THREE ESSAYS ON THE MACROECONOMICS OF MALAYSIA

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Submitted for the degree of Doctor of Philosophy in Economics at Royal Holloway, University London

JULY 2020

Declaration of Authorship

I, Mohamad Khair Afham Bin Muhamad Senan, hereby declare that this thesis and the work presented in it is entirely my own. Where I have consulted the work of others, this is always clearly stated.

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ABSTRACT

This thesis consists of three chapters. The first chapter examines the impact of monetary policy shocks on disaggregated loans from conventional and Islamic banks in Malaysia by employing Factor Augmented VAR (FAVAR). The results suggest that expansionary monetary policy reduces output, price level, and bank lending. The results validate the role of Islamic banks in the monetary transmission mechanism and show that loans from Islamic banks are more responsive to monetary policy shocks compared to conventional loans. We also found strong heterogeneity across sectors and purposes loans from these two types of banks.

The second chapter examines the effects of credit supply shocks on the economy of Malaysia by using Bayesian SVAR approach and implementing the sign restrictions to identify the shocks. We found that expansionary credit supply shock increases GDP growth, inflation, lending growth, and policy rate and does have substantial importance in explaining the forecast variance of macroeconomics variables in Malaysia. We further breaking down the loans to its components: households and non-financial corporations and found some differences of the responses and differences on the relative importance of credit supply shocks in both models.

The third chapter studied the impacts of US Economic Policy Uncertainty (EPU) on the economy of Malaysia. This chapter uses a Bayesian SVAR with the sign and zero restrictions, but we expand the model with block exogeneity, as Malaysia is a small open economy. The results show that US economic policy uncertainty exerts negative impacts on the Malaysian economy. We also found that US EPU shocks do explain considerable fractions of forecast variance of the macroeconomic variables of Malaysia. We further expand the model to include financial stability and forward-looking economic indicator for Malaysia and found that US EPU shock negatively affects both.

ACKNOWLEDGEMENT

I would like to express my gratitude to my PhD supervisor, **Professor Andrew Mountford** for the guidance, patience, and support throughout this journey. I would also like to thank Economics Department of Royal Holloway, University of London, especially **Dr. Ija Trapeznikova**, and **Dr. Michael Naef**. Special appreciation goes to **Professor Law Siong Hook**, for all the encouragement, knowledge, and inspiration.

My two guarantors for the scholarship: **Mohd Firham Affendy** and **Mohd Fahmi**. It was a big risk, signing the agreement to bail me if I failed. Thank you for trusting me.

To my friend, **Ahmad Noorfarizlan**. Thank you for sticking with me throughout these years. I still have the photo from 2006, where we pretended to be cold, as if we were studying overseas. It was in Malacca, and it was so hot. I have fulfilled our promise at that time, by completing my study here. Not to forget, **Kamarul Ihsan, Meor Faliq,** and **Shukri** for the helps, love, friendship, and encouragement.

Joe Percival, **Adrien Fisch**, **Ui Yoshida**, and **Hanmin Park**: My life in UK would not be the same without you guys. Thank you for your time, friendship, support, and encouragement. Joe told me on a weekly basis, "You got this Bro". Thanks Bro, I got this, because you were there for me. I will always cherish the moment we had in UK. I would also like to acknowledge the help that I received from my PhD colleague, **Ali Orazgani**, for the technical parts of this thesis, for the life advices and for the encouragements.

My Malaysian friends in UK. **Hanif** (and family), **Syafiq** (and family), **Nik**, **Yasir**, and **Farhan**. May God repay all of your kindness here and in Afterlife. I will never forget all the gatherings, foods, and laughter that we had. Thank you for all the love and help that I received throughout my time there.

To my family, thank you for the love. Thank you to my wife's family as well.

My friends throughout schools, university, and workplace: If I have to list every single one of you, I will probably need 3 pages, typed with font 10, and single spacing. I met too many incredible, kind-hearted, encouraging, lovely, etc. people in my life. All of you have contributed to this thesis. I am grateful for that.

My sponsors: **Ministry of Education (Malaysia)** and **Universiti Putra Malaysia**. Thank you for the financial support.

DEDICATION

This thesis is dedicated to my wife, ***Kartika Ayu***. Thank you for the love and support. None of these would be possible without you. Thank you for pushing me to pursue my dream. I am sorry if I have troubled you in any possible way throughout the process of completing this thesis.

This thesis is also dedicated to my daughter, ***Katherina***. I will always cherish the moment we wrote this thesis together (since you were born until you were 3 years old). Thank you for typing random letters onto Microsoft Words while I was writing this thesis and I have to delete them back. Also, I will never forget those moments when we split the screen in half because you wanted to watch cartoon, on my PC, when I was working, every single day.

I also dedicated this thesis to my mom, ***Noor Zamin***. Raising 8 children after your husband died was tough but you endured it. I borrowed your strength whenever I was lost and weak while writing this thesis.

Lastly, this thesis is written as a present for my late father, ***Mohd Senan***.

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INTRODUCTION

OVERVIEW OF MALAYSIAN ECONOMY

Malaysia is characterized as an upper middle-income country with GDP (PPP) of USD1,064,795 and ranked at number 25 in the world in 2019. It is situated in Southeast Asia, bordering with Thailand, Singapore, Indonesia and Brunei. The population of Malaysia as of March 2020 is 32.73 million people. Malaysia experienced average growth rate of 6.35 per cent over the past six decades. Lehar et. al. (2014) attributed Malaysia's high growth over the past decades to the structural shifts in Malaysian economy, since the independence in 1957 from Great Britain, that has transformed Malaysia into a developing country.

Malaysia employed an economic restructuring plan, New Economic Policy (NEP) from 1971 to 1990. This economic plan was introduced mainly to alleviate poverty and improve the distribution of wealth among citizen, with the target of distributing around 30 per cent of the wealth to *Bumiputra* (or indigenous) people towards the end of 1990 (Torii, 1997). Within this framework, high economic growth in line with industrial transformation took place. Specifically, Malaysia shifted its focus from an economy that was based on agriculture to an economy that is based on manufacturing industry.

The 1970s and 1980s are also the periods of aggressive attempts by the Malaysian government to attract foreign direct investment (FDI), mainly to boost and support the industrialization in the economy. These FDIs further support the transition of Malaysian economy from the primarily mining and agricultural one to a more diverse economy, including manufacturing and services (Sulong, 1990). There are several

factors that contributes to the attractiveness of Malaysia as an FDI destination such as the government's policies (e.g., Investment Incentives Act 1968, which helped to establish the free trading area in the country, and the open policy of the provision on export), sustained growth, political stability, and strategic location. Other than that, as Malaysia's labour force was relatively inexpensive, educated, and abundant at that time, it fulfilled the needs of foreign firms to cut their production costs (Sulong 1990). As a result, Malaysia recorded a high growth of FDI, from 1970 to 1990, of 17.67 per cent annual growth.

Meanwhile, exports have become one of Malaysia's crucial development instrument in 1980s, with its highest value reaching double the value of GDP at that time (Jomo, 1990). During 1970s and 1980s, major commodity exports were palm oil, petroleum, rubber, natural gas, and tin. At that time, exports of manufactured goods have gradually become more significant, and electrical and electronics products accounted for the most important share among all manufactured exports (Jomo, 1990). This was accompanied by a parallel reduction in the importance of the agricultural and mining sector. In 2019, electrical and electronic products account for the largest share representing about 38 per cent of all exports. Malaysia is also considered as one of the most open countries in the world. Percentage of trade over GDP of Malaysia in 2018 was 131 per cent, signifying the importance of trade in Malaysian economy. Malaysia also recorded trade surplus of double digit from 2017 to 2019, and recorded trade surplus for 22 consecutive years.

High dependency on export and FDI for driving the growth in Malaysia could also means that Malaysia is vulnerable to the external macroeconomic shocks. Vast literatures have attempted to study the effects of various external macroeconomic shocks on Malaysia, but none has attempted to investigate the effects of external

economic policy uncertainty shock. Moreover, as one of the main trading partners for Malaysia, and the common proxy for the world economy, any disturbances in US economy will most likely affecting Malaysia as well. Recent advances in quantifying economic policy uncertainty by Baker et. al. (2016) made it possible to study the effects of US economic policy uncertainty shock on Malaysian economy, which will be discussed further in Chapter Three.

Other important policy that contributed to the Malaysian economic growth includes pragmatic monetary policy management. In the next section, we will discuss the monetary policy framework in Malaysia. We will also discuss the evolution of Islamic banks in Malaysia, which makes Malaysia unique as it is one of the countries that practices the dual banking system under the same monetary policy framework.

OVERVIEW OF MALAYSIAN MONETARY POLICY

Monetary policy in Malaysia is governed by the Bank Negara Malaysia (BNM), which was established in 1959. BNM is administered under the Central Bank of Malaysia Act 1958 and it has been amended several times, which the latest amendment is the Central Bank of Malaysia Act 2009. There are four central roles of the BNM as listed by the Central Bank Act 2009: promoting a stable monetary system, promoting high and stable growth, ensure stability of profit and exchange rate, and maintaining price stability.

Monetary policy in Malaysia evolved from the monetary targeting prior to 1990s to interest rates targeting starting from mid-1990s. After the Asian financial crisis in 1997/1998, the monetary policy system in Malaysia changed towards a more market based monetary policy implementation (BNM, 1999).

Firstly, M1 was used as the policy target in Malaysia since 1970s until 1987. Post financial liberalization in the early 1980s, the annual growth of the M1 sharply dropped due to the world oil crisis and the commodity crisis. Due to this high volatility in the growth of M1, BNM shifted its policy from using M1 to M3 as the policy target in 1987. In mid-1990s, money supply became more volatile and this has led the BNM to shift from monetary targeting policy to the interest rate targeting policy. The other reason that interest rate became the targeting policy was the heightened globalisation of the financial services. Globalisation in the financial sector has reduced the power of the BNM to formulate its monetary policy solely based on domestic factors and it also makes it more difficult to predict money demand (Latifah, 2005). Monetary aggregate was also not suitable as the monetary policy target due to its inferior quantitative ability to forecast consumption, investment, and inflation. Consequently, BNM shifted to the interest rate targeting policy and Taylor Rule was utilized to monitor the interest rate and inflation.

There are three main evolutions during the implementation of interest rate targeting in Malaysia. Firstly, from November 1995 to September 1998, the BNM has introduced a new Base Lending Rate (BLR) framework which includes the 3-month interbank rate in the BLR formula. Next, since September 1998, the BNM has employed interest rate targeting with a fixed exchange rate and modified the BLR calculation, by including the Intervention Rate in the calculation of the BLR. BNM also imposed capital control due to the Asian Financial Crisis to stabilize the economy in 1998. Lastly, in April 2004, BNM introduced the Overnight Policy Rate (OPR) to signal the monetary policy stance. Afterwards, BNM progressively liberalized capital control, and has abolished the fixed exchange rate regime in July 2005.

As regard to domestic deposit and lending rate, in 1978, Malaysia liberalized its domestic interest rates where each bank was permitted to determine their own commercial rates. Prior to 1987, each bank calculated their cost of funds and determined the BLR after BNM decided the amount of the Liquidity of Assets, Overhead, and Reserve Requirements. In 1987, computation of the BLR was set following the BLR of two lead banks, with a window of 0.5 per cent. In 1991, the BLR was calculated after including the profit margin of 0.25 per cent and including the costs of staff, funding, and overhead. After 1995, BNM interbank rate was included in the computation of the BLR. In 1998, BNM interbank rate was replaced with the BNM intervention rate. Lastly, in April 2004, the BNM intervention rate was replaced with OPR. It sets the target rate of the day-to-day liquidity operation of BNM and would serve as the primary reference for domestic rates. To minimize the volatility of the OPR, BNM set 0.25 per cent as the upper and lower limits to facilitate the lending activities in Malaysia (BNM, 2004).

BNM's monetary policy stance could affect the inflation level and economic activities in Malaysian economy because BNM could control the money supply and liquidity by setting the statutory reserve requirement and/or adjusting the short-term interest rate in the money market. When BNM wants to stimulate the economy, it could reduce the short-term interest rates and/or increase the bank reserves. This would stimulate the economy where more credit will be available in the money market (and vice versa to contract the economy). However, monetary policy is not the only factor that could influence the availability of credit in an economy, e.g., loans to private sectors. Structural change in financial framework, changes in regulations for loans approval, and changes in the competition in the banking sectors, among others, could significantly affect this as well. These factors are what economists referred to as the

credit supply shock. As loans to private sector is important in driving Malaysian economy, it is important to address the effects of credit supply shock in Malaysia. Private domestic loan per GDP in Malaysia is recorded at 120.9 per cent in 2019, signifying high dependency on credit for private sectors in Malaysia. Shocks affecting the credit to private sectors will have high possibility to affect Malaysian economy as well. In Chapter Two, we discuss the effects of credit supply shocks on the economy of Malaysia. We also compare the effects of credit supply shocks and monetary shocks in Chapter Two.

ISLAMIC BANKING IN MALAYSIA

Malaysia is considered as the leading country in Islamic banking and finance (Husseini et. al. 2019). Malaysia ranked first in Islamic Finance Development Indicator (IFDI) in 2019 and from its five main indicators, Malaysia was ranked first in four of the indicators: quantitative development, knowledge, governance, and awareness. Malaysia's achievement as the leading country in Islamic finance is also consistent throughout past years where it ranked first in the IFDI consistently from 2012 to 2019. It should also be noted that Malaysia is one of the countries that practice dual banking system, where Islamic banks and conventional banks operate together under the same monetary policy framework.

The principle of Islamic finance was first implemented in Malaysia, through the introduction of the Pilgrims Saving Account Corporation (PSAC) in 1963. Main objective of PSAC was to manage the saving for Muslims who intended to perform *hajj* in Mecca. (Perry and Rehman, 2011). PSAC did not pay any interest to the depositors but invested their savings and paid them the dividend in the form of *hibah* every year. PSAC was established without the intention of being a bank, although it

is similar to the extent that they need to keep and manage the depositor's money. Thus, it was only considered as a saving institution or as an investment institution.

Other than the interest-free saving function, Muslims in Malaysia were also in need of financing, such as personal loans, mortgage loans, car loans, and business setup that are interest-free. Since PSAC's function is limited only to saving keeping function for the intention of performing *hajj*, there was a high demand from Muslims in Malaysia for a financing service without charging interest or *riba* as well. Thus, the first Islamic bank, Bank Islam Malaysia *Berhad* (BIMB), was established in 1983. It was the only fully-fledged Islamic Bank in Malaysia for 16 years, until the establishment of the second Islamic bank in 1999. The profit made by this only Islamic bank became a benchmark for the Islamic banking industry at that time and this has motivated the conventional banks to convince the government to allow them to offer Islamic banking products and services as well.

In response to this, BNM introduced the 'Interest Free Banking Scheme (IFBS) for the conventional banks in March 1993. Three banks namely Malayan Banking Berhad, Bank Bumiputra Malaysia Berhad, and the United Malayan Banking Corporation were selected as the pioneers for this scheme. The decision to permit IFBS in the conventional banks was to increase competition in the market and progressively liberalize the industry. To facilitate the Islamic banking industry, in January 1994, BNM launched the Islamic Interbank Money Market (IIMM). One of the main objectives of IIMM was to provide short-term funding to Islamic financial institutions. Furthermore, to enhance competition in the industry, in April 1999, the second full-fledged Islamic bank, Bank *Muamalat* Malaysia *Berhad*, was established.

In 2002, Islamic Financial Services Board (IFSB) was established and Malaysia was chosen to be the Secretariat. The main objective of the IFSB was to issue global guidelines and standards for the Islamic finance and banking industry as well as *Takaful* industry and Islamic capital market for participating countries. After 20 years of the Islamic banks establishment in Malaysia, BNM liberalized the Islamic banking and finance industry by issuing three licences to the foreign Islamic banks in 2004: Al *Rajhi* Investment Bank, Kuwait Finance House, and Saudi and Qatar Investment Group, allowing them to operate in Malaysia alongside existing domestic Islamic banks.

Total asset of the Islamic banks was only RM 326 million in 1984, where there was only one Islamic bank. In 2019, there were 16 Islamic banks and the total assets were valued at RM 835,193.5 million, with an annual average growth rate of 25.13 per cent. As for the financing of Islamic banks, the total financing of Islamic banks grew at an annual average growth rate of 17.22 per cent from 2006 to 2019. For comparison, total financing of Malaysian banking system grew at an annual growth rate of 8.25 per cent and conventional banks' total financing grew at an annual rate of 5.9 per cent from 2006 to 2012. This shows that Islamic loans grew at a much faster rate than conventional loans in Malaysia. Islamic banks' market share of financing was 34.89 per cent in 2019 compared to 65.11 per cent from conventional banks. In 2006, the value was only 13.58 per cent for Islamic banks and 86.42 per cent for commercial banks. This increasing importance of Islamic banking in providing credit in Malaysia, motivated this thesis to investigate further the effects of monetary policy shock on Islamic and conventional loans as well as decomposing them into sectors and purposes of the loans in Chapter One.

THESIS INTRODUCTION

This thesis applies recent advances in econometric analysis to examine the dynamics of the Malaysian economy. The first chapter utilises a large panel dataset in a Factor Augmented VAR (FAVAR) framework to explore the effects of monetary policy shocks on disaggregated loans. The second chapter uses Bayesian SVAR with sign restrictions to identify and measure the effects of credit supply shocks, and further distinguish between households and non-financial corporation's credit supply shocks. The third chapter also uses a Bayesian SVAR to study the effect of external economic policy uncertainty (EPU) shocks on the Malaysian economy. In this chapter, we apply the block exogeneity assumption, given that Malaysia is a small open economy, and we apply sign and zero restrictions to identify the economic shocks.

In the first chapter, we look at the impact of monetary policy shocks on disaggregated loans in Malaysia. Malaysia adopted a dual banking system where Islamic and conventional banks coexist. Islamic banks offer products that required to follow *Shari'ah Law*, including the prohibition of the interest rate. How does this translate into the bank lending channel in the monetary transmission mechanism?

Given that total loan consists of different sectors, we also aim to see if there are any different responses between these sectors while being separated by Islamic and conventional loans. The same analysis is done for the various purposes of loans that make up the total loans. The existing literature typically uses simple VAR to examine the sectoral loans in Malaysia, and it is unrealistic to achieve it for every single component by using simple VAR. We believe that our empirical research is beneficial for central bank and policymakers to better evaluate the monetary strategy in Malaysia, by looking at specific sectors, or purposes, or bank types. To achieve this,

we employ Factor Augmented VAR (FAVAR) which large dataset could be summarised into a smaller number of factors and be added to VAR system. One advantage that this methodology offers is that impulse response function for each variable in the large dataset can be generated. The results suggest that expansionary monetary policy shocks lower Industrial Production growth, lower price, and decreases loans. Islamic loans are significantly more responsive compared to conventional loans, consistent with the findings from recent literature. Decomposing each type of bank loans into sectors and purposes, we found significant heterogeneity of the responses. This first chapter contributes to the study of Islamic bank lending channel and contributes to the sectoral or disaggregated level of bank lending channel.

In the second chapter, we assess the effects of credit supply shocks on the macroeconomic variables of Malaysia. Despite growing interest in the study of credit supply shocks after the Global Financial Crisis, there has been no study of the effects of credit supply shocks in Malaysia. The reason for the literature gap could be that during the economic crisis, drop in lending growth in Malaysia was not as severe as in developed countries. This is probably due to the financial restructuring in Malaysia, implemented after the Asian Financial Crisis. The restructuring involves a lot of innovations in the credit market in Malaysia, and we argue that these innovations lead to credit supply shocks.

We employ the Bayesian SVAR and identify the credit supply shocks, along with other standard economic shocks (aggregate demand, aggregate supply, and monetary shocks), by using sign restrictions and follow the identification scheme from Gambetti and Musso (2016). We found that an expansionary credit supply shock positively effects Malaysian economy, consistent with literature. From the variance

decomposition analysis, we found that credit supply shocks explain substantial percentage of forecast variance of GDP growth, inflation and especially, credit growth in Malaysia.

Motivated by the suggestion for future research in Gambetti and Musso (2016), we decompose total private non-financial corporation loans into its 2 components: households and non-financial corporations (NFC). We notice that the growth rate of households and non-financial corporations varies significantly, unlike in economies studied extensively in this subject matter (US, UK, Euro Area). Thus, there is a need to identify and examine the effects of each component's credit supply shocks. We link the households' credit to consumption part of GDP and non-financial corporations' credit to investment part of GDP, following Duchi and Elbourne (2016). The results show differences between these two components, suggesting that different treatments or policy formulations are needed, instead of using the same policy to boost or regulate the credit market in Malaysia. This second chapter contributes to the literature of credit and financial sector of Malaysia by being the first to identify and examine the effects of credit supply shocks. We also contribute to the literature of credit supply shocks by separating the total credit into its individual components.

In the third chapter, we examine the external Economic Policy Uncertainty on the Malaysian economy. Given the high level of trade openness and financial linkage of Malaysia with others, it is highly possible that economic shocks originated from other countries will have an effect on the Malaysian economy, especially from the major trading partner and advanced country, namely US, which is usually used as the proxy for external economy in the studies of external shocks in Malaysia. Although there have been numbers of studies done to measure the effect of external shocks affecting the Malaysian economy, none has attempted to examine how the external economic

policy uncertainty affecting Malaysian domestic economy. Studies on how US economic policy uncertainty propagated to other economies, especially small open and developing economy, is still limited. We applied Bayesian SVAR with block exogeneity both on impact and on VAR parameters as per the assumption of Malaysia as a small open economy. We identify the shocks based on sign and zero restrictions and do not put any restriction on domestic variables for the shocks originated from US. We found that US economic policy uncertainty lowers Industrial Production growth. We also add the variables for financial stability and forward-looking economic indicator in our extended analysis and found that US EPU shock adversely affects both. The results offer more evidence that US economic policy uncertainty shocks does result in an adverse effect on a small, open, and developing economy like Malaysia. This third chapter add to the literature on the study of external economic shocks affecting Malaysian economy by adding the element of economic policy uncertainty shocks. This chapter also contributes to the study on transmission effects of US economic policy uncertainty to a small open developing economy.

CHAPTER 1: MEASURING DISAGGREGATED RESPONSES OF ISLAMIC AND CONVENTIONAL LENDING TO MONETARY POLICY SHOCKS IN MALAYSIA: A FAVAR APPROACH

1.1 INTRODUCTION

It is well established that the bank lending channel is a key part of the monetary transmission mechanism. The evidence of this channel is well established for banks with different asset size (Kashyap and Stein, 1995), capitalisation (Kishan and Opiela, 2000), and liquidity (Stein and Kashyap, 2000). Nevertheless, there is still limited evidence on the validity of this mechanism for different bank types[1], sectors, and purposes of the loans.

Examining the lending channel for these different categories is important because they may have different responses to monetary policy shock. In this chapter, we empirically compare the bank lending channel in a dual banking system of Malaysia, where Islamic and conventional banks operate together under the supervision of the same central bank regulations. We then further examine the responses of different sectors and different purposes of loans from these two types of banks.

The study of the bank lending channel in Malaysia has received adequate attention. These studies include Ibrahim (2005) and Vaithilingam et al. (2003) among others. Overall, these studies agree on the existence of bank lending channel and also agree on the vital role played by the banking sector in the transmission of monetary policy in Malaysia. However, these studies just focused on aggregate bank lending data for the whole banking system without separating Islamic and conventional loans.

Total loans of the banking institutions in Malaysia increased from MYR 593.01 billion in 2006 to MYR 1673.48 billion, which was equal to 115 per cent of its's gross domestic product (GDP) in 2018. The percentage share of the Islamic loans out of the

[1] In this case, we refer the 'types' to Islamic and conventional banks.

total banking loans was only 13.24 per cent in 2006 and reaching 32.29 per cent in 2018, proving that it is imperative to study this subject matter due to its increasing importance. Figure 1-1 illustrates the increasing importance that Islamic loans play in providing finance to the Malaysian economy. It is also worth noting that the increasing trend of the total loan from both banks where it shows an increase of 182 per cent, 120 per cent for conventional loans, and 588 per cent for Islamic loans from 2006 to 2018.

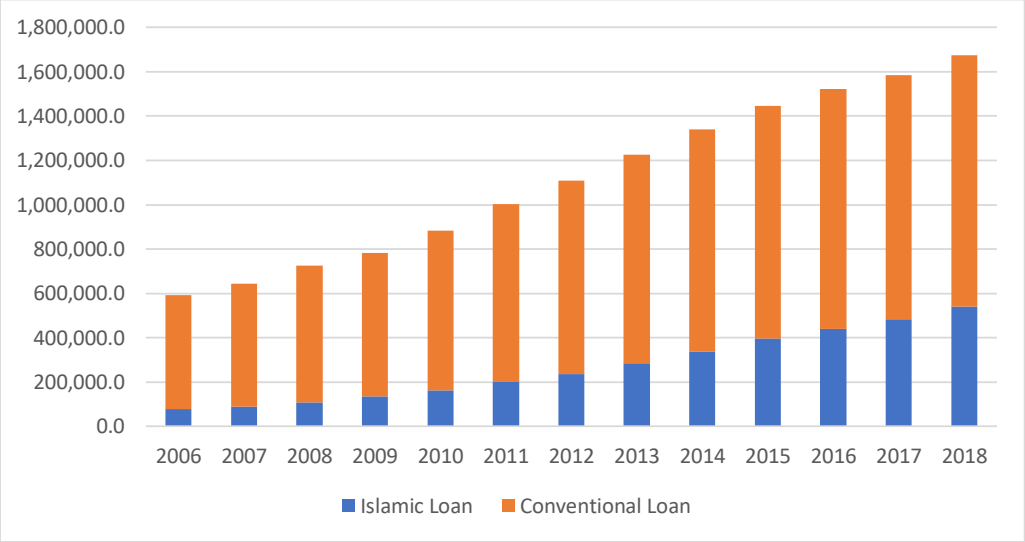

Figure 1-1: Islamic and Conventional Loans in Malaysian Ringgit, 2006-2018

Bank lending is also the most significant component of assets for both conventional and Islamic banks in Malaysia. Figure 1-2 shows the percentage of total loans over total assets for Islamic and conventional banks. There has been an increasing trend of loan percentage in total assets for Islamic banks. In 2007, the value was just 47 per cent and increased to 73 per cent in 2018. The conventional bank maintained the loan contribution to its total asset, ranging from 55 per cent to 59 per cent over the past 11 years.

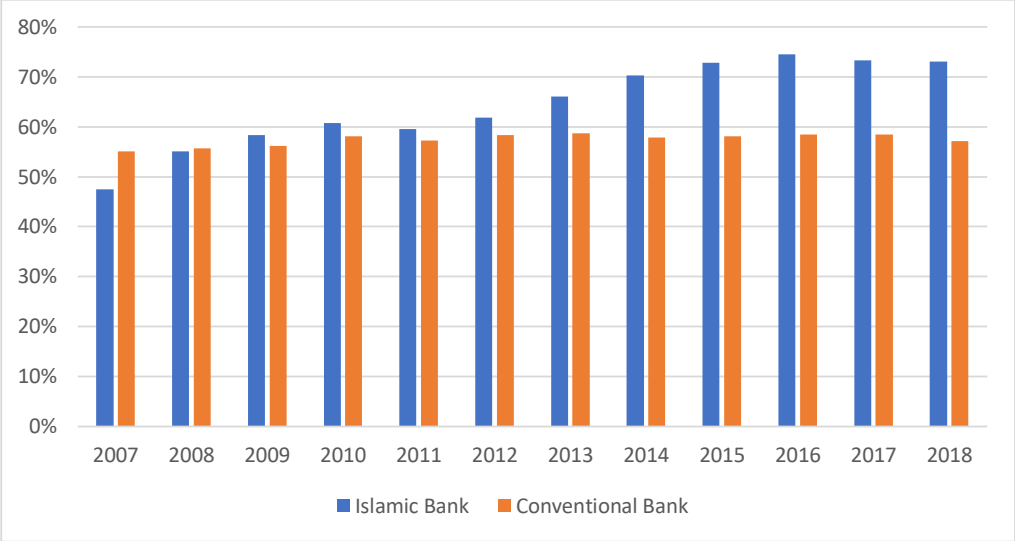

Figure 1-2: Share of Loans in Total Assets of Islamic and Conventional Banks, 2007-2018

Although limited, there are numbers of studies that examine the response of Islamic bank lending channel in Malaysia. Said and Ismail (2007) found the presence of the bank lending channel by using fixed effect model with GLS estimation. Sukmana and Kassim (2010) use VAR analysis and found that Islamic loans are significant in transmitting the monetary policy in Malaysia. Ibrahim and Sukmana (2011) uses Toda-Yamamoto causality test and employed the innovation accounting approach and found a strong causal impact of monetary policy rate on Islamic loans. Majid and Hassin (2014) also found the same conclusion by using ARDL methodology.

Another strand of literature compares bank lending channel between Islamic and conventional banks. Kassim et al. (2009) employs VAR and found that Islamic banks are more affected by monetary policy shocks compared to conventional banks in Malaysia. This is also supported by a study done by Aysan et al. (2017) for Turkey dataset. However, Zaheer et al. (2013) found a contrasting result for Pakistan. Thus, we aim to contribute to this debate on Islamic bank lending channel.

Most of the available literature on bank lending channel focused on the effects of monetary policy on loans at the aggregate level. Sectoral assessment of bank lending channel has not received the required attention from academics and policymakers alike. Little is known about how loans from different sectors respond to monetary shocks. There are only very few studies that compare the effect of monetary policy on bank lending across sectors. Among others, Ibrahim (2005) and Karim et al. (2006) found that monetary policy tightening in Malaysia reduces loans for all the sectors where some sectors are more affected by monetary tightening. Majid and Hasin (2014) study the sectoral Islamic lending channel and found the same conclusion, but this study only focuses on Islamic sectoral loans. One gap that could be found in all these papers is the missing of the household sector, which contributes to the biggest share out of total loan in Malaysia.

We also aim to look at how loans for different purposes respond to monetary shocks. Different firms from different sectors might borrow for a common purpose (e.g. a manufacturing firm and an agriculture firm applying for loans to purchase a fixed asset or to finance working capital). We believe the empirical evidence for this disaggregation of loan could uncover clearer picture on the effectiveness of monetary policy in influencing bank lending channel across purposes of loans.

Therefore, we aim to answer the question as to whether the monetary shocks in Malaysia has had a different impact on different sectors and different purposes of loans from different types of banks. It is believed that such empirics are useful to guide academics and policymakers in Malaysia for the evaluations and formulations of monetary policy.

We aim to contribute to the literature on Islamic finance by applying a more recent econometric approach to analyse the effect of monetary policy in an economy with a dual banking system. To the best of our knowledge, this is the first study to estimate a Factor Augmented VAR model (FAVAR) for the study of the bank lending channel in a dual banking economy. Further, empirical studies on Malaysia have not yet explored whether the responses of Islamic and conventional loans differ across sectors and purposes all in a single study for a better comparison. Therefore, we aim to fill this gap by applying a data-rich methodology in the bank lending channel for Malaysia.

Our results suggest the existence of the bank lending channel in Malaysia. Bank loans respond negatively to a contractionary monetary policy shock, but there are differences in magnitude and timing between Islamic and conventional banks. We found that responses of loans to monetary shocks are more substantial and faster for Islamic banks compared to conventional banks. On the sectoral and purposes level, the results are heterogeneous.

This study will discuss the overview of Malaysian monetary framework, Islamic banking concept and Islamic banking in Malaysia in the next subsections. Section 2 describes the methodology adopted in this study. Section 3 explained the empirical findings emerged from the study, and finally, section 4 concludes.

1.1.1 HISTORY OF MALAYSIAN MONETARY FRAMEWORK

Malaysia focused only on M1 as the monetary target before the 1990s and later changed to M3 as a policy target due to the growth in the financial sector. There were few limitations of using monetary targeting at the time, and this forced Malaysia to look for other means for policy target. Bulk capital flows in the early 1990s contributed to the uncertainty of monetary aggregates, and financial liberalisation has reformed the money demand function. Thus, in 1995, the Malaysia's central bank switched to interest rate targeting by opting to use the 3-month interbank rate as the policy rate. (Bank Negara Malaysia, 1999). The changes were made with the consideration that interest rate stability is crucial to support a steady financial system. In September 1998, the intervention rate was used as a policy rate, replacing the 3-month money market rate. The intervention rate is utilised in the calculation of the Base Lending Rate (BLR) to allow for faster transmission from the policy rate to banking's retail rate. Finally, in April 2004, BNM changed its policy rate to the overnight policy rate (OPR).

1.1.2 CONCEPTS OF ISLAMIC BANKING AND ISLAMIC BANKING IN MALAYSIA

The main difference between Islamic banks and conventional banks is in terms of charging interest rates. In principle, a predetermined interest rate is prohibited in Islamic practice. Islamic banks are prohibited to offer a fixed return on deposits or charge a predetermined rate on loans. The framework of Islamic banks is based on the Sharia principles under the guidelines of the *Quran* and Islamic law. The basis of the framework is to replace the standard predetermined interest rate with profit and

loss sharing rate (Chong and Liu, 2009). There are four types of agreements in Islamic finance, namely *Murabahah, Ijarah, Mudharabah,* and *Musharakah*.

- *Murabahah* fundamentally is an agreement where a commodity is sold for cost plus profit. Islamic banks buy the commodity for the borrowers at first, and the borrowers must buy it back from them at a 'marked-up' price (Shaban et al., 2016). It must be first established, that both buyer and seller know and agree on the cost and profit of the commodity.
- *Ijarah*, or leasing, is a transfer of legal rights to use facilities or equipment at an agreed rent to customers. This type of contract commonly used for financing that involves the purchase of vehicles and properties.
- *Mudarabah* financing requires Islamic banks to act as the capital providers, and customers are the ones managing the funds. Any profit obtained in Mudarabah financing is shared based on a predetermined PLS ratio, and any financial losses occurred must be borne by the banks. This is only if the losses occurred are not because of breach of contracted terms, negligence, or mismanagement by the customers.
- *Musharakah* financing is an agreement where banks and entrepreneurs agree to the contribution of capital and share any profit or loss occurred, for a specific business project according to an agreed ratio. Depending on the agreement, the financing can be paid either in a timely manner or lump sum.

These concepts of Islamic loans portray the absence of interest rates, distinguishing the Islamic financing and conventional financing. However, it is worth noting that profit and loss sharing rate and mark-up rate in the contract may use conventional interest rates as a benchmark (Hans, 2013).

Under the Islamic Bank Act 1983, the first Islamic bank was established in Malaysia in the same year. This was the starting point of the adoption of a dual banking system where Islamic and conventional banks operate together within the overall financial framework in Malaysia.

In 1993, a new concept of "Islamic banking window" was introduced. This concept allows conventional banks to offer Islamic banking products using their existing. There was a fear that the deposit used to offer financing products via this window are from the same source of conventional banking operations, which does not separate legal and illegal business activities according to Sharia law (Ariff, 2017).

As a solution, in 1996, conventional banks that wanted to offer Islamic banking products had to open a full-fledged Islamic banking branches, replacing the concept of Islamic banking windows, with the all the components and activities within these branches to be fully regulated under the Sharia Law (e.g., deposit money could not be invested into gambling businesses).

Under this new policy, conventional banks could continue to leverage their established reputation and network infrastructure. The established reputation resulted in better consumer acceptance among Muslims in Malaysia. Since then, the importance of the Islamic banking industry in the national financial framework in Malaysia has increased significantly.

1.2 METHODOLOGY

In order to preserve the degrees of freedom, studies that employed the standard VAR approach to measuring the effect of monetary policy often opted to utilise a limited number of variables. This leads to a standard limitation of VAR, such as it might not be able to capture the full information necessary in the decision making of policymakers. Sims (1992) mentioned that estimating a VAR with a small number of variables can lead to price puzzle where a small VAR model might show increasing inflationary pressure, but in theory, contractionary monetary policy shocks should lower the prices. In FAVAR methodology, a large panel dataset can be reduced to a few factors, and these factors then added to the VAR model. This approach is more accurate because it uses an information set that is more similar to the one that is available to the monetary authorities as policymakers depend on vast number of macroeconomic data series for their decision making. The following is a brief description of the FAVAR methodology.

