UNIVERSITY OF GHANA

INVESTIGATING THE RESPONSES OF PRIVATE SECTOR CREDIT, OUTPUT AND PRICES TO MONETARY POLICY SHOCKS IN GHANA

BY

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DECLARATION

I, Prosper Kaangmenpuo Kayelle do hereby declare that except for the references cited, which have been duly acknowledged, this thesis is the product of my own research work in the Department of Economics, University of Ghana, Legon, towards the award of Master of Philosophy Degree in Economics under the supervision of Dr. Augustine Fritz Gockel and Dr. Festus Ebo Turkson.

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ABSTRACT

This study investigates the responses of private sector credit (PSC), output (RGDP) and prices (CPI) to monetary policy shocks in Ghana. The study adopted the technique of Vector Autoregression (VAR) using monthly data from 1990 to 2015. A base VAR was first estimated which comprised of RGDP, CPI, PSC and 91-day Treasury bill rate. Shocks to the Treasury bill rate were identified as monetary policy shocks. The base VAR was then extended to include money supply, exchange rate and price of crude oil, one at a time to assess their individual impact on variables of the base VAR. Cholesky ordered impulse response functions and variance decomposition, as well as Granger Causality tests were used to study the dynamic responses of the variables in our models.

The study found that output and private sector credit responded negatively to monetary policy shocks as expected. Prices rose for about four months before falling. Overall, taking in consideration the results from the impulse response functions, variance decomposition and Granger causality tests, our study found that monetary policy is somewhat effective in impacting prices, output and private sector credit in Ghana. The study also found that PSC, RGDP and CPI responded differently to monetary policy shocks in the pre and post inflation targeting regimes, with monetary policy shocks significantly affecting PSC, RGDP and CPI in the latter regime. In the extended models, money supply was found to significantly account for the fluctuations in prices, while PSC outperforms money in forecasting output. Exchange rate was also found to be a moderate conduit for price changes. This study therefore recommends that the monetary authorities ensure that market interest rates at all times reflect the changes in the monetary policy interest rate. This will lead to better response of goal variables. It is also recommended that both the fiscal and monetary authorities ensure that private sector's credit needs are met.

DEDICATION

I foremost dedicate this work to the Lord God Almighty for His faithfulness throughout the years. Secondly, to my late brother Timothy Dassah Kayelle; bro, you sacrificed a lot to get me to this level. Unfortunately, you left us when I was in the middle of this work to our Maker. You will never be forgotten. Finally, to my mother, Puowuoro Kayelle and my other siblings especially Patrick Kayelle and Bright Kayelle for your sacrifices and continuous support throughout my studies.

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LIST OF ABBREVIATIONS

AGI	Association of Ghana Industries
AIC	Alkaike Information Criteria
ARDL	Autoregressive Distributed Lag
BOG	Bank of Ghana
CDs	Certificate of Deposits
CPI	Consumer Price Index
DC	Domestic Credit
DSGE	Dynamic Stochastic General Equilibrium
EFP	External Finance Premium
EIA	Energy Information Administration
ERP	Economic Recovery Programme
EXR	Exchange Rate
FEVD	Forecast Error Variance Decomposition
FINSAP	Financial Sector Adjustment Programme
FOB	Free On Board
FPE	Final Predictor Error
GDP	Gross Domestic Product
GIPC	Ghana Investment Promotion Centre
GNCC	Ghana National Chamber of Commerce
GNP	Gross National Product
GPRS I	Ghana Poverty Reduction Strategy I
GPRS II	Growth and Poverty Reduction Strategy II
GSS	Ghana Statistical Service
HIC	Hanna-Quinn Information Criterion
HIPC	Heavily Indebted Poor Countries
IDO	Industrial Development Organization

IMF	International Monetary Fund
IRFs	Impulse Response Functions
M2+	Money Supply
MASLOC	Microfinance and Small Loans Centre
MPC	Monetary Policy Committee
MPR	Monetary Policy Rate
NBSSI	National Board for Small Scale Industries
NDA	Net Domestic Assets
NDC	National Democratic Congress
NFA	Net Foreign Assets
NLC	National Liberation Council
NPP	New Patriotic Party
OLS	Ordinary Least Squares
OMO	Open Market Operation
PNDC	Provisional National Defence Council
POIL	Price of Crude Oil
PPP	Public-Private Partnership
PS	Private Sector
PSAC	Private Sector Advisory Council
PSAG	Private Sector Advisory Group
PSBR	Private Sector Borrowing Requirement
PSC	Private Sector Credit
PSCC	Private Sector Consultative Committee
PSIs	Presidential Special Initiatives
PSR	Private Sector Roundtable
RGDP	Real Gross Domestic Product
SOEs	State Owned Enterprises

SVAR	Structural Vector Auto Regression
TBILL	91-day Treasury Bill Rate
US	United States
VAR	Vector Auto Regression
VECM	Vector Error Correction Model
WDI	World Development Indicators

CHAPTER ONE

INTRODUCTION

1.1 Background

Economists have tried to understand the relationship between money (monetary policy) and various macroeconomic variables like output, prices, credit, exchange rate and balance of payments etc. They have sought to find out if money has real effects on the economies of nations. An important piece of evidence in this direction was the work done by Friedman and Schwartz (1963) on their monetary history of the United States. The general conclusion from that study was that "money matters". Subsequent studies on the same subject such as Romer and Romer (1989), Bernanke and Blinder (1992), Christiano et al (1994) and Bernanke and Gertler (1995) just to mention a few, have concluded that money indeed matters, as it affects real variables. Thus, most economists advocate for the use of monetary policy for short run stabilization measures.

Generally, the aims of monetary policies across most nations include price stability, enhancing employment, maintaining equilibrium in balance of payment, promotion of output growth and stability in the country's financial system among others. Achieving price stability for instance improves the efficiency of the economy, as it prevents distortions in savings and investment decisions and thus enhances economic growth. Failure to pursue the right monetary policies can have serious ramifications for an economy. For instance, the great Depression of 1929-1933 and the recent financial crisis in 2008 have been partly attributed to the failure of monetary policy in the United States. In the words of Friedman, "the Great Contraction is tragic testimony of the power of monetary policy[…]" (Friedman, 1968, p. 3).

G. K. Shaw defines monetary policy as “any conscious action undertaken by the monetary authorities to change the quantity, availability or cost (interest rate) of money” (Shaw, 1971, p. 65). Controlling the quantity, availability and cost of money is geared towards achieving some defined macroeconomic goals such as increased output, stable prices, stable exchange rates etc. Monetary policy worldwide is conducted by central banks and they have at their disposal various instruments they use to control the level of interest rates and money supply in order to achieve these goals. A monetary policy shock is defined as the movement in the monetary policy variable which is not a normal, predictable response to the state of the economy. Monetary policy shocks are thus exogenous and unexpected and represent a departure of monetary policy from its usual path. Some economists believe that unexpected monetary policy shocks impact on economic activities while those that are anticipated by economic actors do not have any impact.

The process through which policy decisions of the monetary authorities are conveyed to the real side of the economy is termed the transmission mechanism of monetary policy**.** When monetary policy makers conduct policy by influencing the instrument(s) under their control, impulses are relayed to the real economy via various channels (such as interest rate channel, credit channel and exchange rate channel etc.). Thus monetary policy measures normally involve lags before they have an effect on the real economy. By setting the pace through altering its policy rate, a central bank is able to influence the money market and the rates therein. Through this, other long-term rates are impacted. Eventually, output and prices are impacted via aggregate demand (through its response to changes in the consumption and investment behaviour of economic agents). A successful transmission of monetary policy impulses through these channels to the real economy requires a developed financial sector and a stable macroeconomic environment.

The financial system of Ghana has undergone massive transformation since 1983, with the advent of the Economic Reform Programme (ERP). The ERP was introduced mainly to reverse the economic malaise which the country was experiencing then. Financial sector reforms were part of the ERP. Prior to financial reforms, the financial system of most developing countries was characterized by a system of monetary controls and low interest rate policies which were aimed at directing credit to productive sectors of the economy. However, most of these policies proved to be ineffective. Credit ceilings and sectorial credit allocations distorted financial intermediation. There was massive resource misallocation and competition among banks was inhibited. Once banks met their ceilings there was no more incentive to mobilize savings (Gockel, 2000). The financial sector reforms however led establishment of a more market-based system of bank intermediation and also paved the way for financial development, which is a prerequisite for monetary policy transmission.

In Ghana, monetary management can be classified under three different regimes. First is the control regime which was in operation prior to economic reforms. This period was characterized by price, interest rate, exchange rate, credit and distribution controls. The second phase is monetary targeting which is associated with the reform and structural adjustment. The third phase (present regime) is inflation targeting which has been in place since 2002[1]. The legal framework for the current regime was put in place in 2002 with the new Bank of Ghana Act (Act 612). This Act granted operational independence to the Bank of Ghana through its Monetary Policy Committee (MPC) to conduct independent monetary policy with price stability as its overriding goal. With inflation targeting, there is more transparency in the way in which monetary policy is conducted,

[1] Formal inflation targeting began in May 2007. Prior to this, the institutional framework needed for inflation targeting was put in place by the central bank. It also moved away from targeting monetary aggregates. For the purposes of this study, we take inflation targeting to start from 2002.

as policy makers make an announcement of the target for inflation and use the instruments under their control in order to achieve that target. The Bank of Ghana uses its monetary policy rate (MPR) to indicate monetary policy stance and anchor inflation expectations in the economy. Currently the inflation target for Ghana is 8% ±2%. This means headline inflation should range between 6 to 8 per cent over the medium term for the economy to grow at its full potential without excessive inflation pressures (Monetary policy report, May 2016).

Between 1990 and 2015, which covers the period of our study, Ghana's economy has seen some improved performance compared to the decades before. Between 1990 and 2000, output growth was on average 4.2% (WDI, 2015). From 2001 to 2015, growth has been generally moderate, averaging 6.4% per annum with the best growth coming in 2011 with a growth rate of about 14%. Though this is seen as an improvement, these growth rates are not enough to ensure that the country develops rapidly and deliver its masses from poverty. Various national policy documents such as Ghana Poverty Reduction Strategy I, Growth and Poverty Reduction Strategy II and the Ghana Shared Growth and Development Agenda I and II have advocated that output should grow above 8% per annum so as to transform the Ghanaian economy and ensure prosperity for all. For inflation, annual year-on-year inflation averaged 28.7% between 1990 and 2000 whilst between 2001 and 2015 inflation rate has generally been low, averaging 15.3% for the period (Bank of Ghana, 2017). This is however high given the fact that the medium term inflation target for the country is 6%-10%. Given these somewhat remarkable performances, it is crucial to find out the role monetary policy has played in achieving these results.

The private sector in every nation plays a decisive role if that nation is to achieve economic success of ensuring growth and reducing poverty. The story is no different in Ghana where the private sector is seen as the "engine of growth" of the economy. Despite this seemingly important role

deemed to be played by the private sector, it is sad to note that between 1990 and 2015, credit to private sector as a percentage of GDP averaged 11.7%, which is seen as inadequate if the sector is to play a prominent role to engineer output growth. As a result, various business leaders, economists and groups such as the Association of Ghana Industries (AGI) have called for increased lending to the private sector. Furthermore, they demand that government provide the enabling environment through the provision of infrastructure and other logistics as well as policies that will reduce the cost of doing business and enhance private sector growth.

Theoretically, it is argued that monetary policy not only has the ability to affect the amount of bank credit to private sector firms in an economy but also the cost of such credit. If the monetary policy rate which is the benchmark interest rate in Ghana increases, most of the other short term rates especially lending rates also increase. Even when the policy rate is reviewed downwards in order to stimulate the economy, these lending rates either remain the same or they are not able to match the reduction in the policy rate. This hike in lending rates means that bank dependent borrowers (firms) will be constrained and unable to raise enough funds to finance their investments if policy is tightened. This will negatively affect output if firms do not have alternative sources of funding. Once a lower output is delivered, its limited supply puts upwards pressure on prices.

In view of this perceived link between private sector credit, output and prices, this study seeks to find out how changes in the monetary policy variable affects the dynamics of these variables in Ghana for the period 1990 to 2015. The study also compares the pre-inflation targeting era and post-inflation targeting era to see whether private sector credit, output and prices have responded differently to monetary policy shocks in the two regimes. The study will also be extended to assess the impact of exchange rate, money supply and price of crude oil on the movements of private sector credit, output and prices.

1.2 Problem Statement

The Bank of Ghana was set up in 1957 to conduct monetary policy among other functions. Its mission now is to strive for sound financial and monetary policies geared towards stable prices as well as create a conducive environment for sustainable growth. Since its establishment, varied frameworks have been adopted to deliver on its core mandate. Over the years, the goals of monetary policy decisions have been to affect output growth positively and ensure low and stable prices. It is also to ensure that other key macroeconomic variables that are relevant for the overall health of the economy such as balance of payments, exchange rate, money supply, and private sector credit among others are at levels that promote economic growth. Achieving these goals will ensure prosperity and improve on the standard of living of all citizens.

There have been wide and varied opinions on whether monetary policy has delivered on this mandate. For instance Kwakye (2012) contends that the relatively lower rates of inflation under the inflation targeting era cannot be attributed solely to the effectiveness of monetary policy. He argues that improved macroeconomic management, lower food inflation, fuel and utility subsidies and closed management of exchange rate have all played a role in ensuring low prices.

The ability of monetary policy to influence credit, prices, output and other key macroeconomic variables has been well documented by a number of studies in advanced economies. For instance, Gertler and Gilchrist (1993, 1994), Bernanke and Blinder (1992), Christiano et al (1994), Sims (1992) and Morsink and Bayoumi (2001) have all clearly established that monetary policy has significant impact on real economic activities.

In developing countries especially Africa, conclusions on the effectiveness of monetary policy on macroeconomic variables still remain uncertain as the expected theoretical transmission

mechanisms have not been realized consistently over time. This may be due to the underdeveloped financial markets which does not allow the full transmission of monetary policy impulses to target variables. Cheng (2006) showed that monetary policy shocks turn to be followed by significant declines in prices and appreciates the exchange rate in Kenya, but insignificant on output. Chuku (2009) found that when interest rate and exchange rate are used as policy variables, they have no significant impact of prices and output but money supply proved to be the most influential on output and prices in Nigeria. Smith and Du Plessis (2001) found that innovations from the policy variable leads to a reduction in price level but does not have significant effect on output in South Africa.

In the context of Ghana, a number of such studies have been conducted. Allieu (2002) found that output responded slightly to interest rate shocks, whiles prices initially rose but fell after nine months. However, Abradu-Otoo et al (2003) found strong evidence of interest rates affecting prices and output in the long run. Meanwhile, Abradu-Otoo et al (2003) and Allieu (2002) agree that exchange rate is a conduit through which monetary policy acts. Boamah (2009) also found that monetary policy was successful in affecting the savings rate but not quite potent at regulating inflation. Akosah (2015) found that inflation over the medium to long term is explained by interest rate shocks[2], while in the short run, exchange rate shocks have a larger impact on inflation than interest rate. He also found that output was driven by credit and asset price shocks, while monetary policy shocks played an insignificant role.

These studies have all tried in one way or another to look at the monetary transmission mechanism and the effectiveness of monetary policy in the Ghanaian context. Looking at the conclusions of

[2] Interest rate shocks are interpreted as monetary policy shocks in all these four studies.

these studies, it would be difficult to conclude on the effectiveness of monetary policy in Ghana without further empirical research. We also argue that even though these empirical evidence exist for Ghana, it is in the interest of the central bank that these quantitative estimation of the transmission mechanism is revised from time to time so as to enable monetary authorities know the extent to which its policy affect target variables. In terms of methodology our study differs from the above studies by adopting an unrestricted VAR in levels. The above studies have all resorted to some form of restricted VAR such as Vector Error Correction Models and Structural VAR which involved differencing variables that are not stationary at first difference. Some studies argue against differencing even if the variables contain unit root. This is because differencing throws away important co-movements in the data (more on this in section 4.4.1).

Our study therefore considers high frequency data (monthly) which covers the periods before and after inflation targeting (to take into account the effects of possible regime changes) to specifically examine the responses of private sector credit, output and prices to changes in the monetary policy variable. To the best of the author's knowledge no other study has comprehensively considered the analyses before and after inflation targeting in one study. This study also critically examines the linkages between private sector credit, output and prices to examine the extent to which monetary policy shocks and other shocks account for the fluctuations in these variables across the study period.

1.3 Objectives of the Study

The broad objective of this study is to investigate the effect of monetary policy on private sector credit, output and prices in Ghana. Specifically, the study seeks to:

i. Analyse the responses of private sector credit, output and prices to monetary policy shocks in Ghana.

ii. Identify the variations in private sector credit, output and prices that is accounted for by the monetary policy variable.

iii. Examine whether the responses of private sector credit, output and prices differ before and after inflation targeting.

iv. Explore the impact of money supply, exchange rate and price of crude oil on private sector credit, output and prices.

1.4 Justification of the Study

Given that monetary policy plays a key role in tracking inflation and ensuring sustainable output growth, a study of this nature will help policy makers know the dynamics of private sector credit, inflation and output movements and use the right instruments at their disposal in order to achieve their goals. It will also help policy makers to know the efficacy of their policy actions.

Investigating the impact of monetary policy on the economy of Ghana is also relevant for these reasons. First, understanding which variables are impacted by policy would improve our understanding of the links between the various variables in the economy. Second, knowing how fast the various macroeconomic variables respond to policy shocks will help policy makers in the timing of policy to achieve a particular target at a particular time. Thirdly, knowing which factors account for private sector credit, output and price changes will lead to better choice of policy tools and targets. Finally, a study of this nature will add to the empirical evidence on impact of monetary policy on the economy of Ghana since studies on the subject are limited.

1.5 Organization of the Study

This study is structured in six chapters. Chapter one introduces the topic, presents the research problem, objectives and significance of the study. Chapter two reviews both theoretical and empirical literature on the topic. Chapter three gives an overview of private sector, prices and output developments as well as monetary policy and its related issues in Ghana. In chapter four the research methodology and estimation techniques are discussed. Chapter five presents and discusses the results and findings from our estimation. Finally, chapter six gives a summary of the study and provide some policy recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

In this chapter, the study reviews both theoretical and empirical literature on the topic of study. The chapter shall be made up of three sections. The first section will deal with the theoretical review of the relationship between monetary policy and prices and output. The second section looks at the channels of the monetary transmission mechanism. Finally, the third section will present a review of empirical studies on the effects of monetary policy on prices, output and credit.

2.1 Theories on the Relationship between Monetary Policy and Output and Prices

Theories on the relationship between monetary policy and output and prices have evolved over the years. Some of these theories are the quantity theory of money, Keynes theory of money and prices, IS-LM model and the Mundell-Fleming model. The dynamic stochastic general equilibrium (DSGE) model is currently the dominant framework that is widely accepted in academic cycles and in actual central banking practice (Balfoussia et al, 2011).

2.1.1 The Quantity theory of money

The quantity theory postulates that money supply and price level in an economy are directly proportional to each other, thus any change in money supply will not necessarily increase output but will result in equivalent increase in prices instead. It is represented by the equation of exchange

$$MV=PY \qquad (2.1)$$

Where M=money supply, V=velocity of money, P=price level, Y=output/volume of transactions.

It shows that nominal output in an economy must equal the quantity of money times the number of times money changes hands in the economy. The theory assumes V is constant over time since it is determined by institutional and technological factors, which do not change quickly. Output does not depend on money supply in the long run and is thus considered constant. Therefore any increase in money supply will lead to corresponding increase in prices. However, Keynesian economists and monetarists have criticized the theory. They argued that the theory fails in the short run when prices are sticky. It has also been proven that the velocity of money does not remain constant over time.

2.1.2 Keynes Theory of Money and Prices

Keynes theory of money and prices disagrees with the quantity theory of money formulated by classical economists who asserted that there is a direct relationship between money supply and prices. Keynes argued that the relationship is indirect and operates through the rate of interest. He claims that an increase in money supply leads to a fall in the rate of interest, which leads to an increase in investment and thus increase aggregate demand and output. The theory opines that when output is below full employment level, an increase in money supply causes output to increase proportionally as the increase in the money supply but prices do not increase with the increase in output. But when output is at full employment, an increase in money supply does not cause output to increase, thus the change in money supply translate to changes in prices by the same amount.

2.1.3 IS-LM Model

IS-LM model or Investment Savings-Liquidity Preference model describes the equilibrium relationship between output and interest rate in the goods and money market. The IS curve shows equilibrium combinations of output and interest rate in the goods market, while the LM curve

shows equilibrium combinations of output and interest rate in the money market. They are represented below:

IS: $Y=f[C(Y, t(Y)), I(r), G, NX]$ (2.2)

LM: $M/P=L(r, Y)$ (2.3)

Where Y=output/aggregate demand/income, C=aggregate consumption (which depends on disposal income), I=investment (which depends on the rate of interest (r)), G=government spending, NX=net exports, M/P=real money balances (which depends positively on Y and negatively on r, r is the opportunity cost of holding money).

For the IS curve, any increase in C, I, G, or NX will increase aggregate demand/output and cause the IS curve too shift to the right. An increase in interest rate will cause investment to fall and as a result output will fall. The IS curve is downward sloping due to the negative relationship between interest rate and output. The LM curve is upward sloping, which means that increase in output will result in increased demand for money, but since the money supply is assumed fixed, interest rate will have to increase so that money demand can decrease to the real money balance level to restore equilibrium. A change in monetary policy can affect the equilibrium levels of output and the interest rate. If money supply increases, it means the LM curve will shift downwards to the left, which will cause interest rates to fall and increase income.

2.1.4 Mundell-Fleming Model

The Mundell-Fleming model is an extension of the IS-LM model which introduces an open economy with perfect capital mobility. It shows the relationship between interest rate, output and exchange rate. Under a flexible exchange rate regime, a contractionary monetary policy (a decrease in money supply) shifts the LM curve upwards causing the domestic interest rate to rise. All things

being equal, the increase in domestic interest rate encourages capital inflow into the domestic economy which will translate to an appreciation of the local currency. The appreciation makes domestic goods less competitive and hence decrease net exports. The decline in net exports on the other hand causes the IS curve to shift to the left, resulting in a decline in output.

2.1.5 Dynamic Stochastic General Equilibrium (DSGE) Model

Defining a consensus macro model has always been a challenge. But there has been some convergence towards a consensus in recent years. This consensus is typically represented in terms of a simple dynamic stochastic general equilibrium model, which describes the behavior of the economy based on microeconomic foundations of the interactions of key economic agents (households, firms, and the government), which interact and clear at every time and result in a general equilibrium. Following Meyer (2001), this consensus model is summarized by the following three equilibrium equations:

$$Y_t^g = aY_{t-1}^g + bE_t\left(Y_{t+1}^g\right) - c[R_t - E_t(P_{t+1})] + x_t \qquad (2.4)$$

$$P_t = d\left(Y_t^g\right) + w_1 P_{t-1} + w_2 E_t(P_{t+1}) + z_t, \quad w_1 + w_2 = 1 \qquad (2.5)$$

$$R_t = r^* + E_t(P_{t+1}) + fY_{t-1}^g + g(P_{t-1} - P^T), \qquad (2.6)$$

Where Y^g =the output gap (the percentage point difference between actual and potential output), R=nominal interest rate, r^*=equilibrium interest rate, P=inflation, P^T=inflation target, x and z are stochastic shocks, and all coefficients are positive.

Equation 2.4, which represents the aggregate demand equation is basically a dynamic version of the old IS curve, with output gap determined by past and expected future output gap and the real rate of interest. Equation 2.5 represents a Philips curve with inflation based on current output gap

and past and future inflation. The effect of past inflation captures the role of sticky prices, while inflation expectation are assumed to be set, as in equation 2.4 according to rational expectations. Equation 2.6, the policy rule (of the Taylor type), relates the nominal interest rate, viewed as the instrument of monetary policy to the output gap and the difference between inflation and the central bank's inflation target, expected inflation and equilibrium real interest rate. In a sense, equation 2.6 replace the LM curve in the IS-LM framework.

The policy rule in today's consensus model specifies the way policymakers adjust the interest rate to economic developments. This specification has the advantage of more accurately capturing the prevailing operating procedure at central banks around the world. It reflects the current view of monetary policy as a systematic adjustment of the policy instrument(s) to ongoing developments in the economy rather than simply as an exogenous process. Inflation above the target requires higher interest rates to contain inflation, whereas inflation below the target dictates lower interest rates to stimulate the economy and increase inflation.

In this new consensus model, monetary policy operates through the conventional Keynesian interest rate channel. A tight monetary policy in the form of a shock to the policy rule (equation 2.6), that increases the short-term nominal interest rate leads to an increase in the real interest rate as well when nominal prices move slowly due to costly or staggered price setting. This increase in the real interest rate then causes households to cut back on their spending as summarized by the aggregate demand equation. Finally, through the Philips curve, the decline in output puts downward pressure on inflation, which adjusts only gradually after the shock.

Though this new consensus has many facets and has been summarized above, it should be noted that the existence of many channels through which monetary policy is seen to operate is masked

by this simple approach. In the next section, we elaborate on some of the channels of monetary policy transmission mechanisms that have been postulated.

2.2 The Transmission Mechanism of Monetary Policy

Central banks worldwide conduct monetary policy using their grip on short term interest rates to impact the cost of capital and therefore consumption (of households and firms), output, prices and employment in their respective economies. Conventionally, theory on the transmission mechanisms of monetary policy can be categorized into two based on the suppositions made about financial markets. These are the money channel and the credit channel.

2.2.1 The Money Channel

The money channel assumes that financial markets are homogenous and perfect. It further assumes that the central bank can influence short term nominal interest rate. This enables it to affect both the short term and long term real interest rates. Given these assumptions, monetary impulses are able to have real economic impact if only prices are sticky. Another presumption is that consumption and investment expenditures are interest elastic. The more interest sensitive both are, the greater will be the impact of a monetary policy shock on them.

The most common channel of monetary transmission mechanism here is the traditional interest rate channel. Three more channels have evolved out of the money channel, namely; the exchange rate channel, Tobin's q theory and the wealth effect channel. The exchange rate channel is based on the real interest rate changes whiles the latter two are predicated on stock price values.

