MONETARY POLICY AND STOCK RETURNS:

THE CASE OF VIETNAM

A Dissertation
Submitted to the Faculty of the National Graduate Institute for Policy Studies (GRIPS)
in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY IN INTERNATIONAL ECONOMICS

Nguyen Hoang Lan

September, 2015

National Graduate Institute for Policy Studies

Tokyo, Japan

[This page is intentionally left blank]

To My Beloved Ones

[This page is intentionally left blank]

Acknowledgement

It is truly a wonderful moment for me to write this thank you note to many people who supported me along this long journey.

First, I would like to express my sincere gratitude to my advisor, Professor Roberto Leon Gonzalez for his valuable advices, great patience, kindest consideration and immense knowledge. I would not have gone so far without his continuous support and guidance. I am and will forever be grateful. I am also thankful to the members of the Dissertation Committee, Professor Tetsushi Sonobe, Professor Minchung Hsu, Professor Ippei Fujiwara and Professor Ponpoje Porapakkarm for their insightful comments and helpful suggestions. I would also like to thank other members of the faculty who worked to convey some of the most important knowledge of economics to me. I am indebted to GRIPS for their generous fellowship and financial support. My thanks also go to my dearest friends at GRIPS: Be Ngoc Quyen, Yao Ying, Krist Dacharux, Le Thu Trang, Meng Xiangcai, Long Trinh, Le Thu Hang and many others who share all ups and downs throughout my years at graduate school.

I wish to thank my beloved parents for giving me a life filled with dreams, unconditional love and spirit encouragement. I am also thankful to have become the mother of my two adorable sons who have become the force behind my drive to fulfill my dream.

Finally, I would like to thank my precious life partner, Nguyen Xuan Giap, for staying with me for better or for worse, in sickness or in health, and for believing in me more than anyone else.

[This page is intentionally left blank]

Executive Summary

The dissertation aims to study the links between monetary policy, equity prices and real economy in Vietnam. We propose two research questions: 1) Does monetary policy in Vietnam drive financial market performance and other real variables? and 2) Does Vietnamese central bankers take financial market conditions into account in the process of policy decision making? And if yes, to what extend?

This unpreceded study is timely and important for two reasons. First, the monetary transmission mechanism in Vietnam, especially the asset price channel and the wealth effect, has rarely been evaluated quantitatively. A quantitative study of the significance, timing and effect of policy instrument will benefit the Vietnamese policy makers in formulating and implementing monetary policy. Second, recent turbulence in financial sector requires the government to confront with financial market's fluctuations and to regain domestic and foreign investors' confidence through means of monetary policy.

This dissertation starts with a brief overview of monetary policy system in Vietnam (Chapter 1). In Chapter 2, using a Vector AutoRegressions (VARs) approach, we study how stock returns data responds to monetary policy shocks. The study presents evidence that orthogonal shocks in money supply exert a significant effect on stock returns (at a 10% significance level). We also categorize firms into four quartiles and nine industries and find that monetary shocks exert strongest impacts on small firms and the impacts lessen as firm size grows. Financial firms are found to respond faster and stronger to changes in policy than their counter parts in other industries such as Technology, Materials and Consumer

Goods. In chapter 4, we introduce a New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model by Nistico (2012) and let stock returns, as proxy for the Vietnam financial market, enter the aggregate consumption and output. We estimate the model with Vietnam quarterly data from 2001Q2 to 2011Q4 with Bayesian techniques in DYNARE and find a weak linkage between asset price and household consumption pattern. Furthermore, we find a significant and negative reaction of financial performance to an unexpected monetary policy tightening. There is also evidence that the State Bank of Vietnam is adjusting short term interest rate in response to volatility in the stock market. It is important to remain cautious while dealing with the Vietnam case due to high volatility and uncertainty associating with its financial market.

Table of Contents

List of tables and figures

[This page is intentionally left blank]

Chapter 1 : INTRODUCTION

Objectives

In the literature of monetary economics, monetary policy influences the macro economy through real variables such as output, employment and inflation. Monetary policy, similarly, affects financial markets but in a more immediate and direct manner.

Financial economists therefore may want to respond to stock market volatility before other source of macroeconomic instability. They have long been including financial market and asset prices as parts of monetary policy transmission mechanism, along with traditional channels such as “the interest rate channel”, “the exchange rate channel” and “the credit channel” (Mishkin, 1996). Economic theory points out that monetary policy can impact stock prices in many ways. Monetary tightening slowdown economic activities and have an impact on companies’ future earnings. The presumed increase in interest rate affects the discounted stream of future dividends and thus expected stock return. Higher interest rate also discourages households from investing in equities, and thus decreases shares demand and prices. Economic theory indicates that contractionary (expansionary) monetary policy is associated with lower (higher) stock returns.

It is important for policy maker to understand and quantify the links between monetary policy changes and financial market performance. This dissertation contributes to the discussion by studying the monetary policy transmission mechanism in Vietnam. In particular, we explore whether monetary policy can have an impact on equity prices and

real variables and whether monetary policy reacts to changes in the stock market, in inflation or in output growth.

Vietnam is an interesting and worthwhile case to study for two reasons. First, it is an emerging economy in which financial market is growing fast and inflation is persistently high. Inflation in Vietnam from 1991 to 2010 averaged 13.7% and more recently, averaged 11.5% from 2005 to 2010. Financial market experienced high growth in 2006-2007 but tumbled quickly and lost two thirds of its value in 2007-2009. The State Bank of Vietnam is now asked to response to this situation through its set of policy instruments to stabilize macro economy as well as financial market. Second, the role of stock market is expanding in Vietnam. By the end of 2008, Ho Chi Minh Securities Trading Center and Hanoi Securities Trading Center had a combined market capitalization of approximately 9.59 billion US dollars, or 10.5% of GDP of Vietnam. It increased quickly to 17.6% in 2010 and 21.1 in 2012 (World Bank). There were more than 300 companies listed on the Ho Chi Minh Stock Exchange as of 2012 and 730,000 trading accounts with 102 securities companies. Given the growing share of the financial market in GDP, policy makers may wish to moderate its development and to comprehend the mechanism by which monetary policy is transmitted into the financial market.

Main Findings

Using the macroeconomic data collected from the International Monetary Fund's International Financial Statistics and the Bloomberg database, we analyze the link between

monetary policy and equity returns in Vietnam with a Vector AutoRegressions (VARs) approach in chapter 3 and a DSGE framework in chapter 4.

In Chapter 3, we assess the impact of monetary shocks on Vietnamese financial market with the use of Vector AutoRegressions (VARs) during the period of July 2001 – Dec 2011. A Cholesky decomposition of the variance-covariance matrix of the residuals is performed in VARs in which stock returns is ordered last in the ordering, after slow moving variables, i.e. GDP, inflation, and the monetary policy instrument. The ordering of the variables implies that GDP affects all other endogenous variables in the model contemporaneously, inflation does not impact GDP contemporaneously but does impact the monetary policy instrument and stock returns. The policy instrument affects only stock return contemporaneously. Stock return does not have a contemporaneous impact on other variables but is affected contemporaneously by all other variables in the model. The impulse response suggests that the key drivers of the stock market are shocks generated from within the financial sector and money supply. We also find out that monetary shocks exert strongest impacts on small firms and the impacts lessen as firm size grows. Financial firms are found to respond faster and stronger to changes in policy than their counter parts in other industries such as Technology, Materials and Consumer Goods.

In Chapter 4, we estimate Nistico (2012)'s DSGE model with Vietnam data following the estimation strategy proposed by Castelnouvo (2013). To our knowledge, this is the first contribution to estimating a structural DSGE model with financial market condition, i.e. stock returns, for the Vietnam economy. We fit the model to Vietnam data

from 2001Q2 to 2011Q4 with Bayesian techniques in DYNARE. As an empirical proxy for Vietnam financial market condition, we employ stock returns which is the most readily available data in Vietnam that intuitively connects financial market with household's wealth and consumption decision. The empirical results point out that monetary policy shocks drive fluctuations in the financial market, so do non-fundamental shocks, preference shocks and inflation shocks. We also find that monetary tightening is effective in curbing inflation and moderate financial market and output growth. Our results reveal that the asset price channel, via stock returns and wealth effect, is weak in Vietnam. Positive shocks to the financial market do not significantly improve aggregate consumption or output gap. This means that the possibilities of influencing household behavior in Vietnam via monetary policy are limited, probably due to 1) high risk associating with a volatile financial market and 2) limited financial holdings.

Organization of the dissertation

Chapter 2 gives a background on Monetary Policy in Vietnam and the development of the stock market. Chapter 3, entitled "VAR analysis of monetary policy and stock market returns in Vietnam", investigates the linkage using a VAR approach. Chapter 4, entitled "A Bayesian estimation of a DSGE model with stock returns for Vietnam" analyzes the linkage in a microfounded DSGE framework. Chapter 5 concludes.

Chapter 2 : MONETARY POLICY IN VIETNAM

In the late 1980s, following Doi moi policy, Vietnam shifted from a centralized economy controlled by the government to a more open market economy with a "socialist orientation". The new policy encouraged and gave incentives to private businesses and overseas investment, including foreign owned enterprises. Over 30,000 private businesses had been established by the late 1990s and there were apparent improvement in agriculture reforms. The strategy has proven a success as real GDP grew at an average rate of 7.4% from 1991 to 2010, and per capita real GDP almost doubled from 1993 to 2009. The growth was driven by domestic investment, foreign investment and exports. Poverty rate also witnessed a decline during the past two decades (World Bank).

Vietnam is expected to grow as one of the important industrial economies by 2025 as the country embraces a recent healthy growth path, a young and educated working population, rich natural resources and its willingness to develop and internationalize.

1. Phases of development of State Bank of Vietnam (SBV)

During the central planning period, the State Bank of Vietnam performed a dual function. It issued currency as part of the central bank's function and also provided "commercial banking" services as accepting deposits form state-owned enterprises, cooperatives and the general public. It also provided credits to state-owned enterprises when directed by the government.

Reforms in the financial system came in around 1988 when some of the commercial banking functions used to perform by SBV was transferred to state-owned commercial banks (SOCBs) (Decision No. 53, Ministerial Council, 1988). In 1989, SBV raised interest rates so that real interest rates would be positive. Inflation was at its record high inflation in the 1986-1988 period when the rate averaged 365% per year. The official exchange rate was devalued significantly to narrow the gap between the official and parallel market rates. Capital controls on short-term and portfolio capital flows were not liberalized but favorable laws on foreign direct investments was proposed and adopted.

During the 1989-1997 period, all commercial banking activities were transferred to state-owned commercial banks and several new joint-stock banks, foreign joint venture banks and branches of foreign banks were opened. However, the operations of the SBV were still very much dependent on the government's directives because the SBV was still legally governed under the Decree Law. However, as the market became more market-oriented and the new financial system took shape, monetary policies evolved from passively taking orders from the government to more actively targeting inflation.

The National Assembly approved the Law on the State Bank of Vietnam and the Law on Credit Institutions in December 1997 in order to grant central bank more independency and authority to set monetary policies. Vietnam financial sector witnessed accelerating liberalization after the government allows all business organizations, private sector included, to access funds from the public (Decision of the Council of Ministers, March 9, 1988).

There was such a dramatic increase in the number of credit cooperatives and saving funds, which numbered more than 7000 at the end of 1980s (SBV) that the existing financial regulation and supervision system fail to accommodate. The lack of regulation and supervision led to moral hazard and adverse selection problem which later result in the first financial crisis in Vietnam's modern economic history. Most of the credit cooperatives could not pay depositors and were closed at the beginning of 1990s.

After the collapse of the cooperative system, the SBV was assigned the duty of monetary policy management and regulation and supervision of the financial system. During 1990s, SBV implemented tighter banking regulations and used credit ceiling imposed on the commercial banks to manage monetary policies.

In 1997, the Law on the State Bank of Vietnam and the Law of on Credit Institutions were approved by the National Assembly specified the functions and role of the SBV. According the Law, the SBV is required: "To stabilize the value of currency" (Article 1), "to stabilize the value of the currency, control inflation, facilitating the socioeconomic development" (Article 2). It is also specified that " the National Assembly decides and supervises the implementation of national monetary policy, and the projected annual inflation rate in reference to fiscal balance and economic growth" (Article 3). Thus the SBV is bound by the inflation target set by the National Assembly.

2. The Current Financial System

On June 2010, in a move to further strengthen the independence of the SBV, the two Laws of 1997 were replaced by the two new Law on State Bank of Vietnam and the

Law on Credit Institutions. According to the new Law, the SBV is required: "To conduct operations for the purpose of currency value stability; to assure the safety for banking operations and the system of credit institutions; to assure the safety and effectiveness of the national payment system; and to contribute to accelerating socio-economic development along the socialist orientation" (Law on State Bank of Vietnam, 2010). The Law was an improvement in comparison with the one in 1997 due to an implicit emphasis on inflation control. The government advises the National Assembly to select annual inflation rate targets. The decision is made basing on annual reports and projections of main monetary indicators such as broad money, deposits and credit to the private sector submitted to the National Monetary Advisory Board (NMPAB). After being approved by the NMPAB, the projected indicators are submitted to the National Assembly and if approved again, the proposal will be implemented and supervised by the SBV. The Governor of the SBV shall decide on the set of policy instruments and measures to obtain the proposed objectives.

The public in Vietnam is clearly very sensitive to inflation for several reasons. First, there is a vivid memory from the hyperinflation experience during the 1985-1989 period (above 300% per year) and early 1990s (above 50% per year). The mid and late 2000s also witnessed inflation soared from 9.5% in 2004 to 20% in 2008 and later slightly dropped to 19.1% in 2010 and 18.6% in 2011 (Government Statistical Office, GSO). Second, monetary aggregates and interest rates have only gain attention recently as the financial market develops. Although information about changes in interest rates is widely available, monetary aggregates are available at significant lags and not transparent.

Currently, the three main regulatory bodies of the financial system in Vietnam are the SBV, the Ministry of Finance and the State Securities Commission. The SBV is responsible for monetary policies and regulation of credit institutions. The Ministry of Finance is responsible for the fiscal policies and regulation of insurance companies and credit institutions. The State Securities Commission is in charge of the supervision of the securities market.

The SBV is authorized by law to use a number of direct and indirect instruments of monetary control such as refinancing, interest rates and open-market operations.

2.1 Refinancing

Re-financing is an arrangement of providing loans by the SBV to credit institutions, mostly state-owned, targeting at providing these credit institutions with short term investments and payment instruments in case the SBV or the government deems necessary. Refinancing takes forms of loans secured by the pledge of valuable papers or discounting valuable papers.

2.2 Interest rates

Interest rates have been slowly liberalized since the middle of 1990s. The SBV used to set both deposit rates and lending rates but since October 1992, the SBV only control ceilings for lending rates and floors for deposit rates. In 1996, floors for deposit rates, except for foreign currency deposits, were lifted and four years after, in August 2000, ceilings for lending rates were lifted. These eliminations are considered steps towards more market-oriented interest rates. Since then, although interest rates have been liberalized and

started to adjust itself, its response to economic variations has been rather weak. This phenomenon can partly explained by the fact that at the time of liberalization, three quarters of total loans were provided by state-owned commercial banks, which have a history of providing loans without taking credit risks fully into account (Camen, 2006).

Interest rates only response more actively since 2004 in reaction to rising inflation and foreign exchange rate. During 2004 to 2006, due to Vietnam's run-up to accession to the World Trade Organization, the nation experienced high output growth and volatile inflation. By 2008, inflation has hit double-digit and showed sign of persistency. From late 2009, to counter rising double-digit inflation, the SBV has to take administrative controls of the interest rate movements. The SBV raised its base rate, withdraw monetary stimulus such as interest rate subsidies and ceilings.

In 2010, the SBV insisted banks to moderate increases in lending rate an unclear move that confused the public and eroded confidence in the SBV. As inflation increases afterwards, the SBV increased policy rates again in November 2010, almost doubled from 6% to 12% and decreased the ceiling deposit rate at banks from 14% to 11%.

In the first quarter of 2011, the SBV raised the refinancing rate from 9.0% to 12.0% and the discount rate from 7% to 12%, although it maintained the base rate at 9.0%, a level lower than the inflation rate. The refinancing rate was again lifted to 13.0% on 1st April 2011.

The higher interest rates make it more costly to borrow VND from the central bank for commercial banks and increased burden for businesses. The SBV is therefore, trying to

balance between the necessity of a tighter monetary policy and the possible economic loss of firms that already face high borrowing rates of nearly 20%.

2.3 Open Market Operations (OMO)

At the moment, in order to control liquidity in the banking system, the SBV practices OMO as a major policy instrument and will increasingly rely on this policy tool. The SBV increases liquidity by buying government bonds and reduces liquidity by selling them. The SBV closely monitors banks' overnight interest rates and adjusts the volume of lending to stabilize the banking sector. In early 2011, the SBV increased the reverse repo rate from 11% to 15% to help curb inflation. The reverse repo rate is a rate at which the SBV charges to lend money to commercial banks of 7-day or 14-day terms. (HSBC, 2011)

Reference

Camen, U, (2005), “Monetary Policy in Vietnam: the Case of a Transition Economy” BIS Working Papers No. 31.

General Statistics Office of Vietnam, Government Statistical Office, http://www.gso.gov.vn

State Bank of Vietnam, (2003), “The Law on the State Bank of Vietnam”, *Legal Documents*. Hanoi: State Bank of Vietnam.

State Bank of Vietnam, (2005), *Annual Report,* State Bank of Vietnam , Hanoi, Vietnam.

State Bank of Vietnam, (2010), “The Law on the State Bank of Vietnam”. *Legal Documents*. Hanoi: State Bank of Vietnam.

World Bank, “Tanking Stock: An update on Vietnam’s recent economic development”. Prepared for the mid-year consultative group meeting for Vietnam, Dong Ha city, Quang Tri province, June 4-5, 2012

HSBC, (2011), “Vietnam Economics: A closer look”, HSBC Global Research

Chapter 3 : A VAR ANALYSIS OF MONETARY POLICY AND STOCK MARKET RETURNS IN VIETNAM

1 Introduction

Vietnam has experienced high output growth and volatile inflation since 2006 due to extraordinary capital inflows following its run-up to accession to the World Trade Organization. During the period 2006-2007, the Vietnam stock market has its size almost doubled. In 2005, the Vietnam stock market only accounted for as small as 0.8% of GDP but then drastically rose to its peak of 25.2% of GDP in 2007 (World Bank). In the summer of 2008, the overheated financial market bubble was hit by the global financial crisis, shrinking the size of the market quickly down to only 9.7% of GDP in 2008.

Vietnam's response to the outbreak of the global financial crisis was rather quick. The announced stimulus package in 2009 was largely financed by bank credit. Economic activity held up well as real GDP growth decelerated to 5.3% in 2009. Although this pace was Vietnam's slowest growth rate since 2000, it was among the better performers in comparison with other developing countries in Asia (IMF, 2010). The stimulus package, however, had raised questions about negative side effects as credit growth quickly raised to 40% toward the end of 2009, a sufficient increase from 25% in 2008. Domestic residents drastically divested from VND assets to invest in U.S. dollar assets and/or gold in fear of VND devaluations. Inflation was persistently high, staying above 20% for five months in 2011. The government started to respond with aggressive policy tightening in late 2010 and

early 2011 by increasing interest rate and liberalizing lending rates to dampen price pressures and slow credit growth down. After inflation steeply declined in 2013 from 18.6% in 2011, the central bank lowered interest rate to help lift growth.

The question of whether the recovery of the Vietnam stock market in 2009 was the result of the rapid credit growth and whether its slowdown in 2010 and 2011 was the result of the policy tightening is a concern for policy makers. Investigating the relationship between monetary policy and stock market in Vietnam provides economists with a quantitative perspective on monetary policy transmission mechanism and intuition about effectiveness of monetary policy in an emerging economy with a high and volatile inflation as well as a growing financial market.

According to our results, monetary policy indeed has an impact on stock returns in Vietnam. As expected, a monetary policy expansion (an increase in the money supply) leads to an increase in stock prices after about 4 months.

Our results also reveal that stock prices of listed firms with small market capitalization response less strong than stock prices of firms with large market capitalization. Theory suggests that small firms who have less access to credit are more vulnerable to changes in monetary policy. Increase in interest rate (monetary policy tightening) can worsen cash flow net of interest and worsen the firm's balance sheet position and this result means that small firms who are less well collateralized are more vulnerable to stricter credit requirements.

We also find that monetary has strongest influence on financial sector, indicating that monetary policy can increase the effectiveness of monetary policy by focus on this sector. In general, monetary policy impact seems to be short lived, ranging from 9 months to 24 months depending on the variables. This result shows that monetary policy has short lived effect and therefore is neutral in Vietnam in the long run.

2 Literature Review

There are an abundant amount of studies on the topic of monetary policy and financial market performance.

Christiano, Eichenbaum and Evans (1996) show that tightening monetary policy shocks are linked to persistent decreases in real GDP, retail sales, employment and corporate profits. Tighter policy also increases unemployment and manufacturing inventory. Christiano et al. suggest a seven-variable-Vector Autoregression (VAR) model with the indicator of aggregate production activities reflecting the research interest put last in the VAR ordering. Thorbeke (1997) examines portfolio stock returns' responses to monetary policy shocks. Following Christiano et al's identification strategy in VAR, Thorbeke (1997) puts stock prices last in the VAR ordering and finds a large and statistically significant relationship between either negative shocks to the U.S. federal funds rate or positive shocks to non-borrowed reserves and consequent increases in the U.S. stock returns. Furthermore, based on a generalized method of moments and an event study approach, the study shows that news on an expansionary monetary policy is significantly and strongly related with rises in stock returns.

Benanke and Kuttner (2005) study how stock prices react to expected and unexpected changes in policy rate with an event study approach and find that an unexpected 25 basis point cut in the Federal funds rate target leads to an approximately 1% increase in broad stock indexes. Honda and Kuroki (2006) use the same event study approach and find that stock prices and interest rate in Japan are responding significantly to surprise components of monetary policy for the period from July 1989 to March 2001.

Although many studies have investigated the empirical links between monetary policy and stock returns, the focus has been a few major developed countries. Studies on emerging stock markets have been scarce with mixed results. Monetary policy has an impact on stock prices in China according to Koivu (2010) but the result is not robust. Bank of Korea seems to be reacting to the stock price gap as the policy rate response mildly to shocks in the stock market according a study by Hsing and Lee (2004).

Studies on Vietnam monetary transmission mechanism, especially the asset channels are rare. Pfau and Le (2009) find that credit channel plays a much larger role than the traditional interest rate channel in transmitting monetary policy in Vietnam. This result is in line with the State Bank of Vietnam (SBV)'s role in supporting real GDP growth by providing credits to government related enterprises and activities. The exchange rate channel also plays a strong role since its inclusion causes money and inflation to Granger cause real output. The link between money and inflation is rather weak as inflation is solely driven by nominal effective exchange rate in the short run and credit growth and GDP growth in the long run.

Nguyen and Nguyen (2010) find that a change in the interest rate has an immediate effect but rather weak on real variables. This is consistent with results reported by Pfau and Le (2009), who find little effect of the interest rate channel in the period from 1996Q2 to 2005Q4 as money continues to Granger cause real output even after controlling for the impact of interest rates. Bhattacharya (2013), however, reports that interest rate shocks tend to have a significant impact on GDP growth over the short to medium term during the period from 2004Q1 to 2012Q2. Inflation positively responses to a rise in interest rate but the response is short-lived.

3. Data and Methodology

3.1 Data

To study the link between monetary policy and stock returns empirically in Vietnam, we use monthly, seasonally adjusted data from Jan 2001 to Dec 2011. The data set includes the following variables:

GDP	Real gross domestic product (constant 1994 price)
CPI	Consumer Price Index (CPI) (2005=100)
TBILLR	Real Treasury bill rate
LENDR	Lending rate
M2	Broad money, measured in billions of VND
SR	Stock returns, measured in percentage

TR Total Reserves

PO World oil price, in USD/barrel (2005=100)

PR Rice price, in USD/ton (2005=100)

All variables, except for stock returns *SR*, are taken from the International Monetary Fund's International Financial Statistics (IFS). Stock returns *SR* data are taken from the Bloomberg's database. The summary statistics for the variables and their log first differences are presented in Table 1.

