT considers gather on core inflation than headline inflation in the case of the monetary policy rule without RER response. Output gap response parameter (r_y) in $(\mathrm{C.1.Nx})$, which is 0.072, is gather than in (H.4.Nx), which is 0.000 in the case of the monetary policy rule without RER response.

4.1.3 Analysis of Policy Parameters under the Policy Rule with and without RER Response

This section analyses policy parameters in the policy rule with and without RER response under CITR by comparing the policy parameters in the policy rules (C.1) and (C.1.Nx). We find that the interest rate smoothing parameter (ρ_R) in (C.1), which is 0.89, is slightly less than in (C.1.Nx), which is 0.901. This result reflexes that BOT adjusts the policy rate slightly more under CITR than under HITR. Inflation response parameter (r_π) in (C.1), which is 1.751, is gather than in (C.1.Nx), which is 1.688. Output gap response parameter (r_y) in (C.1), which is 0.062, is less than in (C.1.Nx), which is 0.072.

We robustly analyses policy parameters in the policy rule with and without RER response under HITR by comparing the policy parameters in the policy rules (H.2) and (H.2.Nx). We find that the interest rate smoothing parameter (ρ_R) in (H.2), which is 0.901, is gather than in (H.2.Nx), which is 0.835. Inflation response parameter (r_π) in (H.2), which is 1.681, is less than in (H.2.Nx), which is 1.682. This result reflexes that BOT considers less on core inflation than headline inflation in the case of the monetary policy rule without RER response. Output gap response parameter (r_y) in (H.2.), which is 0.042, is less than in (H.2.Nx), which is 0.075 in the case of the monetary policy rule without RER response.

Moreover, we compare the policy parameters in the policy rules (H.3) and (H.3.Nx). We find that the interest rate smoothing parameter (ρ_R) in (H.3), which is 0.926, is gather than in (H.3.Nx), which is 0.911. Inflation response parameter (r_π) in (H.3), which is 1.740, is less than in (H.3.Nx), which is 1.537. The absolute values of output gap response parameter (r_y) in (H.3), which is |-0.001|, is equal the one in (H.3.Nx), which is |-0.001| in the case of the monetary policy rule without RER response.

In addition, we compare the policy parameters in the policy rules (H.4) and (H.4.Nx). We find that the interest rate smoothing parameter (ρ_R) in (H.4), which is 0.926, is less than in (H.4.Nx), which is 0.780. Inflation response parameter (r_π) in (H.4), which is 1.451, is less than in (H.4.Nx), which is 1.653. Output gap response parameter (r_y) in (H.4), which is 0.066, is gather than in (H.4.Nx), which is 0.000 in the case of the monetary policy rule without RER response.

4.2 Monetary Policy Performance Analysis

This section discusses the methods to analyze the performance of the monetary policy under both CITR and HITR by comparing the WFLs proposed by Adolfson (2001). WFLs are conducted from the volatility in the inflation targets and the output gap for the 200-period simulated series. Notably, we simulated the inflation targets and the output gap for the 200-period series by using the parameter values at the posterior means from the Bayesian estimation. Section 4.2 consists of the following subsections. Section 4.2.1 discusses analysis of the monetary policy performance under CITR and HITR. Section 4.2.2 discusses analysis of RER response. Section 4.2.3 presents analysis of the MPT. Section 4.2.4 presents sensitivity analysis of the degree of ERPT. Sensitivity analysis of the policy parameters is discussed in Section 4.2.5.

4.2.1 Analysis of the Monetary Policy Performance under CITR and HITR

As presented in Table 4.8, we analyze the monetary policy performance under CITR and HITR in the policy rules with RER response by comparing the WFLs of the policy rule (C.1) with those of policy rules (H.1), (H.2), (H.3), and (H.4). Table 4.8 shows that the WFL in a function of core inflation ($\mathrm{WFL}^{\mathrm{C}}$) of (C.1) is 25.497, which is higher than 22.612, 20.242, 23.814, and 12.882 of (H.1), (H.2), (H.3), and (H.4), respectively. Similarly, the WFL in a function of headline inflation ($\mathrm{WFL}^{\mathrm{H}}$) of (C.1) is 25.563, which is higher than 22.682, 20.529, 24.661, and 13.757 of (H.1), (H.2), (H.3), and (H.4), respectively. The above results show that considering $\mathrm{WFL}^{\mathrm{C}}$ and $\mathrm{WFL}^{\mathrm{H}}$ provides the same interpretation. In other words, the WFLs do not differ in terms of the type of inflation.

Furthermore, Table 4.8 shows that the variance of output gap $\hat{y}_t$ of (C.1) is 50.203, which is higher than 44.490, 40.457, 46.139, and 21.939 of (H.1), (H.2), (H.3), and (H.4), respectively. Hence, $\hat{y}_t$ plays an important role in determining WFLs, as well as the result of interpretation. In summary, the monetary policy under CITR generates higher WFLs than that under HITR because the one under HITR generates a lower $\hat{y}_t$ in the policy rules with RER response. Hence, the monetary policy under HITR better stabilizes the fluctuation in output gap than that under CITR in the policy rules with RER response.

As shown in Table 4.9, we analyze the monetary policy performance under CITR and HITR in the policy rules without RER response by comparing the WFLs of the policy rule (C.1.Nx) with those of policy rules (H.1.Nx), (H.2.Nx), (H.3.Nx), and (H.4.Nx). Table 4.9 shows that the WFL in a function of core inflation ($\mathrm{WFL}^{\mathrm{C}}$) of (C.1.Nx) is 53.438, which is higher than 22.612, 10.588, 27.335, and 38.019 of (H.1.Nx), (H.2.Nx), (H.3.Nx), and (H.4.Nx), respectively. Similarly, the WFL in a function of headline inflation ($\mathrm{WFL}^{\mathrm{H}}$) of (C.1.Nx) is 53.594, which is higher than 51.845, 11.212, 27.343, and 37.946 of (H.1.Nx), (H.2.Nx), (H.3.Nx), and (H.4.Nx), respectively. The above results show that considering $\mathrm{WFL}^{\mathrm{C}}$ and $\mathrm{WFL}^{\mathrm{H}}$ provides the same interpretation. In other words, the WFLs do not differ in terms of the type of inflation.

Furthermore, Table 4.9 shows that the $\hat{y}_t$ of (C.1.Nx) is 105.179, which is higher than 101.695, 20.242, 8.046, and 74.678 of (H.1.Nx), (H.2.Nx), (H.3.Nx), and (H.4.Nx), respectively. This result indicates that $\hat{y}_t$ plays an important role in determining WFLs and in result interpretation. In summary, the monetary policy under CITR generates higher WFLs than that under HITR because the latter generates a lower $\hat{y}_t$ in the policy rules without RER response. Hence, the monetary policy under HITR better stabilizes the fluctuation in output gap than that under CITR in the policy rules without RER response. Consequently, the monetary policy under CITR generates higher WFLs than that under HITR in both groups of the policy rules with and without RER response because the latter generates a lower $\hat{y}_t$. In other words, the monetary policy under HITR better stabilizes the fluctuation in output gap than that under CITR.

Table 4.8

Welfare Losses of the Monetary Policy under CITR and HITR in the Policy Rules with RER Response

The Rules	Estimated Policy Parameters				Variances					WFLs	
	ρ_R	r_π	r_y	r_{RER}	$\hat{R}_t$	$\hat{\pi}_t^{Core}$	$\hat{\pi}_t^{HL}$	$\hat{y}_t$	$\widehat{RER}_t$	WFL^{C}	WFL^{H}
C.1	0.890	1.751	0.062	-0.0026	0.361	0.378	0.462	50.203	58.387	25.497	25.563
H.1	0.890	1.751	0.062	-0.0026	0.413	0.367	0.437	44.490	57.720	22.612	22.682
H.2	0.901	1.681	0.042	0.0390	0.418	0.195	0.301	40.457	123.234	20.424	20.529
H.3	0.926	1.740	-0.001	0.0070	0.468	0.746	1.592	46.139	48.309	23.814	24.661
H.4	0.926	1.451	0.066	-0.0519	2.514	1.912	2.787	21.939	34.195	12.882	13.757

Source: Author's Calculation

Note: 1) Variance of each variable is calculated from the 200-period simulated series.

2) WFL^{C} = Var($\hat{\pi}_t^{Core}$) + 0.5Var($\hat{y}_t$) and WFL^{H} = Var($\hat{\pi}_t^{HL}$) + 0.5Var($\hat{y}_t$)

Table 4.9

Welfare Losses of the Monetary Policy under CITR and HITR in the Policy Rules without RER Response

The Rules	Estimated Policy Parameters				Variances					WFLs	
	ρ_R	r_π	r_y	r_{RER}	$\hat{R}_t$	$\hat{\pi}_t^{Core}$	$\hat{\pi}_t^{HL}$	$\hat{y}_t$	$\widehat{RER}_t$	WFL^{C}	WFL^{H}
C.1.Nx	0.901	1.669	0.072	-	0.467	0.849	1.005	105.179	93.560	53.438	53.594
H.1.Nx	0.901	1.669	0.072	-	0.520	0.888	0.998	101.695	97.069	51.735	51.845
H.2.Nx	0.835	1.682	0.075	-	0.778	0.467	1.091	20.242	21.440	10.588	11.212
H.3.Nx	0.911	1.537	-0.001	-	0.219	0.829	0.842	53.013	17.297	27.336	27.349
H.4.Nx	0.780	1.653	0.000	-	0.438	0.680	0.607	74.678	41.418	38.019	37.946

Source: Author’s Calculation

Note: 1) Variance of each variable is calculated from the 200-period simulated series.

2) WFL^{C} = Var($\hat{\pi}_t^{Core}$) + 0.5Var($\hat{y}_t$) and WFL^{H} = Var($\hat{\pi}_t^{HL}$) + 0.5Var($\hat{y}_t$)

4.2.2 Analysis of the Monetary Policy Performance with and without RER Response

This section analyzes the monetary policy performance with and without RER response by comparing the WFLs of (C.1) with (C.1.Nx), (H.1) with (H.1.Nx), (H.2) with (H.2.Nx), (H.3) with (H.3.Nx), and (H.4) with (H.4.Nx). Table 4.10 shows that the WFL in a function of core inflation (WFL^C) of (C.1) is 25.497, which is lower than 53.438 of (C.1.Nx). The WFL^C of (H.1) is 22.612, which is lower than 51.735 of (H.1.Nx). The WFL^C of (H.2) is 20.424, which is higher than 10.588 of (H.2.Nx). The WFL^C of (H.3) is 23.814, which is lower than 27.335 of (H.3.Nx). The WFL^C of (H.4) is 12.882, which is lower than the 38.019 of (H.4.Nx). Similarly, the WFL in a function of headline inflation (WFL^H) of (C.1) is 25.563, which is lower than 53.594 of (C.1.Nx). The WFL^H of (H.1) is 22.682, which is lower than 51.845 of (H.1.Nx). The WFL^H of (H.2) is 20.529, which is higher than 11.212 of (H.2.Nx). The WFL^H of (H.3) is 24.661, which is lower than 27.343 of (H.3.Nx). The WFL^H of (H.4) is 13.757, which is higher than 37.946 of (H.4.Nx). The above results show that considering WFL^C and WFL^H provides the same interpretation.

Therefore, the WFLs do not differ in terms of the type of inflation, as presented in Section 4.2.1. Furthermore, Table 4.10 shows that the $\hat{y}_t$ of (C.1) is 50.203, which is lower than 105.179 of (C.1.Nx). The $\hat{y}_t$ of (H.1) is 44.490, which is lower than 101.695 of (H.1.Nx). The $\hat{y}_t$ of (H.2) is 44.490, which is higher than 20.242 of (H.2.Nx). The $\hat{y}_t$ of (H.3) is 46.139, which is lower than 53.013 of (H.3.Nx). The $\hat{y}_t$ of (H.4) is 21.939, which is lower than 104.424 of (H.4.Nx). Hence, $\hat{y}_t$ plays an important role in determining WFLs and in result interpretation. Therefore, no consensus exists whether the monetary policy with or without RER response can improve the welfare because the results show an unclear sign of RER response.

Table 4.10

Welfare Losses of the Monetary Policy with and without RER Response

The Rules	Estimated Policy Parameters				Variances					WFLs	
	ρ_R	r_π	r_y	r_{RER}	$\hat{R}_t$	$\hat{\pi}_t^{Core}$	$\hat{\pi}_t^{HL}$	$\hat{y}_t$	$\widehat{RER}_t$	WFL^C	WFL^H
C.1	0.890	1.751	0.062	-0.0026	0.361	0.378	0.462	50.203	58.387	25.497	25.563
C.1.Nx	0.901	1.669	0.072	-	0.467	0.849	1.005	105.179	93.560	53.438	53.594
H.1	0.890	1.751	0.062	-0.0026	0.413	0.367	0.437	44.490	57.720	22.612	22.682
H.1.Nx	0.901	1.669	0.072	-	0.520	0.888	0.998	101.695	97.069	51.735	51.845
H.2	0.901	1.681	0.042	0.0390	0.418	0.195	0.301	40.457	123.234	20.424	20.529
H.2.Nx	0.835	1.682	0.075	-	0.778	0.467	1.091	20.242	21.440	10.588	11.212
H.3	0.926	1.740	-0.001	0.0070	0.468	0.746	1.592	46.139	48.309	23.814	24.661
H.3.Nx	0.911	1.537	-0.001	-	0.219	0.829	0.842	53.013	17.297	27.336	27.349
H.4	0.926	1.451	0.066	-0.0519	2.514	1.912	2.787	21.939	34.195	12.882	13.757
H.4.Nx	0.780	1.653	0.000	-	0.438	0.680	0.607	74.678	41.418	38.019	37.946

Source: Author's Calculation

Note: 1) Variance of each variable is calculated from the 200-period simulated series.

2) $WFL^C = Var(\hat{\pi}_t^{Core}) + 0.5Var(\hat{y}_t)$ and $WFL^H = Var(\hat{\pi}_t^{HL}) + 0.5Var(\hat{y}_t)$.

4.2.3 Analysis of Monetary Policy Transmission

This section analyzes the MPT under CITR and HITR in the policy rules with and without RER response by considering the impulse response functions (IRFs) shown in Figure 4.1. Note that this section cannot analyze each channel separately. In detail, we analyze the effect of MPT by considering the maximum and minimum points and analyze the persistence of MPT by considering the moving back period, in which the effects of the policy rate shock ($\varepsilon_{R,t}$) disappear. Figure 4.1.a shows the response of the policy rate ($\hat{R}_t$) to $\varepsilon_{R,t}$ in (C.1), (H.1), (H.2), (H.3), and (H.4). IRFs show that when $\varepsilon_{R,t}$ increases, $\hat{R}_t$ increases with the same effect at the maximum point around 0.3 percentage of deviation from the steady state. We can rank the persistence of MPT from high to low as (H.2), (C.1), (H.1), (H.4), and (H.3). In general, the effects of $\varepsilon_{R,t}$ to $\hat{R}_t$ in the monetary policies under CITR and HITR with RER response are similar. However, the persistence of $\varepsilon_{R,t}$ to $\hat{R}_t$ in the monetary policy under HITR with RER response is higher than in that under CITR with RER response. In addition, Figure 4.1.b shows the response of $\hat{R}_t$ to $\varepsilon_{R,t}$ in (C.1.Nx), (H.1.Nx), (H.2.Nx), (H.3.Nx), and (H.4.Nx). IRFs show that when $\varepsilon_{R,t}$ increases, $\hat{R}_t$ increases with the same effect at the maximum point around 0.3 percentage of deviation from the steady state. We can rank the persistence of MPT from high to low as (C.1.Nx), (H.1.Nx), (H.2.Nx), (H.3.Nx), and (H.4.Nx). In general, the effects of $\varepsilon_{R,t}$ to $\hat{R}_t$ in the monetary policies under CITR and HITR without RER response are similar. However, the persistence of $\varepsilon_{R,t}$ to $\hat{R}_t$ in the monetary policies under HITR without RER response is higher than in those under CITR without RER response. Figure 4.1.c shows the response of $\hat{y}_t$ to $\varepsilon_{R,t}$ in (C.1), (H.1), (H.2), (H.3), and (H.4). IRFs show that when $\varepsilon_{R,t}$ increases, $\hat{y}_t$ decreases. We can rank the effects of MPT from high to low as (H.3), (H.4), (H.1), (C.1), and (H.2). We can also rank the persistence of MPT from high to low as (H.3), (H.4), (H.1), (C.1), and (H.2). In general, the effects of $\varepsilon_{R,t}$ to $\hat{y}_t$ in the monetary policies under HITR with RER response are stronger and more persistent than in those under CITR with RER response. In addition, Figure 4.1.d shows the response of $\hat{y}_t$ to $\varepsilon_{R,t}$ in (C.1.Nx), (H.1.Nx), (H.2.Nx), (H.3.Nx), and (H.4.Nx). IRFs show that when $\varepsilon_{R,t}$ increases, $\hat{y}_t$ decreases. We can rank the effects of MPT from high to low as (H.3.Nx), (C.1.Nx), (H.1.Nx), (H.2.Nx), and (H.4.Nx). We can also rank the persistence of MPT from high to low as (H.3.Nx), (C.1.Nx), (H.1.Nx), (H.2.Nx), and (H.4.Nx). In general, the effects of $\varepsilon_{R,t}$ to $\hat{y}_t$ in the monetary policies under CITR without RER response are stronger and more persistent than in those under HITR without RER response. Figure 4.1.e shows the response of core inflation ($\hat{\pi}_t^{Core}$) to $\varepsilon_{R,t}$ in (C.1), (H.1), (H.2), (H.3), and (H.4). IRFs show that when $\varepsilon_{R,t}$ increases, $\hat{\pi}_t^{Core}$ decreases. We can rank the effects of MPT from high to low as (H.3), (H.4), (H.1), (H.2), and (C.1), and their persistence is the same when their effects disappear around the 20th period. Totally, the effects of $\varepsilon_{R,t}$ to $\hat{\pi}_t^{Core}$ in the monetary policies under HITR with RER response are stronger than in those under CITR with RER response, but both regimes achieve the same persistence. In addition, Figure 4.1.f shows the response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{R,t}$ in (C.1.Nx), (H.1.Nx), (H.2.Nx), (H.3.Nx), and (H.4.Nx). IRFs show that when $\varepsilon_{R,t}$ increases, $\hat{\pi}_t^{Core}$ decreases. We can rank the effects of MPT from high to low as (H.3.Nx), (H.4.Nx), (H.1.Nx), (H.2.Nx), and (H.4.Nx), and their persistence is the same when their effects disappear around the 10th period. In general, the effects of $\varepsilon_{R,t}$ to $\hat{\pi}_t^{Core}$ in the monetary policies under HITR without RER response are stronger than in those under CITR without RER response, but both regimes achieve the same persistence. Figure 4.1.g shows the response of headline inflation ($\hat{\pi}_t^{HL}$) to $\varepsilon_{R,t}$ in (C.1), (H.1), (H.2), (H.3), and (H.4). IRFs show that when $\varepsilon_{R,t}$ increases, $\hat{\pi}_t^{HL}$ decreases. We can rank the effects of MPT from high to low as (H.3), (H.4), (H.1), (H.2), and (C.1), and their persistence is the same when their effects disappear around the fifth period. In general, the effects of $\varepsilon_{R,t}$ to $\hat{\pi}_t^{HL}$in the monetary policies under HITR with RER response are stronger than in those under CITR with RER response, but both regimes achieve the same persistence. In addition, Figure 4.1.h shows the response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{R,t}$ in (C.1.Nx), (H.1.Nx), (H.2.Nx), (H.3.Nx), and (H.4.Nx). IRFs show that when $\varepsilon_{R,t}$ increases, $\hat{\pi}_t^{HL}$ decreases. We can rank the effects of MPT from high to low as (H.3.Nx), (H.4.Nx), (H.1.Nx), (H.2.Nx), and (H.4.Nx), and their persistence is the same when their effects disappear around the fifth period. In general, the effects of $\varepsilon_{R,t}$ to $\hat{\pi}_t^{HL}$ in the monetary policies under HITR without RER response are stronger than in those under CITR without RER response, but both regimes achieve the same persistence. Figure 4.1.i shows the response of $\widehat{RER}_t$ to $\varepsilon_{R,t}$ in (C.1), (H.1), (H.2), (H.3), and (H.4). IRFs show that when

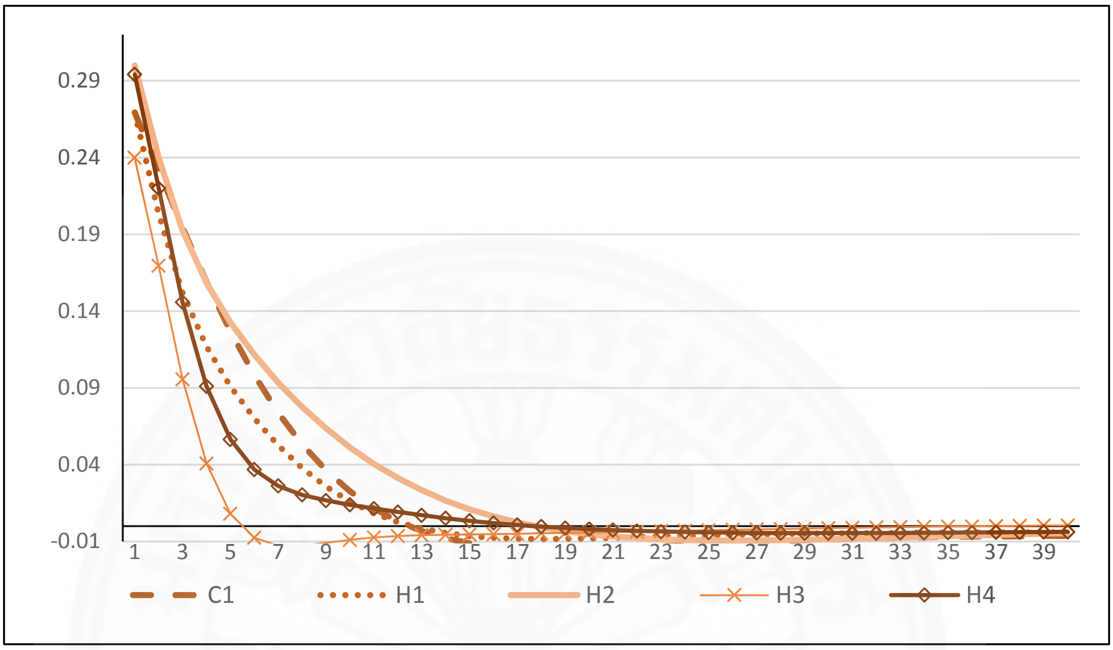
$\varepsilon_{R,t}$ increases, $\widehat{RER}_t$ decreases. We can rank the effects of MPT from high to low as (H.3), (H.4), (H.2), (H.1), and (C.1), and their persistence is the same when their effects disappear around the 15th period. In general, the effects of $\varepsilon_{R,t}$ to $\widehat{RER}_t$ in the monetary policies under HITR with RER response are stronger and more persistent than in those under CITR with RER response. In addition, Figure 4.1.j shows the response of $\widehat{RER}_t$ to $\varepsilon_{R,t}$ in (C.1.Nx), (H.1.Nx), (H.2.Nx), (H.3.Nx), and (H.4.Nx). IRFs show that when $\varepsilon_{R,t}$ increases, $\widehat{RER}_t$ decreases. We can rank the effects of MPT from high to low as (H.3.Nx), (H.2.Nx), (H.1.Nx), (C.1.Nx), and (H.4.Nx). The persistence of MPT in (C.1.Nx) and (H.1.Nx) is the same when their effects disappear around the 15th period. However, the persistence of MPT in (H.2.Nx), (H.3.Nx), and (H.4.Nx) is the same when their effects disappear around the fifth period. In general, the effects of $\varepsilon_{R,t}$ to $\widehat{RER}_t$ in the monetary policies under HITR without RER response are stronger than in those under CITR without RER response. However, no clear finding exists about the persistence of monetary policy under CITR and HITR.

In summary, the following five key messages are drawn from the analysis of MPT. First, the MPT under HITR exerts more effects on $\hat{y}_t$, $\hat{\pi}_t^{Core}$, $\hat{\pi}_t^{HL}$, and $\widehat{RER}_t$ than that under CITR because, in theory, the exchange rate channel of the MPT under HITR is more effective, given the direct effect of exchange rate via the prices of imported goods. Second, the persistence of the monetary policies under CITR and HITR is almost indifferent. Third, the MPT under the policy rules without RER response exerts more the effects on $\hat{y}_t$, $\hat{\pi}_t^{Core}$, and $\hat{\pi}_t^{HL}$ than the MPT under the policy rules with RER response. This imply that more flexible exchange rates correspond to more effects of MPT on $\hat{y}_t$, $\hat{\pi}_t^{Core}$, and $\hat{\pi}_t^{HL}$. Fourth, the MPT under the policy rules without RER response demonstrates less effect on $\widehat{RER}_t$ than the one with RER response. Finally, the MPT under the policy rules without RER response achieves less persistence than with RER response.

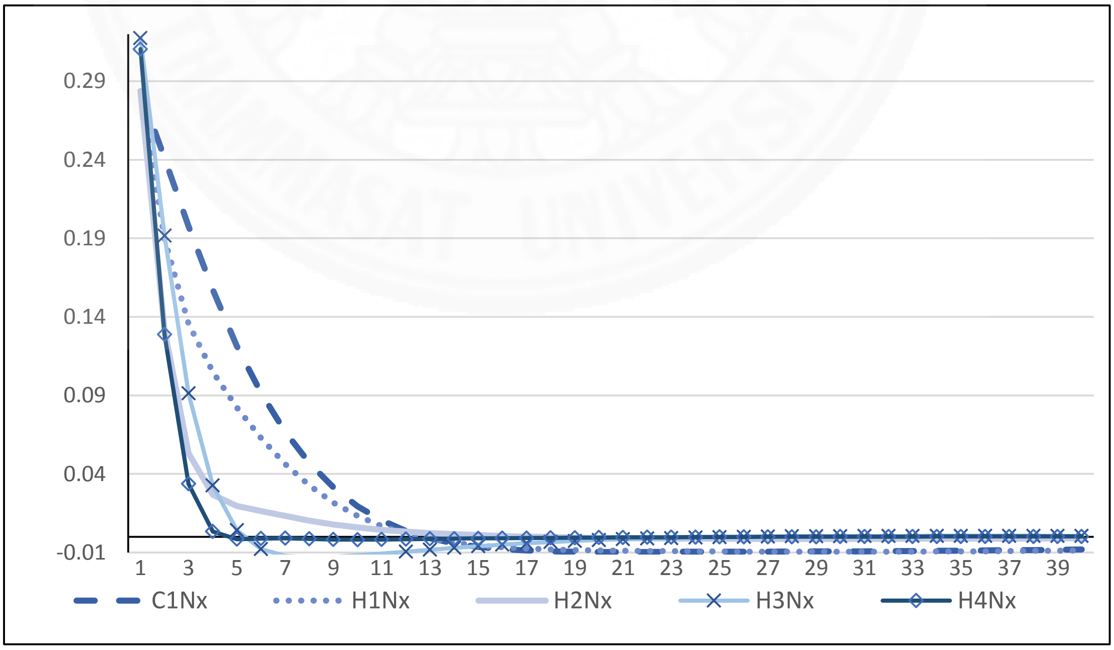
Figure 4.1

The Impulse Response of the Policy Rate Shock ($\varepsilon_{R,t}$)

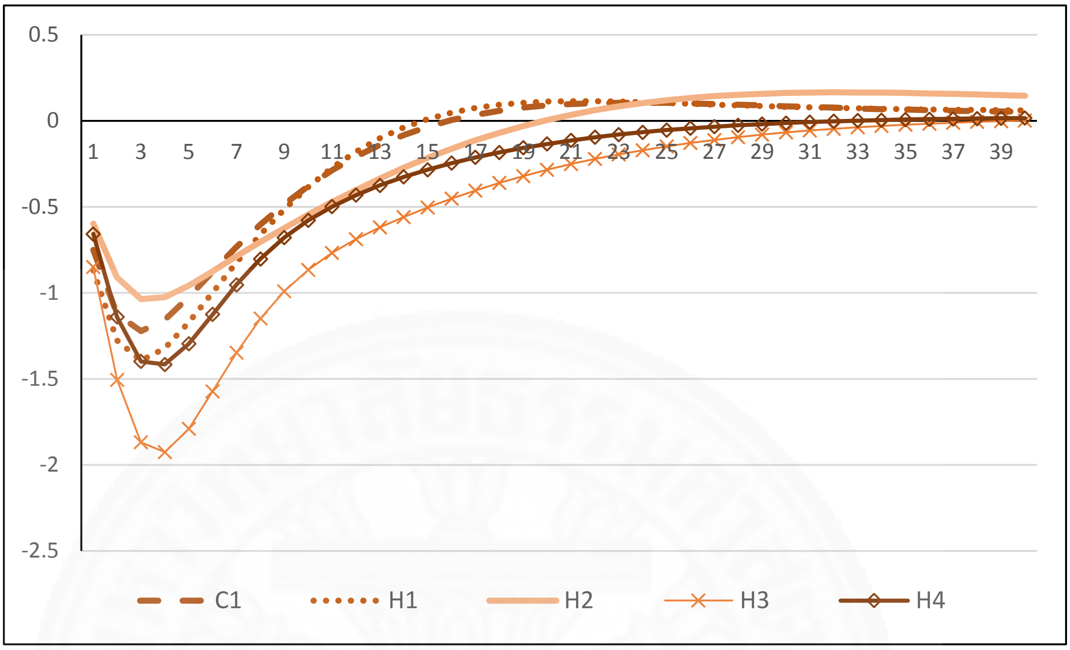
a) Response of $\hat{R}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



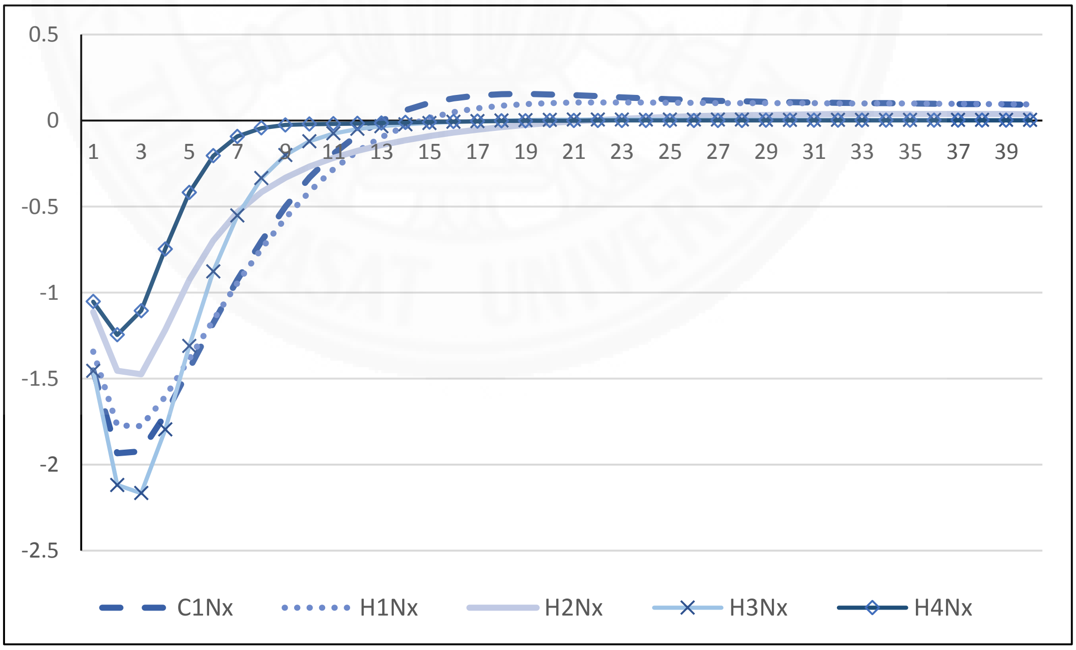
b) Response of $\hat{R}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



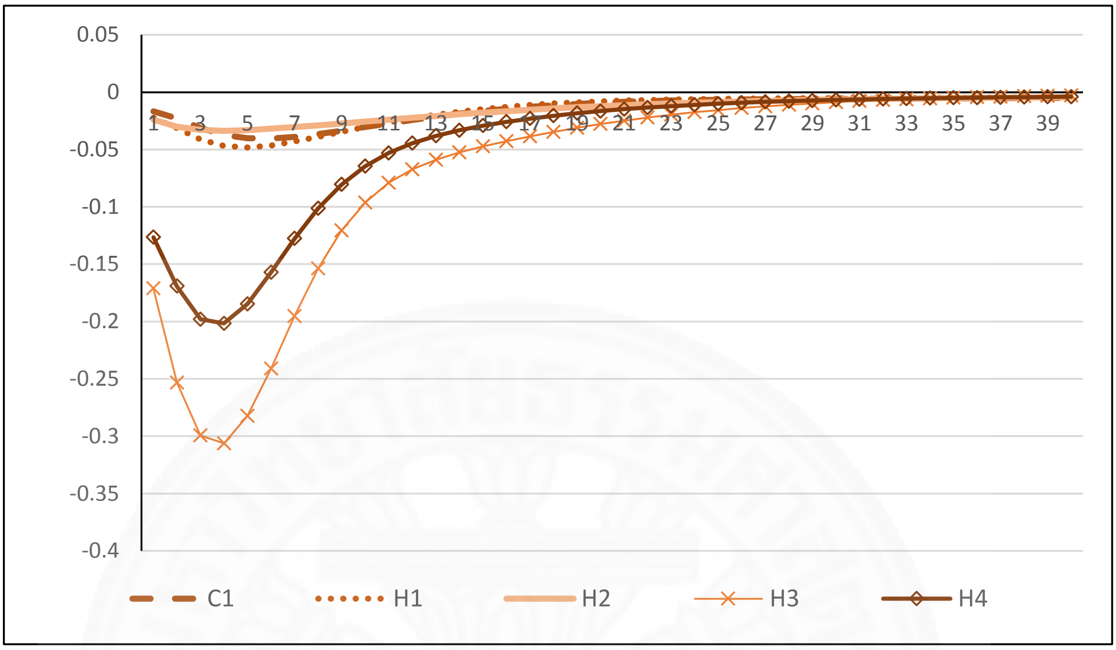
c) Response of $\hat{y}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



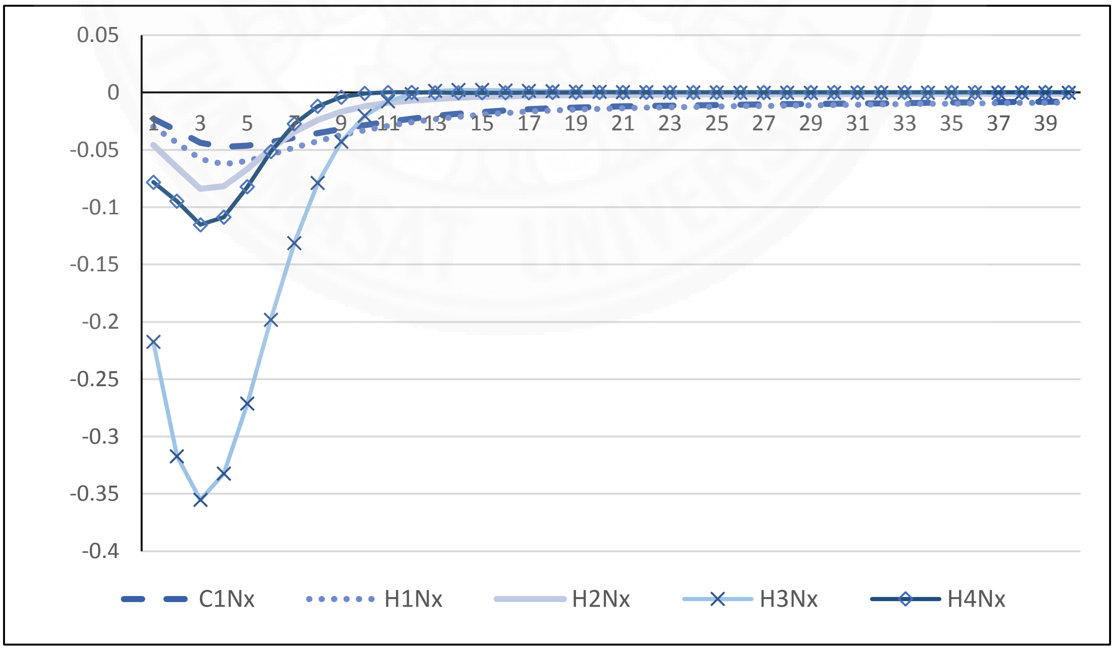
d) Response of $\hat{y}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