2.2.1.1 Interest Rate Channel

The interest rate channel is based on the Keynesian IS-LM model. Here, monetary policy affects the real economy via changes in interest rates which works through the liability side of banks' balance sheet. The banks create money by issuing demand deposits. In the Keynesian view, there are only two financial assets, money and bonds. Bonds represent the whole capital market. Suppose there is a strict monetary policy which reduces reserves. This will limit banks' ability to create and sell demand deposits. This means households' bond holdings increases while their money holdings decline. If prices are sticky to the changes in money supply, the fall in household balances represent a decline in real money balances. In order for equilibrium to be restored, the real interest rate on bonds increases, which causes the user cost of capital to go up and thus discourage investment and consumption. The effects of a monetary contraction is illustrated below:

$$M\downarrow \Longrightarrow i\uparrow \Longrightarrow I\downarrow \Longrightarrow Y\downarrow$$

M↓ represents a monetary contraction, resulting in a rise in real interest rate (i↑) which in turn leads to an increase in the user cost of capital which inhibits business and consumer spending, leading to a fall in investment (I↓) which causes aggregate demand to decline and culminating in a decrease in output (Y↓) (Mishkin, 1995). Initially, this channel was seen as operating through businesses' investment decisions but later studies showed that consumer spending on housing and consumer durable consumptions are investment decisions.

Taylor (1995) contends that the interest rate channel of monetary transmission mechanism is a key element through which monetary policy impulses are conveyed to the real economy. In his model he found that a monetary contraction leads to a rise in short term nominal interest rate. Through sticky prices and rational expectations, the long term real interest rate rise after a while. The

increased long term real interest rate causes fixed business investment, residential investment, consumer durable spending and inventory investment to decrease. This dampens aggregate demand. Due to this Taylor concluded that there are strong interest rate effects on consumer and investment expenditures and hence a strong interest rate channel of monetary transmission. This position was however challenged by Bernanke and Gertler (1995) and other researchers. They opined that empirical studies have had difficulty in identifying a quantitatively substantial effect of the interest rate channel through the neoclassical user cost of capital variable. This has provided the basis for the search for other possible channels of monetary transmission mechanisms, notably the credit channel.

2.2.1.2 Exchange Rate Channel

With economies of the world becoming increasingly interconnected and interdependent due to globalization, a great amount of worldwide capital mobility currently exist globally. Mundell (1962) suggests that capital movement implies there exist a very modest connection between short term interest rate and the exchange rate i.e. the interest parity relationship. This states that "the interest rate differential between any two countries is equal to the expected rate of change in the exchange rate between those two countries" (Taylor, 1995, p. 15). If this parity condition does not hold, capital will flow to the country with higher returns until the expected returns are equalized. By this, an attempt by the central bank of one country to raise short term interest rates will raise the exchange so that expectations of a decline in exchange rate can equalize the rates of return in the home and foreign country. Therefore there exist a positive relationship between the interest rate differential between any two countries and the exchange rate.

Central banks must also decide which exchange rate regime will be suitable for their economy. Under a fixed exchange rate regime with a high degree of capital mobility, there is loss of international monetary independence. In such a system, the two countries short term interest rates must move together. But such a system results in less exchange rate variability. With less exchange rate variability, net exports is less variable which works to reduce output and inflation variability. Unlike a fixed exchange regime, the monetary authorities do not target the exchange rate under a flexible exchange rate regime, thereby preserving monetary independence. Although the exchange rate is more volatile in this case, central bankers can take actions to reduce output and inflation variability. Simulations using the two systems have generally yielded results that flexible exchange rate policies perform better in keeping output and inflation variability low (Taylor, 1995).

This channel also works through the interest rate. A monetary tightening will cause domestic nominal interest rates to increase. All things being equal, this will translate into a surge in local real interest rates. With high real domestic interest rates, domestic currency denominated assets become more attractive relative to assets denominated in foreign currencies. There will therefore be inflow of capital into the domestic economy as investors from the rest of the world seek higher returns which the local economy provides. This will lead to an appreciation of the domestic currency (indicated by E↓)[3]. The appreciation of domestic currency makes domestic goods and services expensive relative to foreign goods and services, thereby causing domestic exports to decline which subsequently reduce net exports. This affects domestic aggregate demand negatively and eventually leads to a decline in output, as indicated below.

[3] Here we use the price quotation system where one unit of foreign currency is expressed in terms of the domestic currency.

$M\downarrow \Rightarrow i\uparrow \Rightarrow E\downarrow \Rightarrow NX\downarrow \Rightarrow Y\downarrow$

Changes in the exchange rate also have implications for both individual and firm investment spending. An appreciation of domestic currency makes domestic exports expensive relative to imported goods while a depreciation makes imports expensive. Given that domestic firms import some of their raw materials for production, this will affect their level of investment. Also if significant amount of both individual and firm wealth is held in foreign currencies, the changes in exchange rate will affect their wealth and hence their spending decisions. All of this can influence aggregate demand. The exchange rate channel also affects inflation in two ways. One way is through aggregate demand as described above. The second way is through import prices. Changes in exchange rate affect import prices directly and as a result influence the inflation rate.

2.2.1.3 Tobin's q Theory

This provides a mechanism through which monetary policy affects the economy via the valuation of equities. It gives a linkage between stock prices, business investment and output. Tobin (1969) defines q as "the market value of firms divided by the replacement cost of capital". A high q means that the value of firms is high relative to the cost of replacing capital and thus new plant and equipment is cheap compared to the market value of firms. Firms therefore take this opportunity to invest in new plant and equipment. This they do by issuing equity and because the firms' valuations are up, they get a high price for these equities relative to cost of replacing the existing capital. Because companies can now purchase a lot of new plant and equipment with small equity issues, their investment spending will go up. A low q on the other hand means that the replacement cost of capital is more than the market value of firms. In this instance, firms will prefer to buy

another firm and acquire old capital than issuing equity and getting a smaller value for it. Hence when q is low firms investment spending too is low.

The key question at this stage is how will monetary policy affect equities (shares)? In a monetarist view, a tight monetary policy means that individuals find themselves holding less money than they would have wished to hold. In order to improve on their money balances, the public must spend less money. One of the places they can achieve this goal is in the stock market. As individuals demand less for shares, share prices will fall. In a Keynesian view, a contractionary monetary policy (M↓) means that interest rates will rise thus making bonds more attractive compared to shares. This makes share prices to fall as the public shift away from demanding for equity to bonds. It is clear from the two views above that equity prices (P_e) will fall. This translate to a lower q which affect investment (I) negatively and lead to the following outcome as espoused by Mishkin (1995):

M↓$\Rightarrow$ P_e↓$\Rightarrow$q↓$\Rightarrow$I↓$\Rightarrow$Y↓.

2.2.1.4 Wealth Effect of Consumption

Like the Tobin's q theory, the wealth effect of consumption channel is grounded on stock prices. However, here the focus is on stocks as a portion of household wealth. As argued by Modigliani (1971) in his Life Cycle Hypothesis, an individual's /household consumption is determined by his/her lifetime resources which comprise of human capital and financial wealth. The individual's desire is to smoothen his/her consumption over a period of time. A significant portion of an individual/household financial wealth is made up of stocks. So any movement in share prices will have implications for individual/household consumption. When monetary policy is eased for instance, individuals spend some of their excess money in the stock market. As people demand

more stocks, stock prices will increase. This increases the wealth of stock holders and as a result increase their lifetime resources. All things remaining constant, this will in turn increase consumption. Aggregate demand is positively affected and thus result in an increased output, as summarized below:

$M\uparrow \Longrightarrow P_e\uparrow \Longrightarrow \text{Wealth}\uparrow \Longrightarrow \text{Consumption}\uparrow \Longrightarrow Y\uparrow.$

Meltzer (1995) in his commentary of the Japanese experience in the 1980s and 1990s observes that monetary policy also has key repercussions on the economy through its influence on land and property value (e.g. housing) other than the ones working through the traditional channels such as interest rates, exchange rates and equity prices. A monetary easing can result in an increase in land and property prices which will expand household wealth. This will be accompanied by a rise in consumption and aggregate output. The recent experience in the United States of America between 2001 and 2008 reinforces the Japanese experience. Following the recession in 2001, the Federal Reserve in trying to stimulate the US economy embarked on the Keynesian policies of easy money. This created a demand bubble, of which most went into real estate. Commercial banks increased their real estate loans. This increased demand for real estate pushed up housing prices and encouraged the construction of new ones. Eventually when the Fed tightened monetary policy, it slowed housing prices and they began to decline sharply. This sharp decline in housing prices caused turmoil in the US financial sector in 2008 and eventually translated into the global financial crises.

2.2.2 The Credit Channel

The credit channel is based on the premise that financial markets are imperfect. In the money channel described above, two critical assumptions were made. Firstly, the central bank can

influence short term nominal interest rate. Secondly, consumption and investment spending are responsive to variations in real interest rate. Reservations have been raised about these two assumptions owing to the fact that monetary policy impulses that are generally insufficient appear to produce large recurrent movements in aggregate demand (in particular business fixed and inventory investment) or huge real effects that cannot be explained using the money channel mechanism only. Also, based on the first assumption, it is presumed that monetary policy must have its greatest impact on short term interest rates. Antithetically, monetary policy should have a comparatively feeble influence on long term rates, particularly real long span rates. It is hence confounding that monetary policy has large effects on expenditures on long-lived assets (e.g. housing). Even if long-lived assets should be responsive to interest rate at all, it should be sensitive to real long term rates.

The failure of the conventional money channel to fully explain the large cyclical movements in aggregate demand following small monetary policy changes as well as the impact of monetary policy on long-lived assets led some economists such as Gertler and Gilchrist (1993), Bernanke and Gertler (1995), among others, to explore other possible channels of monetary transmission mechanisms that could help explain these puzzles. They came to the conclusion that financial market imperfections together with the money channel must play a very significant role in accounting for the comparatively large real effects that were resulting from small monetary policy changes. This view is termed as the credit view of monetary policy transmission mechanism. Bernanke and Gertler (1995) however notes that the credit channel is not a distinct, independent alternative to the conventional money view, but they see it as a set of causes that augment and transmit the traditional interest rate effects.

In the credit channel, the impact of monetary policy on interest rates are magnified by endogenous changes in what is termed as the external finance premium (EFP). Bernanke and Gertler (1995) defines the EFP as the difference between the costs of raising funds externally and that of retained earnings. The depth of the EFP mirrors imperfections in the market for credit which drive a wedge between the expected return received by lenders and the costs faced by potential borrowers. Bernanke and Gertler (1995) identified three types of costs that are mirrored in the EFP. These are: first, costs due to monitoring, evaluation and collection to establish the credit worthiness of the lender; second, costs owing to adverse selection (the borrower possesses better information than the lender); and finally, costs stemming from moral hazard of the borrower.

Changes in monetary policy that decreases or increases market interest rates tend to affect the EFP in the same route. These additional effects on the EFP due to policy alterations help to explain the size, timing and make-up of an economy's response to monetary policy movements than is possible through only interest rates. There are two channels under the credit channel, namely, the balance sheet channel and the bank lending channel.

2.2.2.1 Balance Sheet Channel

The theoretical underpinning of the balance sheet channel is founded on the fact that the EFP facing a borrower must be contingent on the borrower's net worth (Bernanke & Gertler, 1995). The sturdier the financial locus of firms, the lower the EFP and vice-versa. Strong net worth means that the borrower has more collateral and this reduces the adverse selection and moral hazard problems that lenders face when they lend to these firms. The borrower is also able to bear his own losses. The robust net worth also discourages owners from engaging in risky investment projects but gives them incentives to work hard to achieve favourable financial positions because they have

higher equity stake in their firms. Given the fact that firms net worth affect the EFP which in turn affect the general terms of credit they face, investment and spending decisions of firms should respond to variations in the quality of the borrowers' balance sheet.

The balance sheet channel of monetary policy comes about because changes in a central bank's policy will not only influence market interest rates but also the net worth of firms (borrowers) both directly and indirectly. A stringent monetary policy for instance directly dwindles firms' balance sheets in several ways. Firstly, it increases interest payments on outstanding debts. This decreases net cash flows and thus wanes the firm's net worth. It is apparent that numerous firms depend on short term debt to finance their investments hence the rising interest rates will affect their financial positions negatively in quite a substantial manner. The second direct effect is the fact that rising interest rates generally leads to decreasing asset prices, which diminish the value of collateral and creditworthiness of firms. Indirectly, a strict monetary policy that reduces the spending of the firms' customers causes a decline in revenue and thus erode firms' net worth over time as their fixed outlays do not change in the short term.

In effect, lower financial position of firms due to the tightening of policy means less collateral to guarantee their loans. Thus the adverse selection problem becomes more pronounced as lenders cannot differentiate between risky and less risky borrowers. It also increases the moral hazard problem as proprietors of firms are tempted to partake in risky investment due to their smaller equity stakes. This means that creditors will cut back on loaning and hence investment spending will reduce which will eventually translate to lower output as shown below:

M$\downarrow \Longrightarrow P_e\downarrow \Longrightarrow$Adverse selection$\uparrow \Longrightarrow$Moral hazard$\uparrow \Longrightarrow$Lending$\downarrow \Longrightarrow$I$\downarrow \Longrightarrow$Y$\downarrow$.

Notwithstanding the fact that a number of literature on the credit channel centres on expenditures by business enterprises, Bernanke and Gertler (1995) recommend that the credit channel should also apply to consumer expenditures. Reduced bank lending as a result of monetary tightening will cause consumer durables and housing purchases to fall as consumers suffer from lack of alternative sources of credit. Rising interest rates deteriorates household balance sheets as their cash flows are negatively impacted. A different way of viewing how the balance sheet channel work through consumers is by looking at the liquidity effects of consumer purchases on housing and durable goods. In this view if consumers believe that they are likely to find themselves in financial distress, they will prefer to hold fewer illiquid assets such as durable goods and housing and hold more liquid financial assets like shares, bonds and demand deposits just to mention a few. The reason is that consumers will suffer huge losses if they were to dispose off these illiquid assets in a distress sale. On the other hand, the liquid assets can easily be disposed off at their full value to raise cash.

2.2.2.2 Bank Lending Channel

Bernanke (1983) expanding on the effort of Friedman and Schwartz (1963) suggested the existence of a further distinctive channel through which monetary policy can have real impact on an economy. This thought was further heightened by Bernanke and Blinder (1988) and shows how the supply of intermediated loans are impacted by monetary policy by affecting banks' credit. This brings into being the bank lending channel which is centred on the function banks play in transmitting monetary policy impulses. Here, monetary policy affects the EFP by varying the supply of bank credit.

Despite the fact that in recent times non-bank financial institutions and capital markets have gained prominence, where firms have access to other sources of finance, banks remain the major source

of credit in most economies. This is because banks specialized in solving the asymmetry information problems that exist in the market for credit. They are able to devise means such as credit rationing to fish out shady borrowers (Stiglitz & Weiss, 1981). Credit rationing is a situation where lenders restrict the amount they lend to borrowers even though the latter may be willing to pay a higher interest rate for the credit. On average, those willing to pay higher interest rates are the worse risky borrowers. So banks are able to apply some of these strategies in order to identify good borrowers. Disruptions in the supply of bank loans may not necessarily shut off bank dependent borrowers, but they are sure going to incur costs in finding a new creditor, starting a credit link and others. If there is a fall in the quantity of bank loans in relation to other sources of loans, it will most likely increase the EFP and may result in reduced real activity.

This channel provides the connection between monetary policy and banks and between banks, business enterprises and the real economy. By the orthodox opinion of the bank lending channel, a contractionary monetary policy which causes interest rates to increase makes it difficult for banks to access reserves from the central bank. This has repercussions since reserves are connected to bank deposits. The drain in reserves will put a break on banks' capacity to make deposits (D) and thus their capacity to equally grant loans (L). With lower loan grants, activities of bank dependent firms are limited as they are unable to borrow enough to undertake investment projects, hence investment will fall and subsequently output (Y) also falls as shown in the schematic below:

$M\downarrow \Longrightarrow D\downarrow \Longrightarrow L\downarrow \Longrightarrow I\downarrow \Longrightarrow Y\downarrow$.

It has been established that banks perform a central role in curbing the asymmetry information problems in credit markets. The fact that many firms are bank dependent has also been fairly confirmed. The key query about this channel now is whether monetary policy can remarkably have

an impact on the amount (or relative cost) of bank credit. Bernanke and Blinder (1988) came out with a model on the bank lending channel and submitted that the sale of securities by the central bank depletes reserves and thus deposits from banks. This will limit the amount of loans by decreasing banks' sources of funds. This was based on the assumption that banks could not substitute lost deposits for alternative sources of funds such as new equity issues or certificates of deposit (CDs). However, based on Romer and Romer (1990), innovations and deregulation in the banking system since the 1980s, this assumption may no longer be relevant. Romer and Romer (1990) emphasized that banks can increase funds by issuing large certificates of deposit and new equity despite the reality that equity issues remain an expensive source of funds for banks as they have always been especially in times of economic difficulties.

Bernanke and Gertler (1995), however, argue that the existence of the bank lending channel does not require that banks should be completely incapable of replacing lost deposits. Kashyap and Stein (1994) together with others state that in so far as banks do not face a perfectly elastic demand for their open market liabilities, it suffices that an open market sale by the central bank that reduces deposits and compel banks to depend on managed liabilities will also up banks' cost of funds. The increased banks' cost will push loans supply inward, crowd out bank dependent borrowers and raise the EFP.

As noted by Bernanke and Gertler (1995), the role of the conventional bank lending channel has probably lessen over time due to innovation and deregulation in the banking system. They however believe it is still empirically relevant though it may be a daunting task obtaining accurate measurements of its potency.

2.3 Empirical Literature

In this study, we seek to investigate the responses of private sector credit, output and prices to monetary policy shocks in Ghana. Several studies have been conducted to examine the relationship between monetary policy and various macroeconomic variables. This section reviews some of these empirical evidence. It seeks to outline a sample of literature by considering: a) the methodology adopted in such studies (mostly VARs); b) the variables included in the VARs; c) identification assumptions and indicators of policy stance; and d) the dynamic responses of policy shocks discovered. This will serve as a bases for comparing our results.

Modern day investigations of the impact of money on real economic activity can be traced to the work of Friedman and Schwartz (1963). They conducted a study on the monetary history of the United States from 1867 to 1960. It was found that monetary policy actions led to movements in real output. This conclusion supported the short run non-neutrality of monetary policy. The key point of this work was that "money matters" and that the quantity of money is an autonomous and manageable force that sturdily impacts on the economy. This was contrary to the professional view existing at the time that money played an insignificant role in affecting real economic activity (they saw monetary policy as ineffective). Friedman and Schwartz (1963), however, advocated the potency of monetary policy and even argued that the great contraction was the result of the wrong monetary policy action that was taken by the Federal Reserve at that time.

Sims (1980) in his ground breaking work in VARs estimated a six variable VAR that consisted of Money, GNP, Unemployment, Price level, Wages and Import Price Index using post-war time series data for the US and West Germany. The US data covered quarterly data from 1949-1975 and that of Germany was quarterly data from 1958-1976. Innovation in money was interpreted as

monetary policy shocks. He found out the following differences between the countries, in particular GNP and Price level: i) money innovations had persistent impact on both money and other nominal variables in US. Money shock was larger but less persistent in Germany. Also real GNP responded in a much bigger way in US than Germany; ii) innovations in prices were of negligible significance in US, while a major source of disturbance in Germany. In Germany they produced large sustained decline in real GNP and real wage, even though there was a temporarily accommodating response from money supply. The common responses were: i) real wage and real GNP tended to increase temporarily due to money innovations. Unemployment was however reduced following monetary shocks; ii) shocks to money resulted in persistent rise in prices.

Bernanke and Blinder (1992) used a VAR model on US data to investigate the dynamic impact of monetary policy on bank balance sheets and the economy in general. The data comprised of monthly series of the federal funds rate, unemployment, and CPI as well as three balance sheet variables of banks (deposits, securities and loans). They made used of the federal funds rate as indicator of monetary policy stance. From the impulse response functions estimated using the VAR, they found that a positive innovation in the federal fund rate diminishes the amount of deposits held by banks as they expected. The impact was immediate, building steadily and reached its maximum in about three quarters and appeared to be perpetual. They also noted that the bank assets fell alongside liabilities though the make-up of the fall varied. In the first six months after the policy innovation, the fall in assets was borne out almost completely in securities, while after two years, loans essentially borne the entire fall in deposits (assets). The study also found that the timing of the response of unemployment corresponded fairly well with that of loans. This is consistent with the view that bank loans are an essential part of the monetary transmission mechanism despite the fact that loans do not lead real variables.

Christiano et al (1994) in their study used VAR to assess the effect on the borrowing and lending activities of different sectors of the economy following a monetary policy shock. They used two measures of monetary policy shocks: i) orthogonalized shock to nonborrowed reserves and ii) orthogonalized shock to the federal funds rate. The results showed that a tight monetary policy resulted in a fall in total reserves, nonborrowed reserves, M1, and Fed holdings of government securities, while federal funds rose. There was also a fall in various measures of money which indicated evidence of a strong liquidity effect.

A tight monetary policy shock was also accompanied by unwavering declines in real GNP, employment, retail sales and non-financial corporate profits. There was however increases in unemployment and manufacturing inventories. GDP price deflator did not respond to policy shock for about a year and it declined after that. The contractionary policy shocks were connected to sharp persistent fall in commodity prices. Findings from the main focus of the study were as follows: First, after a contractionary policy shock, net funds raised by businesses increased for about a year. It began to fall as the policy shock gained impetus; second, the authors could not discard the notion that funds mobilized by households do not change for several quarters following a monetary shock.

In another study, Gerlach and Smets (1995) compared the effects of monetary policy on output and prices in the then G-7 countries. They adopted a structural VAR model consisting of output, prices and a short term interest rate using quarterly data from 1979:1 to 1993:4. They identified monetary policy shock by making the assumption that monetary policy shocks do not affect real output contemporaneously or in the long run. Generally the study observed that following a monetary tightening, price level in all countries fell. Similarly, output depressed in all countries after increases in interest rates. Specifically, they observed that the effect of a tight monetary policy

on output and prices were similar in the United States, Germany and Canada. Output effect of a tight monetary policy were smaller in France and Italy, while the output effect in Japan and United Kingdom fell somewhere in between.

Using the "Narrative Approach" to identify monetary policy shocks, Romer and Romer (1989) in their study tried to investigate whether nominal disturbances have significant real effects. This approach is based on the situation where the researcher goes into the historical records of the monetary policy authorities and identify episodes when the authorities have taken an anti-inflationary stance. It was introduced by Friedman and Schwartz (1963) in their monetary history of the United States. Based on Federal Reserve records, they identified six episodes since the Second World War where the Fed took a contractionary policy stance in order to reduce inflation. They found that i) the six shocks that were identified explained a greater proportion of the post war economic fluctuations; ii) the real effects of monetary disturbances were persistent; iii) a change to a contractionary policy stance led to a rise in unemployment of about 2%; iv) evidence from the interwar era suggested that monetary distractions had large effects.

Boivin and Giannoni (2006) in another study aimed to unravel the sources of variability in the monetary transmission mechanism and their consequences for various elements of monetary policy effectiveness. They did this through a two-step method. First, they used an estimated VAR over two sub-periods i.e. 1959:1 to 1979:2 and 1979:3 to 2002:2 to identify a reduced form policy response function and the required policy shocks. This allowed them to identify the monetary transmission mechanism and to characterize its evolution over the sample period. The second method was to use a structural macroeconomic model to explain the variations in the impulse response functions. They also performed counterfactual experiments to assess the forces behind the seen variations in the transmission mechanism and the consequences for policy viability. The

main finding of the study was that shocks to the federal funds rate were followed by smaller response of inflation and output since the beginning of the 1980s. That is, there has been less variability in the response of output and inflation since the 1980s than in the decades before. This was attributed to the change in monetary policy operations mainly characterized by stronger response to inflation expectations from the 1980s.

In a study by Vinayagathasan (2013), for Sri Lanka, he attempted to identify the monetary policy variable that best explained the Sri Lankan monetary transmission mechanism. He also sought to estimate how shocks from oil price and foreign monetary policy affected the domestic macroeconomic variables. He employed a seven variable Structural VAR model using monthly data from 1978 to 2011. Impulse response functions and variance decomposition were used to explain the relationship among variables. The study revealed that interest rate shock played a crucial and a better role in describing movements in economic variables than exchange rate or monetary aggregate shocks. A positive interest rate innovation declined output and appreciated domestic currency significantly. A similar shock had insignificant effect on price level. The study also concluded that oil price and foreign monetary policy shocks did not seem to affect the domestic economy.

Morsink and Bayoumi (2001) in their study used VAR to explore the monetary transmission mechanism in Japan. The VAR was estimated using quarterly data for the period 1980:1 to 1998:3. They included prices, interest rate, broad money and economic activity (measured by real private demand) in their base VAR. The VAR was identified using Cholesky decomposition with the following ordering; private demand, prices, the overnight call rate and broad money. The overnight call rate was used to indicate the stance of monetary policy. The VAR was extended in a number of varied forms to investigate other facets of the monetary transmission mechanism. Finally a

summary VAR was also estimated. Results from the base VAR indicated that both interest rate and broad money had significant impact on private demand. The fact that broad money had a remarkable effect on private demand even though interest rate was included in the model is consistent with the view that non-policy monetary shocks also matter in determining economic activity. Price level responded positively to interest rate shock instead of negatively. This suggested that a tight monetary policy results in inflation. This was evidence of a "price puzzle".

Results from the extended models concluded that: i) monetary policy impacts largely on the real economy through business investment; ii) bank loans are both an important channel for monetary transmission mechanism and also a crucial autonomous shocks to private demand; iii) innovations to bank loans had a positive and significant impact on private demand even after broad money and interest rates were controlled for; iv) the summary VAR showed that bank loans, broad money and interest rates all had large and significant impact on business investment and the remainder of private demand.