Monthly GDP data is estimated by interpolating the yearly data using the method presented by Chow and Lin (1971). Given the value of a time series at the beginning of each year for *n* years, and given the value of a related series at the beginning of each month for these 12*n* months, Chow and Lin present a method by which the first series can be estimated for the remaining *11n* months. More specifically, in our paper, monthly data for GDP is estimated given its yearly data and monthly data on related series *X*. Series X includes 6 time series: the consumer price index (*CPI*), the price of oil (*PO*), the price of rice (*PR*), lending rate (*LENDR*), broad money (*M2*), total reserves (*TR*), and stock returns (*SR*). The series was chosen on the basis of how they help explaining the dependent variable and their monthly data availability. See Appendix 1 and 2 for the detailed descriptions.

Treasury bills are considered short-term policy instruments and are not traded on the local exchanges. Only commercial banks that have accounts at the State Bank of Vietnam

have access to Treasury bills. Treasury bills have tenors of less than one year, normally 13 weeks, 26 weeks and 52 weeks. These are discounted securities with a face value of VND100,000. This instrument is issued to temporarily finance the state's budget deficit or assist the SBV in implementing monetary policy.

Variable *M2* is also calculated according to IMF definition of M2, which is frequently called the Money and quasi money. M2, according to International Financial Statistics definition, comprises the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government. This corresponds to lines 34 and 35 in the International Monetary Fund's International Financial Statistics (IFS).

The Ng-Perron tests in Table 3-2 show that all variables except for stock returns *SR* and Treasury bill rate *TBILLR* display evidence of nonstationarity. Therefore, we transform the variables into log first differences to eliminate nonstationarity. Ng-Perron tests reject nonstationarity at the 5% level for the log first differences, as shown in the left hand side of Table 3-2. As the roots of the AR characteristic polynomial were found inside the unit circle, the model fulfills the stability condition. (See Appendix 3).

Various lag length selection criteria suggest different lag lengths for the baseline VAR model, as shown in Table 3. We will use three lags in our model. However, the results are qualitatively similar with various different lag lengths.

Table 3-1: Summary Statistics

	Data in Levels			Data in Log First Differences		
	Jan 2001 to Dec 2011 (132 obs.)			Jan 2001 to Dec 2011 (131 obs.)		
Variable	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
GDP	429722	419335	97328	0.01	0.0099	0.035
CPI	120.54	107.41	37.81	0.01	0.005	0.009
TBILL	0.065	0.06	0.02			
M2	1040105	731185	789833	0.02	0.018	0.02
SR	1.11%	0.07%	0.17			
PO	110.16	108.75	53.87	0.01	0.03	0.09
PR	114.16	98.83	46.23	0.07	0.01	0.06

Table 3-2: Ng-Perron Tests for Nonstationarity

	Data in Levels	Data in Log First Differences
	Jan 2001 to Dec 2011 (132 obs.)	Jan 2001 to Dec 2011 (131 obs.)
Variable	Ng-Perron t-statistics	Ng-Perron t-statistics
GDP	1.70	-64.98
CPI	2.96	-42.51
TBILL	-21.79	-58.99
M2	1.47	-58.52
SR	-37.44	0.092
PO	-2.80	-56.06
PR	-3.92	-49.49

Asymptotic critical values*:	1%	-13.8000
	5%	-8.10000
	10%	-5.70000

Table 3-3: Lag Length Selection of the Baseline Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1899.479	NA	9.93e-24	-30.26367	-30.08265	-30.19013
1	2110.668	391.9657	9.44e-25	-32.61868	-30.98957*	-31.95686*
2	2179.875	119.5903*	8.79e-25*	-32.70200*	-29.62479	-31.45189
3	2220.079	64.32589	1.33e-24	-32.32126	-27.79595	-30.48287
4	2263.848	64.42828	1.94e-24	-31.99756	-26.02417	-29.57089
5	2310.820	63.13008	2.82e-24	-31.72511	-24.30362	-28.71015
6	2364.810	65.65282	3.85e-24	-31.56497	-22.69537	-27.96172

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

3.2 Methodology

We estimate a reduced form Vector Autoregression (VAR) model and analyze the impulse response functions so as to understand the effect of monetary shocks on stock returns. A VAR approach was suitable mainly because this approach lets us fully capture the interaction among macroeconomic variables and their feedback effects. There are a vast amount of studies on monetary policy transmission mechanism using VARs. Thorbeke (1997), Christiano et al (1996) and Benanke and Kuttner (2005) use VAR frameworks for the U.S. Fujiwara (2003, 2004) and Shibamoto (2014) investigate the monetary transmission mechanism in Japan following a VAR based approach.

The VAR involves regressing an n by 1 vector of endogenous variables, $y_{t,}$ on lagged values of itself:

$$y_t=\beta_1 y_{t-1}+ \ldots.. \beta_p y_{t-p}+\varepsilon_t \ , E(\varepsilon_t \ \varepsilon'_t)=\Omega \qquad (1)$$

Assume that y_t is covariance stationary, equation (1) can be inverted and represented as an infinite vector moving average process:

$$y_{t=} \varepsilon_t + \mu_1 \varepsilon_{t-1}+ \mu_1 \varepsilon_{t-2}+ \mu_2 \varepsilon_{t-3}+\ldots. \qquad (2)$$

Since the variance covariance matrix of ε_t (Ω) is symmetric and positive definite, the Cholesky factorization implies that there exists a lower triangular matrix P such that Ω = PP'. Using P, equation (2) can be rewritten as

$$y_t = PP^{-1} \varepsilon_{t-1}+ \mu_1 PP^{-1} \varepsilon_{t-2}+ \mu_2 PP^{-1} \varepsilon_{t-3}+\ldots.$$

$$= \Gamma_0 v_t + \Gamma_1 v_{t-1}+ \Gamma_2 v_{t-2}+\ldots. \qquad (3)$$

where $\Gamma_i=\mu_i P$, $v_t=P^{-1}\varepsilon_t$ and $E[vv_t'] = I$. Equation (3) represents the endogenous variables (y_t) as functions of the orthogonalized innovations (v_{t-i}).

In deciding which variables to include in our empirical analysis, we must deal with the following trade-off. On one hand, we want to include all of the variables that might have influence on stock returns and report all the response functions. However, this strategy is not feasible due to the large number of parameters to be estimated. On the other hand, if we include too few variables in our VAR model, we will encounter omitted variable bias.

We, thus, choose to estimate the basic unstructured VAR model with four variables following the strategy of Christiano et al (1996): growth rate of GDP (GDP), growth rate of CPI (CPI), monetary policy instrument and stock returns of portfolios. In the following, whenever we refer to *GDP*, *CPI* or *M2*, we mean the first differences of the logs of such variables. Growth rate are approximated with the first difference of the logs.

For the baseline VAR, we use GDP, CPI, M2 and SR, a constant and two lags. The order of orthogonalization is the same as the order in which the variables are listed above. We later replaced M2 with TBILLR and consider a VAR model with GDP, CPI, TBILLR and SR. Now, the price of oil (*PO*) and price of rice (*PR*) were included in the model as exogenous in order to control for external shocks.

This ordering implies that GDP affects all the remaining variables contemporaneously, but others affect GDP with a lag. M2 can affect stock returns contemporaneously but cannot affect GDP and CPI contemporaneously. Stock returns are affected by the remaining variables contemporaneously, but it does not affect them contemporaneously. Finally, each variable affects another with a lag.

In the baseline model, orthogonalized innovations in M2 are used to measure monetary policy. Our decision to work with M2 rather than other broad monetary aggregates is motivated by arguments in Le and Pfau (2008) that M2 is an operating target for monetary policy at the State Bank of Vietnam. In the alternative model, we use real interest rate (Treasury bill rate) as proxy for monetary policy to account for the fact that

interest rates have been more actively used by the central bank to curb inflation and maintain growth.

In previous literature, inflation and its lags are included so as to capture the effect of real money and real interest rate on real variables. In this model, we include them with a similar purpose.

We further study the effect of monetary shocks on firms of different sizes or hereafter, “size portfolios” and firms of different industries or hereafter, “industry portfolios”. Size portfolios are sorted into quartiles based on market capitalization as of 2012 and represent value-weighted averages. Industry portfolios are sorted based on the Global Industry Classification Index developed by Morgan Stanley Capital International and Standard & Poor’s. Industry portfolio returns are value-weighted averages of the returns on individual firms.

The size portfolios are useful for investigating monetary policy’s effect on firms’ access to credit. Thorbecke (1997) find evidence that large firms are less affected by shocks to monetary policy. This result supports the hypothesis proposed by Gertler and Gilchrist (1994) that credit constraints caused by a monetary tightening should affect small firms, which are less well-collateralized and have less ability to borrow, more than large firms. Monetary policy, thus, matters because it affects firms’ access to credit.

4. Results

4.1 Baseline VAR

In this section, we consider the baseline VAR with GDP, CPI, M2, SR (market stock returns) and two lags, and analyze the impulse responses of all variables to one standard deviation shocks to monetary policy and financial market (See appendix 4).

4.1.1 Responses to orthogonal shocks in M2

Line 1 in Table 3-4 indicates that market returns respond significantly at 10% significance level to monetary policy shock M2 at the first horizon. A positive shock to *M2* associates with an increase in index returns but with a four months delay. More specifically, an expanding supply of money or looser monetary policy boosts returns by approximately 0.021 percent per month. This compounds to an annual effect of appoximately 0.252 percent. The impact, however, is short lived.

Figure 3-1 plots the impulse responses of GDP, inflation and SR to orthogonal shocks in M2. The link between output and money supply seems to be weak in this period 2001- 2011. Money supply and inflation, on the other hand, are positively related: an increase in money supply put a significant upward pressure on inflation. Inflation increases about 0.2% in response to a one standard deviation shock to monetary aggregates. By contrast, Hung and Pfau (2008) find that money supply granger causes real output growth but not inflation over the period 1996-2005. This differing conclusion is likely due to the liberation of domestic prices over the period 2002-2004, which possibly increases the responsiveness of prices to money supply.

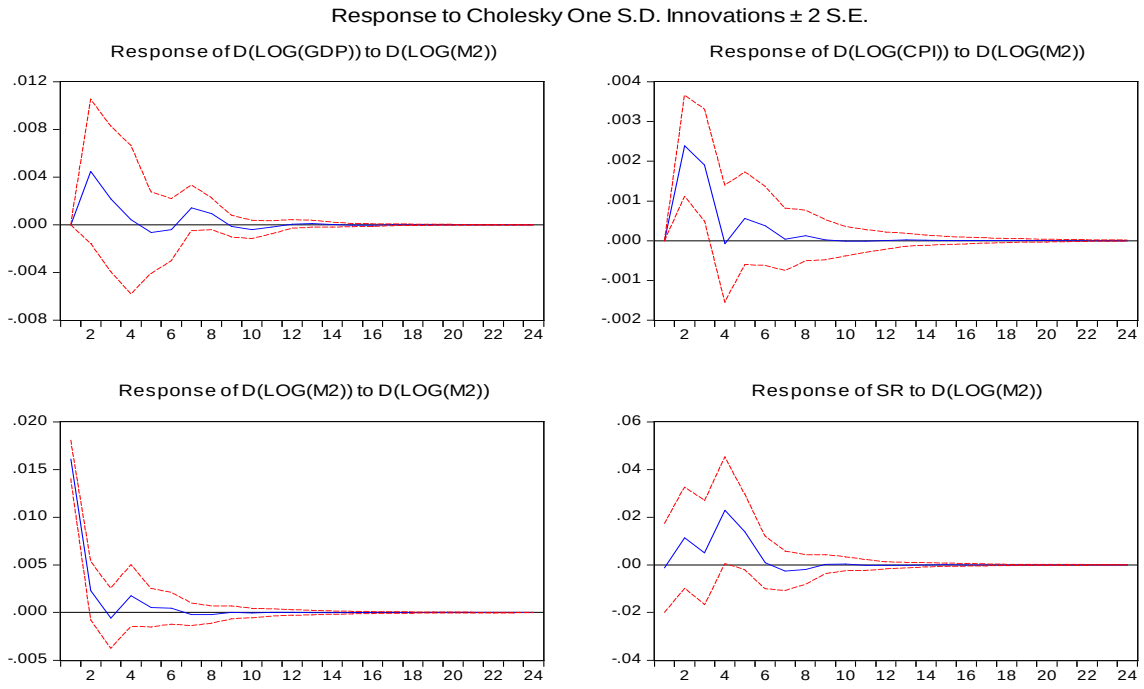


Figure 3-1: Responses of GDP, CPI and SR to shocks in M2

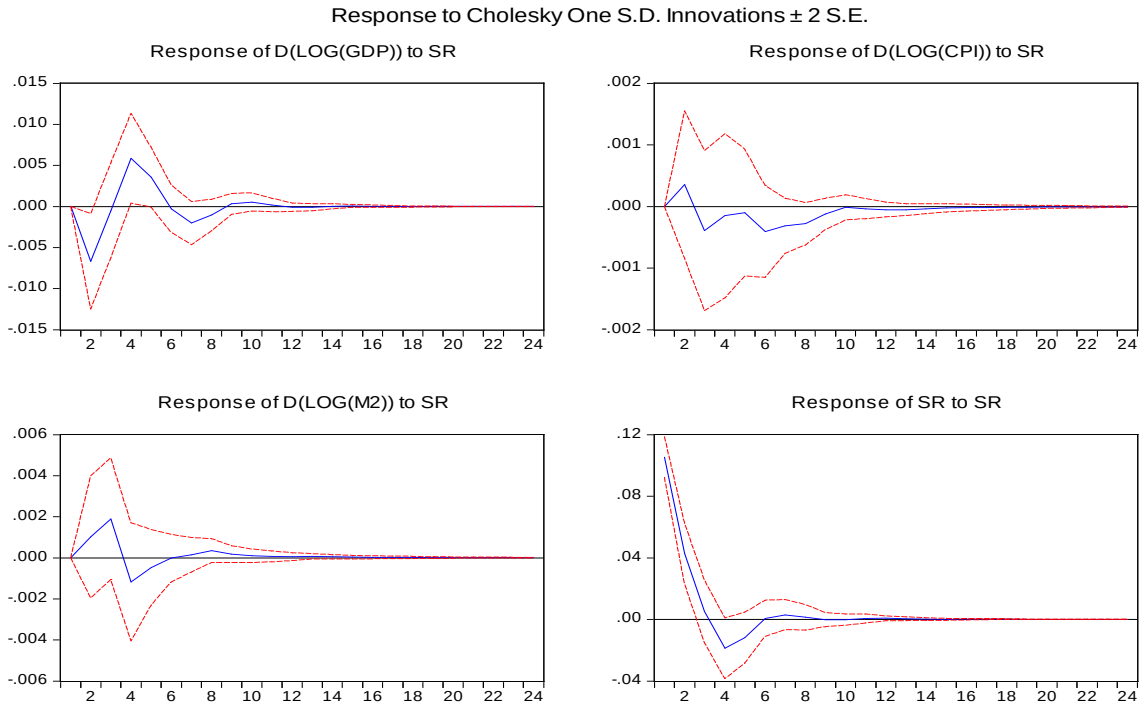


Figure 3-2: Responses of GDP, CPI and M2 to shocks in SR

4.1.2 Responses to orthogonal shocks in SR

Impulses responses to shocks in *SR* are presented in Figure 3-2. The response of money supply and inflation is insignificant while the response of GDP is significant yet puzzled. In response to a boom in stock market performance, GDP growth first declines and then rises again. The volatility and unpredictability of the Vietnamese stock market probably complicated the impact of stock price on GDP. The significant result is, in fact, rather unexpected as the size of the stock market remains small compared to developing Asia at about 20% of GDP.

4.1.3 Central Bank's reaction

The Impulses Reponses functions of M2 to all other shocks imply that the central bank is adjusting money supply to changes GDP and inflation. Specifically, in response to an increase in GDP, money supply decreases and in response to an increase in inflation, money supply decreases.

4.1.4 Responses of size and industries portfolios

In this section, we consider various VAR models with GDP, CPI, M2, size/ industries portfolio stock returns and two lags. Each line in Table 3-4 and Table 3-5 represents a VAR model with the last variable in the ordering represents stock return of each portfolio. The results indicate that only returns of smallest firms (1^{st} quartile) and second smallest (2^{nd} quartile) significantly respond to changes in monetary policy, but only at the forth horizon. In other words, with more money being injected into the market, stock

returns of smallest firms tend to respond with a rise of approximately 0.006% per month or 0.072% per year.

Overall, standard errors in the estimation for the largest firms (4th quartile) and the second largest firms (3rd quartile) indicate that these firms' stock returns do not significantly respond to orthogonal shocks in monetary policy. Figure 3-3 plots the impulse response for the size portfolios.

The findings are consistent with Thorbecke (1997) and Gertler and Gilchrist (1994). Gertler and Gilchrist (1994) find that in response to a tightening of monetary policy, small firms' manufacturing level declines and consequently inventory demand also largely declines. Financial factors, i.e. declines in future cash flow and declines in value of collateral assets, are found to be at work. Along the same line with the hypothesis by Gertler and Gilchrist, as balance sheet position of small firms worsens, their stock price performance may as well suffer.

Monetary policy shocks exert statistically significant effect on the returns of small firms but only insignificant effect on larger firms. Large firms are most likely to be well collateralized and thus protected from binding credit constraints. This finding is consistent with the economic theory that monetary policy can work by affecting firm's cost of investment, balance sheet status and consequently, access to credit (the credit channel).

Table 3-4: Impulse Response of Stock Returns of Market and Size Portfolios to One-Standard Deviation Shock to M2 in the fourth horizon

The coefficients in the Table 3-4 represent the 4,3rd element of the matrix Γ_4 in the orthogonalized moving average process:

$$y_t = \Gamma_0 v_t + \Gamma_1 v_{t-1} + \Gamma_2 v_{t-2} + \ldots.$$

Where y_t is an (4 × 1) vector whose elements are growth rate of GDP (GDP), growth rate of CPI (CPI), growth rate of M2 (M2), Stock returns for portfolio i (SR_i). The 4,3rd element of the matrix Γ_4 measures the response of SR_i in the initial period to a one standard deviation shock to *M2*. Each line in this table represents a VAR with GDP, CPI, M2 and stock returns for the specified portfolio.

Portfolio	Response to One-Standard Deviation Shock to *m2*	(Standard Error)
Market	0.021*	(0.011)
First quartile (smallest)	0.006*	(0.004)
Second quartile	0.015*	(0.009)
Third quartile	0.026	(0.023)
Forth quartile (biggest)	0.119	(0.419)

* Coefficients are significant at 10% level

Impulse responses for industrial portfolios in Table 3-5 imply that shocks in money supply have little impact on most sectors, except for the Finance sector. Returns for Finance sector increase by 0.587% monthly, or 7.04% yearly in response to one standard deviation shocks to board money supply. The Finance sector consists of 58 listed commercial banks, insurance firms, real estate firms and investment firms. This sector has its profit closely tied with movements of monetary policy instruments such as interest rates, reserve ratio, lending rate ceiling and credit growth cap.

Table 3-5: Impulse Responses of Industries Portfolios' stock returns to One-Standard Deviation Shock to the Log of M2 in the first horizon

The coefficients in the Table represent the 4,3rd element of the matrix Γ_0 in the orthogonalized moving average process:

$$y_t = \Gamma_0 v_t + \Gamma_1 v_{t-1} + \Gamma_2 v_{t-2} + \ldots.$$

Where y_t is an (4 × 1) vector whose elements are growth rate of GDP (GDP), growth rate of CPI (CPI), growth rate of M2 (M2), Stock returns for portfolio i (SR_i). The 4,3rd element of the matrix Γ_0 measures the response of SR_i in the initial period to a one standard deviation shock to *M2*. Each line in this table represents a VAR with GDP, CPI, M2 and stock returns for the specified portfolio.

Portfolio	Response to One-Standard Deviation Shock to *m2*	(Standard Error)
Oil&Gas	0.017	(0.018)
Basic Materials	0.013	(0.029)
Industrials	0.032	(0.054)
Consumer Goods	0.005	(0.110)
Health Care	0.001	(0.003)
Consumer Services	0.005	(0.007)
Utilities	0.002	(0.002)
Financials	0.587*	(0.356)
Technology	0.005	(0.028)

* Coefficients are significant at 10% level

4.2 Variance Decompositions

The impulse response functions indicate how stock returns are affected by unpredicted monetary policy shocks, while the forecast error variance (FEV) error decompositions show the proportion of variations in returns explained by changes in

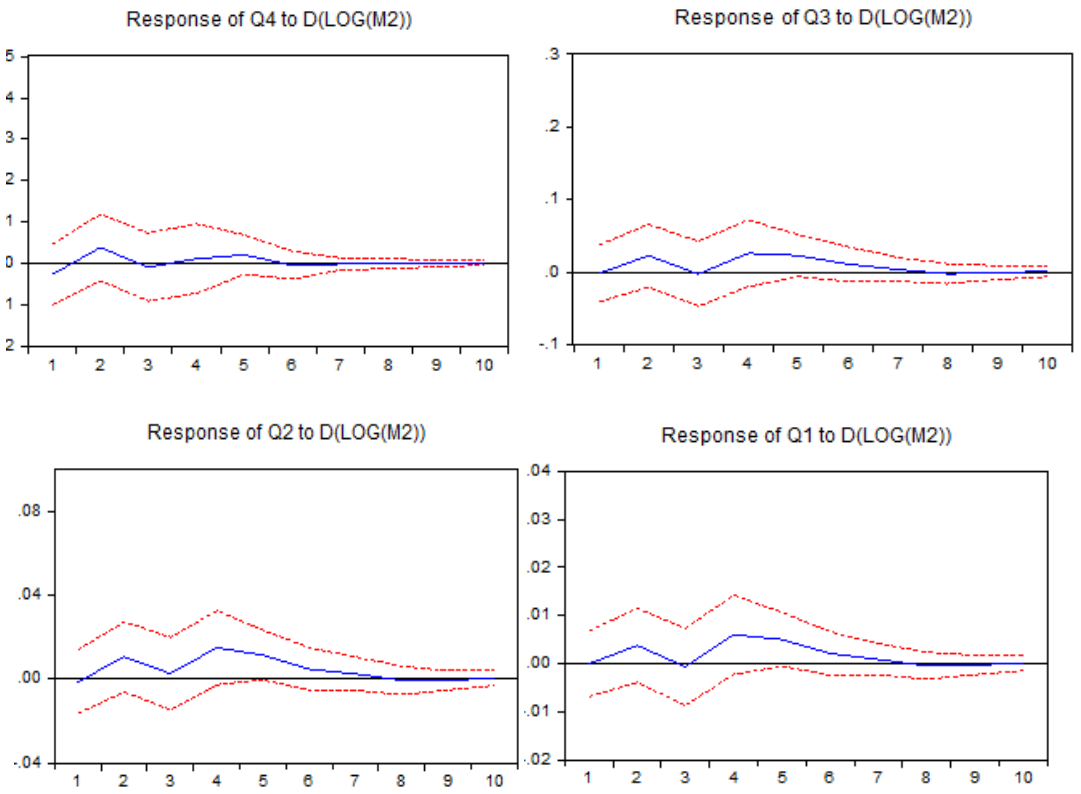
monetary policy. Table 3-6 indicates that, monetary policy innovations explain about 4.61% of the FEV of market returns after four months. The statistics are 3.445 and 1.64% for smallest and largest firms respectively. Note that monetary policy shocks explain fluctuations in returns of small firms better than for large firms. This is consistent with the findings we discussed with the impulse response functions.

4.3 Treasury bill rate as the proxy for monetary policy

We further consider the case in which interest rate (Treasury bill rate) replaces M2 as the proxy for monetary policy. The VAR ordering is now modified to: GDP, CPI, TBILL and SR. The impulse responses are resented in Figure 4.

First, we notice a link between TBILL and GDP and that an increase in TBILL negatively affects GDP after 4 lags, cutting GDP growth by 0.05%. This result is in line with the findings proposed by Bhattacharya (2013) who uses quarterly data from 2004Q1-2012Q2 whose timeline almost overlaps ours. Note that we do not observe this link between monetary policy and GDP in the base model with broad money M2.