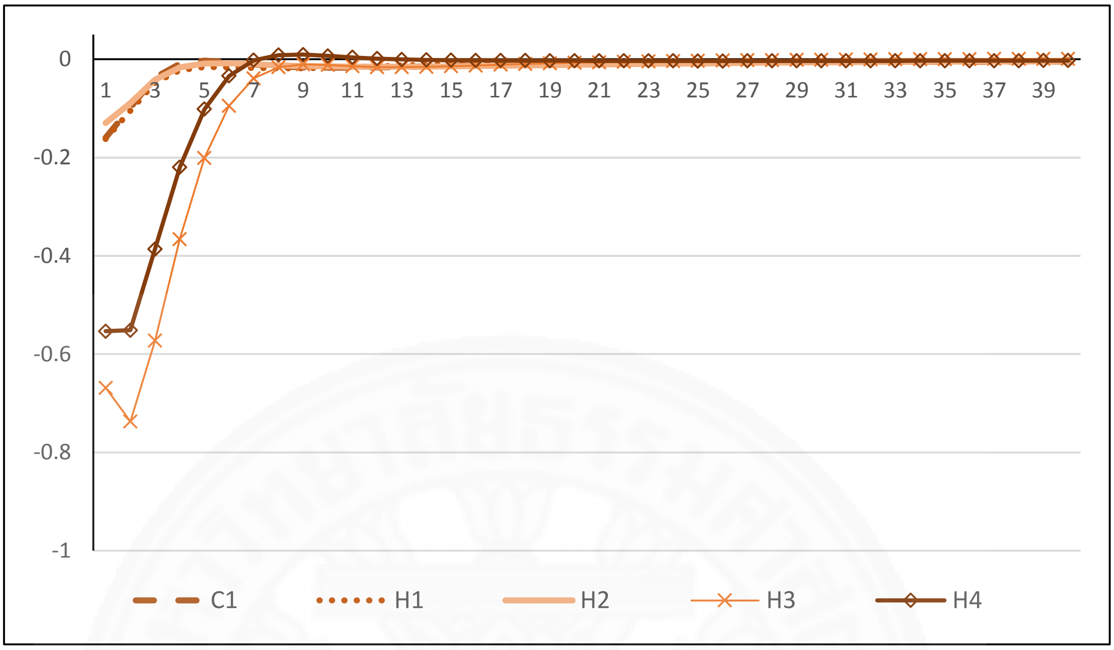
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{R,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



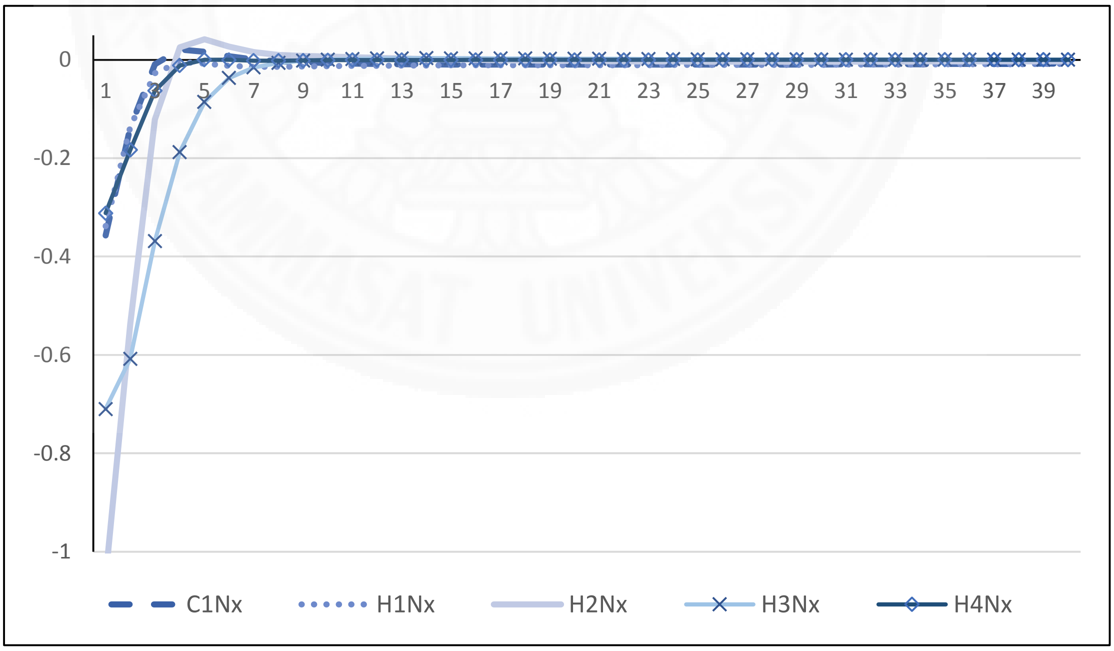
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{R,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



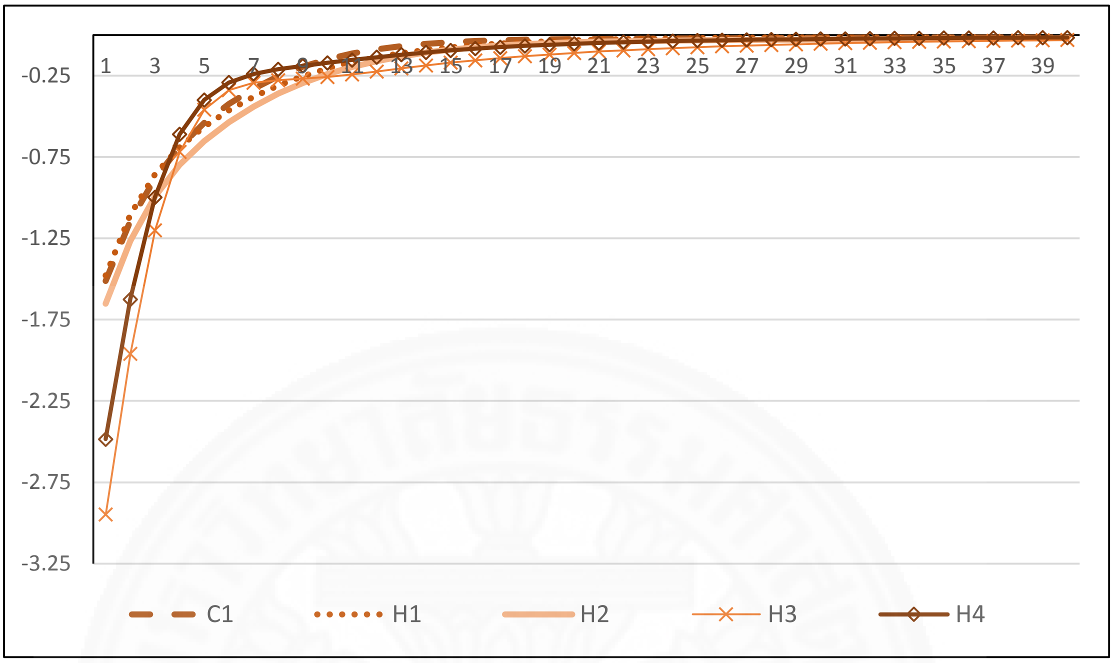
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{R,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



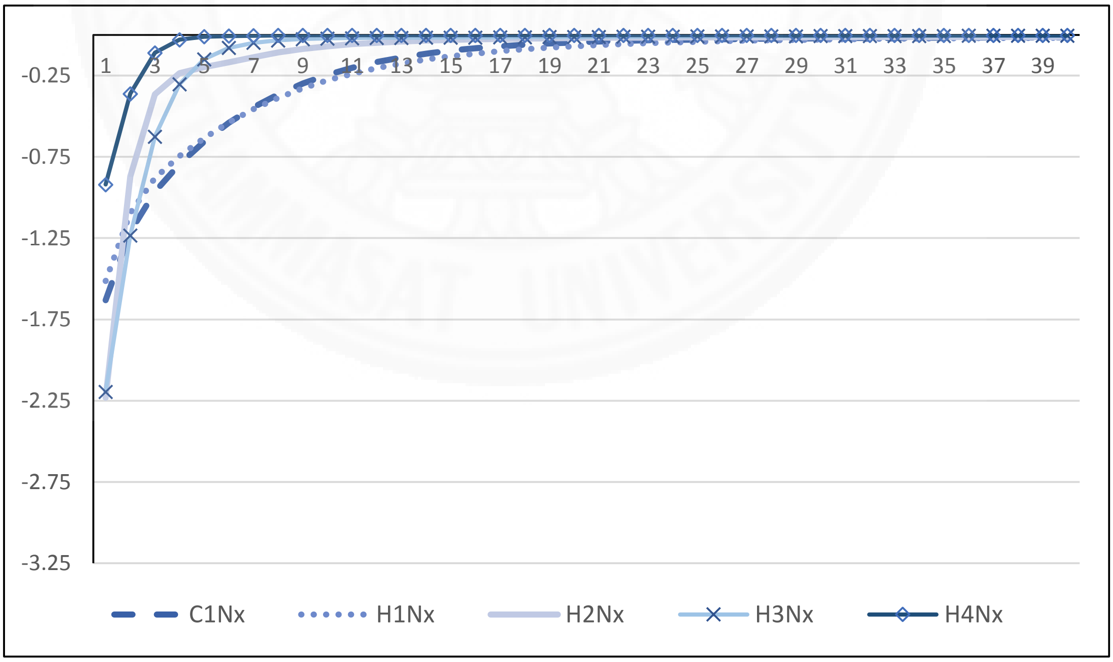
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{R,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{R,t}$in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



Source: Impulse Response Function based on Bayesian Inference

4.2.4 Sensitivity Analysis on the Degree of Exchange Rate Pass-Through

This section presents sensitivity analysis on the degree of Exchange Rate Pass-Through (ERPT) to WFLs under both CITR and HITR. The degree of ERPT refers to the degree at which a change in the prices of imported goods accords to a change in exchange rate. According to Adolfson (2001); Monacelli (2002); Smets and Wouters (2002) and Gali and Monacelli (2005), the degree of ERPT plays an important role in determining the degree of distortion in the prices of imported goods or the degree of price stickiness in these prices. Given that the prices of imported goods are the components in headline consumer prices, the optimal choice for IT can vary according to the different degrees of ERPT. In the present study, the degree of ERPT is measured by the degree of the price flexibility on imported consumption goods ($1-\xi_{m,c}$). We vary the degrees of ERPT as 0.001, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, as 0.999, and the results are listed in Tables 4.11, 4.12, and 4.13 For simplification, we use the results from those tables to draw Figures 4.2 and 4.3 As shown in Figure 4.2.a, the Y-axis is $\mathrm{WFL}^{\mathrm{C}}$, and the X-axis is the degree of ERPT. In Figure 4.2.b, the Y-axis is $\mathrm{WFL}^{\mathrm{H}}$, and the X-axis is the degree of ERPT. Figure 4.2 shows that the $\mathrm{WFL}^{\mathrm{C}}$ of (C.1) is lower than those of (H.1) and (H.2) when the degrees of ERPT are between 0.001 and 0.2. In addition, the $\mathrm{WFL}^{\mathrm{C}}$ of (C.1) is higher than those of (H.1) and (H.2) when the degrees of ERPT are between 0.2 and 0.999. Similarly, Figure 4.2.b shows that the $\mathrm{WFL}^{\mathrm{H}}$ of (C.1) is lower than those of (H.1) and (H.2) when the degrees of ERPT are between 0.001 and 0.2. The $\mathrm{WFL}^{\mathrm{H}}$ of (C.1) is higher than those of (H.1) and (H.2) when the degrees of ERPT are between 0.2 and 0.999. Figures 4.2.a and 4.2.b provide the same result.

According to Monacelli (2002), the theoretical supports imply that at low degrees of ERPT, the monetary policies under CITR present a low degree of PTF between stabilizing core inflation and output gap, whereas those under HITR exhibit the high degree of PTF between stabilizing headline inflation and output gap. Therefore, at low degrees of ERPT, the monetary policies under CITR can generate lower than those under HITR. At high degrees of ERPT, both the degrees of PTF in the monetary policies under CITR and HITR decrease, particularly in those under HITR. In detail, at high degrees of ERPT, the degree of PTF in the monetary policies under

CITR is higher than the degree of PTF in those under HITR. Therefore, at high degrees of ERPT, the monetary policies under CITR can generate higher than those under HITR. Basing from these findings, we can conclude that a higher degree of ERPT corresponds to a lower difference in the degree of PTF in the monetary policies under CITR and HITR. As shown in Figure 4.3, the Y-axis is the degree of PTF, and the X-axis is the degree of ERPT. Notably, for the monetary policies under CITR in (C.1), the degree of PTF refers to PTF^C. For the monetary policies under CITR in (H.1) and (H.2), the degree of PTF refers to PTF^H. Figure 4.3 shows that at low degrees of ERPT, the monetary policies under CITR present a lower degree of TPF than those under HITR. At high degrees of ERPT, the degree of PTF in the monetary policies under CITR is higher than that in the monetary policies under HITR.

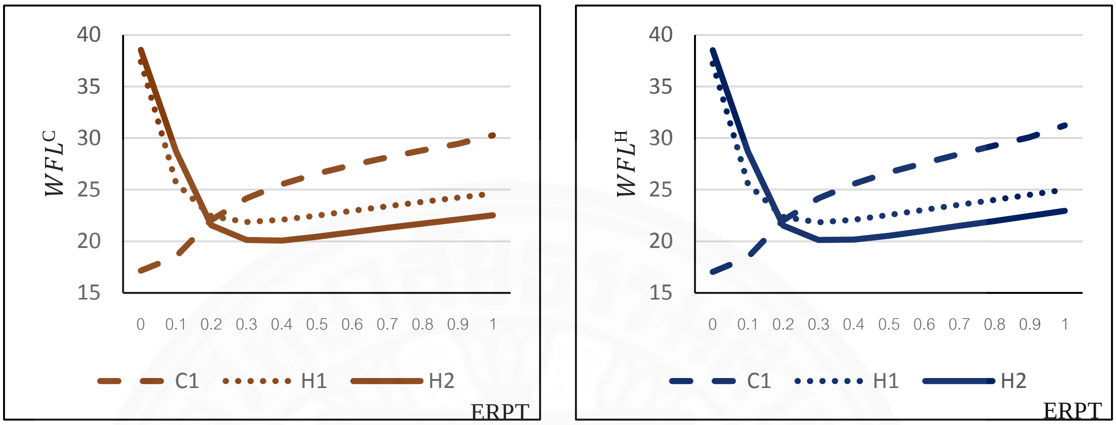
In summary, the degree of ERPT at 0.2 is the turning point in which WFLs in the monetary policies under CITR and HITR are different. At low degrees of ERPT within 0.001 to 0.2, the monetary policies under CITR generate lower WFLs relative to those under HITR. Therefore, at low degrees of ERPT, stabilizing core prices and ignoring the prices of imported goods are better strategies than stabilizing overall or headline prices. Considering that the prices of imported goods suffer less from exchange rate shocks, central banks should focus on stabilizing core prices. Conversely, at medium and high degrees of ERPT within 0.2 to 0.99, the monetary policies under CITR generate higher WFLs relative to those under HITR. Therefore, at medium and high degrees of ERPT, stabilizing core prices and ignoring the prices of imported goods are worse than stabilizing overall or headline prices. Given that the prices of imported goods suffer more from exchange rate shocks, central banks should consider the effect to such prices. In this model, the degrees of ERPT of Thailand from (C.1), (H.1), (H.3), (H.4), (C.1.Nx), (H.1.Nx), (H.2, (H.2.Nx), (H.3.Nx), and (H.4.Nx) are 0.528, 0.528, 0.292 ,0.353 ,0.690, 0.690, 0.502, 0.511, 0.412, and 0.515, respectively. Hence, the monetary policies under HITH are more appropriate than those under CITR.

Figure 4.2

Sensitivity Analysis on the Degree of ERPT

a) Sensitivity on the degree of ERPT to WFL^C

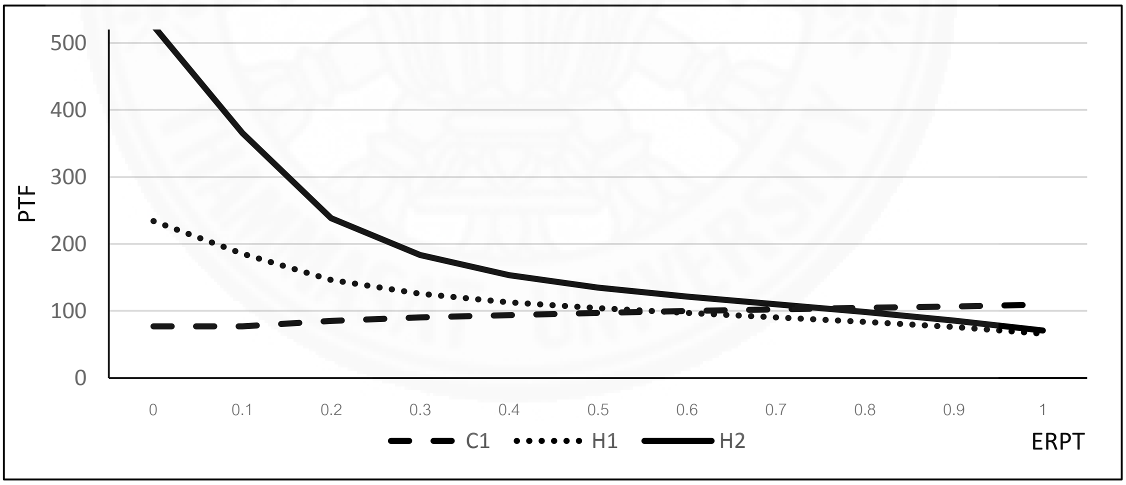
b) Sensitivity on the degree of ERPT to WFL^H



Source: The Results from Table 4.11, Table 4.12 and Table 4.13

Figure 4.3

The Relationship between the Degree of ERPT and the Degree of PTF



Source: The Results from Table 4.11, Table 4.12 and Table 4.13

Note: More explanations are shown in Appendix F.

Table 4.11

Sensitivity Analysis on the Degree of ERPT in the Policy Rule (C.1)

The Rule	ERPT	Variances					WFLs		PTFs	
	(1-$\xi_{m,c}$)	$\hat{R}_t$	$\hat{\pi}_t^{Core}$	$\hat{\pi}_t^{HL}$	$\hat{y}_t$	$\widehat{RER}_t$	WFL^C	WFL^H	PTF^C	PTF^H
C.1	0.001	0.481	0.434	0.316	33.438	68.856	17.152	17.034	77.046	105.816
	0.1	0.526	0.469	0.390	36.108	62.859	18.522	18.444	76.989	92.585
	0.2	0.574	0.507	0.474	43.073	57.463	22.044	22.010	84.957	90.871
	0.3	0.590	0.524	0.525	47.262	54.371	24.154	24.156	90.195	90.023
	0.4	0.597	0.532	0.577	49.979	52.134	25.521	25.566	93.945	86.619
	0.5	0.600	0.536	0.643	52.025	50.380	26.548	26.655	97.062	80.910
	0.6	0.601	0.538	0.730	53.711	48.957	27.394	27.586	99.835	73.577
	0.7	0.602	0.540	0.844	55.190	47.782	28.135	28.439	102.204	65.391
	0.8	0.603	0.541	0.993	56.568	46.801	28.825	29.277	104.562	56.967
	0.001	0.481	0.434	0.316	33.438	68.856	17.152	17.034	77.046	105.816
	0.1	0.526	0.469	0.390	36.108	62.859	18.522	18.444	76.989	92.585

Source: Author's Calculation

Note: 1) The Degree of ERPT is measured by the degree of the price flexibility on imported consumption goods (1- $\xi_{m,c}$).

2) DSGE cannot provide the result in the cases where the degree of ERPT (1- $\xi_{m,c}$) are 0 and 1 due to the rank condition.

3) Variance of each variable is calculated from the 200-period simulated series.

4) WFL^C = Var($\hat{\pi}_t^{Core}$) + 0.5Var($\hat{y}_t$) and WFL^H = Var($\hat{\pi}_t^{HL}$) + 0.5Var($\hat{y}_t$).

5) PTF^C =Var($\hat{y}_t$) / Var($\hat{\pi}_t^{Core}$) and PTF^H =Var($\hat{y}_t$) / Var($\hat{\pi}_t^{HL}$).

Table 4.12

Sensitivity Analysis on the Degree of ERPT in the Policy Rule (H.1)

The Rule	ERPT	Variances					WFLs		PTFs	
	(1-$\xi_{m,c}$)	$\hat{R}_t$	$\hat{\pi}_t^{Core}$	$\hat{\pi}_t^{HL}$	$\hat{y}_t$	$\widehat{RER}_t$	WFL^C	WFL^H	PTF^C	PTF^H
H.1	0.001	0.204	0.507	0.315	73.780	68.359	37.397	37.205	145.523	234.222
	0.1	0.301	0.366	0.273	50.587	85.978	25.660	25.567	138.216	185.300
	0.2	0.356	0.365	0.302	44.134	72.772	22.432	22.369	120.915	146.139
	0.3	0.384	0.365	0.342	43.012	65.520	21.871	21.848	117.841	125.766
	0.4	0.400	0.366	0.384	43.410	61.191	22.071	22.089	118.607	113.047
	0.5	0.411	0.366	0.425	44.236	58.344	22.484	22.543	120.863	104.085
	0.6	0.418	0.367	0.466	45.148	56.347	22.941	23.040	123.019	96.884
	0.7	0.423	0.368	0.508	46.042	54.881	23.389	23.529	125.114	90.634
	0.8	0.428	0.369	0.560	46.894	53.759	23.816	24.007	127.084	83.739
	0.001	0.204	0.507	0.315	73.780	68.359	37.397	37.205	145.523	234.222
	0.1	0.301	0.366	0.273	50.587	85.978	25.660	25.567	138.216	185.300

Source: Author's Calculation

Note: 1) The Degree of ERPT is measured by the degree of the price flexibility on imported consumption goods (1- $\xi_{m,c}$).

2) DSGE cannot provide the result in the cases where the degree of ERPT (1- $\xi_{m,c}$) are 0 and 1 due to the rank condition.

3) Variance of each variable is calculated from the 200-period simulated series.

4) $WFL^C = Var(\hat{\pi}_t^{Core}) + 0.5Var(\hat{y}_t)$ and $WFL^H = Var(\hat{\pi}_t^{HL}) + 0.5Var(\hat{y}_t)$.

5) $PTF^C = Var(\hat{y}_t) / Var(\hat{\pi}_t^{Core})$ and $PTF^H = Var(\hat{y}_t) / Var(\hat{\pi}_t^{HL})$.

Table 4.13

Sensitivity Analysis on the Degree of ERPT in the Policy Rule (H.2)

The Rule	ERPT	Variances					WFLs		PTFs	
	(1-$\xi_{m,c}$)	$\hat{R}_t$	$\hat{\pi}_t^{Core}$	$\hat{\pi}_t^{HL}$	$\hat{y}_t$	$\widehat{RER}_t$	WFL^{C}	WFL^{H}	PTF^{C}	PTF^{H}
	0.001	0.315	0.183	0.146	76.759	224.052	38.562	38.526	419.448	525.747
	0.1	0.368	0.190	0.156	57.058	194.440	28.719	28.685	300.305	365.756
	0.2	0.401	0.192	0.179	42.709	156.339	21.547	21.533	222.443	238.598
	0.3	0.412	0.193	0.217	39.838	138.728	20.112	20.135	206.415	183.585
	0.4	0.417	0.194	0.259	39.768	129.194	20.078	20.143	204.990	153.544
H.2	0.5	0.418	0.195	0.300	40.462	123.352	20.426	20.531	207.497	134.873
	0.6	0.419	0.196	0.340	41.337	119.471	20.865	21.009	210.903	121.579
	0.7	0.419	0.197	0.384	42.215	116.739	21.304	21.491	214.289	109.935
	0.8	0.420	0.197	0.437	43.051	114.720	21.723	21.963	218.533	98.515
	0.001	0.420	0.197	0.512	43.852	113.158	22.123	22.438	222.599	85.648
	0.1	0.421	0.198	0.629	44.640	111.893	22.518	22.949	225.455	70.970

Source: Author's Calculation

Note: 1) The Degree of ERPT is measured by the degree of the price flexibility on imported consumption goods (1- $\xi_{m,c}$).

2) DSGE cannot provide the result in the cases where the degree of ERPT (1- $\xi_{m,c}$) are 0 and 1 due to the rank condition.

3) Variance of each variable is calculated from the 200-period simulated series.

4) WFL^{C} = Var($\hat{\pi}_t^{Core}$) + 0.5Var($\hat{y}_t$) and WFL^{H} = Var($\hat{\pi}_t^{HL}$) + 0.5Var($\hat{y}_t$).

5) PTF^{C} =Var($\hat{y}_t$) / Var($\hat{\pi}_t^{Core}$) and PTF^{H} =Var($\hat{y}_t$) / Var($\hat{\pi}_t^{HL}$).

4.2.5 Sensitivity Analysis on the Policy Parameters

This section shows the sensitivity analysis on the policy parameters, which are inflation response parameter (r_π), output gap response parameter (r_y) and RER response parameter (r_{RER}), to the welfare losses (WFLs). We analyze changes in WFLs according to change in the policy parameters in the policy rule $(\mathrm{C.1})$, $(\mathrm{H.1})$ and $(\mathrm{H.2})$. We vary the value of the policy parameters as -20%, -10%, 10% and 20%, changes from their base cases and calculate WFLs in each policy rule. The results of sensitivity on the policy parameters in the policy rule (C.1), (H.1) and (H.2) are shown in Table 4.14, Table 4.15 and Table 4.16.

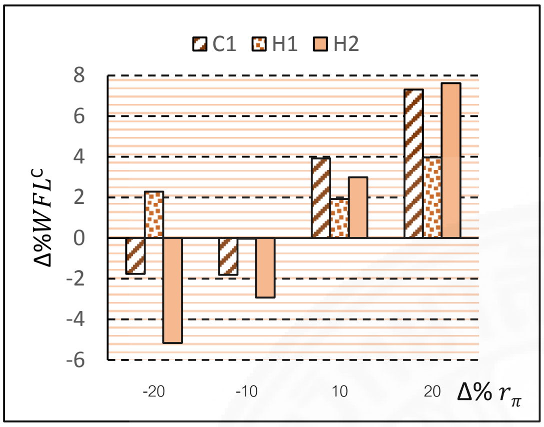
For simplification of analysis, we use the results from those tables to draw the Figure 4.4.a, Figure 4.4.b, Figure 4.4.c, Figure 4.4.d, Figure 4.4.e and Figure 4.4.f. Figure 4.4.a and Figure 4.4.b are the sensitivity analysis on r_π to WFL^{C} and WFL^{H}, respectively. Y-axis is the percentage change of WFLs from the base cases, X- axis is percentage change of r_π from the base cases. The results show that BOT can reduce WFLs by decreasing the degree of r_π in the policy rules (C.1) and (H.2), except (H.1). Particularly, the degree of sensitivity in the policy rule (H.2) is higher than the one in the policy rule (C.1). Figure 4.4.c and Figure 4.4.d are the sensitivity analysis on r_y to WFL^{C} and WFL^{H}, respectively. Y-axis is the percentage change of WFLs s from the base cases, X- axis is percentage change of r_y from the base cases. The results show that BOT can reduce WFLs by increasing the degree of r_y in the policy rules (C.1), (H.1) and (H.2). The degrees of sensitivity in all policy rules are the same. Figure 4.4.e and Figure 4.4.f are the sensitivity analysis on r_{RER} to WFL^{C} and WFL^{H}, respectively. Y-axis is the percentage change of WFLs from the base cases, X- axis is percentage change of r_{RER} from the base cases.

The results show that BOT can reduce WFLs by increasing the degree of r_x in the policy rules (H.2), except (C.1) and (H.1). In sum, BOT can improve WFLs by decreasing inflation response parameter (r_π) and increasing the degree of output gap response parameter (r_y). Increasing the degree of output gap response parameter (r_y) is the most effective way to improve WFLs comparing to the others. However, there is no suggestion for RER response parameter (r_{RER}) because the estimation result shows the unclear sign of RER response parameter (r_{RER}).

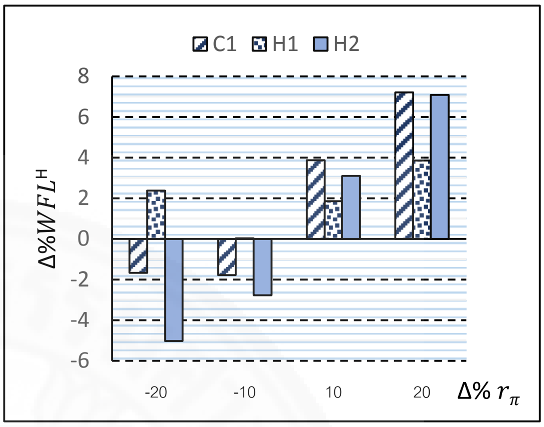
Figure 4.4

The Sensitivity Analysis on the Policy Parameters to WFLs (Percentage Change)

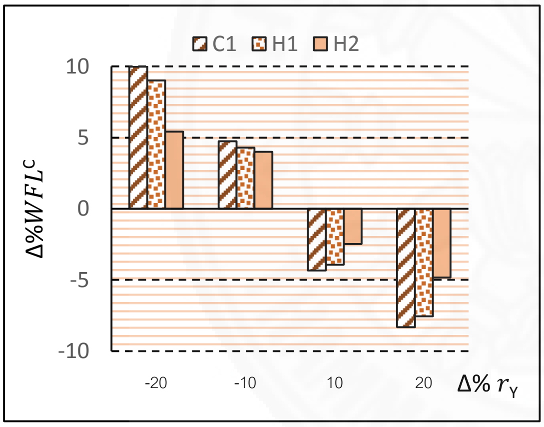
a) The sensitivity on r_π to WFL^C



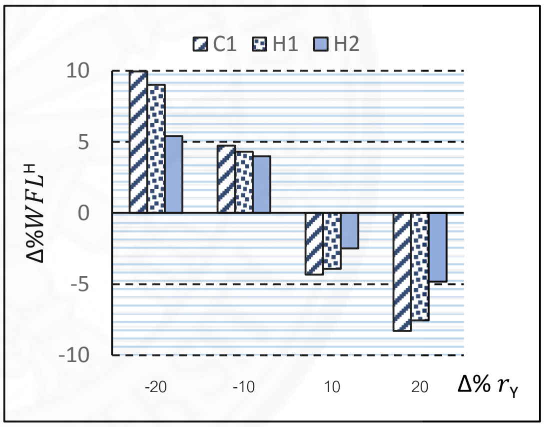
b) The sensitivity on r_π to WFL^H



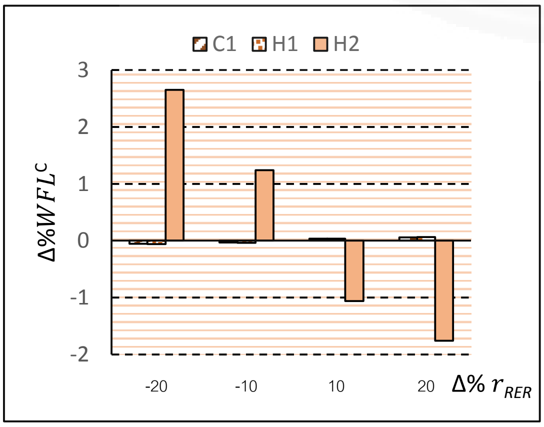
c) The sensitivity on r_y to WFL^C



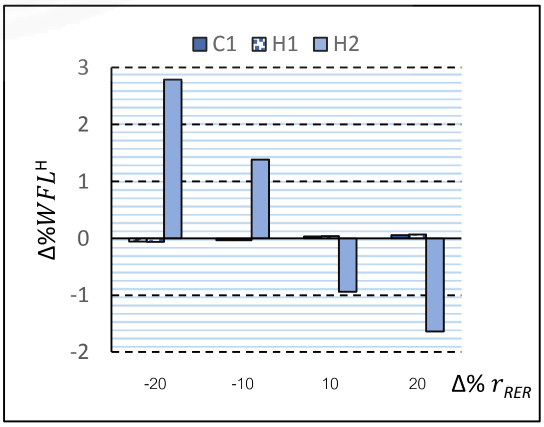
d) The sensitivity on r_y to WFL^H



e) The sensitivity on r_{RER} to WFL^C



f) The sensitivity on r_{RER} to WFL^H



Source: The Results from Table 4.14, Table 4.15 and Table 4.16

Table 4.14

Sensitivity Analysis on the Policy Parameters in the Policy Rule (C.1)

The Rule	Δ% Parameter	Parameters				WFL^C		WFL^H	
		ρ_R	r_π	r_y	r_x	Value	Δ%	Value	Δ%
C.1	Base	0.890	1.751	0.062	-0.0026	25.497	0.000%	25.563	0.000%
	-20% Δr_π	0.890	1.400	0.062	-0.0026	25.030	-1.765%	25.138	-1.667%
	-10% Δr_π	0.890	1.576	0.062	-0.0026	25.015	-1.821%	25.110	-1.773%
	10% Δr_π	0.890	1.961	0.062	-0.0026	26.479	3.924%	26.553	3.869%
	20% Δr_π	0.890	2.101	0.062	-0.0026	27.340	7.303%	27.408	7.213%
	-20% Δr_y	0.890	1.751	0.050	-0.0026	28.021	9.977%	28.109	9.956%
	-10% Δr_y	0.890	1.751	0.056	-0.0026	26.690	4.754%	26.776	4.744%
	10% Δr_y	0.890	1.751	0.068	-0.0026	24.373	-4.341%	24.456	-4.332%
	20% Δr_y	0.890	1.751	0.074	-0.0026	23.360	-8.318%	23.442	-8.300%
	-20% Δr_x	0.890	1.751	0.062	-0.0021	25.465	-0.055%	25.549	-0.056%
	-10% Δr_x	0.890	1.751	0.062	-0.0023	25.471	-0.033%	25.555	-0.034%
	10% Δr_x	0.890	1.751	0.062	-0.0029	25.488	0.034%	25.572	0.034%
	20% Δr_x	0.890	1.751	0.062	-0.0031	25.494	0.057%	25.578	0.057%

Source: Author's Calculation

Note: 1) Variance of each variable is calculated from the 200-period simulated series.

2) $\mathrm{WFL}^{\mathrm{C}} = \mathrm{Var}(\hat{\pi}_t^{Core}) + 0.5\mathrm{Var}(\hat{y}_t)$ and $\mathrm{WFL}^{\mathrm{H}} = \mathrm{Var}(\hat{\pi}_t^{HL}) + 0.5\mathrm{Var}(\hat{y}_t)$

Table 4.15

Sensitivity Analysis on the Policy Parameters in the Policy Rule (H.1)

The Rule	Δ% Parameter	Parameters				WFL^C		WFL^H	
		ρ_R	r_π	r_y	r_x	Value	Δ%	Value	Δ%
H.1	Base	0.890	1.751	0.062	-0.0026	22.612	0.000%	22.682	0.000%
	-20% Δr_π	0.890	1.400	0.062	-0.0026	23.126	2.275%	23.222	2.382%
	-10% Δr_π	0.890	1.576	0.062	-0.0026	22.605	-0.029%	22.687	0.024%
	10% Δr_π	0.890	1.961	0.062	-0.0026	23.045	1.917%	23.102	1.855%
	20% Δr_π	0.890	2.101	0.062	-0.0026	23.506	3.957%	23.556	3.856%
	-20% Δr_y	0.890	1.751	0.050	-0.0026	24.651	9.018%	24.724	9.004%
	-10% Δr_y	0.890	1.751	0.056	-0.0026	23.584	4.302%	23.656	4.295%
	10% Δr_y	0.890	1.751	0.068	-0.0026	21.721	-3.937%	21.790	-3.931%
	20% Δr_y	0.890	1.751	0.074	-0.0026	20.904	-7.551%	20.972	-7.539%
	-20% Δr_x	0.890	1.751	0.062	-0.0021	22.598	-0.062%	22.667	-0.062%
	-10% Δr_x	0.890	1.751	0.062	-0.0023	22.603	-0.037%	22.673	-0.038%
	10% Δr_x	0.890	1.751	0.062	-0.0029	22.620	0.038%	22.690	0.038%
	20% Δr_x	0.890	1.751	0.062	-0.0031	22.626	0.063%	22.696	0.064%

Source: Author's Calculation

Note: 1) Variance of each variable is calculated from the 200-period simulated series.

2) $\text{WFL}^{\text{C}} = \text{Var}(\hat{\pi}_t^{Core}) + 0.5\text{Var}(\hat{y}_t)$ and $\text{WFL}^{\text{H}} = \text{Var}(\hat{\pi}_t^{HL}) + 0.5\text{Var}(\hat{y}_t)$

Table 4.16

Sensitivity Analysis on the Policy Parameters in the Policy Rule (H.2)

The Rule	Δ% Parameter	Parameters				WFL^C		WFL^H	
		ρ_R	r_π	r_y	r_x	Value	Δ%	Value	Δ%
H.2	Base	0.901	1.681	0.042	0.039	20.424	0%	20.529	0%
	-20% Δr_π	0.901	1.345	0.042	0.039	19.379	-5.171%	19.483	-5.024%
	-10% Δr_π	0.901	1.512	0.042	0.039	19.837	-2.930%	19.428	-2.784%
	10% Δr_π	0.901	1.849	0.042	0.039	21.046	2.985%	21.150	3.103%
	20% Δr_π	0.901	2.017	0.042	0.039	21.992	7.618%	22.095	7.091%
	-20% Δr_y	0.901	1.681	0.034	0.039	21.533	5.431%	21.640	5.413%
	-10% Δr_y	0.901	1.681	0.038	0.039	21.243	4.012%	21.350	3.998%
	10% Δr_y	0.901	1.681	0.046	0.039	19.916	-2.485%	20.021	-2.477%
	20% Δr_y	0.901	1.681	0.050	0.039	19.437	-4.834%	19.540	-4.818%
	-20% Δr_x	0.901	1.681	0.042	0.031	20.977	2.650%	21.086	2.792%
	-10% Δr_x	0.901	1.681	0.042	0.035	20.689	1.239%	20.796	1.377%
	10% Δr_x	0.901	1.681	0.042	0.043	20.218	-1.064%	20.312	-0.935%
	20% Δr_x	0.901	1.681	0.042	0.046	20.075	-1.764%	20.177	-1.640%

Source: Author's Calculation

Note: 1) Variance of each variable is calculated from the 200-period simulated series.