Allieu (2002) also conducted a study on the monetary transmission mechanism for Ghana using quarterly data from 1983:1 to 2000:4. He employed the technique of VAR. He included in his basic model real GDP, the price level, Treasury bill rate and money (M2). It was extended to include Total Deposits, Domestic Credit to Private sector and Exchange rate. The Treasury bill rate was used to indicate the stance of monetary policy. Results from the base VAR indicated that output and broad money response to monetary policy shocks were very slight (insignificant) though they response followed conventional theory. The price level responded positively to the Treasury bill shock and was found to be positive up to the third quarter after the shock and thereafter declined. This was a clear case of a price puzzle, where prices rise instead of declining after a contractionary monetary policy shock. He also found that deposits declined. Though

exchange rate initially depreciated instead of appreciating following a monetary shock, it was found that the exchange rate is an important conduit for price changes. The study also found that domestic credit to private sector initially rose following monetary tightening. It however falls by the second quarter. Theoretically credit is expected to fall following a policy rate hikes. Allieu (2002) attributes the initial puzzle to the fact that it may be costly for banks to immediately adjust their interest rate on credit due administrative and customer relations reasons. This however does not seem to be the case in Ghana since lending rates are immediately adjusted upwards following policy rate increases.

Abradu-Otoo et al (2003), also investigated the transmission mechanism of monetary policy in Ghana using a Structural Vector Error Correction Model. The main goal of the study was to have an understanding of how monetary policy actions affected inflation and output. A seven variable system was used and generalized impulse response functions were generated to examine the dynamic response of variables in the system following a policy shock. The 91-day Treasury bill was used to indicate the stance of monetary policy. They found evidence that a monetary policy shock affected inflation and output in the long run. In the case of inflation, the impulse response analysis showed that in the short run (about a period of two quarters) inflation rose. Prices began to fall afterwards. This differs from Allieu (2002) where prices rose for about 3 quarters before falling. Output appeared to fall after the interest rate shocks. It stayed well below the baseline level and returned to the pre-shock figure after about three and a half years. Like Allieu (2002), bank credit responded to interest rate shock by rising initially and falling by the sixth quarter. This is inconsistent with what theory predicts. The study also revealed that the exchange rate remains an important channel via which monetary impulses are transmitted in Ghana.

Boamah (2009) in a study sought to investigate whether monetary policy is effective in controlling inflation control in Ghana. He used cointegration and error correction model as well as VAR techniques to investigate the monetary transmission mechanism for the economy using the 91-day Treasury bill rate and the bank of Ghana prime rate as policy instruments. The variables used in the VAR were: output gap, inflation, real exchange rate, and policy rate for the base VAR. The base VAR was extended to include commercial bank savings rate and broad money.

His results showed that monetary policy was potent in impacting the savings rate but not quite effective in controlling inflation. In an alternative method, he used monetary aggregates as policy variable and that appeared to explain monetary policy in Ghana better. Results from the VARs impulse response analyses showed that an unanticipated policy change had been insignificant for real exchange rate and output gap as they hardly responded to policy shocks. Thus unlike Abradu-Otoo (2003) who found monetary policy to be effective in affecting output and inflation, Boamah (2009) found the opposite. This may be due to differences in estimation techniques. Abradu-Otoo (2002) used a Structural Vector Error Correction Model where restrictions were imposed on some variables whereas in the case of Boamah (2009) he used Vector Error Correction Model where no such restrictions were imposed.

Kovanen (2011) in his study sought to answer the question of whether the interest rate channel of monetary transmission works in Ghana. He researched the consequences of a change in the prime rate on short term wholesale market interest rates and the transmission thereof to retail deposit and lending rates in Ghana during the period 2005 to 2010. Two sets of data were used. The first set was monthly data made up of wholesale market interest rates from 2004:12 to 2010:4, while the second set contained quarterly bank specific data of the twenty biggest banks in Ghana from 2005:1 to 2010:1. The analysis concluded that: i) there is a strong response from changes in the

prime rate to the wholesale market interest rate; ii) retail interest rates adjust to changes in the wholesale market interest rates but with slow speed and incomplete adjustment in the long run.

From the empirical studies reviewed in this section, we observed the following. Firstly, for developed countries, the response of various macroeconomic variables conform to theoretical predictions. That is output, prices and bank credit (loans or private sector credit as referred to in some studies) fell following monetary policy shocks. The only exception was in Morsink and Bayoumi (2001) where prices initially rose but subsequently fell as theory predicted. Secondly, for the studies reviewed for Ghana, Allieu (2002) and Abradu-Otoo et al (2003) found that private sector credit responded positively following policy shock, which is against what theory predicts. Also, Allieu (2002), Abradu-Otoo et al (2002) and Boamah (2009) all found that prices rose for 9 months, 6 months and 15 months respectively. In terms of output's response, Allieu (2002) and Abradu-Otoo et al (2002) found that output responded to monetary policy shocks by falling as expected. However, Boamah (2009) found that output hardly responded to monetary policy shocks (the response was generally flat).

In conclusion, it is obvious that the effectiveness of monetary policy in developed countries is not in doubt. However, when it comes to developing countries like Ghana, conclusions on the effectiveness of monetary policy still remain uncertain as the expected theoretical transmission mechanisms have not been realized consistently over time. Thus a study of this nature comes in handy, as it will help add to empirical literature so as to help build consensus on the effectiveness of monetary policy in developing countries.

CHAPTER THREE

OVERVIEW OF OUTPUT, PRICES, PRIVATE SECTOR DEVELOPMENTS AND MONETARY POLICY IN GHANA

3.1 Introduction

This chapter is in two sections. In the first section, we deal with a brief historical overview of the performance of output and inflation in Ghana. We then proceed to review developments between the state and the private sector in Ghana. The second section reviews the conduct of monetary policy in Ghana. It outlines a brief historical account of monetary policy implementation in Ghana. It also considers the various frameworks that have been used since the establishment of the central bank as well as the various instruments that have been employed to implement monetary policy in Ghana.

3.2 Output, Inflation and Private Sector Developments

3.2.1 Output Growth

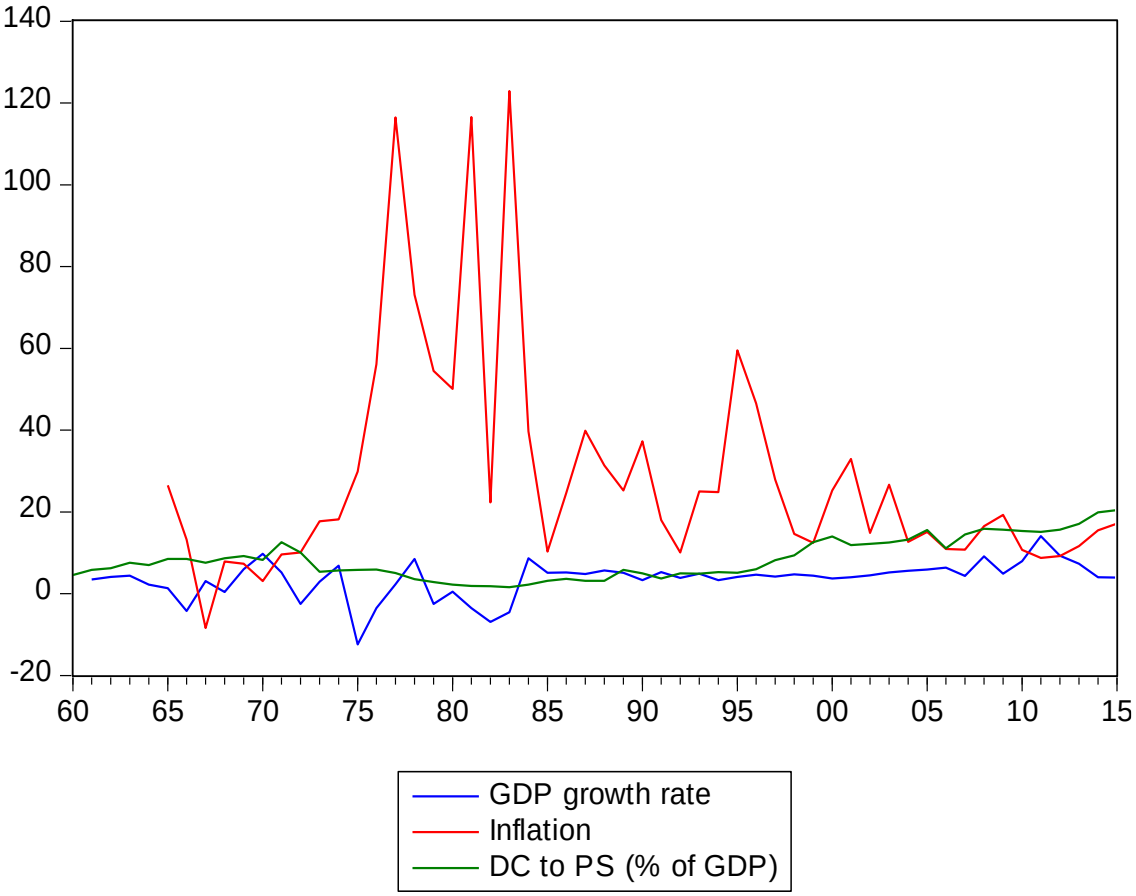
On gaining political independence in 1957, Ghana was seen as a country with huge potential for rapid economic development. It was at par with countries like Malaysia, Singapore and South Korea and was in a position to develop and perform better economically than its peers in Sub-Sahara Africa. It had a favourable balance of payment position, as its reserves could cover about three years of imports. It was the leading producer of cocoa globally and accounted for about a tenth of global exports of gold. With these fundamentals, the country was poised for rapid growth and transformation to deliver its masses from the shackles of poverty and inequality.

In order to ensure that the economy grew at levels that would ensure development, rapid industrialization was embarked on in the 1960s. As a result, government intervened in almost every facet of the economy. Policies undertaken were geared towards an "import-substituting industrialization" strategy. These policies came in the form of price, exchange rate and interest rate controls, credit ceilings and providing cheap credit to sectors that were deemed as priority sectors of the economy such as manufacturing and Agriculture.

Despite these efforts at ensuring rapid growth, actual performance was much lower than desired. Between 1961 and 1970, output growth averaged 3.04%. Between 1971 and 1980, GDP growth averaged 0.52%, with 1975 recording the worst growth rate of negative 12.4%. From 1981 to 1983, output grew at negative rates for all the three years. Figure 3.1 below shows the trend of output growth, inflation and domestic credit to private sector as percentage of GDP from 1960 to 2015.

It became obvious that the economic policies that were pursued in these periods were not yielding the desired results. This economic decay led to the adoption of the Economic Recovery Programme (ERP) in 1983. The ERP which was supported by the World Bank and International Monetary Fund (IMF) comprised of a set of policies that were aimed at reforming the fiscal, monetary and trade sectors of the economy, so as to reverse the abysmal output growth. All the controlled price, exchange rate and interest rate policies were deregulated. Following the initial stabilization policies, an adjustment phase began in 1987, which also included a Financial Sector Adjustment Programme (FINSAP). It sought to lay the ground for a sustained output growth and ensure a viable balance of payment position. These measures thus established a more market-based system of monetary management.

Figure 3.1: Trend of Output growth, Inflation and DC to PS (as a % GDP) from 1960-2015



After the adoption of the ERP, the economy began to pick up. In 1984, GDP grew at 8.6% before declining to an average of 4.9% between 1985 and 1990. The early 1990s saw government continuing with the policies adopted during the ERP but output growth could not be sustained as it averaged 4.4% between 1991 and 1999. In 2000, GDP growth declined to 3.7%. In that year, the country's macroeconomic environment was also characterized by unstainable public debt, budget deficit of about 8.2% of GDP, depreciation of the local currency against the Dollar of about 57% and an inflation rate of about 40% in the last quarter of the year. Due to the high debt stock and the generally unfavourable macroeconomic environment, Ghana applied for the Heavily Indebted

Poor Countries (HIPC) initiative in 2002, which led to a substantial cancelation of her debts by her creditors.

The then government also developed two national policy documents; Ghana Poverty Reduction Strategy (GPRS I)[4] and Growth and Poverty Reduction Strategy (GPRS II). GPRS I covered the period 2003-2005 and comprised of policies, strategies, programmes and projects that would aid growth and reduced poverty over the period 2003-2005. The government aimed to create wealth by "transforming the nature of the economy to enhance growth, reduce poverty and protect the vulnerable". This was to be achieved through sound economic management, increasing production, human resource development, good governance and "active participation of the private sector as the main engine of growth and partner in nation building" (GPRS I, 2003, Executive Summary p.i). The government envisaged that in order to reduce poverty, the economy needed to grow by more than 8% per annum by 2010.

GPRS II covered the period 2006-2009, with its objectives following from GPRS I and covered the same areas as GPRS I. However, "the central goal of [GPRS II] was to accelerate the growth of the economy so that Ghana could achieve middle-income status within a measurable planning period" (GPRS II, 2005, p.i). The strategy was to support the private sector to create wealth, accelerate growth and reduce poverty.

Bolstered by these policies, output growth rate picked up and averaged 5.6% during the GPRS I period (2003-2005), whilst it averaged about 6.2% during the GPRS II period (2006-2009), with the highest growth rate for the two periods coming in 2008 with a growth rate of 9.1%. In terms of per capita income, Ghana was declared a middle income country in 2010 with a per capita

[4] GPRS I was launched as condition for development assistance under the World Bank-IMF supported HIPC debt relief initiative in 2002.

income of $1323 after Ghana Statistical Service rebased[5] Ghana's national accounts from the 1993 base year to 2006 in 2010. Meanwhile, GDP growth rate between 2009 and 2014 averaged 8.5% with the highest ever GDP growth of about 14% in 2011. This improved performance was largely driven by oil production[6] and strong performance in the non-oil sector. This high growth could not however be maintained, as output growth consistently declined from the 14 % in 2011 to about 3.9% in 2015.

3.2.2 Inflation Movements

Inflation can be defined as the sustained rise in the general level of prices of goods and services in an economy. It can be measured using Consumer Price Index (CPI) or GDP deflator, but CPI is the most commonly used measure. CPI measures the change in price of a representative basket of goods and services that households acquire for the purposes of consumption with reference to a price level in the base year which has an index of 100. The current base year used by the Ghana Statistical Service (GSS) is 2012.

The causes of inflation can be categorized broadly under demand side factors and supply side factors. Demand pull inflation arises as a result of the inability of output to increase in the short run. When demand for the limited output increases, it pushes prices upwards. Supply side inflation mainly result from factors that lead to increase in the cost of production of firms such as increased wages, increased interest rates etc. Once cost of production increases, it affects prices of output.

To assess the inflation history of Ghana after independence, we look at it in three periods: Before ERP in 1983; from ERP to 2001; and from 2002 to present.

[5] Before the rebasing to 2006, the per capita income value was much lower than the one stated here.
[6] Ghana discovered oil in 2007, with commercial production taking off in 2010.

3.2.2.1 Before ERP

Inflation has been one of the major macroeconomic problems that has confronted this country since its independence. It is argued that low and stable prices enhance economic growth as it ensures that production decisions are taken without worrying about high inflation rates in future. This explains why every economy tries to ensure that inflation is well controlled. Ghana enjoyed relatively low and stable levels of inflation between 1957 and 1963. Inflation was in single digits in these years. According to Sowa and Kwakye (1993), this stable inflation between independence and 1963 was due to the fact that government relied on the accumulated foreign exchange reserves prior to independence to finance its budget deficits. Once these reserves were depleted, government relied on bank financing to meet its fiscal needs. Thus, inflation began to rise and by 1965 it reached 26.4%. This increased in inflation could also be attributed to the fact that, following independence, industries that were established, in the country's bid to develop through industrialization, relied on imported inputs. Once reserves were depleted, it became extremely difficult to import the required inputs for production. This led to shortages in inputs for industries and consequently affected supplies of most consumer goods. This put upward pressure on prices.

In 1967 the National Liberation Council (NLC) government signed a stabilization package with the IMF. Resultantly, there was reduced government expenditure, decreased bank financing and tighter monetary policy which slowed economic activity. All these factors culminated in the deflation of 8.4% in 1967 and the subsequent single digit inflation from 1968-1971.

Between 1972 and 1982, the country's political climate was highly unstable, as it was characterized by successive military take overs. This period was characterized by excessive expansionary fiscal policies and the huge budget overruns were monetized. The outcome of this was upward pressure on prices. To address these pressures, various forms of price controls were

instituted. This distorted prices and resulted in scarcity of goods and further increased inflationary pressures. Thus, this period witnessed the most volatile rates of inflation in the nation's history. Inflation averaged about 51.3%, with 1977 and 1982 recording the highest rate for the period with inflation of about 116% in both years. Other factors such as scarce reserves, low food supply, inadequate performance of the manufacturing sector, excess demand, just to mention a few. accounted for the high prices in this period.

By 1983, inflation was at an all-time high of about 123%. This high rate of inflation coupled with worsening BOP position and low output growths led to the adoption of the ERP in 1983. This programme sought to reverse the economic decay that the country was experiencing. Measures were put in place to do away with all forms of controls. Monetization of deficits was also minimized and measures were instituted to increase revenue mobilization.

3.2.2.2 From ERP to 2001

The ERP led to inflow of resources into the country which eased the supply constraints the economy was experiencing. With policies of the ERP in placed, the economy was now on the path to recovery. By 1984, output grew by 8.6% from a negative growth of 4.6% in 1983 and inflation dropped significantly to about 40% from 123%. Though this could be as a result of the ERP, it is worthy of note that this success could also have been due to the fact that the country recovered from a drought it had experienced in 1983. As food became abundant, food prices which made up about 50-60% of CPI fell, thus accounting for the marked improvement in inflation.

From 1985 to 1992, inflation rates were generally low though not at desired levels. Inflation rate averaged 24.6% in this period. Between 1993 and 2001, inflation rate averaged 29.9%. Though the period after the ERP recorded relatively lower levels of inflation compared to the periods

before ERP, notably from 1972-82, the post ERP rates of inflation were still considered to be high. The post ERP period which mainly targeted monetary aggregates in order to control inflation was seen not to be doing well in reducing both inflation and its variability. As a result, Ghana adopted the inflation targeting regime in 2002.

3.2.2.3 From 2002 to Present: Inflation Targeting Period

Inflation targeting was instituted to enhance transparency in tackling inflation and also to reduce the volatility of inflation. This regime started by the coming into being of a new Bank of Ghana Act (Act 612), which gave operational independence to the central bank. Through this, the central bank uses its monetary policy rate to conduct monetary policy with the aim of delivering low and stable prices. Though targets set are sometimes missed, in a nutshell, this period has significantly reduce the volatility in inflation. Between 2002 and 2009, annual inflation rate averaged 15.8%.

The most successful period under inflation targeting came between June 2010 and January 2013 when monthly inflation rate was consistently in single digit for the entire period, with an average of 9%. This was due to continued fiscal discipline by the then government, improved food production, tighter monetary policy to rein in on inflationary pressures and stability in exchange rate. Inflation rate then climbed up to an average of 12.4% between 2011 and 2015.

3.2.3 Private Sector Developments

In Ghana, the private sector typically refers to institutions and organizations such as financial institutions, business associations, privately owned domestic and foreign corporations and the informal sector (Aryeetey & Owoo, 2015). The private sector of every nation is seen as a crucial player in the nation's development efforts. When the right environment is created for private sector

businesses to thrive, the entire economy thrives as well. Thus the private sector is seen as the main driver of economic growth.

Until recent times (2000s) when the private sector was declared as the main engine of growth of Ghana's development, the private sector played a limited role in the country's developmental efforts in earlier periods. Between 1957 and 1966, the state was the main driver of economic activities in the country. Some reasons accounted for this limited participation of the private sector in the development efforts of the nation. One such reason being proposed is that, the then government did not trust private entrepreneurs as it feared that a successful private sector could be a threat to the government politically (Opoku, 2014). Private corporations that thrived during this period were the ones that had close ties with the government and could support the fortunes of the government and were not seen to present any threat to state domination.

However, recognizing the crucial role that credit plays in growing private businesses, institutions such as the Industrial Development Organization (IDO) were established, where businesses could access credit. The attempts by the state to boost the private sector could be seen with an increase in domestic credit to private sector as a percentage of GDP from 4.5% in 1960 to 5.8%, 6.2%, 7.5% and 8.5% in 1961, 1962, 1963, and 1965 respectively. Regardless of these efforts by the state to promote private sector participation in the nation's development, growth was slower than expected as resources put into stimulating domestic businesses' capacity did not deliver the desired outcomes. This led to "the state taking up the core mandate of development, with the private sector playing a less pronounced role within the economy" (Aryeetey & Owoo, 2015, p. 4). Thus, State Owned Enterprises (SOEs) were established to spearhead the development efforts, with the number of SOEs rising to about 53 in 1966 (Appiah-Kubi, 2001).

Between 1966 and 1991, this period was characterized by incessant military takeovers and as a result the private sector was hugely constrained for most of the period. There were however interventions once a while by the various governments to advance the course of the private sector. Most of these came in the form of setting up institutions and special decrees to promote private sector participation in the development process. For instance in 1972, the main economic policy of the National Redemption Council regime was "indigenization". This policy incentivized private sector involvement in economic activity. Special decrees such as: Ghana Enterprises decree of 1975 and the Investment Policy decree of 1975 were passed (Ackah et al, 2010). The National Board for Small Scale Industries (NBSSI) was also instituted.

By 1981, the Provisional National Defence Council (PNDC) regime believing that there were glimpses of corruption in the alliance between the private sector and the state, in particular, issues relating to acquiring import licenses and other profited ventures rarely involved the private sector in its main policy decisions in its early days. However, faced with economic downturn, energy crises and drought, the PNDC government resorted to the World Bank and IMF. These organizations impressed on the government that market forces would have greater discipline for individual economic behaviour than the state (Ackah et al, 2010). Based on this impression, the ERP was adopted in 1983, with objectives of realigning relative prices in order to stimulate more productive economic activity, reverse government dependence on state control of economic activity towards dependence on private sector and improve government fiscal and monetary performance.

In the late 1980s, efforts were made to dialogue with the private sector through the establishment of the Private Sector Consultative Committee (PSCC) in 1988 and later in 1991, the Private Sector Advisory Group (PSAG). These groups however collapsed without making major headways in

enhancing private sector engagement in development. Between 1966 and 1991, domestic credit to private sector as a percentage of GDP averaged just about 5.2%.

In 1992, the National Democratic Congress (NDC) won the general elections that year and ruled till 2000. Within this period, other groups such as Private Sector Roundtable (PSR) in 1993 were set up. The PSR represented a large section of the private sector but was unsuccessful because it had no clear cut mandate. The Ghana Investment Promotion Centre (GIPC) was also formed in 1994 to encourage investments in the economy. In 1995, the Private Enterprise Foundation (PEF) was formed. It was tasked to play an advocacy role for Ghana's private sector. Thus, within this period, the government engaged the private sector through the establishment of new business organizations notwithstanding the fact that organizations such as the Association of Ghana industries (AGI) and Ghana National Chamber of Commerce (GNCC) were in existence. From 1992 to 2000, domestic credit to private sector as a percentage of GDP averaged 7.8%, which was an improvement when compared to the 1966-1991 period.

When the pro-business New Patriotic Party (NPP) took over the management of the state in 2001, there were huge anticipations that the private sector would be transformed radically, which would translate to improved economic performance. True to these expectations, the government declared "a golden age of business and set up a Ministry for Private Sector Development to oversee and promote business development" (Aryeetey & Owoo, 2015, p. 10). Due to its pro-market ideologies, it was expected that the private sector will perform better under the new government. The number of new businesses increased from about 5,989 in 2004 to 14,485 in 2008 (Aryeetey & Owoo, 2015).

The government initiated the Presidential Special Initiatives (PSIs), which were aimed at identifying and lending support to potential business opportunities in Ghana in the areas of Salt, Cassava, Starch, Textiles and Garments. Despite the special attention that the President gave to the PSIs, they collapsed soon after their introduction. Asante (2012) attributes this collapse to: lack of "continued consultation with local entrepreneurs and the industry" in planning the PSIs; inadequate funding, expertise, and other logistical support, among other factors.

The government also set up the Business Assistance Fund, Venture Capital Fund, and Microfinance and Small Loans Centre (MASLOC) to increase access to credit to the private sector. Thus, domestic credit to private sector as a percentage of GDP increased from about 11.8% in 2001 to about 15.9% in 2008.

After 2008, the new NDC government in a bid to engage and promote private sector activities created a Private Sector Advisory Council (PSAC) and promoted Public-Private Partnership (PPP). The PSAC was inaugurated in 2012 and its member council was chaired by the President. It aimed at addressing strategic issues regarding private sector development, in an effort to accelerate growth and transform the economy. From 2009 to 2015, domestic credit to private sector as a percentage of GDP has stayed above 15% with 2014 recording 19.9%.

To sum up, although private sector credit and state-businesses engagement is on the rise in recent times, more needs to be done. In terms of credit to businesses, it still remains limited and both central government and the monetary authorities have a huge role to play to further the course of the private sector so that it can deliver on its mantra of "engine of growth" of the Ghanaian economy.

3.3 Monetary Policy Framework before Economic Recovery Programme (ERP)

The general believe after independence was that the ailing economy at the time was due to the inability of the financial system to mobilize domestic resources for development. The widespread perception was that the low growths were induced by the lack of adequate credit to important sectors such as Agriculture, Manufacturing and Exports. Thus there were interventions to ensure that the needed credit got to the priority sectors of the economy to deliver the envisaged growth. These interventions came mainly in the form of directed credit and low interest rate policies. The belief was that it would promote high investment. As investment increases, it would lead to higher output and hence increased savings.

Thus the monetary policy measures in Ghana before financial reforms were intended to: i) boost investment and its allocation among the different sectors of the economy; ii) ensure that interest costs were low to counter the perceived inflationary effects of decontrolled market interest rates; iii) ensure low and steady interest rates to offset the adverse effects of the outrageous interest rate hikes in the informal financial markets; iv) use the banks and the central bank to provide cheap funds for budget deficits.

In this regard, the monetary policy framework after independence was one of low interest rates, credit ceilings, sectorial credit controls, high reserve requirements, and government instructions to lend to SOEs. There was also the establishment of sector specific development banks and foreign owned banks were nationalized. As noted by Gockel (2000), “the low interest rate and sectorial credit ceilings were designed to reinforce each other to ensure that bank credit flowed to the designated priority sectors of the economy namely Agriculture, Manufacturing and Exports” (p. 6). These sectors were believed to have a huge unmet credit demand, meaning that this unsatisfied credit demand was the constraining factor that was largely responsible for the low output growth

at the macro level. At the micro level, it was considered as the factor responsible for the retardation in the productive capacity of enterprises. As a result, the credit measures were aimed at meeting these constrained credit demands and at the same time regulating any excesses in the money supply.