Bernanke et al. (2005) introduced the application of FAVAR in studying monetary policy. Since then, numbers of literature have followed the approach; as in Lagana and Mountford (2005); Mumtaz and Surico (2009); Fernald et al. (2014); and Kabuni and Ngwenya, (2011). These papers found that FAVAR methodology can provide more accurate and reliable estimates than standard VAR. Nonetheless, the application of FAVAR in assessing monetary policy in Malaysia is minimal as only one article has used this approach so far. Chua (2012) employed the FAVAR framework to assess the monetary policy in Malaysia and employed 78 macroeconomic time series data reflecting numbers of economics variables to investigate the effects of monetary shocks to the Malaysian economy. The study focused only on the problem of price

puzzle, and on the financing side, Chua (2012) only included total loan as the variable. As for studying the responses of from Islamic banks, no literature yet to explore it by using this method. Thus, we attempt to fill the gap by studying responses of sectoral loans and loans by purposes for both Islamic and conventional banks to monetary shocks by using FAVAR approach.

1.2.1 FAVAR

We assume that a $(N \text{ x } 1)$ vector of macroeconomic time series X_t to be represented as a linear combination of the $(K \text{ x } 1)$ vector of unobservable factors, F_t, where K is relatively small, $(K << N)$ and R_t, $(M \text{ x } 1)$ matrix of observable variables[2]. The joint dynamics of (F_t, R_t), also the FAVAR system, can be represented by:

$$\begin{bmatrix} F_t \\ R_t \end{bmatrix} = A(L) \begin{bmatrix} F_{t-1} \\ R_{t-1} \end{bmatrix} + \delta_t \quad (1\text{-}1)$$

where $A(L)$ is a conformable lag polynomial of finite order d. The error term δ_t has zero mean and covariance matrix (Ψ).

The FAVAR model in (1-1) cannot be estimated directly as F_t is not observed. Nevertheless, since F_t is assumed to represent the information contained in X_t, it should be possible to infer something about F_t from the dataset. The following relationship between X_t and F_t is assumed:

$$X_t = \psi^f F_t + \psi^r R_t + e_t \quad (1\text{-}2)$$

where ψ^f is the $(N \text{ x } K)$ matrix of factor loadings and ψ^r is the $(N \text{ x } M)$ matrix. e_t is the $(N \text{ x } 1)$ vector of error terms with mean zero and assumed to be serially and

[2] We only include monetary policy as the only observable variable following Chua (2012).

mutually weakly correlated. Equation (1-2) implies that the dynamics of each time series in the vector X_t are driven by common factors (F_t, R_t) and e_t.

1.2.1.1 ESTIMATION

It is not possible to estimate equation (1-1) directly because the factors are not observed. There are two methods to recover the unknown factors, as suggested in Bernanke et al. (2005). The first method is the two-step estimation using principal components. The second method is a joint estimation by single-step likelihood approach. The two-step estimation approach is based upon the methodology facilitated in Stock and Watson (2002). The single-step approach was commonly denoted as likelihood-based Gibbs-sampling and its application to large factor model was discussed in Eliasz (2002).

In the two-step estimation approach, the factors are first estimated by using the principal components, and then their dynamics are estimated. Principal component involves a mathematical technique that is used to transform a large set of correlated variables into a smaller set of uncorrelated variables, called the principal components, which account for most of the variation in the original dataset. This approach provides a nonparametric way of uncovering the common space spanned by the factors of X_t. In contrast, the single step approach is fully parametric, requiring the model to be fully specified. Thus, imposing incorrect restrictions will lead to a biased estimates and this can be avoided by using the two-step approach.

Moreover, Bernanke et al. (2005) compared these two methods and concluded that the computationally more difficult single-step approach did not generate significantly better results than the two-step approach. This conclusion could help explain the

predominantly favouring of two-step approach in factor estimation throughout the vast literature on FAVAR.

1.2.1.2 IDENTIFICATION OF THE FACTORS

In the first step of the principal components approach, we estimate the common component, $C(F_t, R_t)$ from the first $(K + M)$ principle components of X_t. Since $R_t$is not imposed as an observable component in the first stage, the first K principal components are assumed to uncover the space spanned by the estimated factors of the dataset X_t. This would mean that our monetary policy instrument, R_t, would be part of a linear combination of underlying $\hat{C}(F_t, R_t)$. Thus, it would not be valid to estimate a VAR and then identifying the monetary policy shock recursively. Hence, we must remove the dependence of $\hat{C}(F_t, R_t)$ on R_t. To obtain the factors free from the policy instrument effect, Bernanke et. al. (2005) procedure is followed.

Common factors $\hat{C}(F_t, R_t)$ are first estimated utilising all the variables in X_t by using principal components. Then, variables in X_t are divided into two categories: 'fast-moving' and 'slow-moving'. The slow-moving variables are usually reported in a frequency of monthly or quarterly basis (e.g., Industrial Production Index), while the fast-moving variables are usually reported in a daily basis (e.g., stock market data and exchange rate) and highly sensitive to economic news or policy shocks. These fast-moving variables are expected to react contemporaneously to changes in observable variables. The classification of variables for each category is provided in Appendix 1-C.

Common components $\hat{C}$ then are regressed on the estimated slow-moving factors and on the observed variable.

$$\hat{C} = \varpi^s \hat{F}_t^s + \varpi^f R_t + \eta_t \quad (1\text{-}3)$$

where ϖ^s is the coefficient matrix of estimated slow-moving factors, ϖ^f is the coefficient vector of the monetary policy variable and η_t is the vector of error terms. The unobservable factors $\hat{F}_t$ are obtained from:

$$\hat{F}_t = \hat{C}(F_t, R_t) - \varpi^f R_t \quad (1\text{-}4)$$

As regard to the extraction procedures of the factors using the principal components, we follow Bernanke et. al. (2005) to restrict the factors by $F'F/T = I$ and obtained $\hat{F} = \sqrt{T}\hat{Z}$, where $\hat{Z}$ are the eigenvectors corresponding to the K largest eigenvalues of XX', which are sorted in a descending order. The second stage involves estimating Equation (1-1) with the estimated factors $\hat{F}_t$ and the observable variables R_t.

1.2.1.3 IDENTIFICATION OF THE VAR

Once the estimated factors are obtained, the next step involves estimation of the VAR model that includes $\hat{F}_t$ and R_t. Following Bernanke et al. (2005), to identify the macroeconomic shocks, we are assuming a recursive structure, where the factors entering equation (1-2) respond with a lag to an unanticipated change in monetary policy rate. This recursive assumption utilizes Cholesky Decomposition of the variance covariance matrix of the estimated residuals. Cholesky decomposition is an algorithm for transforming a symmetric positive definite matrix into a lower triangular matrix multiplied by its transpose. Although there are other alternative identification schemes for the monetary policy shock identification available in the literature (e.g., sign restrictions as in Mumtaz and Surico (2009)), the focus of our study is to highlight the different responses of different type of loans to the monetary policy shock and not to analyze alternative identification schemes. Thus, we follow

Bernanke et al. (2005) in using a Cholesky decomposition scheme for the shock identification.

The Cholesky decomposition implies a strict causal ordering of the variables in the VAR. The variable ordered last responds contemporaneously to all the other variables, while other variables respond with a lag to the variable ordered last. The variable ordered first responds with a lag to all the other variables. A standard identification assumption in VAR studies of the monetary policy shock is that it is orthogonal to the variables in the policy rule, as in other economic variables do not respond contemporaneously to the monetary policy shock. Thus, we utilizes the Cholesky decomposition scheme in which our short-term interest rate is ordered last and we treat its innovations as the monetary policy shocks.

We follow the procedure of VAR estimation using Matlab code from Koop and Korobilis' (2009). We use diffuse priors to obtain impulse responses and the error band was derived from the posterior density of the impulse responses. We employed Gibbs sampling of 30,000 iterations, and we discard the first 20,000 draws to estimate the prior distribution. We standardise the monetary policy shocks to an increase of 1 per cent of the overnight interbank rate.

1.2.2 DETERMINATION OF THE NUMBER OF FACTORS

We need to determine the appropriate number of factors to be extracted from the Principle Component and include them in our FAVAR model. In doing so, we need to make a choice in the trade-off between over-fitting and goodness-of-fit of the specification. This can be done through two different suggested manners: principal component analysis or using information criteria.

Figure 1-3 illustrates the scree plot which shows us the eigenvalues ordered from largest to smallest[3]. Sum of all eigenvalue is equal to the number of variables. In our case, it would be 113.

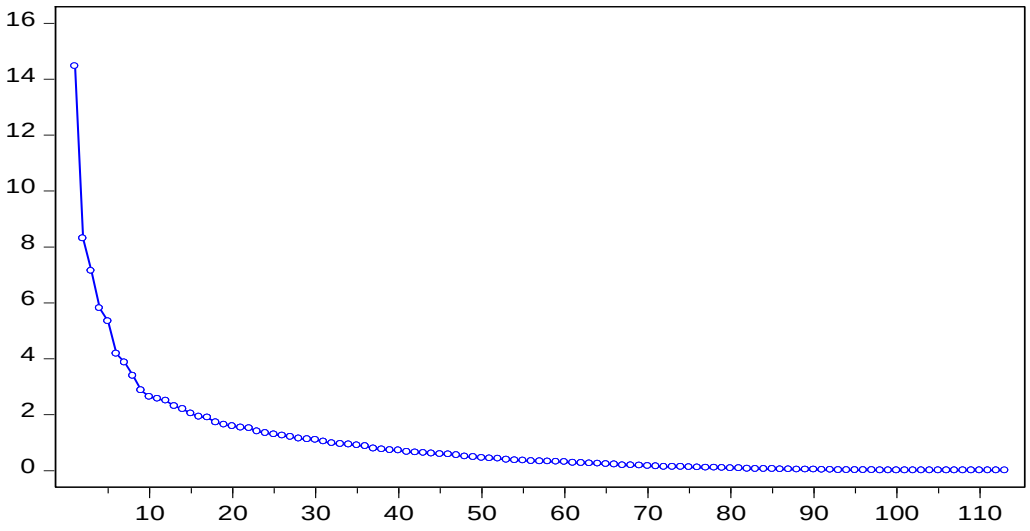

Figure 1-3: Scree Plot

We can get the percentage of cumulative percentage of variation in our dataset of each factor by dividing eigenvalue with scaled variances of our variables (113). The percentage of cumulative variation is shown in Figure 1-4. From this, we decided to include 10 factors in our FAVAR model, as 51.3 per cent variation in our dataset could be represented as we decided that 50 per cent is our threshold[4].

[3] We show the results when using sectoral loans data as the benchmark model. Results for this analysis is included in Appendix 1-D. Although 9 factors are enough to reach 50 per cent of variation explained in purposes model, we opted for 10 factors for consistency with sectoral model.
[4] Choosing 9 factors will give us 48.97 per cent variation explained. Choosing more than 10 factors will cost us more degree of freedom.

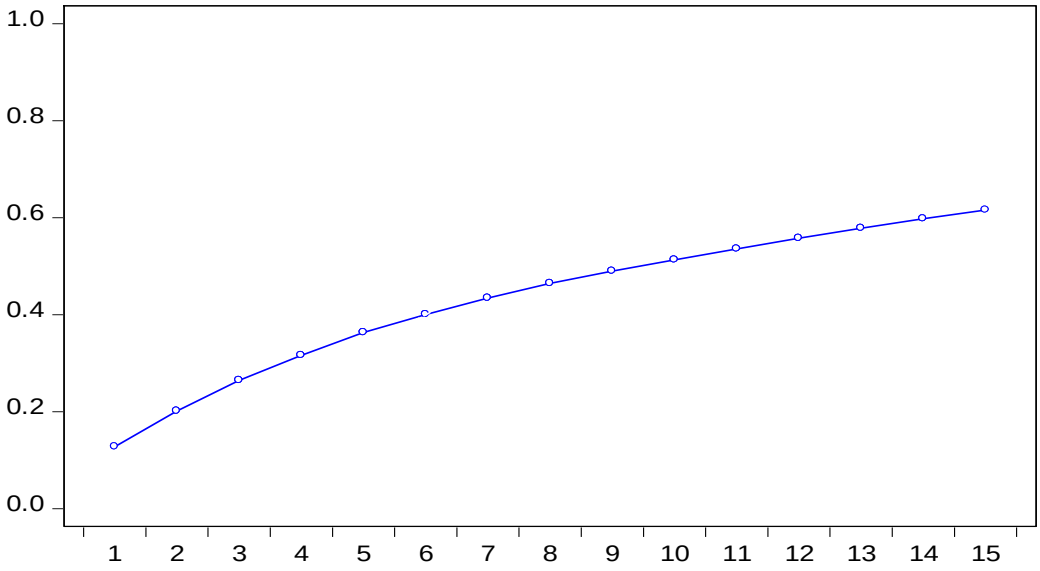

Figure 1-4: Cumulative Variation Explained

Applying the Bai and Ng (2002) criteria to determine the optimal number of (static) factors produces results as shown in Table 1-1

Factors	IC1	IC2	IC3	PC1	PC2	PC3	BIC3	AIC3
1	-0.079	-0.070	-0.102	0.897	0.902	0.887	0.939	0.881
2	-0.103	-0.085	-0.148	0.856	0.864	0.834	0.938	**0.823***
3	-0.120	**-0.095***	-0.188	0.824	0.837	0.791	0.947	0.775
4	-0.128	-0.094	-0.219	0.804	0.821	0.760	0.967	0.739
5	**-0.135***	-0.092	-0.249	0.789	0.810	0.734	0.990	0.706
6	-0.131	-0.079	-0.267	0.783	**0.808***	0.717	1.024	0.684
7	-0.125	-0.064	-0.284	**0.780***	0.810	0.704	1.059	0.664
8	-0.115	-0.046	-0.296	0.782	0.815	0.694	1.098	0.648
9	-0.099	-0.021	-0.303	0.788	0.825	0.689	1.141	0.637
10	-0.081	0.005	**-0.308***	0.796	0.838	**0.686***	**1.185***	0.628

Table 1-1: Results for Bai and Ng (2002) Information Criteria

As suggested by the results from both inspections, we simulate our FAVAR model with 10 factors, as it is a reasonable compromise between choosing too many factors and having too few factors.

1.2.3 LAG SELECTION

To further specify our model, we also need to determine the number of lags p in the VAR. The VAR literature usually advocates the use of Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) criteria for lags selection. We ran the lag length criteria for the data in the VAR part based on 5 different criteria: sequential modified LR test statistic: Final prediction error, Akaike information criterion, Schwarz information criterion, and Hannan-Quinn (HQ) information criterion. We decided on employing lag order of 1 as suggested by SC and supported by HQ. We ran the same test for the model with loans by purposes model and obtained similar suggestion which is 1 lag by SC and HQ.

Lag	LR	FPE	AIC	SIC	HQ
0	NA	3.59E-16	-4.34523	-4.11731	-4.25261
1	1238.876	1.53E-19	-12.11	**-9.375053***	**-10.99864***
2	279.3689	**8.33e-20***	-12.7458	-7.5038	-10.6157
3	183.6282	9.02E-20	-12.7381	-4.98913	-9.5893
4	140.6596	1.34E-19	-12.4811	-2.2251	-8.31356
5	118.7824	2.37E-19	-12.1541	0.608913	-6.96783
6	**191.5138***	1.53E-19	-12.9817	2.288325	-6.77671
7	129.4936	2.04E-19	-13.2816	4.495445	-6.05787
8	116.4785	3.09E-19	**-13.74632***	6.537767	-5.50384

Table 1-2: Results for Lag Selection Criteria

1.2.4 DATA

We included a balanced panel of 113 monthly macroeconomic data in our FAVAR model. The data span the period from April 2006 through December 2018. The reasoning behind this choice of timeframe is the reclassifications under the Financial Institutions Statistical System (FISS) which took effect on April 2006. Loans to all customers except households are classified under both economic sectors and purpose. Loans to households are classified under purpose only. BNM (2018) stated that the breakdown before this new reclassification is strictly not comparable.

A list of all the variables included in our study is provided in Appendix A. These 113 series[5] were subjected to three preliminary handlings:

1. All the variables are checked to detect any presence of seasonality. Variables that exhibits seasonality is treated using X-12 function in EViews.
2. Stationarity of each variable is tested using the Augmented Dickey-Fuller test. The appropriate transformation will be carried out for each variable that has a unit root to ensure stationarity.
3. Standardize all variables to have zero mean and unit variance. This is because the data employed are on a different scale, and this can impair the factor extraction process in principal component analysis.

We also need to decide on the proxy for the monetary policy rate. Chua (2012) applied 3 months rate as the policy rate as it is considered the standard proxy for the policy rate for his FAVAR model. Figure 1-5 shows the overnight policy rate and interbank money market rate for both overnight and 3 months in Malaysia from 2000 to 2016. It can be seen from the figure that the overnight interbank rate is closer to the Overnight Policy Rate compared to 3 months interbank rate. We chose the overnight interbank rate as the proxy for monetary policy as it resembles[6].

[5] Number of loans by sectors and number of loans by purpose is identical (12 each).
[6] Results using overnight money market rate as the proxy for the interest rate is included in order to satisfy robustness check. (Appendix 1-E).

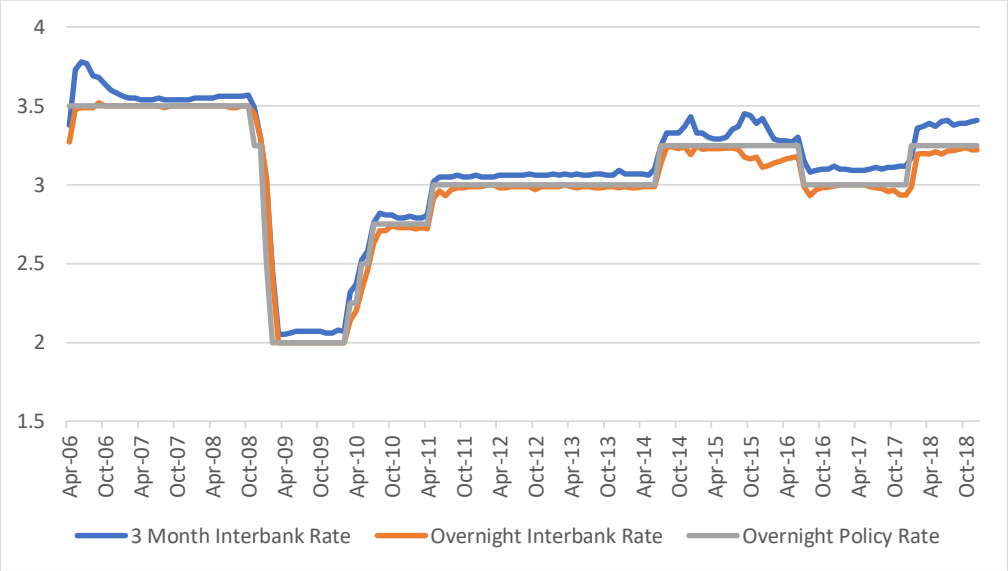

Figure 1-5: Overnight Interbank Rate, 3 Month Interbank Rate, and Overnight Policy Rate

1.3 RESULTS

This section describes the main results. First, we present the impulse response of macroeconomic variables response to the monetary policy shock. Second, we discuss the response of conventional and Islamic bank loans along with their disaggregated loans. Third, we check for sensitivity of our model with a series of robustness tests presented at the end of this section.

1.3.1 MACROECONOMICS VARIABLES

Figure 1-6 shows the responses of the selected macroeconomic variables to a contractionary monetary policy over 36 months for our FAVAR model with ten factors. The impulse response function traces the effects of a one per cent shock to a monetary policy innovation. The significant impact of monetary policy shocks on the overall macroeconomic variables is clear, and the direction of the impact is in line with economic theory, as expected, except for effective exchange rate. Industrial

Production Index (proxied as output) decreases after 1-month lag. 1 per cent increase in policy rate decreases IPI up to 0.8 per cent over 36 months, and Consumer Price Index decreased by 0.19 per cent on impact and up to -0.07 per cent on 14th month before the response becomes insignificant. Total loan decreases immediately and up to -0.78 per cent on the 3rd year. Here, we witness an exchange rate puzzle where effective exchange rate responded negatively. Raghavan et al. (2010), found the same result in the sub-period after 1999-2007 in Malaysia. Lagana and Mountford (2005) found the same puzzle in UK and stated that this could possibly due to the prior increase of interest rate in US.

5 Year Government securities increases immediately. The total loan took 2 months lag to be significantly responsive to the contractionary monetary policy shock. After 3 years horizon, total loan decreases by 0.8 per cent due to 1 per cent shocks on monetary policy.

Comparing our results of macroeconomics variables to the established studies done on the effects of monetary policy in Malaysia, we found consistency with the results of others. Almost all agree that contractionary monetary policy decreases output. On the other hand, Fung (2002), Manap and Kassim (2007), Raghavan et al. (2010), found the presence of price puzzle when studying the effects of monetary policy shocks. As pointed by Chua (2012), prize puzzle in Malaysia could be eliminated by using data-rich methodology. We found no presence of prize puzzle in our results, in line with the finding by Chua (2012), who also uses FAVAR methodology to examine monetary policy shocks in Malaysia.

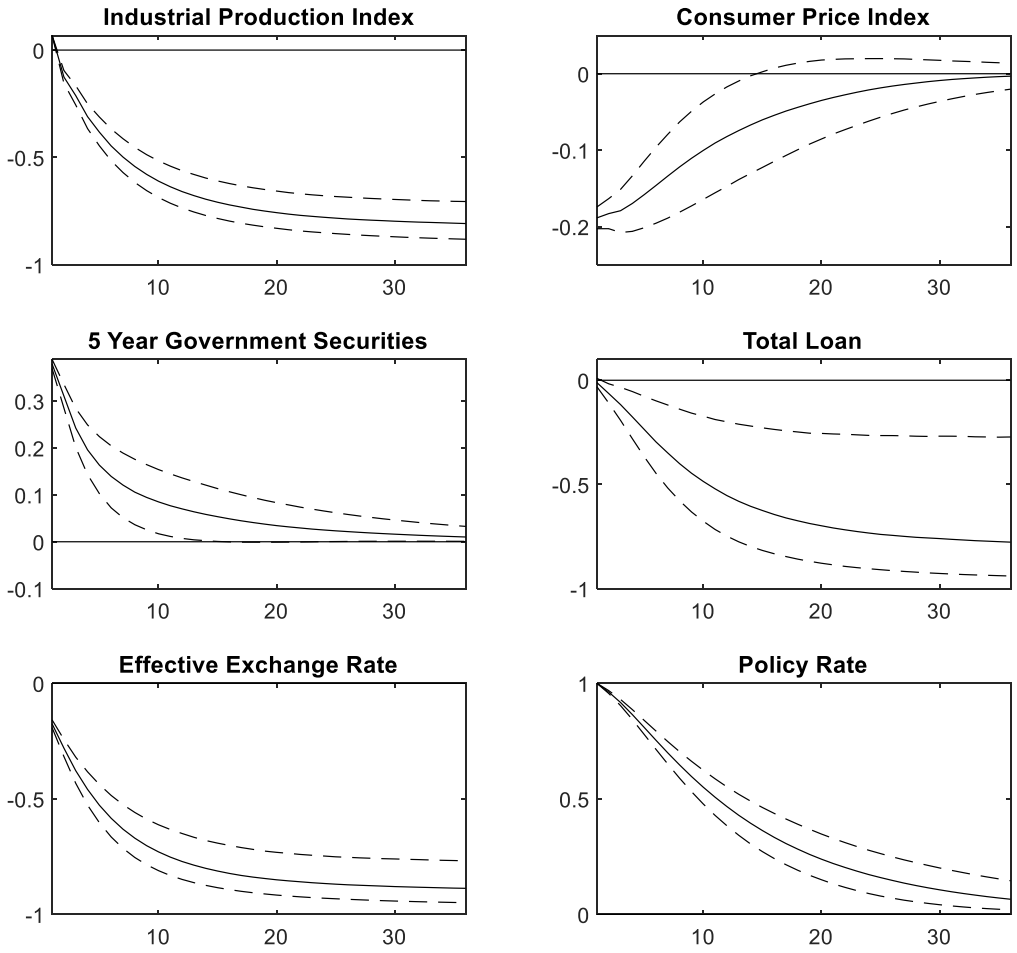

Figure 1-6: Aggregate Macroeconomic Response to Monetary Policy Shock
This figure shows the median response and the 68 per cent confidence band. The monetary policy shock is normalized to 100 basis point increase of policy rate. 30000 Gibbs replications draw, and 20000 burn-in draws were used to generate impulse response.

1.3.2 DISAGGREGATED BANK LOANS

Breaking the loans into conventional and Islamic loans, we could see a difference of responses between these two, although both are showing negative responses. Islamic loans appear to be more responsive to the contractionary monetary shocks compared to the conventional counterpart. The same results were found in Kassim et al. (2009) and Akhatova et al. (2016) for Malaysia. Ergeç and Arslan (2013) and Aysan et al. (2017) also found similar results for Turkey. Figure 1-7 shows the response of Islamic and conventional loan for the 36-month horizon. 1 per cent increase in monetary

policy decreases Islamic loan immediately, reaching 1 per cent decrease after 2 years. There is a bit delayed reaction from the conventional loan before being significantly negative. This suggests the higher capacity of the conventional banks to guard their lending against contractionary monetary policy. The possible explanations for this as given by literature includes:

- Islamic banks rely too heavily on their deposits as a source of financing. (Sukmana and Kassim, 2010).
- Islamic banks are less developed in term of the money market. This means they have limited access to alternative sources of funding (Farooq and Zaheer, 2015).
- Islamic banks are relatively smaller in size, hence, more affected by monetary shocks (Kishan and Opiela, 2000).

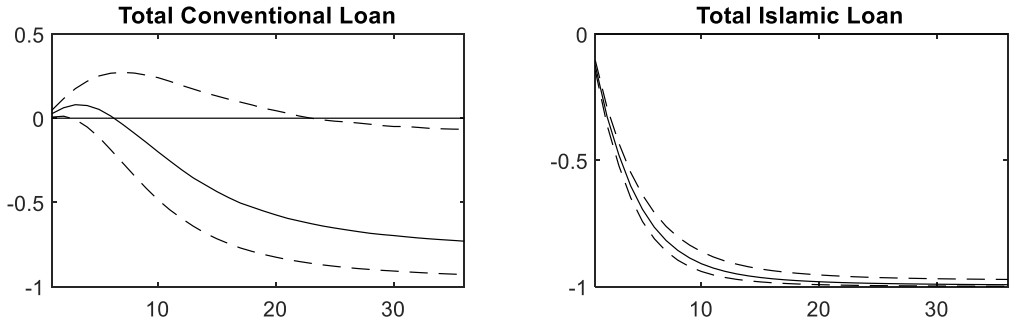

Figure 1-7: Total Conventional and Islamic Loan Responses to Monetary Policy Shock
This figure shows the median response and the 68 per cent confidence band. The monetary policy shock is normalized to 100 basis point increase of policy rate. 30000 Gibbs replications draw, and 20000 burn-in draw were used to generate impulse response.

Next, we look at the sectoral lending of both types of banks. Detail descriptions of each sectors are provided in Appendix 1-A. We present the decomposition of conventional and Islamic loans according to their sectors in Figure 1-8 and Figure 1-9 from 2006 to 2018. The household sector contributes to the most significant fraction of both conventional and Islamic loan. The other important sectors for both banks are

manufacturing, 'wholesale and retail trade, restaurants and hotels' (WRHR), construction, real estate, and 'finance, insurance, and business activities' (FIB).

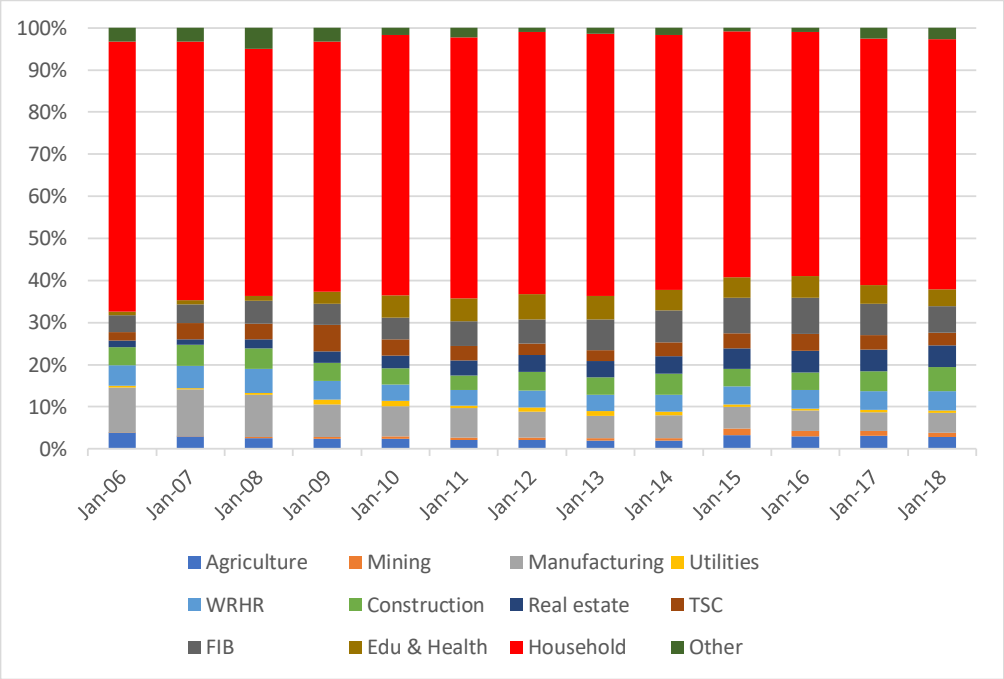

Figure 1-8:Decomposition of Islamic Loans into Sectors

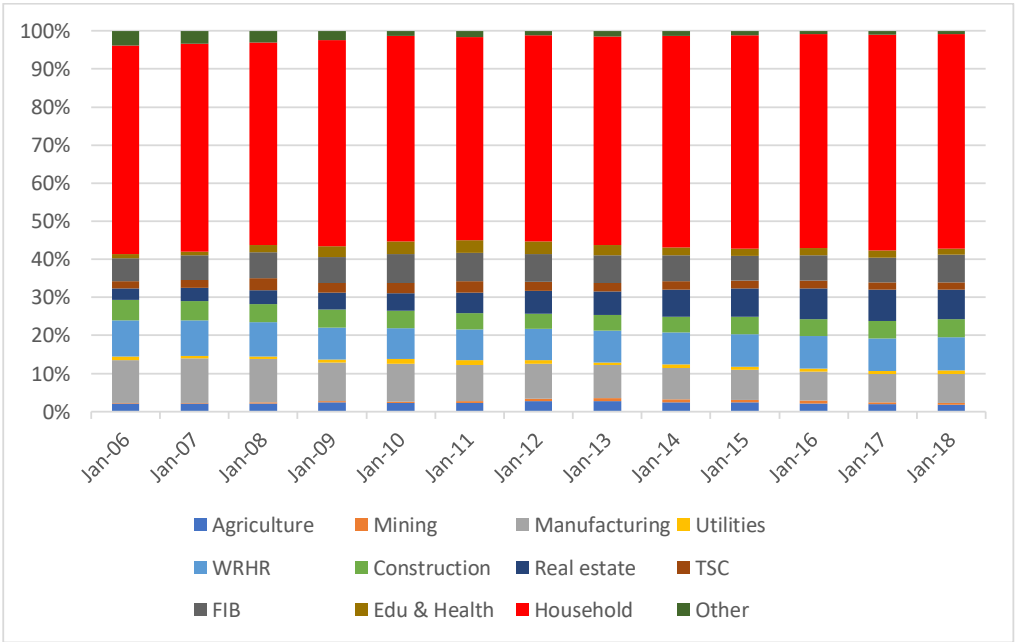

Figure 1-9:Decomposition of Conventional Loans into Sectors

We are mostly interested in the response of household sector, as it is the biggest contributor to both types of banks. As shown in Figure 1-10, the household sector for both banks responded negatively, and Islamic household loan reached maximum impact faster than the conventional counterpart. On impact, Islamic household loan decreases by 0.5 per cent, while conventional household loan decreases by less than 0.1 per cent.

Agriculture, mining, and construction sector show an insignificant response for both banks. Utilities and real estate loans for both banks follow the expectation of responding negatively to monetary policy shocks. As for manufacturing, conventional banks shows a positive response for the first year and Islamic banks show a negative response after 2 years. This is contrary with the findings from Ibrahim (2005) and Karim et al. (2006) where loans for manufacturing decreases as a response to monetary policy shocks. This is probably due to loans reclassifications or different methodology adopted. Most importantly, we found the evidence of heterogeneity across sectors from both type of bank. This suggests that monetary policy is not transmitted in the same manner across sectors. A hypothetical situation where economy is in downturn, and the central bank of Malaysia decided to lower the interest rate to increase output, loans in agriculture and mining sectors are not responding positively, thus render the effectiveness of the monetary transmission in these sectors.

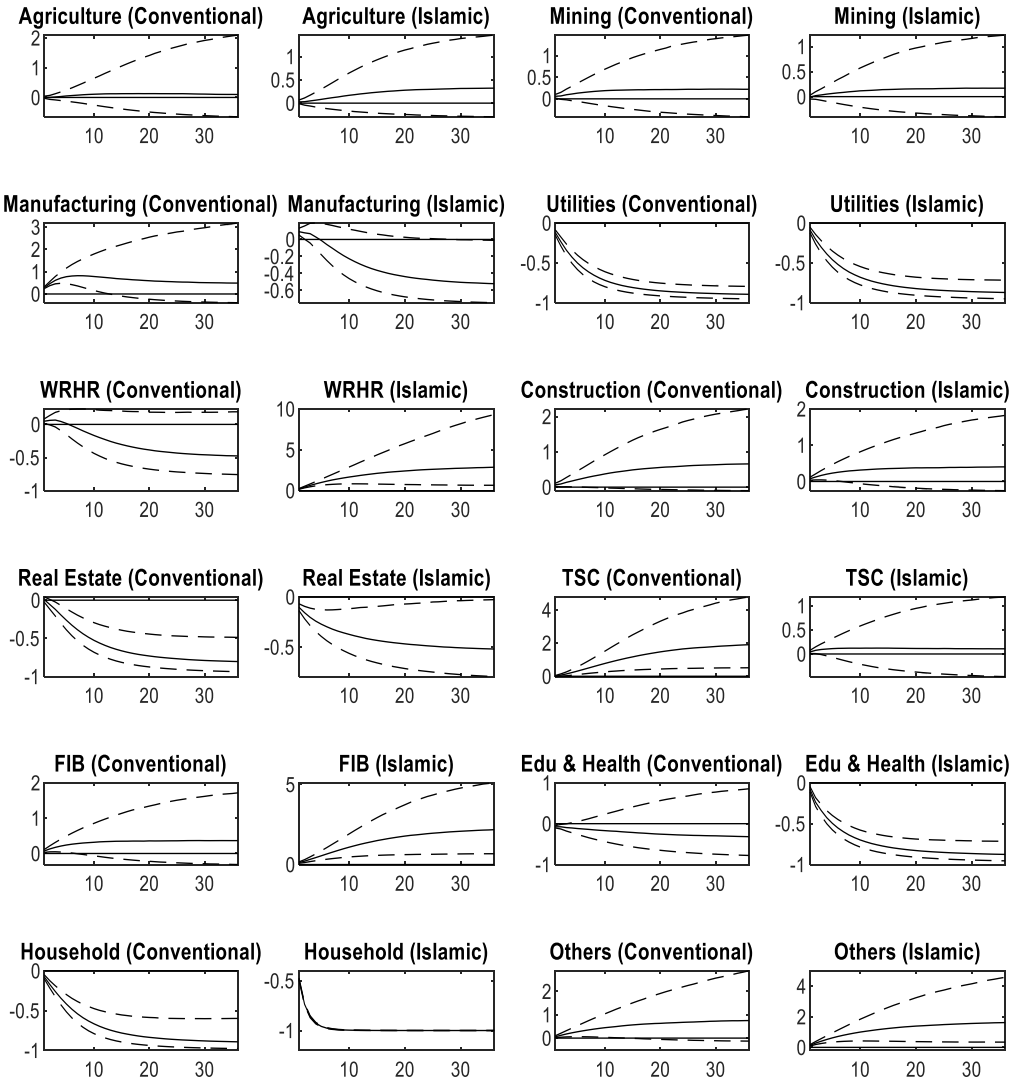

Figure 1-10: Sectoral Loan Response to Monetary Policy Shock
This figure shows the median response and the 68 per cent confidence band. The monetary policy shock is normalized to 100 basis point increase of policy rate. 30000 Gibbs replications draw, and 20000 burn-in draw were used to generate impulse response.