2) $\text{WFL}^{\text{C}} = \text{Var}(\hat{\pi}_t^{Core}) + 0.5\text{Var}(\hat{y}_t)$ and $\text{WFL}^{\text{H}} = \text{Var}(\hat{\pi}_t^{HL}) + 0.5\text{Var}(\hat{y}_t)$

CHAPTER 5
CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Conclusions

This study mainly aims to analyze the performance of monetary policies under CITR and HITR, as well as to evaluate the importance of exchange rate response in the Taylor rule. This study uses a small open-economy DSGE model with incomplete ERPT, as proposed by Adolfson et al. (2007). We estimate all relevant parameters by Bayesian techniques. All of these variables involve the Thai quarterly data between 2001Q1 to 2015Q4, which is the period when IT is implemented by the BOT. In particular, we construct monetary policy rules under both CITR and HITR, and analyze them by adopting the WFLs proposed by Adolfson (2001).

The estimated policy parameters indicate that the Taylor principle holds under both CITR and HITR for Thailand. In analysis of the monetary policy performance under CITR and HITR, the key finding is that the monetary policy under CITR gives the higher WFLs than under HITR because of the higher volatility in the output gap. It can be implied that the monetary policy under HITR performs better than under CITR. Whereas, analysis of RER response shows no concrete conclusion whether the BOT can improve the welfare by adjusting the policy rate in response to RER movement.

Analysis of the MPT indicates that the effects of the MPT under HITR are higher than under CITR because the exchange rate channel of the MPT under HITR is more effective, given the direct effect of exchange rate because of the prices of imported goods. However, the persistence of MPT under CITR and HITR is almost indifferent. Furthermore, the MPT under the policy rules without RER response exerts more effects on the output gap, core inflation, and headline inflation than the one with RER response. This finding can be interpreted that the increased flexibility of exchange rate presents more effects of the MPT on output gap, core inflation, and headline inflation. Conversely, the MPT under the policy rules without RER response demonstrates less effect on RER than the one with RER response. Lastly, MPT under the policy rules without RER response display less persistence than the one with RER response.

Sensitivity analysis of the degree of ERPT indicates that the degree of ERPT plays an important role in determining the optimal choice of inflation target. The finding shows that, at the low degree of ERPT, the monetary policy under CITR generates lower WFLs than under HITR. It is because, at the low degree of ERPT, the monetary policy under CITR presents a low degree of PTF between stabilizing core inflation and output gap, whereas the one under HITR demonstrate the high degree of PTF between stabilizing headline inflation and output gap. Intuitively, at low degree of ERPT, the prices of imported goods suffer less from the foreign shocks; hence ignoring the movement of the prices of imported goods would be the optimal monetary policy.

Whereas, at the medium and high degrees of ERPT, WFLs of the monetary policy under CITR turn to be higher than under HITR because the higher degree of ERPT leads to the lower degree of PTF between stabilizing headline inflation and output gap. The logic is that, at the medium and high degrees of ERPT, the MPT under exchange rate channel of HITR is more effective, given the direct effect of exchange rate via the prices of imported goods. Empirically, these results support the fact that the monetary policy in Thailand under HITR perform better than under CITR because the degrees of ERPT in Thailand are in the medium level, shown in the results from Bayesian estimation. Lastly, sensitivity analysis of the policy parameters displays that WFLs can be minimized by a decrease in inflation response and an increase in output gap response. However, no clear suggestion exists on RER response because of unclear signs of RER response parameter in the Taylor rule.

5.2 Policy Implications

According to the previously mentioned results, the policy implications are drawn as follows:

1. The monetary policy under HITR in Thailand is the optimal monetary policy because it provides the better stabilization on the volatility in output gap. The degrees of ERPT in Thailand are in the medium level; thus, the one under HITR presents the

more effective exchange rate channel, which leads to the lower degree of PTF and eventually to the better stabilization on the volatility in output gap.

2. To improve the welfare, the BOT should less aggressively respond to core inflation in the policy rule (C.1) and less aggressively respond to headline inflation in the policy rule (H.2).

3. To improve the welfare, the BOT should more aggressively respond to output gap in the policy rules (C.1), (H.1), and (H.2).

5.3 Limitation of the Study

5.3.1 Limitation on the number of periods under HITR

The BOT has adopted HITR since January 6, 2015; thus, only four observations are related to HITR for this study. This study then uses many estimation strategies to obtain values of the estimated parameters as accurately as possible. In the future, enough observations will be provided for HITR to obtain more accurate values of the estimated parameters.

5.3.2 Limitation on realistic parameters of the model

According to Anand and Prasad (2010), the incomplete financial market, which is the realistic feature for developing countries, should be considered for decision making of monetary policy authority. The future research should extend to the incomplete financial market feature in order to obtain the more creditable conclusion.

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APPENDICES

APPENDIX A
STEADY STATE

We derive for the solution of the steady state in the model by using the stationary first-order condition for m_{t+1} in the equation in order to get

$$-1 + \beta\left[\frac{1}{\mu_z}\frac{1}{\pi^{HL}}\left(R - \tau^k(R-1)\right)\right] = 0 \tag{A.1}$$

and rearrange (A.1) to get

$$R - \tau^k(R-1) = \frac{\pi^{HL}\mu_z}{\beta}$$

$$\Leftrightarrow$$

$$R = \frac{\pi^{HL}\mu_z - \tau^k\beta}{(1-\tau^k)\beta}\,. \tag{A.2}$$

As we formulate for money growth, we get

$$\pi^{HL} = \frac{\mu}{\mu_z}\,. \tag{A.3}$$

From the stationarized version of the first-order condition for b^*_{t+1}, we get

$$-NER_t + \beta\left[\frac{1}{\mu_z\pi^{HL}}\begin{pmatrix} NER_{t+1}R^*\Phi\left(\frac{A}{z},\tilde{\phi}\right) \\ -\tau^k NER_{t+1}\left(R^*\Phi\left(\frac{A}{z},\tilde{\phi}\right)-1\right) - \tau^k(NER_{t+1} - SNER_t)\end{pmatrix}\right] = 0. \tag{A.4}$$

We assume that

$$R^* = R, \tag{A.5}$$

To get (A.1) from transforming (A.4), we need further conditions, which are

$$NER_t = NER_{t+1} = 1,$$

$$\Phi\left(\frac{A_t}{z_t}, \tilde{\phi}_t\right) = \Phi\left(\frac{A}{z}, \tilde{\phi}\right) = 1.$$

From the assumption that $\left(\frac{A}{z}, \tilde{\phi}\right) = exp\left(-\frac{\tilde{\phi}_a A}{z} + \tilde{\phi}\right)$, it implies that $B^* = A = 0$ and $\tilde{\phi} = 0$. Therefore the net foreign asset position is zero. We combine the first order-condition for i_t in the equation (3.55) with (2.48) to get

$$P_{k'} = \frac{P^i}{P^{Core}}. \qquad \text{(A.6)}$$

Next, we find the relative price in the steady state by assuming that $R = R^*$, $\pi = \pi^*$ and $P_0 = P_0^*$, which is also assumption for the steady-state price level in the initial time. Then we get

$$\gamma_t^{HL,Core} \equiv \left(\frac{P_t^{HL}}{P_t^{Core}}\right) = \left[(1-\omega_c) + \omega_c\left(\frac{P_t^{m,c}}{P_t^{Core}}\right)^{1-\eta_c}\right]^{1/(1-\eta_c)}, \qquad \text{(A.7)}$$

$$\gamma_t^{HL,mc} \equiv \left(\frac{P_t^{HL}}{P_t^{m,c}}\right) = \left[(1-\omega_c)\left(\frac{P_t^{m,c}}{P_t^{Core}}\right)^{1-\eta_c} + \omega_c\right]^{1/(1-\eta_c)}. \qquad \text{(A.8)}$$

In a flexible price situation, the importing firms will set their price by

$$P_t^{m,j} = \lambda_t^{m,j} NER_t P_t^*$$

where $\lambda_t^{m,j} \equiv \frac{\eta_t^{m,j}}{\eta_t^{m,j}-1}$ for $j = \{c, i\}$.

Applying the condition, (A.7) and (A.8) become

$$\gamma_t^{HL,Core} = \left[(1-\omega_c) + \omega_c \left(\frac{\eta^{m,c}}{\eta^{m,c}-1}\frac{NER\times P_t^*}{P_t^{Core}}\right)^{1-\eta_c}\right]^{1/(1-\eta_c)},$$

$$\gamma_t^{HL,mc} = \left[(1-\omega_c)\left(\frac{\eta^{m,c}-1}{\eta^{m,c}}\frac{P_t^{Core}}{NER\times P_t^*}\right)^{1-\eta_c} + \omega_c\right]^{1/(1-\eta_c)},$$

where $\eta_t^{m,c}$ is the substitution elasticity among the imported consumption goods.

Following the above condition, we apply with the condition $\frac{NER\times P_t^*}{P_t^{core}} = 1$. Then we get

$$\gamma_t^{HL,Core} = \left[(1-\omega_c) + \omega_c \left(\frac{\eta^{m,c}}{\eta^{m,c}-1}\right)^{1-\eta_c}\right]^{1/(1-\eta_c)}, \quad \text{(A.9)}$$

$$\gamma_t^{HL,mc} = \left[(1-\omega_c)\left(\frac{\eta^{m,c}-1}{\eta^{m,c}}\right)^{1-\eta_c} + \omega_c\right]^{1/(1-\eta_c)}. \quad \text{(A.10)}$$

Similarly, we obtain these following equations

$$\gamma_t^{i,core} \equiv \left(\frac{P_t^i}{P_t^{Core}}\right) = \left[(1-\omega_i) + \omega_i \left(\frac{\eta^{m,i}}{\eta^{m,i}-1}\right)^{1-\eta_i}\right]^{1/(1-\eta_i)}, \quad \text{(A.11)}$$

$$\gamma_t^{i,mi} \equiv \left(\frac{P_t^i}{P_t^{m,i}}\right) = \left[(1-\omega_i)\left(\frac{\eta^{m,i}-1}{\eta^{m,i}}\right)^{1-\eta_i} + \omega_i\right]^{1/(1-\eta_i)} \quad \text{(A.12)}$$

where $\eta_t^{m,i}$ is the substitution elasticity among the imported investment goods. Note that $0 < \eta_j < \infty$ and $1 < \eta^{m,j} < \infty$ then $\frac{P^j}{P^{Core}}$ is greater than unity where $\omega_j > 0$. It is because the households substitute between the domestic and foreign goods and the mark-up on the foreign good is higher than unity $\left(\frac{\eta^{m,j}}{\eta^{m,j}-1}\right)$ when $\eta_t^{m,i} < \infty$. In addition, we assume that $\frac{P^j}{P^{m,j}}$ less than unity when $\omega_c < 1$ and $\eta^{m,j} < \infty$. It is because the price of the domestic good is lower than the charged price of the foreign good. We apply the assumption $\frac{NER \times P_t^*}{P_t^{Core}} = 1$ to (A.9) and (A.10) to get

$$\frac{P^{m,c}}{P^{Core}} = \left[\frac{(1-\omega_c)+\omega_c\left(\frac{\eta^{m,c}}{\eta^{m,c}-1}\right)^{1-\eta_c}}{(1-\omega_c)\left(\frac{\eta^{m,c}-1}{\eta^{m,c}}\right)^{1-\eta_c}+\omega_c}\right]^{1/(1-\eta_c)} = \frac{\eta^{m,c}}{\eta^{m,c}-1}. \tag{A.13}$$

We also apply $\frac{SP_t^*}{P_t^{core}} = 1$ in equations (A.11) and (A.12) and get

$$\frac{P^{m,i}}{P^{core}} = \left[\frac{(1-\omega_i)+\omega_i\left(\frac{\eta^{m,i}}{\eta^{m,i}-1}\right)^{1-\eta_i}}{(1-\omega_i)\left(\frac{\eta^{m,i}-1}{\eta^{m,i}}\right)^{1-\eta_i}+\omega_i}\right]^{1/(1-\eta_i)} = \frac{\eta^{m,i}}{\eta^{m,i}-1}. \tag{A.14}$$

Note that all relative price will equal unity if and only if $\eta^{m,j} = \infty$. Also, we assume that the price of the export good will equal the foreign price in the steady state ($P^x = P^*$), which imply that the markup price in the export good market will be one as the steady state. Then we get

$$P^x = \frac{P^{Core}}{NER}. \tag{A.15}$$

In short run, we allow the law of one price can be not held. We combine the equation (A.6), which is the first-order condition for $\bar{k}_{t+1}$ in the equation (3.54), to these set of the assumption: $u_t = k_t/\bar{k}_t = u = 1 \Rightarrow a(u) = a(1) = 0$ in order to get

$$\beta\left[\frac{1}{\mu_z}\left((1-\delta)P_{k'} + (1-\tau^k)\tau^k\right)\right] = P_{k'},$$

$$\Leftrightarrow$$

$$r^k = \frac{\mu_z P_{k'} - \beta(1-\delta)P_{k'}}{(1-\tau^k)\beta},$$

and apply to the equation (3.14) to get

$$r^k = \frac{\alpha}{1-\alpha}\mu_z \overline{w} R^f \frac{H}{k}, \tag{A.16}$$

and apply to the equation (3.9) to get

$$R^f \equiv vR + 1 - v. \tag{A.17}$$

From

$$P = \lambda_d MC$$

,we rearrange it and get

$$\frac{MC}{P} = \frac{1}{\lambda_d}, \tag{A.18}$$

and apply with the equation (3.15) to get

$$\frac{1}{\lambda_d} = \left(\frac{1}{1-\alpha}\right)^{(1-\alpha)} \left(\frac{1}{\alpha}\right)^{\alpha} (r^k)^{\alpha} (\overline{w} R^f)^{1-\alpha} \ . \tag{A.19}$$

Next, we solve for c, y, g, H, K, m and q. From the real profits, $\prod^R$,are as follows:

$$\prod^R \equiv \left(\frac{P^{Core}}{MC}\right) y - \left(r^k \frac{k}{\mu_z} + \overline{w} R^f H\right) - \phi,$$

where y is the stationarized output ($\frac{Y}{z} = y$) in the equation (3.4). [29]

Since the domestic firm is monopolistic firm, it can set a markup, λ_d, over its marginal cost an in the equation (A.18). Conversely, in the case of perfect competitive

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[29] Note that if there is the profit or loss, the model will allow the firm to enter or exit. As a result, we need the zero profit condition.

market, there is no markup then we get that: $y = r^k \frac{k}{\mu_z} - \bar{w}R^f H$. We need the condition that $\prod^R = 0$ in the steady state, but it is the case of monopolistic market. Then we introduce the value of the fixed cost, ϕ, to complete our zero profit condition it the steady state.In the case of perfect competitive, output, y, must equal the real production cost, which is the equation (3.8). We apply these two above equations to (A.18) to get

$$\prod^R \equiv \lambda_d y - y - \phi = 0,$$

and we rearrange it to get

$$\phi = (\lambda_d - 1)y. \quad \text{(A.20)}$$

We plug the stationarized version of production function (3.4) in to (A.20).[30] Then we get

$$\phi = \frac{\lambda_d - 1}{\lambda_d} \mu_z{}^{-\alpha} \left(\frac{k}{H}\right)^{\alpha} H \quad \text{(A.21)}$$

We combine the law of motion for capital in the equation (3.46) with the properties (3.47) and stationarize $\bar{K}_{t+1}$with z_t. Then we get

$$k = \frac{1-\delta}{\mu_z} k + i,$$

and rearrange it to get

$$i = \left(1 - \frac{1-\delta}{\mu_z}\right) k. \quad \text{(A.22)}$$

In the steady state, the consumption Euler equation (3.51) becomes

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[30] Note that the stationarized version of (3.4) is that $y_t = \mu_{z,t}^{-\alpha} \epsilon_t k_t^{\alpha} H_t^{1-\alpha} - \phi$ and then, in the steady state, we get that $y = \mu_z^{-\alpha} k^{\alpha} H^{1-\alpha} - \phi$.

$$\frac{1}{c - bc\frac{1}{\mu_z}} - \beta b \frac{1}{c\mu_z - bc} - \psi_z \frac{P^{HL}}{P^{Core}}(1 + \tau^c) = 0,$$

and rearrange it to get

$$\psi_z = \frac{1}{c}\frac{\mu_z - \beta b}{(1+\tau^c)(\mu_z - b)}\left(\frac{P^{HL}}{P^{Core}}\right)^{-1}.$$

We find the effective steady state wage by dividing with the wage markup, λ_w. In the steady state, the first-order condition for households work hours in (3.64) then becomes

$$-A_L H^{\sigma_L} + (1 - \tau^y)\frac{\psi_z}{\lambda_w}\frac{\bar{w}}{1+\tau^w} = 0,$$

and rearrange it to get

$$H = \left[\frac{(1-\tau^y)\frac{\psi_z}{\lambda_w}\frac{\bar{w}}{1+\tau^w}}{A_L}\right]^{1/\sigma_L}. \qquad \text{(A.24)}$$

In the steady state, the resource constraint in the equation (3.78) becomes

$$c^d + i^d + c^x + i^x = (1 - g_r)\left(\mu_z^{-\alpha}\left(\frac{k}{H}\right)^{\alpha} H - \phi\right)$$

and applying it to (3.39), (3.35), (3.43), (3.36) and (A.21) to get

$$(1 - \omega_c)\left[\frac{P^{HL}}{P^{Core}}\right]^{\eta_c} c + (1 - \omega_i)\left[\frac{P^i}{P^{Core}}\right]^{\eta_i} i + c^x + i^x = \frac{(1-g_r)}{\lambda_d}\mu_z^{-\alpha}\left(\frac{k}{H}\right)^{\alpha} H. \qquad \text{(A.25)}$$

Next, we assume that, in the steady state, export equals import and also assume that there are a zero foreign debt and unchanged nominal exchange rate. We combine these assumptions with the stationarized version of the equation (3.82) to get

$$c^m + i^m = c^x + i^x.$$

We apply the above equation to the equations (3.40) and (3.44) to get

$$c^m = \omega_c \left[\frac{P^{m,c}}{P^{HL}}\right]^{-\eta_c} c = \omega_c \left[\frac{P^{HL}}{P^{m,c}}\right]^{\eta_c} c,$$

$$i^m = \omega_i \left[\frac{P^{m,i}}{P^i}\right]^{-\eta_i} i = \omega_i \left[\frac{P^i}{P^{m,i}}\right]^{\eta_i} i.$$

We can rewritten the condition: $c^m + i^m = c^x + i^x$ as

$$\omega_c \left[\frac{P^{HL}}{P^{m,c}}\right]^{\eta_c} c + \omega_i \left[\frac{P^i}{P^{m,i}}\right]^{\eta_i} i = (c^x + i^x),$$

$$\omega_c \left[\frac{P^{HL}}{P^{m,c}}\right]^{\eta_c} c + \omega_i \left[\frac{P^i}{P^{m,i}}\right]^{\eta_i} i = \tilde{x}\,, \tag{A.26}$$

which affects both of consumption and investment goods. Next, we combine the relative prices from equations (A.10), (A.12), (A.13) and (A.14) with the equation (A.22) and (A.25) to get

$$\left((1-\omega_c)\left[\frac{P^{HL}}{P^{Core}}\right]^{\eta_c} + \omega_c\left[\frac{P^{HL}}{P^{m,c}}\right]^{\eta_c}\right)c + \left((1-\omega_i)\left[\frac{P^i}{P^{Core}}\right]^{\eta_i} + \omega_i\left[\frac{P^i}{P^{m,i}}\right]^{\eta_i}\right)\left(1-\frac{1-\delta}{\mu_z}\right)\left(\frac{k}{H}\right)H$$
$$= \frac{(1-g_r)}{\lambda_d}\mu_z^{-\alpha}\left(\frac{k}{H}\right)^{\alpha} H$$

and rearrange it to get

$$\left((1-\omega_c)\left[\frac{P^{HL}}{P^{Core}}\right]^{\eta_c} + \omega_c\left[\frac{P^{HL}}{P^{m,c}}\right]^{\eta_c}\right)c = \left[\frac{(1-g_r)}{\lambda_d}\mu_z^{-\alpha}\left(\frac{k}{H}\right)^{\alpha} - \left((1-\omega_i)\left[\frac{P^i}{P^{Core}}\right]^{\eta_i} + \right.\right.$$
$$\left.\left.\omega_i\left[\frac{P^i}{P^{m,i}}\right]^{\eta_i}\right)\left(1-\frac{1-\delta}{\mu_z}\right)\left(\frac{k}{H}\right)\right]H.$$

Next, we will substitute for *H* by using the equations $(A.23)$, $(A.24)$ and the following equations:

$$D_1 \equiv (1-\omega_c)\left[\frac{P^{HL}}{P^{Core}}\right]^{\eta_c} + \omega_c\left[\frac{P^{HL}}{P^{m,c}}\right]^{\eta_c},$$

$$D_2 \equiv \left[\frac{(1-g_r)}{\lambda_d}\mu_z^{-\alpha}\left(\frac{k}{H}\right)^{\alpha} - \left((1-\omega_i)\left[\frac{P^i}{P^{Core}}\right]^{\eta_i} + \omega_i\left[\frac{P^i}{P^{m,i}}\right]^{\eta_i}\right)\left(1-\frac{1-\delta}{\mu_z}\right)\left(\frac{k}{H}\right)\right],$$

$$D_3 \equiv \left[\frac{(1-\tau^y)\frac{1}{\lambda_W}\frac{\bar{w}}{1+\tau^W}}{A_L}\right]^{1/\sigma_L}, \tag{A.27}$$

$$D_4 \equiv \frac{\mu_z-\beta b}{(1+\tau^c)(\mu_z-b)}\left(\frac{P^{HL}}{P^{Core}}\right)^{-1}.$$

Then we get

$$D_1 c = D_2 H,$$

$$H = D_3(\psi_z)^{1/\sigma_L},$$

$$\psi_z = \frac{1}{c}D_4,$$

and the solution for *H*, *c* and ψ_z as follow

$$H = \left[D_3 D_4^{1/\sigma_L}\left(\frac{D_2}{D_1}\right)^{-1/\sigma_L}\right]^{\frac{\sigma_L}{1+\sigma_L}}, \tag{A.28}$$

$$c = \frac{D_2}{D_1}H,$$

$$\psi_z = \frac{1}{c}D_4.$$

From the solution H, we get the solution for y as follow

$$y = \frac{1}{\lambda_d} \mu_z^{-\alpha} \left(\frac{k}{H}\right)^{\alpha} H \,, \tag{A.29}$$

and apply it with the solution for $\frac{k}{H}$ and ϕ to the steady state for government expenditures, g, as follow

$$g = g_r y. \tag{A.30}$$

In the steady state, the first order condition for capital utilization rate, u, in the equation (3.56) becomes

$$a'(1) = (1 - \tau^k)\tau^k. \tag{A.31}$$

In the steady state, the first order condition for cash balance, q, in the equation (3.57) becomes

$$A_q q^{-\sigma_q} = (1 - \tau^k)\psi_z(R - 1)$$

$$\Leftrightarrow$$

$$q = \left(\frac{A_q}{(1 - \tau^k)\psi_z(R - 1)}\right)^{\frac{1}{\sigma_q}}.$$

Finally, we use the loan market clearing condition in the equation (3.84) to find the steady state value of m. Then we get

$$v\bar{w}H = \frac{\mu m}{\pi \mu_z} - q, \tag{A.32}$$

$$\Leftrightarrow$$

$$m = v\bar{w}H + q.$$

We compute $P_{k'}, r^k, \bar{w}, R, R^f$ and $\frac{H}{k}$ in the following steps. First, we get R from $(\text{A}.2)$ then we get R^f from $(\text{A}.17)$, $(\text{A}.6)$ and $(\text{A}.16)$ and then we get r^k from $(\text{A}.19)$

$\overline{w}R^f$ with R^f to get $\overline{w}$. Finally, we apply the solution for $r^k, \overline{w}$, and R^f in $(A.16)$ to obtain $\frac{H}{k}$.

Next, we use the above steady state solution of the financial variables to find the steady state solution of the following variables: $c, i, y, g, \phi, \psi_z, H, k, m, \tilde{x}$ and q. First, we get the steady state solution of the coefficients D_1, D_2, D_3 and D_4 in the equation $(A.27)$, then apply them in the equation $(A.28)$ to get c, H and ψ_z, then use (A.21) to get ϕ, then use (A.29) to get k and H , then we use (A.30) to get y , then use $(A.32)$ to get q , then use $(A.22)$ to get I , then use $(A.26)$ to get $\tilde{x}$ and finally use (A.32) to get m.

APPENDIX B
LOG-LINEARIZED MODEL

From the equations (3.19) we get the domestic (core sector) Phillips curve is

$$\hat{\pi}_t^{Core} = \frac{\beta}{1+\kappa_d\beta} E_t\hat{\pi}_{t+1}^{Core} + \frac{\kappa_d}{1+\kappa_d\beta}\hat{\pi}_{t-1}^{Core} \frac{(1-\xi_d)(1-\beta\xi_d)}{\xi_d(1+\kappa_d\beta)}\left(\widehat{mc}_t + \hat{\lambda}_{d,t}\right). \tag{B.1}$$

From equation (3.15), log-linearized marginal cost is

$$\widehat{mc}_t = \alpha\hat{r}_t^k + (1-\alpha)\left[\hat{\bar{w}} + \hat{R}_t^f\right] - \hat{\epsilon}_t$$

$$= \alpha\left(\hat{\mu}_{z,t} + \hat{H}_t - \hat{k}_t\right) + \hat{\bar{w}}_t + \hat{R}_t^f - \hat{\epsilon}_t.$$

From equation (3.14), log-linearized real rental rate of capital is

$$\hat{r}_t^k = \hat{\mu}_{z,t} + \hat{\bar{w}}_t + \hat{R}_t^f + \hat{H}_t - \hat{k}_t.$$

From equation (3.30), the Phillips curves for the imported consumption goods is

$$\hat{\pi}_t^{m,c} = \frac{\beta}{1+\kappa_{m,c}\beta} E_t\hat{\pi}_{t+1}^{m,c} + \frac{\kappa_{m,c}}{1+\kappa_{m,c}\beta}\hat{\pi}_{t-1}^{m,c} + \frac{(1-\xi_{m,c})(1-\beta\xi_{m,c})}{\xi_{m,c}(1+\kappa_{m,c}\beta)}\left(\widehat{mc}_t^{m,c} + \hat{\lambda}_t^{m,c}\right), \tag{B.2}$$

and investment goods is

$$\hat{\pi}_t^{m,i} = \frac{\beta}{1+\kappa_{m,i}\beta} E_t\hat{\pi}_{t+1}^{m,i} + \frac{\kappa_{m,i}}{1+\kappa_{m,i}\beta}\hat{\pi}_{t-1}^{m,i} + \frac{(1-\xi_{m,i})(1-\beta\xi_{m,i})}{\xi_{m,i}(1+\kappa_{m,i}\beta)}\left(\widehat{mc}_t^{m,i} + \hat{\lambda}_t^{m,i}\right). \tag{B.3}$$

From the equations (3.73) and (3.74), we get

$$\widehat{mc}_t^{m,c} = -\widehat{mc}_t^{x} - \hat{\gamma}_t^{x,*} - \hat{\gamma}_t^{mc,d},$$

$$\widehat{mc}_t^{m,i} = -\widehat{mc}_t^x - \hat{\gamma}_t^{x,*} - \hat{\gamma}_t^{mi,d}.$$

From the equations (3.34), the Phillips curve for the exporting firms is

$$\hat{\pi}_t^x = \frac{\beta}{1+\kappa_x\beta} E_t \hat{\pi}_{t+1}^x + \frac{\kappa_x}{1+\kappa_x\beta} \hat{\pi}_{t-1}^x + \frac{(1-\xi_x)(1-\beta\xi_x)}{\xi_x(1+\kappa_x\beta)} \left(\widehat{mc}_t^x + \hat{\lambda}_t^x\right). \tag{B.4}$$

From the equations (3.63), the log-linearized real wage is

$$E_t \begin{bmatrix} \eta_0 \widehat{w}_{t-1} + \eta_1 \widehat{w}_t + \eta_2 \widehat{w}_{t+1} + \eta_3 \hat{\pi}_t^{Core} + \eta_4 \hat{\pi}_{t+1}^{Core} + \eta_5 \hat{\pi}_{t-1}^{HL} \\ +\eta_6 \hat{\pi}_t^{HL} + \eta_7 \hat{\psi}_{z,t} + \eta_8 \widehat{H}_t + \eta_9 \hat{\tau}_t^y + \eta_{10} \hat{\tau}_t^w + \eta_{11} \hat{\zeta}_t^h \end{bmatrix} = 0. \tag{B.5}$$

for $cpi = \{HL, Core\}$ where $b_w = \frac{[\lambda_w \sigma_L - (1-\lambda_w)]}{[(1-\beta\xi_w)(1-\xi_w)]}$ and

$$\begin{pmatrix} \eta_0 \\ \eta_1 \\ \eta_2 \\ \eta_3 \\ \eta_4 \\ \eta_5 \\ \eta_6 \\ \eta_7 \\ \eta_8 \\ \eta_9 \\ \eta_{10} \\ \eta_{11} \end{pmatrix} = \begin{pmatrix} b_w \xi_w \\ \left(\sigma_L \lambda_w - b_w(1+\beta\xi_w^2)\right) \\ b_w \beta \xi_w \\ -b_w \xi_w \\ b_w \beta \xi_w \\ b_w \xi_w \kappa_w \\ -b_w \beta \xi_w \kappa_w \\ (1-\lambda_w) \\ -(1-\lambda_w)\sigma_L \\ -(1-\lambda_w)\tau^y/(1-\tau^y) \\ -(1-\lambda_w)\tau^w/(1-\tau^w) \\ -(1-\lambda_w) \end{pmatrix}.$$

We log-linearize equation (3.51) to get

$$E_t \begin{bmatrix} -b\beta\mu_z \hat{c}_{t+1} + (\mu_z^2 + b^2\beta)\hat{c}_t - b\mu_z \hat{c}_{t-1} + b\mu_z\left(\hat{\mu}_{z,t} - \beta\hat{\mu}_{z,t+1}\right) \\ +(\mu_z - b\beta)(\mu_z - b)\hat{\psi}_{z,t} + \frac{\tau^c}{1+\tau^c}(\mu_z - b\beta)(\mu_z - b)\hat{\tau}_t^c + (\mu_z - b\beta)(\mu_z - b)\hat{\gamma}_t^{c,d} \\ -(\mu_z - b)\left(\mu_z \hat{\zeta}_t^c - b\beta\hat{\zeta}_{t+1}^c\right) \end{bmatrix} = 0.$$

(B.6)

We log-linearize equation (3.55) and apply to the properties of (3.47) to obtain

$$E_t\{\hat{P}_{k',t} + \hat{\Upsilon}_t - \hat{\gamma}_t^{i,d} - \mu_z^2 \tilde{S}''[(\hat{\imath}_t - \hat{\imath}_{t-1}) - \beta(\hat{\imath}_{t+1} - \hat{\imath}_t) + \hat{\mu}_{z,t} - \beta\hat{\mu}_{z,t+1}]\} = 0. \quad \text{(B.7)}$$

We log-linearize equation (3.52) to get

$$E_t\left[-\mu\hat{\psi}_{z,t} + \mu\hat{\psi}_{z,t+1} - \mu\hat{\mu}_{z,t+1} + (\mu - \beta\tau^k)\hat{R}_t - \mu\hat{\pi}_{t+1} + \frac{\tau^k}{1-\tau^k}(\beta - \mu)\hat{\tau}_{t+1}^k\right] = 0$$

(B.8)

and equation (3.54) to get

$$E_t\left[\begin{array}{c}\hat{\psi}_{z,t} + \hat{\mu}_{z,t-1} - \hat{\psi}_{z,t+1} - \frac{\beta(1-\delta)}{\mu_z}\hat{P}_{k',t+1} + \hat{P}_{k',t} - \frac{\mu_z - \beta(1-\delta)}{\mu_z}\hat{r}_{t+1}^k \\ + \frac{\tau^k}{(1-\tau^k)}\frac{\mu_z - \beta(1-\delta)}{\mu_z}\hat{\tau}_{t+1}^k\end{array}\right] = 0, \quad \text{(B.9)}$$

The log-linearized UIP condition is given by

$$E_t\Delta\widehat{NER}_{t+1} - \left(\hat{R}_t - \hat{R}_t^*\right) - \tilde{\phi}_a\hat{a}_t + \hat{\tilde{\phi}}_t = 0, \quad \text{(B.10)}$$

and, from equation (3.81), the aggregate resource constraint is

$$(1-\omega_c)(\gamma^{HL,Core})^{\eta_c}\frac{c}{y}\left(\hat{c}_t + \eta_c\hat{\gamma}_t^{HL,Core}\right) + (1-\omega_i)\left(\gamma^{i,Core}\right)^{\eta_i}\frac{i}{y}\left(\hat{\imath}_t + \eta_i\hat{\gamma}_t^{i,Core}\right) +$$
$$\frac{g}{y}\hat{g}_t + \frac{y^*}{y}\left(\hat{y}_t^* - \eta_f\hat{\gamma}_t^{x,*} + \hat{\tilde{z}}_t^*\right) = \lambda_d\left(\hat{\epsilon}_t + \alpha\left(\hat{k}_t - \hat{\mu}_{z,t}\right) + (1-\alpha)\hat{H}_t\right) -$$
$$(1-\tau^k)\tau^k\frac{\bar{k}}{y}\frac{1}{\mu_z}\left(\hat{k}_t - \hat{\bar{k}}_t\right). \quad \text{(B.11)}$$

The log-linearized law of motion for capital is

$$\hat{\bar{k}}_{t+1} = (1-\delta)\frac{1}{\mu_z}\hat{\bar{k}}_t - (1-\delta)\frac{1}{\mu_z}\hat{\mu}_{z,t} + \left(1 - (1-\delta)\frac{1}{\mu_z}\right)\hat{\Upsilon}_t + \left(1 - (1-\delta)\frac{1}{\mu_z}\right)\hat{\imath}_t,$$

(B.12)

and, from equation (3.56), the expression for the capacity utilization rate

$$\hat{u}_t = \hat{k}_t - \hat{\bar{k}}_t$$

$$\hat{u}_t = \frac{1}{\sigma_a}\hat{r}_t^k - \frac{1}{\sigma_a}\frac{\tau^k}{(1-\tau^k)}\hat{\tau}_t^k \; . \tag{B.13}$$

From the equations (3.57), the log-linearized version of the first-order condition for cash balance is

$$\hat{q}_t = \frac{1}{\sigma_q}\left[\hat{\zeta}_t^q + \frac{\tau^k}{1-\tau^k}\hat{\tau}_t^k - \hat{\psi}_{z,t} - \frac{R}{R-1}\hat{R}_{t-1}\right]. \tag{B.14}$$

Next, we define money growth in the function of real balances, domestic inflation and real growth as follow:

$$\mu_t = \frac{M_{t+1}}{M_t} = \frac{\bar{m}_{t+1} z_t P_t}{\bar{m}_t z_{t-1} P_{t-1}} = \frac{\bar{m}_{t+1}\mu_{z,t}\pi_t}{\bar{m}_t},$$

and log-linearized to get

$$\hat{\mu}_t - \hat{\bar{m}}_{t+1} - \hat{\mu}_{z,t} - \hat{\pi}_t^{HL} + \hat{\bar{m}}_t = 0 \; . \tag{B.15}$$

From the equations (3.83), the log-linearized version of the equilibrium law of motion for net foreign assets is

$$\hat{a}_t = -y^*\widehat{mc}_t^x - \eta_f y^*\hat{\gamma}_t^{x,*} + y^*\hat{y}_t^* + y^*\hat{\tilde{z}}_t^* + (c^m + i^m)\hat{\gamma}_t^f$$
$$-\begin{pmatrix} c^m\left(-\eta_c(1-\omega_c)(\gamma^{c,d})^{-(1-\eta_c)}\hat{\gamma}_t^{mc,Core} + \hat{c}_t\right) \\ i^m\left(-\eta_i(1-\omega_i)\left(\gamma^{i,d}\right)^{-(1-\eta_i)}\hat{\gamma}_t^{mi,Core} + \hat{\imath}_t\right) \end{pmatrix} + \frac{R}{\pi\mu_z}\hat{a}_{t-1}. \tag{B.16}$$

From the equations (3.85), the log-linearized version of the loan market clearing condition is

$$v\bar{w}H\left(\hat{v}_t + \hat{w}_t + \hat{H}_t\right) = \frac{\mu\bar{m}}{\pi^{HL}\mu_z}\left(\hat{\mu}_t + \hat{\bar{m}}_t - \hat{\pi}_t^{HL} - \hat{\mu}_{z,t}\right) - q\hat{q}_t. \quad \text{(B.17)}$$