Increases in TBILL, however, do not slow down financial market performance and do not decrease SR. In contrast, by looking at the impulse responses of TBILL to SR, we notice that good financial market condition actually has a significant and mild effect on the central bank's decision and results in consequent counter-intuitive decrease in TBILL after 3 periods. The volatility and uncertainty in the financial market or an omitted variable bias may be held responsible for such puzzle.

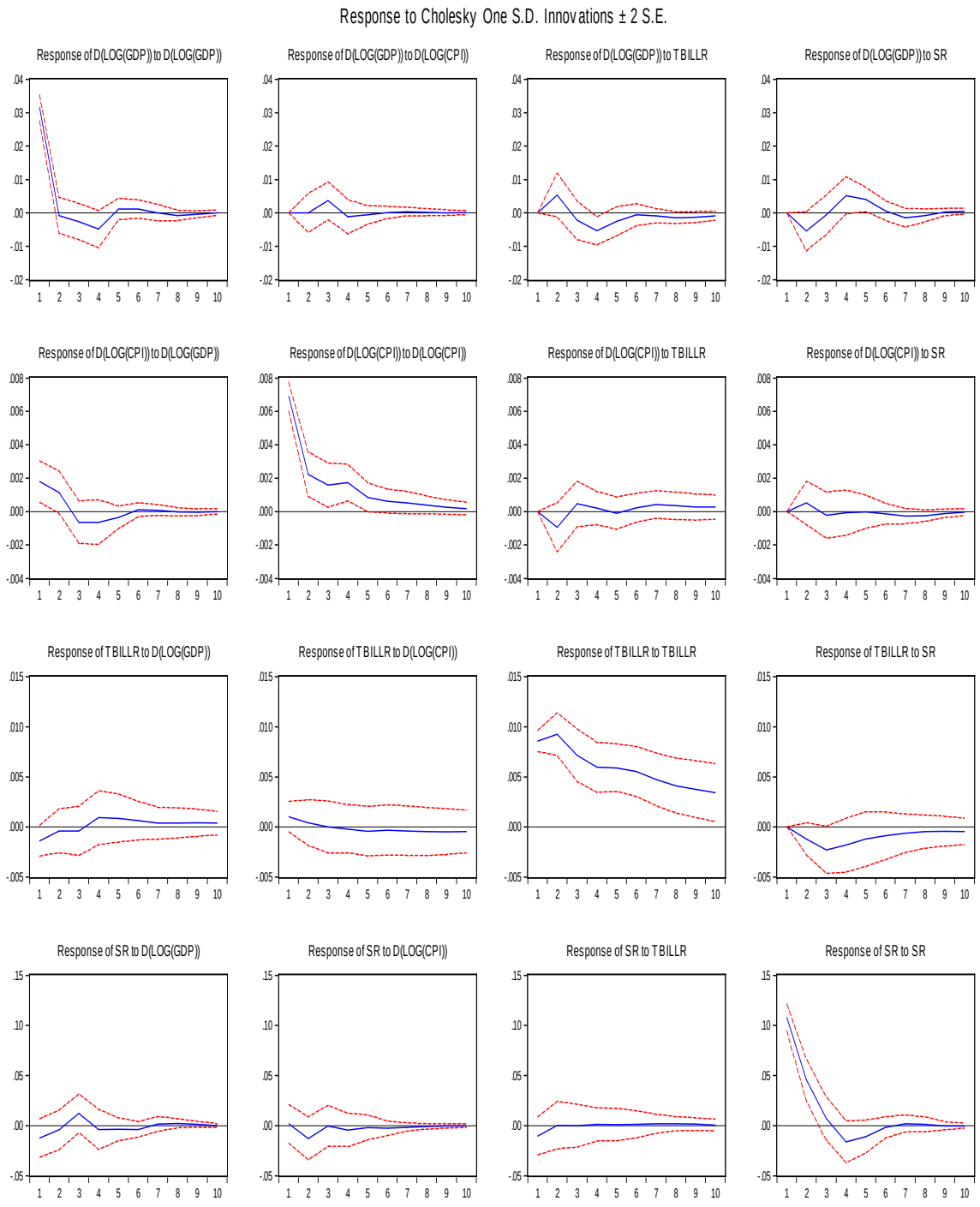


Q1: smallest firms, Q2: second smallest firms, Q3: second largest firms, Q4: largest firms

Figure 3-3: Responses of Size Portfolios' Returns to Cholesky One S.D. Innovation

Table 3-6: Percent of a 12 month Forecast Error Variance (FEV) of Industry and Size Portfolios' Stock Returns Accounted for by Innovations in M2

	Percent of 12-month FEV
Market	4.61
First quartile (smallest)	3.44
Second quartile	4.84
Third quartile	2.56
Forth quartile (biggest)	1.64



VAR ordering: GDP, CPI, TBILL and SR

Figure 3-4: Responses of Market Stock Returns to Cholesky One S.D. Innovations in TBILLR

The impulse responses also indicate that GDP is positively affected by increases in SR after 4 or 5 lags, which is in line with our findings in the base model.

5 Conclusion

This chapter aims to better our understanding of the monetary policy transmission channels in Vietnam. The study is timely and important for policy makers in Vietnam as it helps quantify the timing and effect of the monetary policy transmission mechanism, especially the asset price channel.

We look into the responses of stock return data to monetary policy shocks and investigate how returns of market portfolio, size portfolios and industries portfolios react to changes in money supply and interest rate.

Since it is unclear recently as to which monetary policy instrument is the primary tool, we consider both broad money and interest rate as measures of monetary policy and observe some interesting results.

Firstly, we see in both VAR models evidences of a significant and mild linkage between monetary policy and stock market. Money supply significantly affects stock returns but interest rate does not; interest rate, however, moves in responses to stock market fluctuations. This outcome is not surprising taking into account the fact that the central bank has only been actively using interest rate, in addition to money supply, in response to macroeconomic fluctuations since very recently. Interest rates controlling was a part of monetary tightening policy to deal with overheating financial market or persistently high

inflation and as part of monetary expansion policy to boost investment and output growth. This mixed outcome from the two VARs models indicates that although the central bank attempt to move interest rate to response to market fluctuations, the market has not reflected such moves.

Results from size portfolio indicate that monetary shocks exert strongest impacts on small firms and the impacts lessen as firm size grows. This evidence supports the hypothesis that monetary policy matters partly because it affects firms' access to credit. Financial firms are found to respond faster and stronger to changes in policy than their counter parts in other industries such as Technology, Materials and Consumer Goods.

The link from monetary policy to equity prices, found in this paper, is relevant to the discussion on optimal stimulus package. Loosening monetary policy through increasing money supply can boost financial market performance; in fact, small firms and financial firms will benefit the more from such policy than larger firms and firms in other industries.

REFERENCE

Bernanke, Ben S., and Mark Gertler, (1999), "Monetary policy and asset price volatility", *Federal Reserve Bank of Kansas City Economic Review* 84, 17-51.

Cargill, Thomas and Nguyen, Tuan, (2013) "State Bank of Vietnam needs a single mandate not independence", *Central Banking Journal*, 28 Feb 2013

Chow, Gregory C and Lin, An-loh, (1971), "Best Linear Unbiased Interpolation, Distribution, and Extrapolation of Time Series by Related Series", *The Review of Economics and Statistics* 53, 371-375.

Christiano, Lawrence, Martin Eichenbaum, and Charles Evans, (1996), "The effects of monetary policy shocks: Some evidence from the flow of funds", *the Review of Economics and Statistics* 78, 16-34.

Conover, C.M., G.R. Jensen, and R.R. Johnson (1999), "Monetary environments and International stock returns," *Journal of Banking and Finance* 23, 1357-1381.

Durham, J.B (2002). "The effect of monetary policy on monthly and quarterly stock market returns: cross-country evidence and sensitivity analyses," *Finance and Economics Discussion Series* 2001-42, Board of Governors of the Federal Reserve System (U.S.).

Gertler, Mark, and Simon Gilchrist, (1994), "Monetary policy, business cycles, and the behavior of small manufacturing firms", *Quarterly Journal of Economics* 109, 310-338.

Hsing, Yu and Lee, Sang H., (2004), "Estimating the Bank of Korea's Monetary Policy reaction function: new evidence and implications", *The Journal of the Korean Economy* 5, 1-16

Honda, Y and Kuroki, Y., (2006), "*Financial and capital markets' responses to changes in the central bank's target interest rate: The Case of Japan*", Economic Journal 116 (513), 812-842

IMF, (2010), "Vietnam: 2010 Article IV Consultation – Staff Report and Public Information Notice", International Monetary Fund, Washington D.C.

Koivu, Tuuli, (2010), "Monetary Policy, Asset Prices and Consumption in China", *European Central Bank Working Paper Series*, No 1240, Sep 2010.

Lastrapes, W.D. (1998), "International evidence on equity prices, interest rates, and money", *Journal of International Money and Finance* 17, 377-406.

Le, H. V., and Pfau, W. D., (2009), "VAR Analysis of the Monetary Transmission Mechanism in Vietnam". *Applied Econometrics and International Development*, 9(1), 165-179.

Nguyen, Thi Thu Hang and Duc Thanh Nguyen, (2010), "Macroeconomic Determinants of Vietnam's Inflation 2000-2010: Evidence and Analysis", December, Vietnam Center for Economic and Policy Research, University of Economics and Business, Vietnam National University, Hanoi, Vietnam.

Rigobon, Roberto, and Brian Sack, (2003), "Measuring the reaction of monetary policy to the stock market", *Quarterly Journal of Economics* 118, 639-670.

Rina Bhattacharya, (2013), "Inflation Dynamics and Monetary Policy Transmission in Vietnam and Emerging Asia", *Journal of Asian Economics*, 34, 16-26.

State Bank of Vietnam, (2003), "The Law on the State Bank of Vietnam", *Legal Documents*. Hanoi: State Bank of Vietnam.

State Bank of Vietnam, (2005), *Annual Report*, State Bank of Vietnam , Hanoi, Vietnam.

State Bank of Vietnam, (2010), "The Law on the State Bank of Vietnam". *Legal Documents*. Hanoi: State Bank of Vietnam.

Thorbecke, Willem, (1997), "On Stock Market Returns and Monetary Policy", *The Journal of Finance* 52, 635-654.

APPENDIX

Appendix 1: Interpolation of GDP data

In this paper, we observed quarterly data for gdp from Jan 2001 to March 2012 and monthly data for a series X which includes 6 time series: the consumer price index (CPI), the price of oil (PO), the price of rice (PR), lending rate (LENDR), broad money (M2), total reserves (TR), and stock returns (SR) for the same period. There are a total of n= 11 years and 12n= 132 months in the study.

It is assumed that monthly observations of *gdp*, denoted y, to be estimated satisfy a multiple regression relationship with related series *X*:

$$y = X\beta+u \qquad (1)$$

Equation (1) is based on monthly data. Since monthly observations for *gdp* is not available, equation (1) must be converted into quarterly observations using a (n X 3n) matrix C_I, which takes forms

[matrix]

The vector of n yearly observations of gdp, to be subscripted by a dot which signifies being yearly, will satisfy the regression model

$$y_{\cdot}=C*y=C*X.\beta+C*u. \qquad (2)$$

with Eu.u.'=V.=CVC'

The problem is to estimate a vector z of 132 observations on the dependent variables where z would be identical with y in the case of interpolation. A linear unbiased estimator z that satisfies:

$$\hat{z} = Ay_{\cdot} = A(X_{\cdot}\beta + u_{\cdot})$$

The resulting estimator is

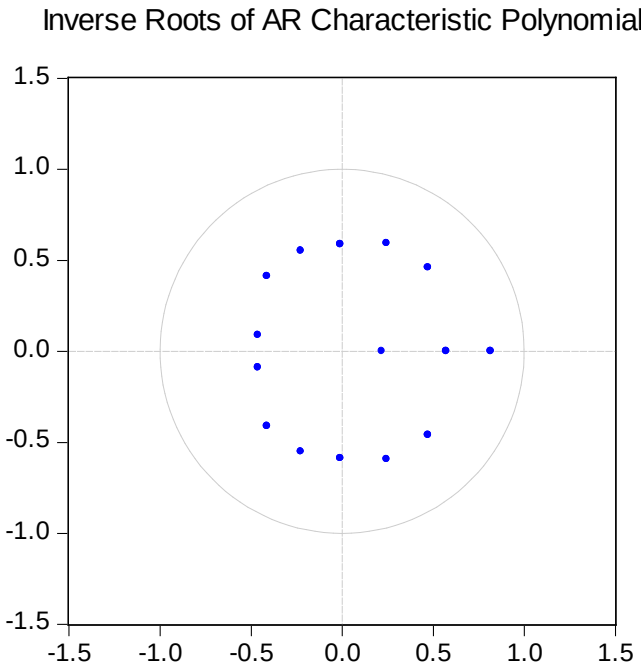
$$\hat{z} = Ay_{\cdot} = X_z\beta + (V_{z\cdot}V_{\cdot}^{-1})\hat{u}_{\cdot}$$

Appendix 2

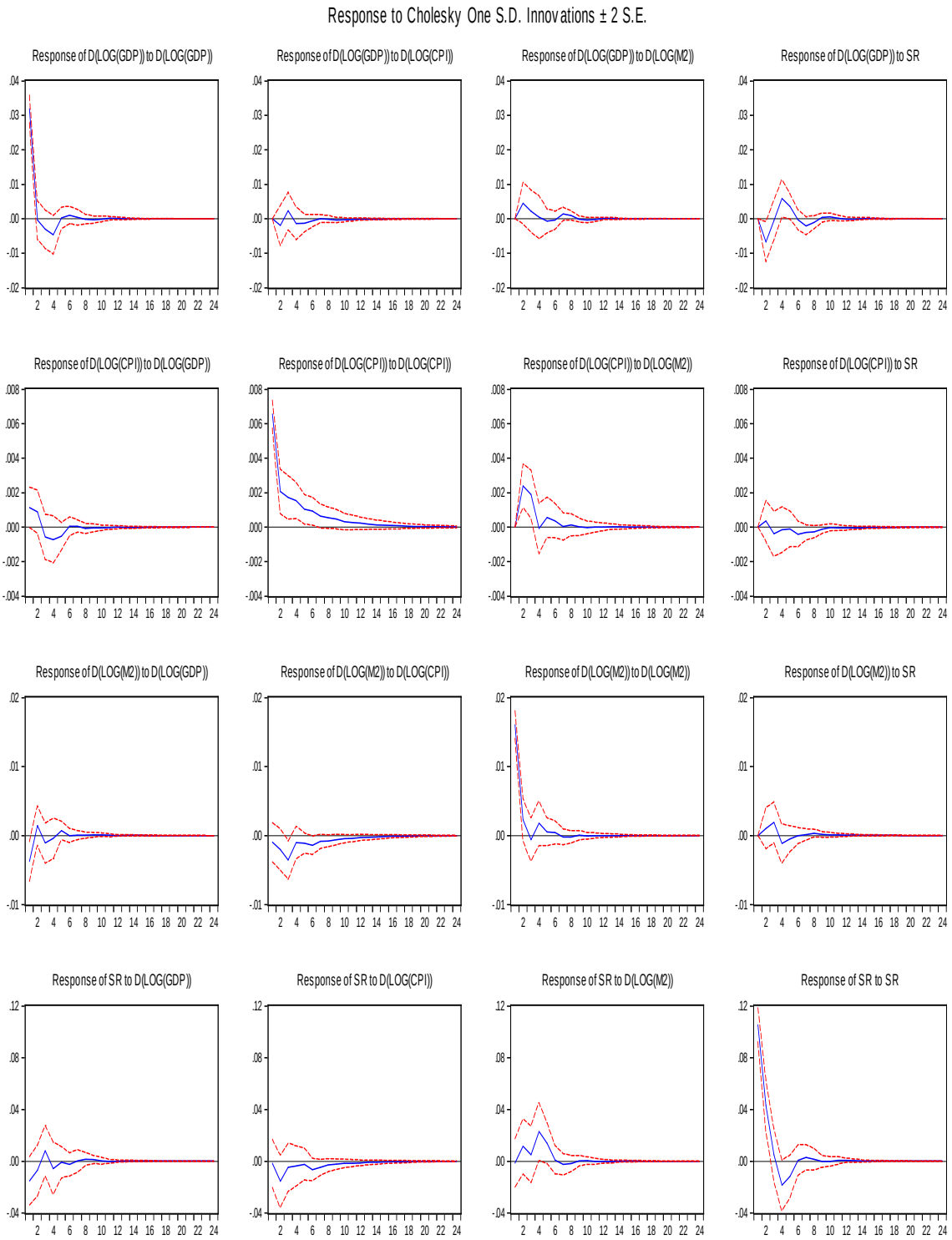
MATLAB code for interpolation

```
clear
format bank

load vietnam_monthly_data.txt;
load vietnam_GDP_yearly.txt;
data1=vietnam_monthly_data;   %monthly data of explanatory variables
data2=vietnam_GDP_yearly;     %quarterly data of GDP
num =12;

x=data1(:,1:end);
y=data2(:,1:end);
[n d]=size(y)

%Creating Ci matrix
c=zeros(n,m);
   j=1;
for i=1:11
        c(i,j)=1;
        j=j+num;
end
size(c)

X=c*x;   %X=x.=c*x
Y=y;     %Y=y.=y
C=c*c';
sigma_sq=eye(n);
V=C*sigma_sq;

b_hat=inv(X'*inv(V)*X)*(X'*inv(V)*Y);%estimating b_hat
U_hat=Y-(X*b_hat);                   %estimating residual (U=u.)
z_hat=x*b_hat;                       %estimating fitted value
M=c'*U_hat;                          %add up (Vz*inv(V))*U_hat=M
z_hat=x*b_hat+M;                     %getting interpolated GDP data
```

Appendix 3


Inverse Roots of AR Characteristic Polynomial
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5

Appendix 4: Impulse Responses functions of all variables to all orthogonal shocks in baseline VAR



Appendix 5: Impulse Responses in the baseline VAR - Statistics Table

Response of D(LOG(GDP)):				
Perio...	D(LOG(GDP...	D(LOG(CPI)...	D(LOG(M2))	SR
1	0.031914	0.000000	0.000000	0.000000
	(0.00199)	(0.00000)	(0.00000)	(0.00000)
2	-0.000423	-0.001947	0.004487	-0.006669
	(0.00278)	(0.00291)	(0.00303)	(0.00290)
3	-0.003056	0.002260	0.002185	-0.000491
	(0.00279)	(0.00274)	(0.00305)	(0.00288)
4	-0.004650	-0.001327	0.000428	0.005881
	(0.00281)	(0.00241)	(0.00311)	(0.00273)
5	0.000247	-0.001249	-0.000655	0.003567
	(0.00156)	(0.00127)	(0.00171)	(0.00182)
6	0.001046	-0.000580	-0.000410	-0.000270
	(0.00127)	(0.00092)	(0.00130)	(0.00145)
7	0.000413	-3.84E-05	0.001416	-0.002029
	(0.00114)	(0.00059)	(0.00096)	(0.00132)
8	-0.000158	-9.13E-05	0.000929	-0.001039
	(0.00068)	(0.00052)	(0.00066)	(0.00096)
9	-0.000282	-0.000416	-0.000116	0.000331
	(0.00050)	(0.00040)	(0.00046)	(0.00064)
10	-6.84E-05	-0.000342	-0.000399	0.000549
	(0.00042)	(0.00030)	(0.00038)	(0.00054)

Response of D(LOG(CPI)):				
Perio...	D(LOG(GDP...	D(LOG(CPI)...	D(LOG(M2))	SR
1	0.001145	0.006557	0.000000	0.000000
	(0.00058)	(0.00041)	(0.00000)	(0.00000)
2	0.000884	0.002058	0.002389	0.000359
	(0.00063)	(0.00064)	(0.00064)	(0.00060)
3	-0.000573	0.001717	0.001901	-0.000391
	(0.00066)	(0.00063)	(0.00070)	(0.00065)
4	-0.000723	0.001547	-7.37E-05	-0.000149
	(0.00067)	(0.00052)	(0.00074)	(0.00067)
5	-0.000522	0.001035	0.000566	-0.000101
	(0.00040)	(0.00043)	(0.00058)	(0.00051)
6	4.54E-05	0.000919	0.000373	-0.000406
	(0.00027)	(0.00040)	(0.00050)	(0.00037)
7	6.29E-05	0.000632	3.49E-05	-0.000315
	(0.00018)	(0.00035)	(0.00039)	(0.00022)
8	-8.94E-05	0.000540	0.000131	-0.000279
	(0.00014)	(0.00031)	(0.00032)	(0.00017)
9	-4.48E-05	0.000453	2.10E-05	-0.000118
	(0.00012)	(0.00028)	(0.00025)	(0.00013)
10	-4.15E-05	0.000316	-1.49E-05	-1.43E-05
	(8.1E-05)	(0.00024)	(0.00018)	(0.00010)

Response of D(LOG(M2)):

Perio...	D(LOG(GDP...	D(LOG(CPI)...	D(LOG(M2))	SR
1	-0.003751	-0.000974	0.016074	0.000000
	(0.00144)	(0.00142)	(0.00100)	(0.00000)
2	0.001431	-0.002057	0.002293	0.001016
	(0.00142)	(0.00148)	(0.00154)	(0.00149)
3	-0.001091	-0.003564	-0.000589	0.001903
	(0.00146)	(0.00140)	(0.00158)	(0.00148)
4	-0.000418	-0.001028	0.001770	-0.001171
	(0.00146)	(0.00119)	(0.00162)	(0.00144)
5	0.000715	-0.001107	0.000507	-0.000468
	(0.00068)	(0.00074)	(0.00101)	(0.00092)
6	-4.73E-06	-0.001432	0.000447	-1.76E-05
	(0.00050)	(0.00067)	(0.00083)	(0.00058)
7	6.42E-05	-0.000846	-0.000200	0.000143
	(0.00032)	(0.00052)	(0.00059)	(0.00042)
8	3.08E-05	-0.000770	-0.000219	0.000352
	(0.00022)	(0.00043)	(0.00045)	(0.00029)
9	7.91E-05	-0.000587	2.25E-05	0.000175
	(0.00017)	(0.00038)	(0.00034)	(0.00021)
10	9.82E-05	-0.000453	-5.34E-05	9.64E-05
	(0.00013)	(0.00030)	(0.00024)	(0.00016)