Next, we look at the responses of the bank lending based on the purposes of the loans. Detail descriptions on each purpose are provided in Appendix 1-B. We rerun the model by replacing the sectoral loans with loans by purposes. The impulse response results for macroeconomic variables for purposes model are reported in Appendix 1-G. As shown in Figure 1-11 and 1-12, the distributions of loans across purposes are more dispersed compared to loans across sectors. Loans to purchase passenger cars,

residential property, non-residential property, and working capital makes up the most out of total loans for both banks.

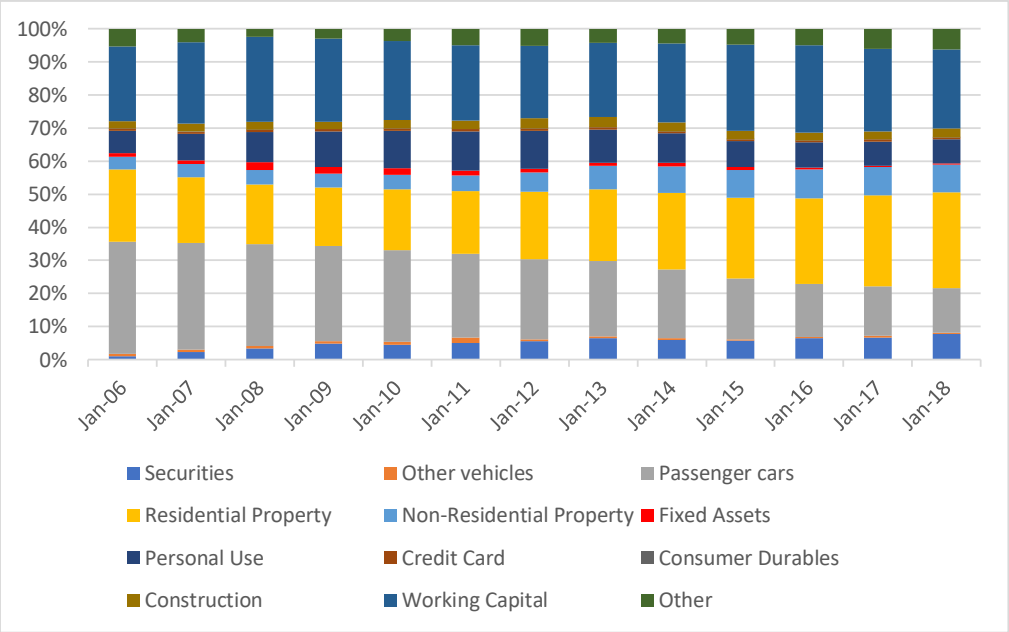

Figure 1-11: Decomposition of Islamic Loans into Purposes

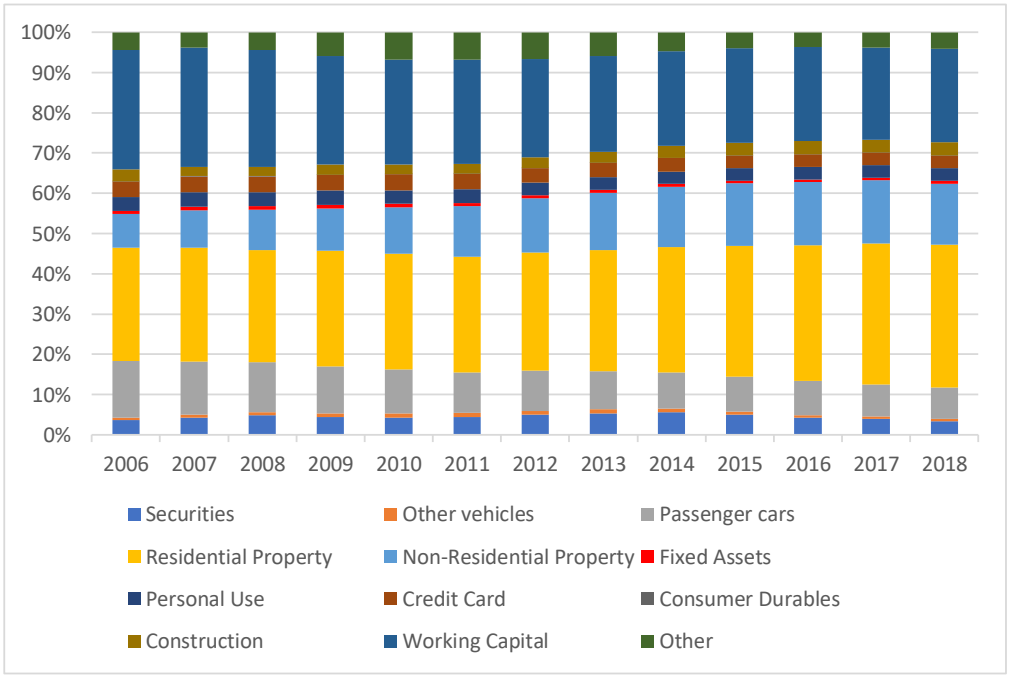

Figure 1-12: Decomposition of Conventional Loans into Purposes

Responses of loans across purposes again suggest heterogeneity for both banks. Loans for both residential and non-residential properties responded negatively to monetary policy shock. For passenger cars, Islamic loan shows immediate negative response while the result for a conventional loan is not significant. As for working capital and fixed asset, both banks show positive response. Interestingly, both purposes are similar in the sense that firms must use it for productions and operations.

We can also see contrasting responses of loans to purchase securities, passenger cars, and personal use. These purposes are similar in the sense that the consumption could be postponed or cancelled, unlike working capital and fixed assets. These purposes are also on a shorter-term with less amount compared to the purchase of residential and non-residential properties.

We argue that conventional banks could be taking advantage of the situation where Islamic banks must lower the supply during contractionary monetary policy due to the reasons given above. Conventional banks could make extra profit by offering more loans to the customers that could not get the loans for these purposes from Islamic banks.

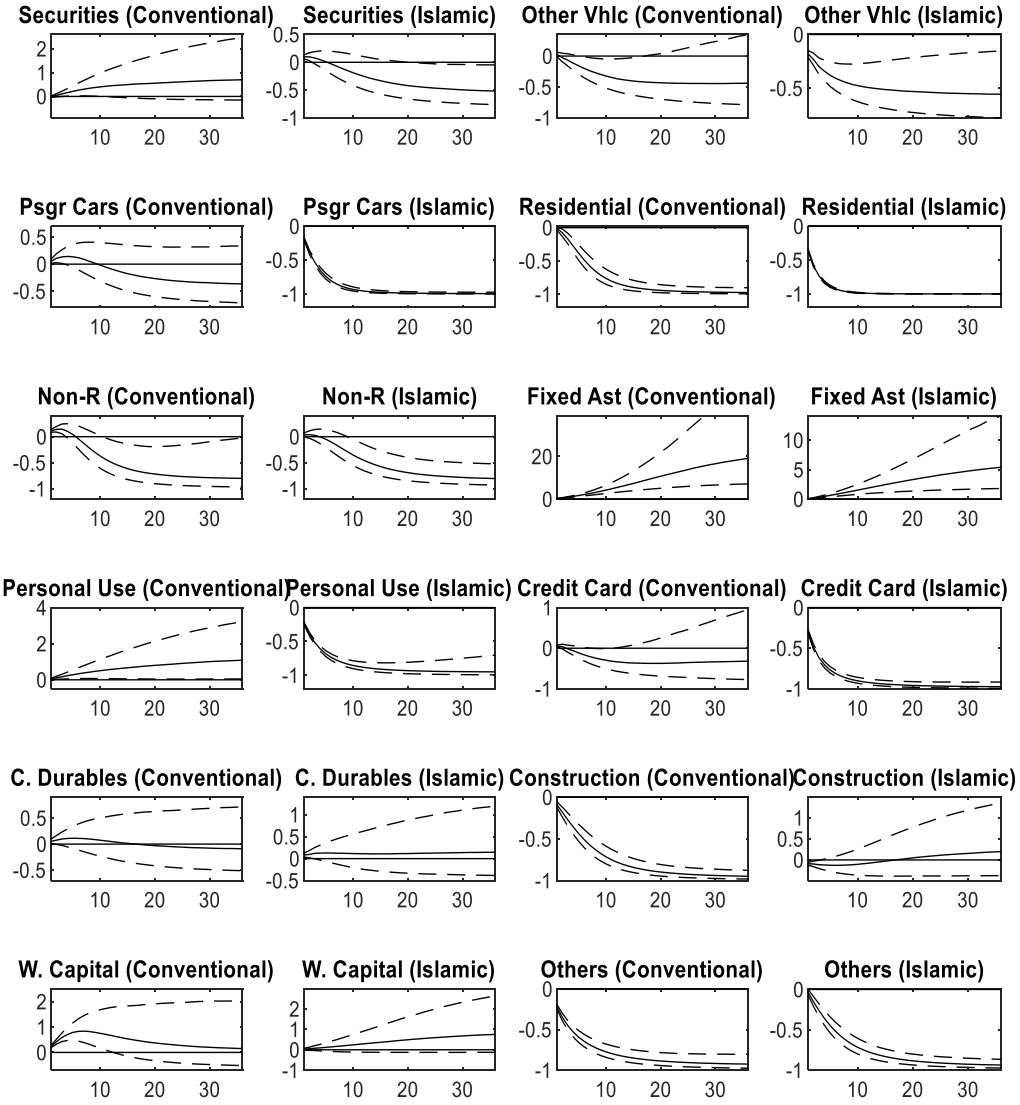

Figure 1-13: Loans by Purposes Response to Monetary Policy Shock
This figure shows the median response and the 68 per cent confidence band. The monetary policy shock is normalized to 100 basis point increase of policy rate. 30000 Gibbs replications draw and 20000 burn-in draw were used to generate impulse response.

1.3.3 VARIANCE DECOMPOSITIONS

We look at forecast error variance decompositions to determine the contribution of the monetary policy shocks to the loans provided by each type of banks in Malaysia. Forecast error variance decomposition determines the fraction of the forecasting error of a variable, at a given horizon, that is attributed to any particular shock. This is an essential exercise as it shows how much of the forecast error is attributed to the monetary policy shock.

Table 1-3 reports the results for forecast error variance decompositions (FEVD) for the horizon of 6, 12, 24, and 36 months ahead the forecast error owes to the monetary policy shocks. The contribution of the monetary policy shock to the forecast error of total loan is 17.48% after 36 months. This may suggest a significant impact of the monetary policy shock in affecting the total loan movement in Malaysia. Decomposing the loan into Islamic and conventional loans, we could see contrasting results. Forecast variance of conventional loan is more significantly explained by monetary policy shocks (18 per cent on the first year and 17 per cent on the third year) compared to Islamic loans (6 per cent on first and third year). This suggests that there are other more important shocks that could influence the movement of Islamic loans (e.g., demand shock).

As for sectoral analysis of the variance decompositions, for conventional loans, Manufacturing, Restaurants and Hotels, Construction, Transport, Storage and Communication, and Others recorded forecast error of more than 10 per cent that are attributed to monetary policy shock. The results for same sectors show the same behaviour for Islamic loans except for Manufacturing, which is lower than 10 per cent. This result suggests that movement of most of the sectors of loans from both

Islamic and conventional banks are affected largely by other shocks, compared to monetary policy shock and the movement of sectoral loans that are largely explained by monetary policy shock are generally the same for both banks.

Looking at the results for purposes of loans, only Securities, Construction, and Working Capital shows more than 10 per cent of forecast error due to monetary policy shock, for commercial banks. Contrasting results is obtained for Islamic banks where Residential Property, Non-Residential, and Personal Use are the only purposes with more than 10 per cent forecast error due to monetary policy shock. This is in line with the results for sectoral loans where the movement of most purposes of loans from both banks are affected largely by other shocks. Although, the purposes are different for Islamic and conventional loans.

The last column on Table 1-3 gives the R^2 for the regression of the estimated factors plus the interest rate on each variable. It shows how well each variable represented by the factors and the observable variable in our VAR. Output level, price level, and loan variables shows R^2 values of higher than 70 per cent which indicates that they are well represented by our model. However, observing the R^2 of each sectoral loans and loans by purposes, we could see that amount of variation explained by the factors are much lower, with only a few of R^2 being greater than 70%, such as Household (Islamic), Residential Property (Islamic), and Personal Use (Islamic).

Variables	6	12	24	36	R^2
Policy Rate	**9.2697**	**6.9297**	**6.7226**	**6.8017**	**100***
Industrial Production Index	**2.2579**	**2.3436**	**2.4092**	**2.4206**	**74.4013**
Consumer Price Index	**12.6057**	**12.3545**	**12.258**	**12.2812**	**90.0335**
Total Loan	**19.2898**	**18.2865**	**17.7668**	**17.4845**	**75.5924**
Total Islamic Loan	**6.07**	**6.095**	**6.3688**	**6.458**	**70.1318**
Total Conventional Loan	**20.7766**	**19.4563**	**19.0878**	**18.7496**	**77.8654**
Sectoral					
Agriculture (Conventional)	3.1581	3.9163	4.5636	4.6499	31.6528
Mining (Conventional)	2.8253	3.1282	3.3971	3.4599	15.558
Manufacturing (Conventional)	15.1927	14.8778	14.6352	14.5795	48.3078
Utilities (Conventional)	5.1847	5.2246	5.3262	5.4454	12.4802
Wholesale and Retail Trade, Restaurants and Hotels (Conventional)	25.1596	24.6127	23.5986	23.4128	34.3995
Construction (Conventional)	11.2001	11.7234	11.2744	11.1878	5.2799
Real Estate (Conventional)	3.2679	3.6956	4.3001	4.4351	33.0576
Transport, Storage and Communication (Conventional)	22.7374	22.4706	22.3228	22.2681	44.5671
Finance, insurance, and business activities (Conventional)	4.3948	4.8321	5.2295	5.2553	12.0791
Education & Health (Conventional)	8.7297	8.7501	8.9139	8.8719	48.5168
Household (Conventional)	6.3201	6.9008	7.5223	7.7159	63.7209
Others (Conventional)	17.6829	18.7168	18.2357	18.1089	8.7429
Agriculture (Islamic)	6.36	6.7628	6.9722	7.0649	17.6459
Mining (Islamic)	9.7175	9.9649	9.8906	9.9895	13.8458
Manufacturing (Islamic)	5.5417	5.6232	5.7147	5.6871	23.9116
Utilities (Islamic)	3.4486	3.8927	4.4283	4.5224	14.8129
Wholesale and Retail Trade, Restaurants and Hotels (Islamic)	14.9151	14.6808	14.4762	14.4209	28.0133
Construction (Islamic)	11.0741	11.8703	11.8339	11.6808	13.1598
Real Estate (Islamic)	3.4896	3.8621	3.9487	4.0774	22.8964
Transport, Storage and Communication (Islamic)	21.3788	21.1153	20.7693	20.6289	45.1109
Finance, insurance, and business activities (Islamic)	3.5718	3.8887	4.1177	4.2352	18.4576
Education & Health (Islamic)	2.696	3.4185	3.7101	3.8451	25.0158
Household (Islamic)	2.1393	3.316	4.0892	4.2421	74.2907
Others (Islamic)	9.7940	10.5358	10.5795	10.4694	9.3674
Purposes					
Securities (Conventional)	19.0898	18.6700	18.2715	18.0608	49.6185
Other Transport Vehicles (Conventional)	6.5455	7.3311	7.8756	7.9347	25.8586
Passenger Cars (Conventional)	2.5659	2.8945	3.0752	3.1159	20.7074

Residential Property (Conventional)	9.4226	8.9407	8.7031	8.7734	51.5910
Non-Residential (Conventional)	4.7765	5.6991	6.4045	6.5913	70.5203
Fixed Assets (Conventional)	3.8608	4.4872	4.6634	4.8943	26.4169
Personal Use (Conventional)	6.5311	7.0048	7.1565	7.1472	13.5626
Credit Card (Conventional)	6.8817	7.7534	8.2536	8.3333	65.1323
Consumer Durables (Conventional)	5.0886	5.3021	5.5265	5.8678	3.5417
Construction (Conventional)	13.4322	14.1427	13.2706	12.6112	25.8394
Working Capital (Conventional)	20.0089	19.1575	18.7837	18.6640	34.3656
Other Purposes (Conventional)	7.3544	7.3072	7.3966	7.5541	29.9067
Securities (Islamic)	8.4618	8.4064	8.3665	8.5063	45.0748
Other Transport Vehicles (Islamic)	4.2174	4.4767	4.6017	4.6518	22.1312
Passenger Cars (Islamic)	1.8288	2.6313	3.4431	3.8015	66.1855
Residential Property (Islamic)	28.7229	23.1342	17.6951	16.8726	71.2581
Non-Residential (Islamic)	11.2133	10.8625	10.5425	10.5002	30.8210
Fixed Assets (Islamic)	6.9043	7.9728	8.2239	8.1505	31.6285
Personal Use (Islamic)	13.5466	13.4918	13.1006	13.0046	73.9828
Credit Card (Islamic)	4.1882	4.6792	5.0694	5.1576	34.1759
Consumer Durables (Islamic)	3.6203	3.7227	3.8959	4.0132	9.2107
Construction (Islamic)	4.4369	4.9643	5.1675	5.2269	22.5670
Working Capital (Islamic)	2.6241	3.1357	3.3272	3.4191	20.3481
Other Purposes (Islamic)	8.9220	9.6788	9.1164	8.9207	27.6480

Table 1-3: Variance Decompositions for Selected Variables

1.3.4 ROBUSTNESS

We evaluate the robustness of our results by running the baseline model with few adjustments. This discussion will be based only on the results of the main macroeconomic variables. First, we look at the responses of macroeconomic variables when we replace the sectors of loans to purposes of loans. Given that 24 variables out of 118 are changed now[7], we expect there would be some differences in the results. The impulse response result is shown in Appendix 1-G. The signs of the responses are similar except for the shape of the responses of CPI inflation and 5-Year Government Securities.

Next, as discussed in 1.3.4 under the Data section, we change the proxy of monetary policy from the overnight interbank rate to the 3 months interbank rate. The responses look very similar as reported in Appendix 1-E; thus, our results are robust in this sense as well. We also look if adding more factors into the VAR could change our results significantly. For this practice, we use 12 factors instead of 10 and reported the results in Appendix 1-F. The only thing noticeable is total loan takes 2 months longer to be significant.

Considering that Malaysia is a small open economy, we also introduce extra observable variables to the VAR to capture the international movement and to see if it will significantly affect our baseline results. We added Real Effective Exchange Rate, world oil price, and US interest rate as the additional observable variable. For Real Effective Exchange Rate, we ordered it last in VAR ordering under the assumption that it is affected contemporaneously by other shocks. As for world oil price and US interest rate, we ordered them first in the VAR ordering as they are

[7] 12 classifications of Islamic and conventional banks each.

assumed to not contemporaneously be affected by any domestic variables. The model with effective exchange rate in VAR shows price level decreases for the first 8 months and increases after 19 months, after a monetary policy shock. The downward response of effective exchange rate to monetary shocks is not too severe as in other models. We believe that this does not hinder the credibility of our main model as the signs are still similar. The results are reported in Appendix 1-H. Results for adding world oil price are consistent with our benchmark model, except that response of price level takes a little longer to be significantly negative and response of 5 year government securities is only positively significant for the first 3 months. The results are reported in Appendix 1-I.

Finally, given that all our main model and models in our robustness checks exhibit exchange rate puzzle, we attempted to include the US interest rate to the VAR and report the results in Appendix 1-J. We managed to eliminate the exchange rate puzzle, at least, for 2 months, along with price puzzle. Government Securities first exhibits positive response then changes to negative response after 3 months.

All the results from these models are presented in the Appendix section. Overall, the benchmark model is robust against the results of other models described above. The general direction of the movement of the variables is mostly identical to what we obtained earlier, except when we ordered the US interest rate last, where we eliminated the exchange rate puzzle.

1.4 CONCLUSION

This study investigates the effects of monetary policy shocks on disaggregated loans from both Islamic and conventional banks in Malaysia. This chapter employed the FAVAR approach that combines principal component analysis with VAR. Unlike the traditional VAR model that relies on a few variables, the advantage of the FAVAR model is that it uses factors that are derived from large information set. Recent studies (Lagana and Mountford, 2005; and Mumtaz and Surico, 2009) have shown that this approach provides more reliable and accurate estimates because the model is estimated based on a data-rich environment. This approach also offers the advantage of the impulse response function that can be generated for every variable in the dataset.

The results confirm recent findings of how Islamic banks are more responsive compared to conventional banks to monetary policy shock. This means that they could propagate the monetary transmission better than the conventional ones. We also found heterogenous results from different sectors and purposes for both banks. This could mean that there is still some room left for the central bank of Malaysia to improve the effectiveness of monetary transmission mechanism in Malaysia via bank lending channel, especially on the sectors or purposes that does not respond accordingly to the expectation of monetary policy.

This could also signal that, if monetary policy stances could not affect these sectors or purposes accordingly, policy makers in Malaysia should attempt other measures to influence these sectors and purposes. For example, via liberalization or incentives.

1.5 APPENDIX FOR CHAPTER 1

1.5.1 APPENDIX 1-A: DEFINITIONS OF SECTORS OF LOANS

Agriculture, Hunting, Forestry and Fishing	Loans for agricultural activities, agricultural services, livestock farming, cultivation of crops, timber extraction, poultry, forest management, farming, fishing and
Mining and Quarrying	Loans for activities of mining, quarrying, and oil and gas production.
Manufacturing	Loans for manufacturing and production of goods. Examples: • processing of rubber, food, palm oil. • manufacture of leather goods, chemical products, wood products, coal, rubber, food, and plastic products.
Utilities	Loans for firms in the activities of generation and distribution of electrical energy with intent to sell to households and commercial users Also includes loans for firms in the production and distribution of manufactured gas and natural gas.
Wholesale and Retail Trade, Restaurants and Hotels	Loans for firms involved in the business of wholesale trade, retail trade, and restaurants and hotels.
Construction	Loans for firms in general contracting including construction of industrial buildings, civil engineering work, construction of infrastructure, special contracting work, construction of commercial complexes, and construction of residential houses.
Real Estate	Loans for firms involved in operating real estate services. (renting, buying, and selling services for others) .
Transport, Storage and Communication	Loans for firms involved in the provision of transport, storage and communication services to others.
Finance, insurance, and business activities	Loans for firms involved in: • Finance - banking institutions and non-bank financial institutions. • Insurance - general insurance services. • Business Services - provision of auditing services, legal services, accounting, and data collection.
Education, health and others	Loans for institutions involved in health, education, social work, and other community services or activities.
Household Sector	Total loans by purpose to households

Table 1-4: Definitions of Sectors of Loans

1.5.2 APPENDIX 1-B: DEFINITIONS OF PURPOSES OF LOANS

Purchase of Securities	Loans granted to purchase securities in primary and secondary market.
Purchase of Other Transport Vehicles	Loans granted to purchase motor vehicles other than passenger cars.
Purchase of Passenger Cars	Loans granted to purchase motor vehicles which are used mainly to transport a limited number of people.
Residential Property	Loans granted to purchase or refinance the residential property.
Non-Residential Property	Loans granted to purchase or refinance the non-residential property. It includes land, factories, industrial buildings, commercial complexes, and warehouses.
Purchase of Fixed Assets	Loans granted to purchase fixed assets, other than land or building, that are used or to be used for the business activity.
Personal Uses	Loans granted to individuals for private use only.
Credit Cards	Loans granted to customers using credit cards issued by a reporting institution.
Purchase of Consumer Durables	Loans granted to purchase consumer durable goods such as washing machines, refrigerators, and televisions.
Constructions	Loans granted to general contracting works include constructions by household
Working Capital	Loans granted to businesses to fund its daily business operations (e.g., receivables financing, purchasing inventory, and operating expenses).

Table 1-5: Definitions on Purposes of Loans

1.5.3 APPENDIX 1-C: DATA

The transformation codes are: 1 – no transformation; 2 – first difference; 4 – logarithm; 5 – first difference of logarithm.

Variable Name	Variable Code	Transformation Code	Slow/ Fast Code
IPI	IPI	5	1
IPI Mining	IPIM	5	1
IPI Electricity	IPIE	5	1
IPI Manufacturing	IPIMA	5	1
IPI Electronics	IPIEI	5	1
IPI Electricals products	IPIEL	5	1
IPI Chemicals and chemical products	IPIC	5	1
IPI Petroleum products	IPIP	5	1
IPI Textiles wearing apparel and footwear	IPIT	5	1
IPI Wood and wood products	IPIW	5	1
IPI Rubber products	IPIR	5	1
IPI Paper products	IPIPA	5	1
IPI Non-metallic mineral products	IPINM	5	1
IPI Iron and steel	IPIIS	5	1
IPI Fabricated metal products	IPIFM	5	1
IPI Food products	IPIF	5	1
IPI Transport equipment	IPITE	5	1
IPI Beverages	IPIB	5	1
IPI Tobacco products	IPITO	5	1
Interbank Money Market (Overnight)	MMO	1	0
Interbank Money Market (1 week)	MM1W	1	0
Interbank Money Market (1 month)	MM1M	1	0
Interbank Money Market (3 months)	MM3M	1	0
Interest Rate: Fixed Account 1 month	IRF1	1	0
Interest Rate: Fixed Account 3 month	IRF3	1	0
Interest Rate: Fixed Account 6 month	IRF6	1	0
Interest Rate: Fixed Account 9 month	IRF9	1	0
Interest Rate: Fixed Account 12 month	IRF12	1	0
Interest Rate: Savings deposit	IRSD	1	0
Interest Rate: Base Lending Rate	BLR	1	0
Interest Rate: Average Financing Rate	AFR	1	0
Malaysian Government Securities (1 year)	GS1	1	0
Malaysian Government Securities (2 years)	GS2	1	0
Malaysian Government Securities (3 years)	GS3	1	0
Malaysian Government Securities (4 years)	GS4	1	0
Malaysian Government Securities (5 years)	GS5	1	0
Malaysian Government Securities (10 years)	GS10	1	0
Malaysian Government Securities (15 years)	GS15	1	0
Malaysian Government Securities (20 years)	GS20	1	0
Narrow Quasi-Money	NQM	5	1
M1	M1	5	1
M2	M2	5	1
M3	M3	5	1
Total Reserve Money	TRM	5	1
Currency in Circulation	CIC	5	1
Required Reserves	RR	5	1
Excess Reserves	ER	5	1
Purchase of securities (Islamic Loan)	LSI	5	1

Purchase of Vehicle (Islamic Loan)	LVI	5	1
Purchase of residential property (Islamic Loan)	LRI	5	1
Purchase of non-residential property (Islamic Loan)	LNRI	5	1
Personal use (Islamic Loan)	LPI	5	1
Construction (Islamic Loan)	LCI	5	1
Primary agriculture (Islamic Loan)	LAI	5	1
Mining and quarrying (Islamic Loan)	LMQI	5	1
Manufacturing (Islamic Loan)	LMI	5	1
Utilities (Islamic Loan)	LUI	5	1
Wholesale and retail trade, and hotels and restaurants (Islamic Loan)	LWI	5	1
Real estate (Islamic Loan)	LREI	5	1
Transport, storage and communications (Islamic Loan)	LTI	5	1
Finance, insurance and business activities (Islamic Loan)	LFI	5	1
Islamic Loan Total	LI	5	1
Purchase of securities (Conventional)	LSC	5	1
Purchase of Vehicle (Conventional)	LVC	5	1
Purchase of residential property (Conventional)	LRC	5	1
Purchase of non-residential property (Conventional)	LNRC	5	1
Personal use (Conventional)	LPC	5	1
Construction (Conventional)	LCC	5	1
Primary agriculture (Conventional)	LAC	5	1
Mining and quarrying (Conventional)	LMQC	5	1
Manufacturing (Conventional)	LMC	5	1
Electricity, gas and water supply (Conventional)	LUC	5	1
Wholesale and retail trade, and hotels and restaurants (Conventional)	LWC	5	1
Real estate (Conventional)	LREC	5	1
Transport, storage and communications (Conventional)	LTC	5	1
Finance, insurance and business activities (Conventional)	LFC	5	1
Conventional Loan Total	LC	5	1
Demand Deposit (Conventional Banks)	DDC	5	1
Saving Deposit (Conventional Banks)	SDC	5	1
Demand Deposit (Islamic Banks)	DDI	5	1
Saving Deposit (Islamic Banks)	SDI	5	1
External Reserve (Special Drawing Rights)	ERSR	5	1
External Reserve (IMF reserves position)	ERIF	5	1
External Reserve (Gold and foreign exchange)	ERGF	5	1
Total External Reserve	TER	5	1
Bankruptcy	BKRP	4	1
All groups (CPI)	CPI	5	1
Food (CPI)	CPIF	5	1
Beverages and tobacco (CPI)	CPIBT	5	1
Clothing and footwear (CPI)	CPICF	5	1
Gross rent, fuel and power (CPI)	CPIGFP	5	1
Furniture, furnishings and household equipment and operation (CPI)	CPIFF	5	1
Medical care and health expenses (CPI)	CPIMH	5	1
Miscellaneous goods and services (CPI)	CPIM	5	1
Employee Provident Fund Contribution	EPFC	5	1
Employee Provident Fund Withdrawal	EPFW	5	1
Rubber Price	PR	5	1
Palm oil Price	PPO	5	1
Saw logs Price	PSA	5	1
Tin Price	PT	5	1
Crude oil Price	PCO	5	1
Liquefied natural gas Price	PLNG	5	1
Gross exports	GE	5	1

Gross imports	GI	5	1
Leading Index	LEAI	2	1
Coincident Index	CI	2	1
Lagging Index	LAGI	2	1
Composite Index	COI	5	0
Market Capitalisation (RM billion)	MC	5	1
FBM EMAS Index	FBME	5	0
Stock Market Turnover (RM Million)	SMT	5	1
Net P/E Ratio (Composite Index)	PER	1	1
Foreign Exchange (USD) (Real Efective)	FXUSD	5	0
Foreign Exchange (GBP)	FXGBP	2	0
Foreign Exchange (SGD)	FXSGD	2	0
Foreign Exchange (JPY)	FXJPY	2	0
Foreign Exchange (HKD)	FXHKD	2	0

Table 1-6: List of Variables for FAVAR

1.5.4 APPENDIX 1-D: VARIABILITY EXPLAINED AND LAG SELECTION IN PURPOSES MODEL

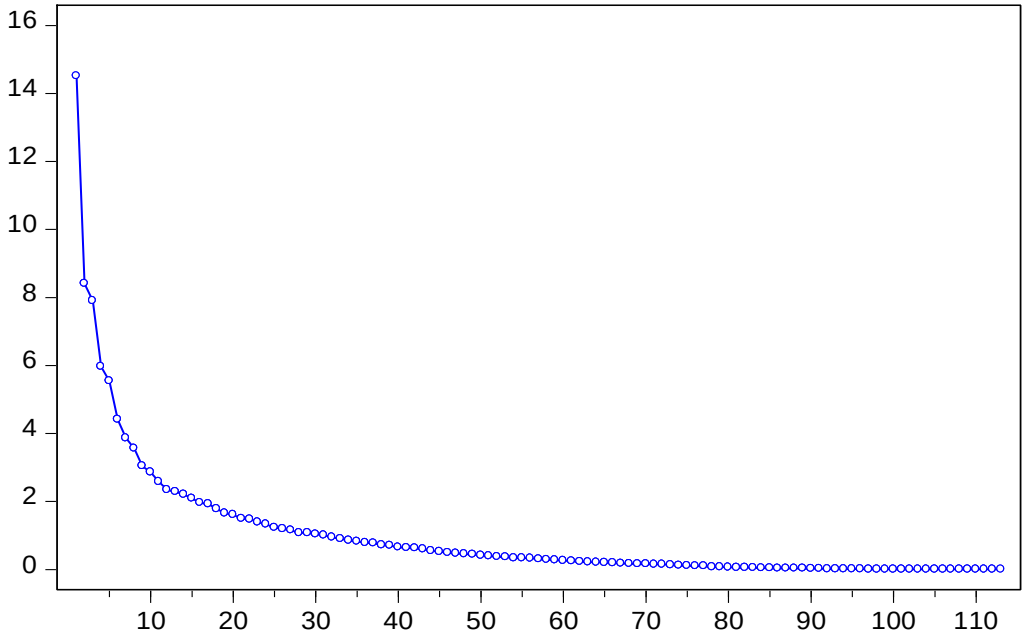

Figure 1-14: Scree Plot for Purposes Model

Factors	Eigenvalue	Proportion	Cumulative Proportion
1	14.51	12.84 %	12.84 %
2	8.41	7.44 %	20.28 %
3	7.9	6.99 %	27.27 %
4	5.96	5.28 %	32.55 %
5	5.54	4.90 %	37.45 %
6	4.41	3.90 %	41.35 %
7	3.86	3.42 %	44.77 %
8	3.55	3.15 %	47.91 %
9	3.04	2.69 %	50.60 %
10	**2.86**	**2.53 %**	**53.14 %**
11	2.58	2.28 %	55.42 %
12	2.34	2.08 %	57.49 %
13	2.29	2.02 %	59.52 %
14	2.21	1.95 %	61.47 %
15	2.09	1.85 %	63.32 %

Table 1-7: Cumulative Variation Explained for Purposes Model

Lag	LR	FPE	AIC	SC	HQ
0	NA	5.05E-16	-4.00511	-3.7772	-3.9125
1	1283.173	1.54E-19	-12.108	**-9.373087***	**-10.99667***
2	296.2919	**7.25e-20***	-12.8848	-7.64286	-10.7547
3	175.6489	8.44E-20	-12.804	-5.05498	-9.65515
4	**156.9256***	1.06E-19	-12.7129	-2.45694	-8.54539
5	137.2712	1.52E-19	-12.5985	0.164565	-7.41218
6	137.7367	1.99E-19	-12.7185	2.551571	-6.51346
7	139.0684	2.29E-19	-13.1657	4.611387	-5.94193
8	103.927	4.38E-19	**-13.39795***	6.886144	-5.15546

Table 1-8: Results for Lag Selection Criteria for Purposes Model

1.5.5 APPENDIX 1-E: MODEL WITH 3 MONTH INTERBANK RATE

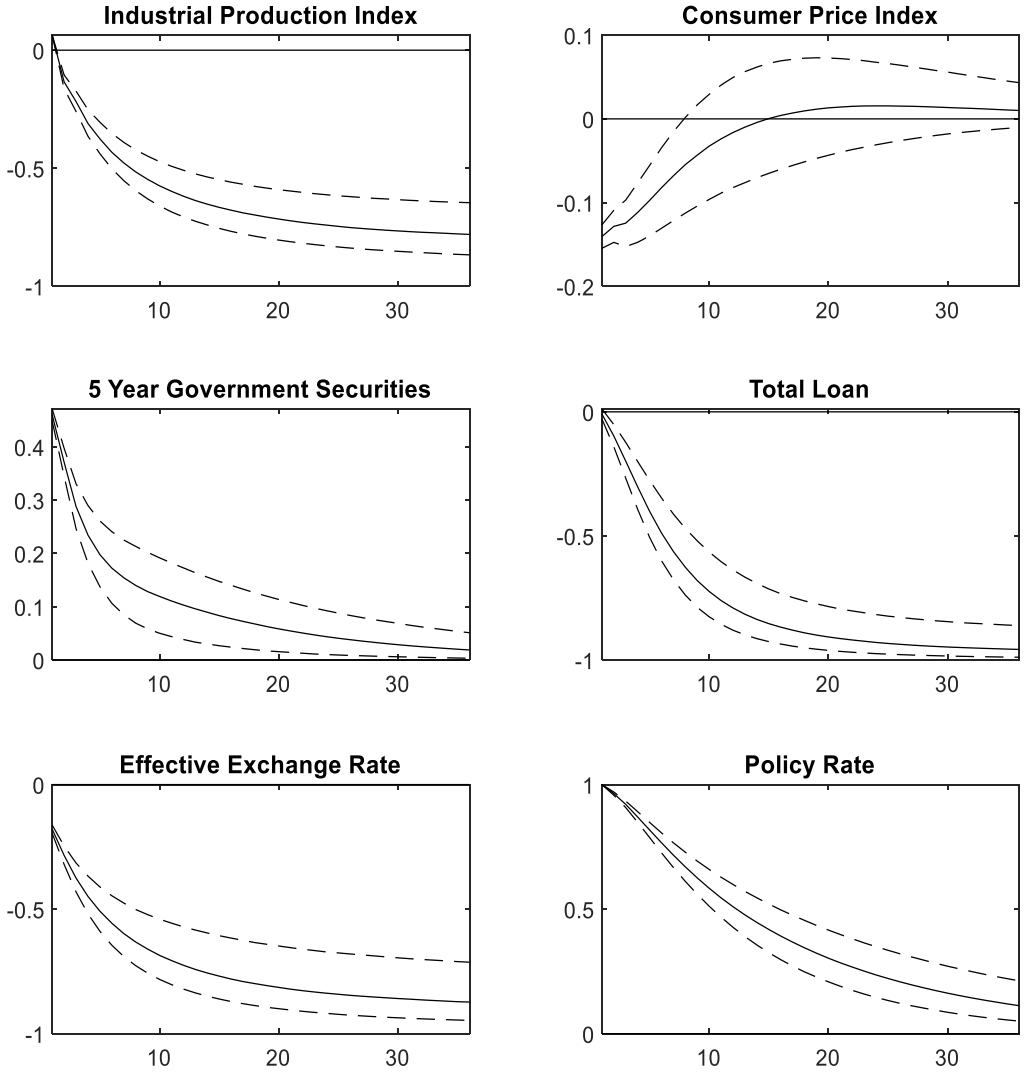

Figure 1-15: Aggregate Macroeconomic Response to Monetary Policy Shocks (3 Month Interbank Rate Model)

This figure shows the median response and the 68 per cent confidence band. The monetary policy shock is normalized to 100 basis point increase of policy rate. 30000 Gibbs replications draw, and 20000 burn-in draw were used to generate impulse response.