Thus from 1960-90, the major tools used by Bank of Ghana in its monetary management were credit ceiling and sectorial credit controls. Credit ceilings were estimated based on caps that were placed on the banking system net domestic assets in accordance with the money supply and inflation projections. By assessing the turn out in economic developments during the year, the central bank calculated expected increase in money supply and other assets and liabilities of the bank. The needed expansion in total credit was subsequently derived and divided among the different sectors' credit demands based on their anticipated increases in output. Gockel (2000) notes that "in determining the various sectors shares in total credit, government financing needs were taken as given and the shares of the other sectors as residual. In the case of bank specific ceilings, each bank's ceilings was categorized into credit to the rest of the economy and credit to the government and to cocoa financing" (p. 7).

Though these policies were easy to administer, they were highly ineffective in the end. They discouraged competition among banks. Due to the fact that banks were allocated credit ceilings, they had no motivation to mobilize savings once they attained this limit. The managers of these banks also found ways of cheating the system. For instance, they advised some of their core clients to set up pseudo subsidiaries that fell within the priority sectors in order to have access to credit that was allocated to these sectors. These policies promoted intermediation outside the banking system and capital flight. Low interest rate policies also ensured that less funds were available for credit in the economy as it discourages individuals from saving. It also resulted in large number of

non-performing loans as credit was given to borrowers without recourse to their ability to repay the loans.

Reserve requirements was also one of the tools used by the Bank of Ghana for its monetary management purposes prior to the reforms. They came in the form of cash reserve requirement and secondary liquid assets requirements. These reserves were estimated as a proportion of some chosen classifications of deposits with each bank. Prior to March 1990, different ratios were imposed on the varied forms of deposits. The cash reserves had separate reserve requirements for demand deposits, and savings and time deposits. Reserves against time and savings deposits was 10% while that for demand deposits was 30%. The Bank of Ghana then took custody of these reserves either as balances or cash in tills. The lower percentage for savings and time deposits was to mobilize long term financial resources for medium to long term lending.

"Reserves in liquid assets were to be held as Government stocks, Treasury bills, BOG bills, Cocoa bills, Grain and Cotton bills as well as any other paper approved by the monetary authorities" (Gockel, 2000, p.13). At times, these liquid asset requirements were insufficient to make up for banks' secondary reserve requirements, which resulted in banks holding excess cash with BOG which earned no interest and thus discouraged banks' efforts to mobilize savings (Gockel, 1996). Generally, the reserve requirements were higher in the controlled regime, which meant that potential borrowers were starved of the required funds and they had to depend on the informal financial sector. Such high reserve requirements also resulted in distortions to interest rates due to the fact that these reserves earned no interest for the banks. They therefore tried to recover their lost revenues by increasing the spread between the deposit and lending rates, or by increasing fees, commission and service charges.

3.4 Overview of Monetary Policy Measures during and after Economic Recovery

As a result of the negative impact of the controlled regime such as escalations in inflation, fiscal deficits, overvalued exchange rate and persistent declines in output growth, as well as the inability of the financial sector to mobilize the needed resources for development, Ghana adopted the ERP in 1983 which was directed by the IMF. The aim of the programme was to restore monetary and fiscal discipline and remove all forms of control in order to realign prices. An adjustment phase was later brought on board and included a Financial Sector Adjustment Programme (FINSAP) which was instituted between 1987 and 1992. Under this programme, monetary policy was deregulated and a more market-based system of monetary management was institutionalized and indirect money control measures adopted.

With the advent of this policy, the direct credit ceilings and sectorial credit guidelines were gradually phased out and the new indirect means of monetary management came into force. These indirect monetary policy tools are used by the Bank of Ghana to absorb or inject liquidity into the banking system and also to affect the level of interest rates. The effects of these instruments on interest rates and liquidity is more transparent and spreads quickly throughout the economy, impacting all economic actors and thus proved to be more efficient. In order to facilitate the transmission of monetary policy measures to banks, the monetary authorities declassified banks as Primary and Secondary banks. The Ghana Stock Exchange and Discount Houses were also established, where secondary issues could be traded.

Prior to the ERP, government relied on central bank financing to deal with its budget deficit. As part of the reforms, a securities market was established to cater for both the fiscal and monetary policy motives. A weekly auction in Treasury bills was instituted in 1986. Two years later, Bank of Ghana bills were launched to manage excess liquidity in the system. By 1992, all the direct

control instruments were done away with and the indirect system of monetary management was now under way.

The indirect instruments that are used by the Bank of Ghana include: reserve requirements, open market operations, discount window, foreign exchange swaps (or Repurchase Agreements) and transfer of deposits banks to Bank of Ghana and vice-versa.

3.4.1 Framework for Monetary Management by Bank of Ghana

The monetary policy strategy used by the Bank of Ghana is premised on the quantity theory of money. This theory establish a link between money supply and inflation by assuming an invariant velocity of money and constant output. The framework comprises three targets: inflation (final goal), broad money (the intermediate target) and reserve money (operating target) (Wampah, 1998). The Bank of Ghana seeks to control the money supply in its policy framework in order to tract inflation.

In any ensuing year, the Bank of Ghana together with the Finance Ministry determine targets for output growth, balance of payment and inflation which they deem suitable for the economy. Hinging on these targets and an established velocity of money, the Bank of Ghana using the quantity theory equation determine the implied money supply. Once the money supply is determined, the money multiplier and reserve money are also subsequently derived. After the reserve money is determined, it is then targeted using Bank of Ghana balance sheet variables of Net Domestic Assets (NDA) and Net Foreign Assets (NFA), which sum up to the reserve money. If NFA (which is the overall balance of payment) target is taken as given, then the Net Domestic Assets is manipulated in order to hit the operating target (reserve money). The main instrument employed in manipulating the NDA is the open market operations.

3.4.2 Reserve Requirements

Reserves requirements during and after the ERP are similar to what was pertaining in the controlled regime. There were however some changes during the reforms which are worthy of mentioning. From March 1990, the central bank abandoned the situation where reserves were prescribed for the distinct types of deposits to uniform reserve requirements and calculated the required reserves based on total deposits namely time, savings and demand deposits. In a similar vein, the categorization of banks as Primary and Secondary Commercial Banks was also done away with. As a result of the increasing use of dollars for transactions in the economy, money supply was redefined from M2 to M2+ to cover foreign currency deposits. Thus in April 1997, reserve requirements was widened to include foreign currency holdings. It is therefore important that reserve requirements be calculated on all constituents of M2+ to ensure effective monetary management. An exclusion of some constituents of the money supply would lead to an inaccurate estimation of the money multiplier and this would make monetary management inefficient. Also in 2006, secondary reserves were also abolished. Currently, the primary reserve requirement is 11%.

3.4.3 Open Market Operations

Open Market Operations (OMOs) involve the sale and purchase of securities by a central bank. The securities can be for government or the central bank. OMOs were launched by the Bank of Ghana in 1986 with a weekly primary auction in treasury bills to meet government financing needs. Two years later, BOG bills were also launched for monetary management purposes. This separation was however abandoned in 1996 and Treasury bills are now used exclusively for both monetary control and meeting government debt financing needs. Since its introduction, OMOs have become the preferred tool for the conduct of monetary policy. Some of the reasons

responsible for this choice include the fact that the central bank can buy and sell securities for any quantity it chooses to on any single day and also the fact that the initiative is with the central bank and it is done to affect the cost and availability of credit (Gockel, 2000).

When the central bank conducts Open Market operations, it seeks to indirectly control its balance sheet, so as to regulate reserve money. In this direction, the operating target of monetary policy is reserve money. In a given year under some financial programming, reserve money is determined, with broad money (M2+) and inflation as the intermediate and ultimate targets respectively. "The amount of bills offered for sale are based on the difference between the projected target reserve money and Public Sector Borrowing Requirements (PSBR)" (Gockel, 2000, p.30). The government has first claim on the proceeds while the residual is used for monetary management. When Treasury and Bank of Ghana bills were introduced, the weekly auctions were held on Fridays (presently auctions are held on Wednesdays).

Thus every Wednesday, the BOG conducts auctions in government instruments on behave of government and itself. The auctions are wholesale auctions to primary dealers (Licensed Brokerage firms, Discount Houses and deposit money banks) through competitive bidding at the weekly sales. Previously, a weekly average price was declared and investors could purchase on tap without taking part in the auction. Tap sale was however closed to both primary dealers and non-bank public in 1997 but continued at BOG's Currency Centres in the regions outside Accra. This was because access to tap sales hindered the development of a secondary market in the securities.

Through OMO, Bank of Ghana is able to inject or withdraw liquidity from the system by buying or selling securities to deposit money banks and the non-bank public. It has also been able to

mobilize idle funds and private savings in areas where the banks have not offered effective intermediation and develop savings habit in the public.

3.4.4 Foreign Exchange Operations

Before the coming into being of the ERP in 1983, Ghana operated a fixed exchange rate regime. There were also exchange rate controls, rationing and surrender laws in order to ensure compliance. The fixed exchange rate resulted in over-valuation of the Cedi and this negatively affected the country's export base whilst acting as subsidy for imports. The overvalued currency led to the emergence of a black market in foreign exchange. In order to boost exports and stimulate growth, the Cedi was devalued by the end of 1983 from 2.75 Cedis per Dollar to 30.03 Cedis per Dollar. Between 1984 and 1986, there was further devaluation and by September 1986, the exchange rate was 90.09 Cedis to the Dollar.

In 1988, in an effort to move to a flexible exchange rate regime, government licensed the establishment of foreign exchange bureaus and introduced auction trading which was later converted into an interbank market. With these developments, authorized dealers now bought and sold foreign exchange to the general public in what could be considered a floating exchange rate regime.

Basically, the strategy used by BOG in its exchange rate management is based on targeting reserves. When reserves are above the target, the central bank sells foreign exchange to absorb the excess liquidity. These sales can also be used to compliment Treasury bill auctions. There are other measures the BOG can take to ensure a more stable exchange rate. One of such measures was the introduction in 1997 of foreign exchange swaps. Just like Repurchase Agreements (repos), swaps are reversed transactions in foreign exchange market. They involve the sale of securities or foreign

exchange at a determined price and an agreement to repurchase them at some date in the future. "When the Bank of Ghana buys foreign exchange in a swap with domestic currency, it injects liquidity into the market. Similarly, in a reverse transaction, liquidity is taken out of the market" (Gockel, 2000, p.44). Foreign exchange swaps can make a meaningful impact in absorbing or injecting large quantities of liquidity into the system if there are large number of participants in the foreign exchange market.

3.4.5 Interest Rate Policies

Before financial sector reforms, Ghana operated low interest rate policies in order to stimulate investment for economic growth. It however turned out that these kind of policies were not effective as they rather inhibited financial intermediation and as such, much domestic resources could not be mobilized for the needed development. Thus financial reforms were necessary to reverse the negative impact of low interest rate policies. With financial sector reforms, interest rates were liberalized i.e. they were allowed to be determined by market conditions.

During the reforms, interest rate policies mainly took the form of open market operation and bank rate changes. The central bank used the bank rate as a tool to regulate monetary expansion. It indicated the stance of monetary policy and was expected to set the pace for other commercial bank rates. In conducting its market operation, the central bank attempts to regulate the level of currency and deposits directly, by convincing private agents to hold fewer assets issued by deposit money banks. The central bank is able to do this by manoeuvring the interest rates on Treasury bills and other government securities (which are alternatives to deposit money banks instruments).

Conceptually, in a competitive banking system, if the central bank raises the interest on its instruments, banks should also instantly review their rates on deposits upwards. However, it turns

out that banks are not able to match BOG's interest rate increases from open market operations. This means that the actions taken by the central bank has rather led to distortions in the interest rate structure, which works against effective intermediation.

To avoid this, the central bank has to understand that there exist a complicated connection between government's fiscal deficits and its PSBR on one hand, the rate of growth of money supply, and the level of interest rates on the other hand. As noted by Gockel (2000) "With a given public sector borrowing requirement, either the money supply or the level of interest rates is determined in the market; government cannot determine both simultaneously […]" (p.38). For monetary management to be a success, Bank of Ghana must allow the primary dealers to interact in the market to determine interest rates, once the targeted money supply is determined. This will help avoid the under-subscription of securities that is experienced at times.

3.4.6 Repurchase Agreements or REPOS

The Bank of Ghana launched repurchase agreements or repos in 1998 to "enhance the central bank's control over bank reserves, and to permit banks to better manage their liquidity" (Gockel, 2000, p.55). Under it the central bank sells securities to deposit money banks, but there is an agreement to sell back the securities (reverse the transaction) to the central bank at a fixed date in the future. By its short-term nature, it is a prudent way of carrying out a defensive open market purchase as the transaction will be reversed after a short while.

Despite this temporary nature, repos are used by the central bank as a foundation to develop a long term market in securities. A benefit of repos is that, by selling a BOG security and agreeing to buy it back at a pre-set price, the central bank retains the initiative in terms of amount, maturity and

timing regardless of the conditions of the underlining security. It also ensures that funds are available for sterilization over the predetermined period of the transaction.

3.4.7 Transfer of Government Deposits

This is one of the tools that can be used by the central bank for managing liquidity in the banking system. It involves shifting deposits of government from deposit money banks to the central bank and vice-versa. A decrease in banks' share of government deposits reduces bank liquidity just like a tight open market operation. Increasing banks' share of government deposits improves the liquidity position of banks.

The monetary authorities made a decision to explore this only in October 1997, by asking that all government deposits should be moved from banks to the Bank of Ghana. This maiden policy directive was meant to "improve the monetary control process and also [improve] government position with the central bank, reducing the need for additional borrowing by government" (BOG Annual Report, 1997) (cited in Gockel, 2000, p.4).

3.4.8 Inflation Targeting Framework in Ghana

At the turn of the millennium, Ghana was grappling with high rates of inflation, huge public debt, and a general instability in the economy. Inflation rate was about 40% by December 2000, whilst Ghana's debt as a percentage of GDP was at an all-time high of about 110%. It became obvious that the policies that were adopted in managing the economy, both monetary and fiscal, had failed in achieving any meaningful success regarding key macroeconomic variables such as the debt stock, GDP growth and inflation. In a bid to reverse this trend, Ghana adopted inflation targeting regime in 2002.

The adoption of inflation targeting was generally influenced by its success in reducing both inflation and its variability in nations that had adopted it. Examples of such nations include New Zealand, Canada, and Japan, just to mention a few. The move for inflation targeting was also fuelled by the "the limited success in achieving inflation targets under the monetary targeting framework and the apparent weakening of the link between monetary aggregates and inflation" (Kwakye, 2012, p. 15).

The regime started with the enactment of the Bank of Ghana Act 612 of 2002. The Act stipulated the goals of monetary policy and how it was to be conducted under this framework. The goals of monetary policy being: to maintain price stability and to support the general economic policy of government. The Act also set up the Monetary Policy Committee (MPC) spelling out its responsibilities as: to initiate proposals for the formulation of the Monetary Policies of the Bank; and providing the statistical data and advice necessary for the formulation of monetary policies. The members of the Monetary Policy Committee are: the Governor; the First and Second Deputy Governors; the Head of monetary policy analysis of the Bank; the Head of banking operations of the Bank; and two other persons appointed by the Minister[7] being persons with knowledge or experience relevant to the functions of the Monetary Policy Committee.

The Act granted operational independence to the central bank to use the tools at its disposal to achieve the goals of monetary policy. The meetings of the MPC are held bi-monthly and it lasts for two days. It normally starts on Mondays and end on Tuesdays. The meeting is concluded with a press briefing on Wednesday to communicate the decisions of the MPC to the general public. The MPC's main tool for monetary management is the Monetary Policy Rate (MPR). It uses this

[7] The Minister here refers to the Minister of Finance.

to indicate the stance of monetary policy and anchor inflation expectations. An increase in the policy rate signifies that the central bank is embarking on a tight policy whilst a reduction indicates that policy is eased. Before the decision is made on the MPR at each meeting, the Committee considers a wide range of factors such as developments in the real sector, banking sector, inflation outlook, and world economic outlook. Minutes of the meetings are not published but the bank makes available a variety of economic reports within two weeks after its announcement of the policy rate detailing the thinking and data that informed the choice of a particular policy rate.

One of the major characteristics of inflation targeting regime is the increased transparency of the policy maker's actions. Through these press releases, which explains the Monetary Policy Committee's process, the public becomes confident in the actions taken by the MPC which therefore enhances the credibility of the monetary authorities. This increases the efficiency of the pass-through effects of monetary policy and will lead to the achievement of the targets set by the authorities.

CHAPTER FOUR

METHODOLOGY

4.1 Introduction

The focus of this chapter is to provide a short account of the econometric strategy that was adopted for the study, as well as give a brief description of the data and their sources. The chapter is in three (3) sections. The first section provides the theoretical framework and method of identification of monetary policy shocks. In the second section, we specify the empirical model and the techniques that will be employed in estimating the VAR. The last section deals with the data, their sources and a priori expectations.

4.2 Conceptual Framework

This study is based on the transmission mechanism of monetary policy, particularly how monetary policy affects the amount of credit available to firms and how that in turn affects economic activity (output and prices). Our goal is to find out the extent to which the responses of private sector credit, output and prices to monetary policy shocks are consistent with conventional theory and, in doing so, find out the interdependence among these variables. We make use of VAR in order to achieve this goal.

VAR basically involves the regression of a vector of variables on current and lagged values of the same vector. VARs are specified such that the number of equations equals the number of variables. There is a different dependent variable for each equation but each equation has the same independent variables. Since the introduction of VARs in 1980 by Christopher Sims, they have been widely used in analysing the effects of monetary policy on an economy. As noted by

Bernanke (1983), “identified VAR models are currently the best available means of measuring effects of monetary policy changes on the economy” (Leeper et al, 1996, p. 73).

Prior to the adoption of VAR models in the 1980s, macroeconomists employed simultaneous equations models to assess the effects of alternative macroeconomic policies, including monetary policy, on the overall economy. Simultaneous equation models involved estimating a complete set of structural equations of the economy, one equation at a time. Thus, they involved large-scale models.

Simultaneous equation models were also characterized by a priori distinction between endogenous and exogenous variables. This presented challenges for econometricians at the time. As a result, Sims (1980) advocated and popularized the use of VAR models as alternatives to the traditional large scale models. He criticized these large-scale models by arguing that, the identification of these models is often subjective and imposes too many “incredible” restrictions. He also criticized the exogeneity assumptions for some of the variables in simultaneous equations models as ad hoc and often not backed by fully developed theories.

By assuming exogeneity of monetary variables in simultaneous equations models, it makes it inappropriate for policy analysis if there is an endogenous reaction by monetary policy to the state of the economy. Monetary policy shocks should be identified using theory-free restrictions, taking into account the possibility of policy variables being endogenous. In VAR models, all the variables are treated as a priori endogenous and minimal restrictions are required in order to identify the system of equations. Unlike simultaneous equations models, VAR models do not required a complete specification of a structural model for the economy. This is seen as a crucial advantage

of VARs especially so, when economic theory hardly provide a complete specification of the dynamic relationship among variables.

Generally, a VAR model for a vector of macroeconomic variables can be specified as follows:

$\beta_0 Y_t=\alpha+\beta_1 Y_{t-1}+\beta_2 Y_{t-2}+\ldots+\beta_p Y_{t-p}+\mu_t$ ..... (4.1)

Where $Y_t=(y_{1t}, y_{2t}, \ldots, y_{kt})'$ is a (K×1) vector of macroeconomic variables, $\alpha=(\alpha_1, \ldots, \alpha_k)'$ is a (K×1) vector of constant terms, β_i is a (K×K) vector of coefficient matrix, i=1,2,…,K, p is the lag length, $\mu_t=(\mu_{1t}, \mu_{2t}, \ldots, \mu_{kt})'$ is a $(K \times 1)$ vector of structural shocks; $E(\mu_t)=0$, $E(\mu_t \mu_t')=\Sigma_\mu=I_k$, $E(\mu_t \mu_s')=0$ for s≠t. Σ_μ is the covariance matrix and it is assumed to be non-singular. By definition μ_t(structural shocks) are mutually uncorrelated, this means Σ_μ is a diagonal matrix.

To estimate the structural model, we first have to obtain the reduced form of equation (4.1) above. This is achieved by pre-multiplying both sides of equation (4.1) by β_0^{-1}(the inverse of β_0):

$\beta_0^{-1}\beta_0 Y_t = \beta_0^{-1}\alpha + \beta_0^{-1}\beta_1 Y_{t-1} + \beta_0^{-1}\beta_2 Y_{t-2} + \cdots + \beta_0^{-1}\beta_p Y_{t-p} + \beta_0^{-1}\mu_t$ ..... (4.2)

$Y_t = \gamma + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \cdots + \theta_p Y_{t-p} + \varepsilon_t$ ..... (4.3)

Where $\gamma=\beta_0^{-1}\alpha$, $\theta_i=\beta_0^{-1}\beta_i$, i=1,2,…,p, and $\varepsilon_t=\beta_0^{-1}\mu_t$ is a white noise process with nonsingular covariance matrix Σ_ε.

In order to move from the reduced form (4.3) to the structural model (4.1), there is the need to impose some identifying restrictions. As mentioned above, Σ_μ(covariance matrix for μ_t) is assumed to be diagonal, whereas β_0 has ones on its principal diagonal but is not restricted elsewhere. This means that each component of Y_t is given its own structural equation to ensure that the shocks can be interpreted economically. The reduced form coefficients (γ *and* $\theta_{i's}$) in

equation (4.3) can be obtained using OLS. It will be difficult to estimate β_0 if the $\beta_{i's}$ are unrestricted. This is because the $\theta_{i's}$ contain pK^2 known coefficients whilst there are $(p+1)K^2$ unknown coefficients in the $\beta_{i's}$. β_0 can be obtained by solving:

$$\Sigma_\varepsilon = Cov(\varepsilon_t) = Cov(\beta_0^{-1}\mu_t) = \beta_0^{-1}\Sigma_\mu(\beta_0^{-1})' \ldots\ldots\ldots \text{(4.4)}$$

Σ_ε contains $K(K-1)/2$ different covariances (as a result of symmetry). Given that Σ_μ is diagonal and has K^2 elements, it means that $K(K-1)/2$ additional restrictions are needed to identify the system. Before tackling the identification methods in VAR models, it will be convenient to recast the reduced form in equation (4.3) in a moving average format as follows:

$$\theta(L)Y_t = \gamma + \varepsilon_t \ldots\ldots\ldots \text{(4.5)}$$

Where $\theta(L) = I - \theta_1 L - \theta_2 L^2 - \cdots - \theta_p L^p$ denotes the autoregressive lag order polynomial.

If we assume that Y_t is a covariance stationary vector, equation (4.5) can be represented in Wold moving average format as follows:

$$Y_t = \sum_{i=0}^{\infty} \phi_i \, \varepsilon_{t-i} = \phi(L)\varepsilon_t \ldots\ldots\ldots \text{(4.6)}$$

Where $\phi(L) = \theta(L)^{-1}$ and $\phi_0 = I$

4.2.1 Identification of VAR

Equation (4.6) above is not identified. Identification means the ability to assign the response of a certain variable to an economically interpretable change in another variable. To identify the system (disentangle the structural innovations/shocks μ_t from the reduced form innovations ε_t), the different shocks needs to be orthogonalized. By orthogonalization we mean making errors

uncorrelated across time and equations. This can be accomplished by defining a non-singular matrix Q such that the positive definite symmetric covariance matrix Σ_ε can be expressed as $\Sigma_\varepsilon = QQ'$. Equation (4.6) can be rewritten as:

$$Y_t = \sum_{i=0}^{\infty} \phi_i \, QQ^{-1} \varepsilon_{t-i} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (4.7)$$

$$= \sum_{i=0}^{\infty} \delta_i \, e_t \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (4.8)$$

Where $\delta_i = \phi_i Q$ and $e_t = Q^{-1} \varepsilon_{t-i}$. e_t are white noise errors with covariance matrix $cov(e_t) = Q^{-1} \Sigma_\varepsilon (Q^{-1})' = I$.

Σ_ε can be factorized in many ways. But identification in VAR is normally achieved by defining Q to be a lower triangular matrix with positive covariates in the principal diagonal which factorizes uniquely into QQ'. This is known as Cholesky decomposition of the covariance matrix. If we make the standard normalizing assumption that $\Sigma_\mu = I_K$ then equation (4.4) becomes $\Sigma_\varepsilon = \beta_0^{-1} (\beta_0^{-1})'$. From $\Sigma_\varepsilon = QQ'$, it follows that $Q = \beta_0^{-1}$ is one possible solution to the problem of how to recover the structural shocks μ_t. In other words, the orthogonalized shocks coincides with the true structural shocks (i.e. $\mu_t = \beta_0 \varepsilon_t = Q^{-1} \varepsilon_t = e_t$). If $Q \neq \beta_0^{-1}$, it means that we have been unsuccessful at recovering any structural relationship.

This strategy of identifying shocks is known as recursive identification. It requires a causal ordering on how the variables in the system interact in order to identify the required shocks. Within the VAR framework, the recursive identification method has been widely relied on to isolate monetary policy shocks. It is crucial to note that orthogonalization of the reduced form errors using

a Cholesky decomposition of the covariance matrix is appropriate only if the recursive structure embodied in Q can be justified on economics grounds.

Sims (1980) for instance assumed that β_0 was lower triangular and orthogonalized the reduced form innovations through a Cholesky decomposition of the variance-covariance matrix. In his six variable system, the VAR was ordered as follows: money, real GNP, Unemployment, Wages, Price Level, and Import Prices. By ordering money supply (policy variable) first, he assumed that the rest of the variables had no contemporaneous effect on the money supply, whilst money supply could affect all other variables within the period. Bernanke and Blinder (1992), Christiano and Eichenbaum (1992), Sims(1986, 1992) and Christiano et al (1999) on the other hand placed the policy instrument(s) after the non-policy variables. Christiano et al (1999) for example recursively identified monetary policy shocks by ordering their VAR as follows: output, prices, commodity prices, Federal Funds rate, Non-borrowed Reserves, total reserves and money supply. The Federal Funds rate was used as policy variable. They did this by assuming that policy variables affected non-policy variables with a lag.