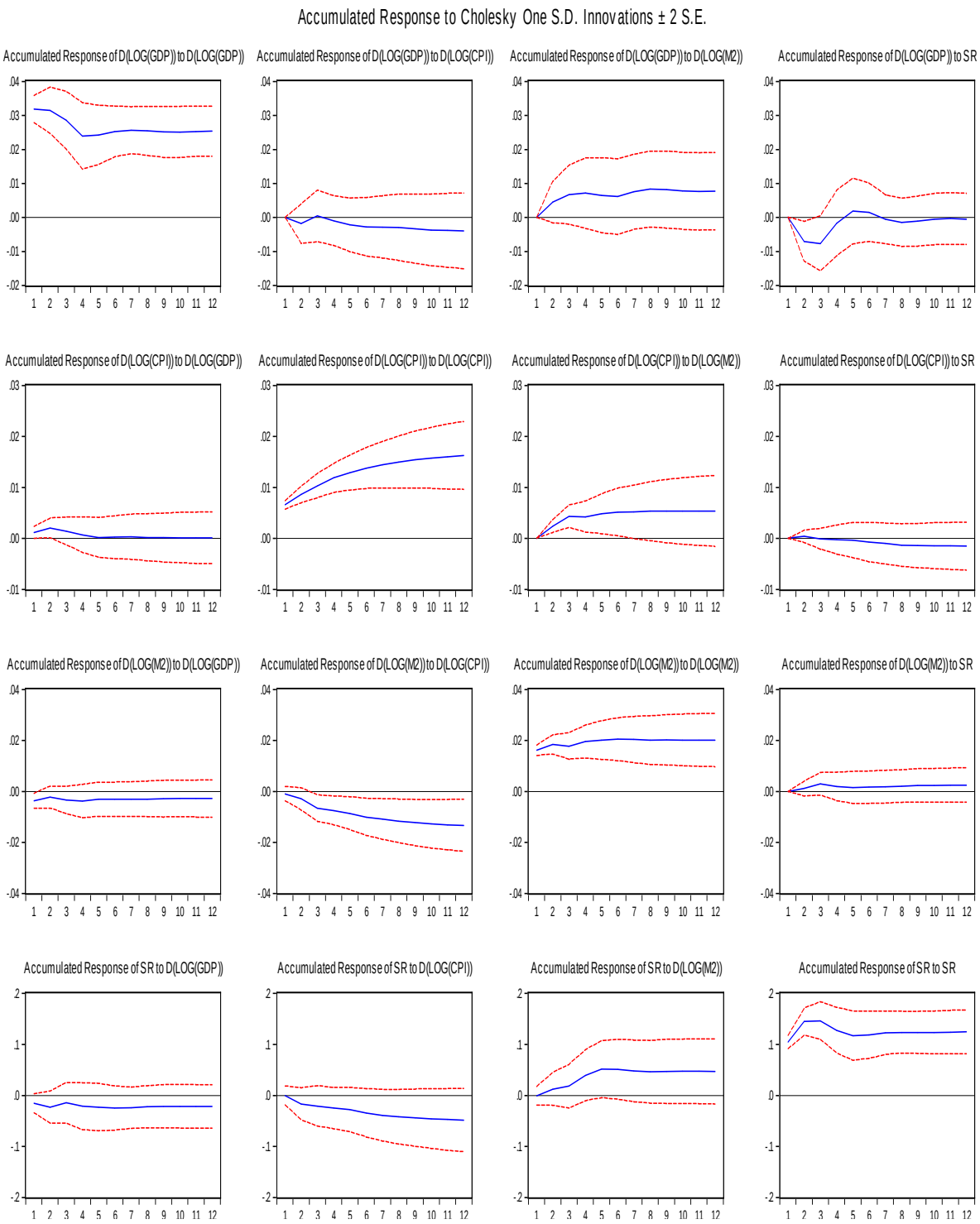
Response of SR:

Perio...	D(LOG(GDP...	D(LOG(CPI)...	D(LOG(M2))	SR
1	-0.015307	-0.001699	-0.001316	0.105366
	(0.00936)	(0.00931)	(0.00931)	(0.00659)
2	-0.007208	-0.015589	0.011359	0.042858
	(0.00989)	(0.01025)	(0.01060)	(0.00993)
3	0.008014	-0.004758	0.005095	0.005087
	(0.00967)	(0.00934)	(0.01090)	(0.01020)
4	-0.005784	-0.003790	0.022900	-0.018764
	(0.01013)	(0.00775)	(0.01120)	(0.00987)
5	-0.000940	-0.002328	0.013824	-0.011765
	(0.00605)	(0.00614)	(0.00793)	(0.00828)
6	-0.002485	-0.006593	0.000979	0.000685
	(0.00446)	(0.00442)	(0.00552)	(0.00588)
7	0.000165	-0.004819	-0.002529	0.003022
	(0.00437)	(0.00302)	(0.00415)	(0.00490)
8	0.001543	-0.003032	-0.001950	0.001349
	(0.00252)	(0.00251)	(0.00312)	(0.00413)
9	0.001134	-0.002283	0.000257	-0.000198
	(0.00156)	(0.00201)	(0.00200)	(0.00229)
10	0.000227	-0.001748	0.000422	-0.000202
	(0.00132)	(0.00163)	(0.00146)	(0.00185)

Cholesky Ordering: D(LOG(GDP)) D(LOG(CPI)) D(LOG(M2)) S...
Standard Errors: Analytic

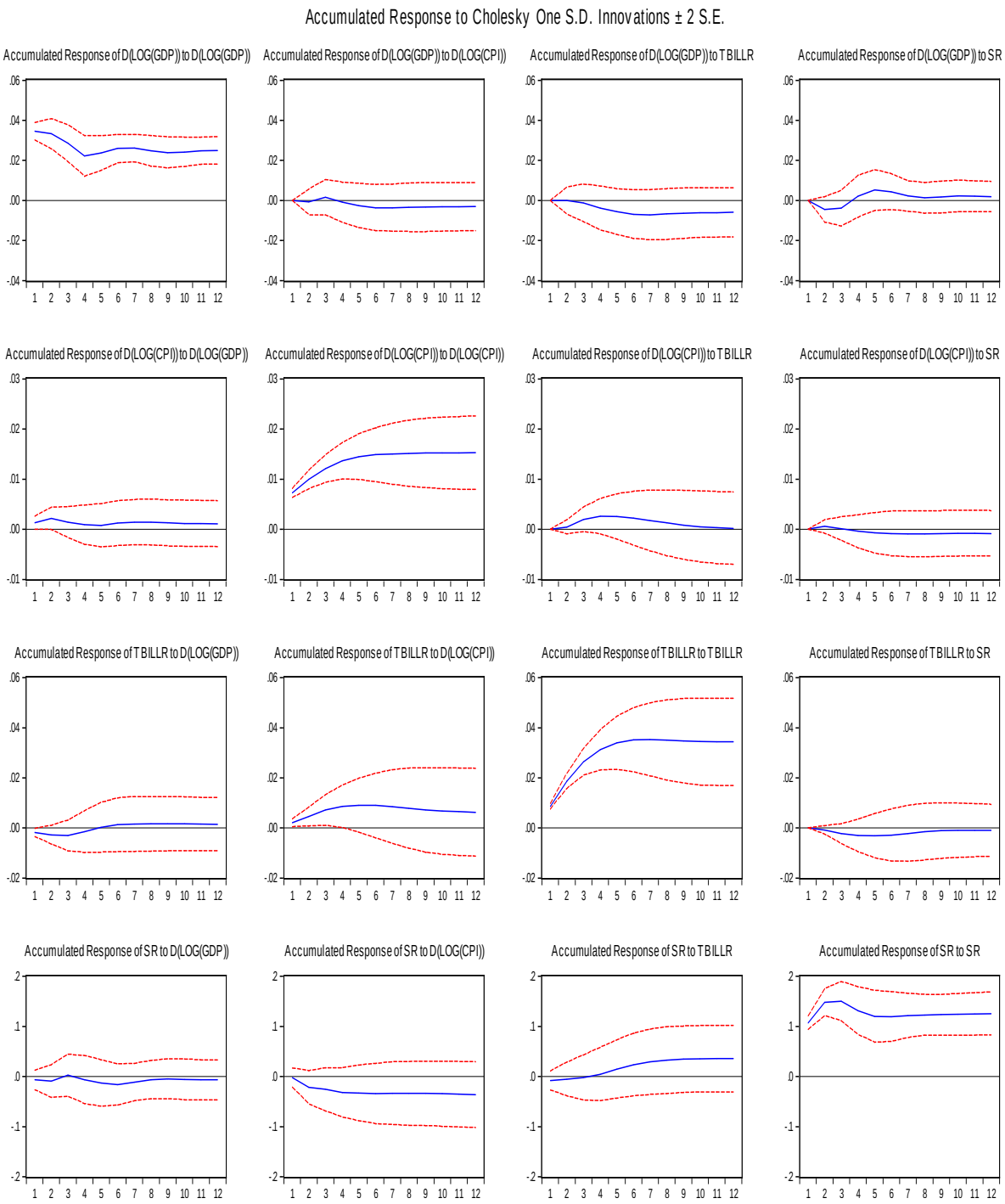
Appendix 6: Accumulated Responses Functions

VAR model: GDP, CPI, M2 and market stock returns



Appendix 7: Accumulated Responses Functions

VAR model: GDP, CPI, TBILLR and market stock returns



Appendix 8: Accumulated Responses Functions for VAR models with data in levels

Instead of estimating the model with the first differences of the non-stationary data, we also attempt to estimate the same model with data in levels.

First, we test if there is any cointegrating relationship among variables. Johansen test suggest that there is one cointegrating relationship among variables and thus, we can estimate a VAR model in levels. The results for the Johansen test are as follows.

Date: 08/15/15 Time: 17:12
Sample (adjusted): 2001M06 2011M12
Included observations: 127 after adjustments
Trend assumption: Linear deterministic trend
Series: LOG(GDP) LOG(CPI) LOG(M2) SR
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.244182	63.04503	47.85613	0.0010
At most 1	0.118552	27.49085	29.79707	0.0902
At most 2	0.086275	11.46486	15.49471	0.1845
At most 3	4.90E-05	0.006221	3.841466	0.9366

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

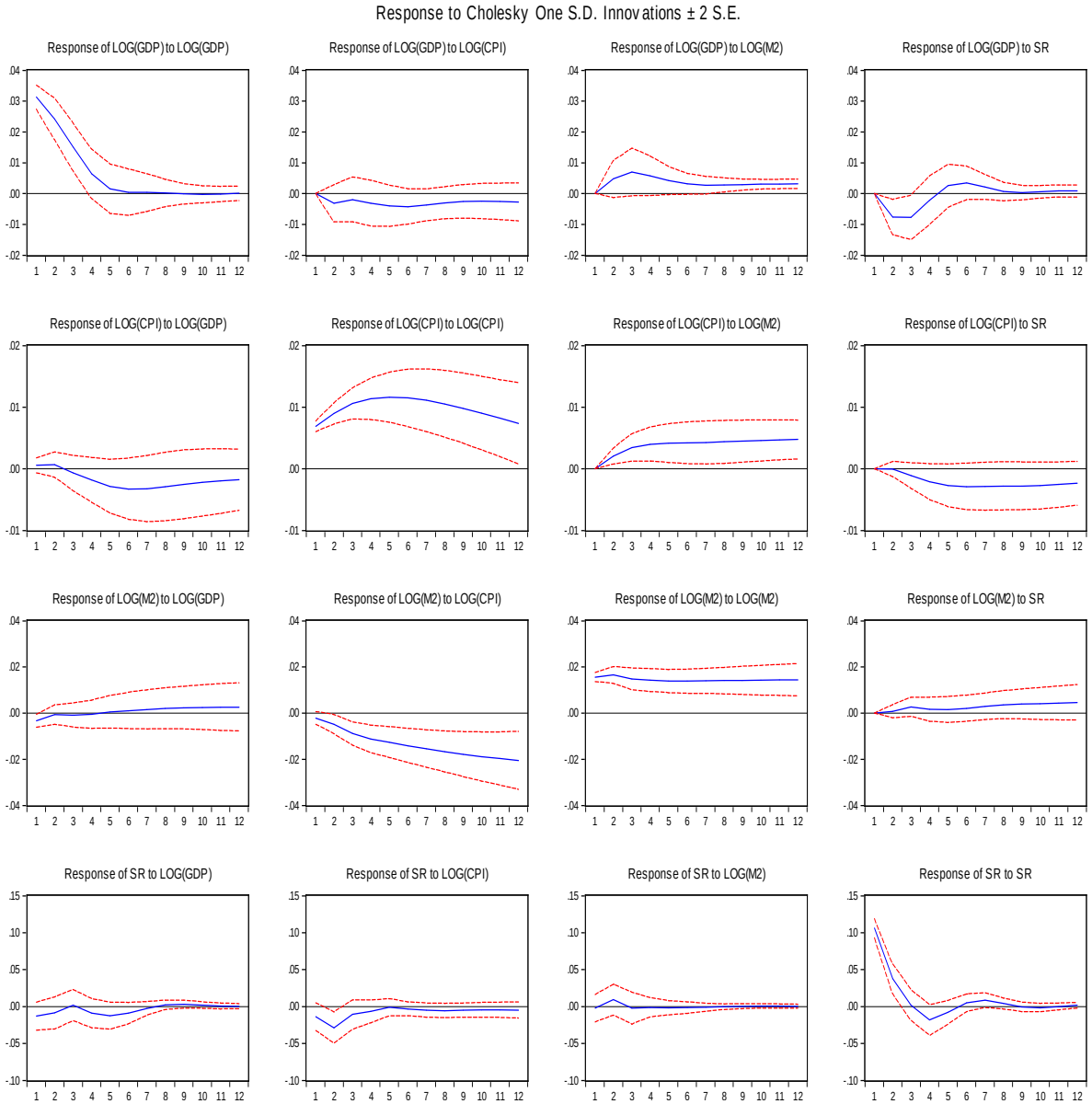
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.244182	35.55418	27.58434	0.0039
At most 1	0.118552	16.02599	21.13162	0.2233
At most 2	0.086275	11.45864	14.26460	0.1327
At most 3	4.90E-05	0.006221	3.841466	0.9366

We then obtain the following impulses responses and accumulated impulses responses functions. In summary, the responses of stock returns to monetary policy as well as the

responses of central bank to financial market performance are found to be insignificant when we estimate data in levels.

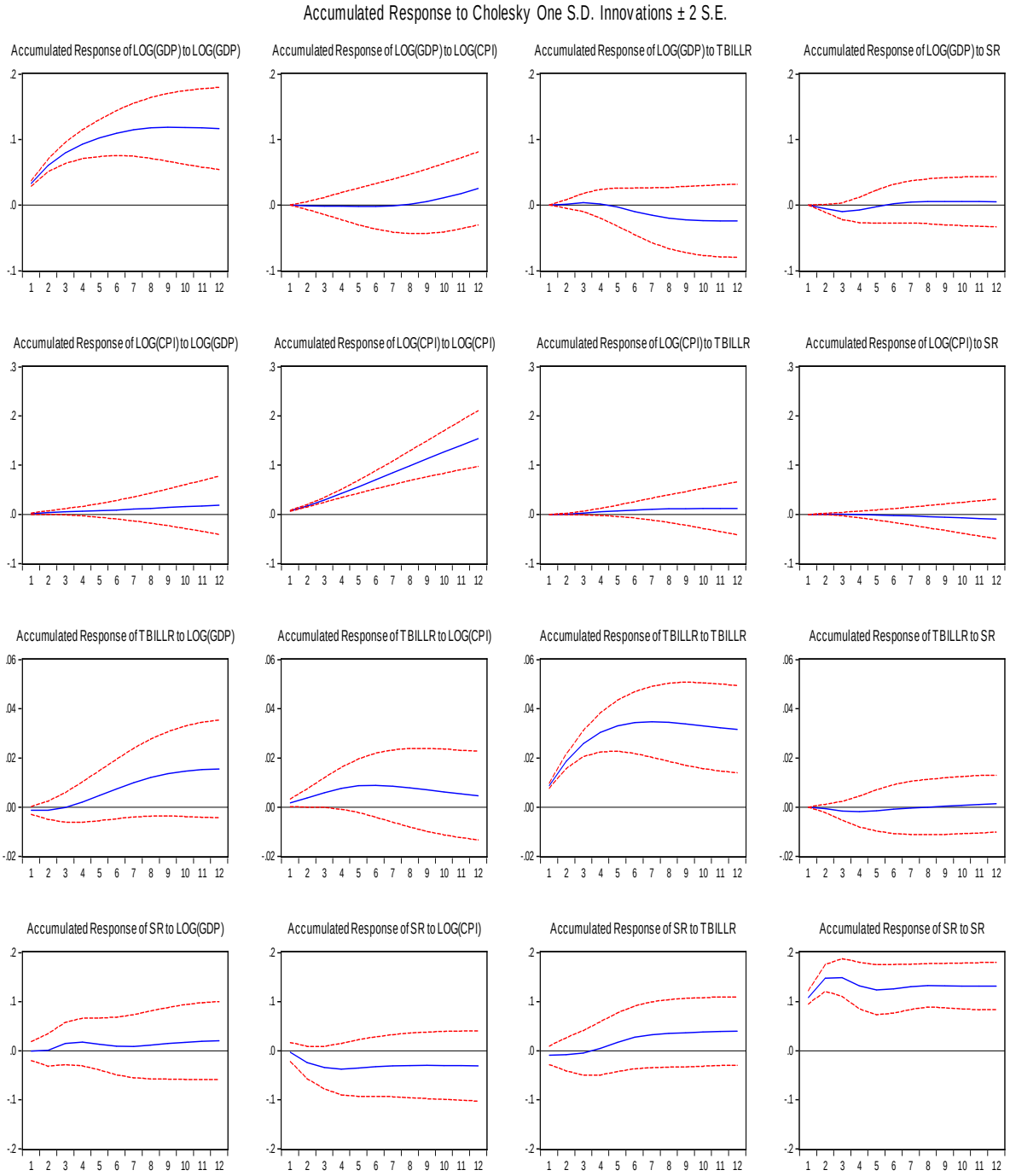
Accumulated Impulses Responses:

VAR model in level: GDP, CPI, M2 and stock returns



Accumulated Impulses Responses:

VAR model in level: GDP, CPI, TBILLR and stock returns



Appendix 9: Data set

DATE	GDP	CPI	ER	PO	PR	LENDR	TBILLR	M2	SR	TR
Jan-01	269977.65	80.43	14545	48.64	68.63	10.65%	5.00%	208379.90	18.84%	3537.98
Feb-01	272860.37	80.76	14564	51.06	68.10	10.80%	5.10%	209841.80	2.69%	3607.12
Mar-01	274733.69	80.16	14544	46.89	67.07	10.50%	5.10%	216185.40	6.70%	3423.24
Apr-01	295934.36	79.76	14566	48.09	63.59	9.45%	5.20%	217303.00	19.22%	3454.66
May-01	292006.29	79.62	14661	51.64	64.47	9.60%	5.30%	219492.00	25.91%	3723.61
Jun-01	299171.40	79.62	14846	50.55	65.51	9.00%	5.40%	226932.70	23.75%	3523.49
Jul-01	293332.37	79.49	14943	46.48	66.82	9.00%	5.40%	231262.50	-15.56%	3675.37
Aug-01	307458.55	79.49	15018	48.37	65.40	9.00%	5.40%	233225.80	-34.34%	3911.45
Sep-01	312373.68	79.89	14999	46.91	66.18	9.00%	5.50%	235254.80	-11.87%	3782.28
Oct-01	298903.45	79.76	15029	38.85	65.94	9.00%	5.45%	239741.40	6.48%	4056.05
Nov-01	295368.92	79.96	15063	35.03	65.16	8.52%	5.45%	245194.00	10.85%	3770.45
Dec-01	298299.25	80.63	15083	34.71	67.97	8.52%	5.45%	250845.70	-18.41%	3765.13
Jan-02	307457.28	81.52	15124	35.89	72.62	8.55%	5.51%	257112.40	-11.83%	3792.76
Feb-02	320285.70	83.35	15138	37.45	73.50	8.50%	5.64%	256076.80	-7.93%	3967.74
Mar-02	323275.45	82.64	15186	44.31	70.88	8.50%	5.80%	256018.40	4.74%	3990.31
Apr-02	323557.97	82.64	15221	47.66	71.01	8.46%	5.70%	260442.40	4.16%	3919.43
May-02	324257.77	82.94	15247	48.15	73.25	8.46%	5.25%	264988.80	-0.65%	3930.30
Jun-02	305078.48	83.05	15273	45.90	73.49	9.33%	5.33%	263877.00	-2.44%	3893.70
Jul-02	303460.16	82.94	15320	48.26	70.98	9.54%	5.67%	268028.00	-2.22%	3859.39
Aug-02	307741.86	83.05	15330	50.19	69.62	9.48%	5.75%	268515.30	-2.99%	3883.33
Sep-02	311772.20	83.15	15344	53.00	69.64	9.48%	5.75%	269683.80	-4.97%	3940.36
Oct-02	311922.57	83.45	15362	51.60	69.87	9.48%	5.85%	274901.60	-2.48%	3995.92
Nov-02	306632.62	83.65	15384	46.46	69.97	9.48%	6.00%	278166.40	0.15%	4070.46
Dec-02	313521.93	83.96	15401	52.27	69.20	9.48%	6.00%	284144.30	3.07%	4231.82
Jan-03	334032.10	84.67	15431	57.67	73.73	9.48%	6.01%	300916.50	-5.97%	4938.51
Feb-03	357810.90	86.50	15430	61.63	73.53	9.30%	6.10%	298313.90	-4.51%	5168.82

Mar-03	346114.53	85.99	15454	56.90	72.67	9.46%	6.10%	300781.00	-11.66%	5529.63
Apr-03	340031.80	85.99	15463	47.78	72.22	9.42%	5.98%	305178.50	4.90%	5875.05
May-03	332403.91	85.89	15471	48.84	71.92	9.46%	5.83%	313123.10	-0.20%	6208.65
Jun-03	335362.37	85.69	15496	52.31	73.20	9.46%	5.98%	324526.90	0.02%	6440.35
Jul-03	332613.84	85.38	15514	53.59	71.92	9.53%	6.16%	326319.20	-3.91%	6070.62
Aug-03	335867.20	85.38	15520	55.63	70.62	9.53%	6.20%	329945.50	-2.47%	5912.28
Sep-03	326904.13	85.38	15554	50.38	70.90	9.57%	6.20%	341302.71	-2.38%	6192.63
Oct-03	331801.39	85.28	15642	54.37	69.93	9.47%	6.25%	350632.72	-2.23%	6293.20
Nov-03	332599.22	85.79	15626	54.58	69.46	9.54%	6.25%	358799.60	20.31%	6289.80
Dec-03	329362.60	86.50	15642	56.13	67.50	9.54%	6.25%	378059.80	1.87%	6359.13
Jan-04	337532.49	87.41	15695	58.85	69.98	9.54%	6.20%	392867.28	28.38%	6589.69
Feb-04	345969.80	90.05	15757	58.70	71.94	9.54%	6.07%	392122.16	21.59%	6669.55
Mar-04	347398.55	90.76	15723	63.11	81.81	9.54%	5.16%	404093.02	6.46%	6412.31
Apr-04	353669.26	91.17	15720	63.18	86.23	9.54%	4.88%	410769.93	-4.69%	6340.31
May-04	367145.92	91.98	15743	70.53	88.05	9.54%	5.05%	417129.42	-4.70%	6371.79
Jun-04	369035.87	92.79	15722	66.61	85.99	9.54%	5.25%	420262.71	-0.91%	6526.84
Jul-04	375047.70	93.20	15748	71.09	84.87	9.54%	5.50%	427403.40	-4.51%	6759.60
Aug-04	381220.59	93.81	15760	78.87	90.43	9.63%	5.50%	438362.80	-2.54%	6730.13
Sep-04	375034.77	94.01	15755	78.06	90.18	9.87%	5.68%	445393.07	0.35%	6867.88
Oct-04	379525.96	94.01	15745	87.85	90.38	10.01%	5.72%	456961.13	-0.26%	6927.96
Nov-04	363314.49	94.21	15773	79.15	91.33	0.00%	5.60%	472445.63	-1.30%	6995.30
Dec-04	354324.60	94.82	15773	73.27	94.24	10.25%	5.80%	495447.28	4.24%	7186.07
Jan-05	371851.30	95.84	15785	80.39	96.42	10.25%	5.85%	503130.58	-2.49%	7940.46
Feb-05	372839.36	98.27	15803	83.52	97.09	11.10%	5.85%	510205.38	0.76%	7969.14
Mar-05	383753.61	98.38	15818	95.46	98.25	11.10%	5.85%	517024.26	4.85%	8067.89
Apr-05	389396.61	98.98	15828	94.91	102.02	10.80%	5.85%	526885.16	-0.11%	8410.80
May-05	386808.60	99.39	15855	89.61	101.46	10.80%	5.45%	533128.27	-0.82%	8412.21
Jun-05	393796.26	99.80	15849	101.00	101.34	11.03%	5.95%	544600.54	1.05%	8008.94