1.5.6 APPENDIX 1-F: MODEL WITH 12 FACTORS (SECTORAL)

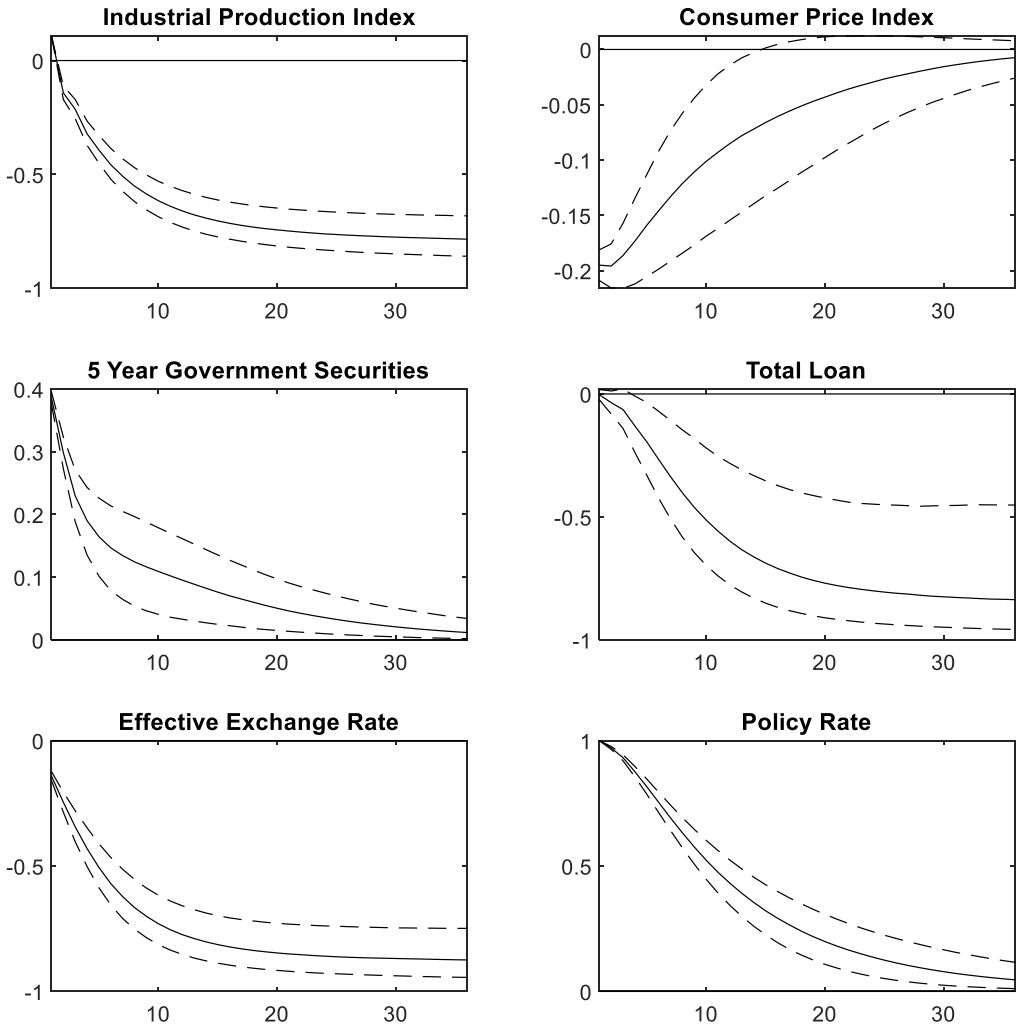

Figure 1-16: Aggregate Macroeconomic Response to Monetary Policy Shocks (12 Factors)
This figure shows the median response and the 68 per cent confidence band. The monetary policy shock is normalized to 100 basis point increase of policy rate. 30000 Gibbs replications draw, and 20000 burn-in draw were used to generate impulse response.

1.5.7 APPENDIX 1-G: MODEL WITH PURPOSES OF LOANS

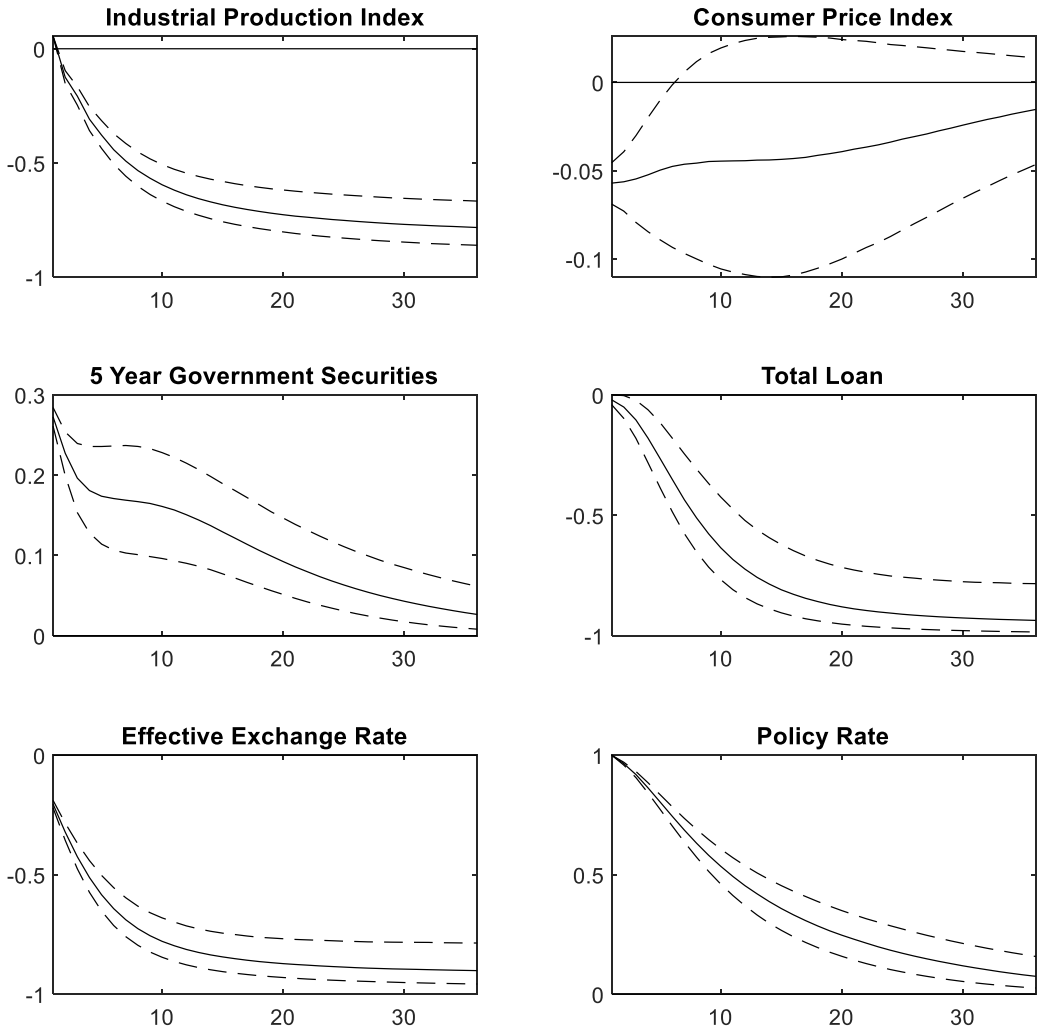

Figure 1-17: Aggregate Macroeconomic Response to Monetary Policy Shocks (Purposes Model)
This figure shows the median response and the 68 per cent confidence band. The monetary policy shock is normalized to 100 basis point increase of policy rate. 30000 Gibbs replications draw, and 20000 burn-in draw were used to generate impulse response.

1.5.8 APPENDIX 1-H: EFFECTIVE EXCHANGE RATE

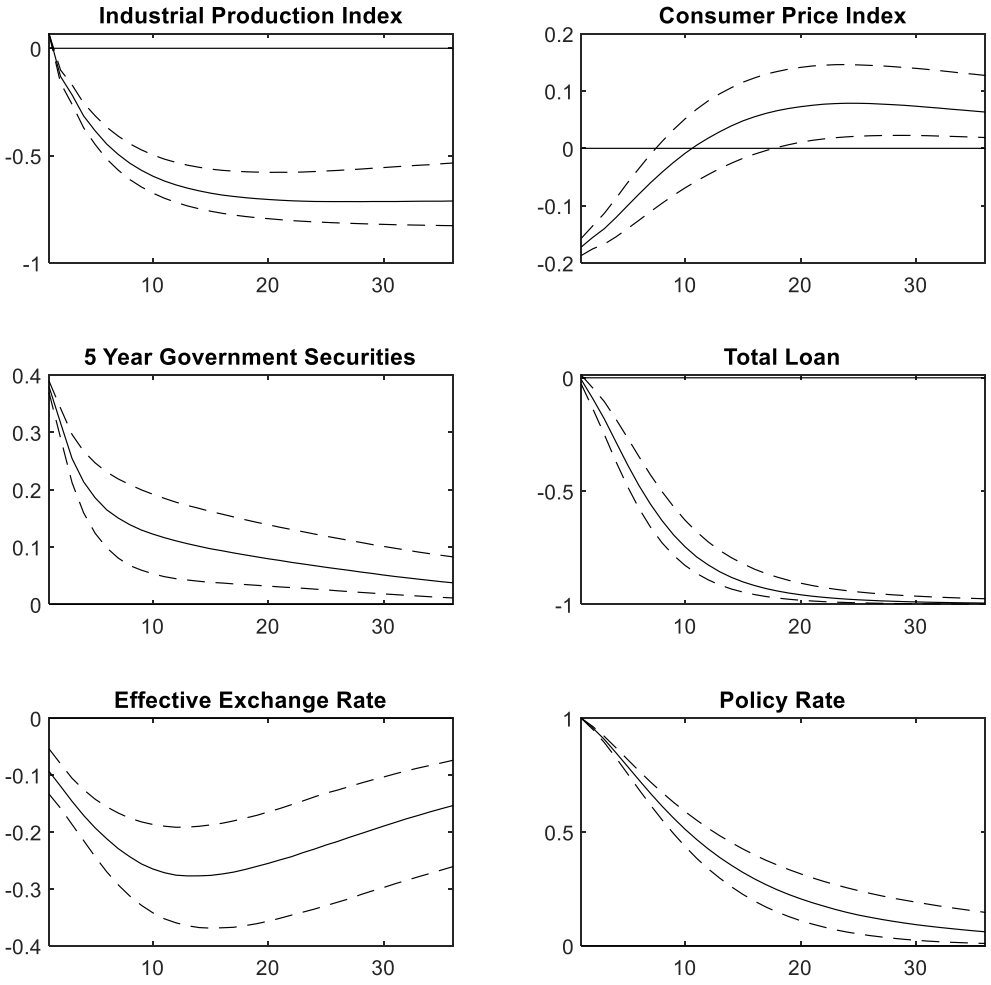

Figure 1-18: Aggregate Macroeconomic Response to Monetary Policy Shocks (Effective Exchange Rate Model)

This figure shows the median response and the 68 per cent confidence band. The monetary policy shock is normalized to 100 basis point increase of policy rate. 30000 Gibbs replications draw and 20000 burn-in draw were used to generate impulse response.

1.5.9 APPENDIX 1-I: WORLD OIL PRICE

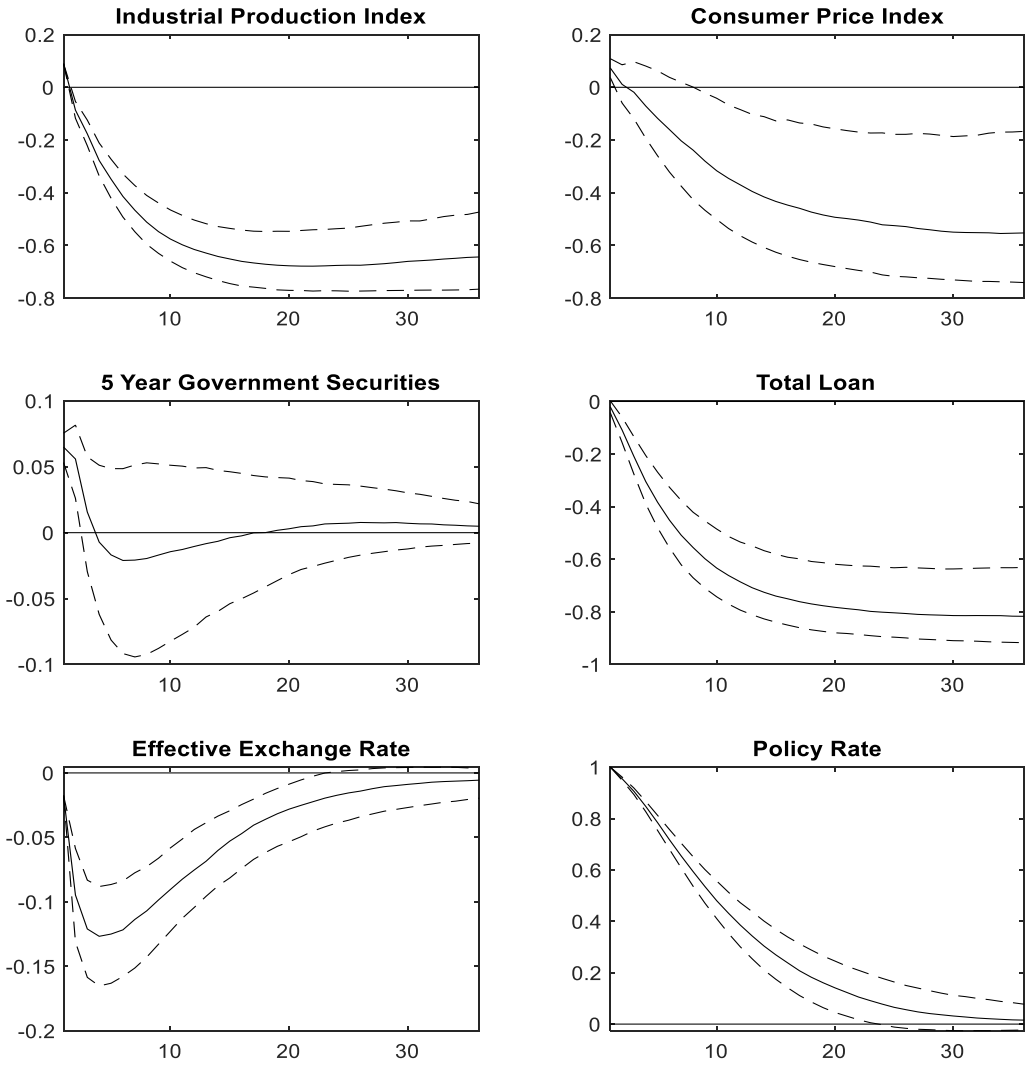

Figure 1-19: Aggregate Macroeconomic Response to Monetary Policy Shocks (World Oil Price Model)

This figure shows the median response and the 68 per cent confidence band. The monetary policy shock is normalized to 100 basis point increase of policy rate. 30000 Gibbs replications draw, and 20000 burn-in draw were used to generate impulse response.

1.5.10 APPENDIX 1-J: US INTEREST RATE MODEL

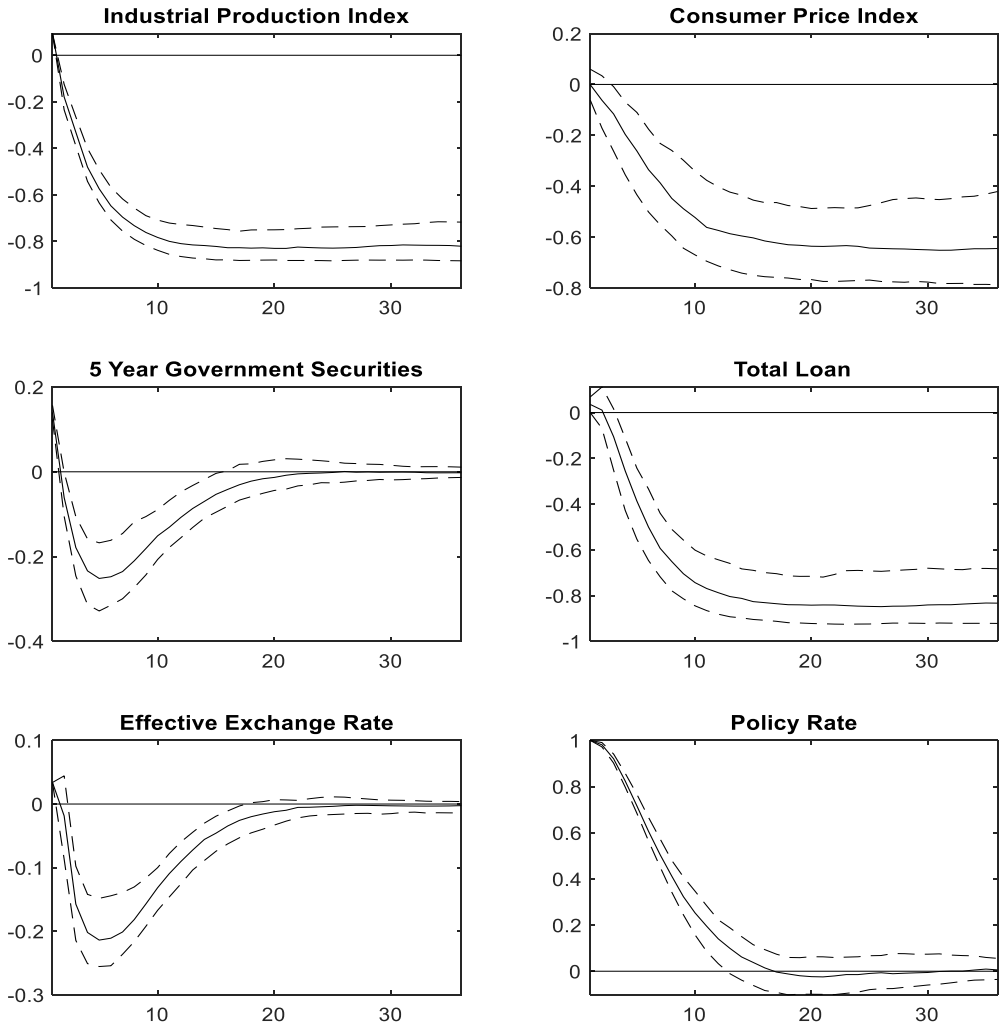

Figure 1-20: Aggregate Macroeconomic Response to Monetary Policy Shocks (US Interest Rate Model)

This figure shows the median response and the 68 per cent confidence band. The monetary policy shock is normalized to 100 basis point increase of policy rate. 30000 Gibbs replications draw, and 20000 burn-in draw were used to generate impulse response.

CHAPTER 2: THE EFFECTS OF CREDIT SUPPLY SHOCKS IN MALAYSIA

2.1 INTRODUCTION

Following the Global Financial Crisis in 2008, there has been a renewed interest in the nexus between the financial sector and the real economy. Specifically, the interest on credit supply shocks. As defined by (Abildgren, 2012), credit supply shock is "shocks that can affect the ability and willingness of monetary and financial institutions to supply credit to non-financial firms and households".

Credit supply shocks could be explained by several reasons, such as changes in bank funding, unexpected changes in bank capital, changes in risk perception of potential borrowers, change in the structure of the industry, and changes in the degree of competition among banks (Gambetti and Musso, 2016). Peersman (2012) gave an example of innovation in the banking structure that makes it more profitable for banks to securitize their loans. This innovation will motivate banks to actively sell more loans in the secondary market, and this increases their ability to supply new loans independently of monetary policy changes.

Recently, academicians are trying to find the effects of this shock on the real economy, especially after the recent financial crisis where credit growth dropped independently of monetary policy, along with the drop in output, and attempted to find out how much does credit supply shocks are accounted for to the economic slowdown. These studies are mostly done in the context of advanced economies. Among others are Busch et al. (2010) for UK, Lucchetta and Nicoló (2010) for G-7, Moccero et al. (2014) for Euro Area, Gambetti and Musso (2016) for US, UK, and Euro Area, and Mumtaz et al. (2018) for US.

Malaysia only experienced a slight drop in output during the recent financial crisis compared to other advanced economies during the Asian Financial crisis. As shown in Figure 2-1, the impact of the Asian Financial Crisis is much more significant than the recent Global Financial Crisis.

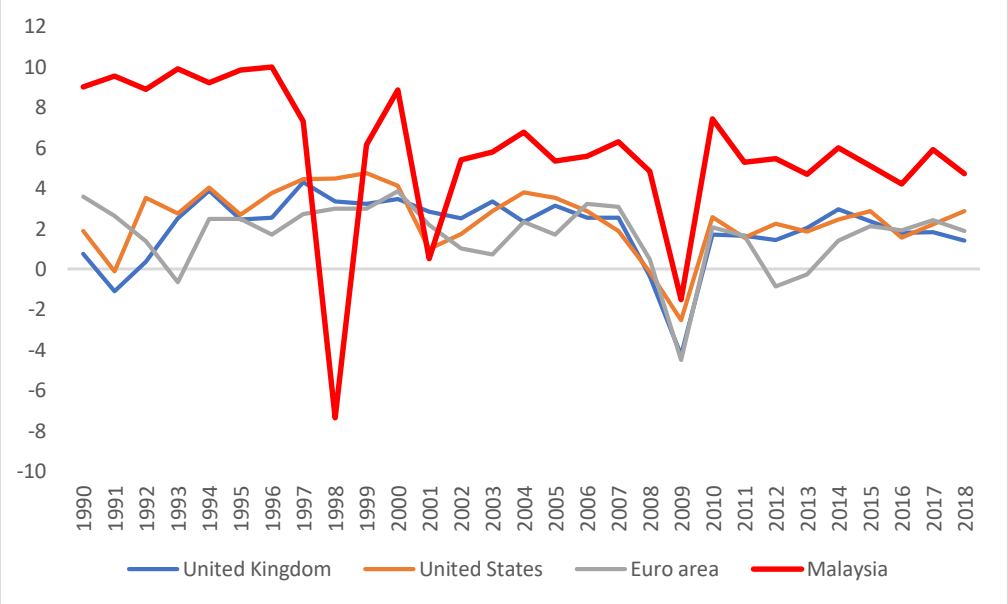

Figure 2-1: Annual GDP Growth for Malaysia, UK, US, And Euro Area

The lack of a clear relationship between households and non-financial corporations' loans and output might be the reason for the nonexistence of studies on credit supply shocks in Malaysia so far. Especially during the Global Financial Crisis in 2009, where there was a big drop in GDP growth, reaching -6 per cent but the loans growth only dropped from 12 to 4 per cent. This observation is very different from the countries extensively studied on this subject matter where the loan growth dropped massively during this period for those economies (e.g., US, UK, Euro Area). Interestingly, before the drop of the loan growth, there was a huge spike from 2007 to 2008.

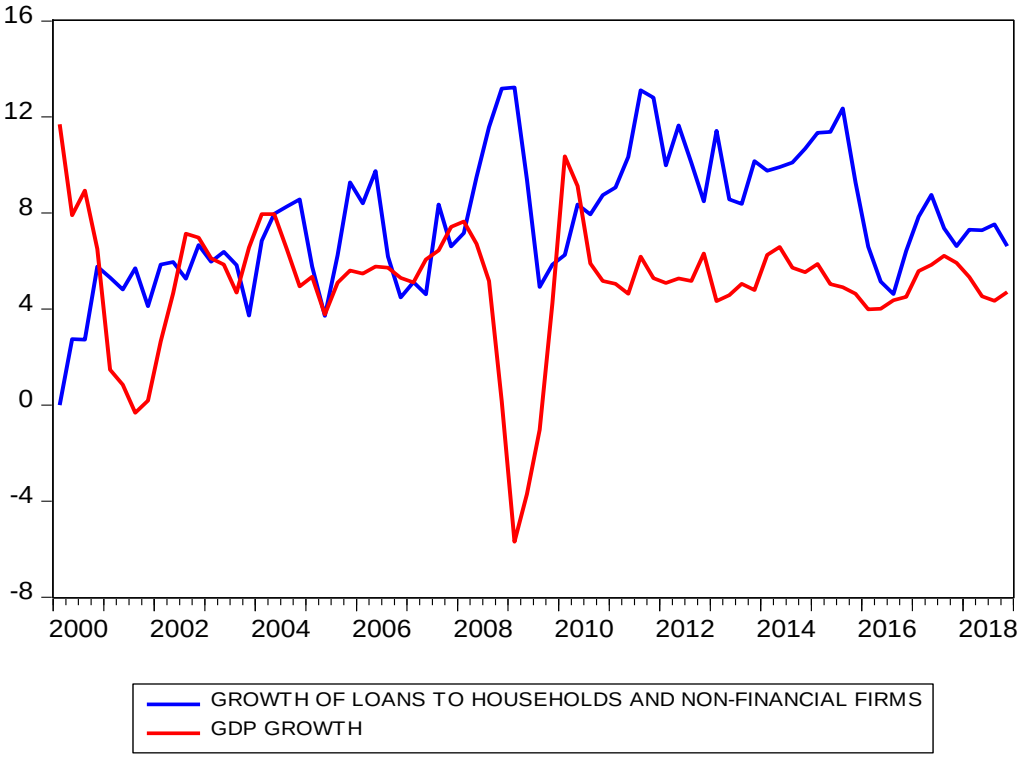

Figure 2-2: Quarterly GDP Growth and Loans to Households and Non-Financial Corporations Growth in Malaysia

There are numbers of studies in Malaysia has attempted to link the financial sector to the real economy. One strand of literature extensively studied is the relationship between financial development and economic growth, (Choong et al., 2003; Ang, 2008; Anwar and Sun, 2008; Majid, 2008; Noor and Ramli, 2017). Another strand is bank lending and macroeconomics variables in Malaysia (Tang, 2000; and Vaithilingam et al., 2003). But none of the studies on financial sector in Malaysia so far has specifically identified and examined the effects of credit supply shocks.

The Asian financial crisis in 1998 left a severe impact on Malaysia's economy and banking system. In an attempt to curb further damage, the central bank of Malaysia introduced a new financial restructuring framework which is a ten-year Financial Sector Master Plan, put into effect from 2001 to 2011 and consists of three major phases.

The first phase focused on strengthening the financial infrastructure and increasing the capacity of the domestic banks in Malaysian. The second phase focused on increasing the degree of competitions in the domestic financial sector. Lastly, the third phase introduced new foreign competition and focused on integration into the global financial sector.

Within these phases of Financial Sector Master Plan, various innovations were introduced such as removing controls on the interest rate, issuance of new foreign banking licenses, and regulations on staff remuneration. Financial Sector Blueprint was introduced later in 2011 to guide a new pathway for financial restructuring in Malaysia. Within this new framework, there are more innovations implemented within the financial structure of Malaysia. Some of these innovations during the restructuring process could be translated into credit supply shocks according to the definition given earlier.

The contribution of this chapter to the existing literature is twofold. First, to the best of our knowledge, this is the first study to identify credit supply shocks and study its impact in Malaysia. Second, we contribute to the literature of credit supply shocks by separating households and non-financial firms, given that the growth rate of household and non-financial corporations exhibits strong heterogeneity and equal proportion to the total private non-financial corporations' loans, and show the different responses and variance decomposition between these two.

Accordingly, this chapter aims to identify credit supply shocks for Malaysia and analyse their macroeconomic effects using Bayesian Structural VAR framework. For identification of shocks, we employed sign restrictions on impulse response function.

The main results show that credit supply shock is important for the business cycle in Malaysia as well as to credit growth, but at the expense of higher inflation.

The remainder of the study is structured as follows. Section 2 discusses the empirical approach and describes the data. Section 3 discusses the results and sensitivity analysis. Lastly, Section 4 provides conclusions.

2.2 METHODOLOGY

In this section, we present the methodology to uncover credit supply shocks in Malaysia. We start with the brief descriptions on SVAR and summary of Arias et al. (2014) algorithm for the identification of the shocks. Next, we discuss the identification scheme and the reasoning behind each restriction. Finally, we discuss the data for the model and followed by the lag length criteria to choose the number of lags in our system.

The application of SVAR with sign restrictions to identify credit supply shocks is widely used by studies on this subject matter such as Busch et al. (2010), Peersman (2012), Bijsterbosch and Falagiarda (2015), Gambetti and Musso (2016), and Mumtaz et al. (2018). Mumtaz et al. (2018) show evidence that VAR models with sign restrictions are able to capture credit supply shocks judiciously well in simulations. With this justification, we decide to follow sign restrictions approach in SVAR framework to identify credit supply shocks and examine its effects in Malaysia.

2.2.1 SVAR WITH SIGN RESTRICTIONS

We start the model with reduced-form VAR where every series is regressed on its lags and the lags of the other series:

$$Y_t = K + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + \mu_t \quad (2\text{-}1)$$

where Y_t is the matrix of endogenous variables, $t = 1, \ldots, T$. T is the sample size, $\mu_t \sim N(0, \Sigma)$ is the reduced-form error terms, p is the lag, and $K, A_1, \ldots, A_p$ and Σ are matrices of the model's parameters. K is the vector of constant terms, $A_i, i = 1, \ldots, p$ is an n × n matrix of the AR coefficients, whereas $\Sigma = E(\mu_t \mu_t')$ is the n × n covariance matrix of the error term vector μ_t. The error terms are the unpredictable

factor of Y_t, given the variables included and considering the lagged values of the included series, which has no economic interpretation without further assumptions.

To solve that, we could use the structural form instead of Equation (2-1) as follows:

$$B_0 Y_t = k + B_1 Y_{t-1} + B_2 Y_{t-2} + \ldots + B_p Y_{t-p} + \varphi_t \quad (2\text{-}2)$$

where $k, B_1, \ldots, B_p$ are defined the same as $K, A_1, \ldots, A_p$, n × n matrix B_0 is the contemporaneous reactions of the variables to the structural shocks, and the n × 1 vector of structural shocks (or structural innovations) φ_t with zero mean and with a diagonal covariance matrix Σ_φ, also shows that the number of variables matches the number of shocks.

We can recover the structural shocks from the reduced-form VAR by multiplying both sides of Equation (2-2) by B_0^{-1}, resulting in:

$$B_0^{-1} B_0 Y_t = B_0^{-1} k + B_0^{-1} B_1 Y_{t-1} + B_0^{-1} B_2 Y_{t-2} + \ldots + B_0^{-1} B_p Y_{t-p} + B_0^{-1} \varphi_t \quad (2\text{-}3)$$

Yielding the results of:

$$K = B_0^{-1} k \quad (2\text{-}4)$$

$$A_i = B_0^{-1} B_i \quad (2\text{-}5)$$

$$\mu_t = B_0^{-1} \varphi_t \quad (2\text{-}6)$$

$$E(\mu_t \mu_t') = \Sigma = B_0^{-1} B_0^{-1\prime} \quad (2\text{-}7)$$

The model is estimated using Bayesian methods with Minnesota prior. We select the hyperparameters by using grid search to obtain the combinations that maximizes the marginal likelihood. Shocks are identified by imposing sign restrictions on the contemporaneous impulse response functions. The estimation is done by using BEAR Toolbox from the European Central Bank by Dieppe et al. (2016), in which the sign

restrictions on the impulse response function procedure follows the algorithm from Arias et al. (2014).

2.2.2 SHOCKS IDENTIFICATION

As we have five endogenous variables in our baseline model, we could identify five structural shocks at most. However, identifying all these five shocks involves complicated identification restrictions and will increase the computational burden (Busch et al. 2010). However, identifying a much smaller number of shocks may result in a large number of unexplained movements. Following Bijsterbosch and Falagiarda (2015) and Gambetti and Musso (2016) for the same variables chosen, we identify four shocks: aggregate demand, aggregate supply, credit supply, and monetary policy shocks. We leave one shock unidentified so that this shock could act as a buffer and could capture the effects of omitted variables. All the restrictions are imposed on impact period only and shown in Table 2-1. We imposed restrictions to identify the structural shocks as follows[8]:

Expansionary aggregate demand shock is assumed to increase output, inflation, lending rate, and policy rate on impact. Theoretical literature agrees that aggregate demand shocks drive output growth and inflation in the same direction. However, the impact on loan growth does not seem to be clear. For example, an expansionary aggregate demand shock may induce people to increase consumption. Thus, the loan growth could increase, but consumers may also withdraw more from their bank deposits to increase their consumption. This leads to a decrease in bank's funds and the loan growth could not expand or could even decrease. Following this reason, we

[8] Gambetti and Musso (2016) presents the sign restrictions of past literatures. Their restrictions were imposed based on the common restrictions between these literatures and considered robust. See Table II in the main paper and Table A-C in the Supplementary Material Annex.

do not put restriction on loan growth. As for the policy rate, central bank reacts to expansionary aggregate demand shock by raising the policy rate to avoid inflationary pressures in line with the monetary policy rule. This in turn increases the lending rate due to the linkage between lending rates and the policy rate in Malaysia. Thus, we restrict the policy rate and the lending rate to be positive.