Generally, in ordering a VAR, assumptions are made based on: "(i) the relative level of variable exogeneity/endogeneity; (ii) lags in data generation; (iii) the speed with which variables respond to shocks; and (iv) the relative ease with which variables can be adjusted" (Boamah, 2009, p. 191). The variable that is ordered first is assumed to be the most exogenous or least endogenous, least responsive to shocks and there is no within the period feedback to it from the other variables in the VAR. The second variable is assumed to affect all the other variables contemporaneously except the first; only the first variable has within the period effect on the second. The rest of the variables are ordered in a similar fashion till the last variable, which is assumed to be the most responsive and most endogenous/least exogenous and respond contemporaneously to all the preceding

variables. The way in which the variables are ordered affects the impulse response functions. Different ordering may produce different response functions.

Although recursive identification by Cholesky decomposition has been widely favoured in identifying monetary policy shocks, it has been criticized as being hard to justify since economic theory hardly gives such an ordering. As a result, several researchers have relied on other ways of identifying monetary policy shocks. Two of such strategies are the use of Structural VAR (SVAR) method and the Narrative Approach. Under SVAR, restrictions are imposed on β_0 using economic theory; e.g. the short run non-neutrality or long run neutrality of money, Keynesian model, and Philips Curve relation among others. Examples of studies that have used this approach are Bernanke (1986), Sims (1986), and Blanchard (1989). SVAR will be advantageous over the recursive method provided economic theory gives a valid description of economic behaviour and enough identifying restrictions. However, this does not guarantee reliable results. Moreover, as the number of variables in the system increases, it becomes increasingly more complicated to explain the theoretical relationship among variables. The Narrative Approach (defined in section 2.2) was pioneered by Friedman and Schwartz (1963) and also used by Romer and Romer (1989). In this study we identify monetary policy shocks using the recursive approach.

4.2.2 Other Issues in VAR Modelling

In undertaking a VAR study of the effects of monetary policy, one has to consider several factors, some of which include: variable(s) to indicate the stance of policy; identification restrictions; non-policy variables to include; data frequency; sample period; and lag length (Nagel & Parker, 2003). Despite the fact that all these factors are crucial, much of the disagreements have centred on the first three issues: which variable(s) to indicate policy stance; how shocks to the selected policy variable are identified; and which variables to include in the VAR.

In answering the first question, so many variables have been used to measure monetary policy since Sims' work in 1980. These variables range from monetary aggregates to interest rates as well as reserve aggregates. Some studies such as Bernanke and Mihov (1998), have used a combination of different variables and imposed several assumptions in order to identify monetary shocks. Our study employ an interest rate to measure and identify monetary policy shocks in the Ghanaian context. The second question of how to identify shocks has been tackled above.

According to Nagel and Parker (2003), the set of variables included in VAR models are real output, prices, at least a monetary and a reserve aggregate and at least one interest rate. Monetary or reserve aggregates and interest rates are possible monetary policy variables. Some studies have also include nominal exchange rate. Commodity prices indices, which have been crucial in resolving some puzzles (e.g. price puzzle) in VAR models are also included.

4.2.2.1 Lag Length

Choosing an appropriate lag length is crucial in estimating a VAR. This is because too short a lag length may result in loss of important information, whereas too long a lag length will lead to over parameterization (i.e. the number of parameters are too large relative to the sample size). There are several criteria used for selecting lag length in VARs. The most popular ones are the Alkaike Information Criterion (AIC) and the Schwartz-Bayesian Information Criterion (SBIC). Others are the Hanna-Ouinn Information Criterion (HIC) and Final Predictor Error (FPE). The procedure is to choose a lag length which minimizes the value of AIC, SBIC, HIC or FPE. In this study, we will try to use all the four in selecting the required lag length.

4.3 Empirical Model

Following Bernanke and Blinder (1992), we construct a set of unrestricted reduced form VAR models made up of policy and non-policy variables. By unrestricted, we mean, “without restrictions based on supposed a priori knowledge” (Sims, 1980). According to Bernanke and Blinder (1992), in order to assess real structural effects of a policy change, two options are available. Firstly, one can do so by specifying and estimating a structural economic model. In this case, a structural VAR method is used to study the relationships among the variables. Regrettably, deductions based on this approach are responsive to the choice of specification and identifying assumptions.

The second option is to try and segregate a direct measure of the central bank’s policy. Let us assume that there exist a variable whose innovations could be explained as policy shocks (the systematic component of this variable could be influenced by lagged economic variables). If in addition to the above assumption, we assume that due to information lags, these quantifiable policy shocks do not depend on within the period changes in the economy, then based on these assumptions, “the reduced form responses of the economy to observed policy shocks would correctly measure the dynamic structural effects of a monetary policy change” (Bernanke & Blinder, 1992, p. 902). In line with Bernanke and Blinder (1992), we employ the second option in this study.

Suppose the economy can be represented by the general structural model as follows:

$$Y_t = B_0 Y_t + B_1 Y_{t-1} + C_0 P_t + C_1 P_{t-1} + u_t \quad \text{(4.8)}$$

$$P_t = D_0 Y_t + D_1 Y_{t-1} + G P_{t-1} + v_t \quad \text{(4.9)}$$

Where Y is a vector of non-policy variables, P is a vector of policy variables, $B_0, B_1, C_0, C_1, C_1, D_0, D_1 \; and \; G$ are structural coefficients, while $u \; and \; v$ are structural disturbances. Here, one lag of the policy and non-policy variables is used for simplicity, but it can be generalized to the appropriate lag. Now, the system (4.8)-(4.9) is unidentified. To identify it, two types of identifying assumptions can be imposed. One way is to assume that in the current period, policy actions are not taken in response to the state of the economy. In this case $D_0 = 0$. We can now convert (4.8) and (4.9) into reduced form VARs by putting $D_0 = 0$ into (4.9) and substituting into (4.8) and solving to get:

$$P_t = D_1 Y_{t-1} + G P_{t-1} + v_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.10)$$

$$Y_t = B_0 Y_t + B_1 Y_{t-1} + C_0(D_1 Y_{t-1} + G P_{t-1} + v_t) + C_1 P_{t-1} + u_t$$

$$(I - B_0) Y_t = (B_1 + C_0 D_1) Y_{t-1} + (C_0 G + C_1) P_{t-1} + u_t + C_0 v_t$$

$$Y_t = (I - B_0)^{-1}[(B_1 + C_0 D_1) Y_{t-1} + (C_0 G + C_1) P_{t-1} + u_t + C_0 v_t] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.11)$$

Now the response of non-policy variables to monetary policy innovation "can be identified with the impulse response function of Y to past changes in v in the unrestricted VAR consisting of [(4.10) and (4.11)] with *P* placed first in the ordering [before the non-policy variables]" (Bernanke & Blinder, 1992, p. 902).

The second way of identifying the system is to assume that $C_0 = 0$, that is, contemporaneous *P* does not enter equation (4.8), so that the policy variable affects non-policy variables with a lag.

When $C_0 = 0$ in equation (4.8),

$$Y_t = B_0 Y_t + B_1 Y_{t-1} + C_1 P_{t-1} + u_t$$

$$(I - B_0)Y_t = B_1 Y_{t-1} + C_1 P_{t-1} + u_t$$

$$Y_t = (I - B_0)^{-1}(B_1 Y_{t-1} + C_1 P_{t-1} + u_t) \quad \text{..... (4.12)}$$

Substituting equation (4.12) into equation (4.9) gives:

$$P_t = D_0[(I - B_0)^{-1}(B_1 Y_{t-1} + C_1 P_{t-1} + u_t)] + D_1 Y_{t-1} + G P_{t-1} + v_t$$

$$P_t = (D_1 + D_0(I - B_0)^{-1} B_1) Y_{t-1} + (G + D_0(I - B_0)^{-1} C_1) P_{t-1} + v_t + D_0(I - B_0)^{-1} u_t \quad (4.13)$$

In this instance, the unrestricted VAR has *P* ordered last (i.e. after the non-policy variables). Also, v_t is still a policy innovation, but P_t is now also affected by contemporaneous macro shocks u_t. When we estimate the resulting VAR system followed by a Cholesky decomposition of the covariance matrix (with policy variable ordered last), it yields an estimated series for the exogenous policy shock v_t. Both identification assumptions will be explored in this study to ensure robustness.

4.4 Estimation and Analytical Procedures

4.4.1 Time Series Properties of Data

In multiple time series analysis, it is necessary to ensure that the series are stationary in order to avoid spurious regressions. In order to make a series stationary if it is not, it requires differencing. If a series is stationary at levels, we termed it as integrated of order zero$\sim I(0)$. If it becomes stationary after first difference, it is $I(1)$. In general if it requires differencing d times (where d is a positive integer) to make it stationary, it is integrated of order $I(d)$.

Sims (1980) argues that in VAR studies, the goal is to determine the interrelationships among the variables, not the parameter estimates. He thus argued against differencing even if the variables

contain a unit root (not stationary). In differencing, information concerning co-movements in the data is lost. Bernanke and Mihov (1997) also argue that specifying a VAR in levels produces consistent estimates whether the variables are cointegrated or not; whereas specifying a VAR in difference format yields inconsistent estimates if some variables are cointegrated. Harvey (1990) also argues that if all the variables in the VAR model are not stationary, attempts to make them stationary may not be satisfactory. He recommends working with the series in levels even if some of them contain unit roots.

Most of the empirical studies (such as Cushman & Zha, 1997; Brischetto and Voss, 1999 and Kim & Roubini, 2000) that identify the impact of monetary policy did not test the stationary condition of their variables. They directly carried out the analysis with the variables in levels without considering to differencing the non-stationary variables. In this study, since our aim is to investigate the responses of the various variables to monetary policy shocks and not to estimate the parameters of the model, we will therefore follow the above arguments and estimate our VAR in levels.

Despite the above arguments against differencing, some studies such as Clarida and Gertler (1997) and Abradu-Otoo et al (2003) specified their models using error correction and allowed for differencing of non-stationary variables.

4.4.2 Estimation

Following Bernanke and Blinder (1992), an unrestricted VAR of non-policy and policy variable(s) is estimated, treating all variables as endogenous. Price of crude oil is considered the least endogenous variable since Ghana is a small country and as such developments within the economy hardly impact on the world price of crude oil. The full VAR is shown below:

$Y_t = (POIL, RGDP, CPI, TBILL, PSC, M2+, EXR)'$

$Y_t = 7 \times 1$ vector of the observed variables, where POIL, RGDP, CPI, TBILL, PSC, M2+ and EXR represent price of crude oil, real Gross Domestic Product, consumer price index, 91-day Treasury bill rate, private sector credit, money supply and exchange rate respectively. The non-policy variables are: RGDP, PSC, CPI, M2+, EXR, and POIL; while TBILL is the policy variable.

The analysis starts by first estimating a base VAR which shall comprise of four variables namely: PSC, RGDP, CPI and TBILL, in order to investigate the responses of output, prices and private sector credit to TBILL shocks. The VAR is identified using Cholesky decomposition with the variables ordered as follows: RGDP, CPI, TBILL and PSC. This ordering was selected based on the speed with which the series respond to monetary policy shocks. Output and prices are assumed to respond to monetary policy shocks with a lag, output being the least responsive. Due to the lags involve in making output and price decisions, these variables are assumed not to respond to monetary shocks contemporaneously. Interest rates and other monetary variables are assumed to respond to policy shocks contemporaneously, thus they are ordered after the policy variable. This is the reason why private sector credit is ordered after the policy variable. TBILL is placed after output and prices to describe the reaction function of the central bank. A look at the operating procedures of BOG indicates that the central bank reacts contemporaneously to output and inflationary pressures. Thus the policy interest rate is placed after output and prices. This ordering is consistent with Bernanke and Blinder (1992), Christiano et al (1999), Sims (1992) and Morsink and Bayoumi (2001).

Our base VAR is specified as follows:

$$RGDP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} RGDP_{t-i} + \sum_{i=1}^{p} \alpha_{2i} CPI_{t-i} + \sum_{i=1}^{p} \alpha_{3i} TBILL_{t-i} + \sum_{i=1}^{p} \alpha_{4i} PSC_{t-i} + u_{1t}$$

$$CPI_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} RGDP_{t-i} + \sum_{i=1}^{p} \beta_{2i} CPI_{t-i} + \sum_{i=1}^{p} \beta_{3i} TBILL_{t-i} + \sum_{i=1}^{p} \beta_{4i} PSC_{t-i} + u_{2t}$$

$$TBILL_t = \gamma_0 + \sum_{i=1}^{p} \gamma_{1i} RGDP_{t-i} + \sum_{i=1}^{p} \gamma_{2i} CPI_{t-i} + \sum_{i=1}^{p} \gamma_{3i} TBILL_{t-i} + \sum_{i=1}^{p} \gamma_{4i} PSC_{t-i} \gamma + u_{3t}$$

$$PSC_t = \delta_0 + \sum_{i=1}^{p} \delta_{1i} RGDP_{t-i} + \sum_{i=1}^{p} \delta_{2i} CPI_{t-i} + \sum_{i=1}^{p} \delta_{3i} TBILL_{t-i} + \sum_{i=1}^{p} \delta_{4i} PSC_{t-i} + u_{4t}$$

Where $\alpha_{i's}, \beta_{i's}, \gamma_{i's},\ and\ \delta_{i's}$ are reduced form coefficients. $u_{i's}$ are the disturbance terms in the respective equations. p is the lag length.

The base VAR is then extended to include M2+, EXR, and POIL. This is done one at a time. These variables are added to examine the role they play in transmitting monetary impulses. M2+ is included to assess the role money plays; whether it serves as a conduit through which monetary impulses are transmitted or not. Exchange rate is added to examine the role of the external sector in the Ghanaian economy. POIL is added to control for supply shocks. Also in VAR literature, such a variable is included as it plays a crucial role in resolving some anomalies such as price puzzle and exchange rate puzzle. So this variable is added to see if these puzzles are resolved if they are present in our model.

In the extended models, the variables in the VAR will be ordered by following the ordering criteria adopted above. When extended to include M2+, the order will be as follows: $(RGDP, CPI, TBILL, PSC, M2+)$. PSC and M2+ are placed after the policy variable because these

variables are assumed to react to policy actions and not the other way around. M2+ comes after PSC based on the same analogy. When extended to include exchange rate, the order will be: $(RGDP, CPI, TBILL, PSC, EXR)$. The exchange rate is ordered last based on the assumption that it responds to output, prices, TBILL and PSC. When extended to include POIL, the order is: $(POIL, RGDP, CPI, TBILL, PSC)$. This is based on the fact that Ghana is a small country and so developments in the local economy will not have any impact on price of crude oil internationally.

VAR models are impulse response analysis and so are sensitive to the order of variables. As a result, different ordering may produce different responses of the variables. If there are K variables there will be $K!$ different orderings. In order to assess the robustness of our results, an alternative ordering will also be considered. In this instance, the policy variable will be placed before the non-policy variables.

4.4.3 Methods of Analysis

VARs are used to study the dynamics of data. They are hard to describe concisely. It is particularly difficult to make meaning of them by scrutinising the coefficients in the regression equations. The estimated parameters on consecutive lags tend to swing and there are complex cross-equation feedbacks. As a result, the best techniques available appear to be Impulse Response Functions (IRFs), Forecast Error Variance Decomposition (FEVD) and Granger Causality Tests.

4.4.3.1 Impulse Response Functions

IRFs trace the effect of a one standard deviation shock to one of the VAR errors on current and future values of the other variables, given that this error return to zero in ensuing period, while all other errors are equal to zero.

Consider a bivariate VAR in reduced form below.

$y_t = \beta_0{}^{-1} A y_{t-1} + \beta_0{}^{-1} u_t$, $\beta_0{}^{-1} u_t = e_t$, y_t is a vector made up of $x_t \; and \; z_t$

The IRF to a unit shock in u_t can be estimated once we know $\beta_0{}^{-1}$. Assume we want to trace out the response of the first variable in the system during period $= 1, 2, \ldots$, when a shock hits the system at time 0, then

$u_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$y_0 = \begin{bmatrix} x_0 \\ z_0 \end{bmatrix} = \beta_0{}^{-1} u_0$

For all > 0 , $y_s = \beta_0{}^{-1} A y_{s-1}$

Thus IRF is a practical way of representing the behaviour of variables in a VAR to various shocks in the error terms over time. They are the time paths of the variables in response to shocks in the system. IRFs are functions of the estimated VAR parameters. In a K-variable system, there are K^2 impulse response functions.

4.4.3.2 Forecast Error Variance Decomposition

It decomposes the variance of a variable into components that are attributable to each of the set of shocks. FEVD also describes the amount of information each variable contribute to the other variables in the VAR. It allows the comparison of the role of different variables in explaining the changes in a certain variable in a system.

4.4.3.3 Granger Causality Tests

In Granger causality tests, the aim is to determine whether the lagged values of a particular variable helps to predict the endogenous variables in the model. If a variable y granger causes (affects) another variable z, then y should help in forecasting z. Let ∪ be the set of all information available

that is relevant in forecasting z. Consider y, a variable that helps in predicting z. Then $\cup -y$ is the information set with values of y excluded. Let $\Sigma(z|\cup)$ be the variance of the forecast error achieved in predicting z based on $\cup$, then according to Granger (1969), "if $\Sigma(z|\cup) < \Sigma(z|\cup -y)$, we say that y is causing z, denoted by $y \Longrightarrow z$. We say that y is causing z if we are better able to predict z using all available information than if the information apart from y had been used". Thus y is deemed to cause z if a lower forecast error can be achieved by including y in the set of variables used to predict z than if it is omitted. The set $\cup$ consists of lagged values of both y and z, so $\cup -y$ is just lagged values of z. So y granger causes z if the coefficients on the lagged y are statistically significant. Causality can run in both directions i.e. $y \Longrightarrow z$ and $z \Longrightarrow y$.

4.5 Sources of Data and Description of Variables

This study employs monthly data from 1990 to 2015. CPI, PSC, EXR, TBILL, and M2+ were all obtained from Bank of Ghana. RGDP was gotten from World Development Indicators (WDI, 2016), while POIL was obtained from United States Energy Information Administration (EIA). All variables except TBILL rate are logged.

4.5.1 Real Gross Domestic Product

GDP is the most commonly used measure of output in an economy. It is defined as the total amount of goods and services that can be produced in a particular country at a given time. It is the sum of consumption expenditure, government spending, investment and net exports. Real GDP is the GDP of a country adjusted for inflation. Since monthly data is not available on RGDP, we interpolate the annual series to monthly series. The method used in doing this was the Chow-Lin procedure developed by Chow and Lin (1971). This procedure is available in Eviews (the software we used for this study). A similar procedure is used for PSC. Time series plot of the interpolated monthly

data and their corresponding annual showed that the series exhibit similar trends. They were also integrated of the same order. This shows that the interpolation did not affect the time series properties of our variables. Apart from these two, all other series are available monthly.

4.5.2 Consumer Price Index

The CPI measures the "change over time in the general price level of goods and services that households acquire for the purpose of consumption, with reference to a base year which has an index of 100" (Ghana Statistical Service (GSS) statistical bulletin, 2016). A sustained rise in the general level of prices in an economy over a period of time is known as inflation. Rising prices implies that the purchasing power of consumers falls. CPI is the most common measure of inflation in Ghana (GDP deflator is another way of measuring inflation).

4.5.3 Private Sector Credit

For the purposes of our study, we will define private sector credit as bank credit provided to the private sector. It is defined as financial resources extended to the private sector by banks in the form of loans, non-equity securities, and others for which a claim for repayment is established.

4.5.4 Exchange Rate

The exchange rate is the price or value at which one currency is exchanged for another. There are several different exchange rates such as the Cedi-Dollar exchange rate, Cedi-Pound Sterling exchange rate, Cedi-CFA franc exchange rate etc. There is also the real effective exchange rate in which the value of one currency is measured against a weighted basket of other currencies. It incorporates differences in inflation across countries, tariffs and transaction costs. For this study, we employ the Inter-bank Cedi-Dollar Exchange rate as our exchange rate variable.

4.5.5 Money Supply

Money supply is the quantity of money available in an economy at a particular period of time. There are different aggregates that are used to measure money supply in the Ghanaian context such as M1, M2, and M2+. M1 is the narrow definition which is made up of currency in circulation plus demand deposits. M2 is a broader definition which comprises of M1 plus time and savings deposits. M2+ is M2 plus foreign currency deposits. In this study we make use of M2+.

4.5.6 Interest Rate (91-day Treasury bill rate)

This is the interest rate on the 91-day Government of Ghana Treasury bills. This variable is used in this study to indicate the stance of monetary policy. As such shocks to the 91-day Treasury bill rate in the VAR model shall represent monetary policy shocks. This follows from Abradu-Otoo et al (2003) and Boamah (2009). Since 2002, with the inception of inflation targeting, the Monetary Policy Rate (or Prime rate) (MPR) has been the official policy variable of the Bank of Ghana. MPR is the rate at which the central bank lends to commercial banks. The central bank uses the MPR to signal its policy stance to banks, which then serves as a guide/base for all other market interest rates.

In this study, we will not resort to the MPR as the policy variable due to the following reasons: i) data is not available on MPR for the entire duration of our sample, so we need a variable that contains information on monetary policy conduct in Ghana and which is also available for the entire study period; ii) the central bank has consistently relied on Open Market Operations (sales and purchase of government securities) as an instrument of monetary policy in Ghana. It uses this instrument to control the size of currency and deposits by persuading private agents to hold fewer assets issued by banks. The central bank does this by manipulating the Treasury bills rate. These bills are alternatives to the assets of banks. OMOs are conducted at the initiative of the central

bank to influence the cost and availability of credit. As is observed in Ghana, the Treasury bill rate also indirectly serve as a benchmark on which lending rates are based. Because government bills are risk free, banks in lending to the public (who are riskier) do so at rates which are above the Treasury bill rate. Because data is available on the 91-day Treasury bill rate for our sample period, we rely on it as our measure of monetary policy since it fairly represent monetary policy actions of the central bank.

4.5.7 Price of Crude Oil

This variable is introduced into our model mainly to help resolve some anomalies that are usually present in VAR models. It can also be seen as a supply shock. We make use of Europe Brent Spot price FOB (Dollars per barrel) as our measure of price of crude oil.

4.6 A Priori Expectations

Concerning the expected responses of the variables included in our model following a positive monetary policy shock (i.e. an increase in the 91-day Treasury bill rate) as well as shocks to other specified variables, we expect the variables to respond as indicated in table 4.1 below. Prices are expected to decline after the shock. In the case of output, the direction of response hugely depends on the degree of short run non-neutrality of money. We however expect that output would fall after the policy shock. Because Ghana is an inflation targeting nation, we expect a stronger response on prices than on output since the main goal of inflation targeting is price stability. Private sector credit is also expected to respond negatively after monetary policy shocks. This is because a tight monetary policy would drain reserves from the banking system, thus squeezing the amount of loans/credit that will be available for lending by banks. Another way of putting this is that, a tight policy would lead to an increase in commercial banks' lending rates and thus crowd out the private sector.

A general rise in interest rates is expected after the shock. A positive shock to the 91-day Treasury bill rate should lead to an increase in the 91-day Treasury bill rate itself. For exchange rate, we anticipate that a tight policy would lead to an increase in the real interest rate, thus causing the domestic currency to gain value (appreciate). If however, a tight policy results in a decrease in the real exchange rate, then the domestic currency will lose value (depreciate). Thus the response of exchange rate hinges on the Fisher effect. Money supply (M2+) is expected to fall following a monetary shock. For price of crude oil, we expect it to either rise of fall.

In addition, we consider shocks in private sector credit, money supply, exchange rate and price of crude oil on output and prices. We expect that a rise in private sector credit will lead to an increase in both prices and output. Exchange rate innovations (an increase or depreciation) is expected to have adverse effects on prices, while increasing output. Money supply innovation is expected to increase both prices and output. A shock to the price of crude oil is considered as a supply shock and will thus lead to inflation and a decline in output.

Table 4.1: A prior expectations of variables response to specified shocks

Shock	**Response**						
	RGDP	**CPI**	**TBILL**	**PSC**	**M2+**	**EXR**	**POIL**
TBILL	Fall	Fall	Rise	Fall	Fall	Fall	Indeterminate
PSC	Rise	Rise	Rise	Rise	Rise	Rise	Indeterminate
M2+	Rise	Rise	Fall	Rise	Rise	Rise	Indeterminate
EXR	Rise	Rise	Rise	Rise/Fall	Rise/fall	Rise	Indeterminate
POIL	Fall	Rise	Rise	Rise/Fall	Rise/fall	Rise/fall	Rise

CHAPTER FIVE

DATA ANALYSIS AND DISCUSSION

5.1 Introduction

This chapter presents and discusses the results from the econometric technique of VAR to investigate the responses of Private Sector Credit, Prices and Output to monetary policy shocks in Ghana. It begins by presenting graphs to show trends of the variables as well as summary statistics. This is followed by followed by the results from the base VAR model impulse response analysis as well as the variance decomposition and Granger Causality tests. We then extend our VAR to include other variables in the model. The estimation is done using Eviews.