Jul-05	401302.47	100.20	15878	105.65	100.42	11.03%	6.00%	548351.54	2.65%	8139.69
Aug-05	411630.99	100.61	15873	115.96	100.76	11.03%	6.03%	566701.32	0.45%	8512.27
Sep-05	411898.11	101.42	15900	115.55	101.82	11.18%	6.08%	577793.22	13.69%	8752.77
Oct-05	401648.74	101.83	15893	109.06	102.62	11.18%	6.10%	588308.57	6.25%	8987.68
Nov-05	393902.61	102.23	15913	103.05	98.97	11.40%	6.19%	604791.28	1.28%	9002.11
Dec-05	397543.33	103.05	15918	105.84	98.27	11.40%	6.20%	648573.74	-1.23%	9216.47
Jan-06	412481.44	104.26	15918	116.88	97.26	11.18%	6.25%	677388.47	1.57%	10159.01
Feb-06	419461.26	106.50	15910	111.91	100.77	11.18%	6.15%	675823.17	25.08%	10365.03
Mar-06	408610.34	105.99	15925	114.20	100.14	11.18%	6.09%	699988.45	28.90%	10907.96
Apr-06	425315.86	106.19	15940	127.45	97.85	11.18%	6.18%	704993.71	18.25%	11345.36
May-06	432227.30	106.80	15958	128.59	98.81	11.18%	6.30%	714822.65	-9.50%	11556.15
Jun-06	438459.46	107.21	15996	127.99	101.11	11.18%	6.30%	727165.42	-4.33%	11458.39
Jul-06	444918.26	107.61	16006	135.90	102.45	11.18%	6.28%	735204.80	-18.07%	11522.40
Aug-06	448238.20	108.02	16014	134.59	101.76	11.18%	6.25%	751781.43	16.28%	11848.83
Sep-06	419210.37	108.32	16055	116.15	101.05	11.18%	5.87%	753011.88	7.24%	12068.74
Oct-06	416156.97	108.63	16075	108.61	99.77	11.18%	5.68%	767106.29	-2.88%	12178.67
Nov-06	422493.90	109.24	16070	108.95	94.79	11.18%	5.12%	789929.68	23.75%	12454.78
Dec-06	416902.64	109.85	16056	114.33	95.60	11.18%	4.04%	841010.72	18.75%	13590.99
Jan-07	408153.59	110.96	16040	100.09	97.29	11.18%	3.71%	872549.42	38.52%	15472.55
Feb-07	423479.84	113.40	15994	107.92	97.45	11.18%	3.44%	905454.77	9.25%	17174.64
Mar-07	431788.17	113.10	16020	113.58	98.66	11.18%	3.36%	949181.07	-5.83%	18533.44
Apr-07	446344.21	113.71	16046	122.01	96.97	11.18%	3.35%	979672.94	-13.76%	19523.16
May-07	452134.90	114.52	16090	122.01	95.76	11.18%	3.34%	1005313.90	17.06%	20480.42
Jun-07	451989.40	115.53	16130	127.81	97.35	11.18%	3.51%	1029561.73	-5.25%	21001.96
Jul-07	474104.85	116.65	16140	138.08	96.72	11.18%	3.56%	1056450.93	-11.39%	21916.03
Aug-07	468219.83	117.26	16240	131.44	97.77	11.18%	3.82%	1076896.02	0.05%	22140.56
Sep-07	478367.38	117.87	16086	144.15	97.53	11.18%	3.91%	1110983.42	15.25%	22813.10
Oct-07	482298.82	118.78	16081	153.97	98.84	11.18%	4.03%	1154499.28	1.74%	23294.54

Nov-07	506750.10	120.20	16045	171.06	104.21	11.18%	4.30%	1183135.05	-8.71%	23690.46
Dec-07	512496.90	123.65	16017	167.62	109.91	11.18%	4.70%	1253997.43	-4.66%	23747.73
Jan-08	522770.52	126.60	15971	170.22	112.66	11.18%	4.80%	1293054.23	-8.94%	24636.32
Feb-08	553489.87	131.17	15931	175.71	135.36	11.18%	8.21%	1280506.18	-21.42%	26147.42
Mar-08	497935.54	135.03	16110	190.88	182.53	14.60%	15.60%	1300249.22	-22.08%	26743.98
Apr-08	489975.34	138.07	16122	204.39	276.64	14.27%	15.40%	1278398.47	1.07%	25588.39
May-08	487946.13	143.45	16246	230.10	279.51	16.53%	14.15%	1298039.01	-20.73%	23899.61
Jun-08	496397.36	146.50	16842	246.50	239.00	19.11%	10.85%	1295492.15	-3.55%	22559.77
Jul-08	481706.41	148.12	16765	248.43	230.89	20.25%	8.56%	1300594.09	13.01%	22054.29
Aug-08	466380.59	150.46	16525	214.73	215.22	20.19%	7.49%	1302892.53	19.44%	22651.14
Sep-08	438564.88	150.76	16724	186.10	213.57	19.86%	6.00%	1347513.93	-15.28%	24135.80
Oct-08	445095.82	150.46	16825	136.24	185.31	18.00%	6.88%	1367228.43	-24.01%	24070.12
Nov-08	505856.31	149.34	16972	101.29	170.49	13.26%	7.20%	1394619.87	-9.31%	23507.67
Dec-08	499389.23	148.32	17483	77.84	166.42	10.98%	7.48%	1513543.89	0.28%	24175.91
Jan-09	506995.31	151.14	17484	82.30	185.32	10.08%	8.18%	1561465.91	-3.93%	23123.16
Feb-09	510923.04	151.47	17479	78.27	193.19	9.39%	8.36%	1589602.96	-18.95%	22963.16
Mar-09	520020.49	151.24	17797	88.00	193.01	9.15%	8.30%	1645308.52	14.21%	23308.24
Apr-09	508272.94	150.78	17783	94.24	176.57	9.15%	9.00%	1693558.13	14.59%	21223.76
May-09	518198.50	151.45	17775	108.89	161.34	9.60%	9.13%	1737815.22	27.99%	21098.46
Jun-09	525346.49	152.27	17798	129.57	161.55	9.96%	10.11%	1775952.13	8.90%	20565.93
Jul-09	508330.70	153.07	17818	121.17	182.97	9.96%	10.60%	1800854.37	4.12%	19375.34
Aug-09	525757.34	153.43	17823	134.25	169.09	10.26%	11.69%	1806202.79	17.14%	19110.92
Sep-09	510318.99	154.39	17841	128.16	173.24	10.35%	12.60%	1842315.49	6.24%	19091.13
Oct-09	526415.85	154.95	17862	138.85	163.19	10.46%	12.10%	1866068.85	1.07%	18655.81
Nov-09	535508.59	155.81	18485	145.37	162.56	10.46%	11.20%	1884088.81	-14.14%	17786.74
Dec-09	502727.76	157.96	18479	140.35	173.72	12.00%	11.47%	1910586.86	-1.85%	16803.16
Jan-10	565641.91	160.11	18437	144.54	170.41	12.00%	11.30%	1912147.31	-2.59%	16088.72
Feb-10	575924.06	163.25	19025	140.05	167.19	12.00%	9.19%	1948241.31	3.10%	15852.23

Mar-10	589582.23	164.47	19069	148.63	151.46	12.00%	5.67%	1982388.71	0.47%	14214.89
Apr-10	561699.30	164.70	18958	157.70	139.85	13.86%	8.50%	2022800.19	8.64%	14711.39
May-10	551486.74	165.15	18980	141.58	132.01	13.23%	8.50%	2076119.66	-6.44%	14331.04
Jun-10	542181.43	165.51	19070	140.06	128.43	13.23%	6.40%	2166591.27	-0.06%	14523.73
Jul-10	536262.84	165.60	19080	139.67	131.24	13.25%	7.16%	2174354.22	-2.61%	14296.07
Aug-10	530322.59	165.98	19490	142.22	133.32	13.00%	6.96%	2257347.53	-7.86%	14128.95
Sep-10	526937.25	168.16	19490	142.65	138.29	13.25%	8.11%	2325022.17	-0.12%	14537.11
Oct-10	544901.49	169.93	19498	153.17	137.80	13.25%	7.81%	2339568.62	-0.42%	14529.59
Nov-10	564450.66	173.09	19498	158.43	140.23	13.25%	7.92%	2358708.25	-0.23%	13741.87
Dec-10	529917.49	176.53	19498	168.82	139.66	15.30%	7.48%	2478310.24	7.32%	12926.17
Jan-11	491190.10	179.59	19498	173.67	139.59	15.30%	6.66%	2484090.54	5.35%	12593.25
Feb-11	495990.38	183.35	20878	183.17	141.38	16.42%	6.26%	2512946.71	-9.64%	12421.36
Mar-11	557073.03	187.32	20895	203.64	133.52	16.42%	5.74%	2495421.92	-0.05%	12681.71
Apr-11	582919.65	193.54	20645	218.01	129.96	17.91%	6.02%	2484011.87	4.11%	13106.82
May-11	591388.35	197.82	20545	202.76	130.78	18.08%	6.33%	2485326.57	-12.23%	14040.27
Jun-11	595611.05	199.97	20585	198.39	136.57	18.08%	6.50%	2544738.52	2.65%	15723.83
Jul-11	604559.09	202.31	20595	202.20	141.92	18.09%	6.24%	2580562.44	-6.21%	17567.16
Aug-11	571461.03	204.19	20832	188.27	149.01	18.09%	6.43%	2721518.51	4.69%	16577.18
Sep-11	592003.84	205.87	20830	188.98	161.75	17.55%	6.33%	2673756.80	0.68%	15873.72
Oct-11	621773.99	206.61	21009	187.28	160.66	16.70%	6.08%	2635058.39	-1.59%	15380.98
Nov-11	657450.15	207.42	21006	197.47	162.87	15.51%	5.73%	2652391.11	-9.53%	14672.25
Dec-11	647779.34	208.51	21034	195.41	156.62	15.32%	5.28%	2774281.10	-7.65%	14045.56

[This page is intentionally left blank]

Chapter 4 : BAYESIAN ESTIMATION OF A DSGE MODEL WITH STOCK RETURNS FOR VIETNAM

1 Introduction

Monetary Policy in Vietnam has multiple goals: maintaining economic growth, fighting inflation, stabilizing exchange rate and preserving the stability of the financial system. (The Law on the State Bank of Vietnam, 2007). Despite the efforts, the period of 2007-2010 witness high inflation, deteriorating currency value and unstable financial markets. Headline inflation hit 25% in 2008, the Vietnam dong depreciated by 9 percent in 2009 and stock market capitalization tumbled from 25.2 percent of GDP in 2007 to 9.7 percent of GDP in 2008 (World Bank). In particular, the Vietnam Stock bubble busted when Vietnam stock index lost more than two thirds of its value from 2007 to 2009, dropping from 909 points to 280 points (Bloomberg Database). As a result, financial investors' confidence deteriorated drastically. The new Law on State Bank of Vietnam in 2010 consequently agreed to put more emphasis on curbing inflation while balancing financial sector stability and maintaining output growth.

This chapter is inspired by the studies of Cechetti et al (2000, 2002, 2003), in which a Central Bank that recognizes a bubble in the stock market is recommended to react to it by putting financial market condition in the policy decision making process. The said studies, following the same model in Bernake and Gertler (1999), show that adding a reaction to stock prices in the policy rule reduces overall volatility in the economy. This is

essentially what State Bank of Vietnam need to investigate in order to establish financial stability.

The interaction between monetary policy shocks on financial market has often been assessed with the use of Vector AutoRegressions (VARs). Chapter 3 of this dissertation follows this approach and finds a link between monetary policy and the Vietnam stock market. VARs approach assumes an ordering in which variables come later only response with some lags. The financial market, therefore, only reacts to monetary policy with some delay in the VAR set up (Christiano et all (1996)). This assumption, though rational, is not always true in practice as assets price is commonly known to be sensitive and reacts immediately to news on monetary policy. The standard New Keynesian DSGE model of business cycle that allows for contemporaneous interactions can solve the above problem. Moreover, the major advantage of a dynamic stochastic New Keynesian model over a more agnostic, but possibly less informative VAR set up, consists in its complex micro-foundations system that bases on the preference of decision makers in the model. Decision makers in the DSGE model are often subject to various random shocks such as technology, preference and macroeconomic policy-making shocks which make the model closely reflects the real economy.

Castelnouvo & Nistico (2010) and Nistico (2012) consider a framework in which stock prices and monetary policy instruments are allowed to enter demand side and work through wealth effects on household's consumption. The demand side in Nistico (2012) consists of households facing a possibility of leaving the financial market in each period

and being switched by new households who enter the financial markets holding no wealth at all. This assumption allows reaction to changes in the financial wealth to be imperfectly smoothed out through aggregation and stock price fluctuations; and thereby affect aggregate demand and enter the IS function. The supply side in this framework consists of profit maximizing monopolistic firms whose profits will be securitized and sold in a financial market. Households will have a choice of buying stocks or state-contingent bonds. Finally, a Taylor-type policy rule with financial market condition allows but does not require the policy decisions to react to financial volatility.

In this paper, we estimate two models with Vietnam data: the original framework by Nistico (2012) and an empirical version of the same model following an estimation strategy proposed by Castelnouvo (2013). This strategy introduces both backward looking and forward looking behavior to the Philips curve and the IS curve, together with an interest rate smoothing parameter in the monetary decision rule. We fit the model to Vietnam data from 2001Q2 to 2012Q4 and estimate with Bayesian techniques in DYNARE. As an empirical proxy for Vietnam financial market condition, we employ stock return which is the most readily available data in Vietnam that intuitively connects financial market with household's wealth and consumption decision. To our knowledge, this is the first contribution to estimating a structural DSGE model with financial market component for the Vietnam economy.

Our main results can be summarized as follows.

First, the link between asset prices and household consumption decision via wealth effect seems weak in Vietnam. Household's consumption is unresponsive to increases in stock returns as the parameter reflecting the impact of stock returns to household consumption decision, and subsequently to the output gap in the IS curve, turns out to be insignificant. This result is not surprise in light of the modest size and high volatility of the financial market.

Second, we identify that the financial market condition is one subject of concern for the State Bank of Vietnam as it enters the central bank's decision rule with a significant impact. These results highlight that SBV is monitoring its financial market and take into account asset price performance in the process of policy decision making.

The chapter is structured as follows. Section 2 presents Nistico (2012)'s micro-founded New Keynesian Model of the business cycles and some of the equation derivations. Section 3 discusses our estimation strategy and results. Section 4 concludes and proposes policy implications.

2 The Model

In this section, we introduce Nistico (2012)'s Dynamic Stochastic New Keynesian model with financial market conditions.

2.1 Households

We first portray the household sector by describing its demographics, characteristics, preferences, the resulting behavior by individuals and the aggregation across the different age groups.

2.1.1 Demography

Following Blanchard (1985) Perpetual Youth Model, Nistico (2012) assumes that the expected remaining time in the financial market for any individual in the demand-side of the economy is independent of age. It is also assumed that people stay in the labor market until death (perpetual youth), ignoring retirement at old age assumption as in overlapping generation models.

The demand side of the economy consists of an indefinite number of households, who enter the financial market in period j and face a constant probability γ of being replaced by new comers before the next period begins (or survival rate 1- γ). As the results, the household sector consists of an indefinite number of cohorts whose participation time in the financial market is different from one another. The existence of replacement probability γ introduces heterogeneity in households which latter allows the accumulation of financial wealth in the aggregate consumption equation. Specifically, γ does not let the effects of financial wealth be smoothed out perfectly during the process of aggregation across cohorts and therefore, allow these effects enter the aggregate demand equation. With replacement probability γ approaches 0, this model becomes the standard New-Keynesian model with a

representative agent. During Bayesian estimation of the model, γ is allocated a normal distribution which allows γ to be zero or non-zero.

Households supply labor, earn wage income and demand consumption goods and two type of financial assets: state-contingent bonds and equity shares issued by the monopolistic (wholesale) firms. This feature of having a stock market for shares on profits distributed by firms is another departure from the Standard New-Keynesian model.

2.1.2 Preference

Each household has a Cobb-Douglas preference over consumption and leisure. Such preferences face stochastic shocks that shifts the marginal utility of consumption and are denoted as:

$$V_t \equiv \exp(\nu_t)$$

These preference shocks, as described later in the first order conditions, affect the equilibrium discount factor $F_{t,t+1}$ and the dynamics of stock prices. Changes in preferences in consumers' consumption, therefore, are link to changes in stock prices.

A standard log-utility function of a j-period-old household at time 0 is described as follows:

$$U(C_t, N_t) = \delta log C_{j,t} + (1-\delta)\log(1 - N_{j,t})$$

where $C_{j,t}$ denotes real consumption and $N_{j,t}$ denotes number of hours worked. δ is the preference parameter.

2.1.3 Households' problem

Households spend income from labor and financial assets returns, net of tax, on two components: consumption and financial assets acquisition.

Households enter financial markets in period j, choose a pattern for numbers of hours worked $N_{j,t}$ and financial assets holdings ($B^*_{j,t+1}$ and $Z^*_{j,t+1}$) seeking to maximize their expected lifetime utility which is discounted by the inter-temporal discount factor (the pure rate of time preference) to account for impatience β, and by the probability of survival across two subsequent periods, 1-γ to account for uncertain stay in financial markets

The maximizing problem at time 0 by the j-period-old representative consumer is

$$Max \qquad E_0 \sum_{t=0}^{\infty} \beta^t (1-\gamma)^t V_t \quad [\delta log C_{j,t} + (1-\delta)\log(1-N_{t,j}\ )]$$

$$\{N_{j,t}, B^*_{j,t+1}, Z_{j,t+1}\} \qquad (1)$$

subject to the budget constraints of the form:

$$P_t C_{t,j} + E_t \{F_{t,t+1} B^*_{j,t+1}\} + P_t \int_0^1 Q_t(i) Z_{j,t+1}(i) di \leq W_t N_{j,t} - P_t T_t + \Omega^*_{j,t} \qquad (2)$$

where E_0 is the expectation operator conditioned on information available at time 0, W_t denotes wage income from labor, $B^*_{j,t+1}$ denotes the one-period ahead expected payoffs of a set of contingent claims, $F^*_{t,t+1}$ denotes the associated discount factor of the contingent claims, $Z_{j,t+1}$ denotes the set of equity shares issued by wholesale firms, $Q_t(i)$ denotes the real price of equity shares at time t, T_t denotes lump-sum taxes, which is assumed to be uniformly distributed across cohorts.

In the budget constraint (2), the current discounted bond price is given by the expectation of the discounted bond payoff one period later $E_t\{F_{t,t+1}\, B^*_{j,t+1}\}$ under an important assumption that the contingent claims are risk-free. Contingent claims in this model are called Arrow securities which have two features: 1) they are risk-free one-period claims that are traded every period and 2) they represent rights to receive pre-specified payoffs at a pre-specified state or zero payoffs otherwise. Details on Arrow assets pricing measure can be found in Kwok (2008, pp 40-41).

$\Omega^*_{j,t}$ denotes nominal financial wealth carried over from the previous period, defined by:

$$\Omega^*_{j,t} \equiv \frac{1}{1-\gamma}\left[B^*_{j,t} + P_t \int_0^1 (Q_t(i) + D_t(i)) Z_{j,t}(i)di\right] \quad (3)$$

The Bellman equation for this problem is

$$U\left(B^*_{j,t}, Z_{j,t}\right) = \max\{(1-\gamma)^t V_t[\left(\delta log C_{j,t} + (1-\delta)\log\left(1-N_{j,t}\right)\right]\}$$
$$+ \beta E_t (1-\gamma)^t V_t U\left(B^*_{j,t+1}, Z_{j,t+1}\right)$$

subject to (2).

The first order conditions for the household's problem are:

1. $\frac{\partial u\left(C_{j,t-1}, N_{j,t-1}\right)}{\partial N_{j,t}}$:

$$\frac{(1-\gamma)^t V_t \delta}{C_{j,t}} \frac{W_t}{P_t} - \frac{(1-\delta)(1-\gamma)^t V_t}{1-N_{j,t}} = 0$$

$$\frac{\delta}{C_{j,t}}\frac{W_t}{P_t} = \frac{1-\delta}{1-N_{j,t}}$$

$$C_{j,t} = \frac{\delta}{1-\delta}\frac{W_t}{P_t}(1-N_{j,t}) \quad (4)$$

2. $\frac{\partial u(C_{j,t-1},N_{j,t-1})}{\partial B^*_{j,t+1}}$:

$$\frac{(1-\gamma)^t V_t \delta}{C_{j,t}}\frac{1}{P_t}\left[-\left(E_t F_{t,t+1}\right)\right] + \beta\frac{(1-\gamma)^{t+1}V_{t+1}\delta}{C_{j,t+1}}\frac{1}{P_{t+1}(1-\gamma)} = 0$$

$$E_t F_{t,t+1} = \beta\frac{V_{t+1}}{V_t}\frac{P_t}{P_{t+1}}\frac{C_{j,t}}{C_{j,t+1}} = \beta\frac{P_t C_{j,t}}{P_{t+1}C_{j,t+1}}\exp(v_{t+1}-v_t) \quad (5)$$

3. $\frac{\partial u(C_{j,t-1},N_{j,t-1})}{\partial Z_{j,t+1}}$:

$$\frac{(1-\gamma)^t V_t \delta}{C_{j,t}}(-\frac{P_t}{P_t})Q_t(i)Z_{j,t+1}(i)$$

$$= \beta\frac{(1-\gamma)^{t+1}V_{t+1}\delta}{C_{j,t+1}}\frac{P_{t+1}}{P_{t+1}}\frac{1}{(1-\gamma)}(Q_{t+1}(i)+D_{t+1}(i))Z_{j,t+1}(i)$$

$$\frac{Q_t(i)}{Q_{t+1}(i)+D_{t+1}(i)} = \beta\frac{V_{t+1}}{V_t}\frac{C_{j,t}}{C_{j,t+1}}$$

Rewrite using equation (5):

$$\frac{Q_t(i)}{Q_{t+1}(i)+D_{t+1}(i)} = E_t F_{t,t+1}\frac{P_{t+1}}{P_t}$$

$$P_t Q_t(i) = E_t F_{t,t+1}P_{t+1}(Q_{t+1}(i)+D_{t+1}(i)) \quad (6)$$

Equation (4) is the intra-temporal optimality condition with respect to consumption and leisure. It shows the best combination of consumption and hours worked possibly achieved with respect to real wage.

Equation (5) describes the equilibrium stochastic discount factor for one-period ahead nominal payoffs (of contingent bonds), as a function of the inter-temporal discount factor β. Equation (5) points out that at the individual level, the stochastic discount factor and the inter-temporal marginal rate of substitution in consumption are equivalent.

In equation (6), the nominal price of an equity share is equal to the its nominal expected payoff one-period ahead which is the sum of expected equity price in period t+1 and its dividends, discounted by the stochastic factor $F_{t,t+1}$. Equation (6) defines stock price dynamics and explains how stock price evolves overtime.

Using equation (3), the nominal financial wealth at period t+1 can be written as:

$$\Omega^*_{j,t+1} \equiv \frac{1}{1-\gamma}\left[B^*_{j,t+1} + P_{t+1}\int_0^1 (Q_{t+1}(i) + D_{t+1}(i))Z_{j,t+1}(i)di\right]$$

Multiplying both sides by $F_{t,t+1}$ and using integral properties give us:

$$F_{t,t+1}(1-\gamma)\Omega^*_{j,t+1} \equiv F_{t,t+1}B^*_{j,t+1} + \int_0^1 F_{t,t+1}P_{t+1}\,(Q_{t+1}(i) + D_{t+1}(i))Z_{j,t+1}(i)di$$

Rewrite using equation (6):

$$F_{t,t+1}(1-\gamma)\Omega^*_{j,t+1} \equiv F_{t,t+1}B^*_{j,t+1} + P_t\int_0^1 Q_t(i)Z_{j,t+1}(i)di$$

Plug the above equation into the equilibrium budget constraint (2), we obtain:

$$P_t C_{t,j} + E_t\left\{F_{t,t+1}(1-\gamma)\Omega^*_{j,t+1}\right\} = W_t N_{j,t+1} - P_t T_t + \Omega^*_{j,t}$$

Plug equation (4) into the above equation and rearrange:

$$\frac{1}{\delta} P_t C_{j,t} + E_t\left\{F_{t,t+1}(1-\gamma)\Omega^*_{j,t+1}\right\} = W_t - P_t T_t + \Omega^*_{j,t} \quad (7)$$

Equation (7) gives the form of the stochastic difference in financial wealth $\Omega^*_{j,t}$.