We log-linearized the relative price equations to get

$$\hat{\gamma}_t^{mc,Core} = \hat{\gamma}_{t-1}^{mc,Core} + \hat{\pi}_t^{m,c} - \hat{\pi}_t^{Core}\ , \quad \text{(B.18)}$$

$$\hat{\gamma}_t^{mi,Core} = \hat{\gamma}_{t-1}^{mi,Core} + \hat{\pi}_t^{m,i} - \hat{\pi}_t^{Core}\ , \quad \text{(B.19)}$$

$$\hat{\gamma}_t^{x,*} = \hat{\gamma}_{t-1}^{x,*} + \hat{\pi}_t^{x} - \hat{\pi}_t^{*}, \quad \text{(B.20)}$$

$$\widehat{mc}_t^{x} = \widehat{mc}_{t-1}^{x} + \hat{\pi}_t^{HL} - \hat{\pi}_t^{x} - \Delta\widehat{NER}_t. \quad \text{(B.21)}$$

From the equations (3.75), the log-linearized version of Taylor rule is

$$\hat{R}_t = \rho_R\hat{R}_{t-1} + (1-\rho_R)\left(r_\pi\hat{\pi}_{t-1}^{cpi} + r_y\hat{y}_{t-1} + r_{RER}\widehat{RER}_{t-1}\right) + \varepsilon_{tR} \quad \text{(B.22)}$$

for $cpi = \{HL, Core\}$ where

$$\hat{\pi}_t^{HL} = \left((1-\omega_c)(\gamma^{Core,HL})^{1-\eta_c}\right)\hat{\pi}_t^{Core} + (\omega_c(\gamma^{mc,HL})^{1-\eta_c})\hat{\pi}_t^{m,c},$$

$$\hat{y}_t = \lambda_d\left(\hat{\epsilon}_t + \alpha\left(\hat{k}_t - \hat{\mu}_{z,t}\right) + (1-\alpha)\hat{H}_t\right),$$

$$\widehat{RER}_t = -\omega_c(\gamma^{HL,mc})^{-(1-\eta_c)}\hat{\gamma}_t^{mc,Core} - \hat{\gamma}_t^{x,*} - \widehat{mc}_t^{x}.$$

APPENDIX C
MEASUREMENT ISSUE

This section explains the way to measure consumption, investment, export, import and output into the model by using observed data.

$$Y_t = \tilde{C}_t + \tilde{I}_t + G_t + \tilde{X}_t - \widetilde{M}_t \tag{C.1}$$

where

$$\tilde{C}_t = C_t^d + C_t^m,$$

$$\tilde{I}_t = I_t^d + I_t^m,$$

$$\tilde{X}_t = C_t^x + I_t^x,$$

$$\widetilde{M}_t = C_t^m + I_t^m.$$

According to the theoretical model, the aggregate production resource constraint is given by

$$C_t^d + I_t^d + G_t + C_t^x + I_t^x \leq \epsilon_t z_t^{1-\alpha} K_t^\alpha H_t^{1-\alpha} - z_t \phi - a(u_t)\bar{K}_t,$$

which is rewritten as

$$\begin{aligned}\left(C_t^d + C_t^m\right) + \left(I_t^d + I_t^m\right) + G_t + C_t^x + I_t^x - C_t^m + I_t^m \\ \leq \epsilon_t z_t^{1-\alpha} K_t^\alpha H_t^{1-\alpha} - z_t \phi - a(u_t)\bar{K}_t\,. \end{aligned} \tag{C.2}$$

This study measures the resource constraint (C.2) with the data (C.1). Since this study pays attention to open economy data, we observe that $\tilde{C}_t = C_t^d + C_t^m$ in the real data. But, in the theoretical model, we use C_t, which aggregate of C_t^d and C_t^m by using CES function. As a result, the demand equation 3.49 and 3.54 are used to link the consumption in the model, C_t, to the consumption in real data, $\tilde{C}_t$, by using the following equation:

$$\tilde{C}_t = C_t^d + C_t^m = \left((1-\omega_c)\left[\frac{P_t^{Core}}{P_t^{HL}}\right]^{-\eta_c} + \omega_c\left[\frac{P_t^{m,c}}{P_t^{HL}}\right]^{-\eta_c}\right)C_t \, . \tag{C.3}$$

Also, investment is given by

$$\tilde{I}_t = I_t^d + I_t^m = \left((1-\omega_i)\left[\frac{P_t^{Core}}{P_t^{i}}\right]^{-\eta_i} + \omega_i\left[\frac{P_t^{m,i}}{P_t^{i}}\right]^{-\eta_i}\right)I_t \, . \tag{C.4}$$

The exports depend on the foreign output by the following equation:

$$\tilde{X}_t = C_t^x + I_t^x = \left[\frac{P_t^x}{P_t^*}\right]^{-\eta_f} Y_t^*. \tag{C.5}$$

The total imports are defined as

$$\widetilde{M}_t = C_t^m + I_t^m = \omega_c\left[\frac{P_t^{m,c}}{P_t^{HL}}\right]^{-\eta_c} C_t + \omega_i\left[\frac{P_t^{m,i}}{P_t^{i}}\right]^{-\eta_i} I_t \, . \tag{C.6}$$

Since we introduce the capital utilization cost as the adjustment cost, the GDP in the model and the real data are not explicitly comparable. As the adjustment costs equivalent to a cyclical component, we then introduce those adjustment costs to investment, instead of explaining them as the residual in the real GDP of real data. As a result, output is as follows:

$$Y_t = \epsilon_t z_t^{1-\alpha} K_t^{\alpha} H_t^{1-\alpha} - z_t \phi. \tag{C.7}$$

The price deflators of consumption and investment are measured by using the following nominal GDP data, which is as follow:

$$P_t^{HL}Y_t = (1+\tau_t^c)\left(P_t^{Core}C_t^d + P_t^{m,c}C_t^m\right) + \left(P_t^{Core}I_t^d + P_t^{m,i}I_t^m\right) + P_t^{Core}G_t + \left(P_t^x C_t^x + P_t^x I_t^x\right) - \left(P_t^{m,c}C_t^m + P_t^{m,i}I_t^m\right).$$

Therefore, the price deflators of consumption is measured as

$$P_t^{def,c} \equiv \frac{(1+\tau_t^c)\left(P_t^{Core}C_t^d + P_t^{m,c}C_t^m\right)}{C_t^d + C_t^m}, \quad \text{(C.8)}$$

and the price deflators of investment is measured as

$$P_t^{def,i} \equiv \frac{P_t^{Core}I_t^d + P_t^{m,i}I_t^m}{I_t^d + I_t^m}. \quad \text{(C.9)}$$

In addition, we measure the growth rate in foreign output as $\mu_z + \Delta\hat{y}_t^* + \Delta\hat{z}_t^*$, which is the first-different measurement equation.

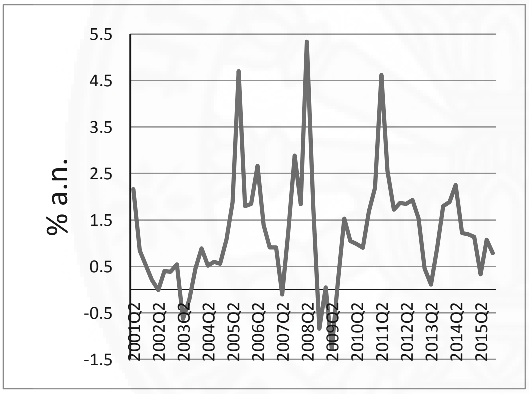
APPENDIX D
DATA FIGURES

This study transforms non-stationary data into stationary data by using first differences method. This study demeans an hour worked, real exchange rate because the model assumes that these data move around their steady state referred to their mean, i.e. $\hat{x}_t = (x_t - x)/x$. Note that all of these data are seasonal adjusted by using X-12 ARIMA method.

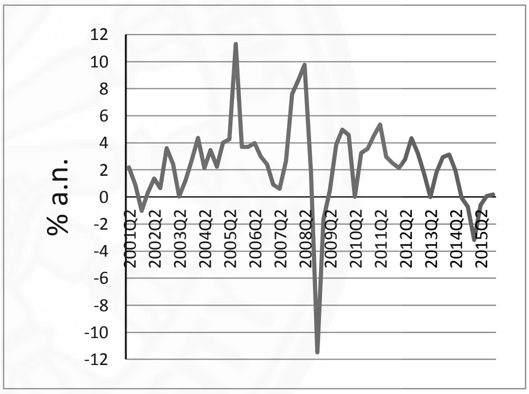
Figure D.1

Data Figures

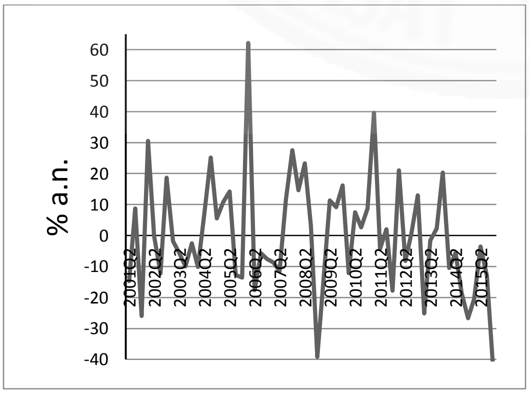
1) Core Inflation ($\Delta lnP_t^{Core} \times 4$)



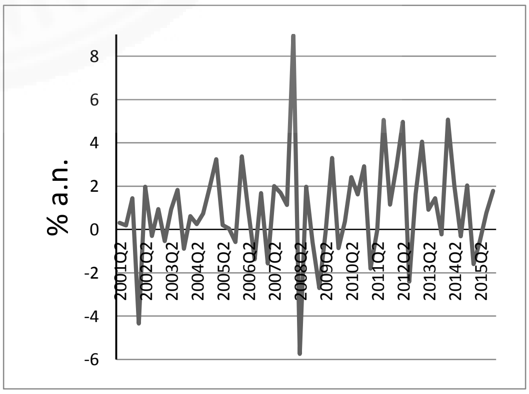
2) Headline Inflation ($\Delta lnP_t^{HL} \times 4$)



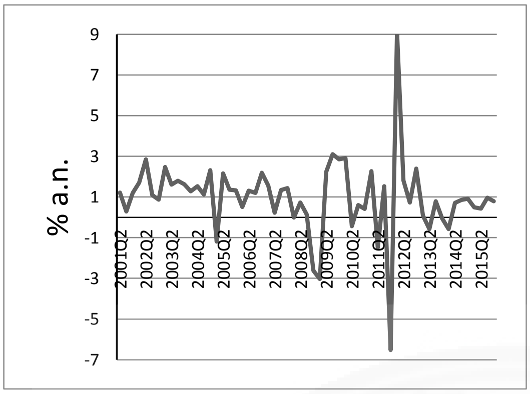
3) Investment Deflator ($\Delta lnP_t^{def,i} \times 4$)



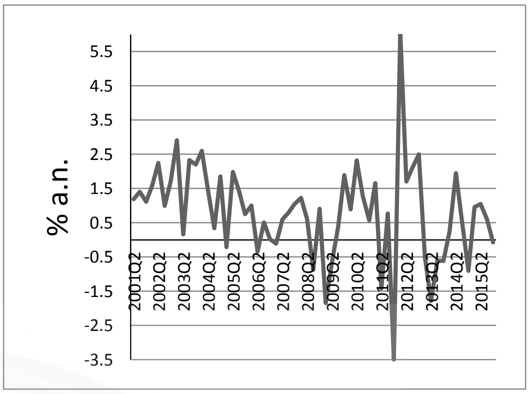
4) Real Wages ($\Delta ln(W_t/P_t^{HL}) \times 4$)



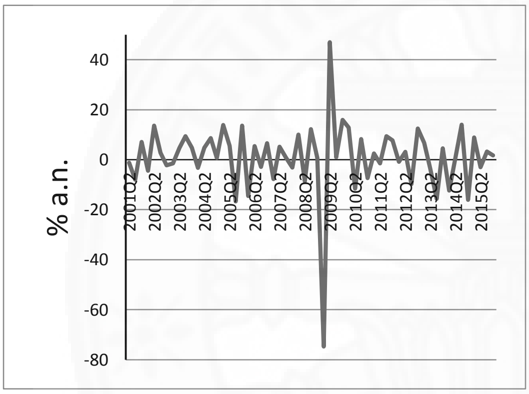
5) Real GDP ($\Delta lnY_t \times 4$)



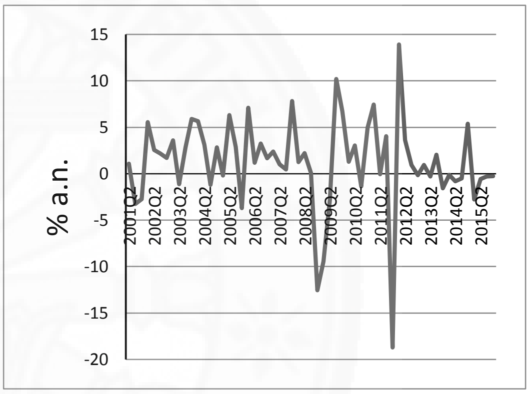
6) Real Consumption ($\Delta lnC_t \times 4$)



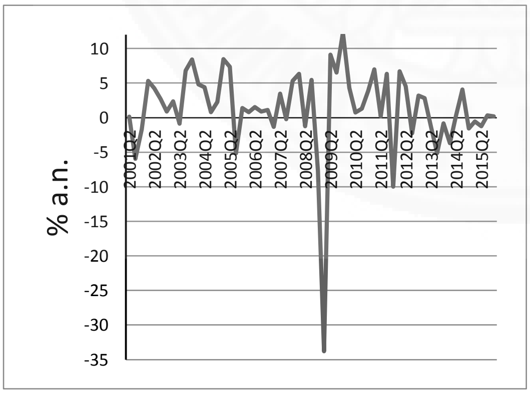
7) Real Investment ($\Delta lnI_t \times 4$)



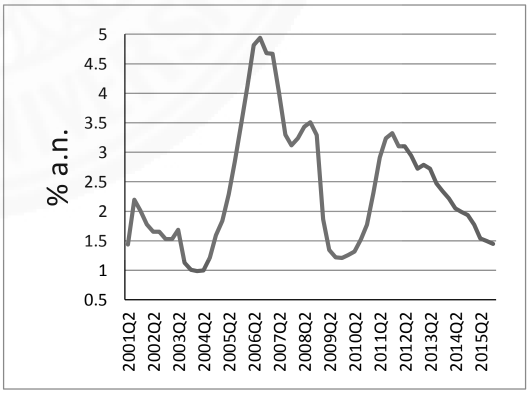
8) Real Export ($\Delta ln\tilde{X}_t \times 4$)



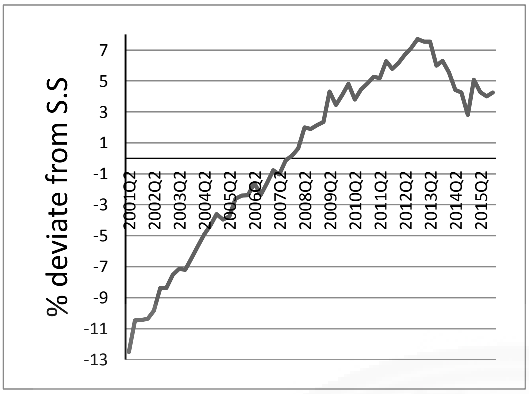
9) Real Import ($\Delta ln\widetilde{M}_t \times 4$)



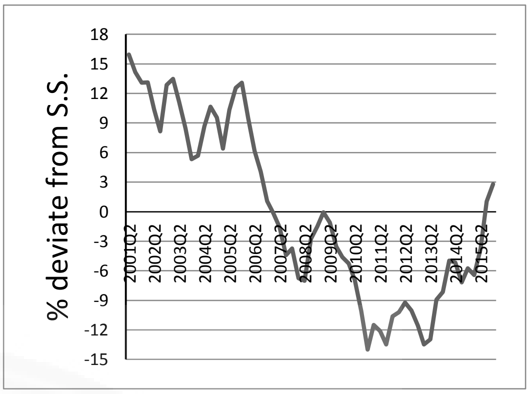
10) RP1 (R_t)



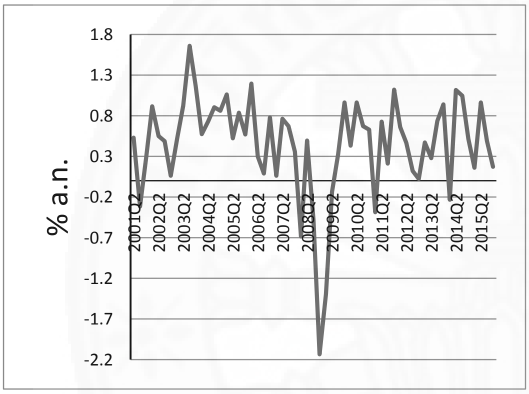
11) Demeaned Work Hours ($\widehat{H}_t$)



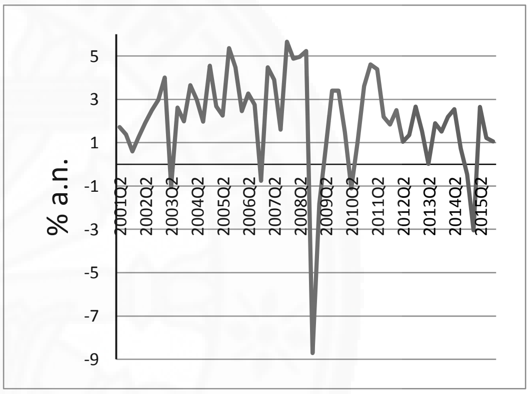
12) Demeaned RER ($\widehat{RER}_t$)



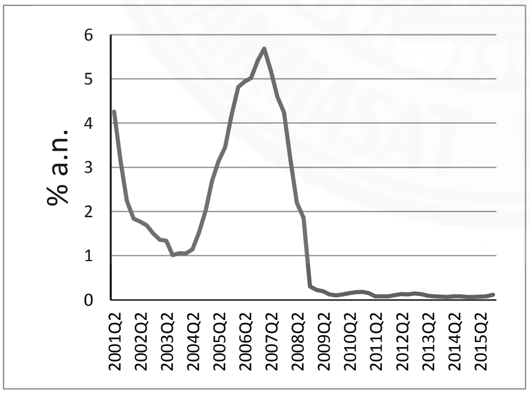
13) Real U.S. GDP ($ln\Delta Y_t^* \times 4$)



14) U.S. Headline Inflation (π_t^*)



15) FED Rate (R_t^*)



Source: National Economic and Social Development Board (NESDB), National Statistical Office (NSO), Bank of Thailand (BOT), Minister of Commerce (MOC), U.S. Bureau of Economic Analysis (BEA), and U.S. Federal Reserve System (FED).

APPENDIX E
VAR ESTIMATION RESULTS

E.1 The Government VAR Shock Processes

E.1.1 The Structure Form of the Government VAR Shock Processes

$$\Gamma_0 \tau_t = \Gamma(L)\tau_{t-1} + \varepsilon_{\tau,t}, \qquad \varepsilon_{\tau,t} \sim N(0, \Sigma_\tau) \tag{E.1}$$

where $\tau_t = \begin{bmatrix} \hat{\tau}_t^k & \hat{\tau}_t^y & \hat{\tau}_t^c & \hat{\tau}_t^w & \tilde{G}_t \end{bmatrix}'$

$\tilde{G}_t$ is the detrended (HP-filtered) government expenditures data.[31]

E.1.2 The Reduced Form of Government VAR Shock Processes

$$\tau_t = B_{G1}\tau_{t-1} + B_{G2}\tau_{t-2} + e_{\tau,t}, \qquad e \sim N(0, \sigma_\tau) \tag{E.1*}$$

Where

$$B_{G1} = \begin{bmatrix} 0.9 & 0 & 0 & 0 & 0 \\ 0 & 0.73 & 0.111 & 0 & -0.016 \\ 0 & -0.172 & 0.616 & 0 & 0.043 \\ 0 & 0 & 0 & 0.9 & 0 \\ 0 & 0.246 & 0.035 & 0 & 0.314 \end{bmatrix}, B_{G2} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & -0.015 & 0.035 & 0 & 0.01 \\ 0 & 0.301 & 0.186 & 0 & 0.051 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & -0.606 & 0.360 & 0 & 0.110 \end{bmatrix},$$

$$\sigma_\tau = \begin{bmatrix} 0.01 & 0 & 0 & 0 & 0 \\ 0 & 0.0065 & 0 & 0 & 01 \\ 0 & 0 & 0.0115 & 0 & 0 \\ 0 & 0 & 0 & 0.01 & 0 \\ 0 & 0 & 0 & 0 & 0.0267 \end{bmatrix}.$$

---

[31]Note that all tax rates are the demean data, i.e. $\hat{\tau}_t^i = \left(\tau_t^i - \bar{\tau}^i\right)/\bar{\tau}^i \quad , \forall\, i = y, c$. For $\hat{\tau}_t^k$ and $\hat{\tau}_t^w$, their coefficients are calibrated, while the others are estimated.

E.2 The Foreign Economy VAR Shock Processes

E.2.1 The Structure Form of Foreign Economy VAR Shock Processes

$$F_0 X_t^* = F(L)X_{t-1}^* + \varepsilon_{x^*,t} \qquad \varepsilon_{x^*,t} \sim N(0, \Sigma_{x^*}) \tag{E.2}$$

Where $X_t^* = [\pi_t^* \quad \hat{y}_t^* \quad R_t^*]'$.

We assume that the foreign inflation, output and interest rate are exogenous variables. It is given that the vector $X_t^* = [\pi_t^* \quad \hat{y}_t^* \quad R_t^*]'$. Note that π_t^* is the quarterly foreign inflation, R_t^* is the quarterly foreign interest rate and $\hat{y}_t^*$ is the quarterly foreign output applied with HP-filter.

E.2.2 The Reduced Form of Foreign Economy VAR Shock Processes

$$X_t^* = B_{F1} X_{t-1}^* + B_{F2} X_{t-2}^* + B_{F3} X_{t-3}^* + B_{F4} X_{t-4}^* + e_{x^*,t} \qquad e_{x^*,t} \sim N(0, \sigma_{x^*}) \tag{E.2*}$$

$$B_{F1} = \begin{bmatrix} 0.282 & 0.087 & -0.067 \\ -0.062 & 1.2 & -0.002 \\ -0.02 & -0.049 & 1.275 \end{bmatrix}, B_{F2} = \begin{bmatrix} 0.124 & -0.046 & 0.147 \\ 0.324 & -0.405 & 0.188 \\ 0.203 & -0.014 & -0.136 \end{bmatrix},$$

$$B_{F3} = \begin{bmatrix} 0.446 & -0.006 & -0.116 \\ -0.378 & 0.003 & 0.390 \\ -0.06 & 0.12 & 0.097 \end{bmatrix}, B_{F4} = \begin{bmatrix} 0.028 & -0.105 & 0.112 \\ 0.606 & -0.056 & -0.474 \\ 0.101 & -0.005 & -0.287 \end{bmatrix},$$

$$\sigma_{x^*} = \begin{bmatrix} 0.0258 & 0 & 0 \\ 0 & 0.0337 & 0 \\ -0.0026 & 0.0057 & 0.023 \end{bmatrix}.$$

APPENDIX F

EXPLANATIONS OF THE RELATIONSHIP BETWEEN THE DEGREE OF ERPT AND THE DEGREE OF PTF

This section provides the examples of the mechanism of monetary policy transmission (MPT) to explain the relationship between the degree of ERTP and the degree of PTF. This section analyzes the four cases: *Case I* is the case of the monetary policy under CITR with the complete degree of ERPT, *Case II* is the case of the monetary policy under CITR with no degree of ERPT, *Case III* is the case of the monetary policy under HITR with the complete degree of ERPT and *Case IV* is the case of the monetary policy under HITR with the no degree of ERPT.

Figure F.1 shows the mechanism of MPT in *Case I*. Once core inflation ($\hat{\pi}_{t-1}^{Core}$) increase, the central bank will stabilize the economy by increasing the policy rate ($\hat{R}_t$). On the interest rate channel of MPT, an increase in the policy rate ($\hat{R}_t$) causes output gap ($\hat{y}_t$) decrease and eventually core inflation ($\hat{\pi}_t^{Core}$) decease. On the exchange rate channel of MPT, an increase in the policy rate ($\hat{R}_t$) causes the capital inflows so that nominal exchange rate ($\widehat{NER}_t$) decrease, imported goods inflation ($\hat{\pi}_t^{m,c}$) decrease, the current account ($X - M$) decease, output gap ($\hat{y}_t$) decrease and eventually core inflation ($\hat{\pi}_t^{Core}$) decease. For *Case I*, MPT is effective in both interest rate and exchange rate channels thank to the complete degree of ERPT. Therefore, the calculated degree of PTF is 4.000.

Figure F.2 shows the mechanism of MPT in *Case II*. Once core inflation ($\hat{\pi}_{t-1}^{Core}$) increase, the central bank will stabilize the economy by increasing the policy rate ($\hat{R}_t$). On the interest rate channel of MPT, an increase in the policy rate ($\hat{R}_t$) causes output gap ($\hat{y}_t$) decrease and eventually core inflation ($\hat{\pi}_t^{Core}$) decease. For *Case II*, MPT is effective only in the interest rate channel. However, the calculated degree of PTF is also 4.000 as equal as *Case I*. In summary, the degrees of PTF in the monetary policy under HITR between the complete and no degree of ERPT are not different.

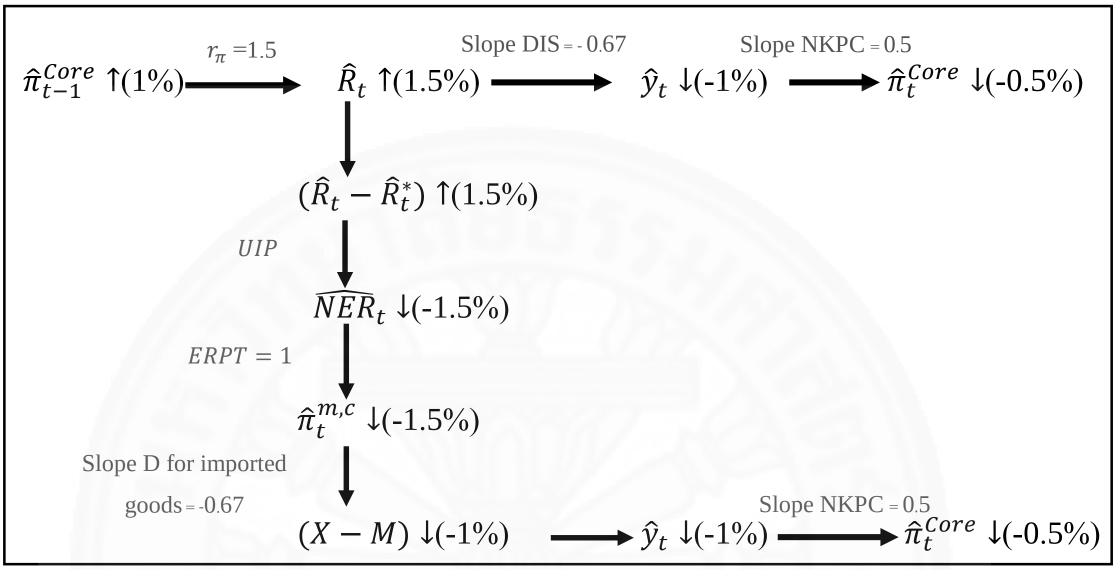
Figure F.3 shows the mechanism of monetary policy transmission (MPT) in *Case III*. Once headline inflation ($\hat{\pi}_{t-1}^{HL}$) increase, the central bank will stabilize the economy by increasing the policy rate ($\hat{R}_t$). On the interest rate channel of MPT, an increase in the policy rate ($\hat{R}_t$) causes output gap ($\hat{y}_t$) decreases, core inflation ($\hat{\pi}_t^{Core}$) deceases and eventually headline inflation ($\hat{\pi}_t^{HL}$) deceases. On the exchange rate channel of MPT, an increase in the policy rate ($\hat{R}_t$) causes the capital inflows so that nominal exchange rate ($\widehat{NER}_t$) decreases, imported goods inflation ($\hat{\pi}_t^{m,c}$) decreases, the current account ($X - M$) deceases, output gap ($\hat{y}_t$) decreases, core inflation ($\hat{\pi}_t^{Core}$) deceases and eventually headline inflation ($\hat{\pi}_t^{HL}$) deceases. Moreover, a decrease in imported goods inflation ($\hat{\pi}_t^{m,c}$) directly causes a decrease in headline inflation ($\hat{\pi}_t^{HL}$). For *Case III*, MPT is effective in both interest rate and exchange rate channels thank to the complete degree of ERPT. Therefore, the calculated degree of PTF is 3.306.

Figure F.4 shows the mechanism of monetary policy transmission (MPT) in *Case IV*. Once headline inflation ($\hat{\pi}_{t-1}^{HL}$) increases, the central bank will stabilize the economy by increasing the policy rate ($\hat{R}_t$). On the interest rate channel of MPT, an increase in the policy rate ($\hat{R}_t$) causes output gap ($\hat{y}_t$) decrease core inflation ($\hat{\pi}_t^{Core}$) decease and eventually headline inflation ($\hat{\pi}_t^{HL}$) deceases. For *Case IV*, MPT is effective only in the interest rate channel. There, the calculated degree of PTF is also 6.250. In summary, the degrees of PTF in the monetary policy under HITR with the complete is lower than the one with no degree of ERPT. Table F.1 summarize the degree of PTF of the four cases, which relate to Figure F.5 from our model. The result can be concluded that in the monetary policy under CITR, the degree of ERPT does not affect the degree of PTF. While in the monetary policy under HITR, the higher degree of ERPT causes the lower degree of PTF.

Case I:The Monetary Policy under CITR with the Complete Degree of ERPT

Figure F.1

The Case of Monetary Policy under CITR with the Complete Degree of ERPT



Source: Author's Calculation

In sum $\hat{y}_t = (-1\%) + (-1\%) = -2\%$

$\hat{\pi}_t^{Core} = (-0.5\%) + (-0.5\%) = -1\%$

Therefore $Var(\hat{y}) = \frac{\sum_{k=0}^{0}(\hat{y}_{t+k} - 0\%)^2}{1} = \frac{(-2\% - 0\%)^2}{1} = 4\%$

$$Var(\hat{\pi}^{Core}) = \frac{\sum_{k=0}^{0}\left(\hat{\pi}_{t+k}^{Core} - 0\%\right)^2}{1} = \frac{(-1\% - 0\%)^2}{1} = 1\%$$

$$PTF_{(ERPT=1)}^{CITR} = \frac{Var(\hat{y})}{Var(\hat{\pi}^{Core})} = \frac{4\%}{1\%} = 4.000$$

Case II : The Monetary Policy under CITR with No Degree of ERPT

Figure F.2

The Case of Monetary Policy under CITR with No Degree of ERPT

$$
\begin{array}{l}
\hat{\pi}_{t-1}^{Core} \uparrow(1\%) \xrightarrow{r_\pi = 1.5} \hat{R}_t \uparrow(1.5\%) \xrightarrow{\text{Slope DIS} = -0.67} \hat{y}_t \downarrow(-1\%) \xrightarrow{\text{Slope NKPC} = 0.5} \hat{\pi}_t^{Core} \downarrow(-0.5\%) \\
\qquad\qquad\qquad \downarrow \\
\qquad\qquad (\hat{R}_t - \hat{R}_t^{*}) \uparrow(1.5\%) \\
\qquad\qquad\qquad \downarrow \; UIP \\
\qquad\qquad \widehat{NER}_t \downarrow(-1.5\%)
\end{array}
$$

Source: Author's Calculation

In sum $\quad \hat{y}_t = -1\% \qquad \hat{\pi}_t^{Core} = -0.5\%$

Therefore $\quad Var(\hat{y}) = \frac{\sum_{k=0}^{0}(\hat{y}_{t+k} - 0\%)^2}{1} = \frac{(-1\% - 0\%)^2}{1} = 1\%$

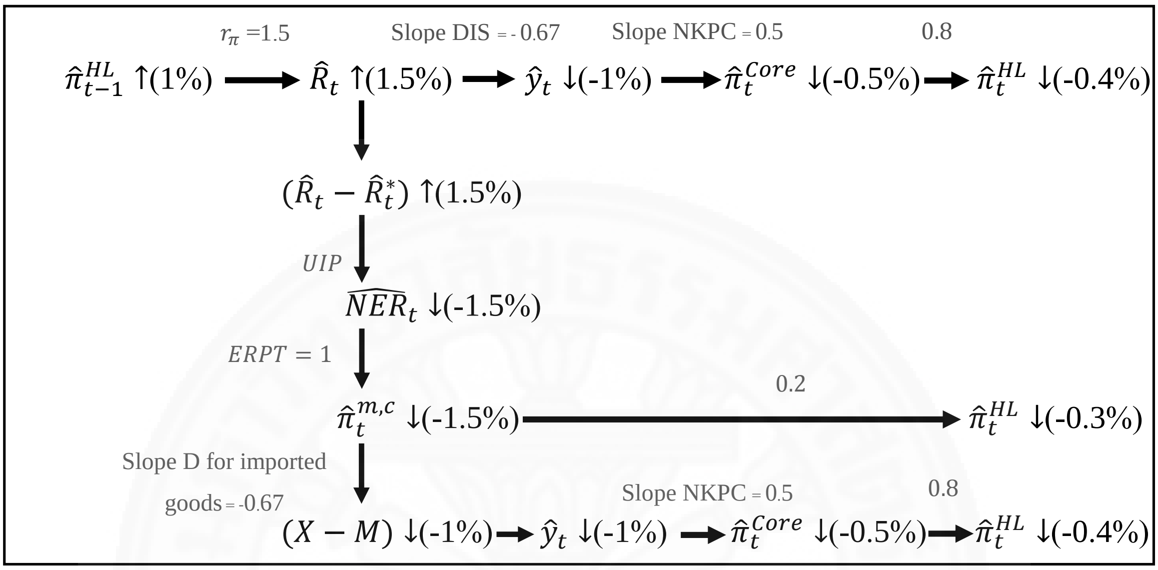
$$Var(\hat{\pi}^{Core}) = \frac{\sum_{k=0}^{0}\left(\hat{\pi}_{t+k}^{Core} - 0\%\right)^2}{1} = \frac{(-0.5\% - 0\%)^2}{1} = 0.25\%$$

$$PTF_{(ERPT=0)}^{CITR} = \frac{Var\ (\hat{y})}{Var(\hat{\pi}^{Core})} = \frac{1\%}{0.25\%} = 4.000$$

Case III: The Monetary Policy under HITR with the Complete Degree of ERPT

Figure F.3

The Case of Monetary Policy under HITR with the Complete Degree of ERPT



Source: Author’s Calculation

Assume $\hat{\pi}^{HL}_t = 0.8\hat{\pi}^{Core}_t + 0.2\,\hat{\pi}^{m,c}_t$

In sum $\hat{y}_t = (-1\%) + (-1\%) = -2\%$

$\hat{\pi}^{HL}_t = (-0.4\%) + (-0.3\%) + (-0.4\%) = -1.1\%$

Therefore $Var(\,\hat{y}) = \frac{\sum_{k=0}^{0}(\hat{y}_{t+k}-0\%)^2}{1} = \frac{(-2\%-0\%)^2}{1} = 4\%$

$Var(\,\hat{\pi}^{HL}) = \frac{\sum_{k=0}^{0}\left(\hat{\pi}^{HL}_{t+k}-0\%\right)^2}{1} = \frac{(-1.1\%-0\%)^2}{1} = 1.21\%$

$$PTF^{HITR}_{(ERPT=1)} = \frac{Var\,(\hat{y})}{Var(\hat{\pi}^{HL})} = \frac{4\%}{1.21\%} = 3.300$$

Case IV: The Monetary Policy under HITR with No Degree of ERPT

Figure F.4

The Case of Monetary Policy under HITR with No Degree of ERPT

$$\hat{\pi}_{t-1}^{HL} \uparrow(1\%) \xrightarrow{r_\pi = 1.5} \hat{R}_t \uparrow(1.5\%) \xrightarrow{\text{Slope DIS} = -0.67} \hat{y}_t \downarrow(-1\%) \xrightarrow{\text{Slope NKPC} = 0.5} \hat{\pi}_t^{Core} \downarrow(-0.5\%) \xrightarrow{0.8} \hat{\pi}_t^{HL} \downarrow(-0.4\%)$$

$$\hat{R}_t \uparrow(1.5\%) \longrightarrow (\hat{R}_t - \hat{R}_t^{*}) \uparrow(1.5\%) \xrightarrow{UIP} \widehat{NER}_t \downarrow(-1.5\%)$$

Source: Author's Calculation

In sum $\hat{y}_t = -1\%$ $\hat{\pi}_t^{HL} = -0.4\%$

Therefore $Var(\hat{y}) = \frac{\sum_{k=0}^{0}(\hat{y}_{t+k} - 0\%)^2}{1} = \frac{(-1\% - 0\%)^2}{1} = 1\%$

$$Var(\hat{\pi}^{HL}) = \frac{\sum_{k=0}^{0}\left(\hat{\pi}_{t+k}^{HL} - 0\%\right)^2}{1} = \frac{(-0.4\% - 0\%)^2}{1} = 0.16\%$$

$$PTF_{(ERPT=0)}^{HITR} = \frac{Var\,(\hat{y})}{Var(\hat{\pi}^{HL})} = \frac{1\%}{0.16\%} = 6.250$$

Table F.1

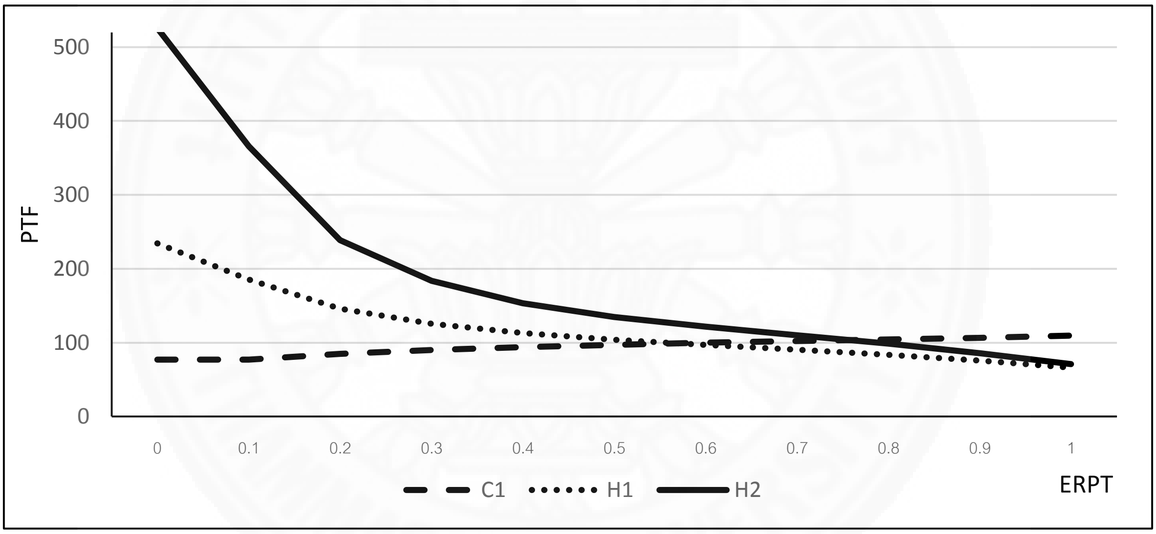
The Summary of the Degree of PTF in the Monetary Policy under CITR and HITR with the Complete and No Degree of ERPT

The Regimes\ ERTP	ERTP = 1	ERTP = 0
CITR	$PTF^{CITR}_{ERTP=1} = 4.000$	$PTF^{CITR}_{ERTP=0} = 4.000$
HITR	$PTF^{HITR}_{ERTP=1} = 3.306$	$PTF^{HITR}_{ERTP=0} = 6.250$

Source: Author's Calculation

Figure F.5

The Relationship between the Degree of ERPT and the Degree of PTF



Source: The Results from Table 4.11, Table 4.12 and Table 4.13

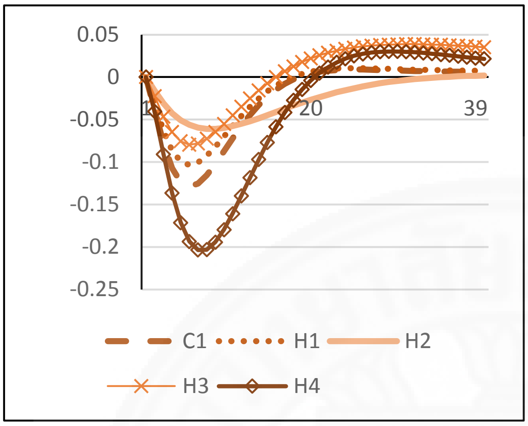
APPENDIX G
IMPULSE RESPONSE FUNCTIONS

This section shows the impulse responses of policy rate ($\hat{R}_t$), output gap ($\hat{y}_t$), core inflation ($\hat{\pi}_t^{Core}$), headline inflation ($\hat{\pi}_t^{HL}$) and real exchange rate ($\widehat{RER}_t$) to 18 shocks as follows: a stationary technology shock ($\varepsilon_{\varepsilon,t}$), a unit root technology shock ($\varepsilon_{\mu_z,t}$), a policy rate shock ($\varepsilon_{R,t}$), a domestic (core) markup prices shock ($\varepsilon_{\lambda_d,t}$), an imported consumption markup prices shock ($\varepsilon_{\lambda_{m,c},t}$), an imported investment markup prices shock ($\varepsilon_{\lambda_{m,i},t}$), an export markup prices shock ($\varepsilon_{\lambda_x,t}$), a consumption preferences shock ($\varepsilon_{\xi_c,t}$), a leisure preferences shock ($\varepsilon_{\xi_h,t}$), an investment specific technology shock ($\varepsilon_{\Upsilon,t}$), a risk premium shock ($\varepsilon_{\widetilde{\phi},t}$), an asymmetric technology shock ($\varepsilon_{\tilde{z}^*,t}$),a foreign output shock ($\varepsilon_{y^*,t}$), a foreign inflation shock ($\varepsilon_{\pi^*,t}$), a foreign interest rate shock ($\varepsilon_{R^*,t}$), a government expenditure shock ($\varepsilon_{g,t}$), a labour income tax shock ($\varepsilon_{\tau_y,t}$) and a labour pay roll tax ($\varepsilon_{\tau_w,t}$).