5.2 Graphical Analysis

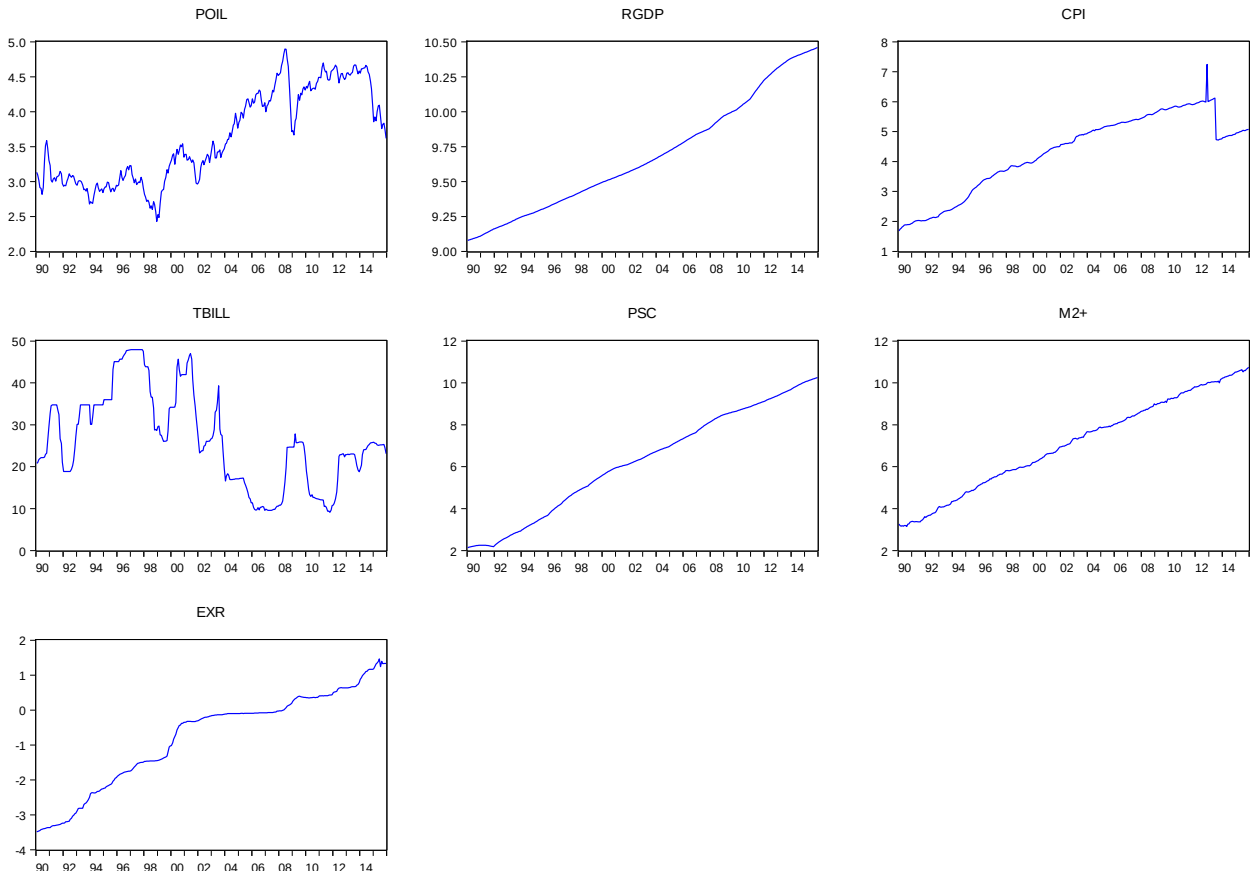
Figure 5.1 below outlines a graphical analysis of the variables in the model for the period 1990 to 2015. All variables except TBILL are in natural logarithms. From the graphs, it is quite obvious that all the variables display some trend terms. Over the sample period, real GDP, private sector credit, consumer price index, money supply and exchange rate have exhibited a consistent upward trend. Consumer price index however shows some inconsistent movements after September 2012. The steady upward movement of exchange rate reflects the fact that our currency has generally depreciated over the period, though there have been periods where the exchange rate has recorded some appreciations. Real GDP has also been growing steadily upwards after the adoption of the economic recovery programme in the early 1980s to deal with growth challenges during that period. The introduction of programmes such as HIPC, GPRS I and GPRS II and the production of oil have all helped to ensure steady growth. Price of crude oil is the most volatile of all the series, rising and falling from time to time. 91-day Treasury bill also exhibits upward and

downward movement from time to time, partly in response to the rate of inflation. Under inflation targeting, the central bank increases the policy rate to curtail rising inflation and lower the policy rate when inflation is falling.

5.3 Data Distribution

Table 5.1 below gives a summary statistics of the variables used in the model. From the Jarque-Bera statistics and probability values, they indicate that all the variables do not follow a normal distribution, since all the probability values are significant. This means that we reject the null hypothesis of normality in each case. The other statistics are indicated in the table.

Figure 5.1: Graph of Variables from 1990 to 2015



5.4 Results from Base VAR

The base VAR is made up of RGDP, CPI, TBILL and PSC. The VAR is identified using the following Cholesky ordering: RGDP, CPI, TBILL and PSC. Monetary policy shocks are identified as Cholesky one standard deviation shock to TBILL in the VAR. A positive one standard deviation shock in the TBILL correspond to a contractionary monetary policy shock. Thus TBILL or interest rate shocks both mean a contractionary monetary policy in this study. For the lag selection criteria, our four major information criteria all selected two lags as shown in table 5.2 below. We therefore run the VAR with two lags and used it to estimate our impulse response functions. The VAR stability tests as reported in Appendix 2 table 1 show that our base VAR is stable. Also, autocorrelation LM tests shown in appendix 3 table 1 indicates that our model is not suffering from serial correlation.

Table 5.1: Summary Statistics

	RGDP	PSC	POIL	M2+	EXR	CPI	TBILL
Mean	9.685541	6.261078	3.625355	7.089108	0.915485	4.305255	26.40432
Median	9.614172	6.402428	3.447273	7.324652	0.848800	4.676861	25.21000
Maximum	10.45838	10.25297	4.896944	10.74624	4.327400	7.245013	47.93000
Minimum	9.077709	2.134361	2.429218	3.148453	0.030600	1.678964	9.130000
Std. Dev.	0.405933	2.518293	0.665494	2.245253	0.915240	1.311342	11.25012
Skewness	0.384357	-0.159848	0.228997	-0.130470	1.508758	-0.494854	0.312684
Kurtosis	1.998016	1.764018	1.609945	1.820015	5.242476	2.061305	2.185679
Jarque-Bera	20.73363	21.18814	27.84615	18.98590	183.7433	24.18872	13.70467
Probability	0.000031	0.000025	0.000001	0.000075	0.000000	0.000006	0.001057
Observations	312	312	312	312	312	312	312

Source: Author's calculations

The results for the impulse response functions from the base VAR are shown in figure 5.2 below. The variables responses to shocks are shown over a period of sixty (60) months. A shock to the Treasury bill rate which indicates a shock to monetary policy initially does not cause any change in output for about 6 months but thereafter output began to fall gradually and became more pronounced and significant about a year after the shock, in line with theoretical prediction. It did not recover for the rest of the 60 months and stayed below baseline level. This is consistent with Christiano et al (1994) and Morsink and Bayoumi (2001) where output after a delay of about six months following a contractionary monetary policy shock, there was a sustained drop in output. In Abradu-Otoo et al (2002) and Allieu (2002), though output also fell following a contractionary monetary policy shock, output returned to its baseline level at some point (three and half years for Abradu-Otoo et al (2002) and four quarters for Allieu (2002)). It is instructive to note that in our study, interest rates stayed well above their pre-shocks level. This means that aggregate demand was dampened thus causing output to stay below baseline.

Private sector credit also responded negatively to monetary policy shocks. Though the response was not significant, it was immediate. This confirms the view that policy decisions taken by the monetary authorities affects money market rates within the period and thus affect the amount of credit available for lending to businesses and individuals. As the market rates go up when policy is tight, it affects the credit worthiness of firms since it impacts their net worth negatively, leaving businesses unable to borrow against their balance sheet. The tight policy also leads to decline in the supply of credit, as it drains bank reserves. This finding is consistent with theory as well as empirical studies such as Bernanke and Blinder (1992) and Morsink and Bayoumi (2001). It however contradicts both Allieu (2002) and Abradu-Otoo et al (2003) for Ghana. In their studies, they found that private sector credit initially rose following a contractionary monetary policy shock

(which is inconsistent with theory). Since the findings of this study follows theoretical predictions we, therefore uphold the results of this study and concludes that it helps in correcting the anomaly found in Allieu (2002) and Abradu-Otoo (2003). The fall in private sector credit following the monetary policy shock also helps account for the fall in output since credit plays a role in output growth.

Table 5.2: Lag Selection Criteria for base VAR

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1561.923	NA	0.401711	10.43949	10.48887	10.45925
1	2141.411	7283.223	8.47e-12	-14.14274	-13.89582	-14.04392
2	2629.552	946.9944	3.64e-13*	-17.29035*	-16.84589*	-17.11248*
3	2634.125	8.748559	3.93e-13	-17.21416	-16.57218	-16.95724
4	2644.704	19.95912	4.07e-13	-17.17802	-16.33850	-16.84205
5	2649.018	8.025394	4.41e-13	-17.10012	-16.06306	-16.68509
6	2656.202	13.17025	4.68e-13	-17.04135	-15.80675	-16.54726
7	2662.736	11.80473	4.98e-13	-16.97824	-15.54611	-16.40510
8	2693.314	54.42787*	4.53e-13	-17.07542	-15.44576	-16.42323
9	2698.787	9.597205	4.86e-13	-17.00525	-15.17805	-16.27400
10	2703.510	8.155177	5.25e-13	-16.93007	-14.90534	-16.11977
11	2708.197	7.967229	5.68e-13	-16.85465	-14.63238	-15.96529
12	2723.293	25.26046	5.73e-13	-16.84862	-14.42882	-15.88021

* 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

Following an interest rate shock, prices rose slightly for the first four months and began to trend down from the fifth month. It reached baseline level by the eighth month and reached its minimum in about two years after the shock. It then inches towards baseline level again and hits that by the 46^{th} month. It then began to rise with a much bigger magnitude than the initial rise for the rest of the forecast period. The initial rise in prices suggests that monetary tightening produces inflation.

This contradicts the expected outcome and is often termed as “price puzzle”. Sims (1992) argues that adding a variable that contains information about inflationary pressures than the ones used in the model may help to resolve or lessen the “price puzzle”. As such, commodity price indices are often used. We later extend our model to include such a variable and see if it helps resolve this puzzle. This result is however not unique to our study, especially for Ghana. Allieu (2002), Abradu-Otoo et al (2003) and Boamah (2009) also found similar results. In each of these three studies, prices rose for nine months, six months and fifteen months respectively before falling. Thus our study performs better since prices rose for four months before falling. The reason for the slight differences could be due to the scope of the data and the variables used in each study.

In Ghana however, this result is not quite unusual given the fact that the country has battled with high levels of inflation especially prior to inflation targeting. One could argue that there was lack of policy credibility (that is, as policy makers continuously failed to bring down inflation, economic agents lost confidence in the policy maker’s ability to ensure low prices) and as such tightening monetary policy did not yield the desired result of bringing down the level of prices. Since the adoption of inflation targeting there has been some improved performance in bringing down inflation and its variability though the inflation targets are missed most of the time. We shall explore the before and after inflation targeting regimes responses of the variables of our base VAR a little later.

As expected, a positive shock to the Treasury bill rate leads to an increase in the Treasury bill rate. It reaches a peak in the third month following the shock. It then falls towards the pre-shock level afterwards but did not hit that level in the 60 months forecast period. Generally, tightening monetary policy through increases in the monetary policy interest rate is expected to affect all other interest rates positively. Thus the policy interest rate of the Bank of Ghana serves as a

benchmark rate. This is observed in Ghana where whenever the central bank increases it policy rate, commercial banks always review their lending rates upwards. Sadly, commercial banks are unable to match the decrease in policy rate when the central bank reduces the policy rate downwards. This makes it difficult for the central bank to realize the intention of the policy reduction.

As noted in figure 5.2 below and the rest of the impulse response functions in appendix 4 figure 1, private sector credit response to policy shocks is negative (not significant). It responds positively to price shocks (significant) and negatively to output shocks (insignificant). A shock to private sector credit results in a fall in output, though not significant. This presents a puzzle since an increase in private sector credit should cause output to increase. Prices also responded positively and significantly to private sector credit shocks. This indicates that private sector credit could act as a channel through which monetary impulses affect prices in the economy. This can be investigated further by exogenizing private sector credit in the VAR. This means that we re-estimate our base VAR but with PSC as an exogenous variable. This method yields a VAR similar to the initial one except that it blocks off any responses within the VAR which passes through private sector credit. Though the re-estimated VAR shows similar impulse response functions to that of the original model, it now takes 17 months for prices to fall to their baseline level following a monetary policy shock. In the original model, it took 8 months for prices to fall to their pre-shock level. This shows that private sector credit is a vital channel for price changes.

To give an idea of the proportion of variability in a particular variable that is caused/explained by different shocks, we estimate the variance decomposition of each variable at the following forecast horizons: 1st month, 12th month, 24th month, 36th month, 48th month and 60th month. Due to limited space, we only display the above selected horizons instead of all the 60 months horizon. The results

are shown in table 5.3 below. The first column in each sub-table gives the forecast horizon while the second column gives the forecast error/standard error (S.E.). The rest of the columns gives the proportion of variance due to each shock (each row adds up to 100%).

Figure 5.2: Impulse Response Functions of Base VAR to Policy Shock

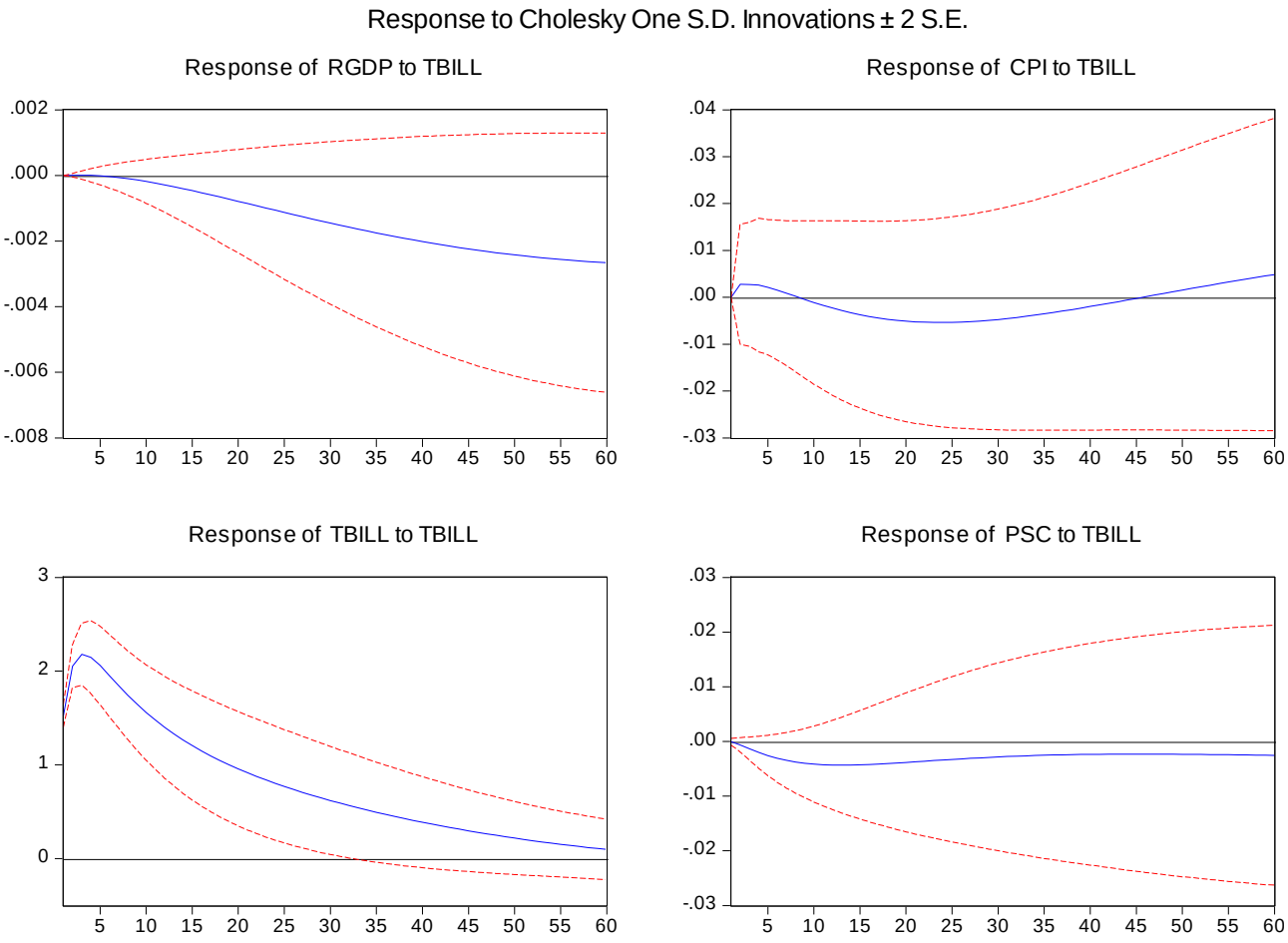


Table 5.3: Variance Decomposition of Base VAR model

a) Variance Decomposition of RGDP

Month	S.E.	RGDP	CPI	TBILL	PSC
1	0.000528	100.0000	0.000000	0.000000	0.000000
12	0.010055	96.87455	1.917889	0.200805	1.006757
24	0.021911	92.23003	3.847260	1.371093	2.551618
36	0.032651	88.34044	5.155003	3.121952	3.382602
48	0.041503	85.29443	6.214220	5.088831	3.402519
60	0.048374	82.72439	7.287703	7.058572	2.929332

b) Variance Decomposition of CPI

Month	S.E.	RGDP	CPI	TBILL	PSC
1	0.121054	0.115961	99.88404	0.000000	0.000000
12	0.249414	4.136607	90.78804	0.063040	5.012312
24	0.299562	3.489870	78.59835	0.327838	17.58394
36	0.347653	4.786558	63.91574	0.449254	30.84845
48	0.402850	8.764775	50.18718	0.353783	40.69426
60	0.460269	12.85324	39.90861	0.331892	46.90625

c) Variance Decomposition of TBILL

Month	S.E.	RGDP	CPI	TBILL	PSC
1	1.524813	5.26E-06	0.045950	99.95404	0.000000
12	6.660014	0.107343	0.025728	89.48935	10.37758
24	7.928916	0.181567	0.131186	84.33133	15.35592
36	8.276393	0.427989	0.298261	84.10688	15.16687
48	8.429426	1.633977	0.352304	83.14319	14.87053
60	8.593702	3.535229	0.343708	80.44678	15.67428

d) Variance Decomposition of PSC

Month	S.E.	RGDP	CPI	TBILL	PSC
1	0.005573	0.251476	0.094829	0.014944	99.63875
12	0.086948	1.759087	2.353123	1.567496	94.32029
24	0.159447	1.859899	6.876752	1.205333	90.05802
36	0.214039	1.350895	10.72006	0.880552	87.04849
48	0.258371	0.959161	13.55256	0.703985	84.78430
60	0.296530	0.728761	15.56714	0.615172	83.08893

The results as reported in table 5.3 above shows that after a year, variations in real GDP is explained by almost 97% of its own shocks, while the rest is borne by prices, interest rate and private sector credit. In three years, private sector credit shocks account for about 3.4% of the fluctuations in real GDP, while Treasury bill shocks, price shocks and own shocks account for 3.1%, 5.2% and 85.3% of output variations respectively. In the fifth year, own shocks account for 82.7% of the changes in output, while prices and interest rate contributed 7.2% and 7.1% respectively in explaining output variations. The fact that interest rate (policy variable) accounts for 7.1% of the variation in output by the fifth year means that monetary policy has a significant impact on output in the medium to long term.

Private sector credit explained 2.9% of output movements in the fifth year, which is a reduction since it explained 3.4% of output variations in the fourth year. It is quite obvious that private sector credit does not contribute much to output variations. This may be attributed to government's increased borrowing in the domestic financial markets which crowds out the private sector. A piece of evidence to this effect is by looking at total investments on banks' balance sheet. Here

investment in treasury bills as a share of total investment increased from 70.2% in December 2014 to 79.2% in December 2015, while investment in shares and other equities made up the rest of the proportions (Bank of Ghana Financial Stability Report, January 2016). Banks in most cases prefer to lend to government than to the riskier private sector. This is because the private sector contributes a greater share of the deposit money banks' non-performing loans. For instance in December 2015, private sector contributed 96% (which is even down from the 97.7% recorded in December 2014) of the total banking sector non-performing loans as compared to 4% by the public sector (Bank of Ghana Financial stability report, January 2016). These developments thus hinder the banks from lending to the private sector though funds may be available. When this happens, the private sector is starved of the needed funds to carry out their investments. This therefore impacts on output growth negatively.

Variability in prices is explained at the end of the first year by shocks to real GDP (4.1%), shocks to PSC (5%) and own shocks (90.8%). TBILL shocks accounted for less than 1% of the variability in prices for all the forecast horizons. In the fifth year, PSC and RGDP explained almost 60% of the fluctuations in prices. This result is not surprising since a strong output growth leads to the abundance of goods and services and thus result in prices falling or rising if there is inadequate output. A rise in credit produces inflationary pressures since credit becomes available to businesses to spend on their investment projects. This result also indicate that monetary authorities should also have their eyes on private sector credit in their bit to control inflation, since it explains about 47% of the variations in prices by end of the fifth year.

The fact the Treasury bill rate explains less than 1% of the variation in prices is surprising because as is the practice in inflation targeting central banks, they raise interest rates in order to counter inflation. We therefore expected interest rate shocks to significantly explain price movements.

However in Ghana, increasing interest rates does not always lead to decline in inflation. One can argue that increase in the policy interest rate (which is a contractionary monetary policy) and translate to a general hike in lending rates is seen as increased cost by producers and can shrink output. If the output supplied is below the demand for it, it might lead to increase in prices and may not lead to the desired effect of the policy. Thus our study found that interest rates do not act as conduit through which monetary policy affect prices in Ghana since it does not contribute much in explaining changes in prices.

Movements in Treasury bill rate are mainly explained by own shocks and private sector credit. In the same vain, changes in private sector credit comes through its own shocks and shocks to prices, with Treasury bill rate and real GDP contributing less than 2% in all forecast horizons. Since Treasury bill rate represent monetary policy shocks, it means that monetary shocks contributes little in explaining the changes in private sector credit. This suggests that though commercial banks take the policy rate into account when setting their lending rates, other crucial factors such as credit worthiness and risk level of borrowers are considered in arriving at these lending rates which are applied to private sector borrowing.

Variance decomposition like impulse response functions are affected by the way in which variables are ordered in the model. But reordering of over base VAR, with the policy variable coming first before the non-policy variables does not significantly changed our results. Due to that results for the alternative ordering are not showed here.

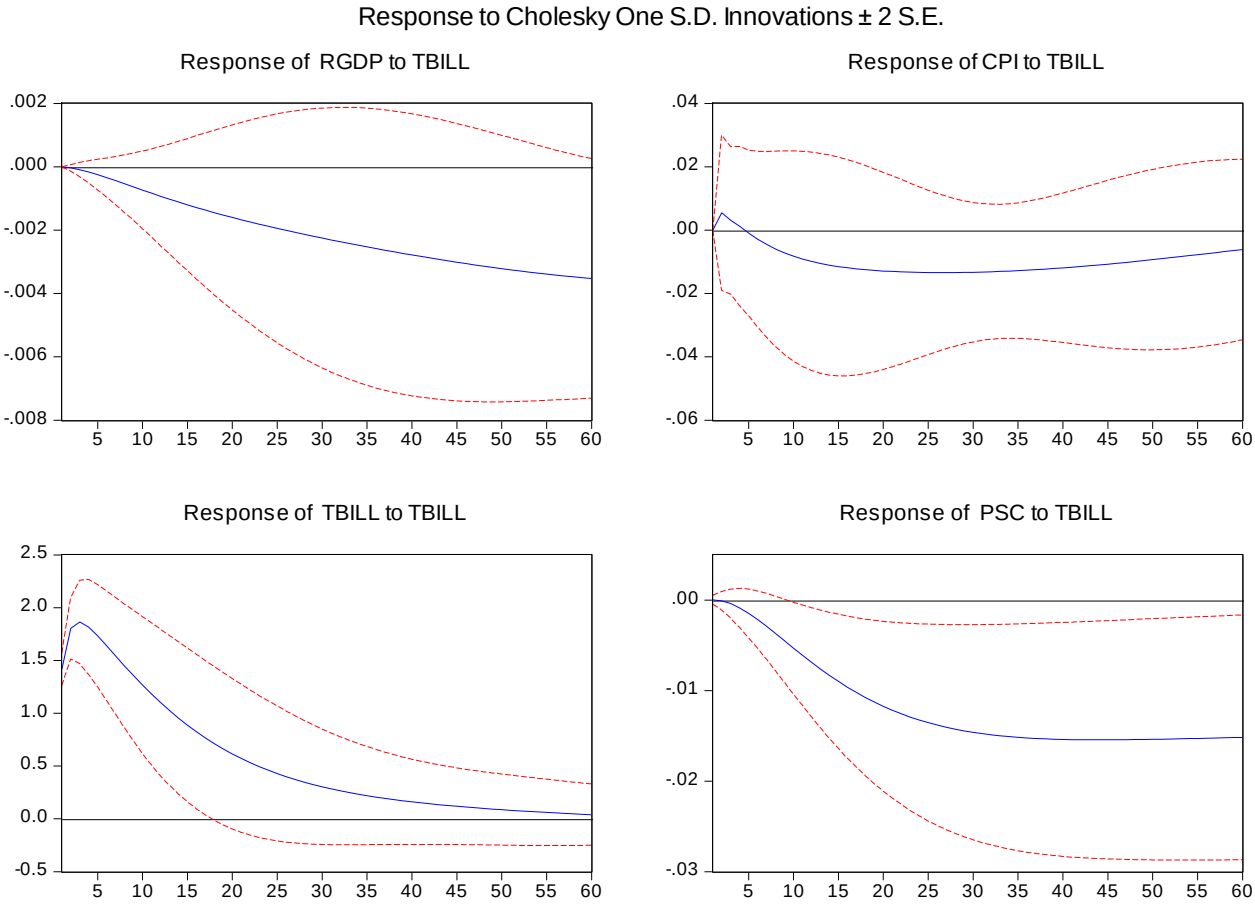
In order to assess whether the responses of private sector credit, prices and output differ before and after inflation targeting, we estimate our base VAR from 1990 month one to 2001 month twelve which represent the pre-inflation targeting era and also from 2002 month one to 2015 to

capture the post-inflation targeting period. We then proceed to use the two models to perform impulse response analysis and variance decomposition to see if there has been significant differences in the response of these variables in the two regimes. The lag selection criterion selected a lag length of 2 for both subsamples. We therefore run our VARs using a lag of 2. The impulse response functions for the pre-inflation targeting period are displayed in appendix 4 figure 2. For the inflation targeting era, we only display the response of the variables to TBILL shocks in figure 5.3 below. For variance decomposition, the results are displayed in appendix 5 table 1 and table 2 for pre-inflation targeting and inflation targeting eras respectively. We use the inflation targeting era as our reference point to explain the results.