Solving equation (7) forward:

$$\Omega^*_{j,t} = \frac{1}{\delta} P_t C_{j,t} + E_t\left\{F_{t,t+1}(1-\gamma)\Omega^*_{j,t+1}\right\} - (W_t - P_t T_t)$$

$$\Omega^*_{j,t+1} = \frac{1}{\delta} P_{t+1} C_{j,t+1} + E_{t+1}\left\{F_{t,t+2}(1-\gamma)\Omega^*_{j,t+2}\right\} - (W_{t+1} - P_{t+1} T_{t+1})$$

$$\Omega^*_{j,t+2} = \frac{1}{\delta} P_{t+2} C_{j,t+2} + E_{t+2}\left\{F_{t,t+3}(1-\gamma)\Omega^*_{j,t+3}\right\} - (W_{t+2} - P_{t+2} T_{t+2})$$

…….

$$\Omega^*_{j,t} = \frac{1}{\delta} P_t C_{j,t} + E_t\left\{F_{t,t+1}(1-\gamma)\frac{1}{\delta} P_{t+1} C_{j,t+1} + F_{t,t+1}F_{t+1,t+2}(1+\gamma)^2\Omega^*_{j,t+2} - F_{t,t+1}(1 - \gamma)(W_{t+1} - P_{t+1} T_{t+1})\right\} - (W_{t+1} - P_{t+1} T_{t+1})$$

$$\Omega_{j,t}^{*} = \frac{1}{\delta} P_t C_{j,t} + E_t \Big\{ F_{t,t+1}(1-\gamma)\frac{1}{\delta} P_{t+1} C_{j,t+1} + F_{t,t+1}F_{t,t+2}(1-\gamma)^2 \frac{1}{\delta} P_{t+2} C_{j,t+2}$$
$$+ F_{t,t+1}F_{t,t+2}F_{t,t+3}(1-\gamma)^3 \Omega_{j,t+3}^{*})$$
$$- F_{t,t+1}F_{t,t+2}(1-\gamma)^2 (W_{t+2} - P_{t+2}T_{t+2}) - F_{t,t+1}(1$$
$$- \gamma)(W_{t+1} - P_{t+1}T_{t+1}) \Big\} - (W_{t+1} - P_{t+1}T_{t+1})$$

$$\Omega_{j,t}^{*} = \frac{1}{\delta} E_t \sum_{k=0}^{\infty} (1-\gamma)^k F_{t,t+k} P_{t+k} C_{j,t+k} - E_t \sum_{k=0}^{\infty} F_{t,t+k}(1-\gamma)^k (W_{t+k} - P_{t+k}T_{t+k}) \quad (8)$$

Let us now assume that cohort j at time t is endowed with a set of labor hours. Labor income earned from hours worked, net of taxes is defined as the nominal human wealth, $h_{j,t}^{*}$

$$h_{j,t}^{*} \equiv E_t \sum_{k=0}^{\infty} F_{t,t+k}(1-\gamma)^k (W_{t+k} - P_{t+k}T_{t+k}) \quad (9)$$

Substituting (9) into (8) gives:

$$\Omega_{j,t}^{*} = \frac{1}{\delta} E_t \sum_{k=0}^{\infty} (1-\gamma)^k F_{t,t+k} P_{t+k} - h_{j,t}^{*}$$

Recalling the definition of the equilibrium stochastic discount (5) and substitute it to the above expression:

$$\Omega_{j,t}^{*} = \frac{1}{\delta} E_t \left\{ \sum_{k=0}^{\infty} (1-\gamma)^k \beta^k \frac{P_t C_{j,t}}{P_{j,t+k} C_{j,t+k}} \exp(v_{t+k} - v_t) P_{t+k} C_{j,t+k} \right\} - h_{j,t}^{*}$$

$$\Omega_{j,t}^{*} = \frac{1}{\delta} P_t C_{j,t} E_t \{ \sum_{k=0}^{\infty} \beta^k (1-\gamma)^k \exp(v_{t+k} - v_t) \} - h_{j,t}^{*}$$

Let us set

$$\Sigma_t \equiv E_t\{\sum_{k=0}^{\infty}\beta^k(1-\gamma)^k \exp(v_{t+1}-v_t)\}$$

to define the reciprocal of the time-varying propensity to consume out of financial and human wealth, which is similar cross cohorts. Plugging Σ_t into the above equation yields:

$$\Omega_{j,t}^* = \frac{1}{\delta}P_t C_{j,t}\Sigma_t - h_{j,t}^*$$

Finally, we obtain:

$$C_{j,t} = \frac{\delta}{\Sigma_t}(\Omega_{j,t} + h_t) \qquad (10)$$

The Σ_t term is a function of preference shocks v_t . A positive shock to preferences in this period therefore, increases the current propensity to consume out of wealth (Σ_t decreases) and reduces the present value the future payoffs.

Equation (10) defines "old traders" consumption pattern. Old traders who have been in the financial markets for more than one period consume out of their financial assets and human wealth. New comers are those who entered the markets in the current period and therefore, have no financial wealth, they can consume only out of their human wealth:

$$C_{j,t} = \frac{\delta}{\Sigma_t}h_t$$

2.1.4 *Aggregating across cohorts*

The aggregate level of consumption across cohorts is calculated as the weighted average of all the cohorts' consumption, in which each cohort is assigned a weight equal to its mass:

$$X_t \equiv \sum_{j=-\infty}^{t} \gamma\,(1-\gamma)^{t-j} X_{j,t}$$

for all X=C_t,N_t,B_t,T_t,$Z_t(i)$.

The equation depicting the dynamic path of aggregate consumption is given at:

$$(\Sigma_t - 1)C_t = \gamma\delta E_t\{F_{t,t+1}\pi_{t+1}\Omega_{t+1}\} + (1-\gamma)E_t\{F_{t,t+1}\Sigma_{t+1}\mathrm{C}_{t+1}\} \qquad (11)$$

in which the first term denotes the financial wealth effects, which is smoothed out as replacement rate γ approaches 0.

2.2 Retail Sector

The economy is composed of a continuum of final goods producers, whose measure is normalized to unity. Final goods producers ensemble a continuum of measure one of intermediate goods, indexed by i, used as inputs according the following constant-return-to-scale technology:

$$Y_t = \int_0^1 Y_t\,(i)^{\frac{\epsilon-1}{\epsilon}} \qquad (12)$$

where $\epsilon > 1$ is the price elasticity of demand, or the degree of competition in the market of inputs. This constant elasticity of substitution production function exhibits diminishing

marginal product with respect to each factor, a property that induces firms to diversify and produce using all available intermediate goods.

Each final goods producer would choose inputs $Y_t(i)$ to solve:

$$\text{Max} \quad P_t Y_t - \int_0^1 P_t(i)\, Y_t(i)\text{di}$$

subject to $$\int_0^1 Y_t\,(i)^{\frac{\epsilon-1}{\epsilon}} = Y_t$$

Here $P_t(i)$ is the price of the intermediate good $Y_t(i)$ and is taken as given because of the assumption of perfect competition among final goods producers. We can also determine input demands from the dual cost minimization problem:

$$\min \int_0^1 P_t(i) Y_t(i)\, di$$

subject to: $$\int_0^1 Y_t\,(i)^{\frac{\epsilon-1}{\epsilon}} = Y_t$$

First order conditions of the maximizing problem yields:

$$\frac{\epsilon}{\epsilon-1} P_t \left(\int_0^1 Y_t^{\frac{\epsilon-1}{\epsilon}}(i) \right)^{\frac{\epsilon}{\epsilon-1}-1} di \;\; \frac{\epsilon-1}{\epsilon} Y_t(i)^{\frac{\epsilon-1}{\epsilon}-1} = P_t(i) Y_t(i)$$

$$P_t \int_0^1 Y_t(i)^{\frac{\epsilon-1}{\epsilon}} di^{\frac{1}{\epsilon-1}} Y_t(i)^{-\left(\frac{1}{\epsilon}\right)} = P_t(i) Y_t(i)$$

$$P_t Y_t^{\frac{1}{\epsilon}} Y_t(i)^{-\left(\frac{1}{\epsilon}\right)} = P_t(i)$$

It is straight forward to obtain the following constant price elasticity demand function for good i:

$$Y_t(i) = \left[\frac{P_t(i)}{P_t}\right]^{-\epsilon} Y_t \tag{13}$$

The assumption of perfect competition among final goods firms brings the following relations:

$$P_t Y_t = \int_0^1 P_t(i)\, Y_t(i)\mathrm{di}$$

Combining with the demand function (13) yields the following price index for intermediate goods:

$$P_t = \left[\int_0^1 P_t(i)^{1-\epsilon} di\right]^{\frac{1}{1-\epsilon}} \tag{14}$$

2.3 Wholesale Sector

The wholesale sector is composed of a continuum of monopolistically competitive firms owned by consumers. Each wholesale firm faces a downward sloping demand for its product. In addition, it uses labor N_t to produce output according to the following constant returns technology:

$$Y_t(i) = A_t N_t(i) \tag{15}$$

where $A_t$is a technology parameter which follow some stochastic process.

Each firm entering a competitive labor market chooses the optimal level of labor to demand and seeks to minimize total costs with respect to the technological constraint.

$$\min \frac{W_t}{P_t} N_t(i) - \tau^* \frac{W_t}{P_t} N_t(i)$$

subject to: $A_t N_t(i) \geq Y_t(i)$

Let MC_t denotes the Lagrange multiplier with respect to constraint. MC_t is the firm's real marginal cost, that is, the derivative of total cost with respect to Y_t. Put differently, it measures the additional cost from a marginal increase in production. Assume that government subsidies employment at a constant rate τ^*.

Let's write the Lagrangian as:

$$\mathcal{L} = \frac{W_t}{P_t} N_t(i) - \lambda\big(A_t N_t(i) - Y_t(i)\big) - \tau^* \frac{W_t}{P_t} N_t(i)$$

The first order condition with respect to $N_t(i)$ is:

$$\frac{\partial \mathcal{L}}{\partial N_t(i)} = \frac{W_t}{P_t} - \tau^* \frac{W_t}{P_t} = \lambda A_t$$

The equilibrium real marginal costs, which are constant across firms and are given by:

$$MC_t = \lambda = (1 - \tau^*) \frac{W_t}{P_t A_t} \tag{16}$$

Wholesale firms set nominal prices on a staggered basis. Following Calvo (1983) and Gertler (2002), each period a firm is assumed to adjust its price with probability $1 - \theta$ and keeps it price fixed with probability θ. The adjustment probability does not depend on how long a firm's price has been fixed. The random variable that describes the event of price

adjustment follows a geometric distribution with parameter θ where $1-\theta$ is the probability of success (i.e. the price is adjusted).

Wholesale firms choose to set its price optimally and seek to maximize the expected stream of future dividends (assuming that all profits will be distributed as dividends). The dynamic problem faced by an optimizing firm at the time t can therefore be stated as:

$$\max_{\{P_t(i)\}} \quad E_t\left\{\sum_{k=0}^{\infty} \theta^k F_{t,t+k} Y_{t+k}(i)(P_t(i) - P_{t+k} MC_{t+k})\right\} \tag{17}$$

subject to the intermediate goods demand coming from the retail sector (13).

The first order condition is:

$$\frac{\partial}{\partial P_t(i)} = E_t\left\{\sum_{k=0}^{\infty} \theta^k F_{t,t+k}(1-\epsilon)\left(\frac{P_t(i)}{P_t+k}\right)^{-\epsilon} Y_t - \theta^k F_{t,t+k}(-\epsilon)\left(\frac{P_t(i)}{P_{t+k}}\right)^{-\epsilon-1} MC_{t+k}\right\} = 0$$

Rearranging the equation gives:

$$E_t \sum_{k=0}^{\infty} \theta^k F_{t,t+k}\left(\frac{P_t(i)}{P_{t+k}}\right)^{-\epsilon} Y_{t+k}(P_t(i) - \left(\frac{\epsilon}{\epsilon-1}\right) P_{t+k} MC_{t+k}) = 0$$

This equation equates expected present value of future marginal revenue with the expected value of future marginal costs. Rearranging terms gives us the following expression for the optimal price at time t:

$$P_t(i) = (1+\mu)\frac{E_t \sum_{k=0}^{0} \theta^k F_{t,t+k}\left(\frac{P_t(i)}{P_{t+k}}\right)^{-\epsilon} Y_{t+k} P_{t+k} MC_{t+k}}{E_t \sum_{k=0}^{\infty} \theta^k F_{t,t+k}\left(\frac{P_t(i)}{P_{t+k}}\right)^{-\epsilon} Y_{t+k}}$$

where $1 + \mu = \epsilon/(\epsilon - 1)$ is the steady state gross mark up.

The above expression can also be rewritten more compactly as:

$$P_t(i) = (1 + \mu)E_t\left(\sum_{k=0}^{\infty} \omega_{t,t+k} P_{t+k} MC_{t+k}\right)$$

where $$\omega_{t,t+k} = \frac{\theta^k F_{t,t+k}\left(\frac{P_t(i)}{P_{t+k}}\right)^{-\epsilon} Y_{t+k}}{E_t \sum_{k=0}^{\infty} \theta^k F_{t,t+k}\left(\frac{P_t(i)}{P_{t+k}}\right)^{-\epsilon} Y_{t+k}}$$

In general, the optimal price equals the steady state markup multiplied by a weighted average of expected future nominal marginal cost. The weight is dependent upon how the firm discounts future cash flows in each period t+k (taking into consideration that the price is fixed in t+k) and also the relative proportion of expected revenues in every period.

2.4 Government

The government budget constraint is given by

$$P_t T_t = P_t G_t + \tau^* W_t N_t$$

where $G_t = \varpi_t Y_t$.

The assumption is that the public sector consumes a fraction ϖ_t of total output. Government subsidizes employment at a constant rate τ^*, appropriately selected to correct to monopolistic distortion in the wholesale sector.

In equilibrium, all agents are maximizing with respect to their constraints, supply equals demand in every market, and all resource constraints are satisfied.

Net supply of state-contingent bonds is zero. ($B_t = 0$). Aggregate stock of outstanding equities for each intermediate firm must be equal to the total amount of issued shares, which is normalized to 1. ($Z_t(i)$=1 for all ($i \in [0,1]$).

The present discount real value of future financial wealth is equal to the current level of real stock price index:

$$E_t\{F_{t,t+1}\pi_{t+1}\Omega_{t+1}\} = Q_t$$

and the state of equation for aggregate consumption reads:

$$(\Sigma_t - 1)C_t = \gamma\delta E_t\{F_{t,t+1}\pi_{t+1}\Omega_{t+1}\} + (1-\gamma)E_t\{F_{t,t+1}\Sigma_{t+1}\mathrm{C}_{t+1}\} \qquad (18)$$

in which

$$Q_t = E_t\{F_{t,t+1}\pi_{t+1}[\mathrm{Q}_{t+1} + D_{t+1}]\} \qquad (19)$$

Nistico (2012) takes as benchmark an equilibrium in which price are fully flexible ($\theta = 0$), and is representative agent setup (replacement rate $\gamma = 0$). He labels this equilibrium the frictionless and denotes variables in this equilibrium with an upper bar.

2.5 The linearized model[1]

Output gap is defined as the log-deviation of equilibrium real output from the frictionless benchmark:

$$x_t \equiv y_t - \bar{y}_t$$

[1] For a detailed description on the linearized model, see Nistico (2012).

Stock price gap (or later mentioned as financial condition) is accordingly defined as the log deviation of real stock price from the potential stock price:

$$s_t \equiv q_t - \overline{q_t}$$

Price inflation is defined as:

$$\pi_t \equiv p_t - p_{t-1}$$

For the derivation of the potential output and potential stock price, see a detailed derivation in Nistico (2012, pp 134-135).

We assume the monetary policy makers set short-term nominal interest in response to derivations of the equilibrium allocation from the frictionless benchmark following the Taylor type rule:

$$r_t = rr_t + (\phi_\pi \pi_t + \phi_x x_t + \phi_s s_t) + \varepsilon_t^r$$

which allows for a response to our measure of financial condition, beyond the one in the response to output gap and inflation.

Nistico (2012, pp 134 and Appendix A2) shows that the steady state equations of the complete model ($\theta \neq 0$ and $\gamma \neq 0$) in derivation with respect to the benchmark steady state can be written as:

$$\pi_t = \tilde{\beta} E_t \pi_{t+1} + \kappa x_t$$

$$x_t = \frac{1}{1+\psi} E_t x_{t+1} + \frac{\psi}{1+\psi} s_t - \frac{1}{1+\psi} (r_t - E_t \pi_{t+1} - rr_t^n)$$

$$s_t = \tilde{\beta} E_t s_{t+1} - \lambda E_t x_{t+1} - (r_t - E_t \pi_{t+1} - rr_t^n) + e_t$$

$$r_t = rr_t + (\phi_\pi \pi_t + \phi_x x_t + \phi_s s_t) + \varepsilon_t^r$$

$$rr_t = \tilde{\rho} + E_t \Delta a_{t+1} - \Delta v_{t+1} - \frac{\varphi}{1+\varphi} E_t \Delta g_{t+1} + \Psi_e e_t + \Psi_g g_t + \Psi_v v_t$$

in which the discount factor $\tilde{\beta}$ is defined as:

$$\tilde{\beta} \equiv \frac{\beta}{1 + \psi}$$

and $\psi = \psi(\gamma)$ such that $\psi'(\gamma) > 0$ and $\psi(0) = 0$.

The coefficients are the following functions of underlying structural parameters:

$$\Psi_g \equiv \frac{\psi \rho_g (1 - \widetilde{\beta})}{1 + \psi - \tilde{\beta} \rho_g}$$

$$\Psi_v \equiv (1 - \rho_v) \left[\frac{\psi_v (1 + \psi) - \tilde{\beta} \rho_v (1 + \psi)(1 + \psi_v) - 1}{1 + \psi - \tilde{\beta} \rho_e} \right]$$

$$\Psi_e \equiv \frac{\psi}{1 + \psi - \tilde{\beta} \rho_e}$$

in which $\psi_v \equiv \frac{\psi[\beta(1-\gamma)\rho_v]}{(1+\psi)[1-\beta(1-\gamma)\rho_v]}$

The stochastic structures are summarized by the following six processes:

$$\Delta a_t = \rho_a \Delta a_{t+1} + \eta_t^a$$

$$v_t = \rho_v \, v_{t-1} + \eta_t^v$$

$$g_t = \rho_g g_{t-1} + \eta_t^g$$

$$\varepsilon_t^s = \rho_r e_{t-1} + \eta_t^s$$

$$\varepsilon_t^r = \rho_u u_{t-1}^r + \eta_t^r$$

$$\varepsilon_t^\pi = \rho_\pi \varepsilon_{t-1}^\pi + \eta_t^\pi$$

with $\eta_t^j \sim N(0, \sigma_j^2)$, for all $j = \{a, v, g, r, p, \varepsilon^s, p\}$. Exogenous shocks include technology shocks, preference shocks, government consumption shocks, monetary policy shocks, inflation shocks, and financial market non-fundamental shocks. Non-fundamental shocks are variations in the risk premium or other non-fundamental shocks that originate within the stock market. Endogenous variables are C_t,N_t,B_t,T_t,$Z_t(i)$.

3 Model Estimation

3.1 The data

We use quarterly Vietnam data running from 2001Q2 to 2011Q4. We employ four observables: output growth rate, inflation (CPI) growth rate, real interest rate (real Treasury bill rate) and stock returns. All data is demeaned prior to estimation.

The measurement equations are as follows.

$$\Delta lnGDP = \xi + y_t - y_{t-1}$$

$$\Delta lnCPI = \xi + \pi_t - \pi_{t-1}$$

$$TBILLR = r + r_t$$

$$\Delta lnSR = \xi + \ q_t - q_{t-1}$$

The empirical proxy for the short-term nominal interest rate is the Treasury bill rate. Treasury bills are considered short-term policy instruments and are issued to help the central bank implement monetary policy or to fund the government's budget deficit. Treasury bills are not traded on the local exchanges and are only available to commercial banks that maintain accounts with the State Bank of Vietnam. Treasury bills are issued by the State Treasury at tenors less than 1 year (normally 13 weeks, 26 weeks, and 52 weeks) with a face value of VND100,000. This instrument is issued to temporarily finance the state's budget deficit or help the SBV in controlling monetary policy. The source of our data for Treasury bill rate is the International Monetary Fund Database.

The empirical counterpart for stock price gap s_t should be a measure that relates financial wealth's impacts with household's consumption decisions. In this chapter, we use stock returns as the proxy for s_t since according to conventional wisdom, stock returns take high (low) values when the financial conditions are good (bad). In theory, good financial market performance affects household's expectations of future returns of private portfolio and consequently urges them to change current consumption patterns. This is called the wealth effect.

In section 3.2 and section 3.3, we estimate two models: the theoretical model by Nistico (2012) described earlier and its empirical counterpart featuring backward looking behavior. The models are estimated using Bayesian methods in DYNARE.

3.2 Estimation of the theoretical model

We compare the fit of both models to the Vietnam data by comparing their log data density. The empirical model featuring backward looking behavior proves to fit the data better than the theoretical model. The log data density of the empirical model reads 118.38, a figure higher than that associated to the theoretical models without lags, which reads 117.53. For this reason, we will discuss the empirical model in more details.

Before estimation, we calibrate some of the parameters of the model. We demean GDP, inflation and the stock returns rate by setting ξ and r to their sample means that read, respectively, 1.99% and 0.62%. We fix the share of public expenditures over GDP ϖ to 0.28, the average share in period 2006-2011. Parameter γ, depicting a wealth effect in the household's consumption pattern is assigned a prior mean of 0 and a normal distribution so that the parameter can freely speak for the data.

The estimates for the theoretical model are presented in Table 4-2. In contrast with the results for the U.S data provided by Castelnouvo and Nistico (2010), we do not find strong support to the role of stock prices in this model from the Vietnam data.

The parameter of interest here is the turnover rate γ or the probability of being replaced in the financial market. γ is estimated at 0 and this result indicates that fluctuations in financial holdings do not have an affect the household's consumption pattern which is described in details by equation (11). The wealth channel that links asset prices and household's consumption in Vietnam is found to be weak, which is not surprising in light of the high volatility and modest size the Vietnamese stock market.

Table 4-1: The theoretical model for estimation

New-Keynesian Philips Curve	$\boldsymbol{\pi_t = \tilde{\beta} E_t \pi_{t+1} + \kappa x_t}$	(20)
IS Curve	$x_t = \frac{1}{1+\psi} E_t x_{t+1} + \frac{\psi}{1+\psi} s_t - \frac{1}{1+\psi}(r_t - E_t \pi_{t+1} - rr_t^n)$	(21)
Real stock price dynamic process	$s_t = \tilde{\beta} E_t s_{t+1} - \lambda E_t x_{t+1} - (r_t - E_t \pi_{t+1} - rr_t^n) + e_t$	(22)
Monetary Policy Rule	$r_t = rr_t + (\phi_\pi \pi_t + \phi_x x_t + \phi_s s_t) + u_t$	(23)
FE natural rate of interest	$rr_t = \tilde{\rho} + E_t \Delta a_{t+1} - \Delta v_{t+1} - \frac{\varphi}{1+\varphi} E_t \Delta g_{t+1} + \Psi_e e_t + \Psi_g g_t + \Psi_v v_t$	(24)
Technology shocks	$\Delta a_t = \rho_a \Delta a_{t+1} + \varepsilon_t^a$	
Public expenditures shocks	$g_t = \rho_g g_{t-1} + \varepsilon_t^g$	
Preference shocks	$v_t = \rho_v \, v_{t-1} + \varepsilon_t^v$	
Risk premium	$e_t = \rho_e e_{t-1} + \varepsilon_t^e$	
Monetary Policy Shocks	$u_t = \rho_u \varepsilon_{t-1}^r + \varepsilon_t^r$	

Wealth channel in more advanced economies likewise has a significant yet small impact on household's behaviors (Koivu, 2010).

As to the systematic monetary policy by the State Bank of Vietnam, our estimates suggest a strong and significant response to inflation and output gap, which is in line with the goals of the central bank. Estimations using U.S. data in Castelnouvo and Nistico (2010) suggest that the Federal Reserve Fund responses strongly to inflation but very weakly to output gap. The difference between findings is due to Vietnam, being a developing nation, has been emphasizing growth since 1986.