Positive aggregate supply shock increases output and decreases price level on impact. Regarding loan growth, a positive aggregate supply shock that decreases costs may increase investment and firms may borrow more to fund these additional investments. However, firms may also be able to fund these higher investments through other means (e.g. extra funds gained as raw material cost is lower now), which may not increase the loan growth. Moreover, as output is increasing and price level is decreasing, there is no clear central bank response, so the impact on the policy rate is uncertain. Because of these unclear effects, the responses of loan growth, the lending rate, and the policy rate are left unrestricted. This restriction is sufficient as this is the only shock that we identified which moves the output and prices in different directions.

Expansionary monetary policy shock is restricted to increase output, inflation, and loan growth, and decrease in the lending rate and the policy rate, on impact. The restrictions on output and price level are based on the standard assumption of monetary transmission mechanism. The decrease of the lending rate reflects the idea that interest rates offered by banks are tied to the policy rate in Malaysia. Lastly, the response of the loan growth is restricted to be positive due to bank lending channel of monetary transmission mechanism.

Expansionary credit supply shock is restricted to increase output, inflation, and loan growth, while decreasing the lending rate and policy rate, on impact. Banks are assumed to increase the availability of loan for the private sector exogenously during expansionary credit supply shock either by increasing the amount of the loan or reducing lending rate, thereby pushing up the loan above the market equilibrium and creating an oversupply. This oversupply of credit in the market pushes down the lending rate further. Thus, a credit supply shock drives the loan growth and the lending rate in opposite directions. Since these restrictions are not sufficient to differentiate credit supply shock from others that we identified, we also set restrictions on other variables as well. We restricted output to be positive due to positive credit supply shock as credit becomes less costly, firms will increase their investment and households will demand more for consumption. Meanwhile, as the economy expands, firms will increase their prices as they expect higher prices. Due to this, we restrict the response of inflation to be positive. This inflationary pressure would then lead the central bank to increase the policy rate to contain them as per monetary policy rule.

	Aggregate Demand Shock	Aggregate Supply Shock	Credit Supply Shock	Monetary Policy Shock
GDP	+	+	+	+
CPI	+	-	+	+
LOAN GROWTH	**?**	**?**	+	+
LENDING RATE	+	**?**	-	-
POLICY RATE	+	**?**	+	-

Table 2-1: Identification Scheme
All the restrictions are imposed on the impact period only

2.2.3 DATA

This section details the variables we use in the baseline scenario. We use quarterly data from the first quarter of 2000 until last quarter of 2018. Seasonal adjustments were carried out using X-12 function in Eviews 9 for output and inflation. Figure 2-3 shows the time series employed in our baseline model. The data that we employed in the estimations are:

- Real GDP
- Consumer Price Index
- Loans to Households and Non-Financial Corporations
- Lending Rate[9]
- Overnight Interbank Rate

Data for real GDP was taken from International Financial Statistics (IFS). Data for Consumer Price Index and loans to household and non-financial firms were taken from Bank for International Settlements. We proxy lending rate by using average lending rate data from Central Bank of Malaysia, which is the weighted average lending rates on loans extended by the commercial banks. Lastly, we use overnight interbank rate data to proxy the short-term rate or policy rate and taken from Central Bank of Malaysia as well.

[9] Few studies use spread in the estimation of credit supply shocks (e.g., Mumtaz et al. 2018). We follow Gambetti and Musso (2016) reasoning to use lending rate instead of spread.

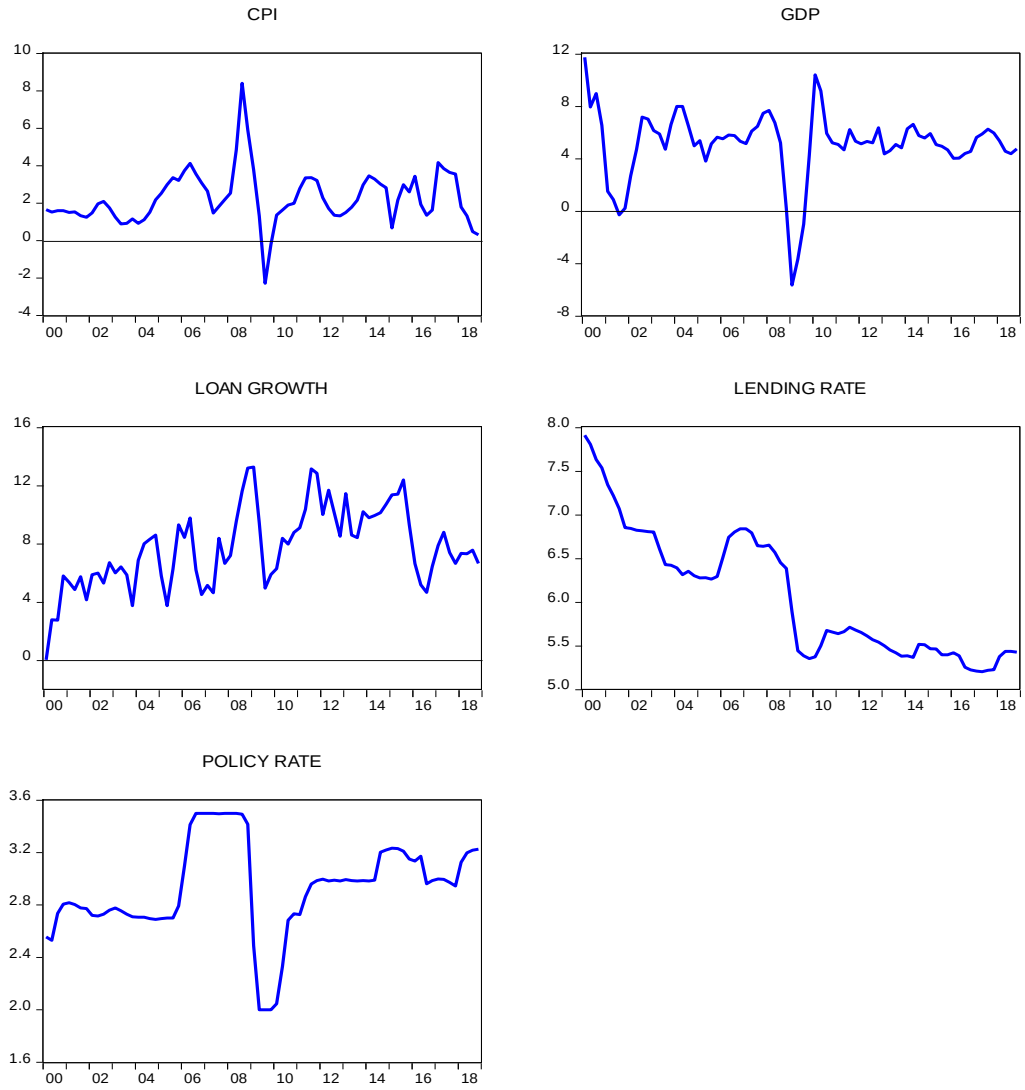

Figure 2-3: Time Series Plots

2.2.4 LAG SELECTION

We carried out lag length criteria tests to choose the appropriate lag for our model. Based on the results in Table 2-2, Final prediction error, and Akaike information criterion suggests that we should use 3 lags while Schwarz information criterion and Hannan-Quinn information criterion suggested 2. We opted to use 2 in our baseline model.[10]

Lag	LR	FPE	AIC	SC	HQ
0	NA	28.21003	17.52906	17.60719	17.56063
1	3003.885	2.18E-05	3.456329	3.925117	3.64572
2	130.3246	1.46E-05	3.05208	**3.911526***	**3.399299***
3	51.90403	**1.42e-05***	**3.024042***	4.274145	3.529086
4	36.58935	1.48E-05	3.067885	4.708646	3.730757
5	25.29539	1.64E-05	3.166233	5.197651	3.986931
6	30.31482	1.76E-05	3.233851	5.655926	4.212375
7	34.16633	1.85E-05	3.275519	6.088251	4.41187
8	34.4283	1.93E-05	3.310268	6.513657	4.604445
9	47.35653*	1.86E-05	3.263181	6.857228	4.715185
10	32.39573	1.95E-05	3.298325	7.283029	4.908155
11	33.29213	2.03E-05	3.321731	7.697092	5.089387
12	37.39389	2.04E-05	3.311961	8.077979	5.237444

Table 2-2: Results for Lag Selection Criteria
*indicates lag order selected by the criterion.

[10] We applied 3 lags for a robustness test.

2.3 RESULTS

As discussed in the previous section, the SVAR model is estimated using Bayesian technique, and the shocks are identified using sign restrictions. Specifically, the model employs Minnesota prior for the SVAR coefficients and the covariance matrix, with 5,000 iterations and 2,000 retained draws. The lag selected is 2.

2.3.1 EFFECTS OF EXPANSIONARY CREDIT SUPPLY SHOCK ON MACROECONOMICS OF MALAYSIA

Figure 2-4 reports the median of the responses and the 68 per cent confidence interval represented by the shaded area. The credit supply shock is normalized for a direct interpretation of the results. We normalized the effects of the credit supply shock to decrease the median response of lending rate by 10 basis points (0.1 per cent) on impact.

GDP growth increases by 2.2 per cent on impact and the response only lasts for 2 months. This large but short-lasting impact on GDP growth is consistent with Gambetti and Musso (2016) for US, UK, and Euro Area.

Inflation increases by 2 per cent on impact and continues to be significantly positive but at a decreasing rate until the 4^{th} quarter. Loan growth increases by 4.1 per cent on impact and becomes insignificant after 6 quarters at a decreasing rate as well. The lending rate continues to be responding negatively throughout the 5 years amidst the insignificant period between 2^{nd} to 5^{th} quarter. Short term rate increases by 1.3 per cent on impact and stay significant for only 3 quarters.

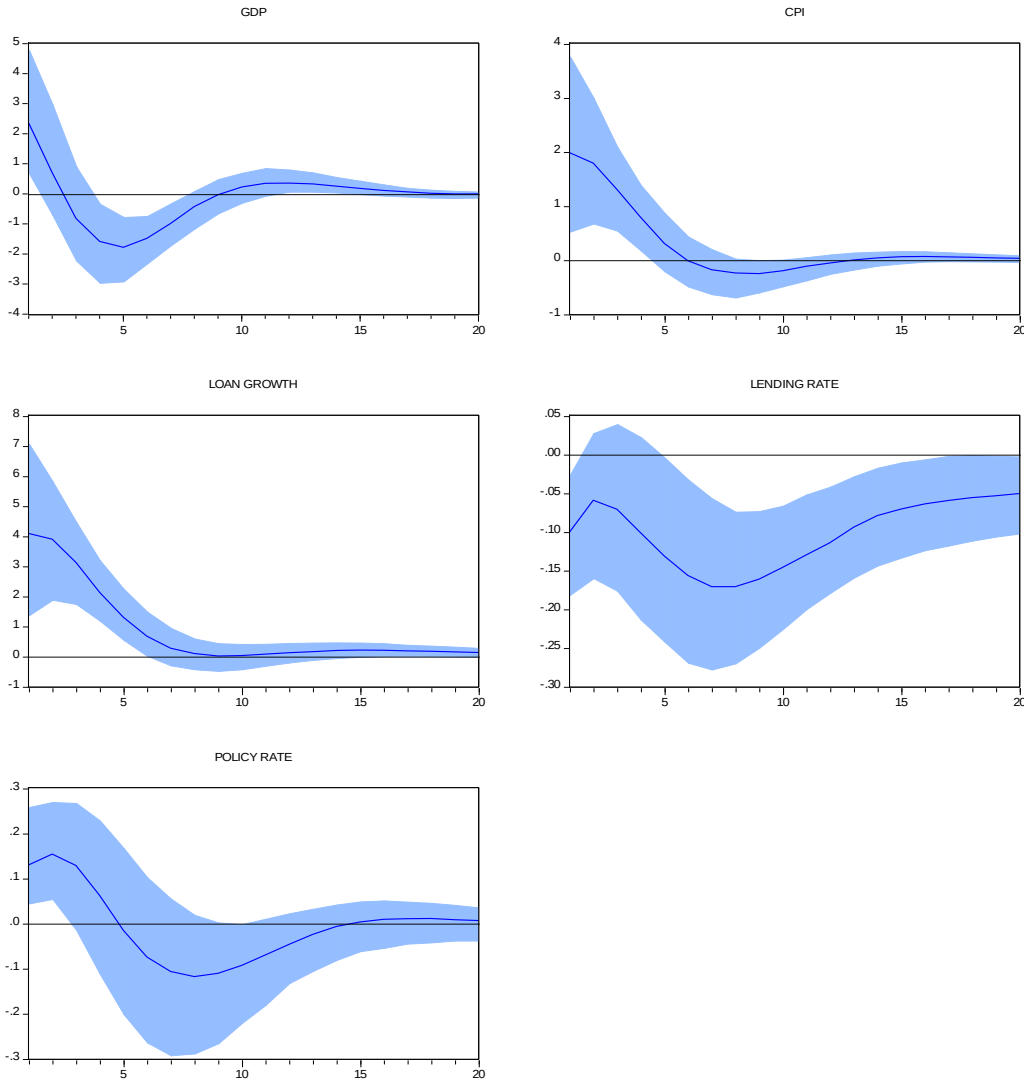

Figure 2-4: Impulse Responses to an Expansionary Credit Supply Shock

2.3.2 THE RELATIVE IMPORTANCE OF CREDIT SUPPLY SHOCKS

Next, we report the results from variance decomposition analysis. Figure 2-5 shows the forecast error variance decompositions of each variable to all shocks.

Firstly, credit supply shocks explain about 12 per cent of the forecast variance of GDP growth after 4 quarters and increases to 15 per cent after 5 years. Although it is not the biggest contributor to the forecast variance of GDP growth, we still consider 15 per cent as substantial. Another notable result from this analysis is that the forecast variance of GDP growth explained by credit supply shock is slightly bigger than monetary policy shock (12 per cent) after 5 years, signifying that credit supply shock is more important in influencing the variation of GDP growth than monetary policy shock.

As for the forecast error variance of credit growth, credit supply shock explains the biggest fraction (32 per cent in the first year and 28 per cent in the fifth year) of it, implying that credit supply shock is the most important factor in influencing the variation of credit growth. Also, monetary policy is the least important shock to contribute to the forecast variance of loan growth (14 per cent).

Aggregate demand explains 23 per cent of the forecast variance of inflation and followed by 21 per cent each by credit supply and aggregate demand shocks on the 5^{th} year. Monetary policy shocks only explain 17 per cent at the same horizon. This result shows that credit supply shock is also important in influencing the variation of inflation in Malaysia.

Forecast variance of lending rate on the 5th year is largely explained by aggregate demand shocks (41 per cent) and followed by aggregate supply (20 per cent). Credit supply shock and monetary policy shock both explain 11 per cent of the forecast variance of lending rate. This shows that aggregate demand is more important than credit supply shocks in influencing lending rate, probably due to credit demand shocks that is entailed together with aggregate demand shock and banks usually set the loan rate based on the demand for the loans.

Forecast variance of the policy rate is explained the most by aggregate demand and aggregate supply shocks. Monetary policy shocks explain around 14 per cent of the forecast variance at year 5. Credit supply shock explains the least fraction of policy rate with 8 per cent at year 5.

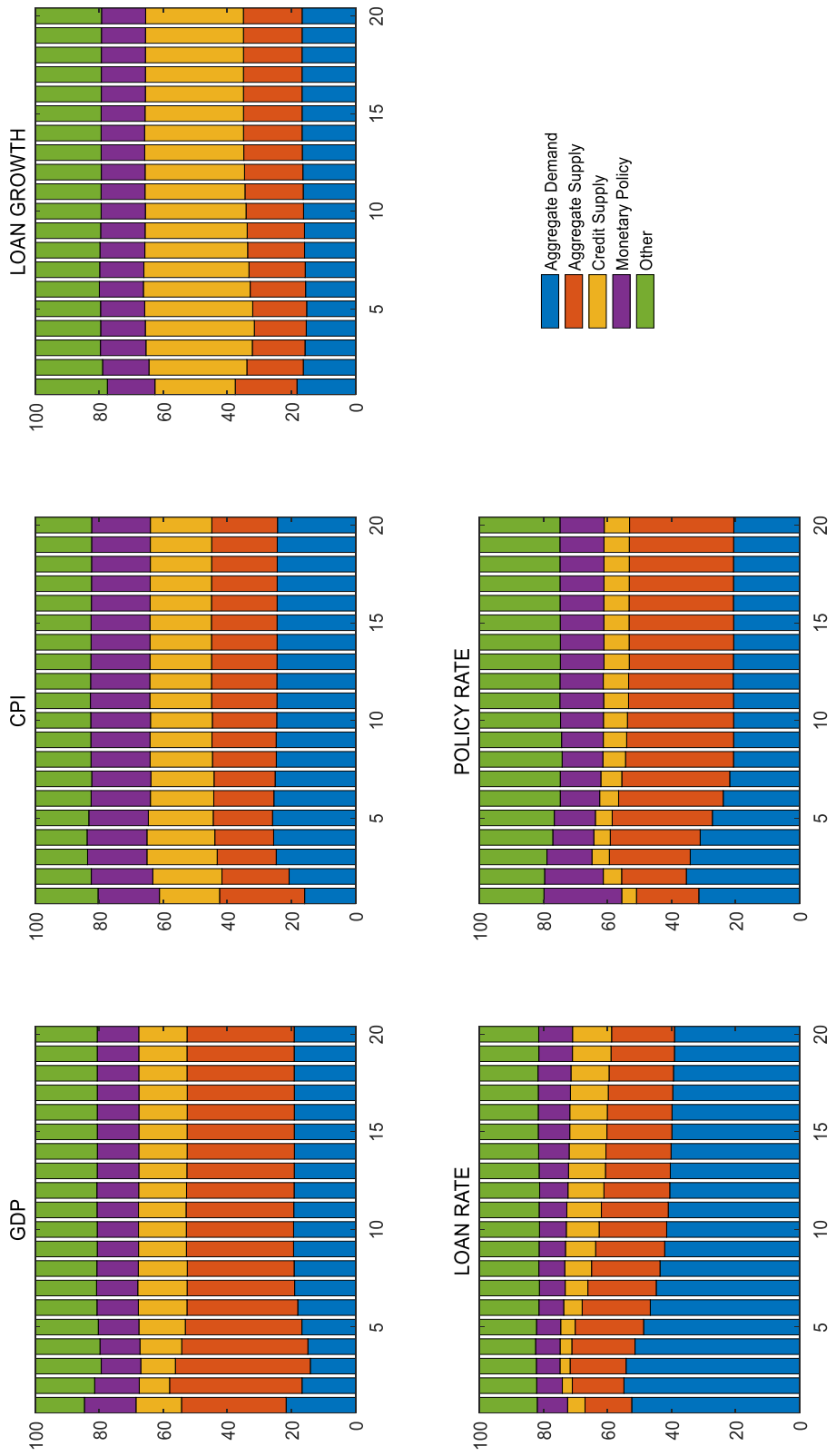

Figure 2-5: Forecast Error Variance Decomposition (Main Model)

2.3.3 SEPARATING HOUSEHOLDS AND NON-FINANCIAL CORPORATIONS

Following the suggestion of Gambetti and Musso (2016) for further research, we decompose loans to household and non-financial firms separately in this subsection. First, we look at the ratio between these two. Note that the data that separates between loans for households and non-financial firms only started from first quarter of 2006 for Malaysia, as provided by Bank for International Settlements, thus, we start our sample for this sub-analysis by following this date.

Figure 2-6 shows the percentage of loans to households and loans to non-financial firms that makes up our data in the main model. The distribution is almost equal over the time presented, signifying the equal weight between these two. Thus, it is important to examine if the responses differ between households and businesses as both bring equal weight to the total loan studied. Different responses might signal for different approach or attention to the government to formulate policies.

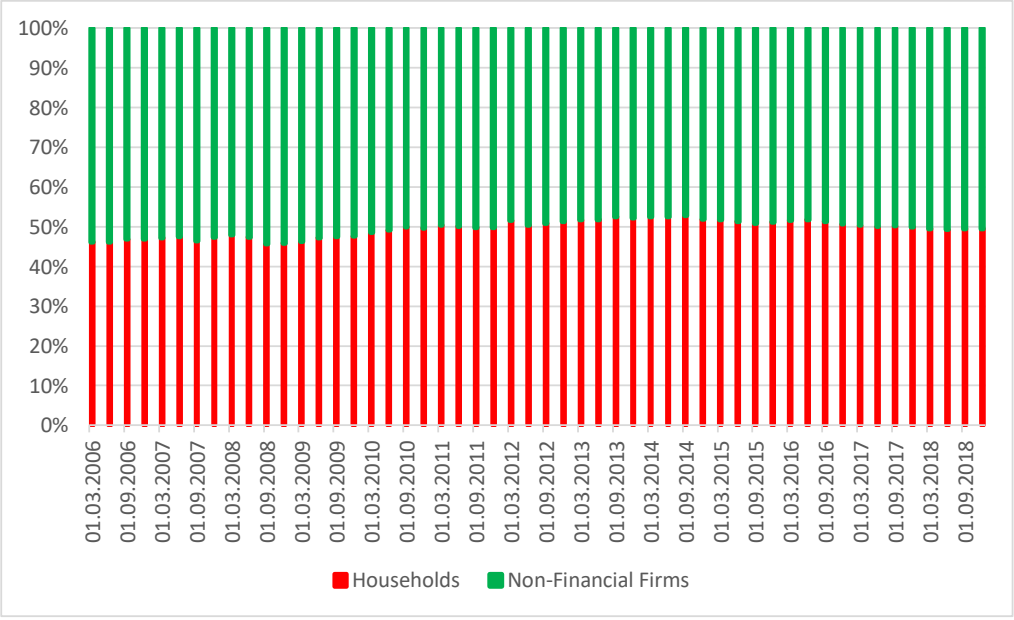

Figure 2-6: Decompositions of Households and Non-Financial Corporations Loans (%)

Next, we look at the growth rate of households' loans and non-financial firms' loans. Figure 2-7 shows the growth rate for both, together with the total loan's growth rate. Prior to the Global Financial Crisis, the high growth rate of total loan was attributed to the spike in the loan growth of non-financial firms.

When the crisis hit, loan growth of non-financial firms reduces immediately to less than 1 per cent. Household loans, on the other hand, acted like a buffer and remained high during this period.

As a result, the drop in total loans for private non-financial sectors was not as severe as in the other economies, especially in US, UK, and Euro Area as studied in Gambetti and Musso (2016).

We plot the same graph for the US, UK, and Euro in Figure 2-8. The main difference in general with the graph for Malaysia is that the growth for household loans in these countries decreased along with NFC loans during the period of the crisis. As a result, the drop for overall loans to private non-financial corporations is drastic for these 3 economies, especially in the US and UK.

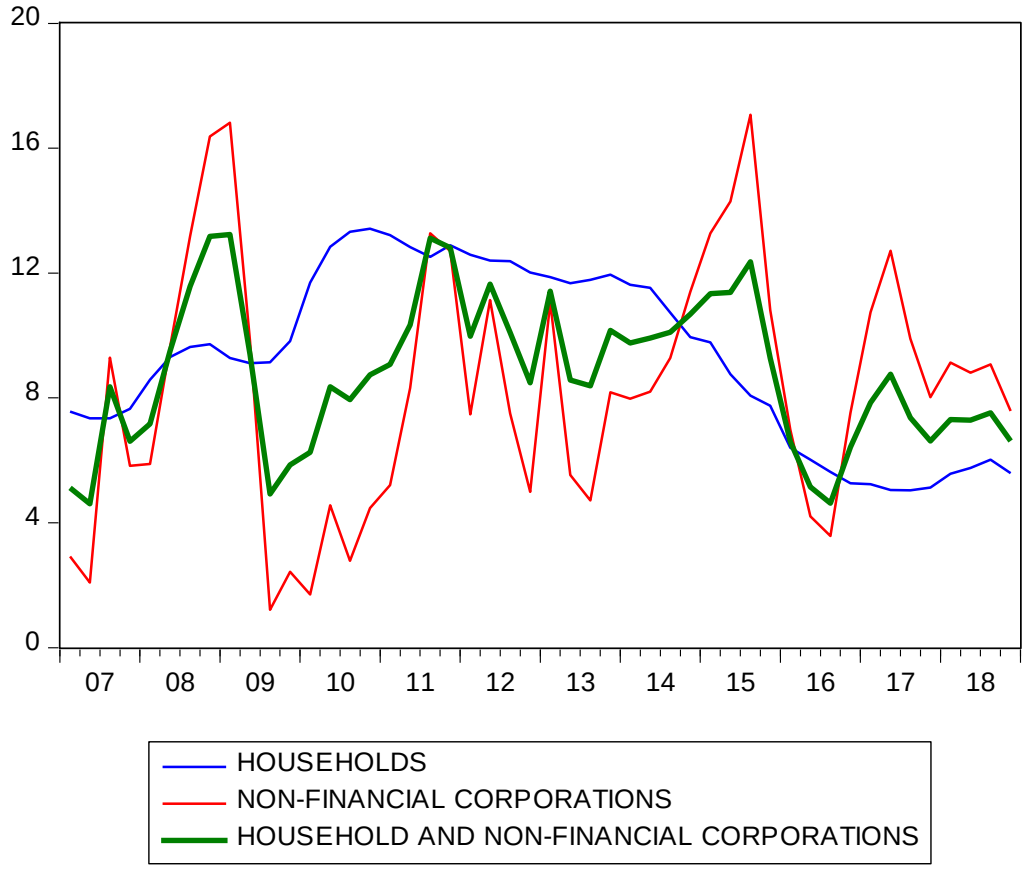

Figure 2-7: Growth Rate of Households, Non-Financial Corporations, and Household Plus Non-Financial Corporations Loans

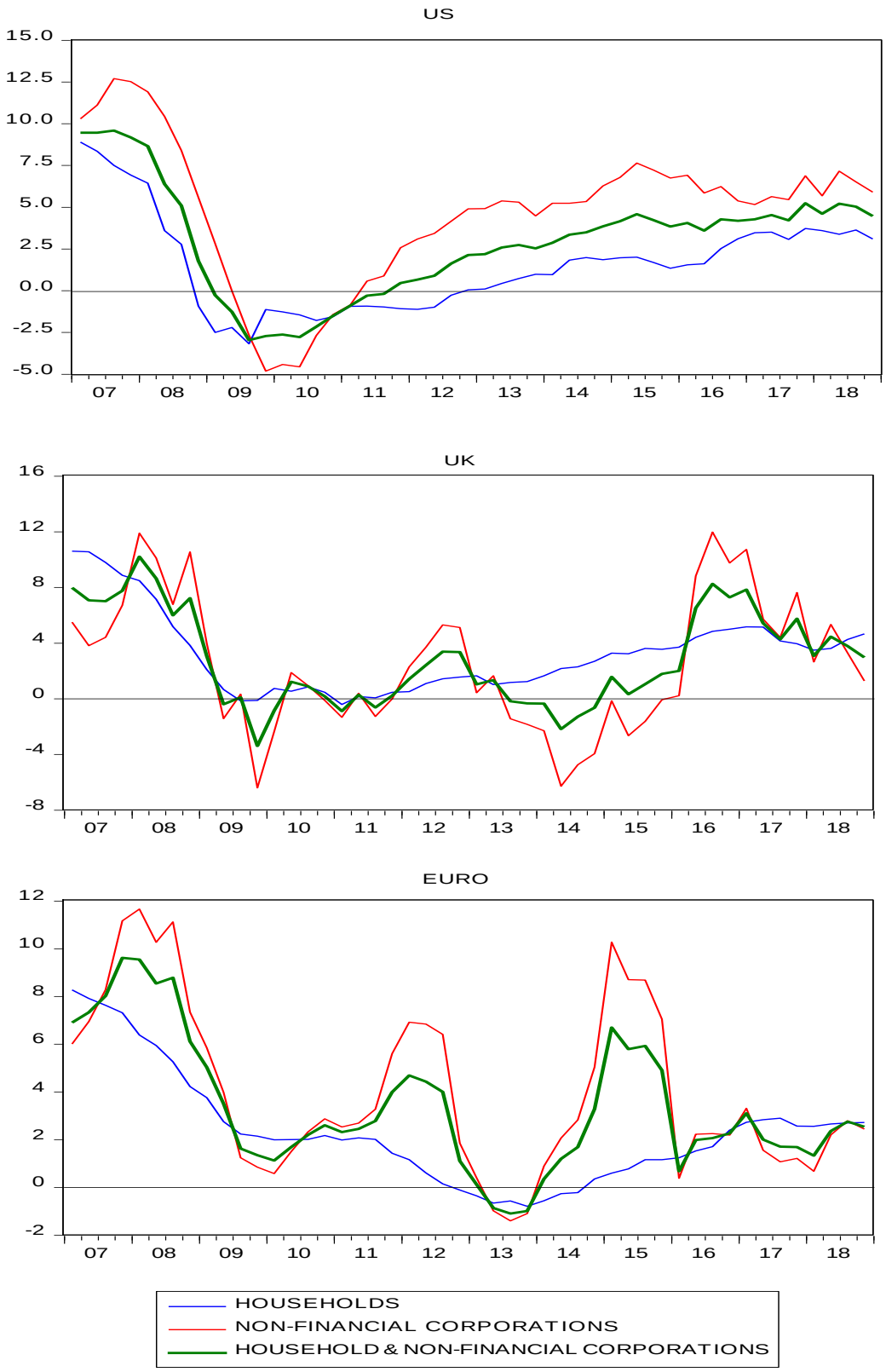

Figure 2-8: Growth Rate of Households, Non-Financial Corporations, and Household plus Non-Financial Corporations Loans (US, UK, EURO)

We re-estimate the model by replacing total households and non-financial firms' loans into these two components one by one. Duchi and Elbourne (2016) separated households and non-financial firms and replaced the GDP growth with respective contributions to GDP; namely consumption and investment for the Netherland data set. Thus, we replace the GDP growth with consumption growth for households' model and investment growth for non-financial corporations' model. For consumption growth, we take the final consumption expenditure and for investment, we take the gross capital formation as a proxy. Both data are taken from central bank of Malaysia. These additional series are adjusted for seasonality by using X-12 and the growth rate is calculated using year-on-year basis.

2.3.3.1 HOUSEHOLDS

First, we look at the household's component of the total private non-financial firms' credit. On impact, consumption growth increases by 8.5 per cent due to an expansionary household credit supply shock (that decreases lending rate by 0.1 per cent on impact) and the inflation increases by 3.8 per cent on impact. The positive response of consumption growth and inflation are both short lasting where it only lasts 2 and 4 quarters, respectively.

An expansionary household credit supply shock only resulted in a 1.4 per cent increase in household loan growth on impact and the positive response lasts for 3 months. The negative response of lending rate due to an expansionary credit supply shocks is only significance on impact and from 8^{th} to 12^{th} quarter. Lastly, policy rate increases by 1.8 per cent on impact and only lasts for 3 quarters.

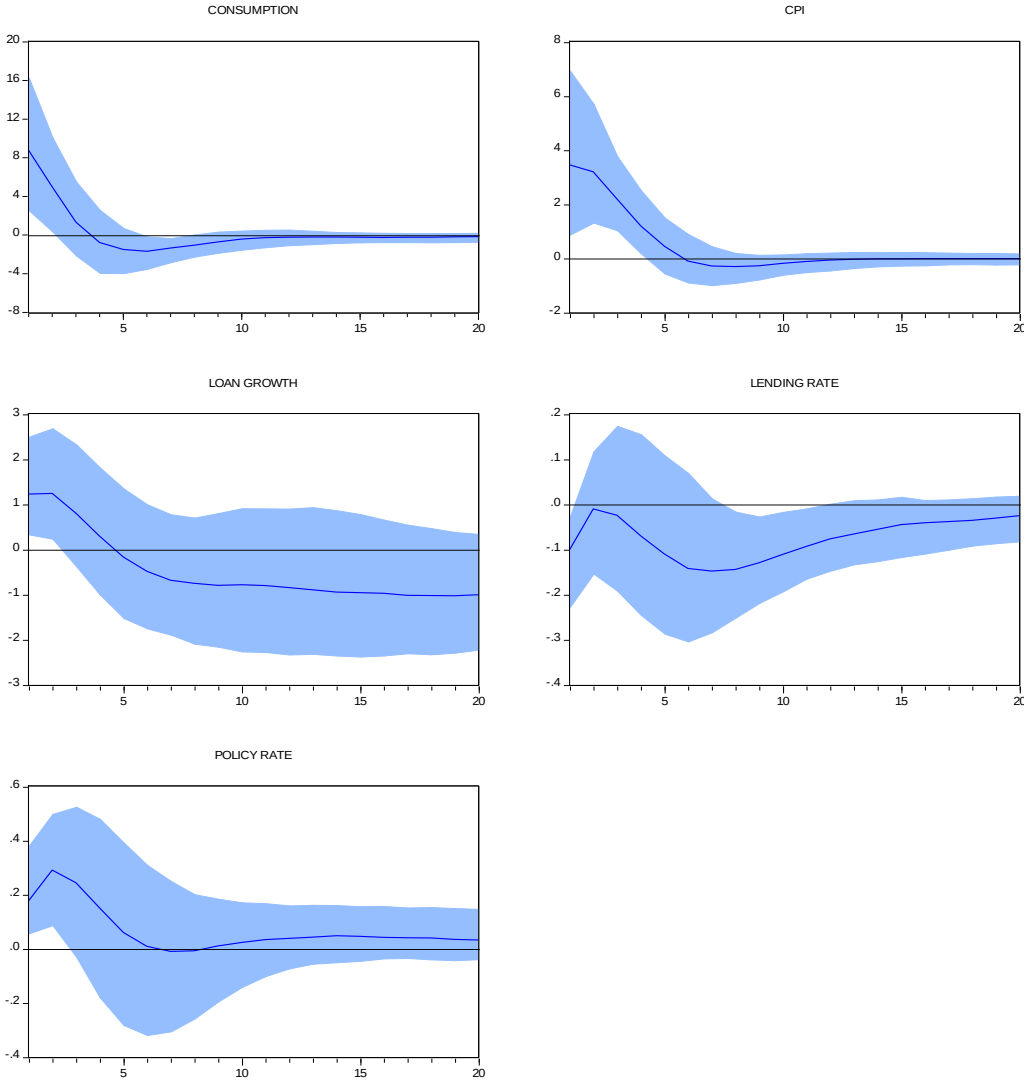

Figure 2-9: Impulse Responses to an Expansionary Household Credit Supply Shock (Households Model)

Then, we look at the variance decompositions of consumption growth and credit growth in the household credit model. Aggregate supply and aggregate demand shocks are the most significant contributors to the forecast variance of consumption growth. Credit supply shock explains 14 per cent while monetary policy shock only explains 10 per cent of the forecast variance of consumption growth on the 5th year.

Finally, it is interesting to the point that household's credit supply shocks play minimal role in the forecast variance of household loan growth and it is contributed mainly by monetary policy shocks. On the 5th year, household credit supply shock only explains 9 per cent of the forecast variance of household loan growth, while monetary policy shock explains 26 per cent of it.