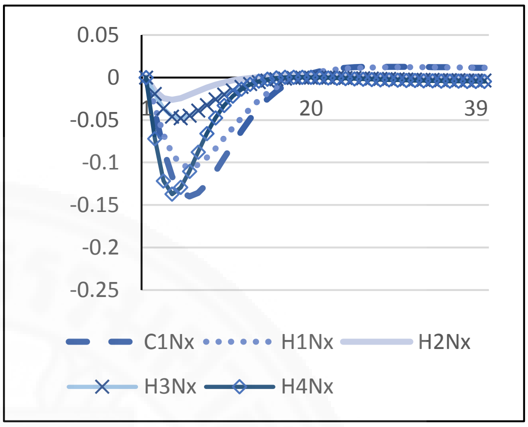
Figure G.1

The Impulse Response of a Stationary Technology Shock ($\varepsilon_{\varepsilon,t}$)

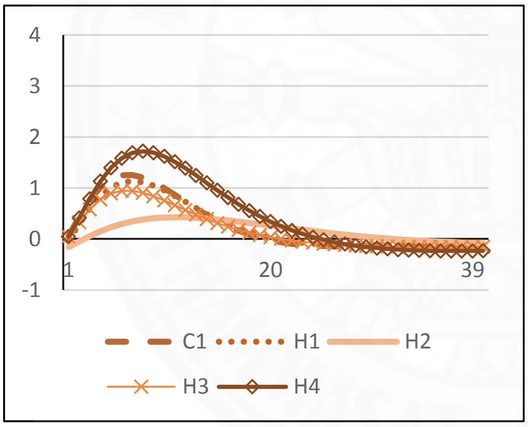
a) Response of $\hat{R}_t$ to $\varepsilon_{\varepsilon,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



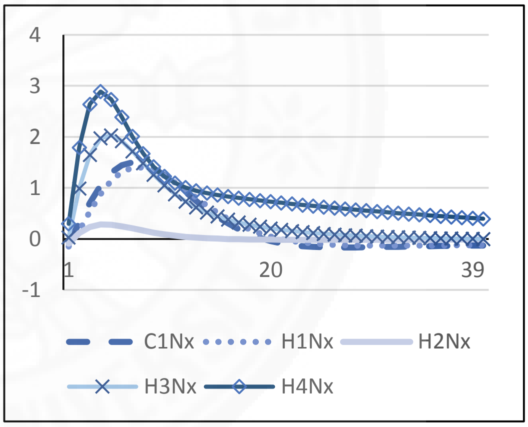
b) Response of $\hat{R}_t$ to $\varepsilon_{\varepsilon,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



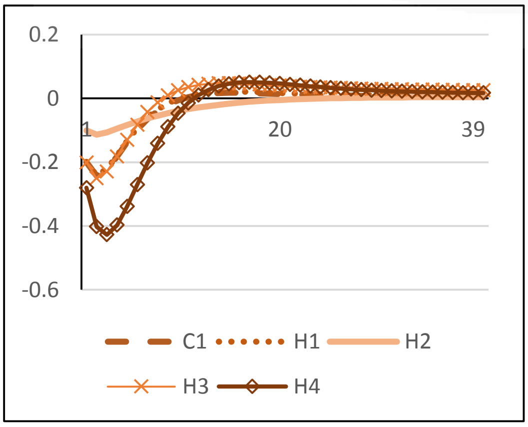
c) Response of $\hat{y}_t$ to $\varepsilon_{\varepsilon,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



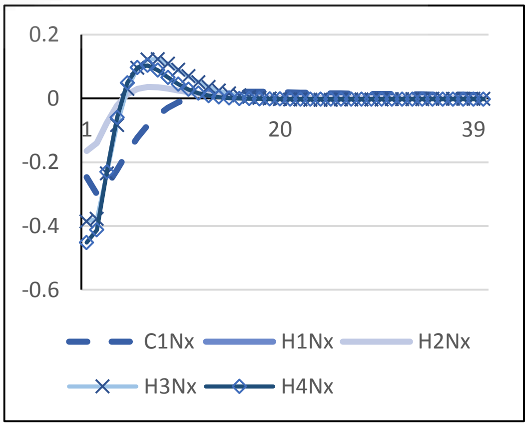
d) Response of $\hat{y}_t$ to $\varepsilon_{\varepsilon,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



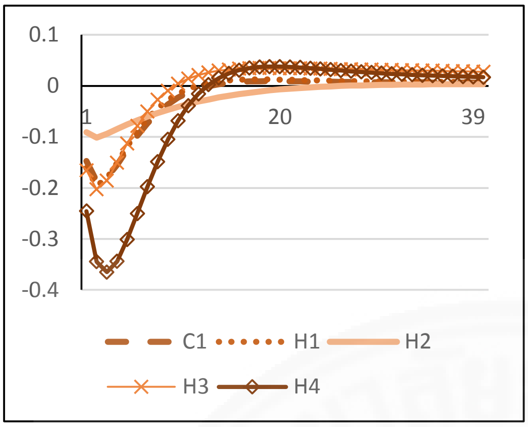
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\varepsilon,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



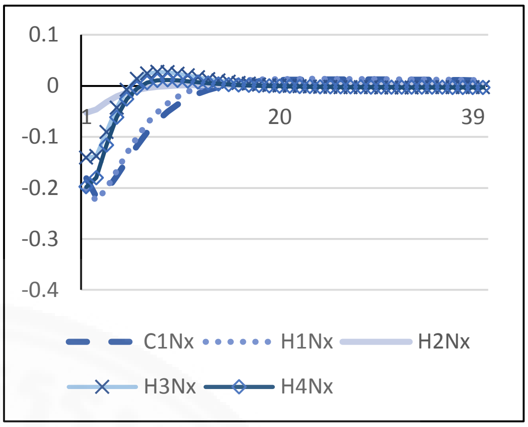
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\varepsilon,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



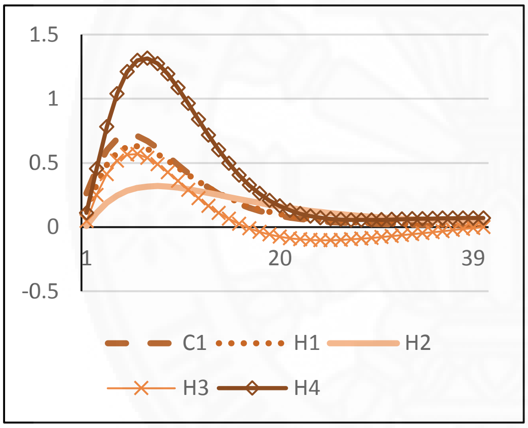
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\varepsilon,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



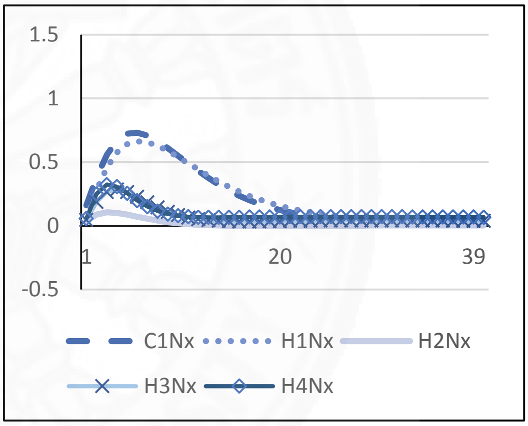
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\varepsilon,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\varepsilon,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\varepsilon,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

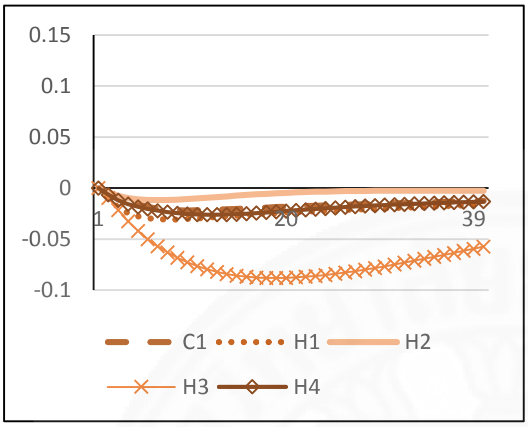


Source: Impulse Response Function based on Bayesian Inference

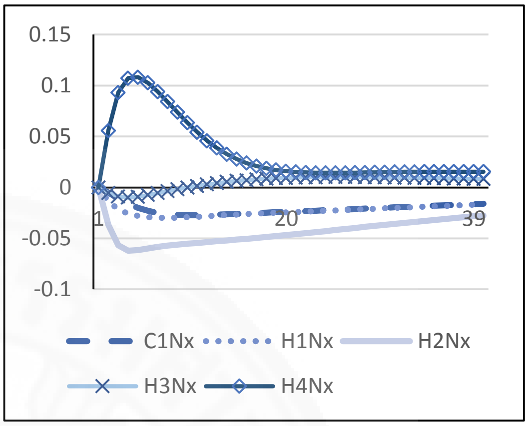
Figure G.2

The Impulse Response of a Unit Root Technology Shock ($\varepsilon_{\mu_z,t}$)

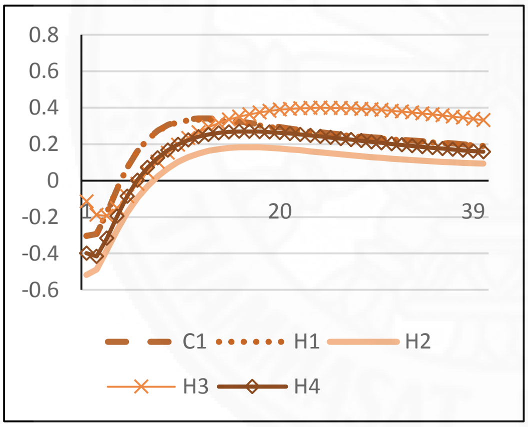
a) Response of $\hat{R}_t$ to $\varepsilon_{\mu_z,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



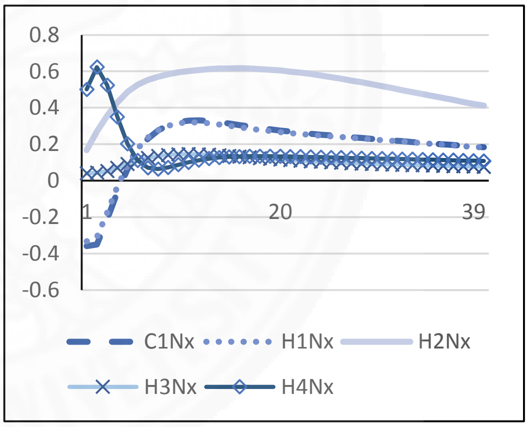
b) Response of $\hat{R}_t$ to $\varepsilon_{\mu_z,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



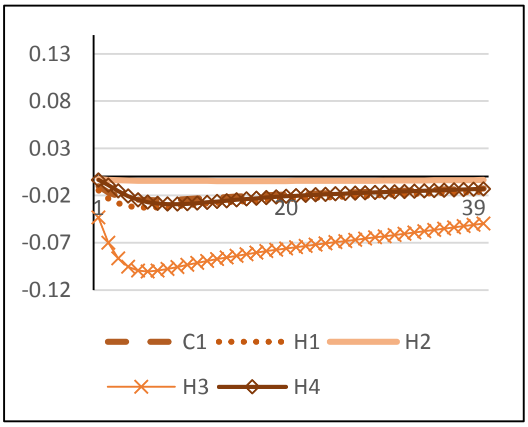
c) Response of $\hat{y}_t$ to $\varepsilon_{\mu_z,t}$in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



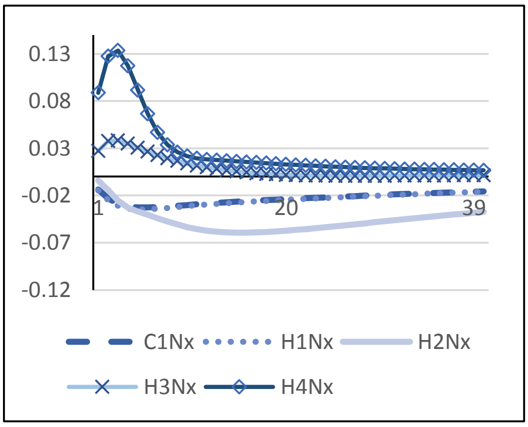
d) Response of $\hat{y}_t$ to $\varepsilon_{\mu_z,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



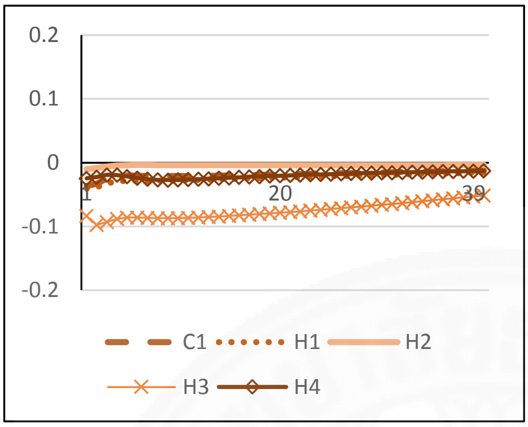
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\mu_z,t}$in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



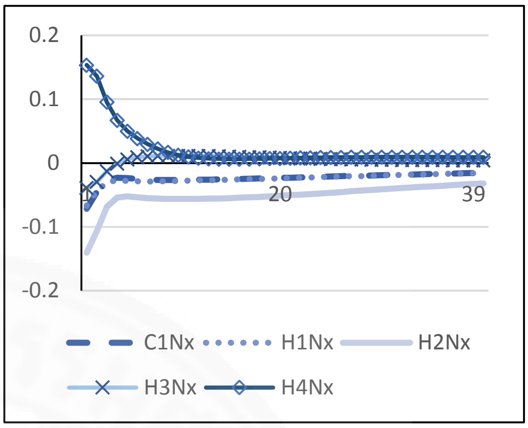
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\mu_z,t}$in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



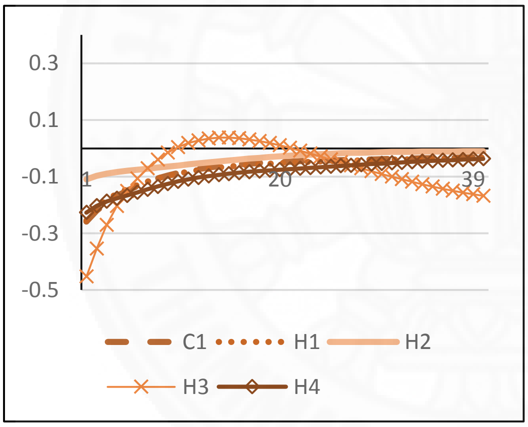
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\mu_z,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



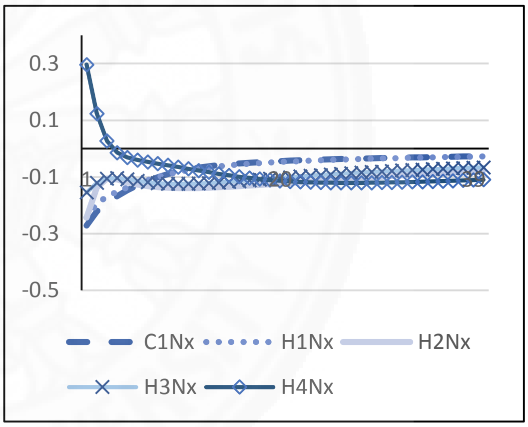
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\mu_z,t}$in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\mu_z,t}$in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\mu_z,t}$in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

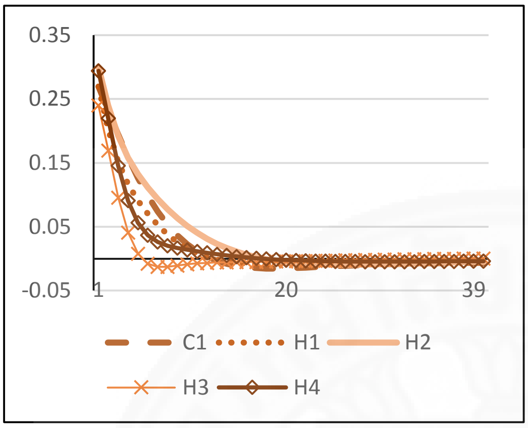


Source: Impulse Response Function based on Bayesian Inference

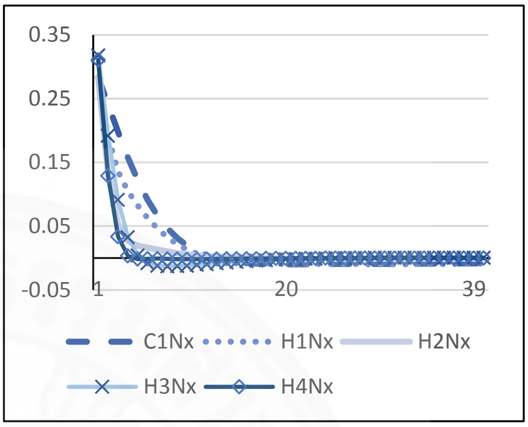
Figure G.3

The Impulse Response of the Policy Rate Shock ($\varepsilon_{R,t}$)

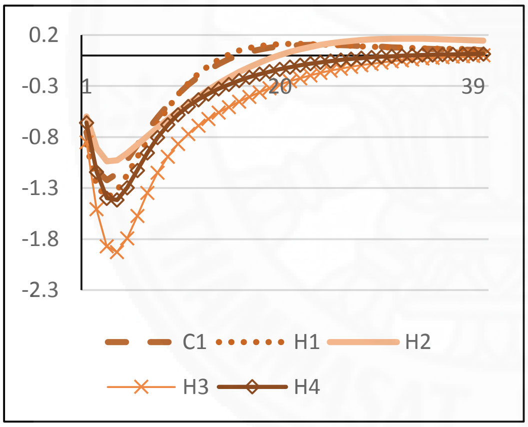
a) Response of $\hat{R}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



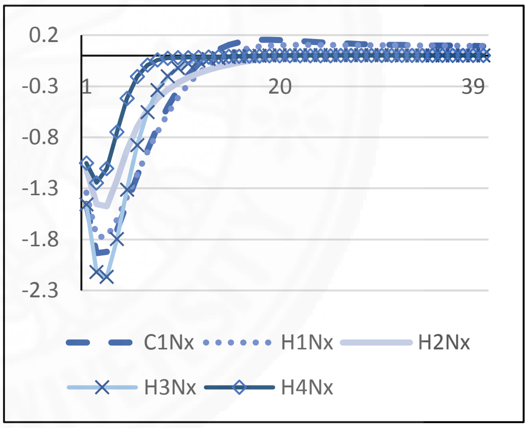
b) Response of $\hat{R}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



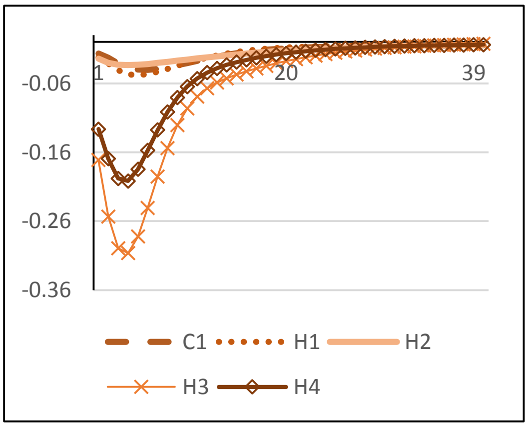
c) Response of $\hat{y}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



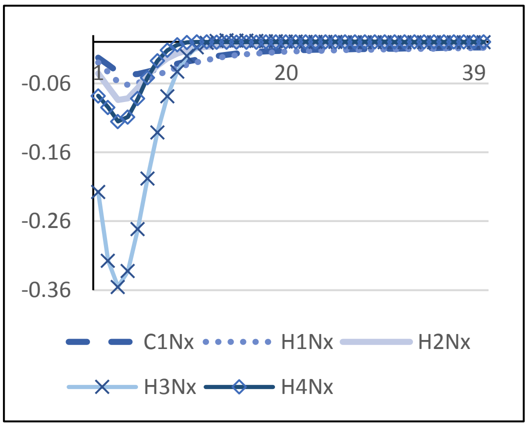
d) Response of $\hat{y}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



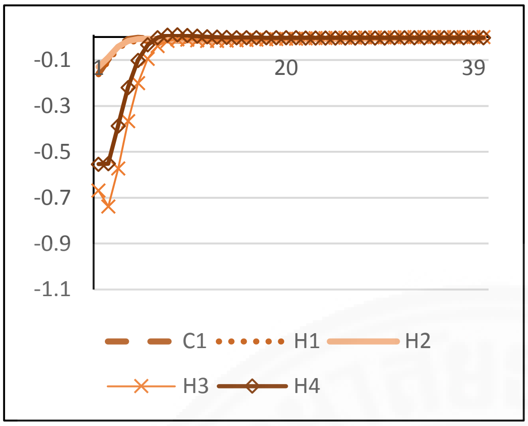
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{R,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



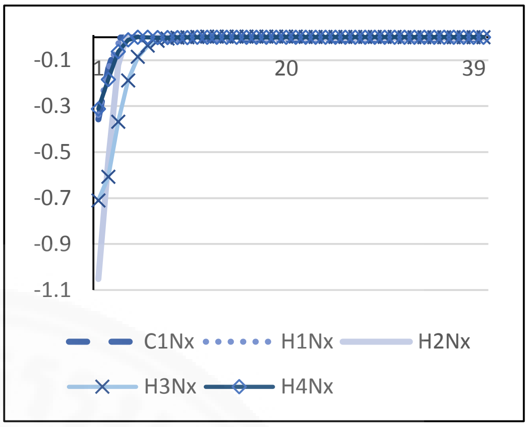
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{R,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



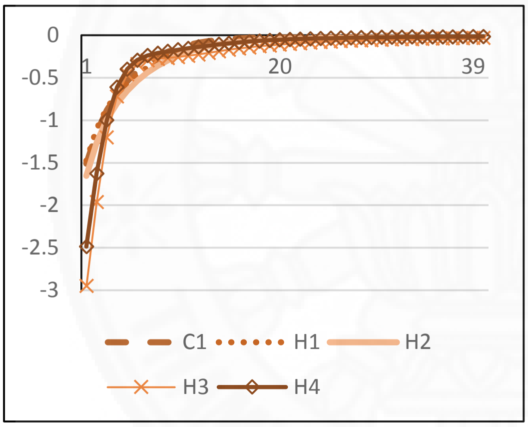
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{R,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



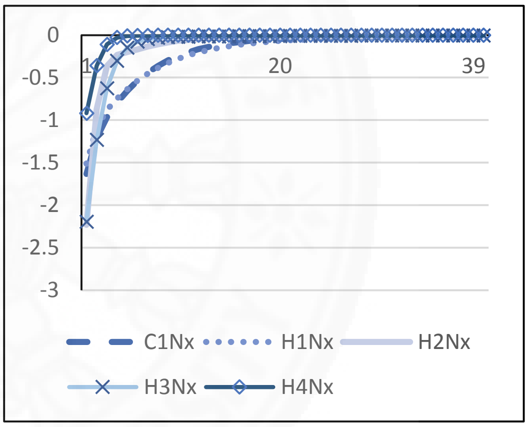
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{R,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{R,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

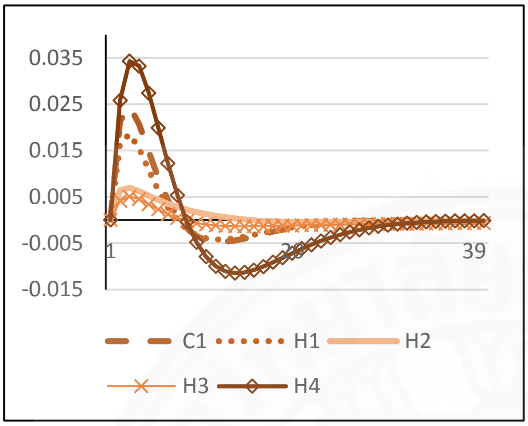


Source: Impulse Response Function based on Bayesian Inference

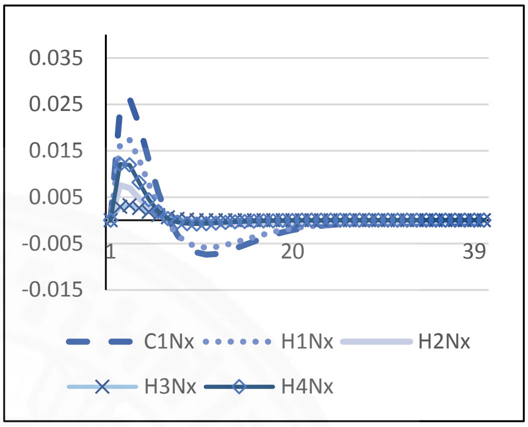
Figure G.4

The Impulse Response of a Domestic (Core) Markup Prices Shock ($\varepsilon_{\lambda_d,t}$)

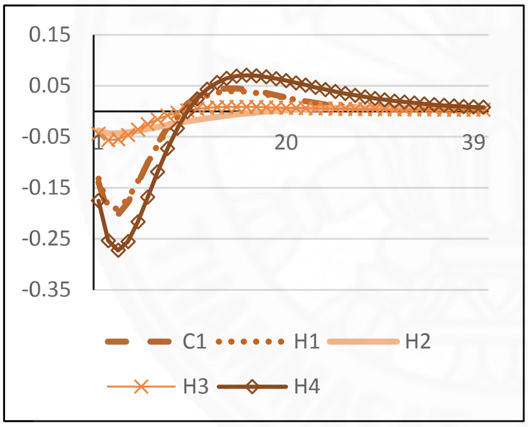
a) Response of $\hat{R}_t$ to $\varepsilon_{\lambda_d,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



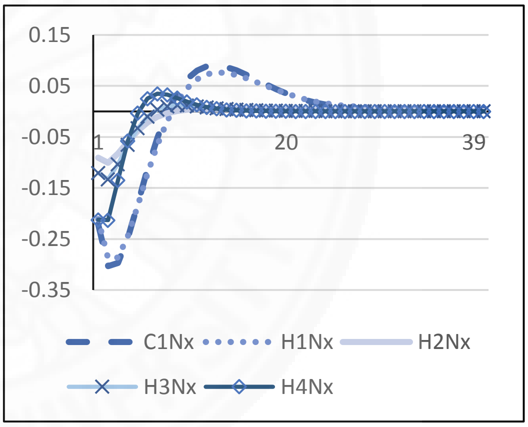
b) Response of $\hat{R}_t$ to $\varepsilon_{\lambda_d,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



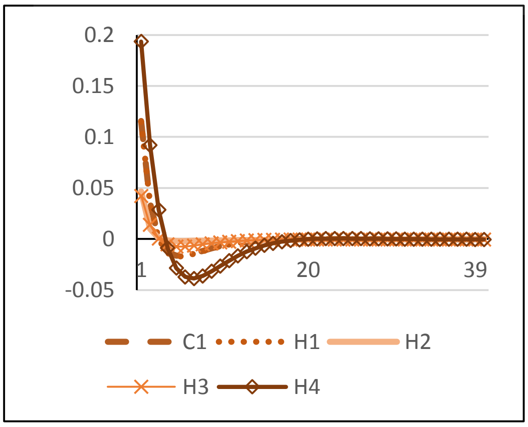
c) Response of $\hat{y}_t$ to $\varepsilon_{\lambda_d,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



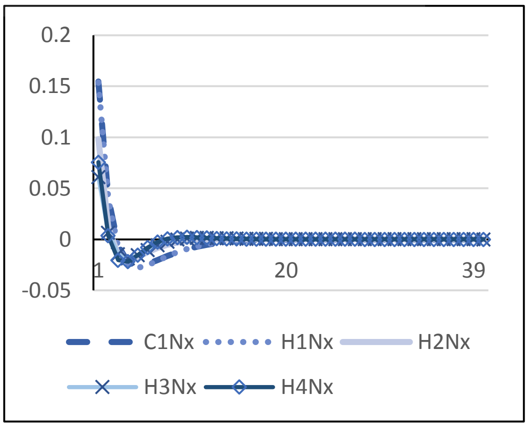
d) Response of $\hat{y}_t$ to $\varepsilon_{\lambda_d,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



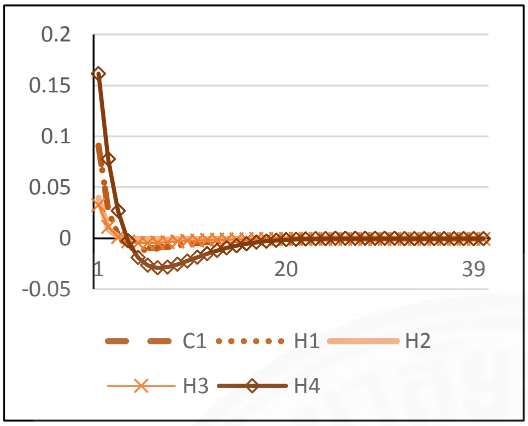
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\lambda_d,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



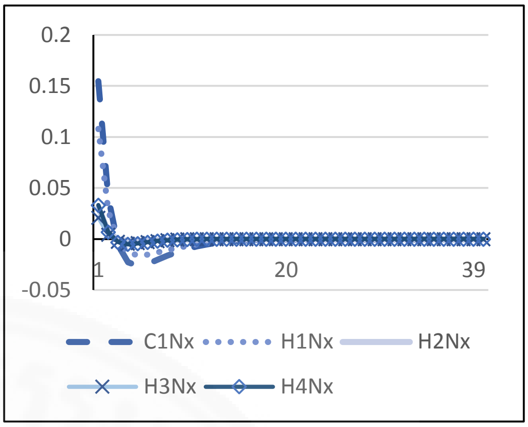
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\lambda_d,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



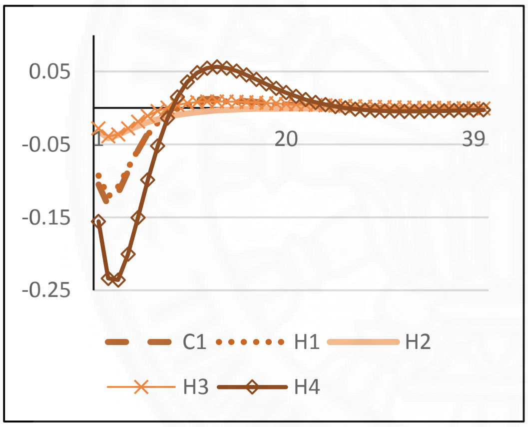
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\lambda_d,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



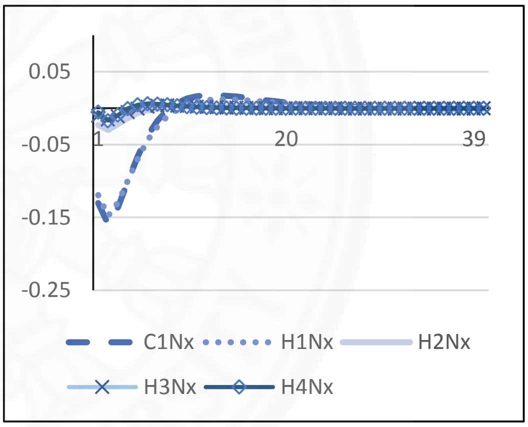
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\lambda_d,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\lambda_d,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\lambda_d,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

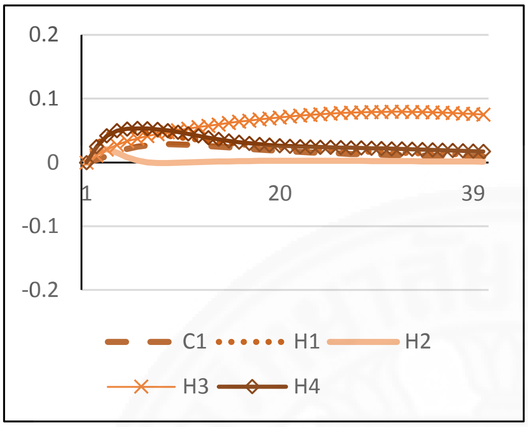


Source: Impulse Response Function based on Bayesian Inference

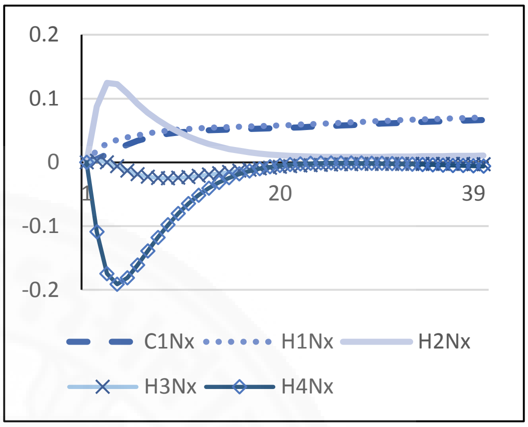
Figure G.5

The Impulse Response of an Imported Consumption Markup Prices Shock ($\varepsilon_{\lambda_{m,c},t}$)