From the response functions below, it shows that RGDP declined significantly following a monetary policy shock as expected and it stayed below the baseline for all the 60-month forecast horizon. In the pre-inflation targeting sample, output responded positively to interest rate shocks. This is inconsistent with theoretical predictions. But it can be argued that in the pre-inflation targeting era, if government (public sector) had a greater share in determining output, this result would not be surprising. This is because government could deliberately cause interest rates on its instruments to increase so as to crowd out the private sector so that it could meet it public sector borrowing requirements in order to undertake developmental projects. When this happens output would increase instead of falling following a contractionary monetary policy shock.

In the inflation targeting era, prices rose slightly for about two months and then declined. It took 5 months before prices fell to their pre-shock level. After the fifth month, prices stayed below the baseline level (though it can be seen gradually rising towards it) for the rest of the forecast horizon. In the pre-inflation targeting era, prices increased significantly following a monetary policy shock.

Figure 5.3: Impulse Response functions of variables of base VAR from 2002 to 2015



This shows that prices respond better to monetary policy shocks in the inflation targeting era than in the pre-inflation targeting era. In the pre-inflation targeting era, Ghana was grappling with high rates of inflation due possibly to the inability of the monetary aggregate targeting framework to help curb inflation. According to Kwakye (2012), this was due to the weakening link between monetary aggregates and inflation. This probably explains why prices rose in the pre-inflation targeting period following a tight policy. Private sector credit did not respond to monetary shocks for the first two months but soon afterwards, it began to fall more sharply and stayed below baseline for the entire forecast horizon in the inflation targeting era. In the pre-inflation targeting subsample, private sector credit did not also respond to monetary shocks in the first two months. It declined to its minimum in about 11 months and thereafter rose and reached baseline level in

about two years and stayed positive for the rest of the forecast horizon. The response of Treasury bill rate to own shocks is the same in both pre-inflation targeting period and the post inflation targeting period. It rose as expected in the first three months but declines significantly towards pre-shock level and almost hits baseline level around the sixtieth month.

In terms of variance decomposition for the inflation targeting period, the results showed that in the first month own shocks account for all the fluctuations in output. By 12 months, own shocks explain 93.1% of the changes in output, while shocks to prices, interest rate and private sector credit account for 2.4%, 2.1% and 2.4% of output movements respectively. In the 5^{th} year, output shocks explain 70% of the variations in output while prices, interest rate and private sector shocks account for the rest, with interest rate shocks being the highest, explaining 20% of output changes. In the pre-inflation targeting era, own shocks accounted for 46.8% of output changes while prices (25.8%), interest rate (26.2%) and PSC (1.1%) explained output movements in the 5^{th} year.

Movements in prices are explained by the end of the first year in the inflation targeting era by own shocks (94.5%), output shocks (4.6%), interest rate and private sector credit shocks (0.46% each). In the third year, own shocks account for 79% of price variability. Output shocks (11.8%), interest rate shocks (3.8%) and PSC shocks (5.4%) explain the rest of the price changes. In the pre-inflation targeting sample, own shocks (83.4%), output shocks (3.2%), interest rate shocks (9.6%) and PSC shocks (3.8%) explained fluctuations in prices at the end of the first year. In 36 months, own shocks (67.1%), output shocks (4.8%), interest rate shocks (23.9%) and PSC shocks (4.1%) accounted for price changes. Swings in private sector credit at the end of 12 months in the inflation targeting era is attributed to own shocks (89.6%), output shocks (1.3%), interest rate shocks (8.7%) and price shocks (0.4%). In the third year, own shocks contributed 54.8% in explaining itself. Interest rate shocks accounted for about 44% of changes in private sector credit, while output and price shocks

both marginally contributed a total of 1.2%. In the 1990 to 2001 subsample, variations in private sector credit was explained at the end of the first year by 70.1% of its own shocks. Output and interest rate shocks explained 10.3% of the oscillations in private sector credit, while price shocks accounted for 19.6%. In the third year, output and interest rate shocks accounted for 12.8% of the fluctuations in PSC, while Price shocks (44.3%) and own shocks (42.9%) made up the rest. From the analysis above, it means that fluctuations in private sector credit was mainly explained by own shocks and interest rate shocks in the 2002-2015 subsample model. Finally, in the 1990-2001 subsample, changes in private sector credit was accounted for significantly by price shocks and own shocks.

Overall, these results show that private sector credit, prices and output responded differently in the pre-inflation targeting era and post-inflation targeting era. In the inflation targeting period, output, prices and private sector credit responded to monetary policy shocks by falling, which is consistent with theoretical predictions. The response of output and private sector credit were significant, while that of prices was insignificant. Despite the insignificance of prices' response, one can conclude that monetary policy has been fairly effective in the inflation targeting era when compared to the pre-inflation targeting era. In the inflation targeting era, prices and output responded positively to a contractionary policy shock, which is not in line with theory, thus implying that monetary policy was ineffective in affecting these variables.

5.5 Results and Analysis from Extended Models

In this section, we extend our base VAR to include broad money supply, exchange rate and price of crude oil. This is to assess how each of this variables impacts on the variables in our base VAR

and also to examine their role in transmitting monetary impulses to the real economy. Here our analysis only looks at results for the full sample (i.e. 1990 to 2015).

5.5.1 Base VAR Extended for Money Supply

When the base VAR is extended for money supply (M2+), the following Cholesky ordering is used: (RGDP, CPI, TBILL, PSC, M2+). Once again, alternative ordering such as bringing M2+ before PSC or bringing TBILL last did not affect our impulse response functions. The four major lag selection criteria once again selected a lag length of 2. The results are shown in appendix 1 table 1. Also, our VAR stability test shows that the VAR with two lags is stable as none of its roots lie outside the unit circle. The result for this is shown in appendix 2 table 2. The VAR with two lags does not suffer from serial correlation as shown in the VAR Residual Serial Correlation LM test in table 5.4 below, which failed to reject the null hypothesis of no serial correlation up the 3rd lag.

Table 5.4: Residual Serial correlation Test for VAR Extended for Money Supply

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h

Lags	LM-Stat	Prob
1	21.67337	0.6545
2	28.94450	0.2662
3	34.40874	0.0995

Probs from chi-square with 25 df.

Having satisfied these requirements, we proceeded to estimate our impulse response functions. From the impulse response functions estimated, it shows that a contractionary monetary policy

shock in the form of a one standard deviation increase in Treasury bill rate resulted in a very slight decline in money supply for two months. Thereafter, the response became positive though insignificant for the rest of the sixty month forecast horizon. The result for the initial drop is consistent with theory. Boamah (2009) and Morsink and Bayoumi (2001) also found similar result. However, Allieu (2002) and Abradu-Otoo et al (2003) found that money supply increased following a contractionary monetary policy shock.

The response of output and prices to interest rate shocks is similar to the ones in the base VAR. For private sector credit, its response differs from the base VAR result. Though it also falls following the shock, in this instance, the response becomes positive after 33 months, unlike in the base VAR where it stayed below baseline for the entire sixty months forecast horizon. The fact that output and money supply fell (though insignificant in the case of money supply) fits the monetarists' view that interest rate shocks represent monetary policy shocks and that monetary contraction leads to declines in output and money supply.

As shown in appendix 4 figure 3, a positive one standard deviation shock to money supply increases both output and prices. Private sector credit also responded positively and significantly to money supply shocks. Interest rate however declines below pre-shock levels and reach a minimum in three months before rising gradually, becoming positive after nine months and fell below baseline again after 45 months. The initial movement of these variables in response to money supply shocks are all consistent with theoretical predictions.

To examine the role of money supply in explaining variations in each of the variables of the model, we estimate the variance decomposition. The variance decomposition results for output, prices, private sector credit and money supply are shown in table 5.5 below.

The results show that in the first year, own shocks account for about 96% of the variations in output, while the rest is accounted for by Private sector credit, prices, interest rate and money supply shocks. In the third year, own shocks explain 84.1% of output variations, while private sector credit shocks (9%), price shocks (2.6%), interest rate shocks (3%) and money supply shocks (1.3%) borne the rest of output's changes.

Table 5.5: Selected Variance Decomposition of Base VAR Extended for Money Supply

a) Variance Decomposition of RGDP

Month	S.E.	RGDP	CPI	TBILL	PSC	M2+
1	0.000529	100.0000	0.000000	0.000000	0.000000	0.000000
12	0.010103	96.03599	1.180472	0.198462	2.109318	0.475757
24	0.021947	89.59032	2.107879	1.344878	6.045353	0.911569
36	0.032541	84.08900	2.595566	2.941272	9.042445	1.331716
48	0.041100	79.95032	2.868967	4.624894	10.68315	1.872662
60	0.047559	76.66515	3.048426	6.219857	11.37014	2.696434

b) Variance Decomposition of Prices (CPI)

Month	S.E.	RGDP	CPI	TBILL	PSC	M2+
1	0.119475	0.069297	99.93070	0.000000	0.000000	0.000000
12	0.222741	3.871715	85.96194	0.201369	0.393512	9.571461
24	0.262263	4.594249	65.99755	0.186099	0.632271	28.58983
36	0.310320	14.50961	47.22735	0.189322	0.796952	37.27677
48	0.368844	26.23372	33.57384	0.624710	2.170144	37.39759
60	0.427116	34.07753	25.28879	1.527112	3.813881	35.29268

c) Variance Decomposition of Private Sector Credit

Month	S.E.	RGDP	CPI	TBILL	PSC	M2+
1	0.005339	0.562126	9.51E-05	0.019957	99.41782	0.000000
12	0.074302	3.445762	0.018010	1.232118	77.59567	17.70844
24	0.128654	7.378885	0.073103	0.952532	51.82256	39.77292
36	0.171679	10.05847	0.069470	0.561962	34.29525	55.01485
48	0.208611	11.48949	0.050417	0.546771	24.64578	63.26754
60	0.240176	12.10271	0.038096	0.765076	19.23325	67.86086

d) Variance Decomposition of Money Supply

Month	S.E.	RGDP	CPI	TBILL	PSC	M2+
1	0.031362	0.011125	0.444636	0.003079	1.738457	97.80270
12	0.102899	0.354683	0.779473	0.022239	2.045130	96.79847
24	0.140330	1.167110	0.558968	0.094449	1.358719	96.82075
36	0.167930	1.947990	0.433723	0.199658	0.966208	96.45242
48	0.190967	2.490429	0.359084	0.321084	0.817747	96.01166
60	0.210963	2.774623	0.312985	0.440197	0.742717	95.72948

In the fifth year, output shocks explain 76% of movements in output. Private sector credit shocks being the highest among the rest of the shocks account for 11.4% of the volatility in output, while interest rate shocks account for about 6.2% of changes in output. Money supply does not significantly affect output in both short and long run, indicating money is neutral both in the short and long run.

Volatility in prices is explained at the end of the first year by own shocks (86%), output shocks (4%), money supply shocks (9.6%) and the rest is explained by interest rate and private sector credit shocks. By end of the fourth year, own shocks accounted for 33.6% of price movements.

Output shocks accounted for 26.2% while money supply shocks led the proportion with 37.4%. In the fifth year, output shocks accounted for 34.1% while money supply shocks explained 35.3% of the fluctuations in prices. This result confirms the monetarist view that inflation is a monetary phenomenon since it explains a greater proportion of price variations. When we combined output and money supply shocks in the fifth year, the two shocks accounted for almost 70% of the variations in prices. This means that for policy makers to have a grip on inflation in Ghana, they should have their eyes on both output and money supply. As shown in the results above, the current situation where policy makers target interest rate does not seem to work in Ghana since interest rate does not contribute much in explaining prices in Ghana.

The results also show that when we control for money supply, the significant proportion of price changes that was explained by private sector credit drastically diminished, with money supply explaining a significant proportion of price movements. This can be attributed to the fact that private sector credit feeds into money supply. Basically, private sector credit are loans to private businesses by commercial banks and since the creation of loans affect the money supply, one can argue that money supply captures these loans. Thus, this explains why when we control for money supply, the proportion of private sector credit that previously explained prices diminished and is taken up by money supply.

The rest of the tables above show that variations in private sector credit is mainly explained by own shocks and shocks to money supply. By the fifth year, money supply shocks explain about 68% of the variations in private sector credit, while own shocks and output shocks account for 19% and 12% respectively. Own shocks also accounts for a greater proportion of the variation in money supply. By the end of the fifth year, money supply shocks alone explains almost 96% of the variations in money supply, with the rest of the shocks contributing less than 3% each.

5.5.2 Base VAR Extended for Exchange Rate

When the base VAR is extended for exchange rate, the following Cholesky ordering is used: (RGDP, CPI, TBILL, PSC, and EXR). This ordering is based on the assumption that all the other variables affect exchange rate. The lag selection criteria again selected a lag length of two. This is shown in appendix 1 table 2. The VAR stability test as shown in appendix 2 table 3 also shows that our VAR of two lags is stable. The model does not also suffer from autocorrelation as reported in appendix 3 table 2. The impulse response functions of this model following monetary policy shocks is reported in appendix 4 figure 4.

The responses of RGDP, CPI, TBILL and PSC are once more similar to those of the base VAR model. An interest rate shock was however followed by a rise in nominal exchange rate for about 5 months and thereafter it remained fairly constant and stayed above baseline for the entire sixty months horizons. This result is consistent with Allieu (2002) and Abradu-Otoo et al (2003) for Ghana but however contradicts Vinayagathasan (2013) for Sri Lanka. This means that tightening of monetary policy leads to depreciation of nominal exchange rate. The general expectation is that tightening monetary policy will lead to an increase in real interest rate, making domestic assets attractive relative to foreign assets. Thus, capital will flow into the domestic economy, all things being equal, in search of higher returns and as a result the local currency appreciates in value. However, if real interest rate falls following a tight monetary policy, then the local currency will lose value (depreciate). The result here therefore suggests the latter case where the currency loses value following monetary tightening. This can also be seen as an exchange rate "puzzle" since it does not follow the general expectation. It is however not surprising in a country like Ghana where inflation has been a problem. Through the Fisher Effect, real interest rate depends on expected

inflation. Therefore high inflation can lead to declines in real interest rates and give us the above result.

One can also argue that though the higher domestic interest rates are expected to lead to the inflow of capital, if as a country there are barriers such as capital controls when foreign investors want to repatriate their capital, it may deter investors and as a result the needed capital inflow to cause our currency to appreciate will not be realized. Also, since Ghana is a net importer of goods and services, it means we will always require foreign exchange to import goods and services that we need. This can cause our currency to depreciate in value despite a tighter monetary policy.

The results also show that a positive shock to exchange rate results in a rise in prices (in figure 5.4 below). This is expected since a depreciation of the local currency makes imports expensive. Movements in exchange rate feeds into people's expectation and price setting which affects future price movements. Depreciation of the local currency may even affect prices immediately even before the needed adjustments work their way through the cost structure. Output responded negatively to exchange rate innovations. The monetary authorities react to the inflationary expectations by increasing short term interest rates. This dampens aggregate demand and thus cause output to fall. The interest rates then fall back sluggishly towards baseline but it took well over 4 years to reach baseline level. Consequently, aggregate demand was not boosted enough due to this slow falling of interest rates. Thus output failed to recover for the entire forecast horizon and stayed below baseline. A depreciation is expected to boost exports while reducing imports and thus improving net exports and increasing aggregate demand and eventually raising output.

The variance decomposition of the model extended to include exchange rate is reported in appendix 5 table 3. It shows that by the fifth year, own shocks account for about 69% of the

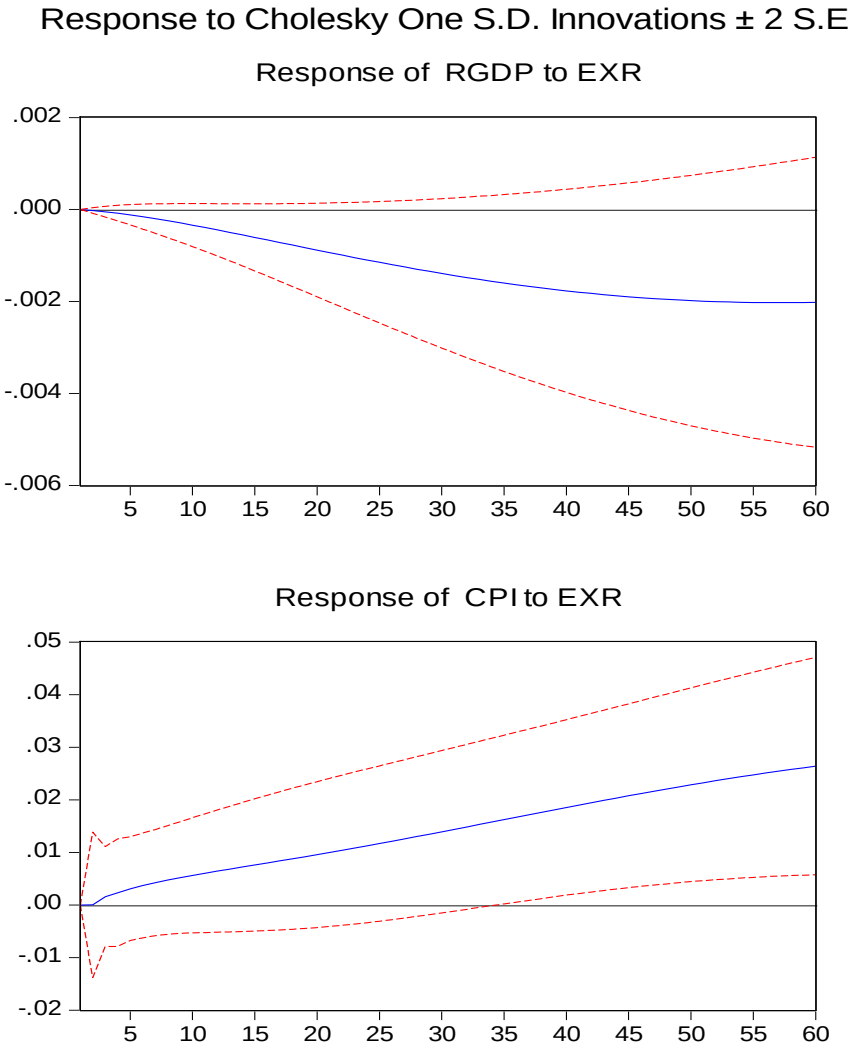
variation in output, while exchange rate shocks accounts for about 5.5% of output volatility. Price shocks (18%), interest rate shocks (6.8%) and private sector credit shocks (0.6%) made up the rest of the changes in output in the fifth year. The table also shows that own shocks explains about 43% of the movements in prices in the fifth year while exchange rate shocks made up a share of about 10%. As it was observed in the base VAR, private sector credit accounts for the highest share of volatility in prices, accounting for about 36% in this model by the fifth year. Own shocks accounts for about 49% of exchange rate fluctuations by the fifth year. Private sector credit comes second with 28% followed by interest rate (12%), prices (10%) and output (1%) in that order.

5.5.3 Base VAR Extended for Price of Crude Oil

When the base VAR is extended to include price of crude oil, the Cholesky ordering used is: (POIL, RGDP, CPI, TBILL and PSC). The lag selection criteria chose a lag of 2 whiles residual tests showed that our VAR is stable (appendix 2 table 4) and not suffering from serial correlation (appendix 3 table 3). The essence of including price of crude oil in our VAR is to see if it helps to resolve the price puzzle that we encountered earlier and also to see how it affects the response of the other variables.

The impulse response functions reported in appendix 4 figure 5 shows that output and prices responded to interest rate shocks in a similar fashion like they did in the base VAR. This suggests that adding price of crude oil does not help resolve our price puzzle. This result is similar to that of Morsink and Bayoumi (2001) for Japan. This may mean that price of crude oil does not contain the information necessary to resolve the puzzle. The response of private sector slightly differs from the base VAR result as it rises marginally above baseline after 38 months. In the base VAR, it stayed below baseline for the entire forecast horizon.

Figure 5.4: Impulse Response of RGDP and CPI to Exchange Rate Innovation



A positive shock to crude oil prices which is expected to have a negative impact on output rather sees output staying above baseline level for the entire forecast horizon. Prices were also expected to rise following oil price shock but here though they rose slightly, they were still below their levels before the shock for the 60 months forecast horizon. This could be possible since in the past, the monetary authorities in Ghana did not at times allow price of crude oil to have their full impact on the economy through subsidies. That said, it is still not clear from this model where the sources of these unusual responses are coming from and it is beyond the scope of this study.

Results from the variance decomposition of this model (not reported here) shows that fluctuations in output is mainly due to own shocks (74.4%), while price shocks (10.2%), price of crude oil shocks (9.1%), policy interest rate shocks (4.4%) and private sector credit shocks (1.9%) make up the rest of the share by in the third year. By the fifth year the proportion of own shocks decline to 64.2%, whilst prices and interest rate shocks shares increased to 14.5% and 11.8% respectively. Volatility in prices at the end of the third year was due to own shocks (63.4%). Private sector credit was the second largest contributor to price changes with a share of 29.7%. In the fifth year, private sector credit became the major contributor to price movement with a proportion of 45.3% followed by own shocks (39%). Output shocks made up 8.3% while price of crude oil shocks accounted for 6.8%.

When we treat price of crude as an exogenous variable it leads to slightly different results (Results not reported here). Output hardly responded to monetary policy shocks (generally flat). Prices rose slightly for 2 months before falling. It reached baseline level in seven months and stayed below baseline for the rest of the forecast horizon. The response of private sector credit and interest rate were similar to that of the base VAR. Since Ghana is a small country and has no significant impact if affecting crude oil prices, this result may reflect the true situation of Ghana.

5.6 Granger Causality/Block Exogeneity Wald Tests

In this section, our goal is to find out if past values of a particular variable or set of variables helps to predict current values of another variable. We do this by starting with the base VAR then followed by the extended models.

5.6.1 Granger Causality/Block Exogeneity Wald Tests for Base VAR

The result reported in table 5.6 below shows that both output and private sector credit Granger cause prices thus confirming the earlier result from the variance decomposition for the base VAR. This suggest that policy makers should put their eyes on output and private sector credit movements in their bit to control prices. Private sector credit was also observed to Granger cause interest rate. It is also observed that output and prices, the ultimate targets of monetary policy do not Granger cause the policy variable. This result suggests that policy makers do not take past values of output and prices into account when setting the policy rate. However, a look at the operating procedures of the central bank clearly shows that policy makers take into account past values of output and prices when setting policy rate. The reason for our result could be that the exact pass-through effects have not been adequately captured in the modelling of our VAR. This finding contradicts Allieu (2002) who found that output and prices granger caused the policy variable. Interest rate is found not to Granger cause prices. This also confirms the results from the impulse response functions in which prices initially responded positively and insignificantly to policy shocks. This means policy interest rate is not effective in controlling prices in Ghana in our model.

5.6.2 Granger Causality Test for 1990-2001 and 2002 to 2015 Sub-samples for Base VAR

As shown in appendix 6 table 1 and 2, output and interest rate are found only to Granger cause prices at 10% level of significance but not at 5% level of significance for the 1990 to 2001 sub-sample. Private sector credit did not Granger cause prices. Output was found to cause private sector credit at 5% level of significance, while prices cause private sector credit at 10% level of significance. For 2002 to 2015 sub-sample, both output and private sector credit Granger cause

prices at the 10% level of significance. Interest rate is also found to cause private sector credit at the 5% significance level.

5.6.3 Granger Causality Test for Base VAR Extended for Money Supply

When we control for money supply, the test as reported in appendix 6 table 3 shows that there is a unidirectional causality running from output and money supply to prices. This confirms the results from the impulse response functions and variance decomposition. When we control for money supply in our base VAR, it is observed that private sector credit fail to Granger cause prices. This is not surprising since inflation, according to monetarists is a monetary phenomenon. Thus controlling for money supply makes private sector credit lose its dominant role in forecasting prices in our model. It is also interesting to note that money supply Granger causes private sector credit, which shows that moneys supply is a major predictor of private sector credit. There is also a causality from private sector credit to interest rate, showing that even in controlling for money supply, private sector credit still has a hand in determining interest rates in Ghana.

5.6.4 Granger Causality Test for Base VAR Extended for Exchange Rate

The result for this test is shown in table 5.7 below. The test shows that exchange rate does not Granger cause prices and output in our model. This is a bit surprising since Ghana is a net importer and thus movements in exchange rate is expected to have an impact on import prices and thus affect the general level of prices. This could be due to the fact that the exchange rate in Ghana is not allowed to float freely, as the monetary authorities frequently intervene when the currency becomes volatile. Thus one can argue that the underlining exchange rate does not truly reflect the economic fundamentals and as a result it does not have the expected impact on prices and output. Private sector credit is found not to cause prices at 5% significance level but does so at 10% level

of significance. Prices, interest rate and private sector credit were all found to Granger cause exchange rate. In the case of prices, this is not a surprising result since according to the purchasing power parity theory, the nominal exchange rate is the ratio of the relative prices of two countries. A rise/fall in domestic interest rates is expected to also affect capital movement in/out of the country and thus affects exchange rate. Private sector enterprises import some of their raw materials for their production activities and thus it is not surprising that credit extended to private sector cause nominal exchange rate. As they demand more foreign currency in order to import, the value of the domestic currency falls.

5.6.5 Granger Causality Test for Base VAR Extended for Price of Crude Oil

The results (appendix 6 table 4) show that price of crude oil Granger causes output at 10% level of significance but fails to cause prices. This is a somewhat surprising result since fluctuations in international crude oil prices tend to affect domestic prices. But as explained earlier, this could be due to the fact that government from time to time put subsidies on petroleum products thus limiting their ability to exert their full impact on local prices. As usual output and private sector credit cause prices.