Table 4-2: Bayesian estimates of the theoretical model with Vietnam data

Structural Parameters							
Parameters		Prior mean	Posterior mean	90% HPV		Prior distribution	Prior Std. dev.
γ		0.5	0	0	0	beta	0.28
θ		0.75	0.7302	0.6949	0.7627	beta	0.05
δ		1.4	3.5628	3.5602	3.5656	gamma	1
μ		0.2	0.4298	0.3814	0.4598	gamma	0.05
ϕ_π		2	1.1013	0.9347	1.2376	norm	0.3
ϕ_x		1	0.9511	0.897	1.0107	gamma	0.1
ϕ_s		0	0.1166	-0.0067	0.2166	norm	0.25
Shock Processes							
ρ_v	Persistence in v	0.5	0.3061	0.176	0.3918	beta	0.2
ρ_a	Persistence in a	0.5	0.855	0.8135	0.8918	beta	0.2
ρ_e	Persistence in e	0.5	0.3345	0.189	0.4366	beta	0.2
ρ_g	Persistence in g	0.5	0.4493	0.3179	0.5537	beta	0.2
ρ_r	Persistence in u	0.5	0.1474	0.023	0.2633	beta	0.2
σ_v	Std. dev. v	0.01	6.2077	4.4693	7.7411	invg	2
σ_a	Std. dev. a	0.01	19.8097	17.7302	21.03	invg	2
σ_e	Std. dev. e	0.01	0.1691	0.1265	0.204	invg	2
σ_g	Std. dev. g	0.01	0.011	0.0022	0.0178	invg	2
σ_r	Std. dev. u	0.01	0.1086	0.0868	0.1291	invg	2

Table 4-3: The complete model for estimation by Castelnouvo (2013)

New-Keynesian Philips Curve	$\boldsymbol{\pi_t = \beta(1+\alpha\beta)^{-1}E_t\pi_{t+1} + \alpha(1+\alpha\beta)^{-1}\pi_{t-1} + \kappa x_t + \varepsilon_t^{\pi}}$	(25)
IS Curve	$x_t = \omega_x E_t x_{t+1} + (1-\omega_x)x_{t-1} - \delta_x(r_t - E_t\pi_{t+1}) + \psi s_t + \varepsilon_t^x$	(26)
Real stock price dynamic process	$s_t = \beta E_t s_{t+1} + \lambda E_t x_{t+1} - \delta_s(R_t - E_t\pi_{t+1}) + \varepsilon_t^s$	(27)
Monetary Policy Rule	$r_t = \phi_r r_{t-1} + (1-\phi_r)(\phi_\pi \pi_t + \phi_x x_t + \phi_s s_t) + \varepsilon_t^r$	(28)
Inflation shocks (supply shocks)	$\varepsilon_t^{\pi} = \rho_\pi \varepsilon_{t-1}^{\pi} + \eta_t^{\pi}$	
Preference shocks (demand shocks)	$\varepsilon_t^x = \rho_x \varepsilon_{t-1}^x + \eta_t^x$	
Risk premium	$\varepsilon_t^s = \rho_s \varepsilon_{t-1}^s + \eta_t^s$	
Monetary policy shocks	$\varepsilon_t^r = \rho_r \varepsilon_{t-1}^r + \eta_t^r$	

In addition to price stability, the central bank is asked to support GDP growth, in particular the growth of State-owned enterprises and it has never explicitly prioritized between the two goals. This is obviously not the case for the U.S. Federal Reserve Fund whose mission is to control price level.

3.3 Estimation of the empirical model

3.3.1 Estimation Strategy

Following Castelnouvo (2013) estimation strategy, we modified the theoretical model and estimate it with Vietnam data. The strategy is described and justified in the followings.

First, we add indexation to past output to the IS curve, indexation to past inflation to the Phillips curve and interest rate smoothing parameter to the policy rule. Although, ideally, lags of output and lags of inflation can be added to the original model by deriving from the household's problems (with habit formation) and the firms' problems (with past inflation in the pricing equation), we choose to add the lags to the final log-linearized equations as a short-cut to achieve the same results. It is important to note that adding indexation to the past does not distort the original model as the steady state of the original model and the empirical model converge. Ireland (2004) also points out that a purely forward-looking model can oversee some dynamics found in the data while they might be the product of back-ward looking behavior of households and firms.

After adding lagged output gap and inflation terms to the original model's IS and Phillips curves, equations (20) and (21) are replaced by (25) and (26). The new parameters ω_x (indexation to past output) and α (indexation to past inflation) both lie between 0 and 1; conveniently, they summarize the importance of backward-looking elements in the economy. If the data prefers the original micro-founded specifications (21) and (22) to the more general alternatives (25) and (26), α and ω_x are allowed to equal to 0.

The equations presented in Table 4-3 form a complete system for estimation, involving four observable variables (output gap x_t, inflation π_t, nominal interest rate r_t, stock returns s_t) and four unobservable shocks (to preference $\boldsymbol{\varepsilon_t^x}$, inflation $\boldsymbol{\varepsilon_t^\pi}$, stock market $\boldsymbol{\varepsilon_t^s}$ and monetary policy $\boldsymbol{\varepsilon_t^r}$). The empirical model has 15 parameters. α, κ, ω_x, $\psi, \lambda, \delta_x, \delta_s, \phi_\pi, \phi_x, \phi_s, \phi_r, \rho_\pi, \rho_x, \rho_s,$ and ρ_r.

In our empirical model, the central bank formulates and implements monetary policy by following the Taylor-type rule in equation (28), according to which it increases or decreases the short-term nominal interest rate r_t in response to past interest rate r_{t-1}, deviation of inflation π_t, output gap x_t and financial condition embedded in stock returns s_t from their target level (the frictionless level).

There are three justifications for adding the interest smoothing parameter ϕ_r to the Taylor rule.

First, past policy decisions matter and influence the current policy.

Second, central banks make changes to their policy typically through a series of small adjustments in the same direction, drawn out over a period of months, rather than through an immediate once-and-for-all response to the new development. Interest rate smoothing helps minimize the volatility of interest rate changes.

Third, adding ϕ_r does not distort the original model's policy rule. Note that equation (28) is an ARMAX(1) in which ϕ_r plays the role of a short term effect or an adjustment process towards steady state. In the long run, r_{t-1} will converge to the steady state level r^* and the only effect on interest rate in the long run will be coming from $x, \pi,$ and s. The long run effect is therefore given by the sum of ϕ_x, ϕ_π and ϕ_s. This is consistent with what the Taylor rule in the original model depicts in equation (24). (See appendix 1)

To rationalize the employment of a Taylor-type rule for Vietnam data, we perform an OLS regression with interest rate (after controlling for the lag of itself) as the dependent variable and output growth, inflation and stock returns as the independent variables. The OLS regression result show that in Vietnam, inflation drives interest rate significantly (at a 10% significance level) and that increases in output and stock return are followed by positive yet insignificant increases in the interest rate. (See Appendix 2 for regression results)

Furthermore, Asso, Kahn & Leeson (2010) argue that other policy strategies including the ones based on money growth targeting, if successful in maintaining price stability over a long period, might be empirically indistinguishable from a policy based on the Taylor rule. Razzak (2001) makes a model-based evaluation of the Taylor rule and McCallum rule which is another monetary supply rule, and finds out that they can be essentially equivalent in their treatment of inflation and output shocks. Nelson (2008) also points out that theoretically, Taylor and Friedman have very similar views on how the economy works, especially in the way that they both emphasize Phillips curve specifications with temporary nominal price and wage rigidities.

3.3.2 Priors calibration

The parameter γ in the IS curve, as mentioned earlier, strikes the difference between the standard New Keynesian model and the model presented above. In this model, agents do not remain in the financial market over an infinite horizon; instead, they face a probability γ of exiting the market regardless of how many period they have stayed in the

market. Following Nistico (2005), we assume a priori a normal distribution with mean 0 and standard deviation of 0.5: $\psi(\gamma) \sim Normal\,(0,0.5)$, and thus letting the data free to speak as regards this key parameters. With this assumption, a financial wealth effect on consumption is allowed, but not required.

Indexation to the past α and ω_x are set at 0.5, implying equal emphasis on past and current economic performance.

The inter-temporal discount factor β can be determined via the steady state condition $\beta = (1 + r)^{-1}$ where r can be calibrated to the average short term quarterly nominal interest rate in the data, which equals 5%. Accordingly, β is set equal to 0.98.

For the policy rule parameters, we consider a "smooth" regime, featuring an aggressive response towards inflation as stated in the Law on the SBV (2010) and an explicit concern for output gap as suggested by Cargill and Nguyen (2013). We therefore set $\phi_\pi = 2$ and $\phi_x = 1$. The interest rate smoothing parameter ϕ_R is set at 0.5 implying an equal emphasis on backward looking and forward looking behavior of the policy rate.

We assume that reaction to stock price ϕ_s is normally distributed with mean zero and standard deviation 0.25. With this setting, we allow the data to freely reflect the reaction of State Bank of Vietnam to stock returns.

3.3.3 Posterior estimates

The posterior estimates of our model are reported in the third column of Table 4-4 (third column). Looking first at the parameter ψ which suggests the absence of a measure

of financial condition in the IS curve. The posterior mean of ψ equals 0.014 and is not significant. This result indicates that the impact of asset prices on household's consumption is extremely small. This finding is in line with the estimates of the theoretical model discussed earlier in section 3.2. Nevertheless, the sign of the posterior mean is consistent with economic intuition: the higher stock returns, the more incentives households have to allocate resources to current consumption, and the better the economic conditions as captured by the output gap.

Second, regarding the systematic reaction of monetary policy by the SBV, our estimates suggest a strong and significant response to inflation as well as output gap. Inflation remains the primary concern for the State Bank of Vietnam, in line with its declared mission to curb inflation in the Law on the SBV (2010).

The SBV's response to stock price gap is found to be small and significant. This result is in line with our VAR analysis in Chapter 3 in which we find a significant and mild response of interest rate to shocks in the financial market. The parameter ϕ_s, which takes the value of 0.3788 with a 90% credible set equal to [0.1783, 0.5627], suggests that fluctuations in the market are incorporated in the decision rule and accordingly, financial market condition has been monitored by the SBV.

Third, backward looking behavior in inflation seems to be dominant. Past inflation has significant impact on current inflation as indexation to the past α takes value of 0.8392. This result is in contrast with that reported for the U.S. as Castelnouvo and Nistico (2010) find a low degree of price indexation of only 0.04.

Indexation to expected output gap is found to be very high for Vietnam as parameter ω_x is reported at 0.974. Output fluctuations seem to be driven much more by future realizations of the output gap rather than by it past realization. This is, again, not the case for the U.S. as the parameter is reported at 0.39, indicating less emphasis on future realizations of output gap.

It is noteworthy that information from the data is found to be useful for all parameters estimation: the posterior distributions of all parameters depart substantially from the prior. (See Appendix 2 for figure of priors and posteriors distributions)

3.3.4 Impulses responses

Figure 4-1 and Figure 4-2 displays Bayesian impulse responses generated from the model. First, what is the impact of an unanticipated monetary policy shock on financial markets? The answer to this question may shed lights on the influence by the SBV on managing financial shocks. On the first column of Figure 4-1, we present the impulse responses to monetary shocks. An unexpected positive one standard deviation shock to short-term interest rate results in a negative and significant response by the financial market as stock returns lose 6 basis points quarterly or approximately 24 basis points annually.

This reaction of stock returns is in line with the one suggested by the VAR set up in chapter 3 in which we find that stock returns are significantly driven by shocks in monetary policy (with money supply as proxy). Both output gap and inflation response negatively and significantly to monetary policy tightening. Output gap decreases by approximately 1.1 basis points and inflation decreases by 3.5 basis point.

Table 4-4: Bayesian estimates of the empirical model

Structural Parameters							
Parameters		Prior densities	Posterior means	90% HPD interval		Prior densities	Prior Standard Deviation
α		0.5	0.8392	0.7463	0.9214	beta	0.28
κ		0.05	0.0495	0.0458	0.0534	gamma	0.01
ω_x		0.5	0.974	0.9537	1	beta	0.28
ψ		0	0.0147	-0.0036	0.0362	norm	0.5
λ		0.05	0.0444	0.0394	0.0485	gamma	0.025
δ_x		0.1	0.0337	0.0104	0.0589	gamma	0.05
δ_s		0.1	0.2618	0.2362	0.2818	gamma	0.05
ϕ_π		2	2.1014	1.9264	2.2505	norm	0.3
ϕ_x		0.25	1.2632	1.2271	1.2996	gamma	0.1
ϕ_s		0	0.3788	0.1783	0.5627	norm	0.5
ϕ_r		0.5	0.8149	0.7488	0.8581	beta	0.28
Shock Process							
		Prior densities	Posterior means	90% HPD interval		Prior densities	Prior Standard Deviation
ρ_π	Persistence in ε_t^π	0.5	0.4689	0.4064	0.5299	beta	0.28
ρ_x	Persistence in ε_t^x	0.5	0.097	0	0.2195	beta	0.28
ρ_s	Persistence in ε_t^s	0.5	0.4202	0.3625	0.4877	beta	0.28
ρ_r	Persistence in ε_t^r	0.5	0.2963	0.1929	0.4635	beta	0.28
η_π	Std. dev ε_t^π	0.01	0.0088	0.0069	0.0107	invg	10
η_x	Std. dev. ε_t^x	0.01	0.0542	0.0422	0.066	invg	10
η_s	Std. dev. ε_t^s	0.01	0.1336	0.1059	0.1612	invg	10
η_r	Std. dev ε_t^r	0.01	0.0539	0.0417	0.0656	invg	10
η_x	Std. dev. ε_t^x	0.01	0.0542	0.0422	0.066	invg	10
η_r	Std. dev ε_t^r	0.01	0.0539	0.0417	0.0656	invg	10

Second, it is also important to understand if financial shocks have an impact, in turn, a significant influence on policy rate. Column 2 on Figure 4-1 indicate that in reaction to an unexpected increase in stock returns, the short term monetary policy rate increases slightly by 0.015%. The response of output gap was insignificant probably because stock price

boom generated though a non-fundamental shocks is not strong enough to feedback into real activity directly through. Stock returns fluctuations seem to be not a source of price instability as increases in stock returns do not lead to changes in inflation rate.

Third, as depicted by the first column in Figure 4-2, a one standard deviation shock to preference raises output gap by approximately 0.06% or 6 basis points. Inflation increases by 0.5 basis point and interest rate rises by 1.5 basis points. Unexpectedly, financial condition worsens by 1.5 basis points.

Forth, results in the second column of Figure 4-2 suggests that a one standard deviation cost push shock increases the annualized inflation rate by 10 basis points or 0.1% and decreases output gap by 0.6 basis point. Financial market reacts negatively and significantly to this shock as stock returns declines 1.5 basis points or 0.015% quarterly. The rise in inflation requires a tightening of monetary policy under which the short term interest responses immediately with a 1 basis points increase; the response then gradually increases and peaks at 2.25 basis point after 5 periods.

It is noteworthy that preference shock and inflation shock both work to increase nominal interest rate. Preference shock, however, boosts output growth and improves financial condition. Inflation shock, on the other hand, decreases output growth and worsens assets returns.

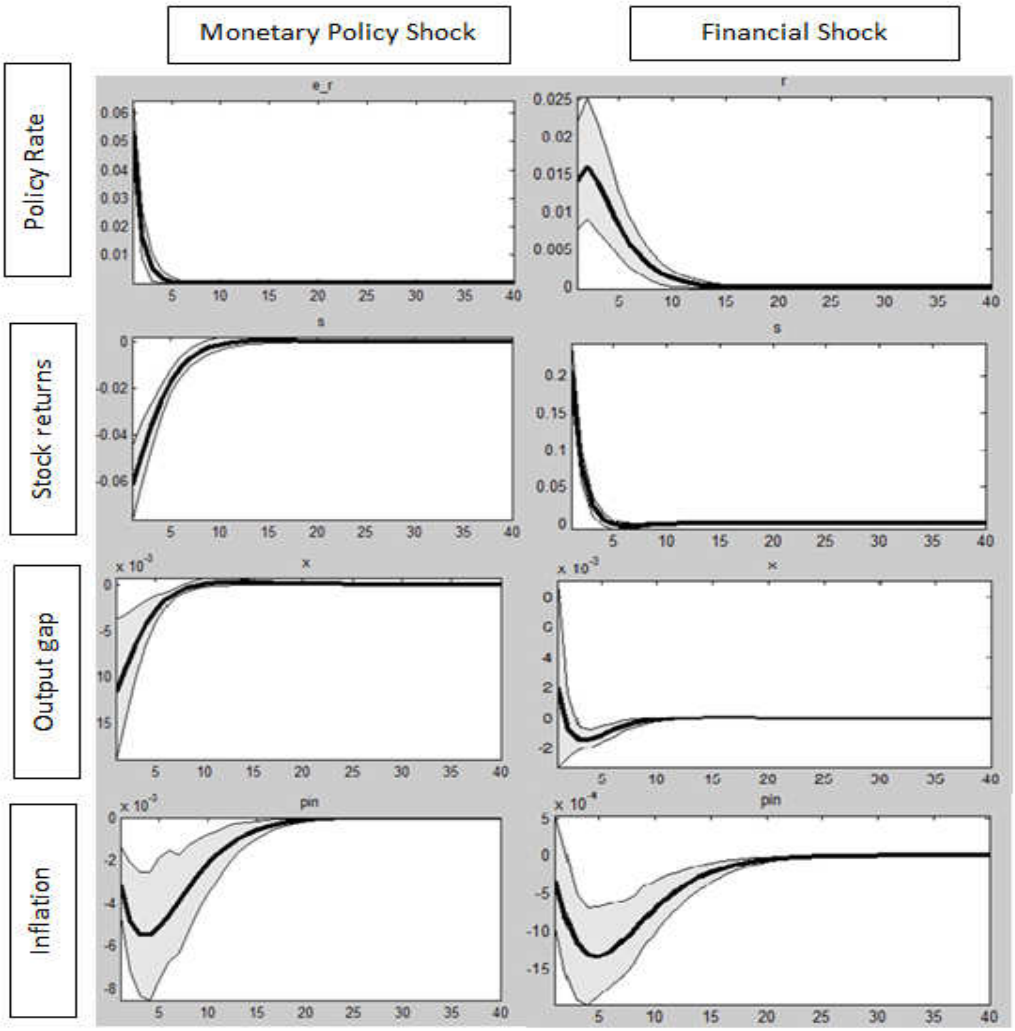


Figure 4-1: Impulses Responses to monetary policy shock and financial shock

3.3.5 DSGE and Bayesian VAR

In this section, we compare the fit of the empirical DSGE model with Bayesian VARs using the same data set and the same number of observations. The log data densities of each model are presented in Table 4-5.

The results indicate that the DSGE model with more restrictions perform not as good as BVARs. The results are not surprising due to stricter restrictions by the DSGE framework vs. a VAR setup, which is a more agnostic but possibly less informative for policy making.

4 Conclusions and policy implication

This paper estimates a New Keynesian model proposed by Nistico (2012) in which financial market performance, with stock returns as proxy, is allowed but not required, to enter the household consumption decision and eventually drives aggregate fluctuations. We use Bayesian techniques in DYNARE with the Vietnam data from 2001Q2 to 2011Q4. This is the first attempt, to our knowledge, to estimate Vietnam economy using a DSGE model with financial market condition.

The results from parameters estimation indicate that stock price and household consumption are weakly linked in Vietnam as stock price does not enter the household aggregate consumption equation as well as the IS curve. In Vietnam, it seems that households do not have a tendency to change their consumption pattern when they are given more expected financial holdings. This result reveals a policy implication that the probability of influencing household behavior in Vietnam via monetary policy is limited.

Monetary policy tightening significantly and negatively affects all variables including output gap, inflation and stock returns. Shocks to the financial market, in turn, have a significant impact on interest rate but not on inflation or output.

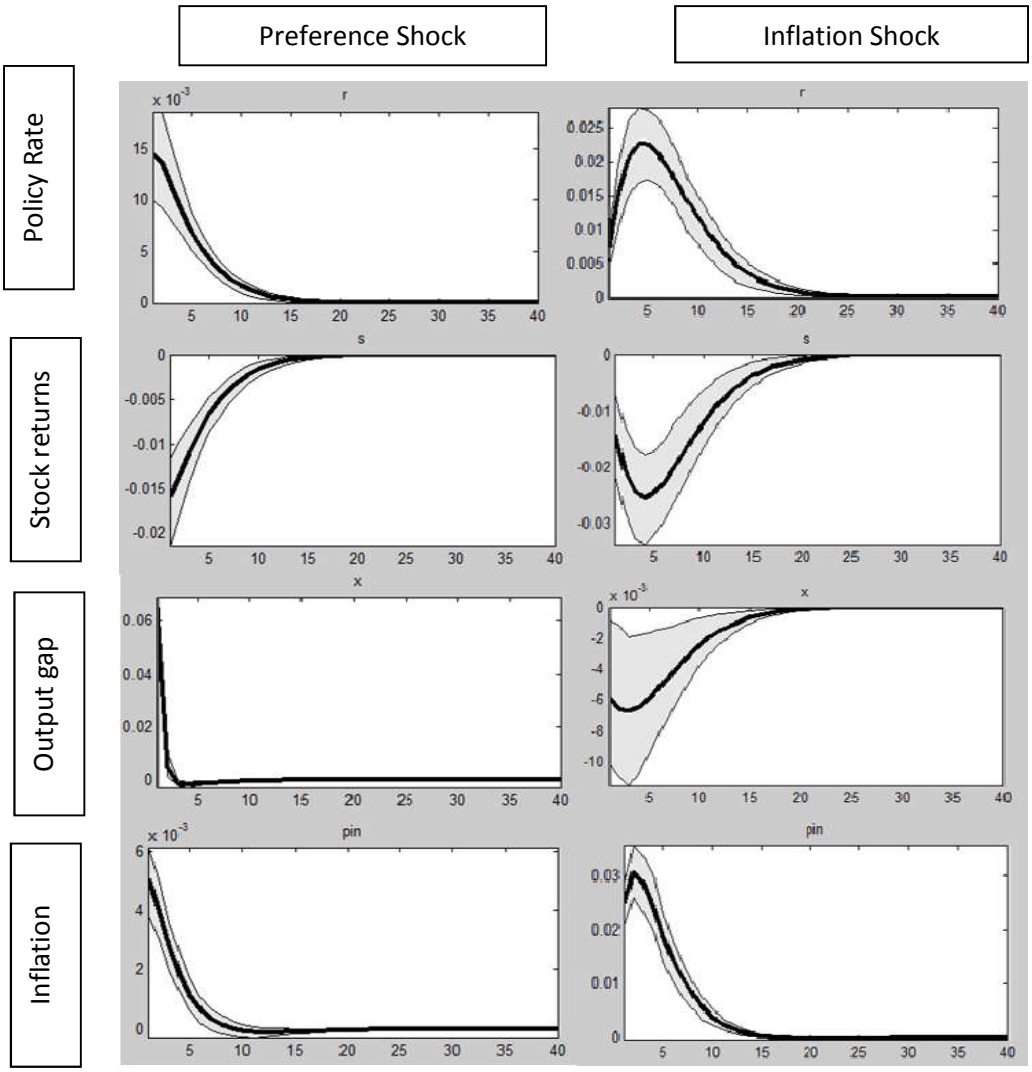


Figure 4-2: Impulses Responses to preference shock and inflation shock

Table 4-5: Log Data Densities for various models

Model	Log Data Density
DSGE	104.763342
BVAR(1)	132.0807
BVAR(2)	128.6828
BVAR(3)	135.9495
BVAR(4)	137.8284

We also detect that the financial market condition is one subject of concerns for the State Bank of Vietnam as it enters the central bank's decision rule with a significant impact. Inflation remains the number one target of monetary policy, followed by output growth. These results highlight that SBV is rather active in monitoring its financial market and growing economy.

REFERENCE

Asso, Pier Francesco, Kahn, G, Leeson, R (2010), "Taylor rule and the practice of Central Banking", *Research working papers*, The Federal Reserve Bank of Kansas City, Economic Research Department

Blanchard, O.J., (1985), "Debt, deficits, and finite horizons". *Journal of Political Economy 93.*

Calvo, G., (1983), "Staggered prices in a utility maximizing framework", *Journal of Monetary Policy* 12.