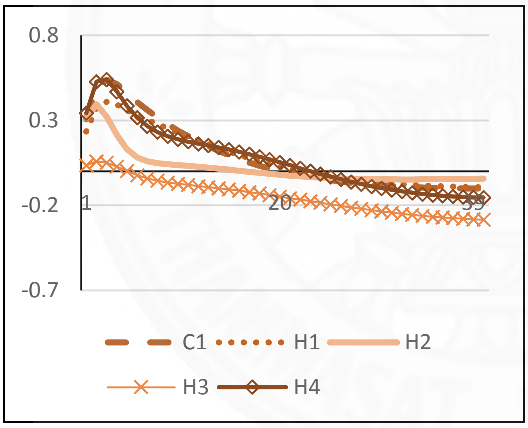
a) Response of $\hat{R}_t$ to $\varepsilon_{\lambda_{m,c},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



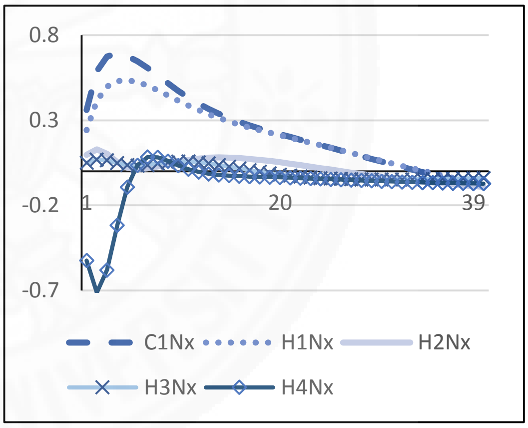
b) Response of $\hat{R}_t$ to $\varepsilon_{\lambda_{m,c},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



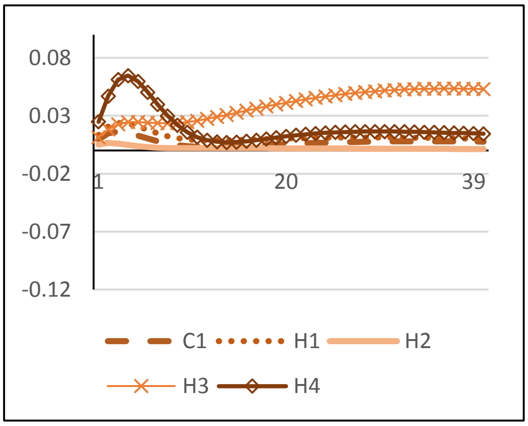
c) Response of $\hat{y}_t$ to $\varepsilon_{\lambda_{m,c},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



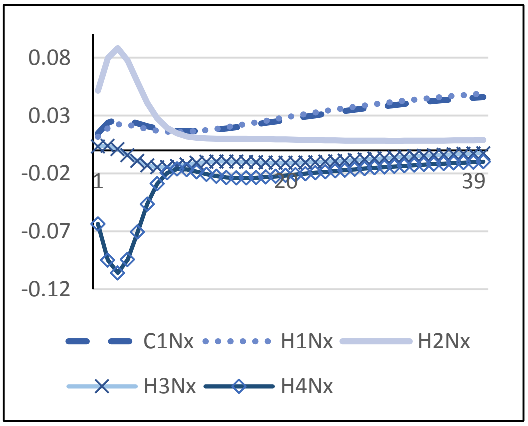
d) Response of $\hat{y}_t$ to $\varepsilon_{\lambda_{m,c},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



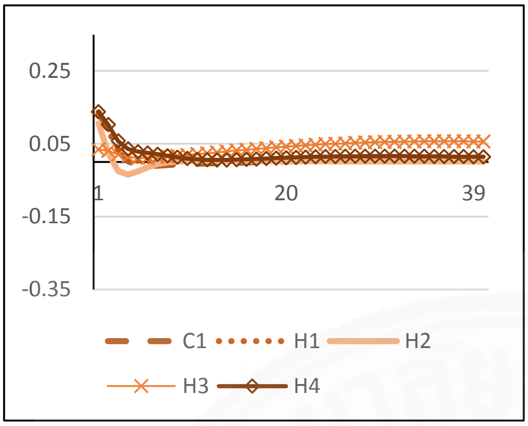
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\lambda_{m,c},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



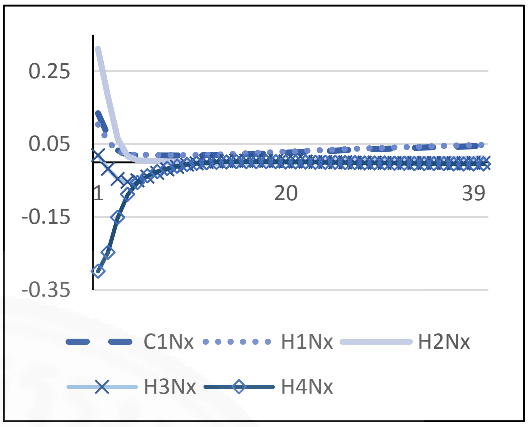
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\lambda_{m,c},t}$in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



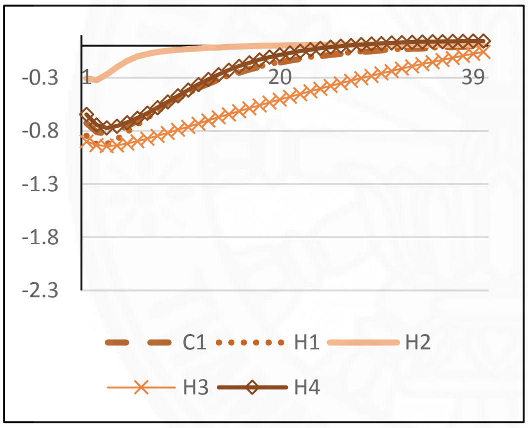
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\lambda_{m,c},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



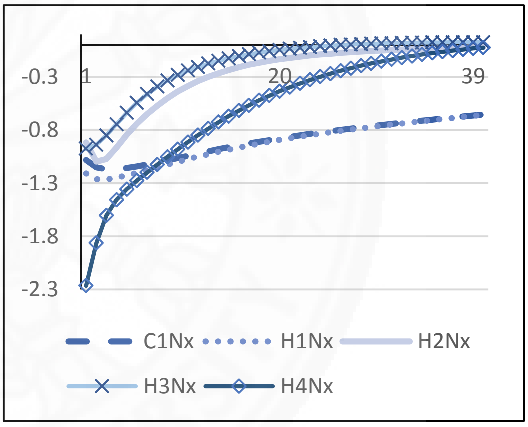
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\lambda_{m,c},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\lambda_{m,c},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\lambda_{m,c},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

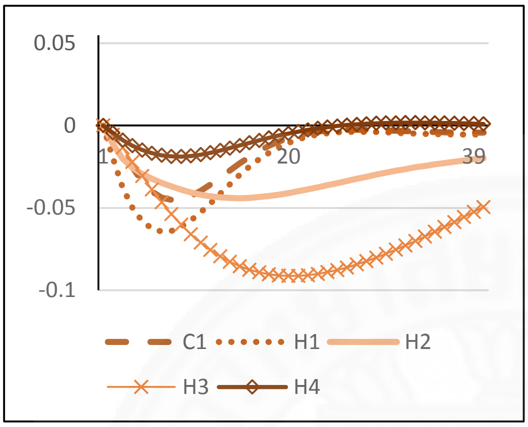


Source: Impulse Response Function based on Bayesian Inference

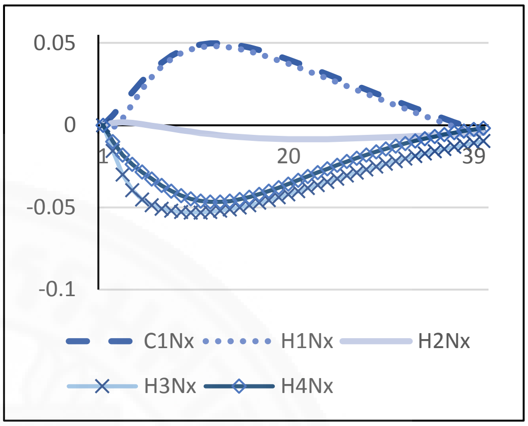
Figure G.6

The Impulse Response of an Imported Investment Markup Prices Shock ($\varepsilon_{\lambda_{m,i},t}$)

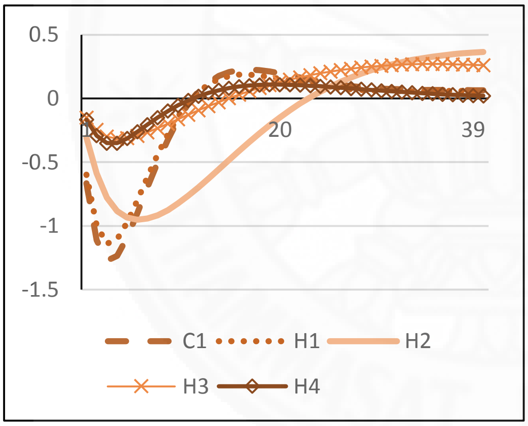
a) Response of $\hat{R}_t$ to $\varepsilon_{\lambda_{m,i},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



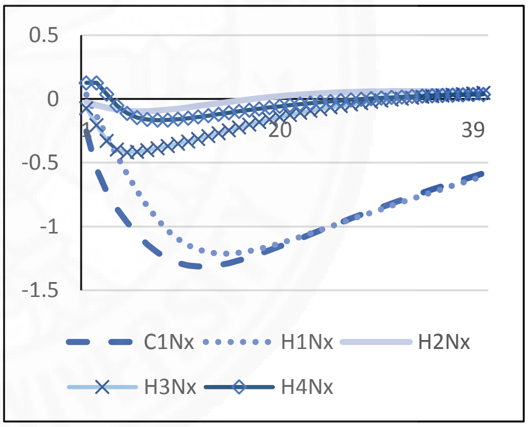
b) Response of $\hat{R}_t$ to $\varepsilon_{\lambda_{m,i},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



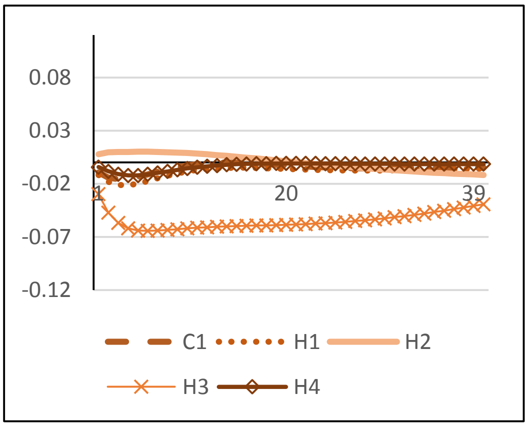
c) Response of $\hat{y}_t$ to $\varepsilon_{\lambda_{m,i},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



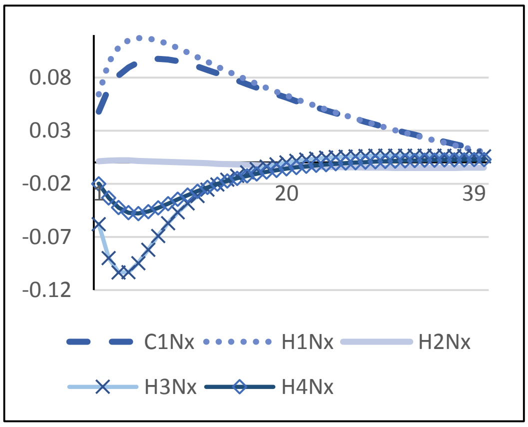
d) Response of $\hat{y}_t$ to $\varepsilon_{\lambda_{m,i},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



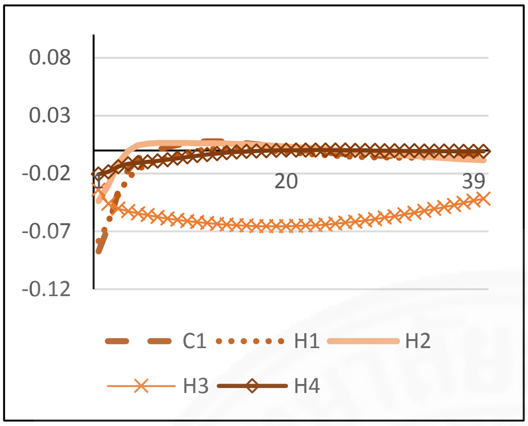
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\lambda_{m,i},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



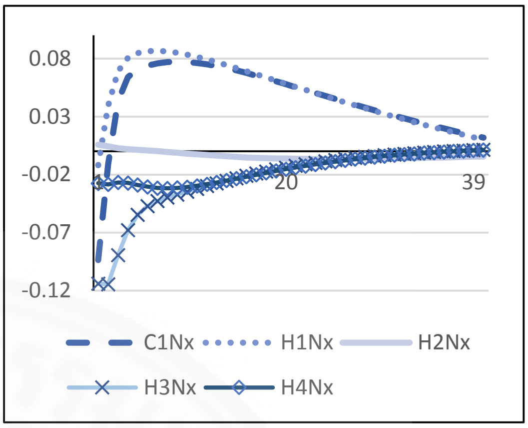
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\lambda_{m,i},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



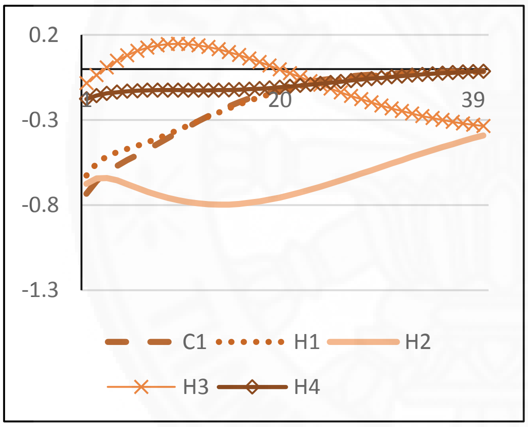
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\lambda_{m,i},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



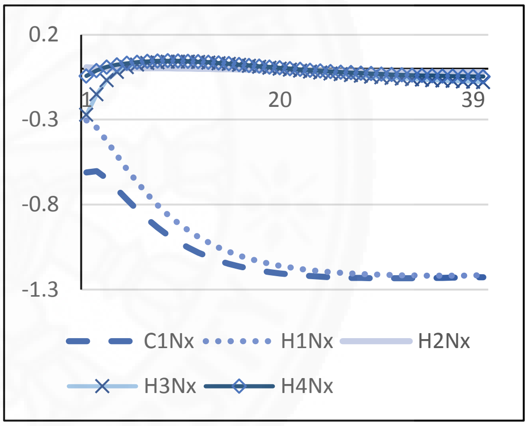
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\lambda_{m,i},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\lambda_{m,i},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\lambda_{m,i},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

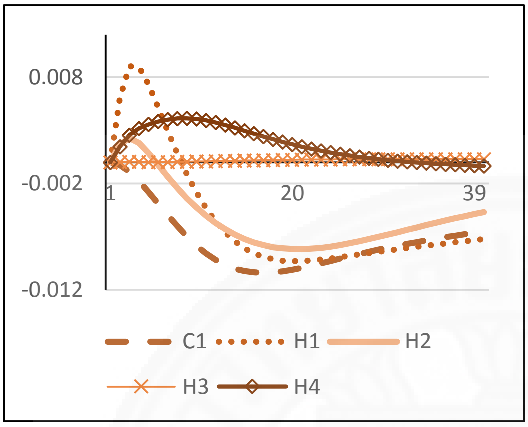


Source: Impulse Response Function based on Bayesian Inference

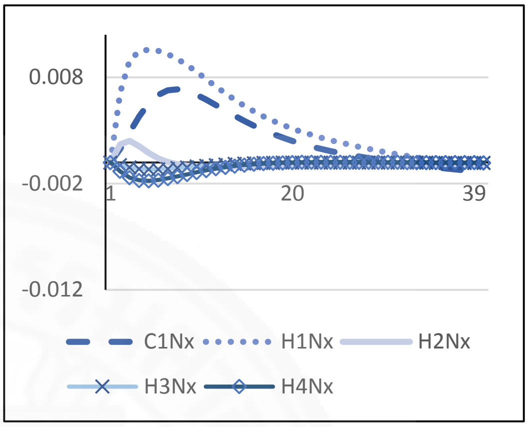
Figure G.7

The Impulse Response of an Export Markup Prices Shock ($\varepsilon_{\lambda_x,t}$)

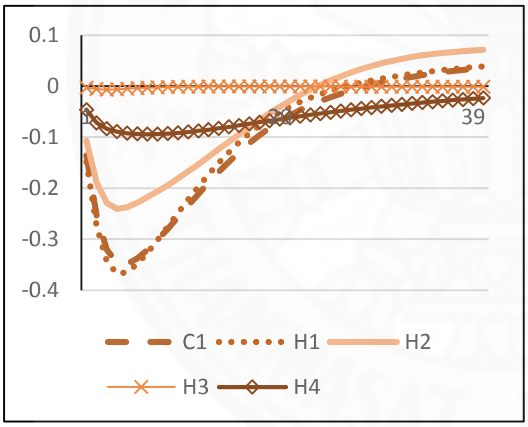
a) Response of $\hat{R}_t$ to $\varepsilon_{\lambda_x,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



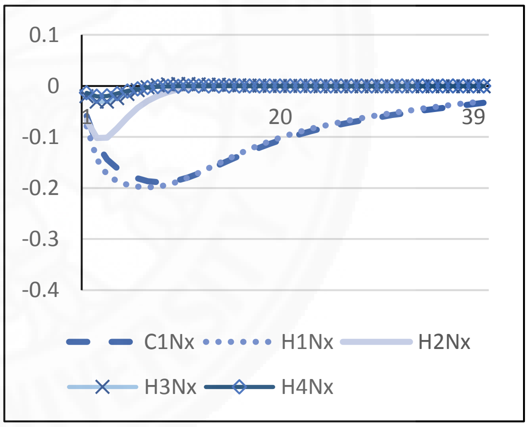
b) Response of $\hat{R}_t$ to $\varepsilon_{\lambda_x,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



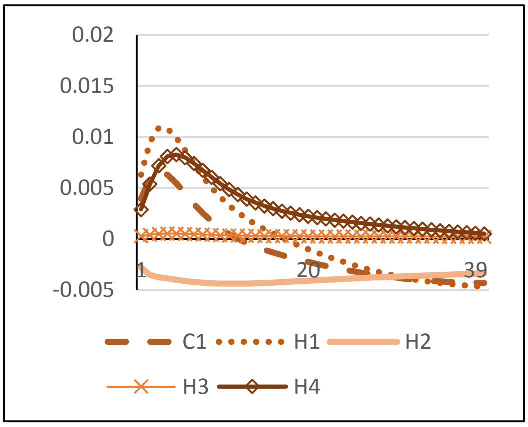
c) Response of $\hat{y}_t$ to $\varepsilon_{\lambda_x,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



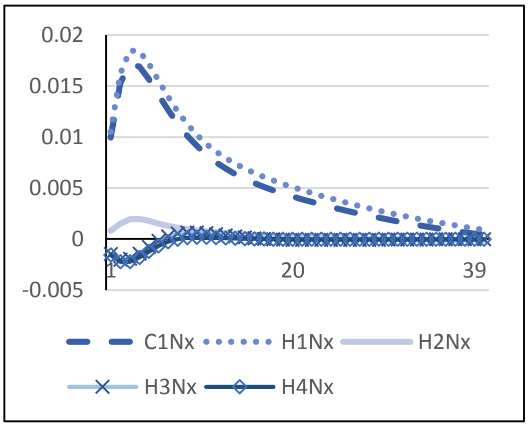
d) Response of $\hat{y}_t$ to $\varepsilon_{\lambda_x,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



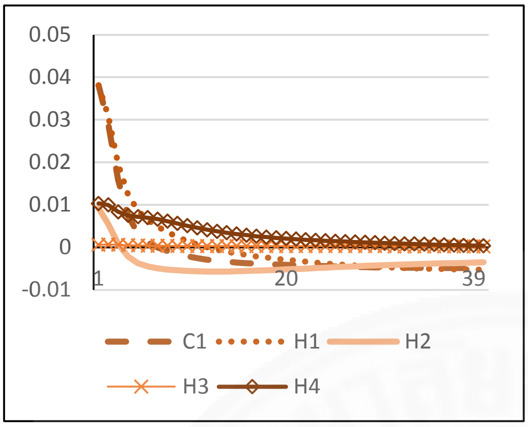
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\lambda_x,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



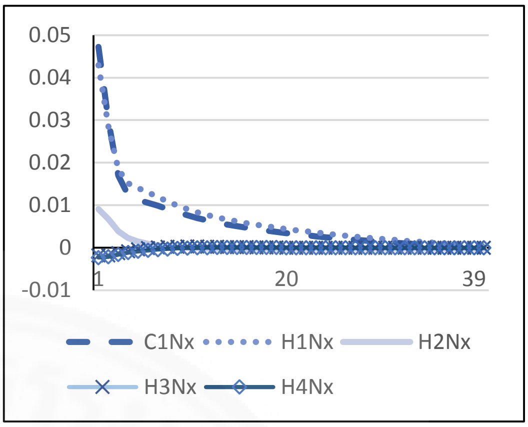
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\lambda_x,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



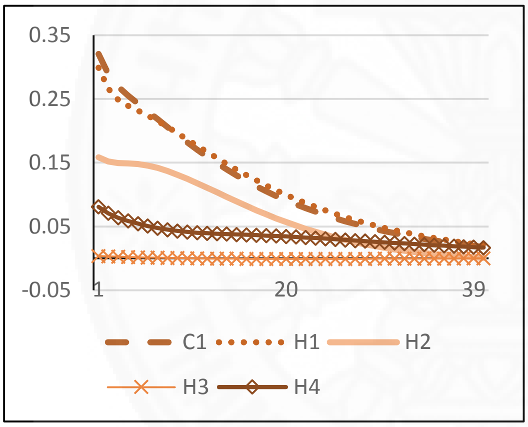
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\lambda_x,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



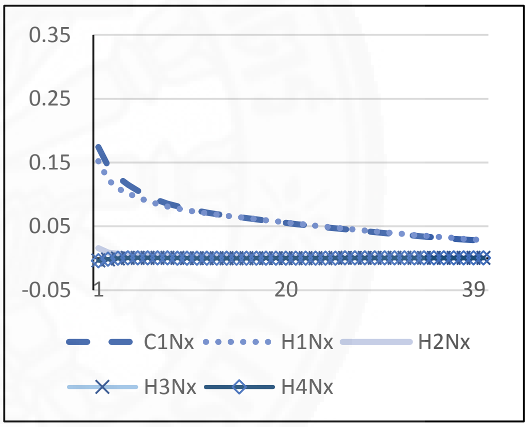
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\lambda_x,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\lambda_x,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\lambda_x,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

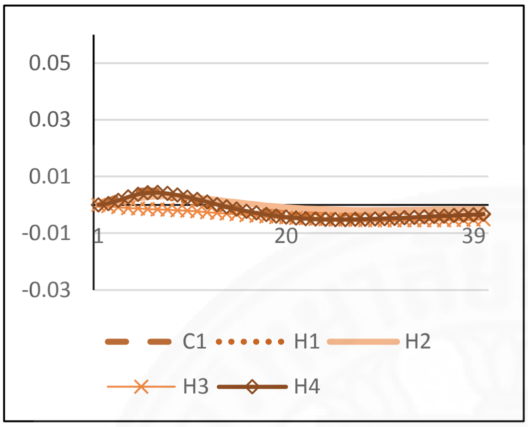


Source: Impulse Response Function based on Bayesian Inference

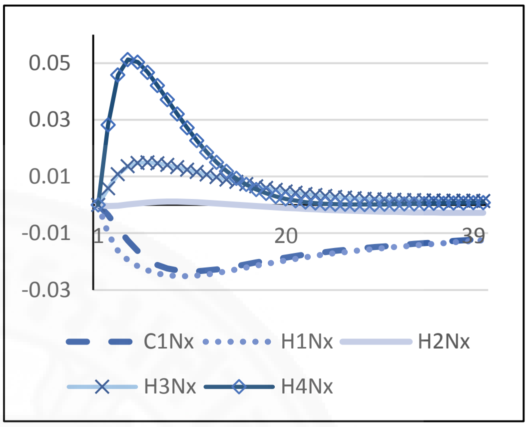
Figure G.8

The Impulse Response of a Consumption Preferences Shock ($\varepsilon_{\xi_c,t}$)

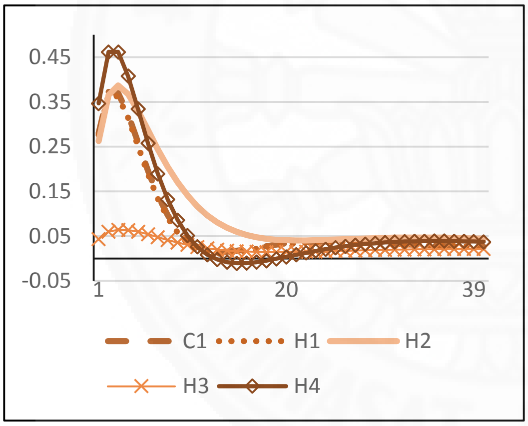
a) Response of $\hat{R}_t$ to $\varepsilon_{\xi_c,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



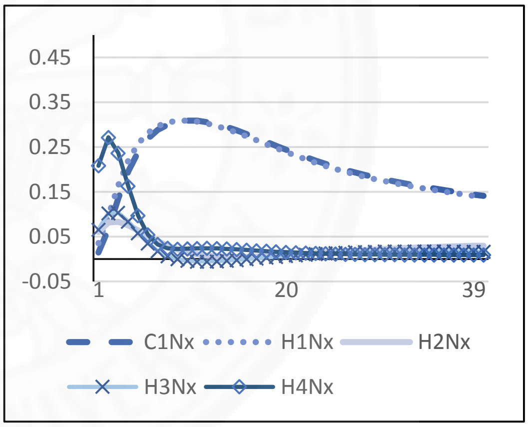
b) Response of $\hat{R}_t$ to $\varepsilon_{\xi_c,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



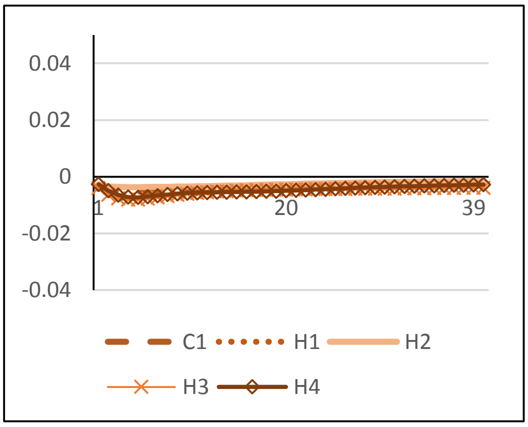
c) Response of $\hat{y}_t$ to $\varepsilon_{\xi_c,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



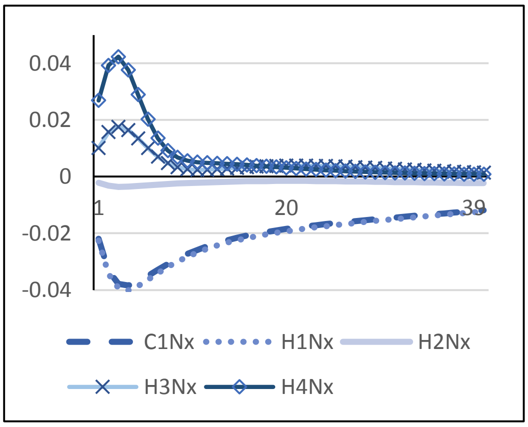
d) Response of $\hat{y}_t$ to $\varepsilon_{\xi_c,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



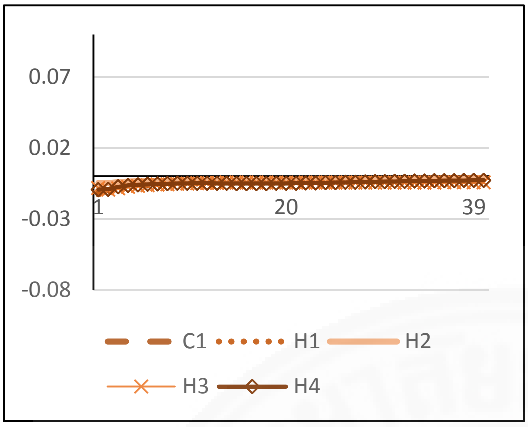
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\xi_c,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



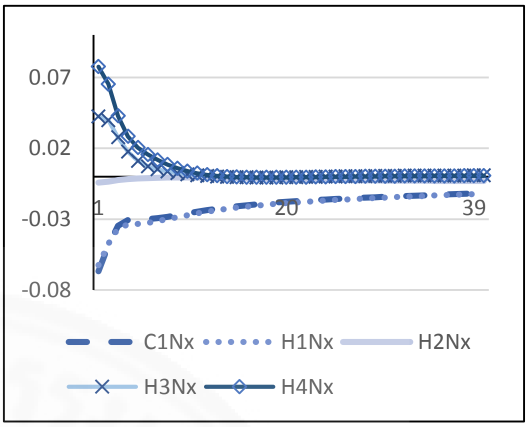
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\xi_c,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



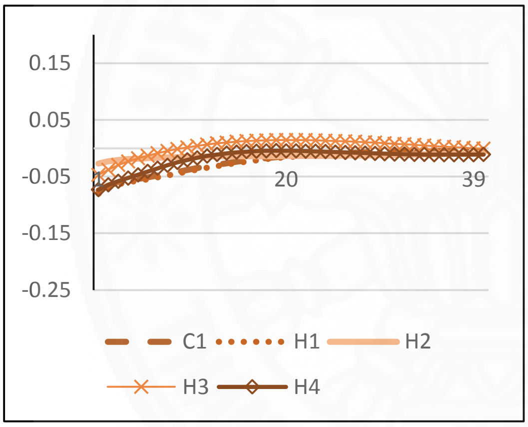
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\xi_c,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



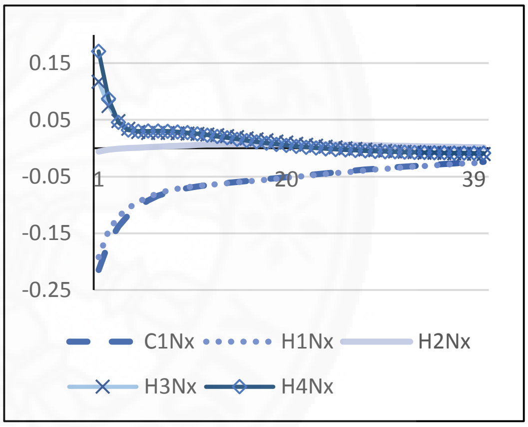
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\xi_c,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\xi_c,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\xi_c,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

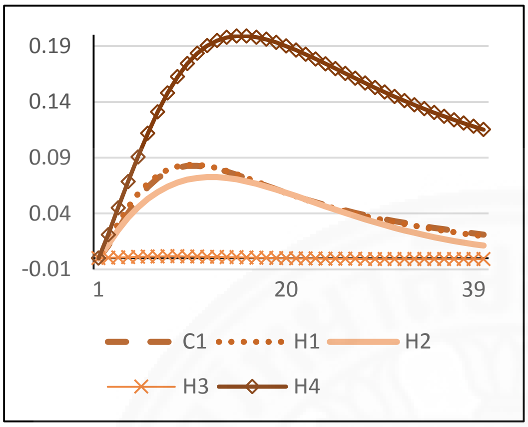


Source: Impulse Response Function based on Bayesian Inference

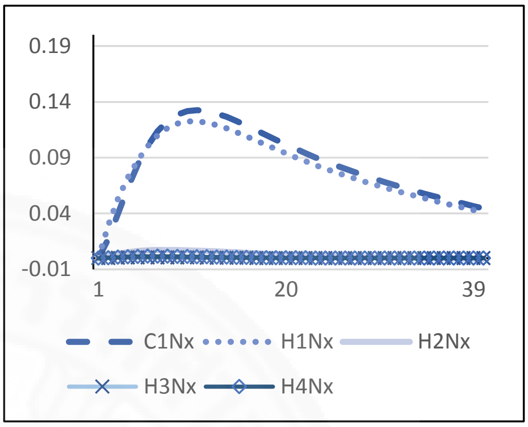
Figure G.9

The Impulse Response of a Leisure Preferences Shock ($\varepsilon_{\xi_h,t}$)

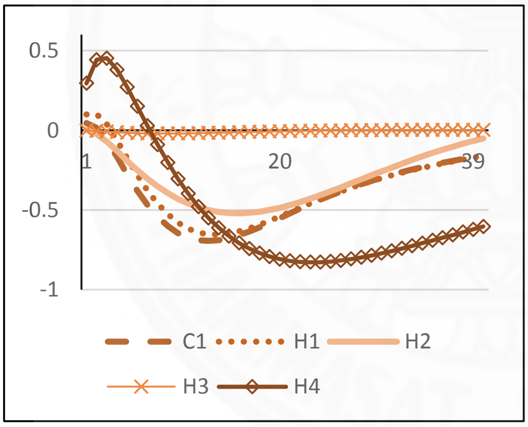
a) Response of $\hat{R}_t$ to $\varepsilon_{\xi_h,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



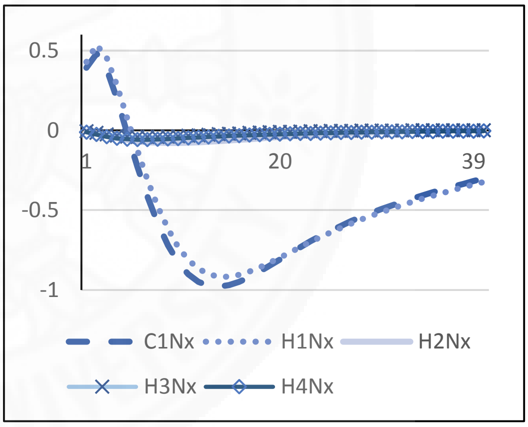
b) Response of $\hat{R}_t$ to $\varepsilon_{\xi_h,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



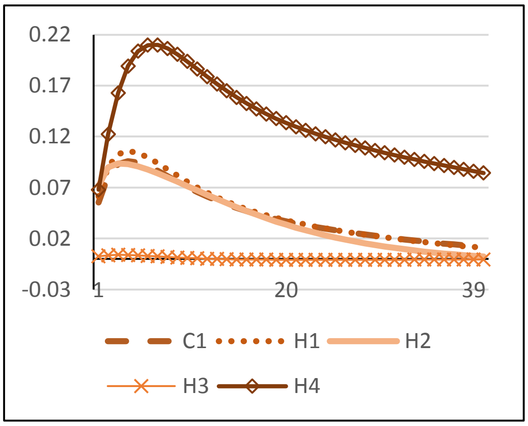
c) Response of $\hat{y}_t$ to $\varepsilon_{\xi_h,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



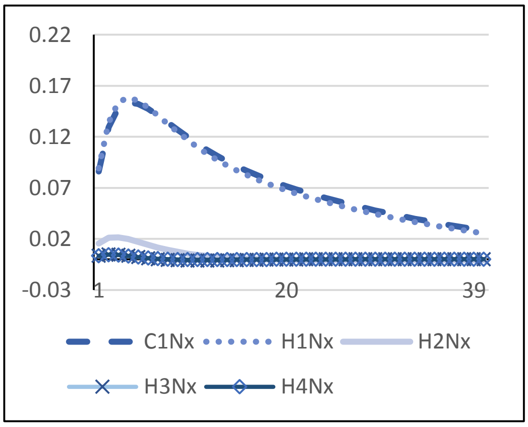
d) Response of $\hat{y}_t$ to $\varepsilon_{\xi_h,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



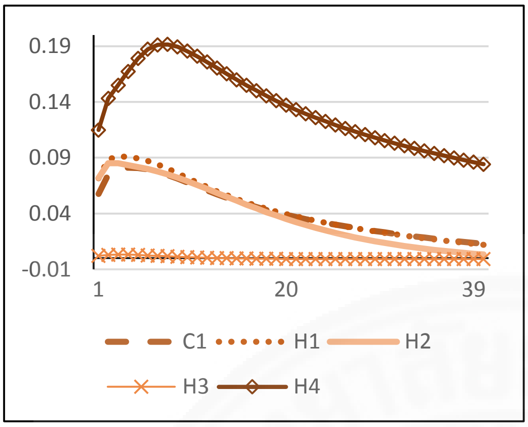
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\xi_h,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



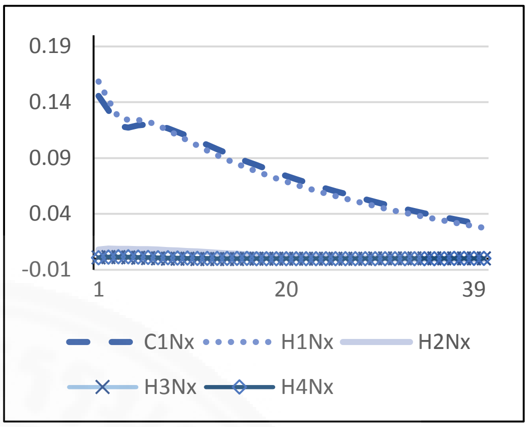
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\xi_h,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