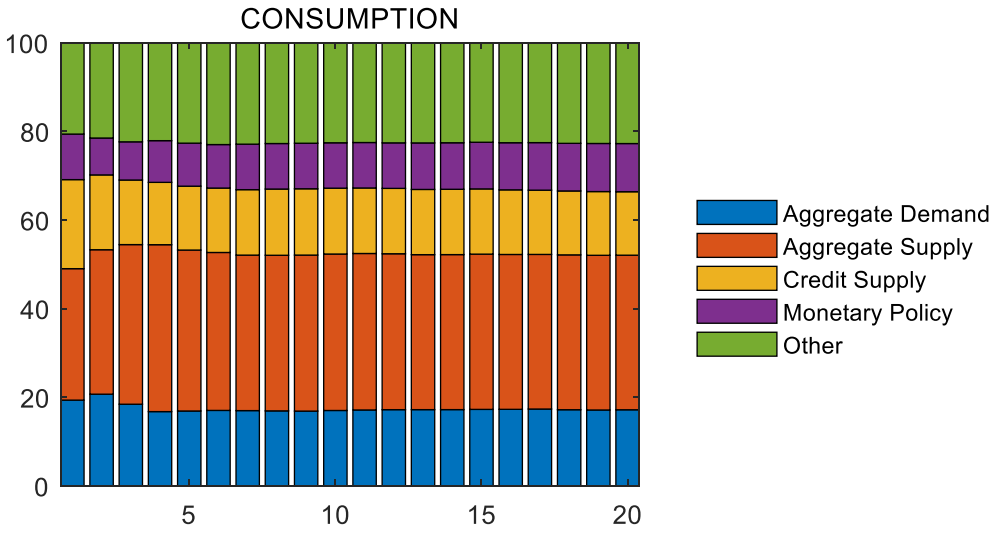

Figure 2-10: Forecast Error Variance Decomposition of Consumption Growth (Households Model)

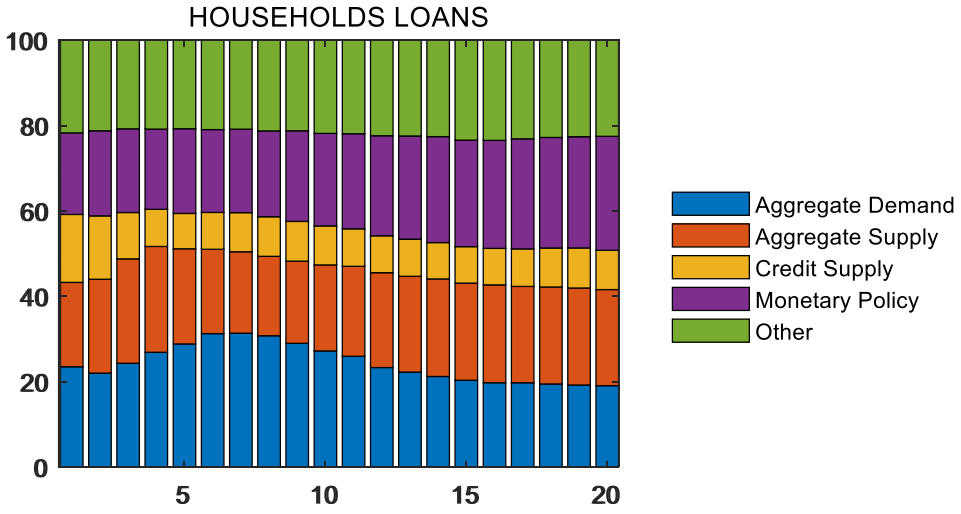

Figure 2-11: Forecast Error Variance Decomposition of Household Loan Growth (Households Model)

2.3.3.2 NON-FINANCIAL CORPORATIONS

Investment growth increases by 13 per cent on impact to an expansionary NFC credit supply shocks that reduces the lending rate by 0.1 per cent on impact. Inflation also increases in response to the expansionary NFC credit supply shocks by 2.8 per cent on impact and lasts for 3 quarters.

NFC loan growth increases by 11 per cent on impact due to an expansionary NFC credit supply shock and the positive response lasts for 6 quarters. Lending rate decreases significantly for 15 quarters, in which the largest impact is on the 6^{th} quarter, where lending rate decreases by 0.14 per cent.

Looking at the variance decomposition of investment growth in the NFC model, we could see that aggregate demand and supply shocks are still the main contributor to the forecast variance throughout 5 years. NFC credit supply shocks contribute 13 per cent of the forecast variance of investment growth in year 5. It is interesting to point that monetary policy shock explains higher fraction of forecast variance of investment growth than NFC credit supply shock.

After 4 quarters, NFC credit supply shock explains 37 per cent of loan growth forecast variance, and the contribution become smaller as it decreases to 30 per cent after 5 years but remains as the most important contributor. It followed by aggregate demand and aggregate supply shocks with 17 per cent each. Monetary policy shock is the smallest contributor to the forecast variance for NFC loans with 15 per cent in year 5.

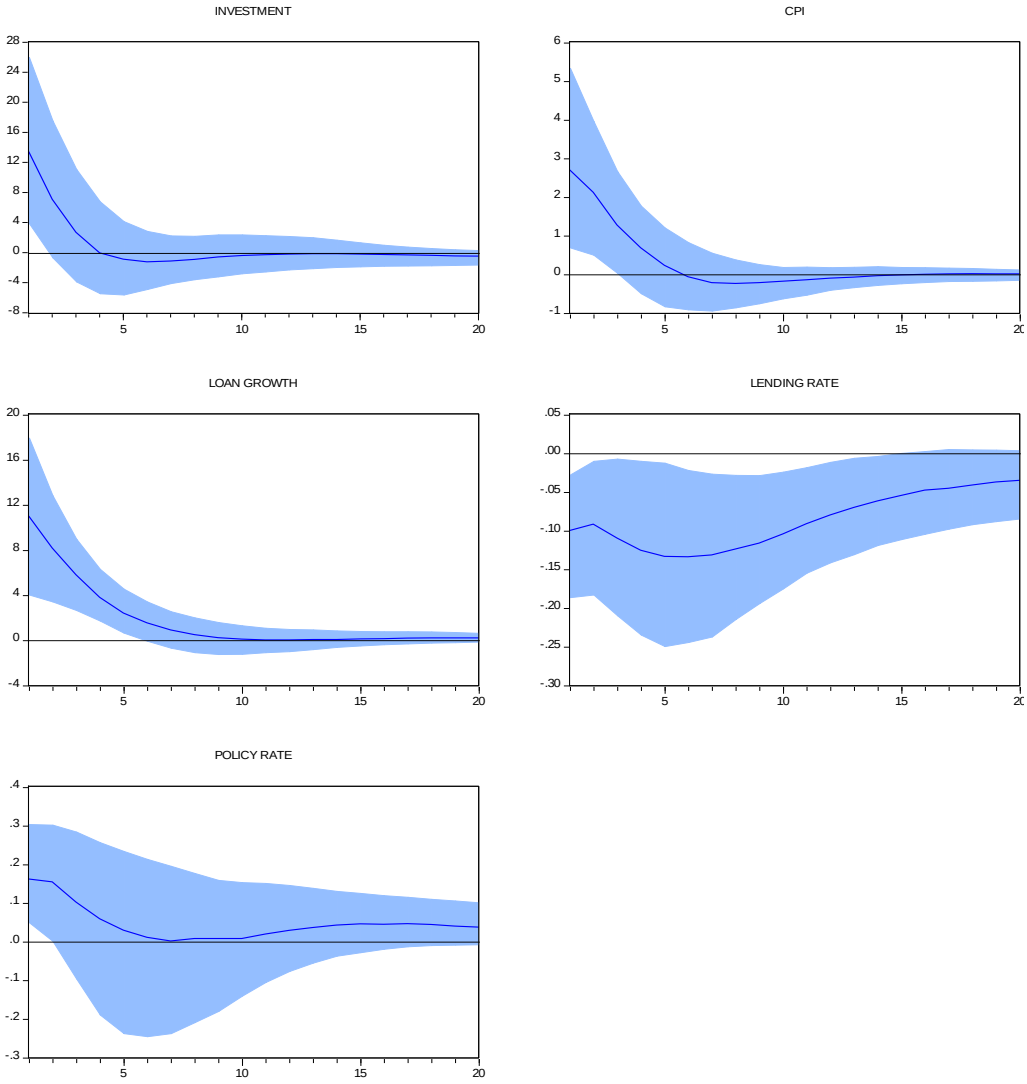

Figure 2-12: Impulse Responses to An Expansionary NFC Credit Supply Shock (Non-Financial Firms Model)

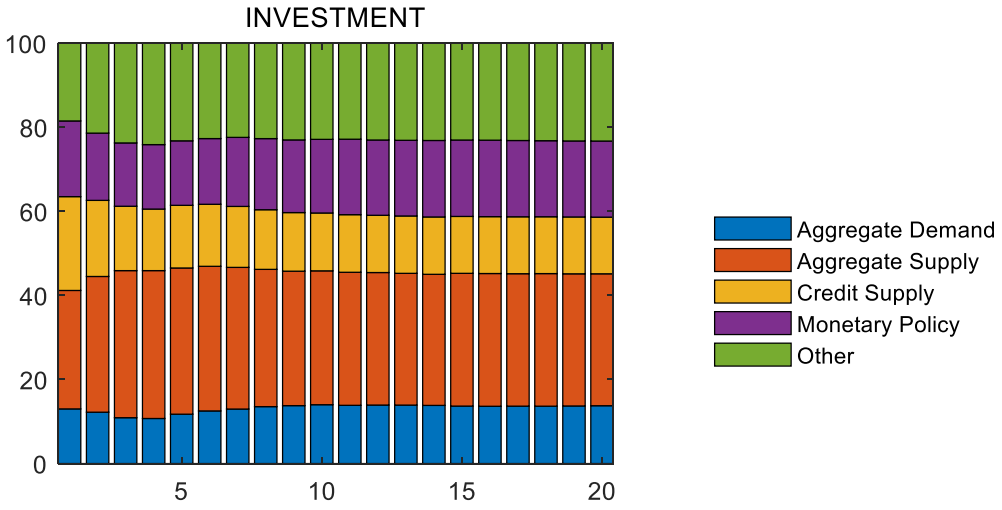

Figure 2-13: Forecast Error Variance Decomposition of Investment Growth (Non-Financial Corporations Model)

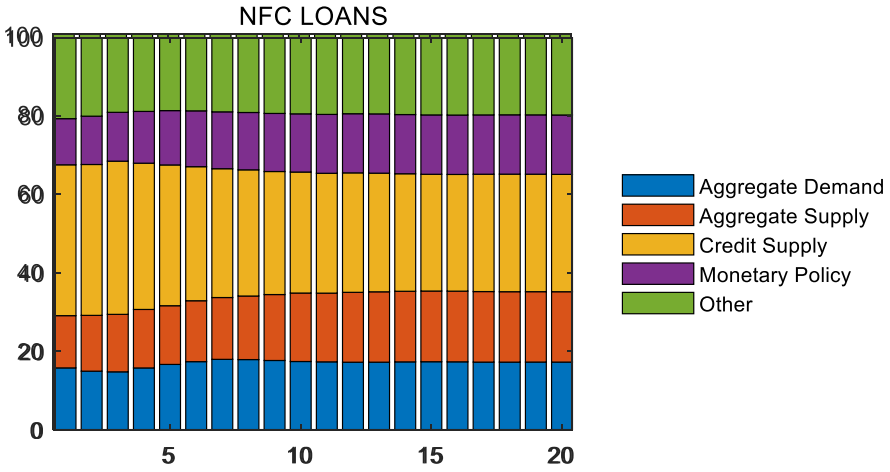

Figure 2-14: Forecast Error Variance Decomposition of NFC Loan Growth (Non-Financial Corporations Model)

2.3.4 ROBUSTNESS

We run our model with few adjustments to check the sensitivity of our main model. First, we change the sample size from 2000 as a starting point to January 2007, consistent with a year after the starting data point that separates households and non-financial corporations' loans. We have to take a year after the data availability as a starting point as we need to calculate the year-on-year growth. The impulse response results are reported in Appendix 2-D. The signs of the responses are generally the same. The duration of the responses of inflation and loan growth is a bit shorter for the sub-sample model.

We also change the lending rate to credit spread following Mumtaz et al. (2018). The spread is calculated as average lending rate minus overnight rate. Results for GDP, inflation and loan growth are generally the same. As for interest rate spread, it was a negative response for 5 months and become insignificant. The response of monetary policy is longer than in the main model. The results are reported in Appendix 2-E.

We also tried only partially identify the credit supply shock as in, we only identify credit supply shock and let other shocks unidentified. We report the results in Appendix 2-F. We found the same results generally as in the main model for the credit supply shocks.

Overall, the benchmark model is robust against the results of other models described above. The general direction of the movement of the variables is mostly identical to what we obtained earlier. However, the magnitude and the duration of responses differ for some variables. All the results for the robustness tests are included in the Appendix section.

2.4 CONCLUSIONS

This chapter investigates the empirical significance of credit supply shock to the Malaysian economy within a structural VAR framework. The structural VAR framework has enabled us to study credit supply shock as a source of macroeconomic variation in Malaysia by making use of sign restrictions approach to identify the structural shocks.

From the main impulse response results, we found that credit supply shock does have a substantial effect on output. An expansionary credit supply shock (normalized to decrease lending rate by 0.1 per cent) increases output by 2.2 per cent on impact. Credit supply shocks also cause loan growth to increase significantly by 4 per cent on impact. The variance decomposition analysis shows us that credit supply shocks does have significant contribution in influencing forecast variance of GDP growth, inflation, and especially credit growth. We also found that credit supply shock is more important in explaining forecast variance of credit growth, compared to monetary policy shock.

Breaking down the total credit into households and non-financial firms, we found that both consumption and investment increases due to respective expansionary credit supply shocks. We also found few noticeable differences between the credit supply shocks of households and non-financial firms: 1) Response of lending rate in NFC model is significantly negative throughout the 20 quarters, while in household model, it is only significant from the 8^{th} to 12^{th} quarter. 2) 0.1 per cent decrease in lending rate due to credit supply shocks resulted in 11 per cent increase in the growth of NFC loans on impact, while it is only 1.2 per cent for households' loan. 3) Variance decomposition analysis shows that credit supply shock is the most important shock to

explain forecast variance of credit growth for NFC, while for household model, the forecast variance of credit growth explained by credit supply shocks is much less important and it is mostly explained by monetary policy shocks.

Overall, the results imply the importance of credit supply shock in influencing Malaysian economy. Credit supply shocks could be used as a tool to boost the economic growth in Malaysia when needed but must be threaded carefully as it comes with increasing inflation, and most importantly, higher level of debt in the economy. Policy makers in Malaysia could also choose which sector to boost separately, between households and non-financial firms, as both contribute to different components of GDP. The choice comes with different costs. Expansionary credit supply shocks to NFC increases more investment growth, but with the cost of higher level of debts in NFC. Expansionary credit supply shocks to households increases less growth of consumption, but the growth in debt level is much lower.

2.5 APPENDIX FOR CHAPTER 2

2.5.1 APPENDIX 2-A: DESCRIPTIVE STATISTICS FOR MAIN MODEL

	GDP	CPI	HOUSEHOLD+NFC	LOAN RATE	POLICY RATE
Mean	5.079916	2.252848	7.686787	6.068640	2.930137
Median	5.294731	1.945433	7.445303	5.690000	2.977728
Maximum	11.69644	8.399102	13.23632	7.903333	3.500000
Minimum	-5.688069	-2.284752	0.000578	5.196667	2.000000
Std. Dev.	2.650035	1.415484	2.705345	0.726253	0.356087
Skewness	-1.433227	0.924011	0.018726	0.612830	-0.474630
Kurtosis	7.367367	7.509357	2.856275	2.318794	3.552226
Jarque-Bera	86.41976	75.20669	0.069855	6.226571	3.819148
Probability	0.000000	0.000000	0.965676	0.044455	0.148143
Sum	386.0736	171.2165	584.1958	461.2167	222.6904
Sum Sq. Dev.	526.7015	150.2696	548.9169	39.55823	9.509856
Observations	76	76	76	76	76

Table 2-3: Descriptive Statistics for Main Model

2.5.2 APPENDIX 2-B: IMPULSE RESPONSE FOR MAIN MODEL

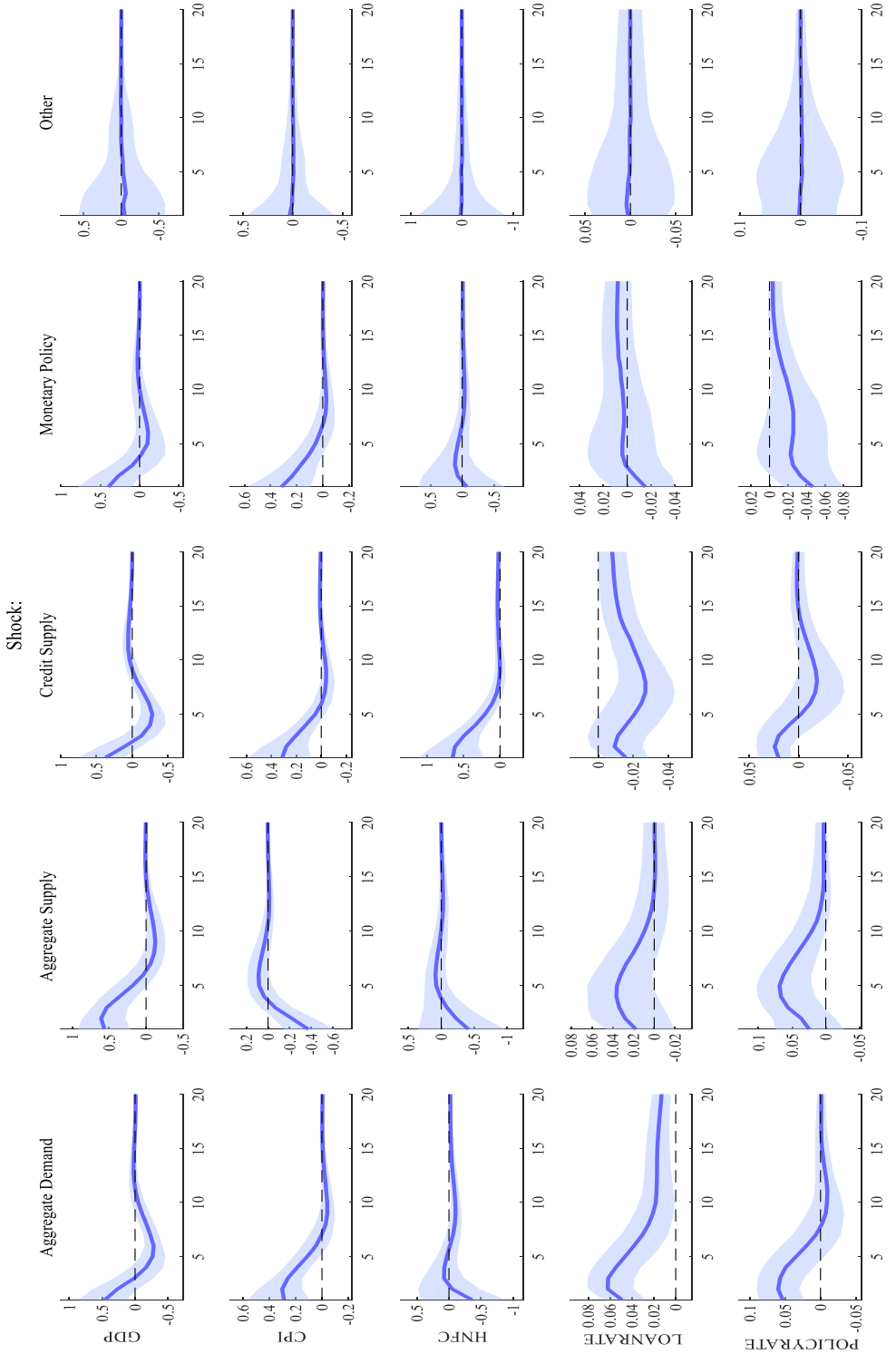

Figure 2-15: Impulse Response for All Shocks (Main Model)

2.5.3 APPENDIX 2-C: DESCRIPTIVE STATISTICS FOR SUB-SAMPLE MODEL

	GDP	CPI	HOUSEHOLDS +NFC	HOUSEHOLDS	NFC	LOAN RATE	POLICYRATE
Mean	4.890915	2.405605	8.788676	9.350092	8.325554	5.647917	2.995634
Median	5.167298	2.171489	8.658961	9.471852	8.189280	5.458333	2.991667
Maximum	10.36130	8.399102	13.23632	13.42020	17.06644	6.833333	3.500000
Minimum	-5.688069	-2.284752	4.608263	5.041154	1.215965	5.196667	2.000000
Std. Dev.	2.659650	1.618292	2.387831	2.793259	4.025363	0.464093	0.393343
Skewness	-2.089184	0.707104	0.110062	-0.151637	0.252682	1.496576	-1.145523
Kurtosis	9.161324	6.614368	2.193598	1.632850	2.485616	3.865115	4.122736
Jarque-Bera	110.8413	30.12728	1.397477	3.922149	1.039968	19.41476	13.01886
Probability	0.000000	0.000000	0.497212	0.140707	0.594530	0.000061	0.001489
Sum	234.7639	115.4690	421.8564	448.8044	399.6266	271.1000	143.7904
Sum Sq. Dev.	332.4658	123.0868	267.9817	366.7078	761.5667	10.12297	7.271796
Observations	48	48	48	48	48	48	48

Figure 2-16: Descriptive Statistics for Sub-Sample Model

2.5.4 APPENDIX 2-D: IMPULSE RESPONSE FOR SUB SAMPLE MODEL

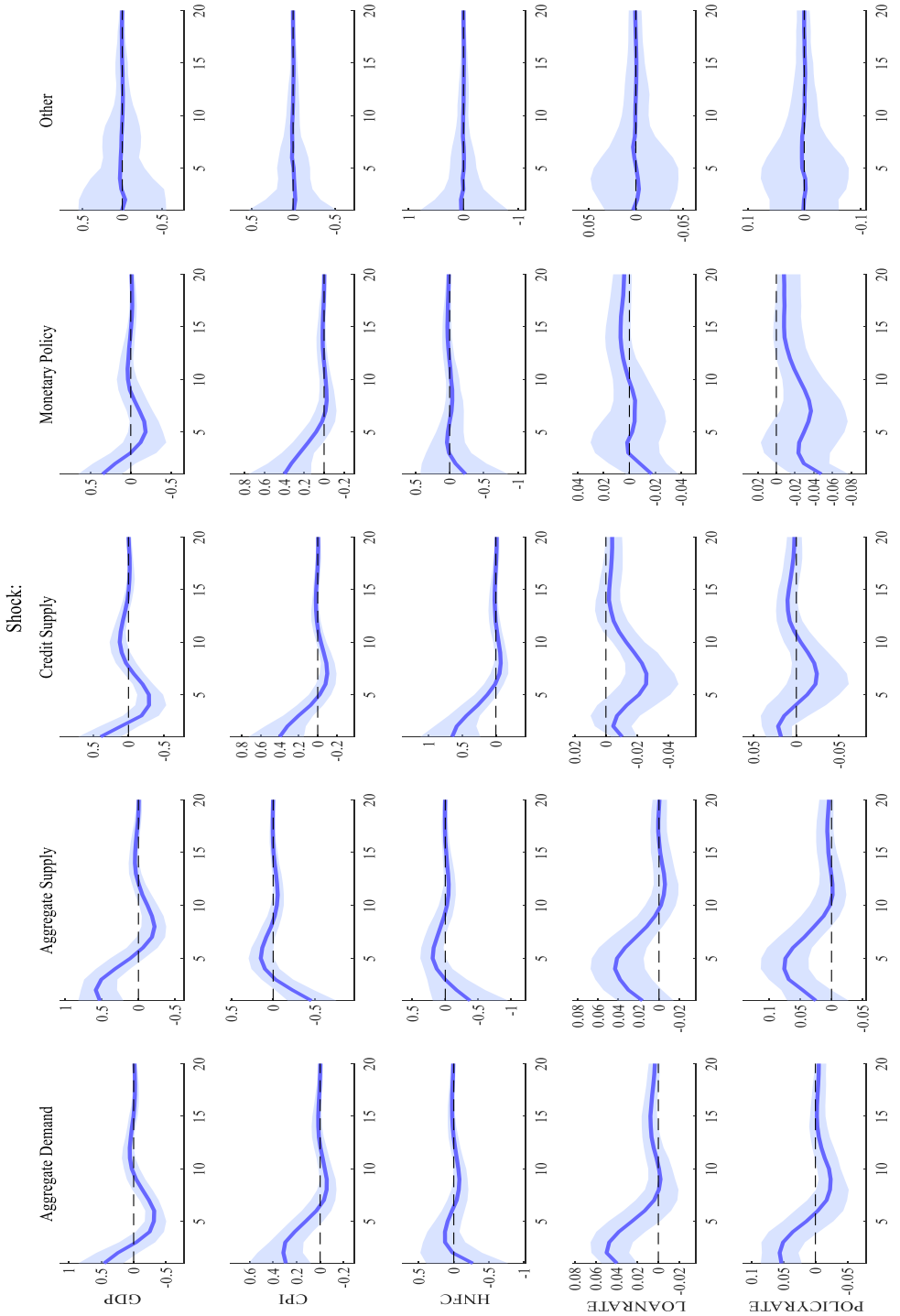

Figure 2-17: Impulse Response for Sub-Sample Model

2.5.5 APPENDIX 2-E: IMPULSE RESPONSE FOR SPREAD MODEL

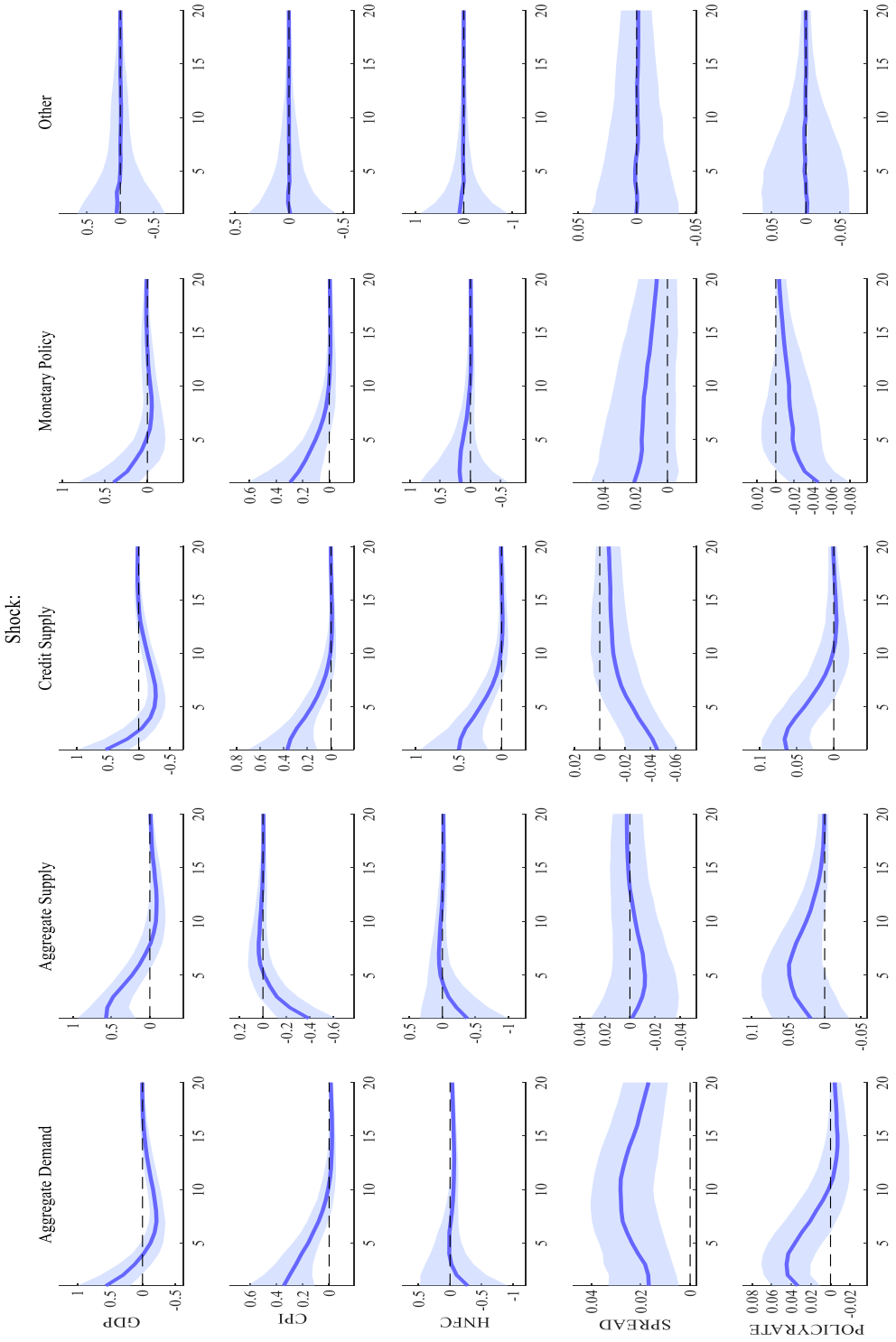

Figure 2-18: Impulse Response for Spread Model

2.5.6APPENDIX 2-F: IMPULSE RESPONSE FOR PARTIAL IDENTIFICATION MODEL

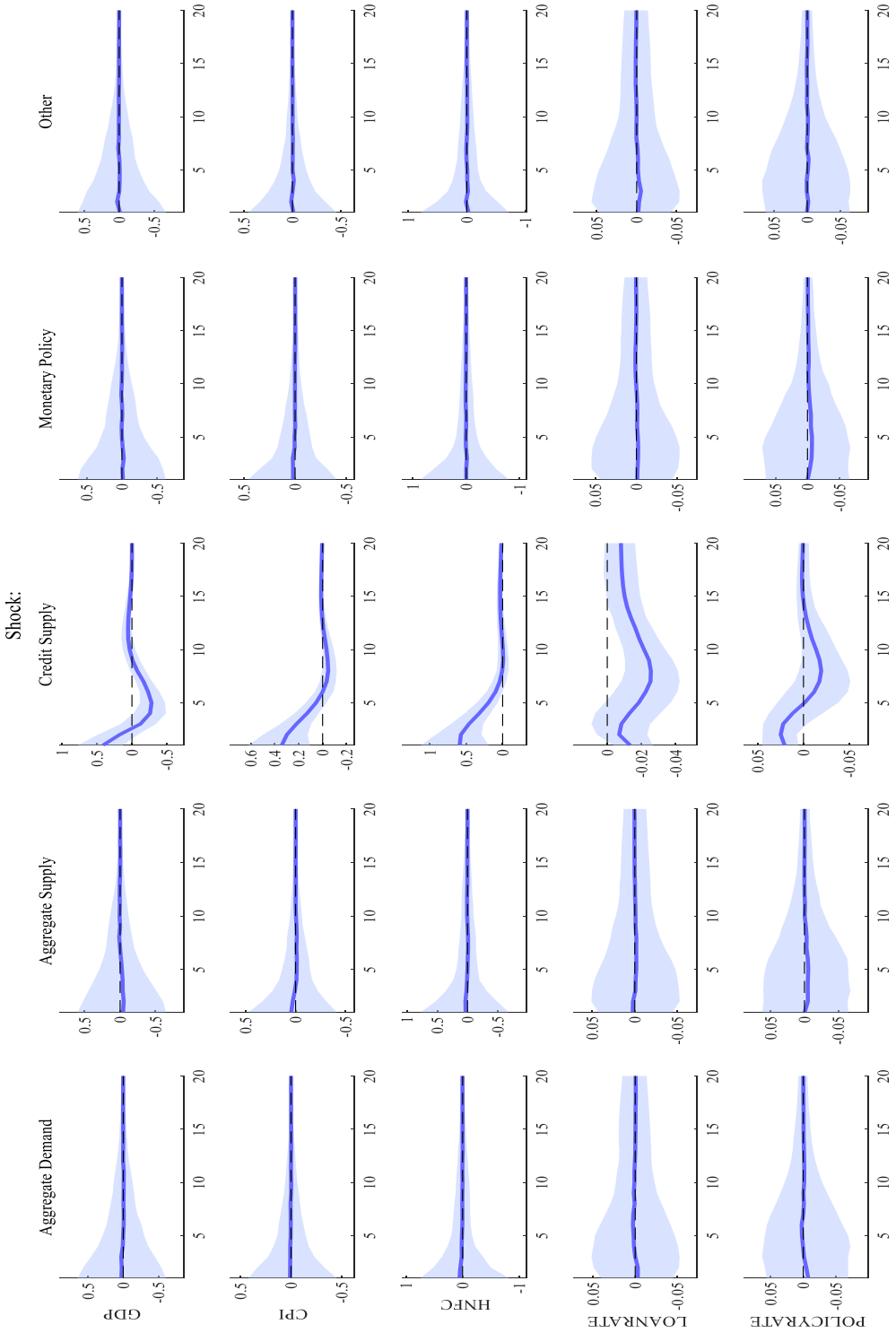

Figure 2-19: Impulse Response for Partial Identification Model

CHAPTER 3: THE EFFECTS OF US ECONOMIC POLICY UNCERTAINTY ON THE MACROECONOMICS OF MALAYSIA

3.1 INTRODUCTION

Global Financial Crisis has reignited economists' interest in a study of uncertainty. A more recent breakthrough from Baker et al. (2016) to quantify the economic policy uncertainty based on text search from newspapers has led to more studies on this subject matter, in which we use as a focus variable of this chapter. Economic policy uncertainty is defined as the inability of economic agents to predict the outcomes for regulatory, trade, fiscal, and, monetary policies (Kostka and van Roye, 2017).

Increasing economic policy uncertainty was found to have an adverse impact on economic activity. Baker et al. (2016) show that economic policy uncertainty significantly impacts real economy in US. One example of the mechanism is if there is any uncertainty on a particular trade policy of one sector, investors in this sector may postpone their decisions on the investment until this uncertainty is dissolved. This brings down the production and ultimately leads to economic slowdown if the scale is massive.

Although most studies would agree with the conclusion that economic policy uncertainty does affect the real economy negatively, there is still a further extension that would benefit from additional empirical investigations in this area of research, which is: its impact on small open developing economies. While there exists a strand of literature that examines the international transmission of external uncertainty shocks (Colombo, 2013; Cerda et al., 2017; Luk et al.,2017; and Stockhammar and Osterholm, 2017), studies that focus on small open and developing economy are still limited.

In an economically integrated world, economic policy uncertainty in advanced foreign economies may have consequences for these vulnerable economies. This points to the motivation of this study. Given the characteristics of Malaysia as a small, open, and developing economy, it is crucial to see if economic policy uncertainty shocks originated from other advanced economy is affecting Malaysia. Moreover, Malaysia is highly dependent on its export and FDI.

We hypothesize that US economic policy uncertainty could potentially affect Malaysian economy based on few reasonings. First, as US EPU Index is based on the articles reported in US newspapers, some of the articles could be reported in Malaysia's newspaper as well. Especially if it concerns major economic news. Investors or other economic agents in Malaysia will probably react to the economic or policy uncertainty reported in the news, especially if it has direct consequences to them. Second, the possibility of transmission of uncertainty is higher if the two economies have a close link in trade. As of 2018, US is one of the most important trading partners for Malaysia with 13 per cent of the export goes to the US, and 7.4 per cent import comes from US.

Trade openness of Malaysia is also one of the highest in the world. Figure 3-1 shows the open economy characteristics of Malaysia. The trade percentage of GDP in Malaysia is constantly above 100 per cent since 1980's. This shows how important external trade is to Malaysian economy and how vulnerable it is to any disturbances originated from external forces.