Cargill, Thomas, Nguyen, Tuan, (2013) "State Bank of Vietnam needs a single mandate not independence", *Central Banking Journal*, 28 Feb 2013

Castelnuovo, E. and S. Nistico, (2010), "Stock market conditions and monetary policy in a DSGE Model for the US", *Journal of Economic Dynamics and Control* 34 (9): 1700-1731

Castelnuovo, Efrem,(2013), "Monetary policy shocks and financial conditions: a Monte Carlo experiment", *Journal of International Money and Finance* 32, 282-303

Cecchetti, S.G. (2003). "What the FOMC says and does when the stock market booms" mimeo, Brandeis University

Cecchetti, S.G., Genberg, H. and S. Wadhwani (2002). "Asset prices in a flexible inflation targeting framework", in W.C. Hunter, G.G Kaufman and M. Pomerleano, eds., Asset Price Bubbles: Implication for Monetary, Regulatory and International Policies, Cambridge, Mass.: MIT Press

Cecchetti, S.G., Genberg, H., Lipsky, J., Wadhwani, S., (2000), "Asset prices and central bank policy", *Report on the world economy* 2, Geneva, CEPR and ICMB

Christiano, Lawrence, Martin Eichenbaum, and Charles Evans, (1996), "The effects of monetary policy shocks: Some evidence from the flow of funds", *the Review of Economics and Statistics* 78, 16-34

Fujiwara I., (2003), "Is there a direct effect of money?: Money's role in an estimated monetary business cycle model of the Japanese economy", *Discussion papers in Economics and Business* 03-15, Osaka University, Graduate Schools of Economics and Osaka School of International Public Policy (OSIPP)

Fujiwara I., (2004), "Output composition of the monetary policy transmission mechanism in Japan", Bank of Japan Working Paper Series.

Ireland P., (2004), "Technology Shocks in the New Keynesian Model", *The Review of Economics and Statistics 86*, No 4, 923-936

Koivu, Tuuli, (2010), "Monetary Policy, Asset Prices and Consumption in China", *European Central Bank Working Paper Series*, No 1240, Sep 2010.

Kwok, Yue Kuen (2008), "Mathematical Models of Financial Derivatives", Berlin, Springer Berlin Heidelberg.

Nelson, Edward (2008), "Friedman and Taylor on monetary policy rules: a comparison," *Federal Reserve Bank of St. Louis Review*, March/April 2008

Nistico, S. (2012), "Monetary policy and stock-price dynamics in a DSGE framework," *Journal of Macroeconomics* 34, 126-146

Nistico, S. (2005), "Monetary Policy and Stock-Price Dynamics in a DSGE Framework," *LLEE Working Document* n. 28.

Nistico, S., (2006), Monetary Policy and Stock Prices: Theory and Methods. In: Di Giorgio, G., Neri, F., (Eds.) Monetary Policy, Banks and Institutions, Luiss University Press, Rome.

Nisticò, S.,(2011), “Optimal Monetary Policy and Stock-Price Dynamics in a Non-Ricardian DSGE Model,” CASMEF Working Paper, LUISS Guido Carli.

Razzak, W. A., (2001), “Is the Taylor rule really different from the McCallum rule? ” *Reserve Bank of New Zealand, Discussion Paper Series.*

State Bank of Vietnam, (2003), “The Law on the State Bank of Vietnam”, Legal Documents. Hanoi: State Bank of Vietnam.

State Bank of Vietnam, (2005), Annual Report, State Bank of Vietnam , Hanoi, Vietnam.

State Bank of Vietnam, (2010), “The Law on the State Bank of Vietnam”. Legal Documents. Hanoi: State Bank of Vietnam.

APPENDIX

Appendix 1.

The Taylor rule in the modified model with lags by Castelnouvo (2013)

$$r_t = \phi_r r_{t-1} + (1 - \phi_r)(\phi_\pi \pi_t + \phi_x x_t + \phi_s s_t)$$

In steady state r_t and r_{t-1} will converge to the steady state level r^*:

$$r^* = \phi_r r^* + (1 - \phi_r)\left(\phi_\pi \pi \quad + \phi_x x \quad + \phi_s s\right)$$

Thus, $\quad r^* = \phi_\pi \pi \quad + \phi_x x \quad + \phi_s s$

In the long run, only changes in inflation, output gap and stock price gap are reflected in the interest rate.

Appendix 2: OLS regression for Taylor-type rule

```
regress r lagr
```

Source	SS	df	MS	Number of obs =	42
				F(1, 40) =	0.49
Model	.000516678	1	.000516678	Prob > F =	0.4894
Residual	.04245972	40	.001061493	R-squared =	0.0120
				Adj R-squared =	-0.0127
Total	.042976399	41	.001048205	Root MSE =	.03258

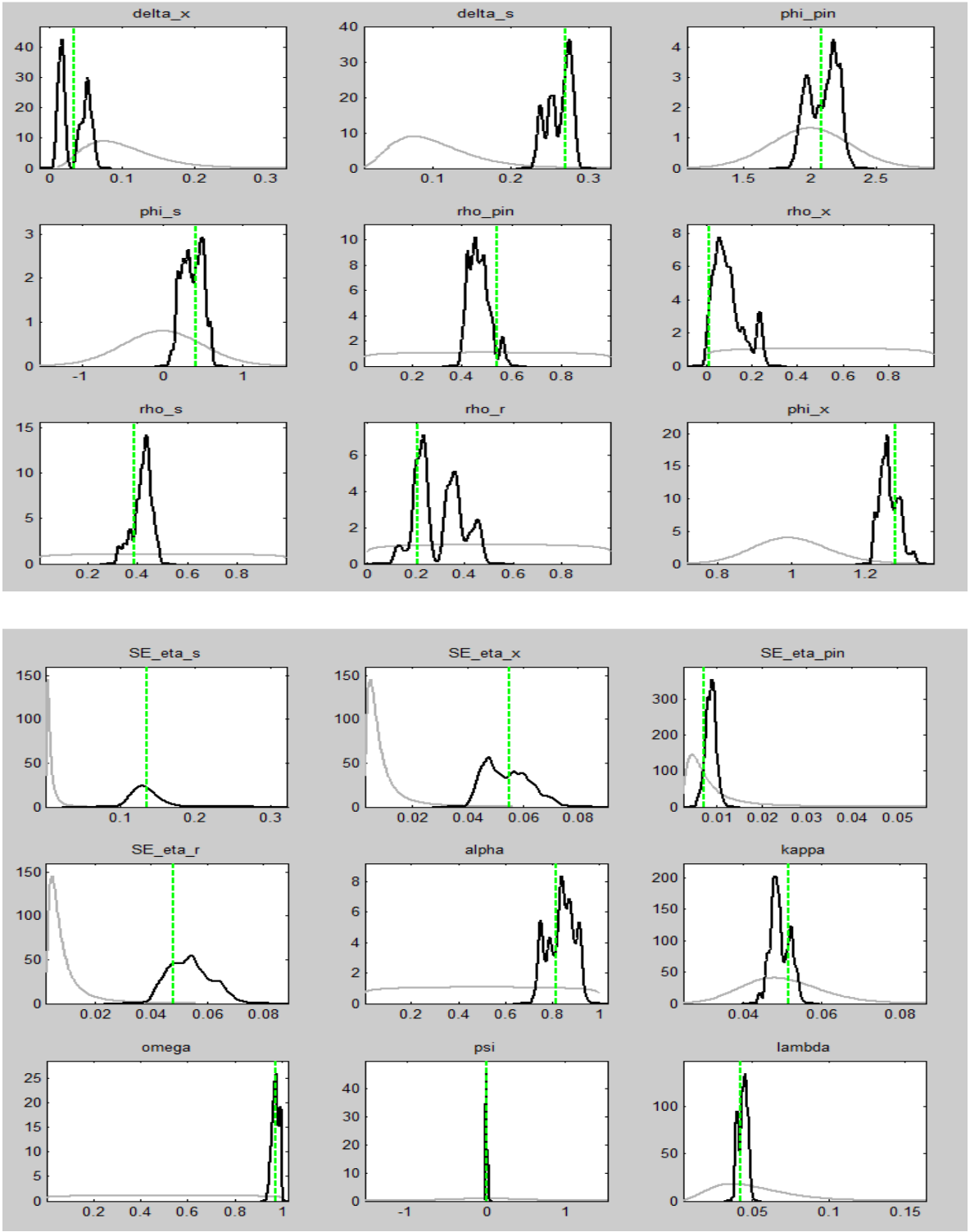
r	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lagr	.1131162	.1621337	0.70	0.489	-.2145682	.4408005
_cons	-.000231	.0050311	-0.05	0.964	-.0103992	.0099372

```
. regress e x pin s
```

Source	SS	df	MS	Number of obs =	42
				F(3, 38) =	1.53
Model	.000055639	3	.000018546	Prob > F =	0.2227
Residual	.00046104	38	.000012133	R-squared =	0.1077
				Adj R-squared =	0.0372
Total	.000516678	41	.000012602	Root MSE =	.00348

e	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
x	.0051156	.0095992	0.53	0.597	-.0143171	.0245482
pin	-.0165376	.0082743	-2.00	0.053	-.033288	.0002128
s	.0004037	.0023186	0.17	0.863	-.0042901	.0050976
_cons	-.000037	.0005418	-0.07	0.946	-.0011339	.0010599

Appendix 3: Priors (grey) and Posteriors (black) Distribution



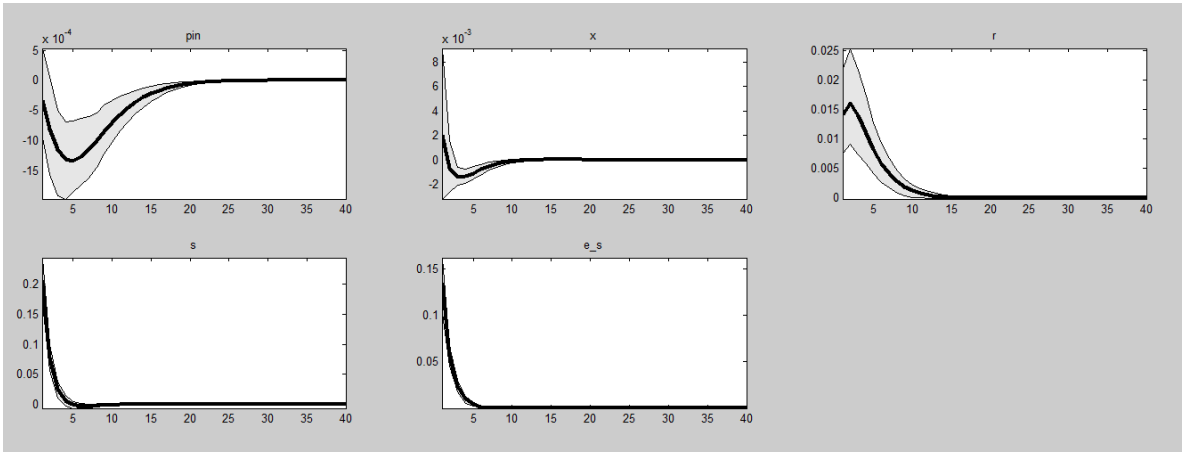
Appendix 4: MATLAB code for the empirical model

```
var pin x r s e_pin e_x e_s e_r ;
varexo eta_s eta_x eta_pin eta_r ;

parameters beta alpha kappa omega psi delta_x lambda delta_s phi_pin phi_x phi_s phi_r rho_pin rho_x rho_s
rho_r;

model (linear);
pin=beta*(1+alpha*beta)^(-1)*pin(+1)+alpha*(1+alpha*beta)^(-1)*pin(-1)+kappa*x+e_pin;
x=omega*x(+1)+(1-omega)*x(-1)-delta_x*(r-pin(+1))+ psi*s+e_x;
s=beta*s(+1)+lambda*x(+1)-delta_s*(r-pin(+1))+e_s;
r=phi_r*r(-1)+(1-phi_r)*(phi_pin*pin+phi_x*x+phi_s*s)+e_r;
e_r=rho_r*e_r(-1)+ eta_r;
e_pin=rho_pin*e_pin(-1)+eta_pin;
e_s=rho_s*e_s(-1)+eta_s;
e_x=rho_x*e_x(-1)+eta_x;
end;

varobs pin x r s;

initval;
   pin= 0;
   x =0;
   r =0;
   s =0;
   e_pin =0;
   e_x =0;
   e_s =0;
   e_r =0;
   eta_r=0;
   eta_pin=0;
   eta_s=0;
   eta_x=0;
end;
beta =0.98;

estimated_params;

alpha, beta_pdf, 0.5, 0.28;
kappa, gamma_pdf, 0.05, 0.01;
omega, beta_pdf, 0.5, 0.28;
psi,  normal_pdf, 0, 0.5;
lambda, gamma_pdf, 0.05, 0.025;
delta_x, gamma_pdf, 0.1,0.05;
delta_s, gamma_pdf, 0.1,0.05;


phi_pin, normal_pdf, 2.0, 0.3;
phi_s, normal_pdf,0,0.5;
phi_x, gamma_pdf,1, 0.1;
phi_r,beta_pdf, 0.5, 0.28;
```

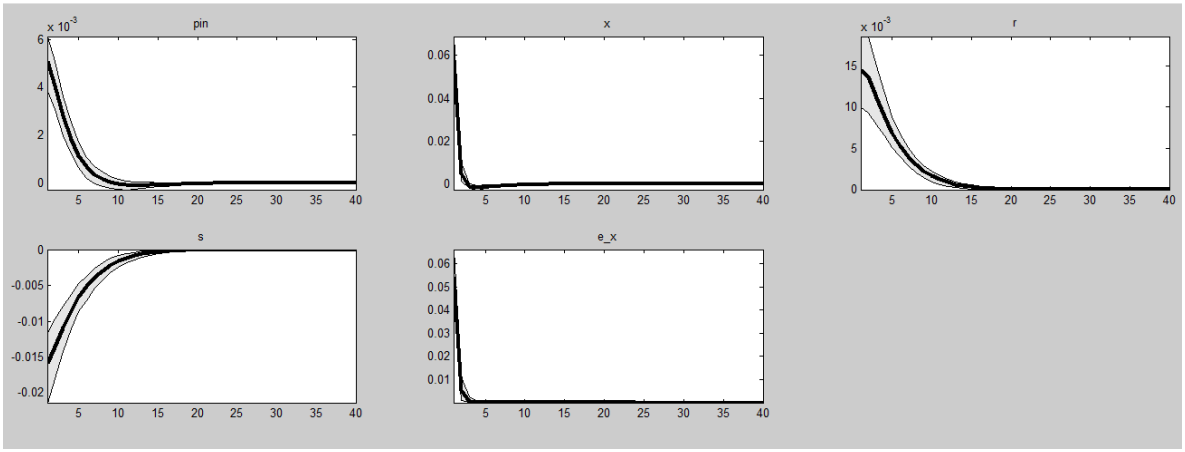
```
rho_pin, beta_pdf, 0.5, 0.28;
rho_x, beta_pdf, 0.5, 0.28;
rho_s, beta_pdf, 0.5, 0.28;
rho_r, beta_pdf, 0.5, 0.28;

stderr eta_s, inv_gamma_pdf, 0.01, 10;
stderr eta_x, inv_gamma_pdf, 0.01, 10;
stderr eta_pin, inv_gamma_pdf, 0.01, 10;
stderr eta_r, inv_gamma_pdf, 0.01, 10;

end;

estimation(datafile=DSGEmoneyquarterly,nobs=43,first_obs=6,bayesian_irf,conditional_variance_decomposi
tion =[1 4 10 40],moments_varendo,
mh_replic=200000,mh_nblocks=2,mh_drop=0.45,mh_jscale=0.8,mode_compute=6);
```

Appendix 5: Impulses Responses for empirical model

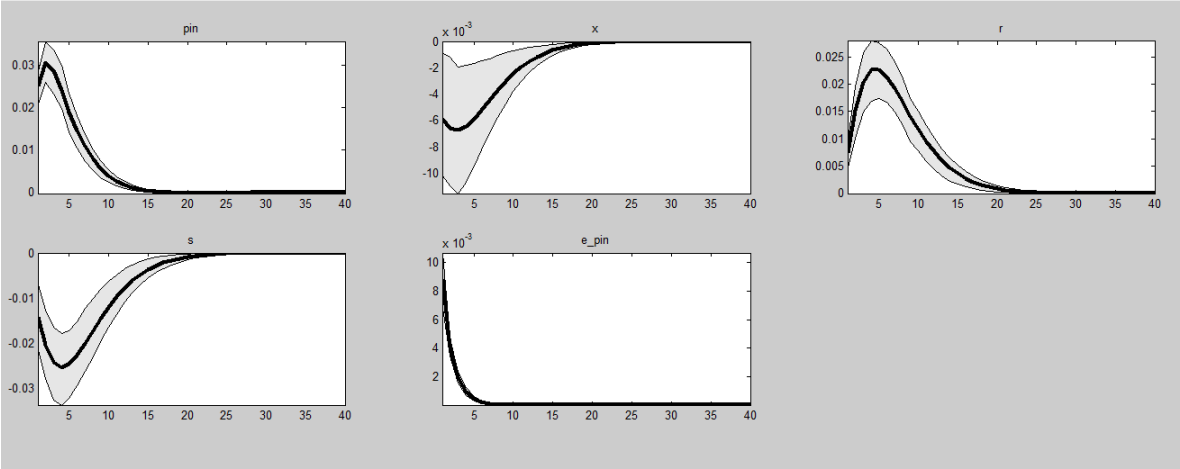
Shock to eta_s



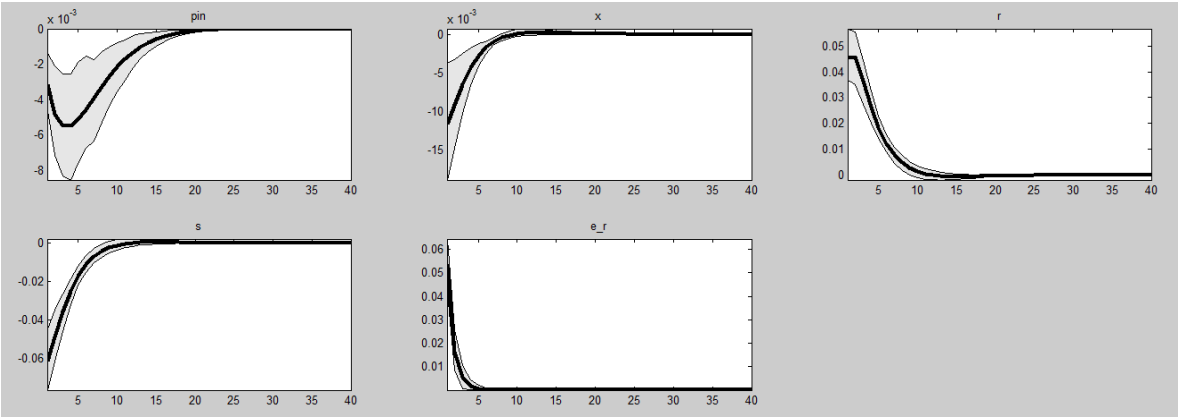
Shock to eta_x:



Shock to eta_pin



Shock to eta_r:



Appendix 6: Data

Date	Output gap (x)	Interest rate (r)	Inflation (pin)	Stock returns (s)
Jun-01	0.085214	0.0545	-0.008	0.619342
Sep-01	0.043184	0.0565	0.003	-0.71612
Dec-01	-0.0461	0.054267	0.002	-0.03777
Mar-02	0.080408	0.057233	0.026	-0.16222
Jun-02	-0.05794	0.0595	0.040	0.009498
Sep-02	0.021704	0.0607	0.043	-0.10384
Dec-02	0.005597	0.0593	0.045	0.006567
Mar-03	0.0989	0.061867	0.039	-0.23173
Jun-03	-0.03156	0.0625	0.036	0.046098
Sep-03	-0.02554	0.0581	0.028	-0.08888
Dec-03	0.007492	0.0506	0.026	0.180861
Mar-04	0.053313	0.0556	0.043	0.50797
Jun-04	0.060421	0.057067	0.071	-0.10534
Sep-04	0.016125	0.0585	0.097	-0.06841
Dec-04	-0.05681	0.0565	0.099	0.025823
Mar-05	0.079787	0.059933	0.090	0.029726
Jun-05	0.025833	0.061233	0.081	0.001216
Sep-05	0.044942	0.062	0.076	0.158949
Dec-05	-0.03547	0.0619	0.085	0.060907
Mar-06	0.027458	0.062767	0.083	0.493228
Jun-06	0.070505	0.055567	0.074	0.023609
Sep-06	-0.04489	0.037305	0.072	0.021376
Dec-06	-0.00552	0.0335	0.067	0.355742
Mar-07	0.035082	0.0363	0.065	0.354226
Jun-07	0.045724	0.0408	0.074	-0.04452
Sep-07	0.05672	0.0475	0.086	0.021415
Dec-07	0.068916	0	0.107	-0.12158
Mar-08	-0.02882	0.082125	0.164	-0.58422
Jun-08	-0.00309	0	0.245	-0.25779
Sep-08	-0.12387	0	0.277	0.134063
Dec-08	0.129878	0.111892	0.236	-0.36949

Mar-09	0.040482	0.0679	0.155	-0.11736
Jun-09	0.01019	0.0762	0.067	0.468261
Sep-09	-0.02902	0.0833	0.024	0.259138
Dec-09	-0.01499	0.094133	0.046	-0.16049
Mar-10	0.159365	0.11145	0.075	0.008994
Jun-10	-0.08381	0	0.085	0.0157
Sep-10	-0.02852	0	0.086	-0.10955
Dec-10	0.00564	0	0.108	0.064206
Mar-11	0.049975	0	0.128	-0.04977
Jun-11	0.066892	0	0.194	-0.06401
Sep-11	-0.00607	0.1235	0.225	-0.01149
Dec-11	0.090037	0	0.198	-0.19584

Chapter 5 : CONCLUSION AND POLICY IMPLICATIONS

Economic theory suggests that changes in monetary policy can be transmitted to the economy through a number of channels: interest rate channel, credit channel, exchange rate channel and asset prices channel. (Mishkin, 1996) This dissertation aims to contribute to the study of monetary policy transmission mechanism in Vietnam by studying the asset price channel and the associated wealth effect on aggregate real variables. In particular, we attempt to answer two research questions:

1) Does monetary policy have an impact on equity prices and is this impact transmitted to the real economy via wealth effect?
2) Does the central bank systematically react to stock market volatility, as well as to inflation and output gap?

Our main findings suggest that:

1) Monetary policy has an impact on equity price in Vietnam but this impact does not enter the IS curve and consequently does not have any effect on real economy.
2) The central bank shows signs of concerns about financial market. The primary concern, however, is inflation, followed by output growth.

In Chapter 3, using a Vector AutoRegression (VARs) approach, we find a significant linkage between money supply and stock market performance. Monetary policy expansion significantly and mildly boosts market stock returns. In the process, there is

evidence that smaller firms benefit from the policy more than larger firms. Similarly, finance sector benefits more from the monetary policy loosening than other sectors such as Materials, Services or Consumer Goods. This result indicates that the monetary policy could be an instrument to support the development of small and medium size firms as well as the financial sector in Vietnam because they are going to benefit more from financial stimulus plans.

In Chapter 4, we estimate a New Keynesian DSGE model featuring stock returns and monetary policy using Vietnam data. This model allows stock returns to enter the households' financial wealth and the aggregate consumption. This feature allows us to examine whether better financial market performance is linked to increases in household consumption and consequently, real output via the wealth channel. The results from parameters estimation indicate that stock price and household consumption are weakly linked. In Vietnam, it seems that households, given more expected financial holdings, do not have a tendency to change their consumption patterns. This result reveals a policy implication that the possibility of influencing household behaviors in Vietnam by means of monetary policy is limited.

We further notice that the financial market condition is one subject of concern for the State Bank of Vietnam as it enters the central bank's decision rule with a significant impact. Inflation remains the primary target of monetary policy, followed by output growth. These results highlight that SBV is making efforts to monitor the financial market and provide benchmark for assessing the central bank's credibility and efficiency.

We remain cautious while dealing with the Vietnam case as high volatility and uncertainty associated with the immature financial sector can distort findings and mislead interpretations.