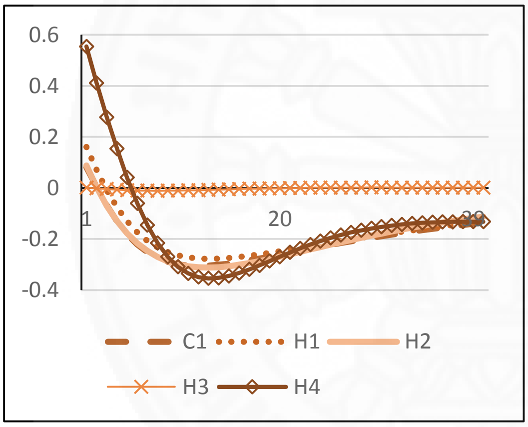
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\xi_h,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



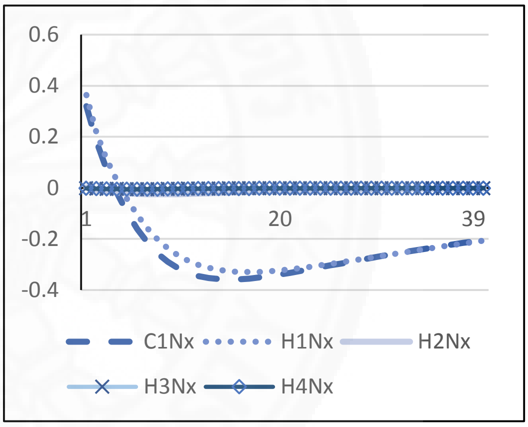
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\xi_h,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\xi_h,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\xi_h,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

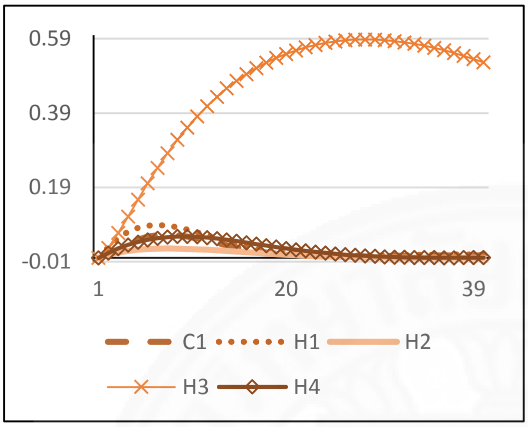


Source: Impulse Response Function based on Bayesian Inference

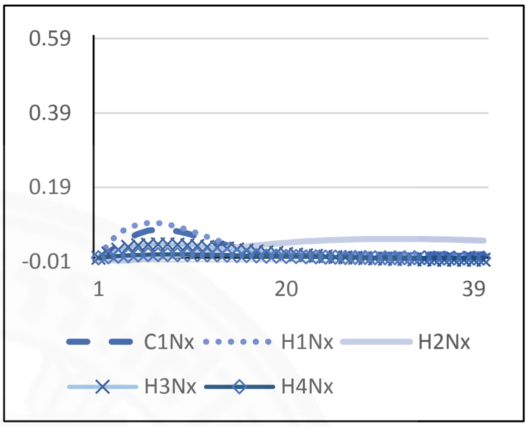
Figure G.10

The Impulse Response of an Investment Specific Technology Shock ($\varepsilon_{\Upsilon,t}$)

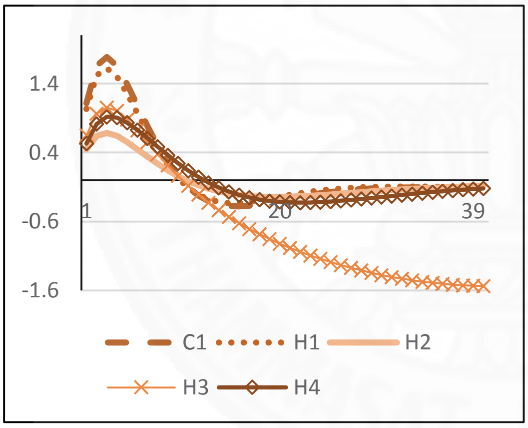
a) Response of $\hat{R}_t$ to $\varepsilon_{\Upsilon,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



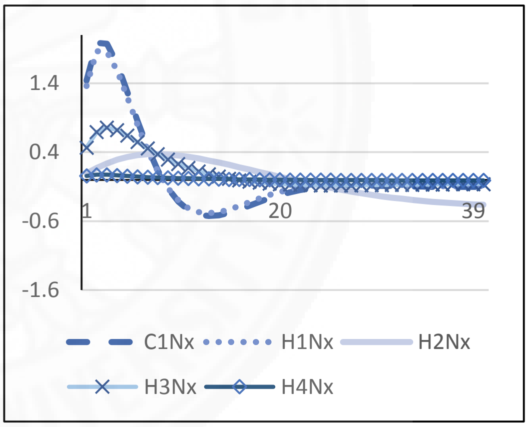
b) Response of $\hat{R}_t$ to $\varepsilon_{\Upsilon,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



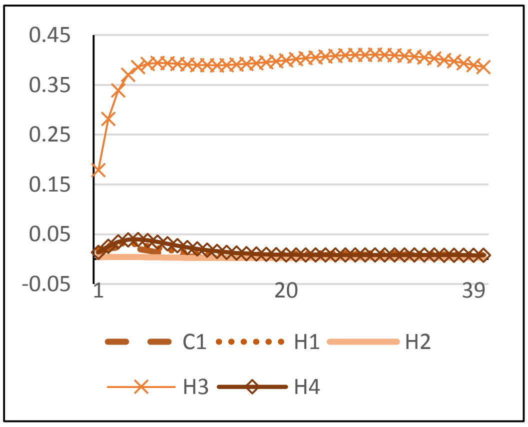
c) Response of $\hat{y}_t$ to $\varepsilon_{\Upsilon,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



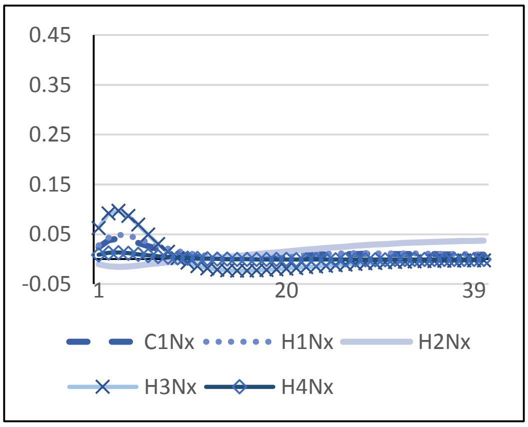
d) Response of $\hat{y}_t$ to $\varepsilon_{\Upsilon,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



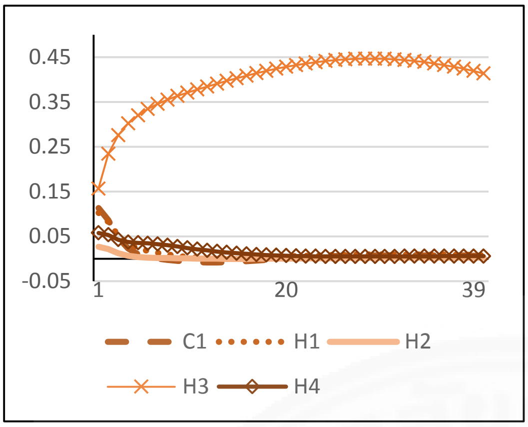
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\Upsilon,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



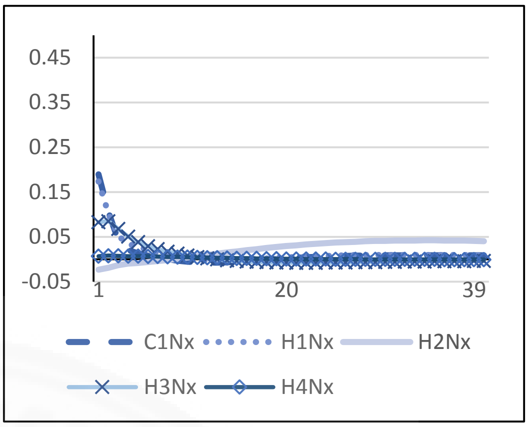
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\Upsilon,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



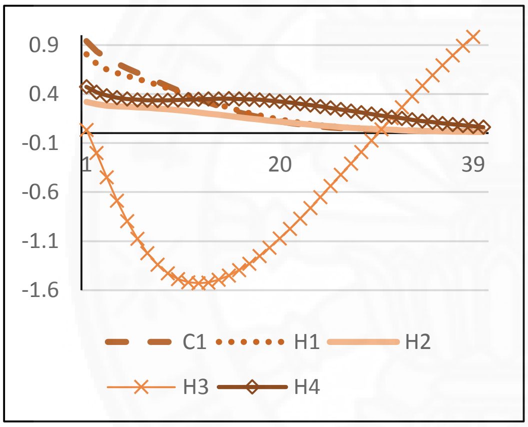
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{Y,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



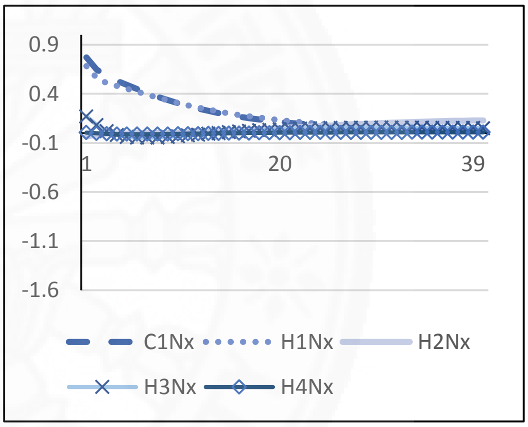
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{Y,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{Y,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{Y,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

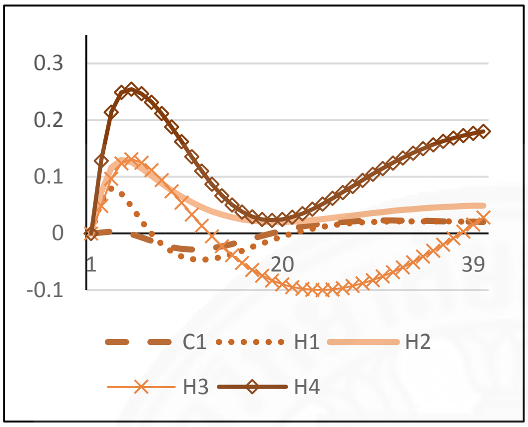


Source: Impulse Response Function based on Bayesian Inference

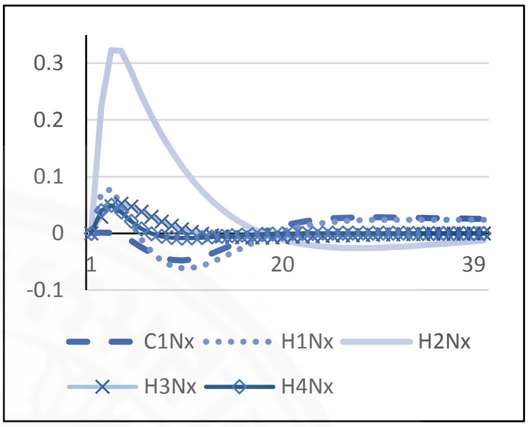
Figure G.11

The Impulse Response of a Risk Premium Shock ($\varepsilon_{\widetilde{\phi},t}$)

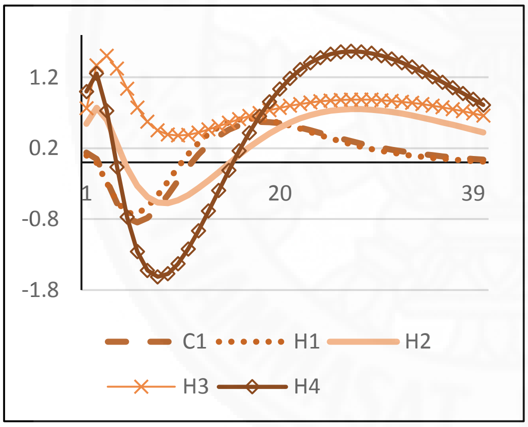
a) Response of $\hat{R}_t$ to $\varepsilon_{\widetilde{\phi},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



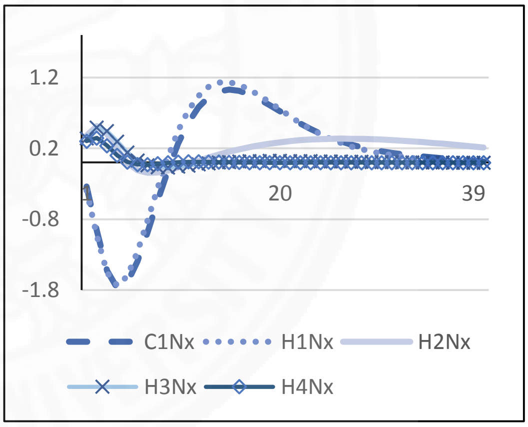
b) Response of $\hat{R}_t$ to $\varepsilon_{\widetilde{\phi},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



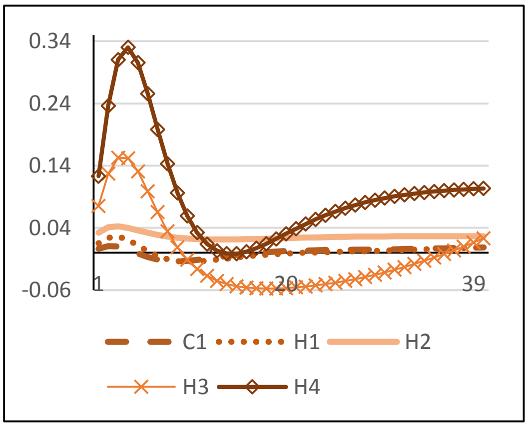
c) Response of $\hat{y}_t$ to $\varepsilon_{\widetilde{\phi},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



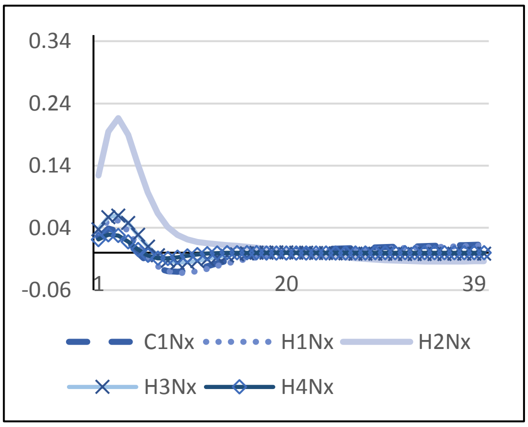
d) Response of $\hat{y}_t$ to $\varepsilon_{\widetilde{\phi},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



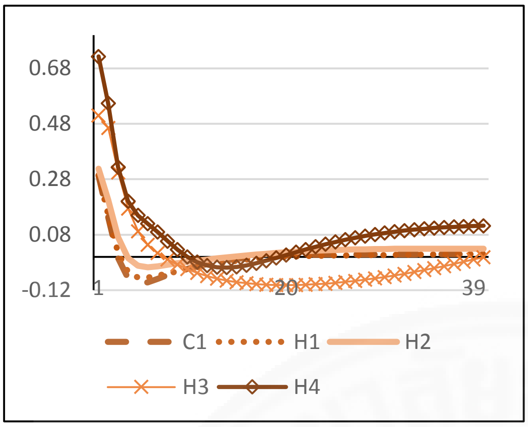
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\widetilde{\phi},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



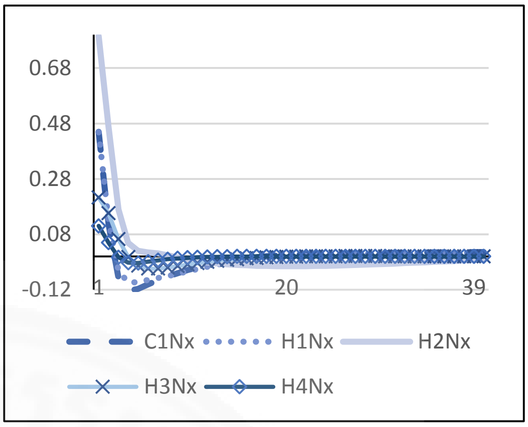
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\widetilde{\phi},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



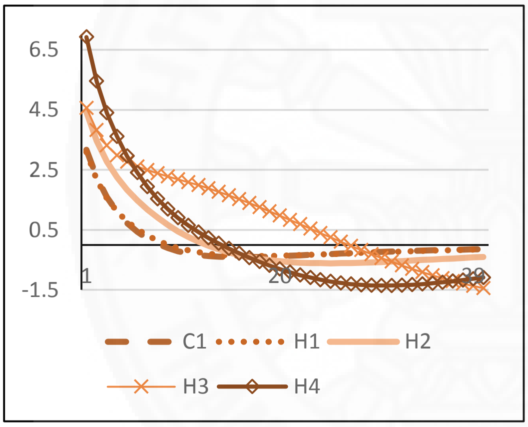
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\tilde{\phi},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



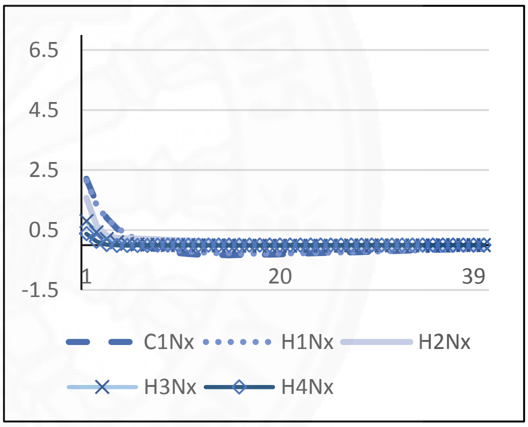
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\tilde{\phi},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\tilde{\phi},t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\tilde{\phi},t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

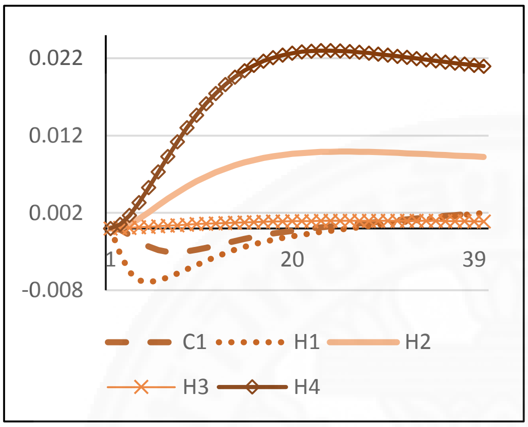


Source: Impulse Response Function based on Bayesian Inference

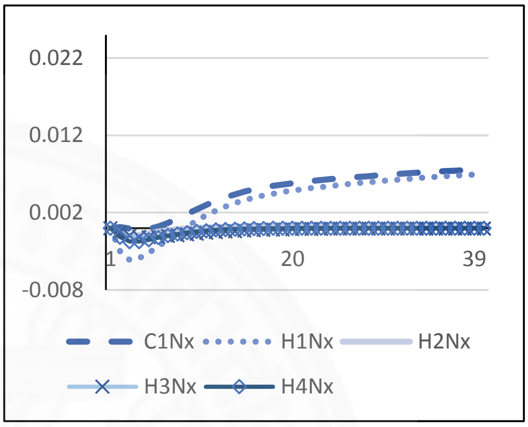
Figure G.12

The Impulse Response of an Asymmetric Technology Shock ($\varepsilon_{\tilde{z}^*,t}$)

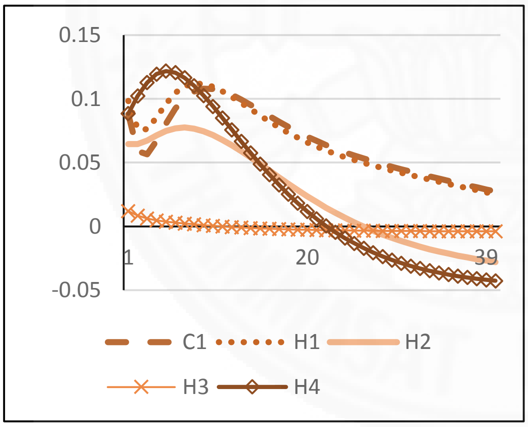
a) Response of $\hat{R}_t$ to $\varepsilon_{\tilde{z}^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



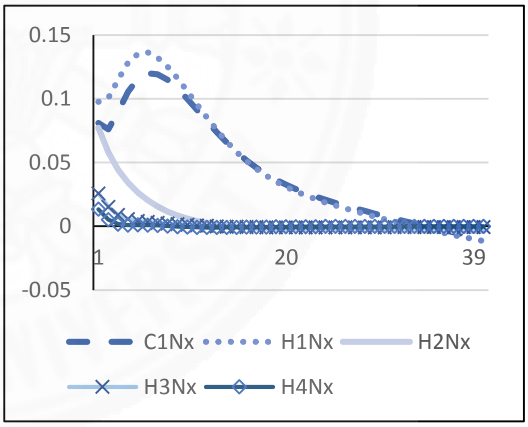
b) Response of $\hat{R}_t$ to $\varepsilon_{\tilde{z}^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



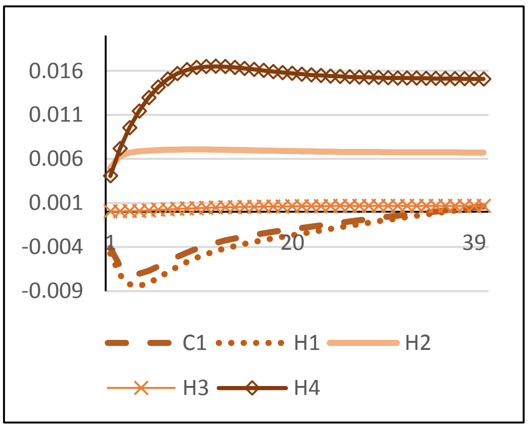
c) Response of $\hat{y}_t$ to $\varepsilon_{\tilde{z}^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



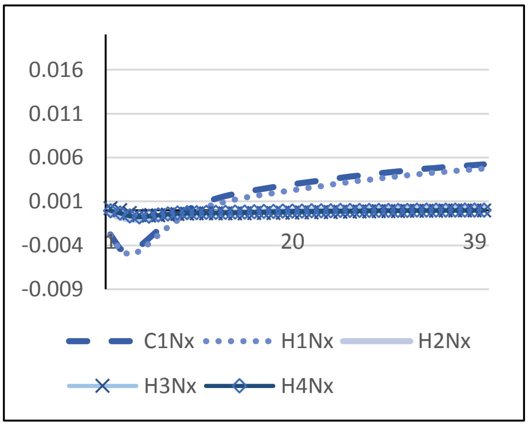
d) Response of $\hat{y}_t$ to $\varepsilon_{\tilde{z}^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



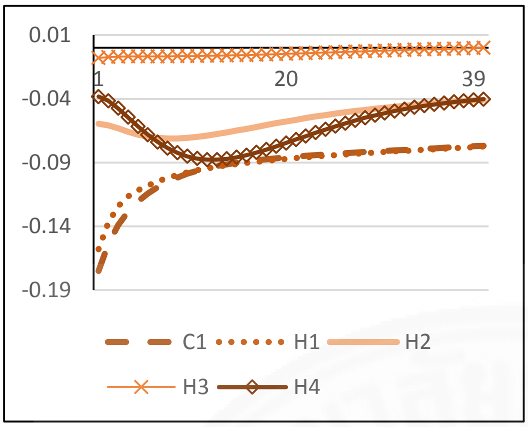
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\tilde{z}^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



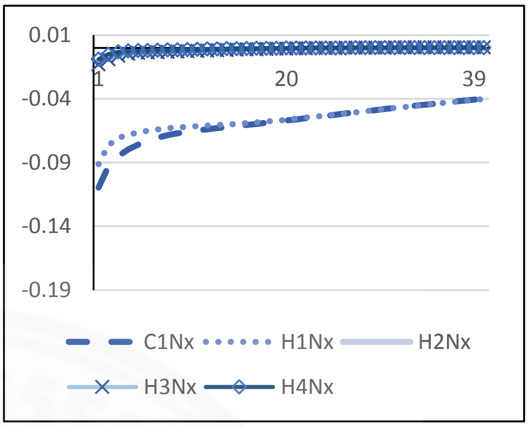
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\tilde{z}^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



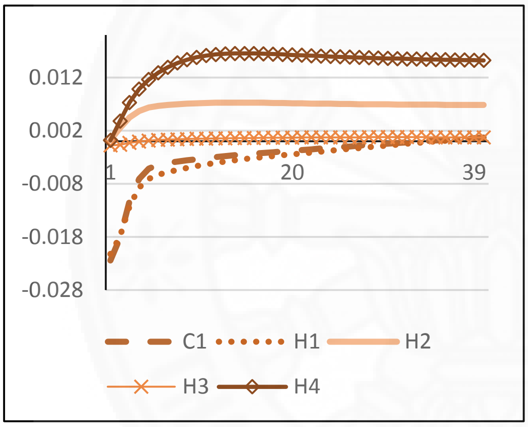
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\tilde{z}^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



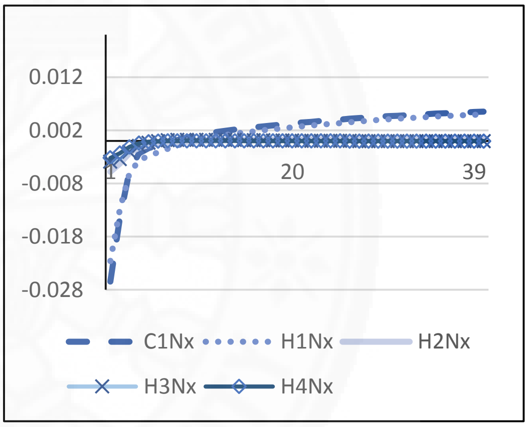
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\tilde{z}^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\tilde{z}^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\tilde{z}^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

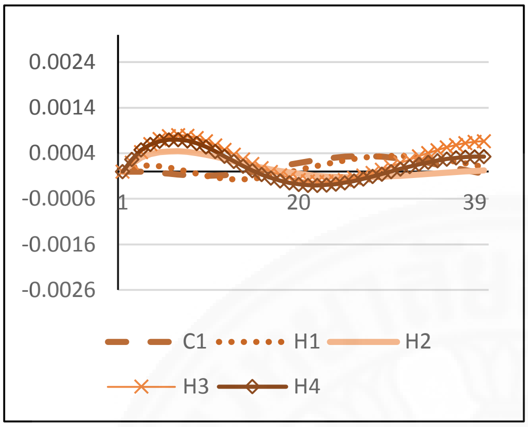


Source: Impulse Response Function based on Bayesian Inference

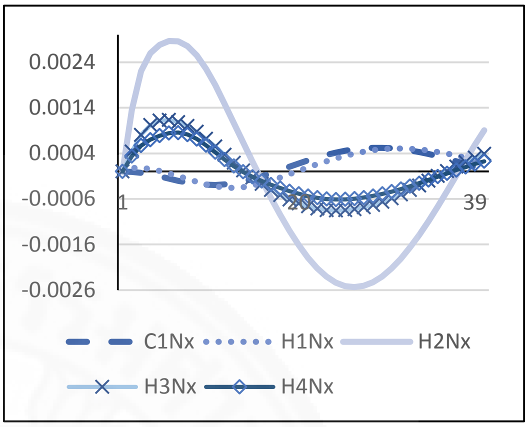
Figure G.13

The Impulse Response of a Foreign Output Shock ($\varepsilon_{y^*,t}$)

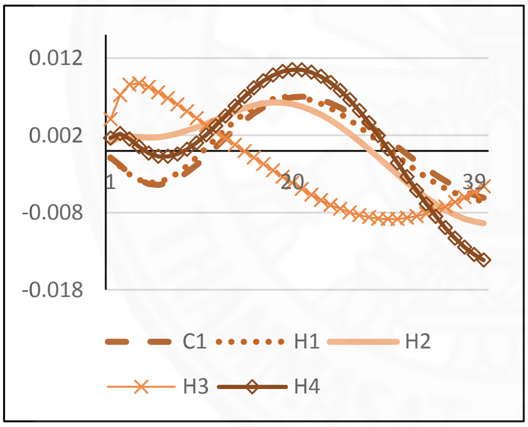
a) Response of $\hat{R}_t$ to $\varepsilon_{y^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



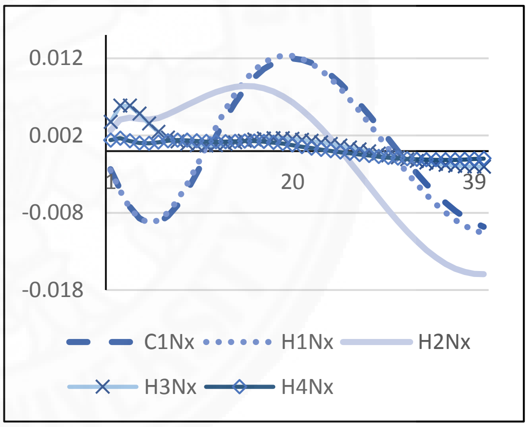
b) Response of $\hat{R}_t$ to $\varepsilon_{y^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



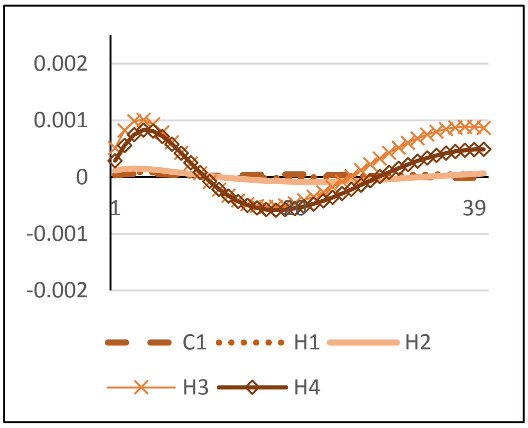
c) Response of $\hat{y}_t$ to $\varepsilon_{y^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



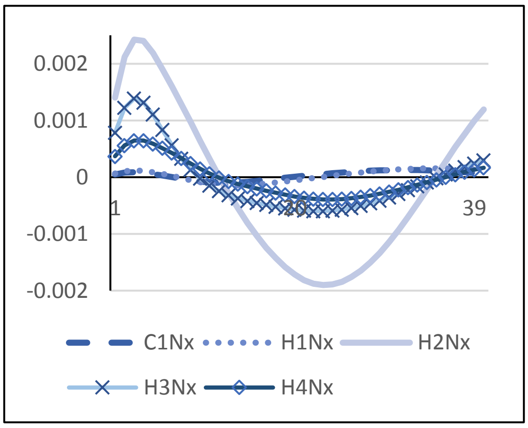
d) Response of $\hat{y}_t$ to $\varepsilon_{y^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



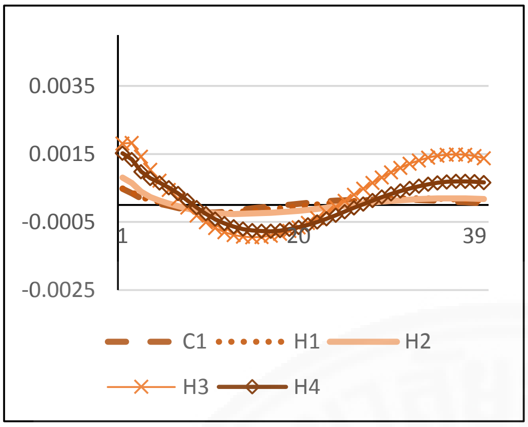
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{y^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



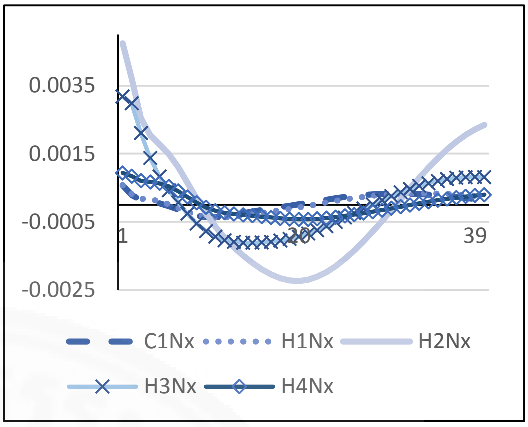
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{y^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



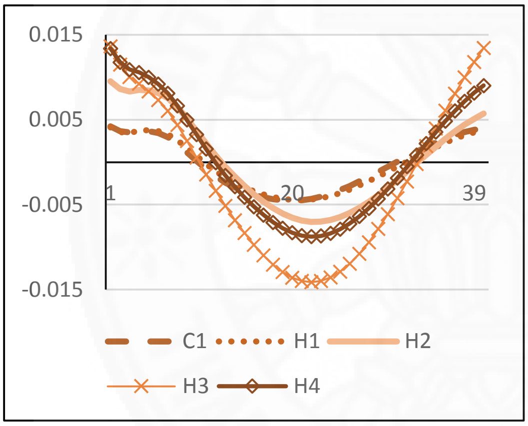
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{y^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



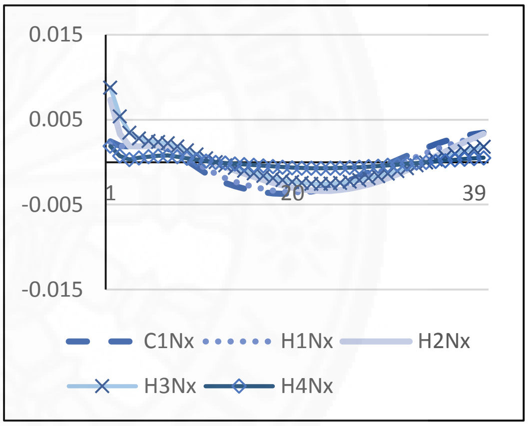
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{y^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{y^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{y^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

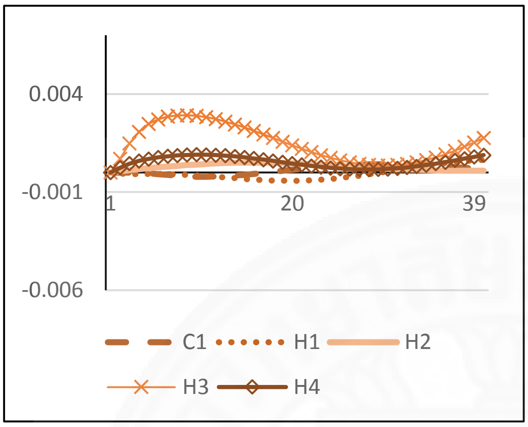


Source: Impulse Response Function based on Bayesian Inference

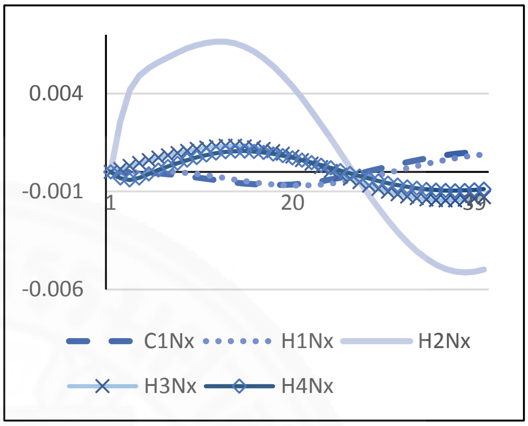
Figure G.14

The Impulse Response of a Foreign Inflation Shock ($\varepsilon_{\pi^*,t}$)

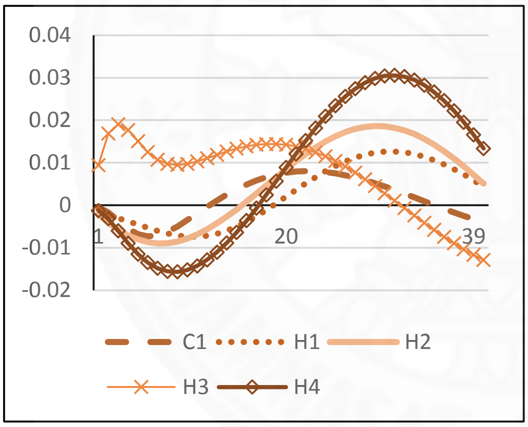
a) Response of $\hat{R}_t$ to $\varepsilon_{\pi^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



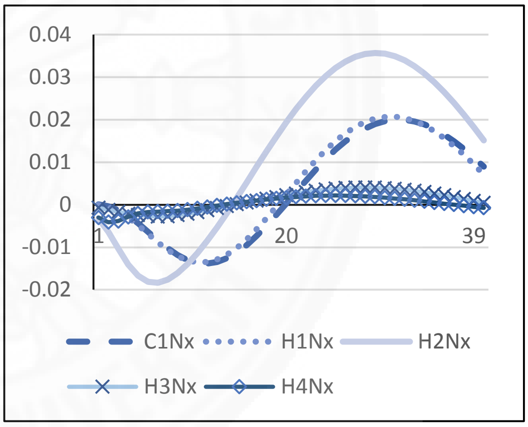
b) Response of $\hat{R}_t$ to $\varepsilon_{\pi^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