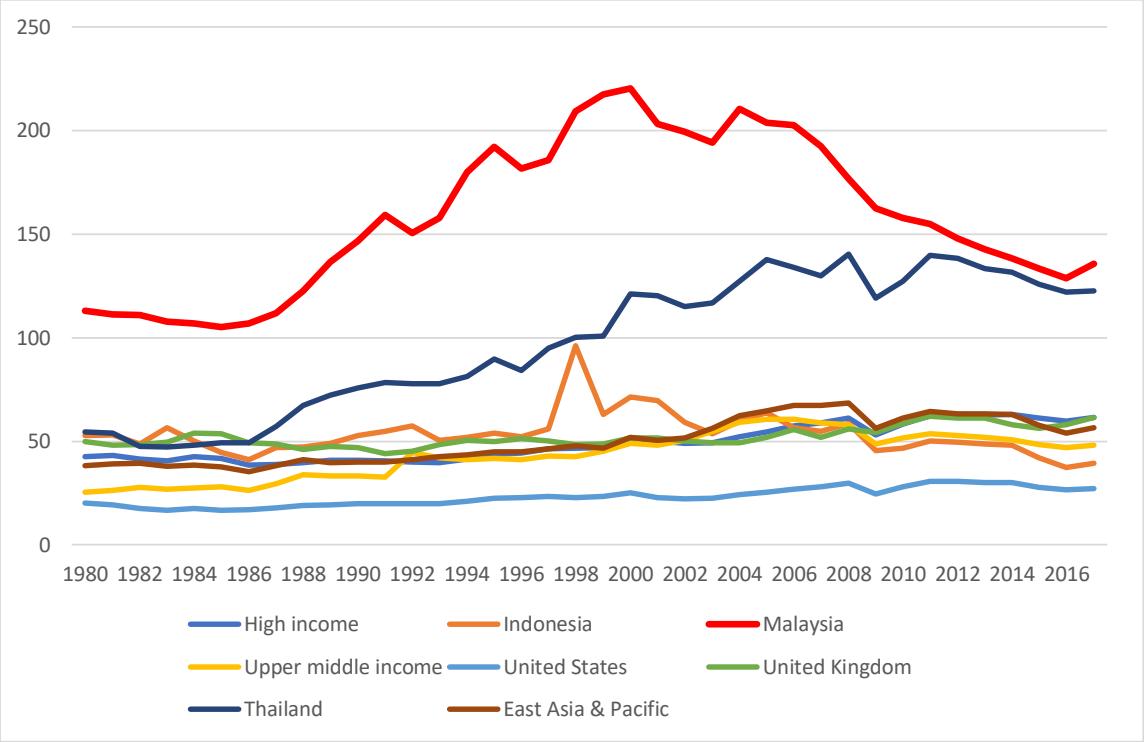

Figure 3-1 Trade Openness (Trade % of GDP)

Understanding the distinct effects of each of the external shocks is an ever-present concern to policymakers in Malaysia. To illustrate, the strategy taken by the central bank to solve slower growth that caused by a pure external demand shock is perhaps more direct than to solve slower growth that was caused by a financial crisis originated from other advanced economies.

Studies of how external factors influences domestic economy in Malaysia is well documented. For example, Chua et al. (1999); Ibrahim (2004); Tang (2006); Mackowiak, 2007; and Zaidi et al. (2014). Most of these studies focuses on the effects of external monetary policy shocks or income shocks. None of the available literature that specifically identify US EPU shock and study its impacts on domestic variables in Malaysia. US is commonly used to proxy the external economy that influences Malaysian economy.

The closest applications of EPU to any economic variables in Malaysia is only related to stock market. Sum (2013) examined the performance of stock market in ASEAN countries, including Malaysia, against the changes in US EPU. He found that increase in US EPU negatively affect the stock market in all ASEAN countries. Balcilar et al. (2019) uses Global EPU Index to analyse the causality to stock market in Hong Kong, Malaysia, and South Korea. They found evidence of causality from global EPU to stock return volatility in Malaysia. Lastly, Hoque and Zaidi (2018) specifically examined the effects of Global EPU on sectoral stock market in Malaysia. They found that Global EPU has significant effects on all sectoral stock returns in Malaysia. However, none of these studies specifically examine the effects on macroeconomics variables of Malaysia, such as output, price level, and interest rate.

Addressing adverse effects arising from the specific external cause may help to formulate a better counter measure for Malaysian economy. However, formulating the right policies in response to specific external shocks requires a deep understanding of their effects on the economy and its transmission mechanisms. It is also essential to measure the relative impacts of different economic shocks as some might have higher relative importance than the others, thus requires more attention from the policymakers.

This chapter aims to measure the effect of US economic policy uncertainty shocks, among other shocks from the US, to the Malaysian economy, focusing on output, price, and monetary policy. We then further include the other variables the examine the effects on financial stability. We adopt a Bayesian Structural Vector Autoregression (BSVAR) with Block Exogeneity approach and apply the sign and zero restrictions algorithm as per Arias et al. (2014) to identify the shocks.

We contribute to the literature in two ways. First, we are the first to our knowledge to measure the effects of US EPU shock and compare it with other economic shocks in Malaysia. Second, we contribute to the literature by adding more evidence on the transmission effects of economic policy uncertainty from the US to a small, open, and especially developing economy.

The rest of the chapter is organized as follows. In section 3.2, we discuss the methodological framework and data. Section 3.3 presents the empirical results by focusing on sign restricted impulse responses function and forecast error variance decompositions. Finally, the last section summarises and concludes.

3.2 METHODOLOGY

In this section, we start the discussion by explaining the framework of SVAR with block exogeneity. Then we proceed with the identification scheme in which we use sign and zero restrictions. Next, we discuss the lag selection for our models. Lastly, we discuss the data included in our models.

3.2.1 SVAR WITH BLOCK EXOGENEITY

The discussion of the methodology starts with:

$$B_0 Y_t = k + B_1 Y_{t-1} + B_2 Y_{t-2} + \ldots + B_p Y_{t-p} + \varphi_t \quad (3\text{-}1)$$

where Y_t is the matrix of endogenous variables, $\mu_t \sim N(0, \Sigma)$ is the reduced-form error terms, p the lag length. k is the matrix of constant terms. The reduced form VAR model obtained from (1) is

$$Y_t = K + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + \mu_t \quad (3\text{-}2)$$

$$E(\mu_t \mu_t') = \Sigma = B_0^{-1} B_0^{-1\prime} \quad (3\text{-}3)$$

Where $\Sigma = E(\mu_t \mu_t{}')$ is the n × n covariance matrix of the error term vector μ_t. The error terms are the linearly unpredictable component of Y_t,.

With the purpose of implementing the block exogeneity assumption, we need to restrict both VAR coefficients and impact matrix B_0. The impact matrix is restricted by putting zeros on the impacts of Malaysian variables to US variables.

Beyond impact period, we can restrict the propagation of the Malaysian variables through the US block by restricting some parameters in the VAR. We can achieve this by assuming the appropriate prior distributions for parameters to be restricted within the Bayesian framework. We chose the Minnesota priors for this purpose as some other priors assumes that prior covariance of coefficients is proportional, in any two equations, to each other.

In restricting the VAR parameters required for block exogeneity, first, in each equation of the US block, we assume zero mean priors with very small variance for all the Malaysia's parameters. This enables us to assign the dominant weight to the prior parameters when computing the posterior. Applying this will ensure that the sample information is largely ignored as the coefficients' posteriors will be mainly determined by the prior. To select the value of other hyperparameters, we utilise grid search approach and select the combination that maximizes marginal likelihood. We estimate our model using BEAR Toolbox by Dieppe et al. (2016) from European Central Bank.

3.2.2 IDENTIFICATION SCHEME

The identification scheme is done by imposing sign and zero restrictions on the impulse response function (IRF). For each draw of the posterior of reduced-form parameters, we compute a Q matrix, which is a uniformly distributed orthogonal matrix. Then, we multiply this Q matrix with the impact matrix B_0.

Arias et al. (2014) offers an algorithm that can produce an orthogonal Q such that QB_0 will satisfy the zero restrictions at any horizons of the IRF. If the sign restrictions are satisfied, the posterior draw is accepted. If not, we repeat the procedure with a new

set of posterior draws of reduced-form parameters. The steps will be repeated until we reach determined number of iterations.

We divide the structural shocks into two blocks: US and Malaysian block. Along with block exogeneity restrictions that we set on the VAR parameters; the Malaysian block is also separated from US blocks by assuming that Malaysian economic shocks do not influence US variables on impact.

We identified four shocks for our baseline model: Aggregate Demand shock, Aggregate Supply shock, Monetary Policy shock, and US EPU shock. The restrictions for aggregate demand shock, aggregate supply shock, and monetary policy shock were chosen following the standard New Keynesian DSGE models and the restrictions are the same for both US and Malaysia. Specifically, we restricted positive aggregate demand shocks to increase output, the price level, and the policy rate. Aggregate supply shocks move output and price level in the opposite direction. Contractionary monetary policy shock increases the policy rate and decrease output and price level.

We identify adverse US EPU shock as the shock that increases EPU, lowers the output and no contemporaneous impacts on monetary policy in US. The first economic reasoning for this restriction on the output is that higher policy uncertainty will affect household's consumption and saving behaviour due to precautionary saving-motive. Because of an unexpected increase in policy uncertainty, households may increase precautionary saving, thereby reducing the means and desire to consume under normal circumstances. Moreover, Eberly (1994) also stated that higher uncertainty encourages households to postpone the decision to purchase durable goods due to its

nature which is costly to reverse. This further drives the aggregate demand to be lower, and thus, lowering the output level.

The second reason for the restriction on the output is firms will delay or lower their investments when uncertainty increases. Higher economic policy uncertainty makes estimating the return on business decisions more difficult. Thus, investment risk premium will be higher, thus inducing firms to postpone or lower their investment, as shown in model with financial frictions (e.g., Gilchrist et al., 2014). Baker et. al. (2016) found that investment level in US dropped due to adverse EPU shock in US. Gulen and Ion (2016) also found a strong negative relationship between corporate investment and Economic Policy Uncertainty Index in US.

The last reasoning concerns the labour market. Higher policy uncertainty could make firms to rethink about the fixed costs of hiring and firing. Leduc and Liu (2016) show how nominal rigidities can interact with labor market search frictions to amplify the negative effects of uncertainty in DSGE models. Baker et. al. (2016) found that employment level decreases due to adverse economic policy uncertainty shock in US. Caggiano et al. (2017), using non-linear VAR, also found that unemployment increases due to adverse EPU shock in US, especially during recession. Consequently, less employment will negatively affect the output via various channel (e.g., decrease in demand for consumption (Malley and Moutos, 1996)).

We imposed the zero restrictions on the effect of the EPU shock on monetary policy on impact under the assumption that the policy makers in US have to wait for the EPU shock to be translated into changes in the price level or output first before responding. Furthermore, we are using monthly data, so this assumption is considerably reasonable.

Responses of domestic variables to foreign shocks are left unrestricted. We aim to see how the US shocks affecting the Malaysian economy without imposing any restrictions on domestic variables. We summarise our identification scheme in Table 3-1.

	AD SHOCK	AS SHOCK	MONETARY SHOCK	US AD SHOCK	US AS SHOCK	US EPU SHOCK	US MONETARY SHOCK
IPI	+	+	-	?	?	?	?
CPI	+	-	-	?	?	?	?
IR	+	?	+	?	?	?	?
USIPI	0	0	0	+	+	-	-
USCPI	0	0	0	+	-	?	-
USEPU	0	0	0	?	?	+	?
USIR	0	0	0	+	?	0	+

Table 3-1: Identification Scheme

3.2.3 LAG SELECTION

Table 3-2 reports the lag length criteria results. We ran the lag length criteria tests for the data in the VAR part based on 5 different criteria: sequential modified LR test statistic: Final prediction error, Akaike information criterion, Schwarz information criterion, and Hannan-Quinn (HQ) information criterion. We follow the results and applies 2 lags in our estimation as given by Final prediction error, Akaike information criterion, and Hannan-Quinn (HQ) information criterion. Schwarz information criterion selected 1 lag and we will test the robustness of our results using this specification.

Lag	LR	FPE	AIC	SC	HQ
0	NA	12.35566	25.21713	25.38212	25.28417
1	2169.668	3.15E-06	10.0344	**11.51931***	10.63778
2	216.4053	**1.41e-06***	**9.219310***	12.02413	**10.35903***
3	63.17509	2.05E-06	9.577316	13.70206	11.25338
4	76.06572	2.61E-06	9.780928	15.22559	11.99333
5	113.8688	2.24E-06	9.564294	16.32887	12.31304
6	70.23774	2.86E-06	9.713839	17.79833	12.99892
7	73.84428	3.43E-06	9.753943	19.15835	13.57536
8	**87.46435***	3.35E-06	9.535688	20.26001	13.89345

Table 3-2: Results for Lag Selection Criteria
*indicates lag order selected by the criterion.

3.2.4 DATA

We use monthly data from January 2000 to December 2018. The data contains domestic macroeconomics variables for Malaysia and the US.

- Malaysian Variables
    1. Industrial Production Index: Seasonally adjusted, year-on-year growth. Data were taken from various issues of Monthly Statistical Bulletin from Central Bank of Malaysia.
    2. Consumer Price Index: Seasonally adjusted, year-on-year growth. Data were taken from Bank for International Settlements.
    3. Overnight Interbank Rate. No transformation. Data were taken from various issues of Monthly Statistical Bulletin from Central Bank of Malaysia.
- US Variables
    1. Industrial Production Index: Year-on-year growth. Data were taken from Federal Reserve, Bank of St. Louis (FRED) and already been adjusted for seasonality.
    2. Consumer Price Index: Year-on-year growth. Data were taken from Federal Reserve, Bank of St. Louis (FRED) and already been adjusted for seasonality.
    3. 3-Month Treasury Bill: No transformation. Data were taken from Federal Reserve, Bank of St. Louis (FRED)
    4. News - based US Economic Policy Uncertainty Index: Log transformation. Data were taken from http://www.policyuncertainty.com

3.3 RESULTS

In this section, we present the results from our models for each macroeconomic variables of Malaysia. First, we present the impulse response of domestic variables to US economic policy uncertainties shocks. Next, we discuss the variance decompositions of domestic variables explained by all identified shocks. In addition to the conventional VAR variables that we analysed in the main model, we also added indicators for financial stability and economic expectations to see their responses to US EPU shocks. And lastly, we discuss the robustness tests for this study which includes analysis of the sub-sample, changing number of lags, applying alternative identification scheme, employing the full three components of US EPU Index, and relax the restrictions on other shocks (only identify the uncertainty shock).

3.3.1 EFFECTS OF US ECONOMIC POLICY UNCERTAINTY SHOCKS ON DOMESTIC VARIABLES

We start the analysis by looking at the results of the impulse response of domestic variables to 1 standard deviation US economic policy uncertainty shocks (or 0.05 percentage increase in US EPU Index on impact for this main model). GDP growth decreases by 0.1 per cent on impact and decreases further to 0.4 per cent at its maximum response on the 4^{th} month. This negative effect on the GDP growth lasted for 14 months before becoming insignificant. There is no immediate effect on inflation upon the impact, and the response only become significant after 15 months, which reduces the inflation by 0.1 per cent.

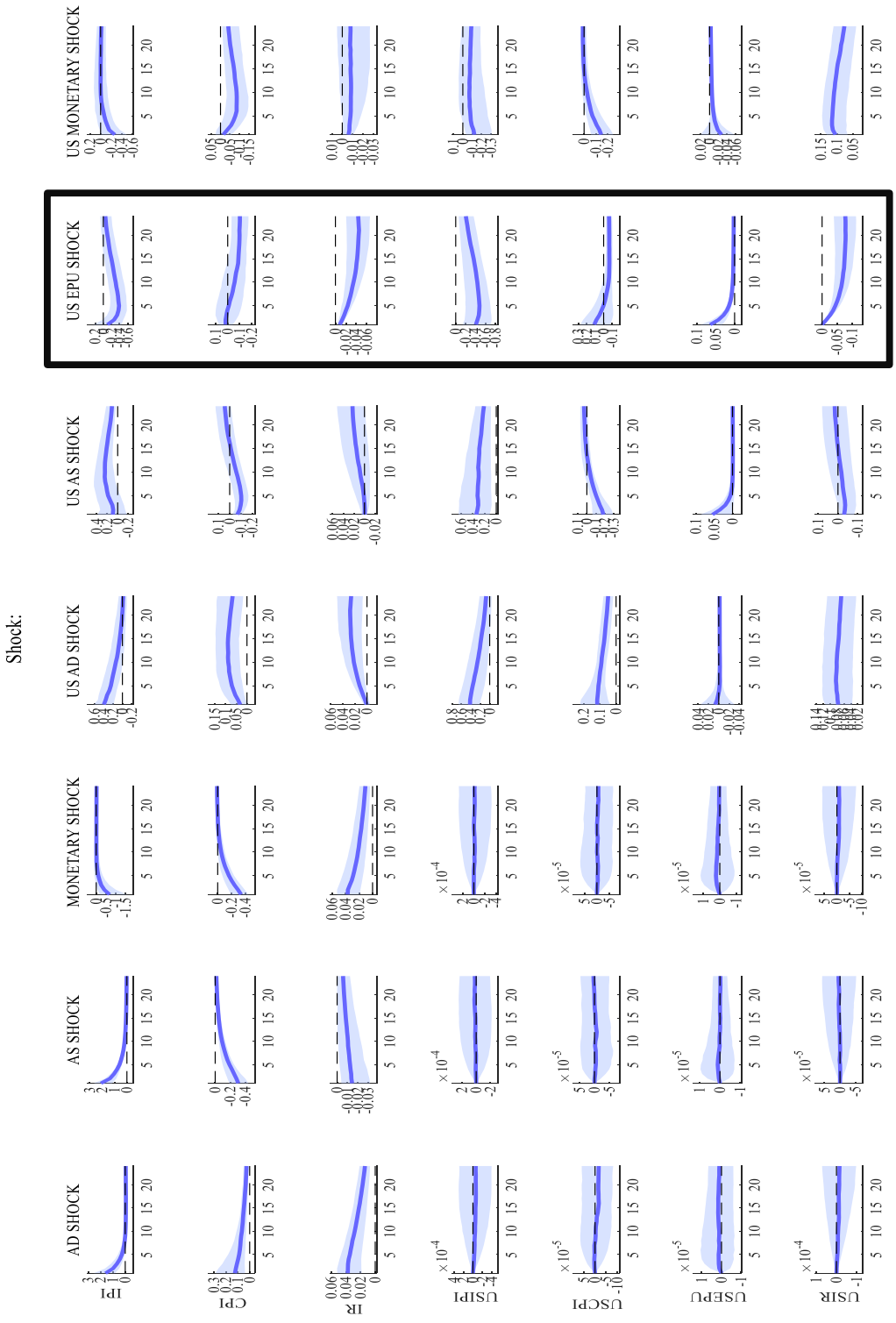

Figure 3-2: Impulse Response Functions of Domestic Variables to All US Shocks (Main Model)

Policy rate responded negatively upon the impact by 1 basis point and continue to decrease throughout the 24 months where it reaches -0.04 basis point. The summary for this subsection is, in response to the positive US EPU shocks, domestic output growth decreases immediately and significant, price level took some time to significantly responding in negative way, and monetary policy responded immediately by lowering the interest rate.

3.3.2 RELATIVE IMPORTANCE OF US ECONOMIC POLICY UNCERTAINTY SHOCKS

From the results of the impulse response function, we are now clear about the signs of the responses of the domestic variables to US EPU shocks. Another question that we need to answer is, how important is the US EPU shocks compared to other external shocks from the US?

To evaluate this relative importance of US EPU shocks compared to other shocks from the US, we compute the forecast error variance decomposition. Figure 3-5 shows the results for the variance decompositions of domestic variables to all identified shocks.

US EPU shocks explained the most forecast variance of Malaysia's output growth after 24 months horizon compared to other shocks from the US. EPU shocks contribute 9 per cent out of 22 per cent forecast variance of domestic IPI growth explained by all shocks from US at the end of the 24^{th} month. Initially, for the first three months, the role of US EPU shock is almost insignificant, and US aggregate demand shock is dominating the contribution to overall US shocks. But after the third

month, we could see the increasing role of US EPU shocks in explaining the forecast variance of output growth. The contribution from US aggregate demand and supply shocks are almost similar in size at the end of the 24th month. And, the contribution of US monetary policy shocks is minimal to the forecast variance of output growth in Malaysia.

41 per cent of the forecast variance of domestic inflation is explained by cumulated US shocks after 2 years. 14 per cent of it is explained by EPU shocks, 10 per cent by aggregate supply shock, 10 per cent by aggregate demand shock, and the rest by monetary shocks. We see the same pattern of increasing role of US EPU shocks in explaining domestic variable over time. US monetary shocks and US aggregate demand and supply shocks also show the same pattern of increasing contribution to the forecast variance of domestic inflation throughout the 24 months.

Lastly, the forecast variance of short-term interest rate in Malaysia is mostly explained by US EPU shocks after 2 years. Out of 48 per cent variation explained by all US shocks, 36 per cent is from US EPU shocks.

Overall, comparing US EPU shocks to other shocks from the US, US EPU shocks play more significant role than the rest in explaining forecast variance of domestic variables. We could also establish that EPU shock originated from US plays substantial role in affecting Malaysian economy in the long run, especially for domestic inflation and interest rate. Thus, Malaysian government should pay extra attention to the movement of US EPU due to its relative importance.

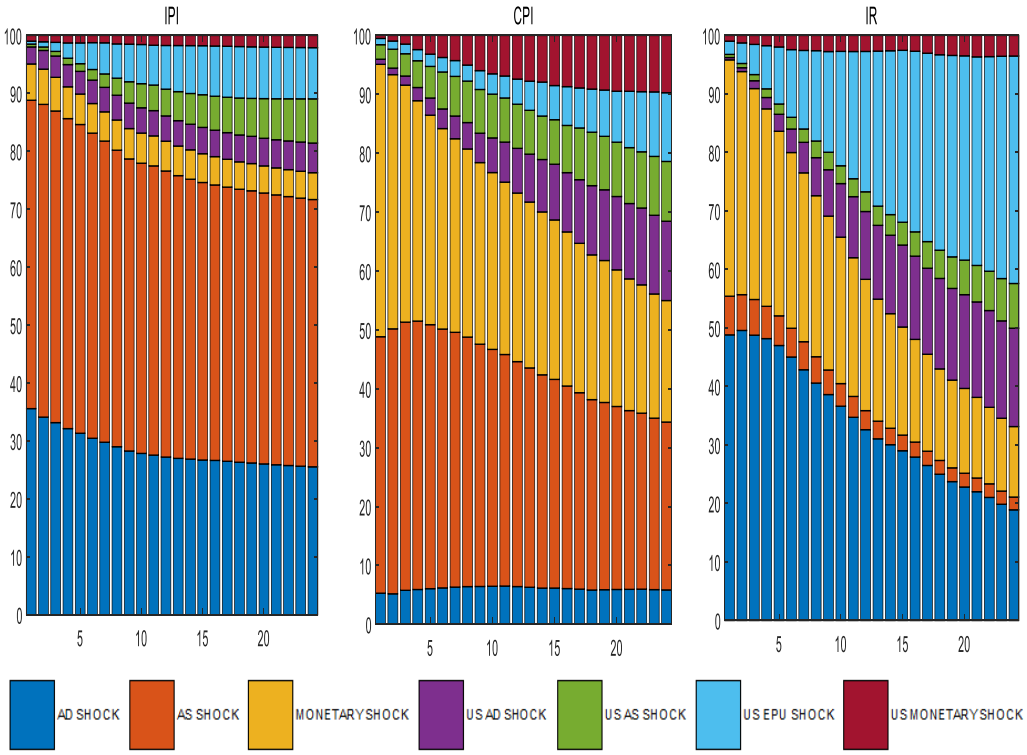

Figure 3-3: Forecast Error Variance Decompositions of Domestic Variables (Main Model)

3.3.3 FINANCIAL STABILITY

In addition to the standard macroeconomic variables that we examined in the base model; we also aim to see if economic policy uncertainty originated from the US could affect the financial stability in Malaysia.

We utilise the Financial Stress Index to proxy financial stability in Malaysia. The data is taken from Asian Development Bank. Several studies have attempted to manually measure and study its impacts on the Malaysian economy such as Tng (2015), and Abdullah et al. (2017). Although there are some minor differences in methodology, the conclusion for these studies are almost similar; increasing Financial Stress Index is associated with negative impact on output growth.

The components of this index are; stress in the banking sector, stock market return, volatility in equity market, stress in debt markets, and exchange rate market pressure[11]. We plot the Financial Stress Index against Industrial Production growth in Figure 3-6.

There is an almost clear inverse relationship between these two, especially during crises. In 2001 crisis, Financial Stress Index was high and accompanied by negative output growth. Same interaction occurred in the recent financial crisis; high financial stress index, negative output growth. During the period when the stress index is low and less volatile (e.g., September 2002-July 2004), the output growth was high.

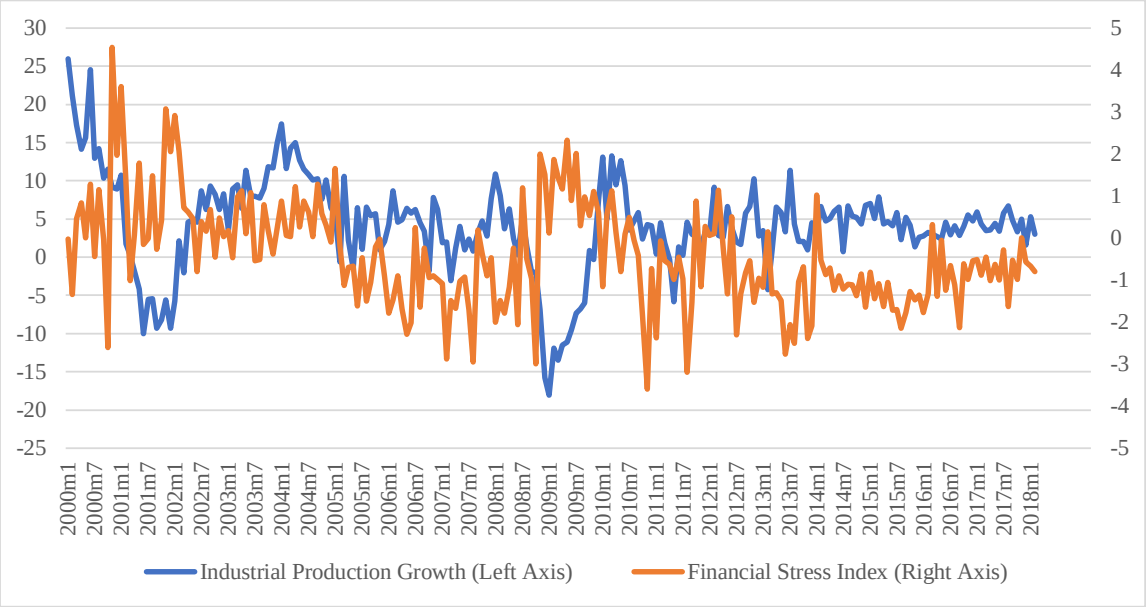

Figure 3-4: Financial Stress Index and Industrial Production Growth

We plot the Financial Stress Index against US EPU in Figure 3-7. The trend is visually apparent, especially before and during the recent financial crisis. Even after the crisis, when there are spikes on the US EPU, it will usually be followed by Financial Stress in Malaysia with few months lag (e.g., August 2011 in US EPU and

[11] Details on Financial Stress calculation is available at https://aric.adb.org/database/fsi

October 2011 in Malaysian Financial Stress, October 2013 in US EPU and January 2014 in Malaysian Financial Stress). To simply make a conclusion just based on this visual inspection would be insufficient. Thus, we use our VAR model to test the relationship.

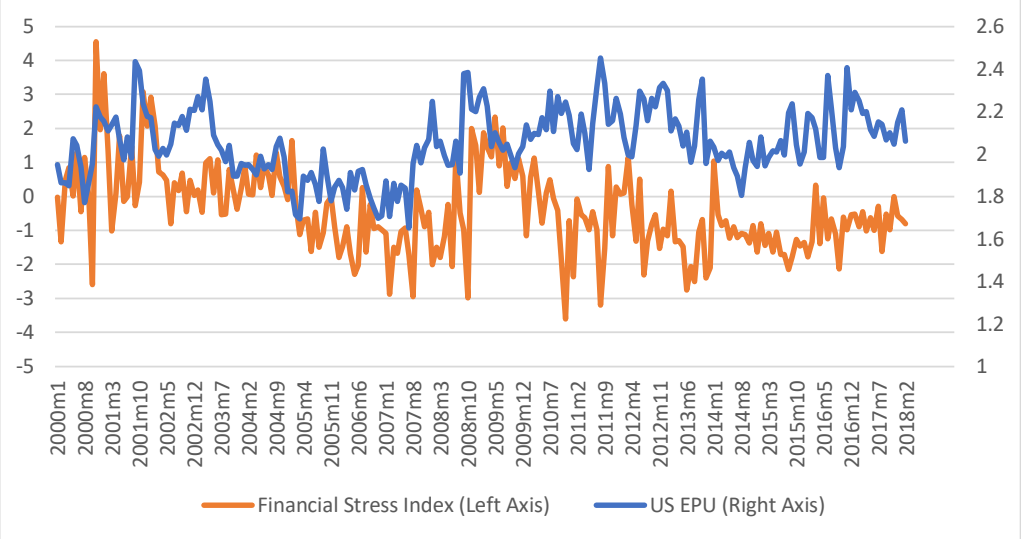

Figure 3-5: Financial Stress Index and US EPU

We include this variable in our VAR and assume some restrictions to uncover the shock. Adverse Financial stress shock is assumed to be increasing itself, lowering the output, and zero contemporaneous effect on monetary policy, as policymakers usually only notice the effect from this shock, to be translated to price changes, before responding. Figure 3-7 shows the impulse response for this model. We frame the individual impulse response function of interest on this figure, which is the response of Financial Stress Index to US EPU shocks

1 standard deviation US EPU shocks (or US EPU shocks that increases US EPU Index by 0.06% on impact in this model) have no contemporaneous impact on domestic Financial Stress Index. But entering the first month after the shock, Financial Stress Index responded positively by 0.05 per cent change. The positive response increases

by double after 3 months to 0.1 per cent increase in Financial Stress Index. The positive response lasts throughout the 24 months horizon. This answers the question of how US EPU shocks affect financial stability in Malaysia; negative (increasing the financial stress), significant and long-lasting.

The impulse response results for financial stress model also confirms the findings from the literature on Financial Stress Index in Malaysia. Increase in financial stress lowers output, and as reported in Tng (2015), tend to reduce policy rate, suggesting the need for expansionary monetary policy to help counterbalance the contractionary effects of adverse financial shocks on the economy.

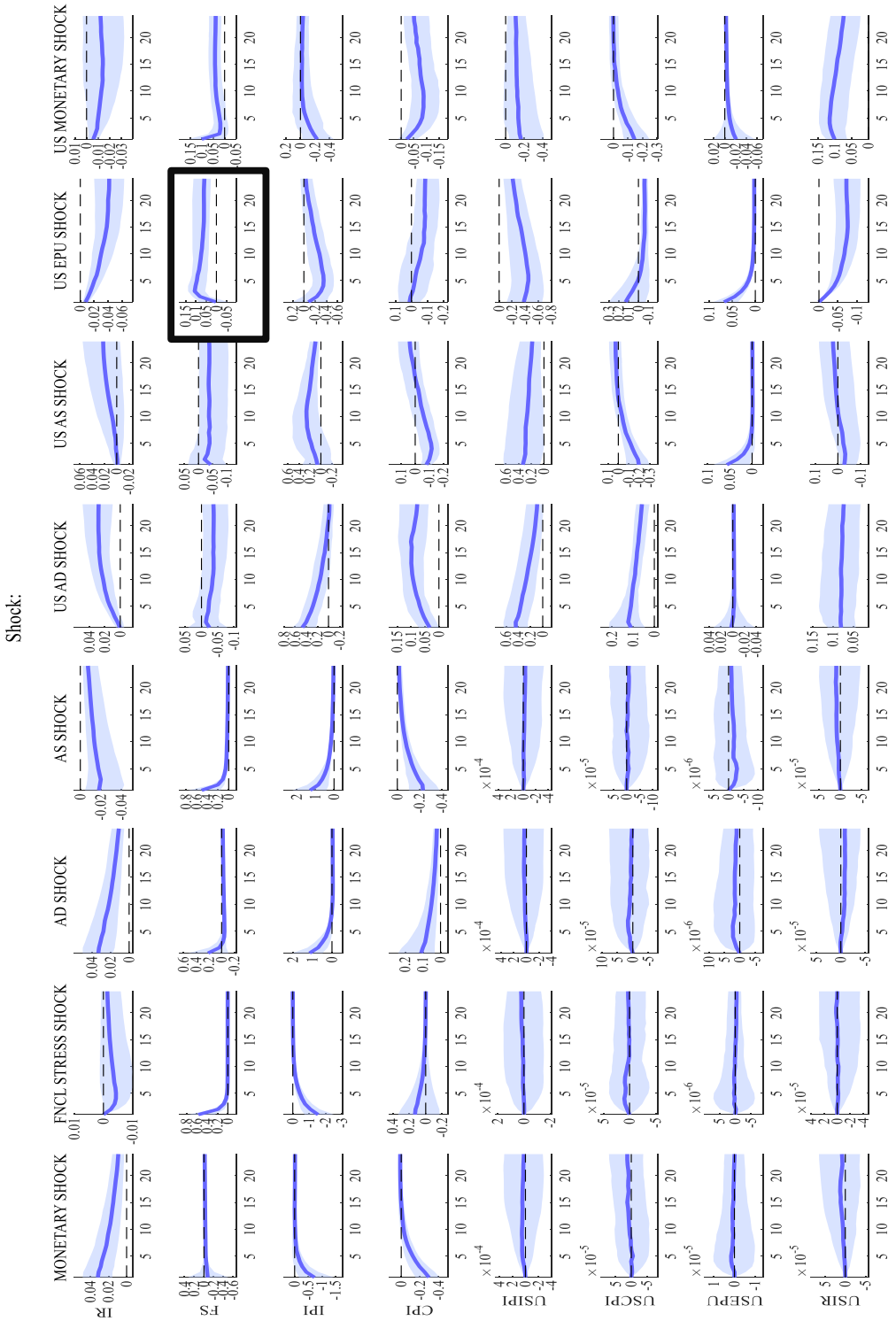

Figure 3-6: Impulse Response Functions of Domestic Variables to All US Shocks (Financial Stability Model)

Results from variance decompositions of the Financial Stress Index shows that after 24 months, the most significant fraction of forecast variance explained by US shocks is contributed by US EPU shocks. This signifies an important transmission of adverse effect from US EPU shocks to financial stability in Malaysia.

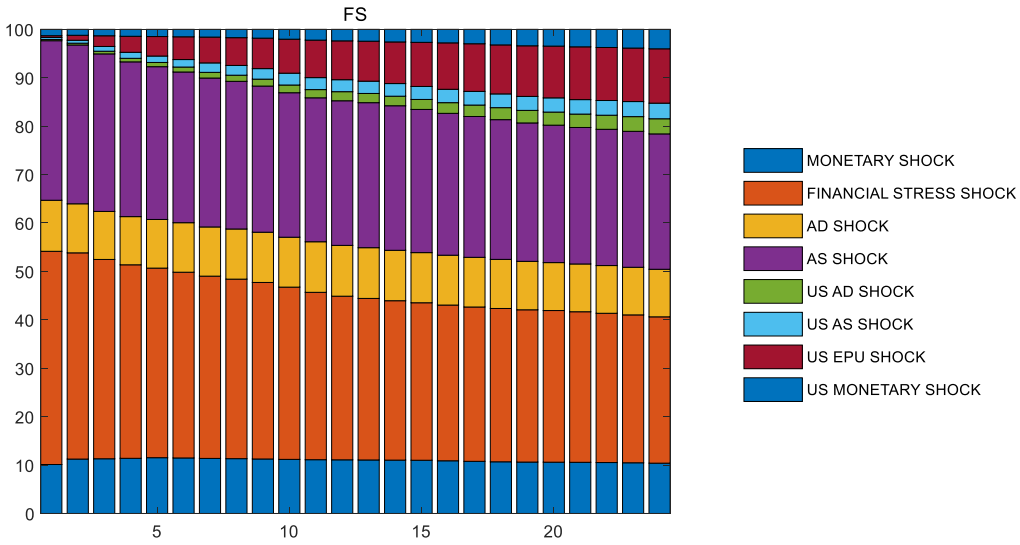

Figure 3-7: Forecast Error Variance Decompositions of Financial Stress Index (Financial Stability Model)

3.3.4 LEADING INDICATOR

Next, we aim to examine whether US EPU shock has any effects on the forward-looking economic indicator of Malaysia. Department of Statistics Malaysia produces Leading Index on monthly basis as an indicator for the forward-looking of the economic condition of Malaysia, specifically, to monitor the Malaysian economic direction in an average of four to six months ahead.