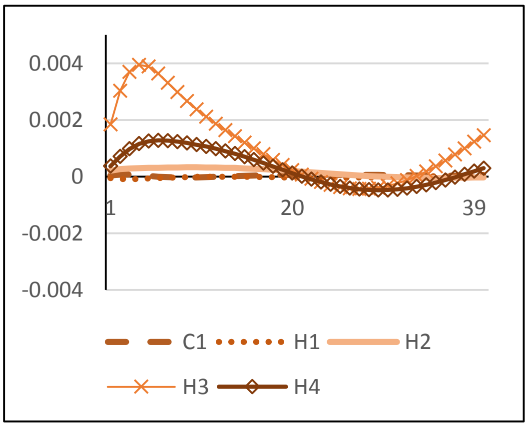
c) Response of $\hat{y}_t$ to $\varepsilon_{\pi^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



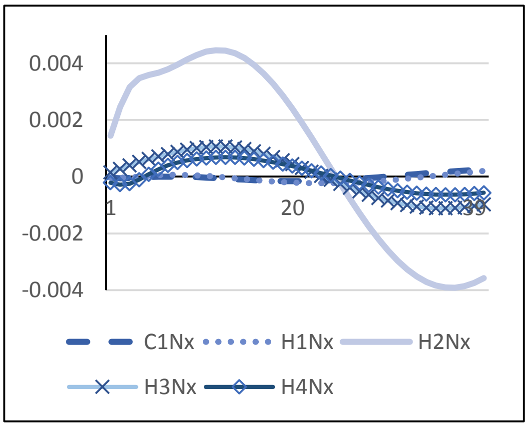
d) Response of $\hat{y}_t$ to $\varepsilon_{\pi^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



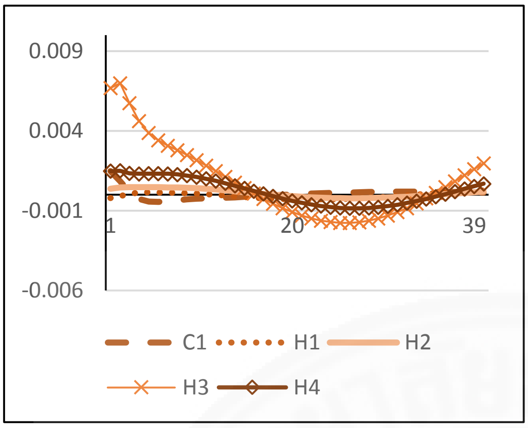
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\pi^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



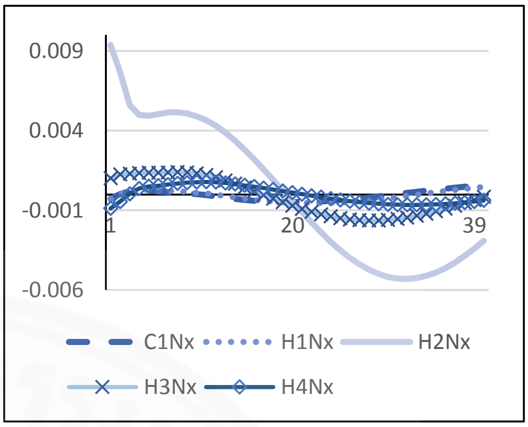
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\pi^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



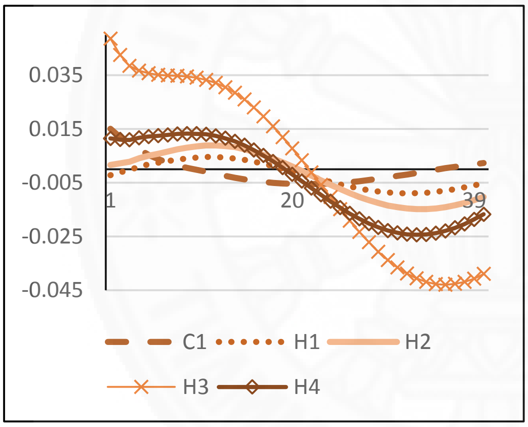
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\pi^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



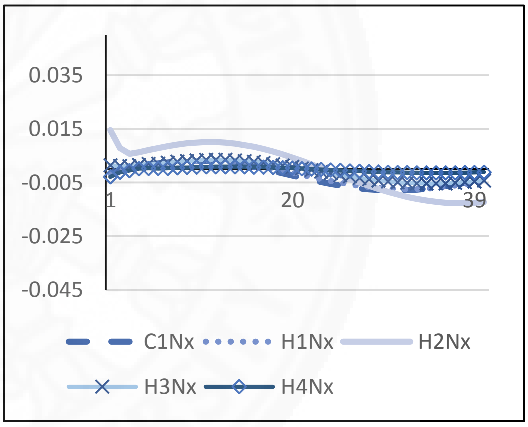
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\pi^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\pi^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\pi^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

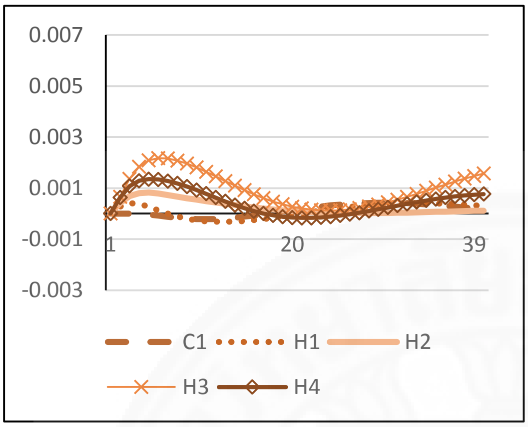


Source: Impulse Response Function based on Bayesian Inference

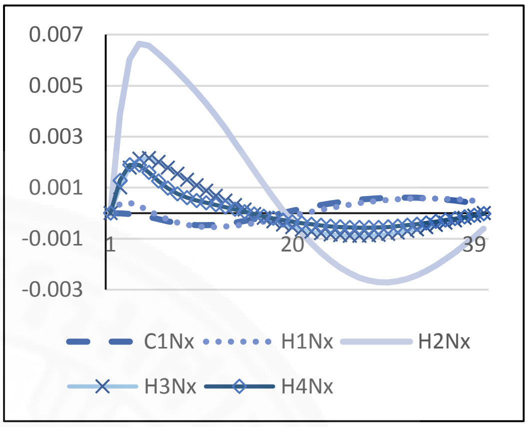
Figure G.15

The Impulse Response of a Foreign Interest Rate Shock ($\varepsilon_{R^*,t}$)

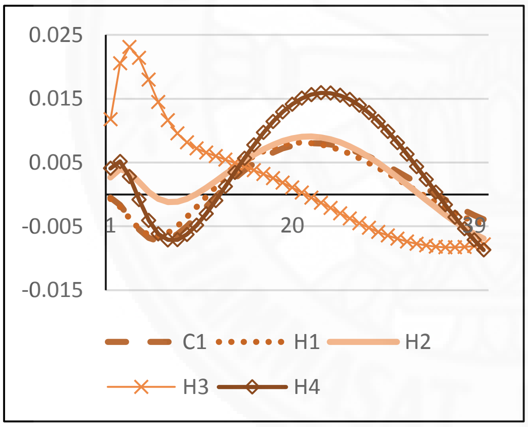
a) Response of $\hat{R}_t$ to $\varepsilon_{R^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



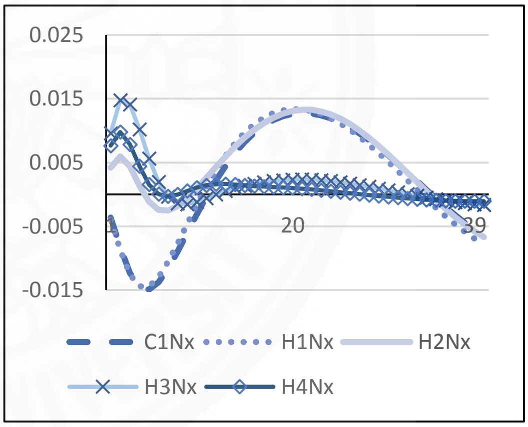
b) Response of $\hat{R}_t$ to $\varepsilon_{R^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



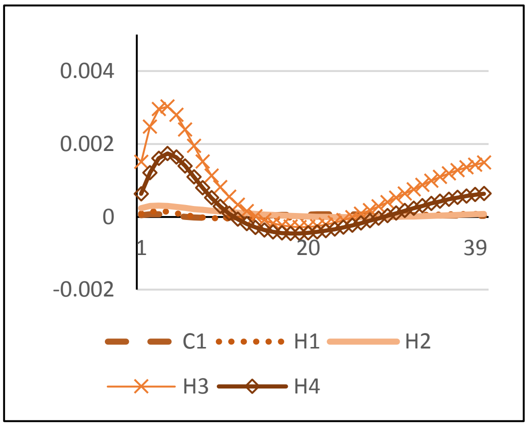
c) Response of $\hat{y}_t$ to $\varepsilon_{R^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



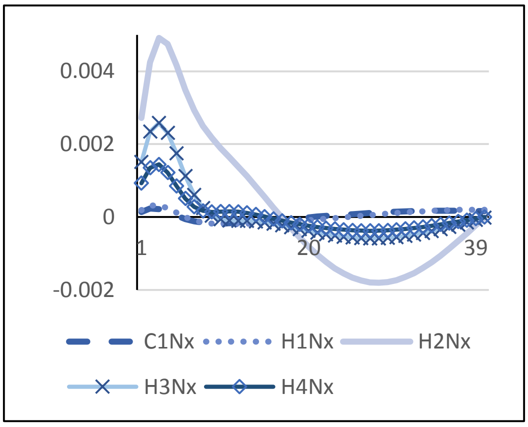
d) Response of $\hat{y}_t$ to $\varepsilon_{R^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



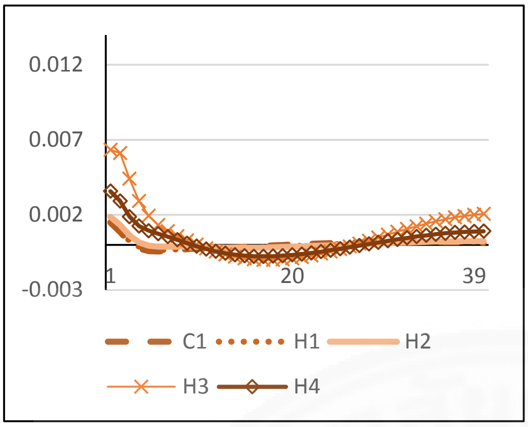
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{R^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



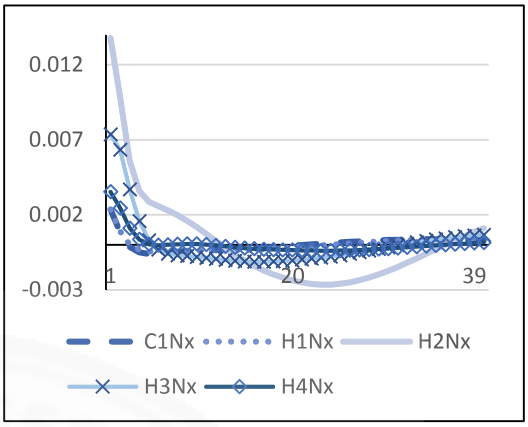
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{R^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



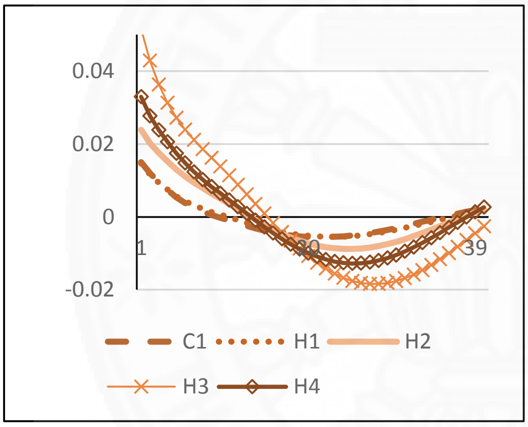
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{R^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



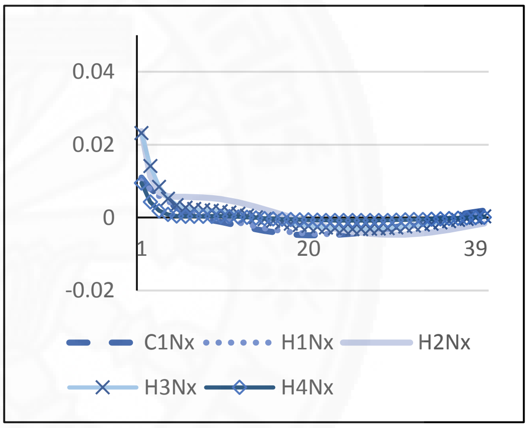
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{R^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{R^*,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{R^*,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

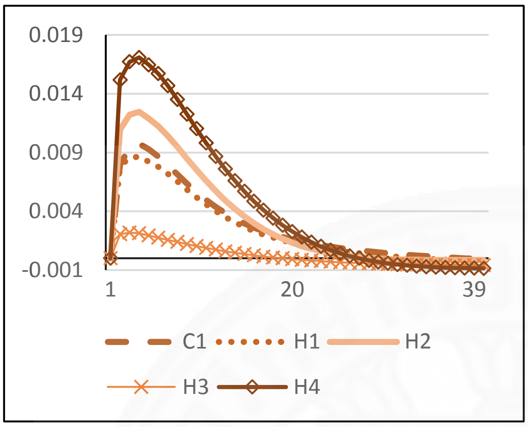


Source: Impulse Response Function based on Bayesian Inference

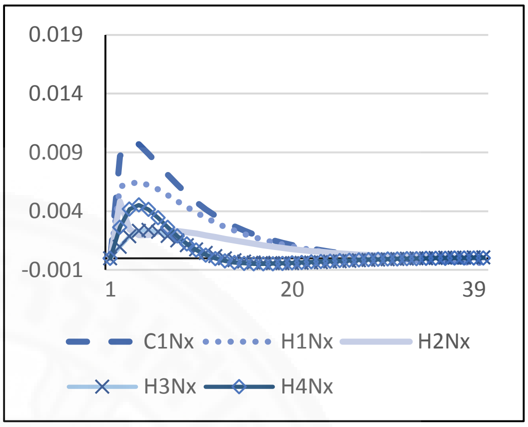
Figure G.16

The Impulse Response of a Government Expenditure Shock ($\varepsilon_{g,t}$)

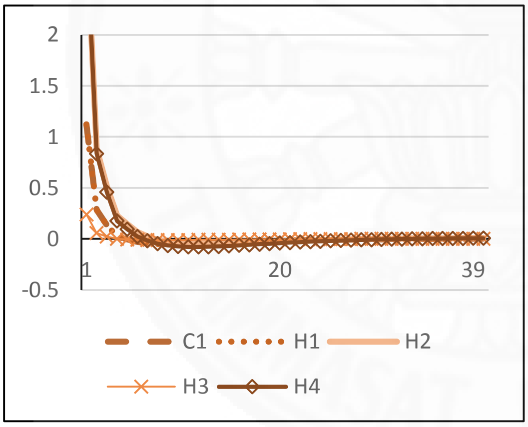
a) Response of $\hat{R}_t$ to $\varepsilon_{g,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



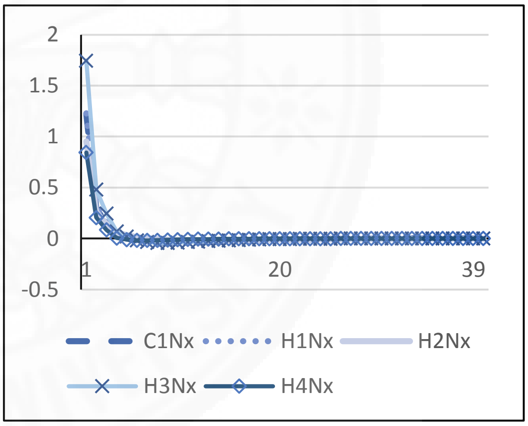
b) Response of $\hat{R}_t$ to $\varepsilon_{g,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



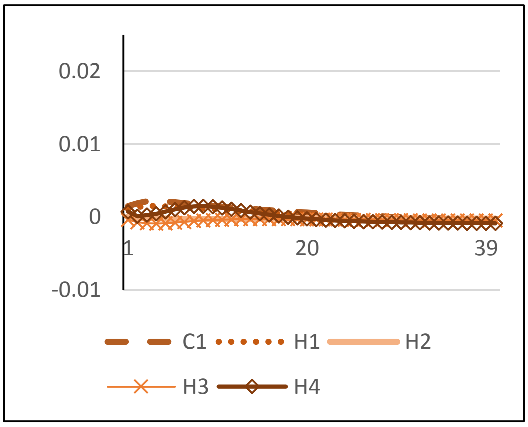
c) Response of $\hat{y}_t$ to $\varepsilon_{g,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



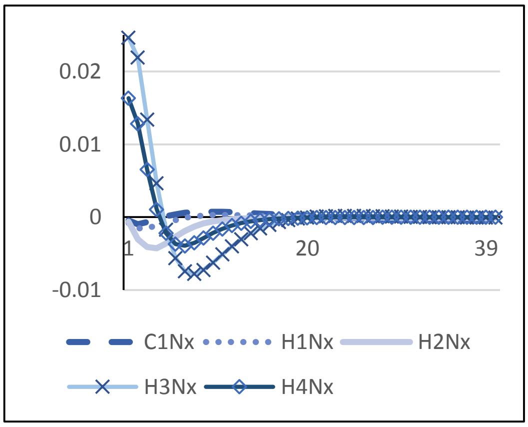
d) Response of $\hat{y}_t$ to $\varepsilon_{g,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



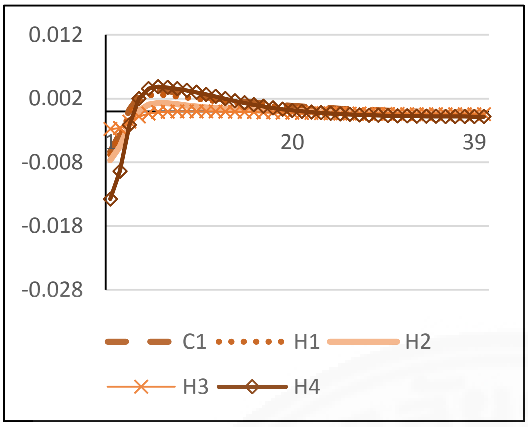
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{g,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



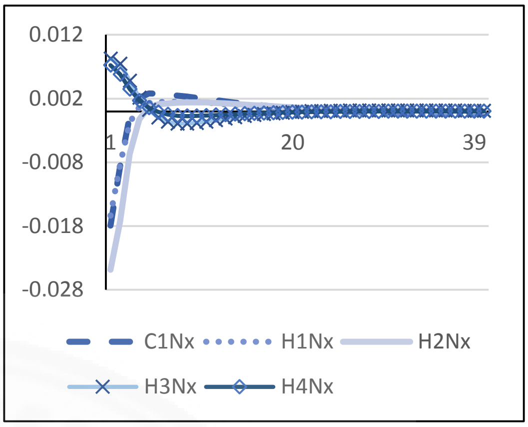
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{g,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



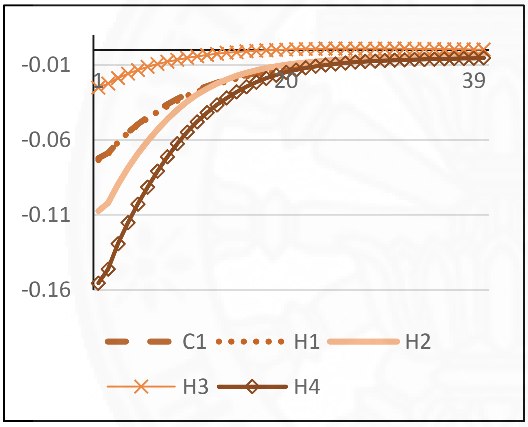
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{g,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



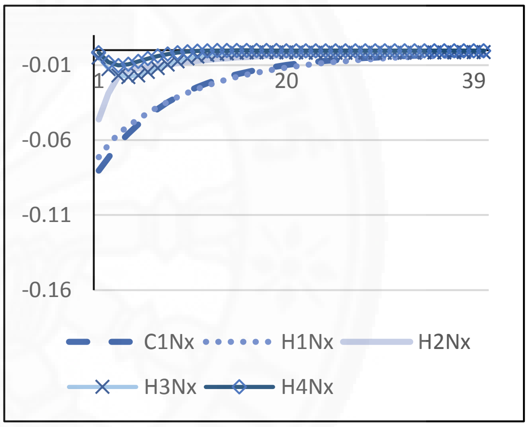
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{g,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{g,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{g,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

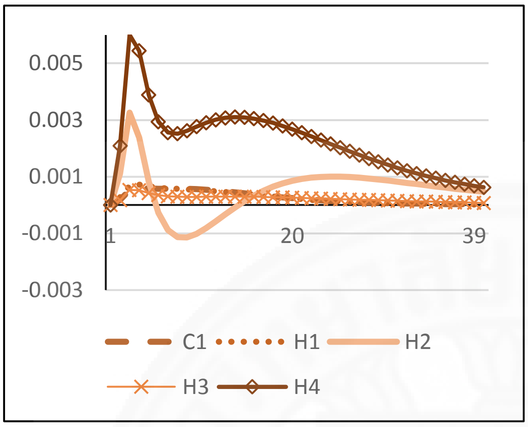


Source: Impulse Response Function based on Bayesian Inference

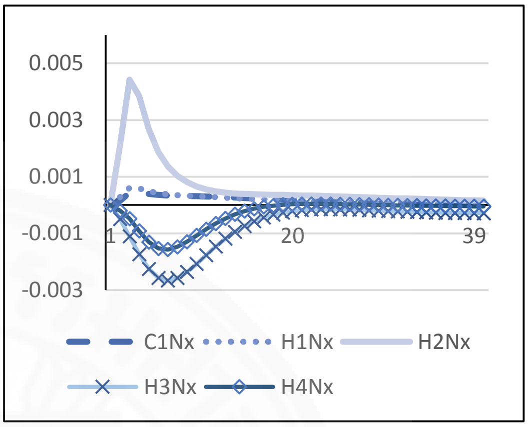
Figure G.17

The Impulse Response of a Labour Income Tax Shock ($\varepsilon_{\tau_y,t}$)

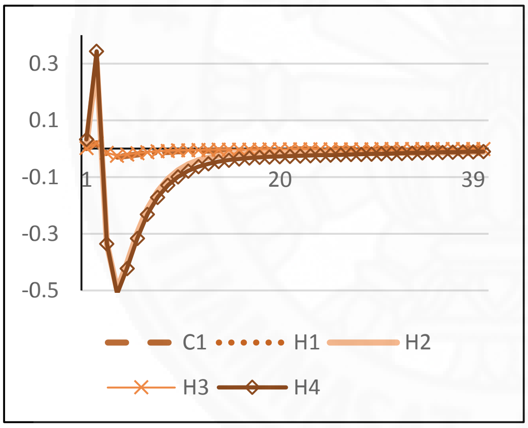
a) Response of $\hat{R}_t$ to $\varepsilon_{\tau_y,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



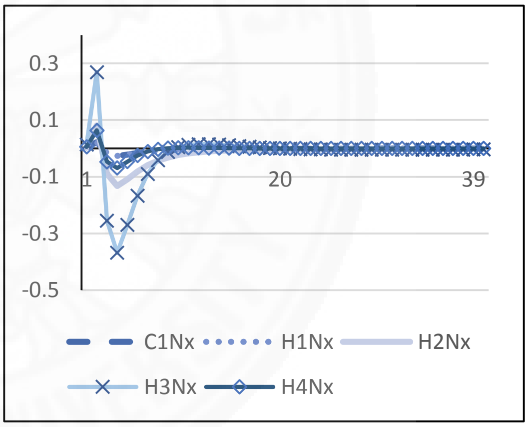
b) Response of $\hat{R}_t$ to $\varepsilon_{\tau_y,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



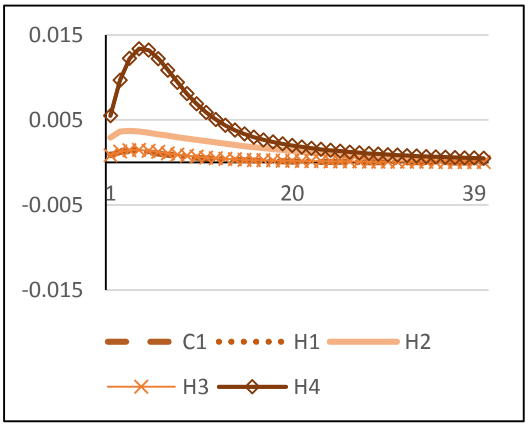
c) Response of $\hat{y}_t$ to $\varepsilon_{\tau_y,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



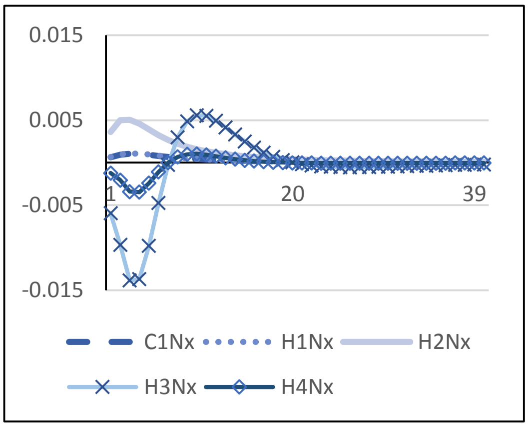
d) Response of $\hat{y}_t$ to $\varepsilon_{\tau_y,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



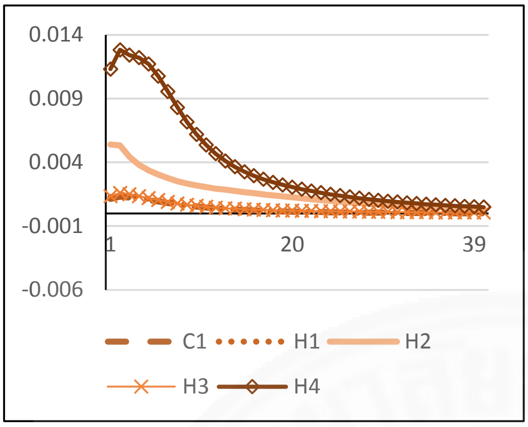
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\tau_y,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



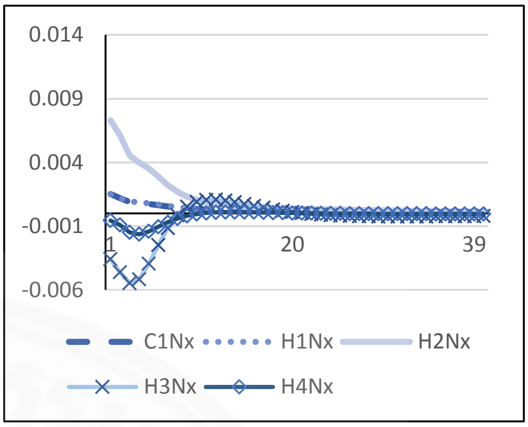
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\tau_y,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



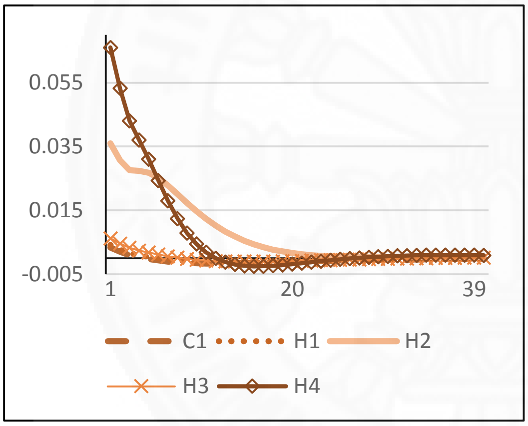
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\tau_y,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



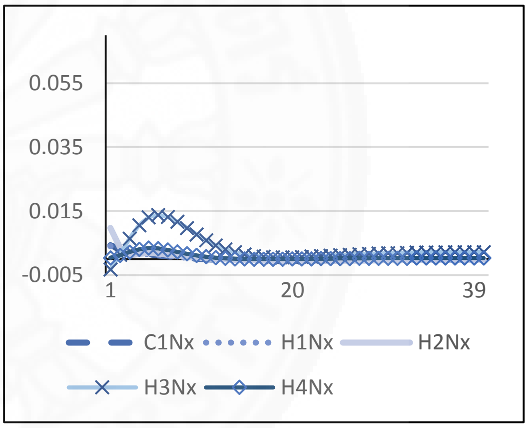
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\tau_y,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\tau_y,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\tau_y,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)

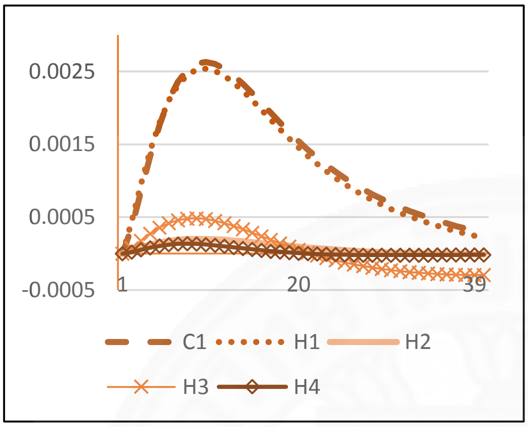


Source: Impulse Response Function based on Bayesian Inference

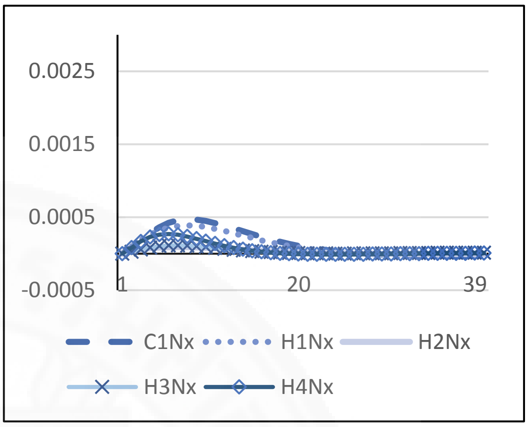
Figure G.18

The Impulse Response of a Labour Pay Roll Tax Shock ($\varepsilon_{\tau_w,t}$)

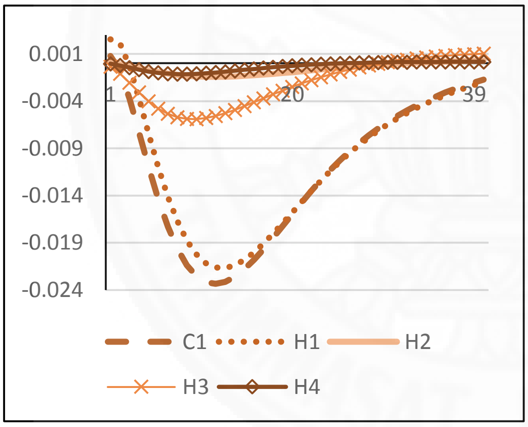
a) Response of $\hat{R}_t$ to $\varepsilon_{\tau_w,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



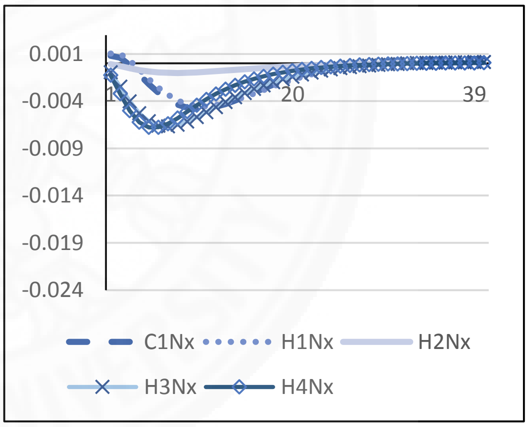
b) Response of $\hat{R}_t$ to $\varepsilon_{\tau_w,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



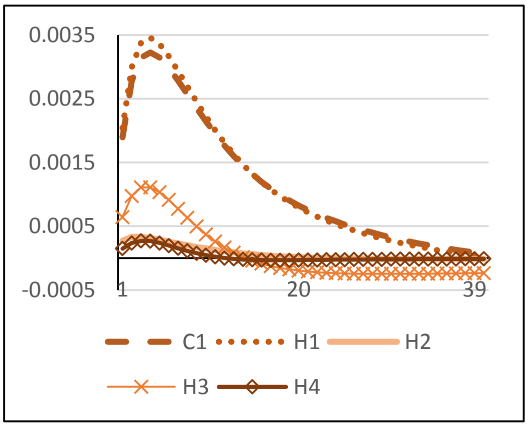
c) Response of $\hat{y}_t$ to $\varepsilon_{\tau_w,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



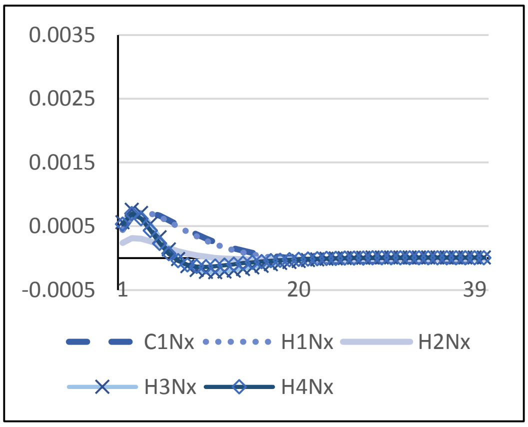
d) Response of $\hat{y}_t$ to $\varepsilon_{\tau_w,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



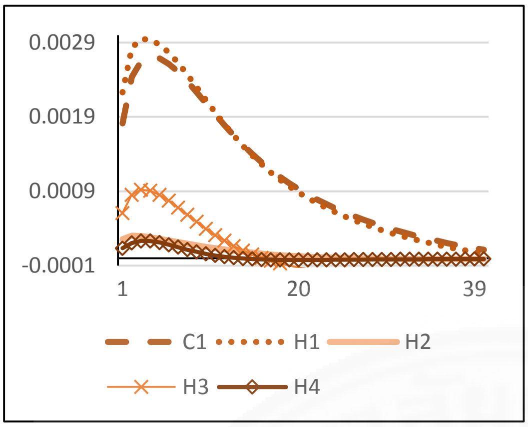
e) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\tau_w,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



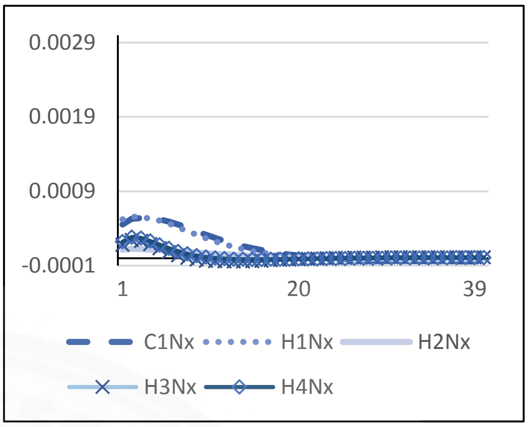
f) Response of $\hat{\pi}_t^{Core}$ to $\varepsilon_{\tau_w,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



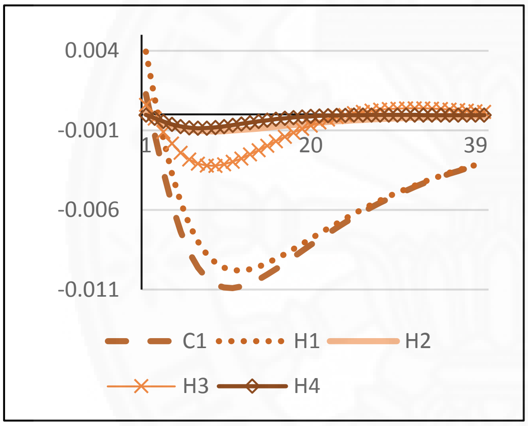
g) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\tau_w,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



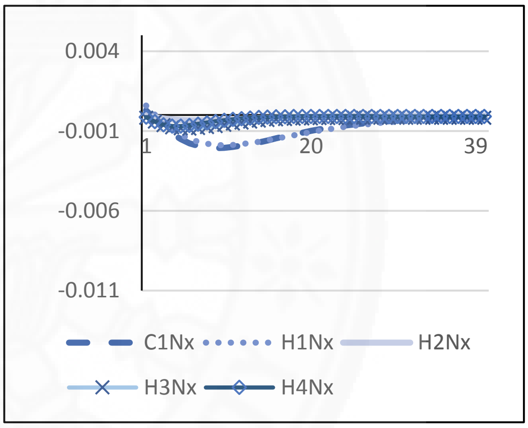
h) Response of $\hat{\pi}_t^{HL}$ to $\varepsilon_{\tau_w,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



i) Response of $\widehat{RER}_t$ to $\varepsilon_{\tau_w,t}$ in the policy rules (C.1), (H.1), (H2), (H3) and (H.4)



j) Response of $\widehat{RER}_t$ to $\varepsilon_{\tau_w,t}$ in the policy rules (C.1Nx), (H.1Nx), (H.2Nx), (H.3Nx) and (H.4Nx)



Source: Impulse Response Function based on Bayesian Inference

BIOGRAPHY

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Publications

Phrommin, K. (2016). Monetary Policy Analysis under Core and Headline Inflation Targeting in Thailand. *IAARHIES 13th International Conference Proceedings May 07, 2016 in Singapore, 46-52.*