We plot the Log of Leading Index with the growth of Industrial Production in Figure 3-9. Just prior to the recent crisis, the Leading Index went down first before IPI growth, and during the crisis, Leading Index went upward first before the IPI growth to recover. This is also true during the recovery of 2001 crisis where Leading Index

went up first before the IPI growth. Given the predictive behaviour from visual inspection, it is interesting to see if this indicator could be affected by uncertainty shocks originated from US.

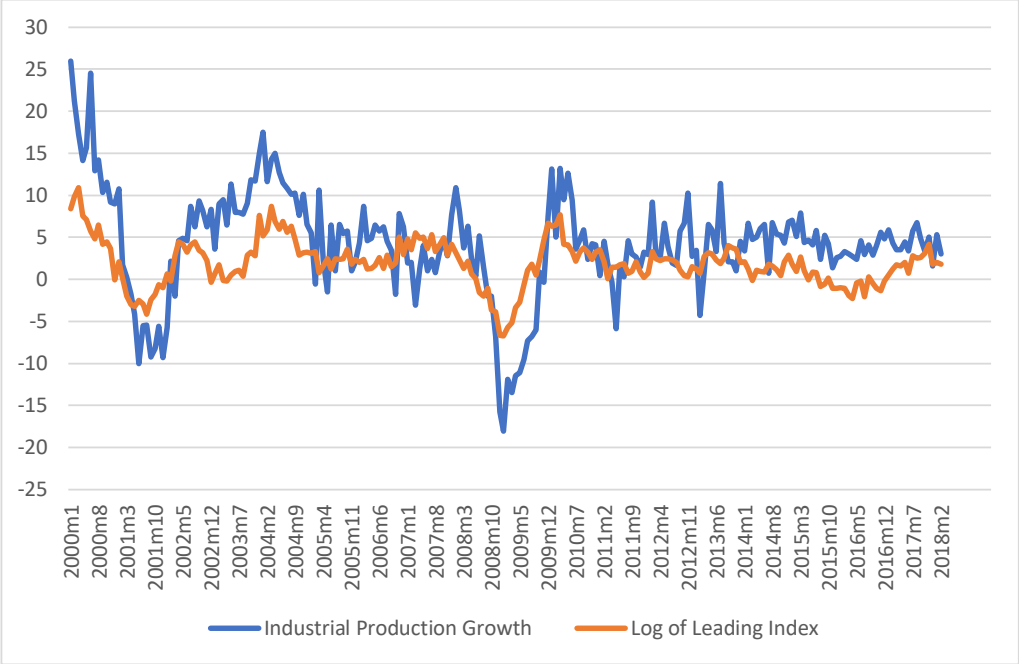

Figure 3-8: Log of Leading Index and Industrial Production Growth

We also plot the Leading Index against the US EPU. There are few episodes of a clear inverse relationship between US EPU and Leading Index that are noticeable by visual inspection, especially during the Global Financial Crisis. Following the exercise from the previous section, we also include this variable into our VAR as visual inspection alone is not enough to establish a conclusion.

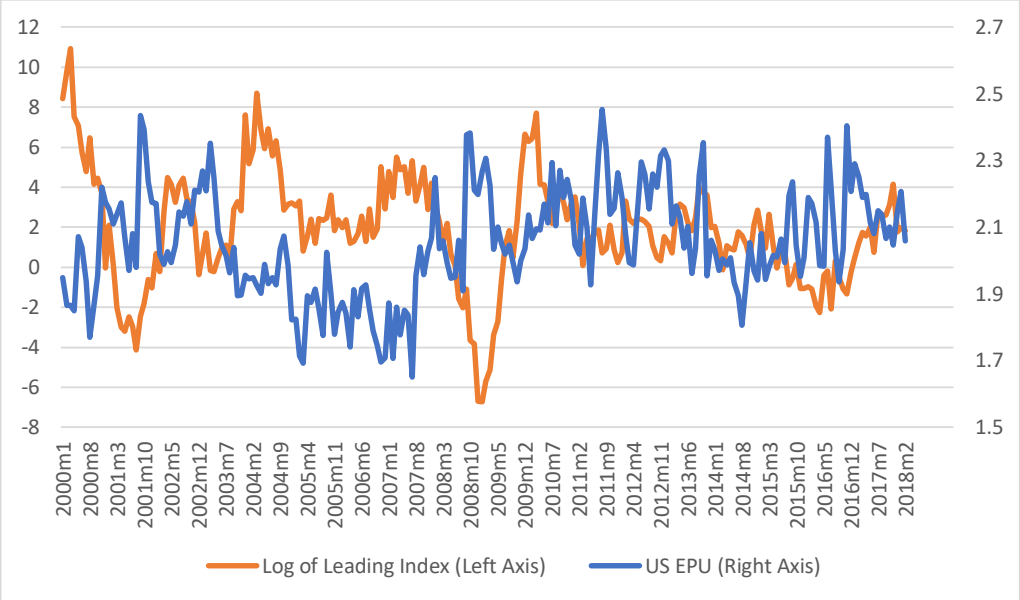

Figure 3-9: Log of Leading Index and US EPU

We replace the Financial Stress Indicator with the log of Leading Index and not putting any sign restrictions for this additional shock. We leave it to be unidentified as we found no credible reference or assumption, for the sign or zero restrictions on this additional variable, to propose a credible shock. Nevertheless, our focus is to examine the effect of US EPU shocks on this additional variable (Leading Index), thus, not putting any additional restrictions for this new shock should not impair the results.

The framed graph in Figure 3-10 is the one that we are interested in. It shows that 1 standard deviation US EPU shock decreases Leading Index in Malaysia by 0.1 per cent on impact, and the response lasts for about 6 months. This result shows us that adverse US EPU shocks will decrease the forward-looking expectation of economic performance in Malaysia.

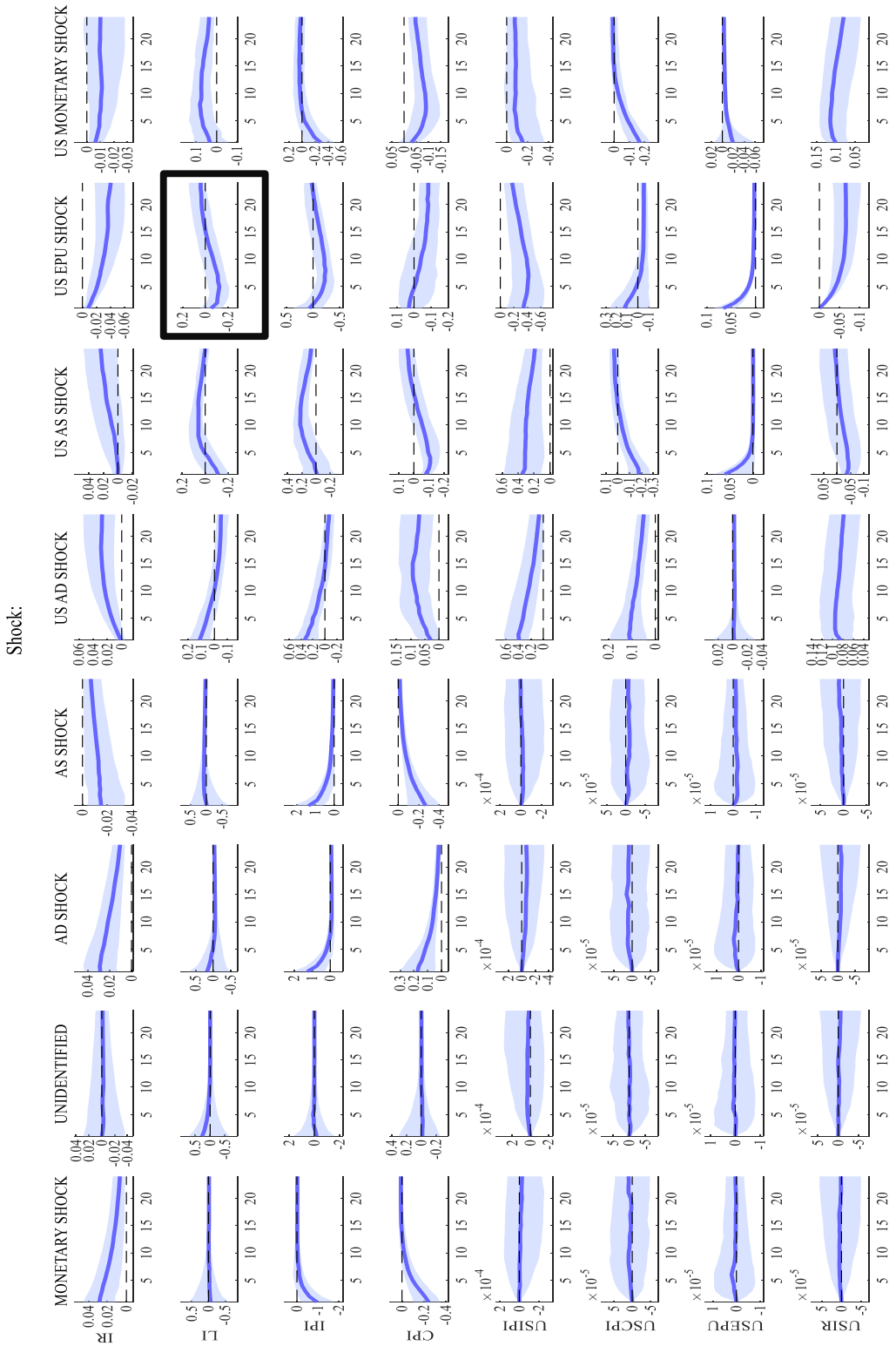

Figure 3-10: Impulse Response Functions of Domestic Variables to All US Shocks (Leading Index Model)

Among all the shocks originated from the US, US EPU shocks contributed the most substantial fraction of forecast variance of Leading Index, although, collectively, they only account for 21% at the end of year 2.

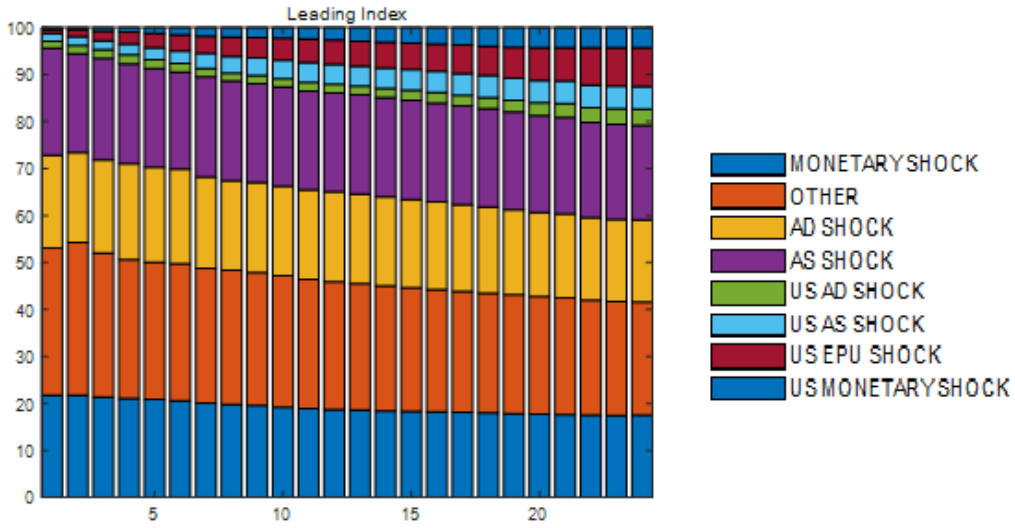

Figure 3-11: Forecast Error Variance Decompositions of Leading Index (Leading Index Model)

3.3.5 ROBUSTNESS

We check the robustness of our results by running few sensitivity checks. We first check the results of the main model by using 1 lag in the VAR as suggested by SC in the lag length criteria. The results are reported in Appendix 3-A and they are robust to our main results.

Then, we tried using only partial identification to identify US EPU shock while we set other external shocks to be unidentified and we also try to set all the domestic shocks to be unidentified. All sign and zero restrictions for the foreign variables, and zero restrictions on domestic variables will remain the same as in main model. We report the results in Appendix 3-B for the first specification and Appendix 3-C for the second specification. The results of our main model are robust against these adjustments as well.

To ensure that our results are not biased to the identification scheme selected, we change the identification technique to Cholesky Decomposition. We order the variables as follow: {USIPI, USCPI, USIR, USEPU, IPI, CPI, IR} following the order of the variables from Stockhammar and Osterholm (2017). We still imposed the block exogeneity restrictions on the VAR parameters here. The results are reported in Appendix 3-D. Response of CPI is negative and long lasting. This is quite different than the one we obtained in our main model, where the response is insignificant on the CPI. Monetary policy rate response is the same as in baseline model. The negative response of IPI growth on the other hand, only significant from the 2nd until 6th month after the impact of US EPU shocks.

Finally, we replace the news based EPU index with the Three Components EPU Index instead news based that we used in the main model and report the results in Appendix 3-E. The three components EPU index consists of news-based EPU, Tax code expiration, and economic forecaster disagreement[12]. We found that our main results survived these robustness test as well.

[12] Refer to Baker et al. (2016) for more detail.

3.4 CONCLUSIONS

In this chapter, we employ a Bayesian SVAR with block exogeneity to study the impact of external shocks from the US on the Malaysian economy. Unlike previous studies of external shocks in Malaysia, we utilise Economic Policy Uncertainty Index developed by Baker et al. (2016) to study the effect of US economic policy uncertainty shocks on Malaysian economy. We identified 3 domestic and 4 US economic shocks by applying sign and zero restrictions by Arias et al. (2014) in our main model.

From the impulse response analysis, we found that Industrial Production growth respond negatively to US economic policy uncertainty shocks and lasts for 1 year and a half. The response of domestic inflation to US EPU shock is negative but not significant. Lastly, response of monetary policy rate to external EPU shock is negative, significant, and long-lasting. These findings suggest that economic policy uncertainty shocks originated from US do affect Malaysian economy negatively. Our results from forecast error variance decompositions, in general, suggest that US EPU shock is substantially important in relative to other shocks originated from US.

Lastly, additional exercises of adding Financial Stress Index and Leading Index for Malaysia further shows that US EPU shocks harming financial stability and lower the expectations of future economic performance of Malaysia.

These findings are beneficial for the policymakers in Malaysia to be aware of the US economic policy uncertainty and to formulate countermeasures in the case of high uncertainty as it is evidenced in this chapter that the effect is substantially important in affecting Malaysian economy.

3.5 APPENDIX FOR CHAPTER 3

3.5.1 APPENDIX 3-A: MAIN MODEL WITH 1 LAG

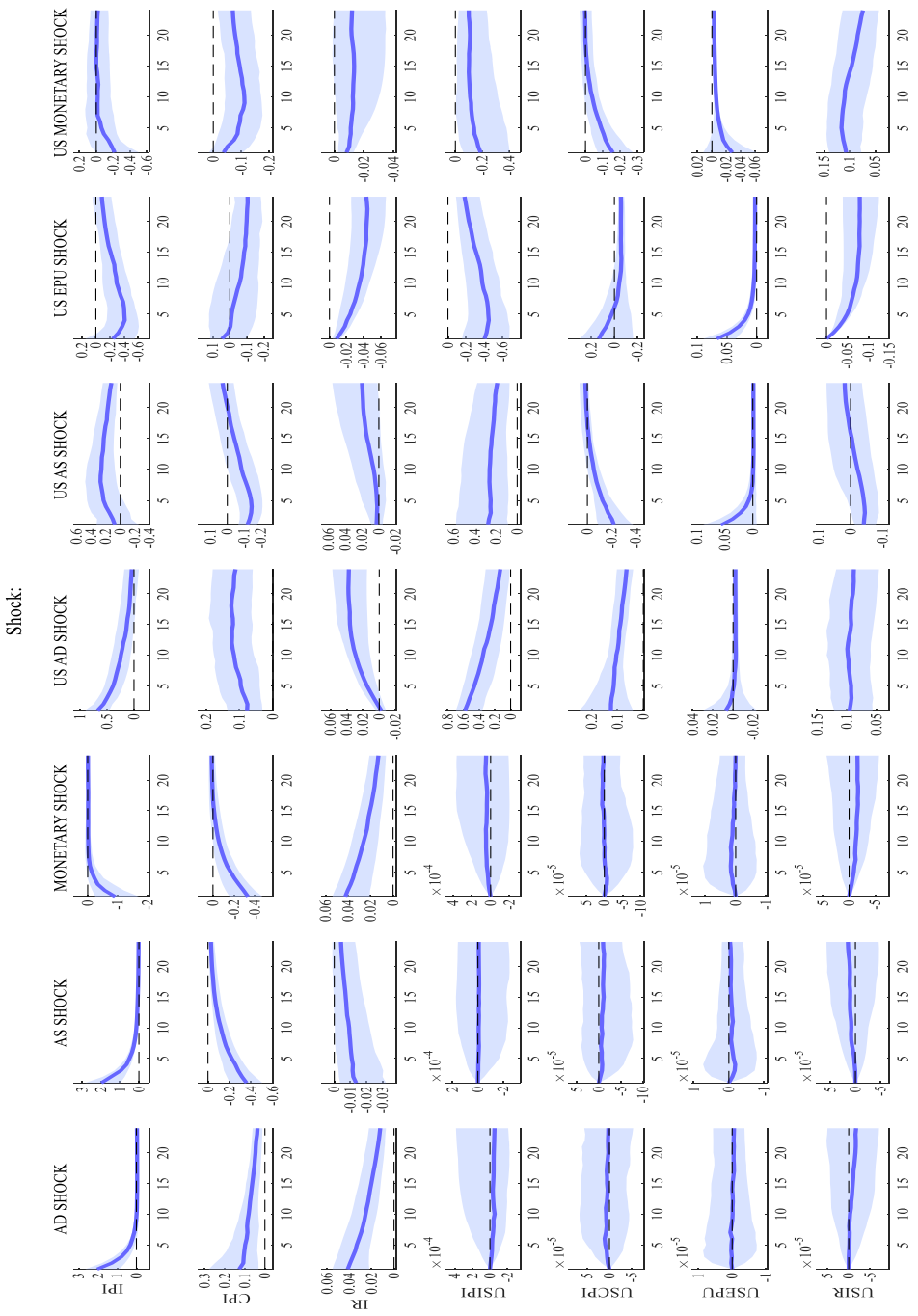

Figure 3-12: Impulse Response Functions of Domestic Variables to All US Shocks (Main Model, 1 Lag)

3.5.2 APPENDIX 3-B: PARTIAL IDENTIFICATION OF EPU SHOCK (US SHOCKS UNIDENTIFIED, DOMESTIC SHOCKS IDENTIFIED)

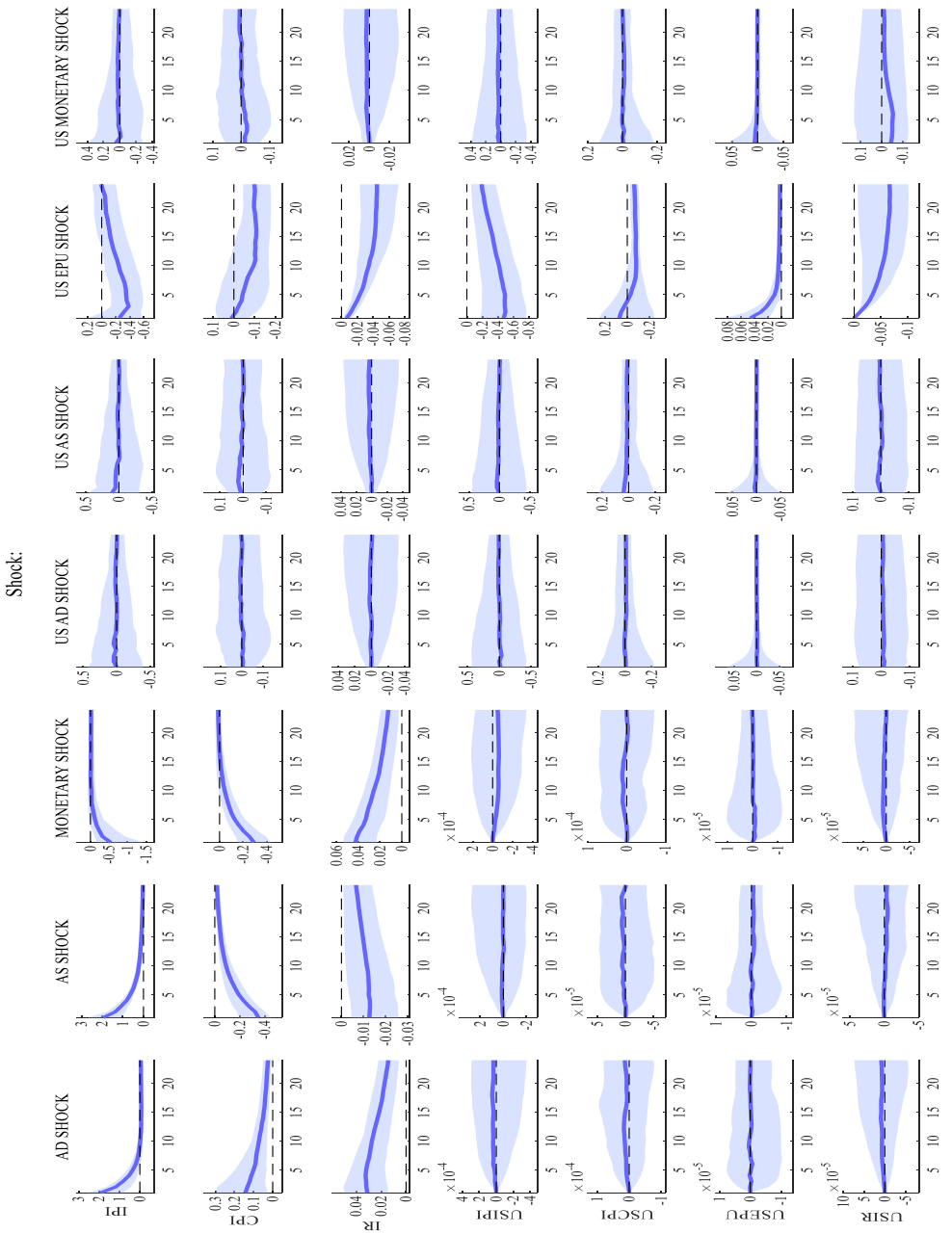

Figure 3-13: Impulse Response Functions of Domestic Variables to All US Shocks (US Shocks Unidentified, Domestic Shocks Identified)

3.5.3 APPENDIX 3-C: PARTIAL IDENTIFICATION OF EPU SHOCK (US AND DOMESTIC SHOCKS UNIDENTIFIED)

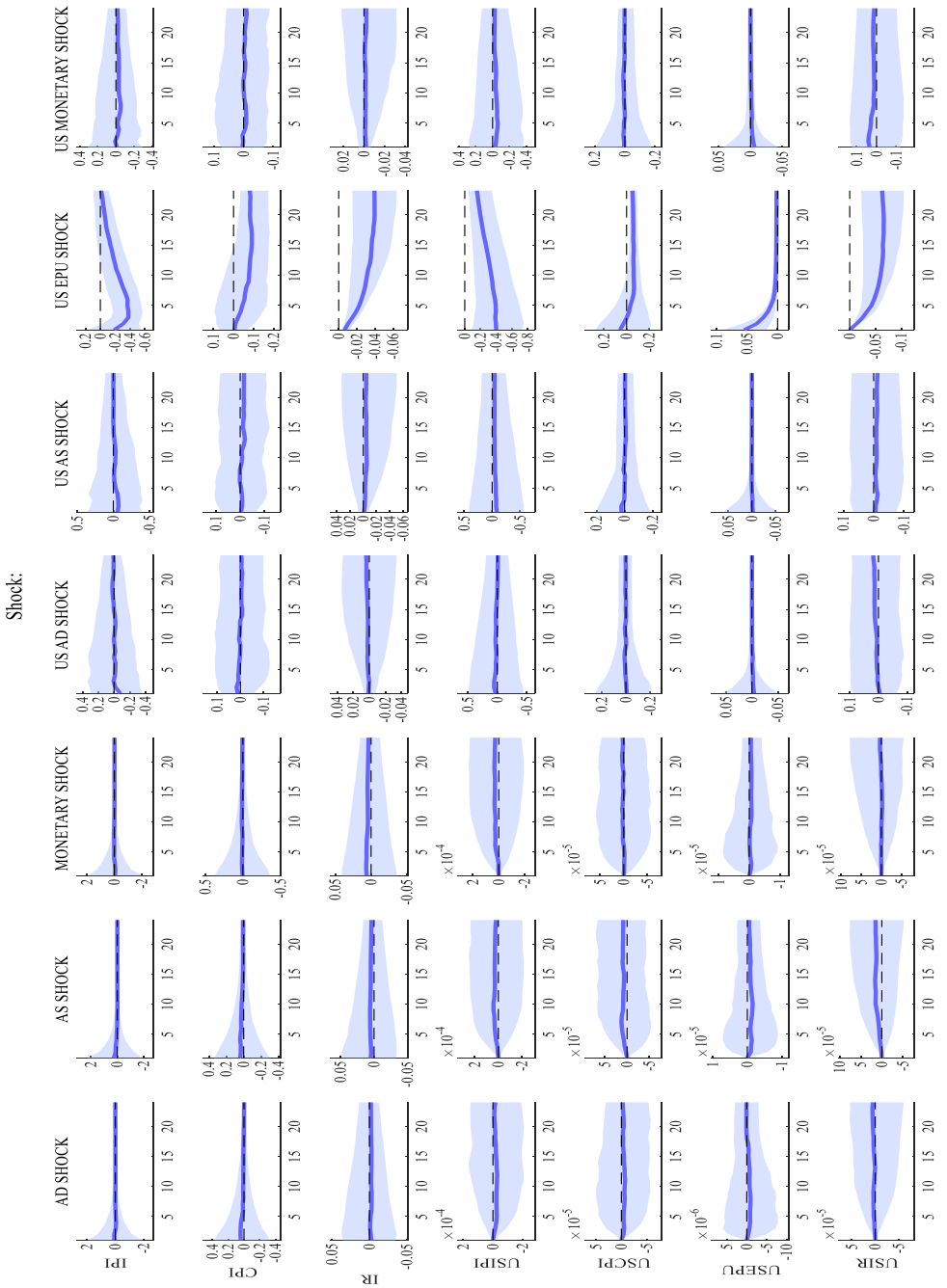

Figure 3-14: Impulse Response Functions of Domestic Variables to All US Shocks (US and Domestic Shocks Unidentified)

3.5.4 APPENDIX 3-D: CHOLESKY DECOMPOSITION

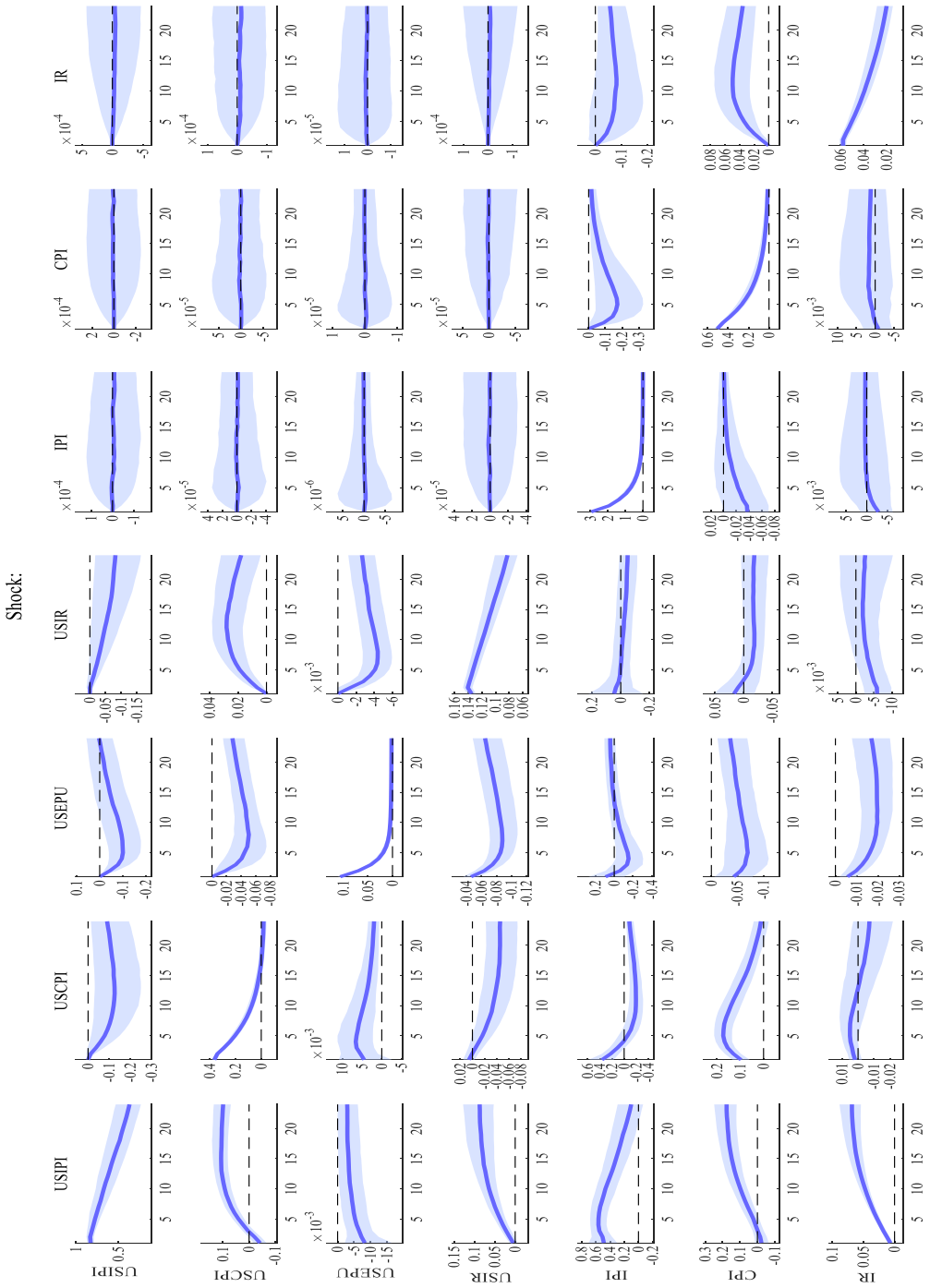

Figure 3-15: Impulse Response Functions of Domestic Variables to All US Shocks (Recursive Identification)

3.5.5 APPENDIX 3-E: THREE COMPONENTS US EPU

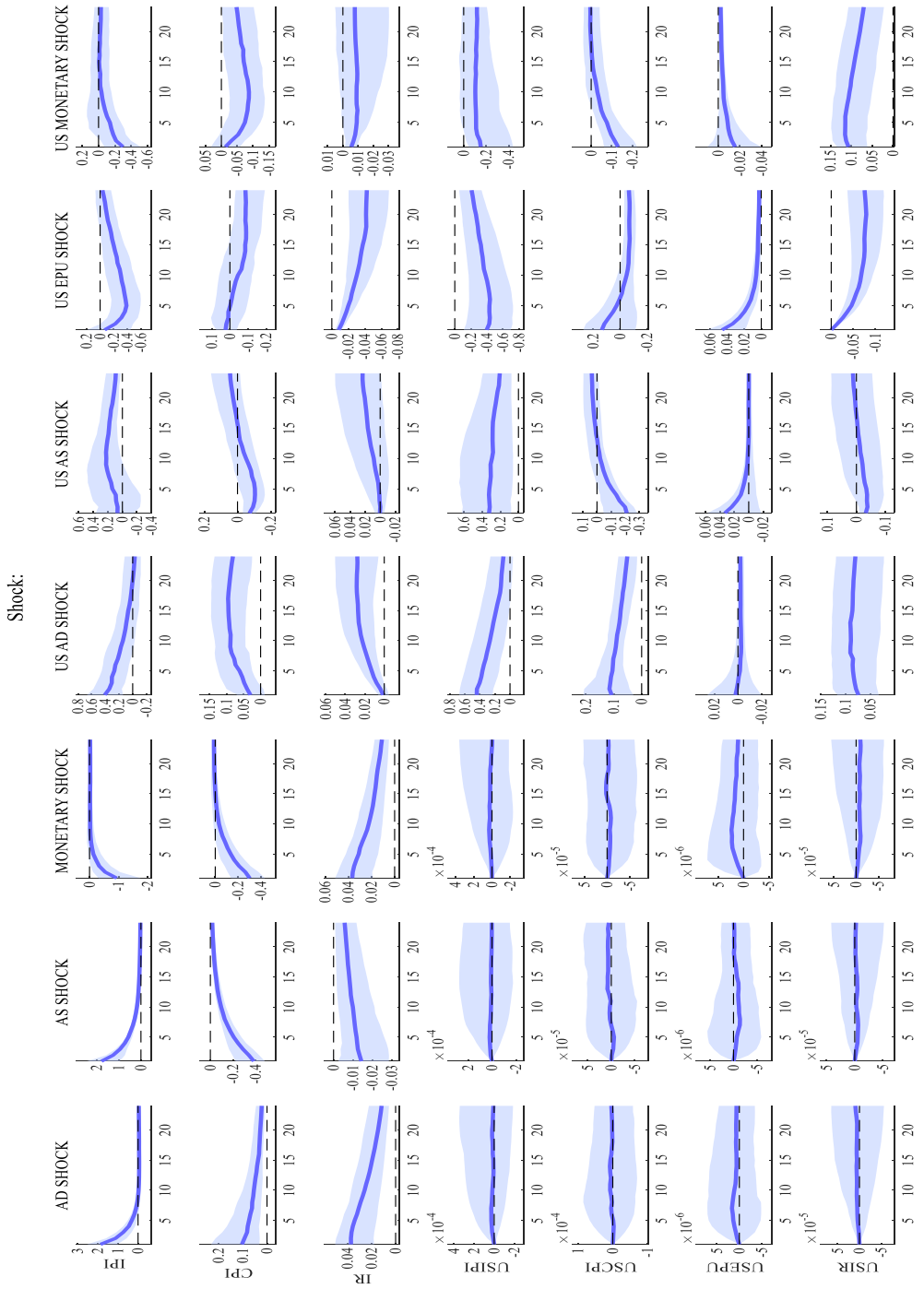

Figure 3-16: Impulse Response Functions of Domestic Variables to All US Shocks (Three Components US EPU)

DIRECTION FOR FUTURE RESEARCH

In chapter one, we have utilised the data-rich methodology namely FAVAR to study the monetary policy shocks across sectors. The results are in accordance with economics theories except for exchange rate puzzle that presents in the main model. Adding 1 additional US variable, which is US interest rate, eliminating the puzzle. This signifies the importance of foreign variables in modelling Malaysian macroeconomics. Further analysis could incorporate more foreign variables into an open economy FAVAR as in Mumtaz and Surico (2009) and utilising sign restrictions for the shock's identifications.

Recent advancement in macro-econometrics has seen the rise of the time-varying approach in estimating VAR. Given the massive changes in the economic structure around the globe for the past few decades, this approach is very interesting to apply. Given the short data availability in or analysis for chapter 2 and 3, we could not apply this methodology. But perhaps, in the future, where the data availability is longer, one could apply this approach to revalidate the results.

In the third chapter, we only focus on US EPU shock in influencing Malaysian economy. As Malaysia is closely linked to other members of ASEAN and benefitting from its free trade agreement, it will be interesting to incorporate this regional factor into the model as well and compare the relative importance between US factors and regional factors.

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