Table 5.6: Granger Causality Test for Base VAR

Note: The values in the tables are the P-Values for the Wald Chi-square test

Dependent Variables	**Explanatory Variables**			
	RGDP	CPI	TBILL	PSC
RGDP	_	0.1768	0.2900	0.4441
CPI	0.0005	_	0.8814	0.0005
TBILL	0.8194	0.7008	_	0.0150
PSC	0.2396	0.1204	0.2182	_

Table 5.7: Granger Causality Test for Base VAR Extended for Exchange Rate

Dependent Variables	Explanatory Variables				
	RGDP	CPI	TBILL	PSC	EXR
RGDP	_	0.1420	0.8099	0.5904	0.2515
CPI	0.0024	_	0.8024	0.0797	0.3707
TBILL	0.7964	0.8057	_	0.0285	0.1876
PSC	0.1326	0.1324	0.1329	_	0.3420
EXR	0.1790	0.0080	0.0442	0.0046	_

CHAPTER SIX

CONCLUSION AND POLICY RECCOMENDATIONS

6.1 Summary and Conclusion

The study sought to investigate the responses of private sector credit, output and prices to monetary policy shocks in Ghana for the period 1990 to 2015. Using monthly data, the study adopted the technique of Vector Autoregression (VAR) to examine the responses of these variables to monetary policy shocks. We began the study by introducing the subject of the study and its objectives in chapter one. In chapter two, we examined both theoretical and empirical literature on the subject of our study. Chapter three presented an overview of the private sector, prices and output in Ghana. It also looked at the monetary policy measures that has been in place since the establishment of the central bank. In chapter four, we introduced the estimation technique and identification of monetary policy shocks and related issues. Chapter five presented and discussed the empirical results from the study.

We began our analysis in chapter five by estimating a base VAR comprising of real output, prices, 91-day Treasury bill rate and private sector credit. Using impulse response functions over a forecast horizon of 60 months, the results showed that private sector credit and output responded negatively to monetary policy shocks. The response of output became significant a year after the shock whereas the response of private sector credit was insignificant. This means that tightening monetary policy resulted in a fall in output and private sector credit, which is in line with theory. The result however showed that prices rose for about four months and thereafter trended down and stayed below baseline level and rose again by the 46^{th} month in response to monetary policy shocks. The general response of prices was also not significant. Prices are expected to fall

following tightening of policy. The initial rise is what is termed in literature as “price puzzle”. This result may be due to price stickiness in the short run, such that policy shocks do not influence prices immediately. Overall our study found that monetary policy is quite effective in affecting prices and output (ultimate goals of monetary policy) since output responded significantly to monetary policy shocks, and prices also took a shorter time to fall compared to Allieu (2002), Abradu-Otoo et al (2003) and Boamah (2009) for Ghana, where prices took a longer time horizon before they fell.

The results from variance decomposition and Granger Causality tests shows that private sector and output are major forecasters of prices, both making up almost 60% of the variations in prices by the fifth year. Private sector credit was however found not to significantly predict output. The fact that private sector credit is a major predictor of prices means it is an important source for transmitting monetary policy impulses to prices.

To examine if there has been any difference in the responses of private sector credit, output and prices before and after inflation targeting, we estimated our base VAR using two sub-samples, 1990-2001 (pre-inflation targeting) and 2002 to 2015 (post-inflation targeting). The results show that in the pre-inflation targeting period, output responded positively to interest rate shocks. This is contrary to what we expected. It was also found that shocks to prices and interest rate accounted for over 50% of the fluctuations in output by the 60^{th} month. Private sector credit responded negatively initially, rose and stayed above baseline in a little over two years. The price puzzle is seen to be more pronounced in this period as prices stayed well above baseline for the entire forecast horizon. In this period, interest rate is also seen to significantly affect prices as it explained about 30% of volatility in prices by the 60^{th} month.

In inflation targeting era, output and private sector credit fell in response to monetary policy shocks as expected and it was significant. Interest rate and price shocks explained about 27% of output changes in this instance. Prices rose slightly for two months before falling below their pre-shock levels and stayed below the baseline for the rest of the forecast horizon. This coupled with the significant response of output and private sector credit shows that monetary policy has been effective in the inflation targeting era. Here output and private sector credit shocks explained about 35% of the variations in prices, interest rate contributing about 4%.

Thus, comparing the results in the pre-inflation targeting era and inflation targeting era shows that private sector credit, prices and output responded differently to monetary policy shocks.

To explore the impact of money supply on our variables in the base VAR, our base VAR was extended to include money supply. The results showed that following a monetary policy shock, the responses of output and prices were similar to those of our base VAR. Private sector credit responded negatively but became positive after 33 months, unlike in the base VAR where it stayed below baseline for the entire forecast horizon. Money supply falls slightly after monetary policy shocks. This result fits the monetarist view that interest rate shocks represent monetary shocks and that output and money supply fall following monetary contraction. A shock to money supply causes private sector credit and prices to rise significantly, while interest rate fell in response to money supply shocks. Output responded positively but it was insignificant suggesting monetary neutrality. The variance decomposition results showed that private sector credit outperforms money supply as forecaster of output albeit insignificant. When we controlled for money supply, money supply outperforms private sector credit as a predictor of prices, fitting the monetary view that inflation is a monetary phenomenon. Output shocks also significantly affected price changes.

Extending the analysis to include exchange rate revealed that exchange rate depreciated for about 5 months and stabilized thereafter following a monetary tightening, indicating an exchange rate puzzle. Although this result is indicative that the monetary policy variable does not affect exchange rate in line with theoretical predictions, the impulse response of prices to exchange rate shocks and the variance decomposition of prices shows that exchange rate is a moderate predictor of prices. This buttresses the findings of Allieu (2002) and Abradu-Otoo et al (2003) that the exchange rate is an important conduit for price movements. This is not different from the experience in Ghana where exchange rate movements are seen as an indicator of future price changes and thus dominate in expectations formation. The exchange rate outperforms private sector credit as a forecaster of output although it is not significant. Private sector credit, prices and interest rates were found to be significant forecasters of exchange rate.

To explore whether adding a commodity price to our model would help resolve the price puzzle, we extended our base VAR to include price of crude oil. The findings shows that adding price of crude oil does not help to resolve the price puzzle.

Overall, taking in consideration the results from the impulse response functions, variance decomposition and Granger causality tests, our study found that monetary policy is quite effective in impacting prices, output and private sector credit in Ghana. It also became evident that money supply, private sector credit and output are important sources of price fluctuations.

6.2 Policy Recommendations

Generally, the role of monetary policy in ensuring stable prices and providing a convenient environment for sustained output growth cannot be overemphasized. For monetary policy to work in achieving the above goals, the policy decisions of monetary authorities need to be transmitted

effectively through policy instruments to affect these goal variables. As a whole, our study found a moderate impact of the policy instrument on output, prices and private sector credit when all facets of the analysis (impulse response analyses, variance decomposition and granger causality tests) are put together. In order for monetary policy to have a bigger impact on the economy, it requires that our financial sector is developed and efficient to ensure that there is full transmission of policy impulses to the affect the economy. This is because it is through the financial sector that monetary policy impulses are relayed to the rest of the economy. Once the financial sector is not well developed there is an incomplete pass-through from policy interest rate to market rates as found in Kovanen (2011) and Akosah (2015).

This study therefore recommends that measures be put in place to ensure a rapid development and efficiency of the financial sector of Ghana so that there is a complete pass-through from policy interest rate to market interest rates. This will lead to better response of goal variables to policy interest rate changes.

Although in this era of inflation targeting monetary policy lay emphasis on interest rates in controlling prices, our study still found that money supply significantly explained price movements in Ghana. This means that monetary authorities need to monitor the growth in money supply so that it does not step out of bounds and have adverse effects on prices.

When we compared the pre-inflation targeting era and the inflation targeting era, we found that monetary policy has been fairly effective in the inflation targeting era. This is because the variables responded as expected and significant in the case of output and private sector credit, and prices also fell after two months. However in the pre-inflation targeting period, prices and output rose, which is inconsistent with theory. We therefore recommend that inflation targeting should be

continued and that measures be put in place to ensure that it is more effective. This will lead to better achievements of the targets of monetary policy.

In our study, private sector credit is found not to significantly impact on output. This may reflect the fact that the credit that is extended to the private sector is inadequate and as a result businesses are unable to carry out their planned investments, and this negatively affects output growth. We therefore recommend that both the fiscal and monetary authorities ensure that the private sector credit needs are met. We however caution that this should be done in a way that it would not have adverse effects on prices since private sector credit is a major source of fluctuations in prices in our model.

6.3 Limitations of the Study

The first limitation of this study is in the method of estimation. In trying to understand the relationships among our variables of interest, we estimated our model using an unrestricted VAR. However there are other methods such as cointegration (through which we can estimate a Vector Error Correction Model (VECM)), Autoregressive Distributed Lag models (ARDL) and Structural Vector Auto-regression (SVAR) (through which structural restrictions are imposed to identify shocks) that can be used to study the relationship among variables. Thus the choice of the estimation technique may give different results. This thus requires further studies that uses all the possible methods to find out which one better describe the data.

Another shortcoming of our study was the unavailability of monthly data for some series (real GDP and private sector credit)[8]. These series are available annually, which required that we

[8] Data on private sector credit is available monthly from January 2000 till December 2015. But to ensure consistency in data, we used only the interpolated data.

interpolated them to monthly series in order to use them for our purposes. The method used in doing this was the Chow-Lin procedure developed by Chow and Lin (1971). As a result, these series may not reflect the actual monthly series and thus may affect the outcome of our results.

The choice of the monetary policy variable was another limitation of the study. Even though most studies in Ghana on monetary policy used the 91-day Treasury bill rate, which our study also adopted, to indicate the stance of monetary policy, there are other candidate variables such as monetary aggregates and other short term interest rates. Thus a study needs to be conducted to examine which candidate variables reflect monetary policy stance in Ghana among the candidate variables, since the 91-day Treasury bill rate seems to poorly reflect that. It must be noted however that from 2002 till present, the monetary policy rate (MPR) is used by the central bank to conduct monetary policy. This does not cover the entire period of our study hence our reliance on the 91-day Treasury bill rate.

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APPENDICES

Appendix 1: Lag Length Selection Criteria

Table 1: Lag Length Selection Criteria for Base VAR Extended for Money Supply

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1315.188	NA	0.004571	8.801253	8.862983	8.825958
1	2789.797	8045.772	7.03e-15	-18.39865	-18.02827	-18.25042
2	3277.645	939.9199	3.22e-16*	-21.48430*	-20.80527*	-21.21255*
3	3292.568	28.25373	3.44e-16	-21.41712	-20.42944	-21.02185
4	3315.974	43.53505	3.48e-16	-21.40649	-20.11017	-20.88770
5	3329.992	25.60661	3.75e-16	-21.33328	-19.72831	-20.69097
6	3343.710	24.60101	4.05e-16	-21.25807	-19.34445	-20.49223
7	3354.249	18.54834	4.46e-16	-21.16166	-18.93939	-20.27230
8	3392.893	66.72575	4.09e-16	-21.25262	-18.72170	-20.23974
9	3408.414	26.28130	4.37e-16	-21.18942	-18.34986	-20.05303
10	3423.331	24.76361	4.69e-16	-21.12221	-17.97399	-19.86229
11	3438.788	25.14255	5.03e-16	-21.05859	-17.60172	-19.67514
12	3472.255	53.32488*	4.79e-16	-21.11504	-17.34952	-19.60807

* 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

Table 2: Lag Length Selection Criteria for Base VAR Extended for Exchange Rate

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1495.677	NA	0.015224	10.00451	10.06624	10.02922
1	2819.130	8457.022	5.78e-15	-18.59420	-18.22382	-18.44597
2	3297.820	922.2761	2.81e-16*	-21.61880*	-20.93977*	-21.34705*
3	3318.259	38.69788	2.90e-16	-21.58839	-20.60072	-21.19312
4	3331.954	25.47166	3.13e-16	-21.51302	-20.21670	-20.99423
5	3338.202	11.41344	3.55e-16	-21.38801	-19.78304	-20.74570
6	3349.383	20.05177	3.90e-16	-21.29589	-19.38227	-20.53005
7	3360.225	19.08148	4.29e-16	-21.20150	-18.97923	-20.31214
8	3403.711	75.08582*	3.80e-16	-21.32474	-18.79382	-20.31186
9	3411.252	12.77020	4.29e-16	-21.20835	-18.36878	-20.07195
10	3418.750	12.44577	4.84e-16	-21.09166	-17.94345	-19.83174
11	3428.642	16.09140	5.38e-16	-20.99095	-17.53408	-19.60750
12	3447.526	30.08924	5.64e-16	-20.95018	-17.18466	-19.44321

Appendix 2: VAR Stability Tests

Table 1: VAR Stability Test for Base VAR

Roots of Characteristic Polynomial

Root	Modulus
0.997228	0.997228
0.988035	0.988035
0.968649 - 0.018282i	0.968821
0.968649 + 0.018282i	0.968821
0.857393 - 0.032030i	0.857991
0.857393 + 0.032030i	0.857991
0.413547	0.413547
-0.285815	0.285815

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table 2: Stability Test for Base VAR Extended for Money Supply

Roots of Characteristic Polynomial

Root	Modulus
0.999749	0.999749
0.985992 - 0.020012i	0.986195
0.985992 + 0.020012i	0.986195
0.928356	0.928356
0.907849 - 0.042319i	0.908834
0.907849 + 0.042319i	0.908834
0.859665	0.859665
0.406754	0.406754
-0.273473	0.273473
-0.029304	0.029304

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table 3: Stability Test for Base VAR Extended for Exchange Rate

Roots of Characteristic Polynomial

Root	Modulus
0.999382	0.999382
0.994530 - 0.020213i	0.994735
0.994530 + 0.020213i	0.994735
0.932527	0.932527
0.925611 - 0.035049i	0.926274
0.925611 + 0.035049i	0.926274
0.838618	0.838618
0.423221	0.423221
-0.285391	0.285391
0.016895	0.016895

Table 4: Stability Test for Base VAR Extended for Price of Crude Oil

Roots of Characteristic Polynomial

Root	Modulus
0.998518	0.998518
0.982995 - 0.024167i	0.983292
0.982995 + 0.024167i	0.983292
0.972959	0.972959
0.887643 - 0.094613i	0.892671
0.887643 + 0.094613i	0.892671
0.826913	0.826913
0.382786	0.382786
0.327056	0.327056
-0.290767	0.290767

Appendix 3: Serial Correlation Tests

Table 1: Serial Correlation LM Test for Base VAR

Null Hypothesis: no serial correlation at lag order h

Lags	LM-Stat	Prob
1	8.704618	0.9251
2	11.46287	0.7801
3	17.15973	0.3753

Probs from chi-square with 16 df.

Table 2: Serial Correlation LM Test for Base VAR Extended for Exchange Rate

Null Hypothesis: no serial correlation at lag order h

Lags	LM-Stat	Prob
1	21.60127	0.6587
2	37.57114	0.0509
3	22.53035	0.6050

Probs from chi-square with 25 df.

Table 3: Serial Correlation LM Test for Base VAR Extended for Price of Crude Oil

Null Hypothesis: no serial correlation at lag order h

Lags	LM-Stat	Prob
1	11.72924	0.9886
2	17.70762	0.8545
3	20.51830	0.7191

Probs from chi-square with 25 df.

Appendix 4: Impulse Response Functions

Figure 1: Impulse Response Functions of Base VAR

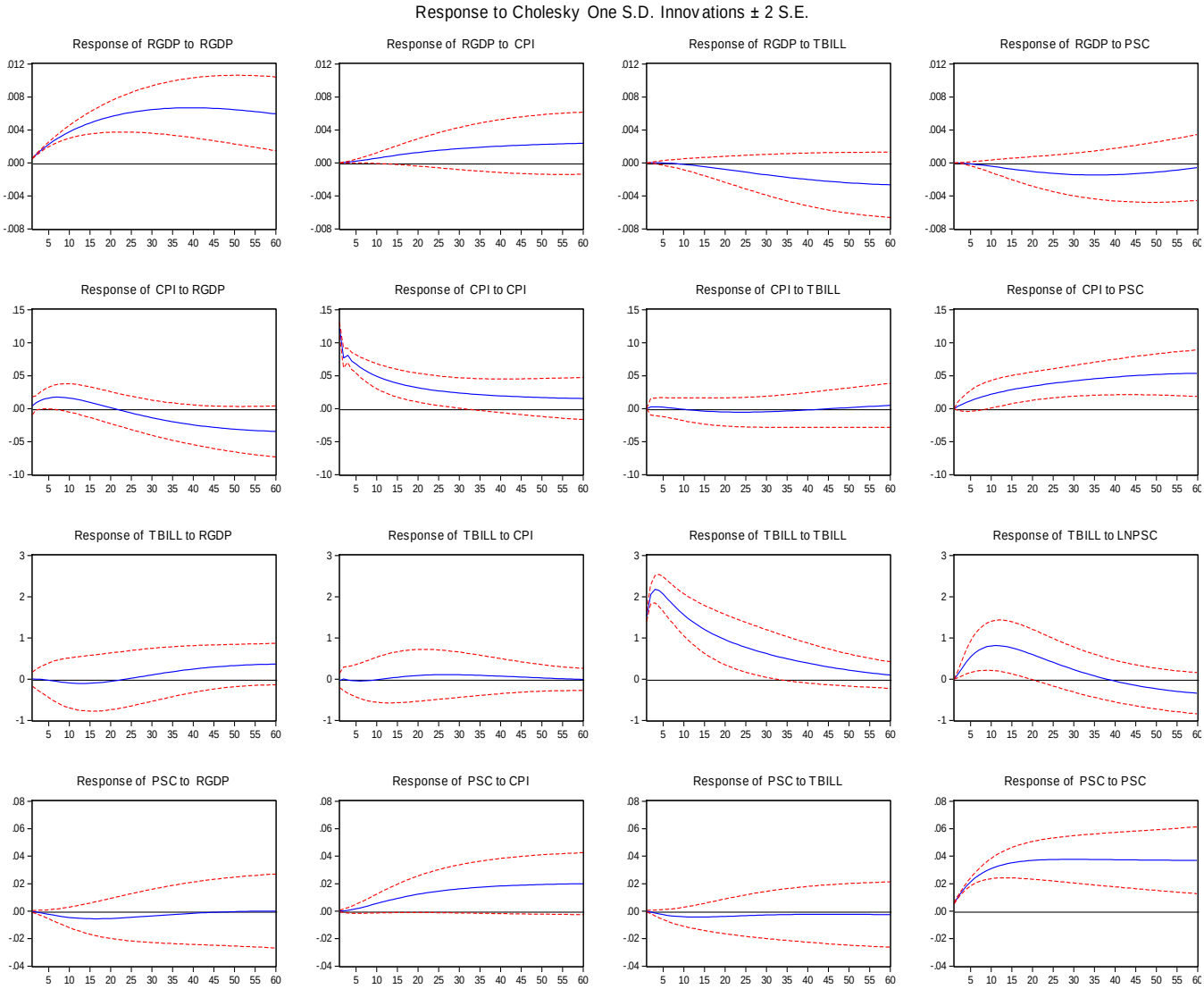


Figure 2: Impulse Response Functions for 1990 t0 2001 Sub-sample

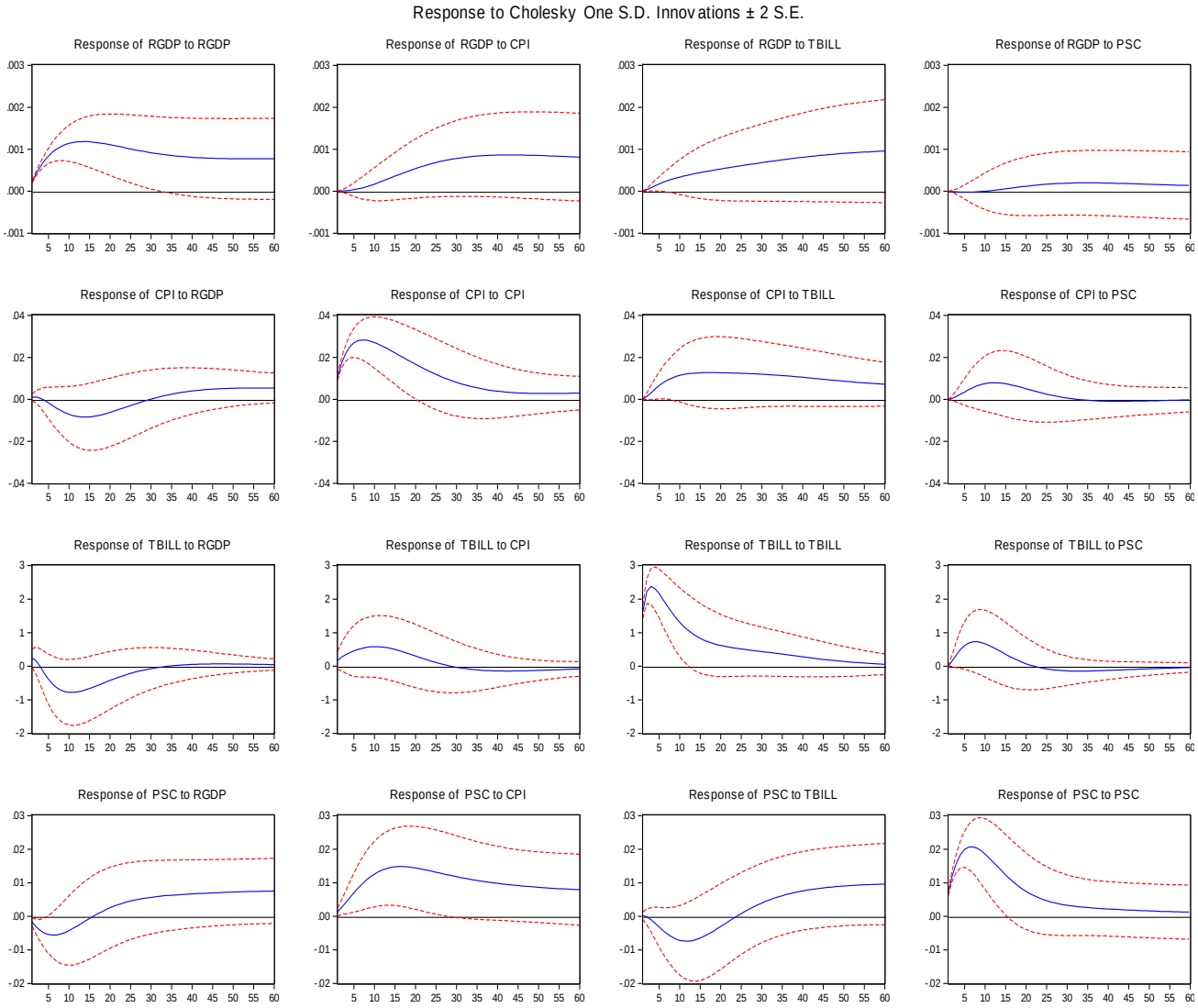


Figure 3: Impulse Response Functions for Base VAR Extended for Money Supply

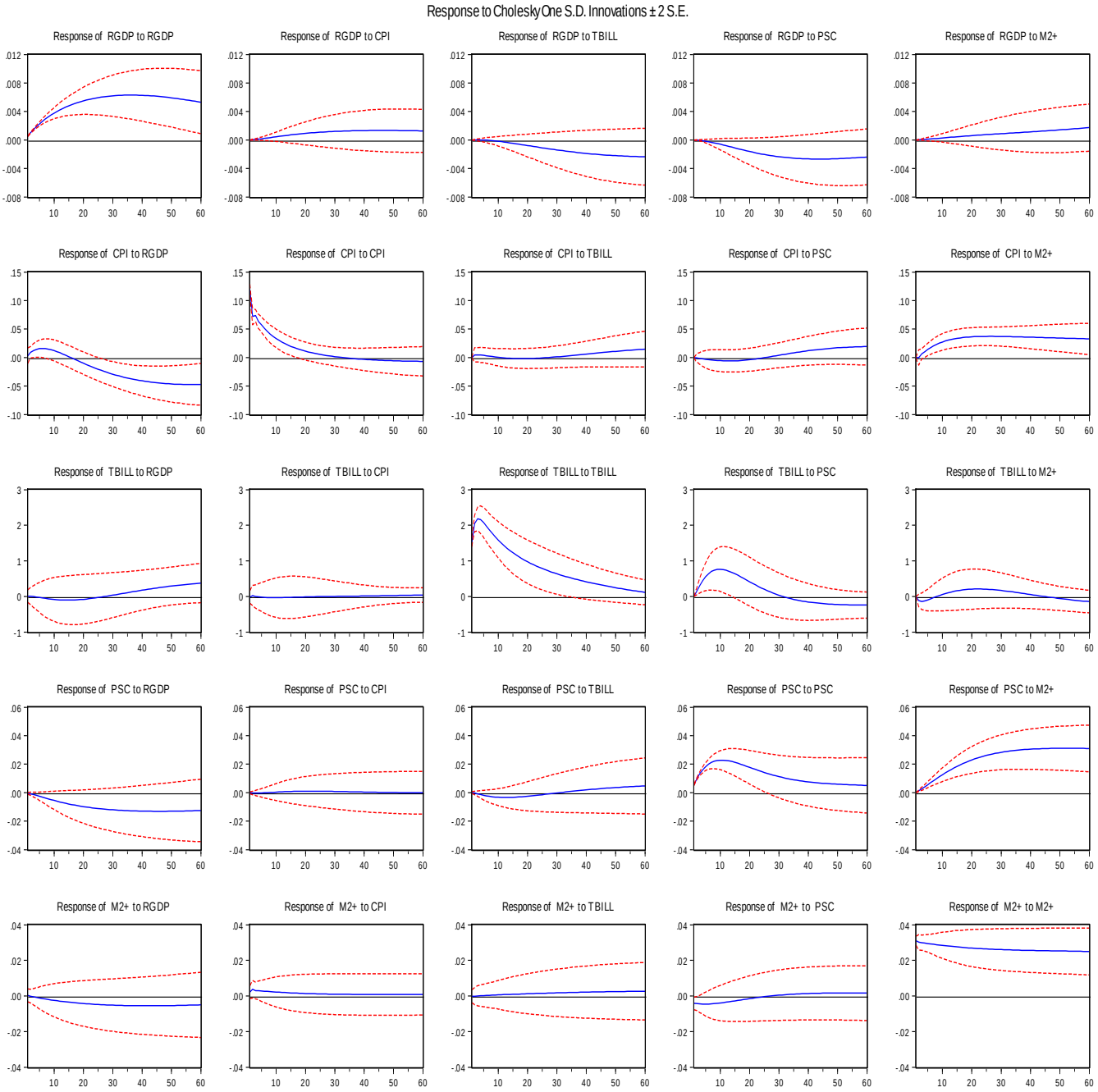


Figure 4: Impulse Response Functions of Base VAR Extended for Exchange Rate

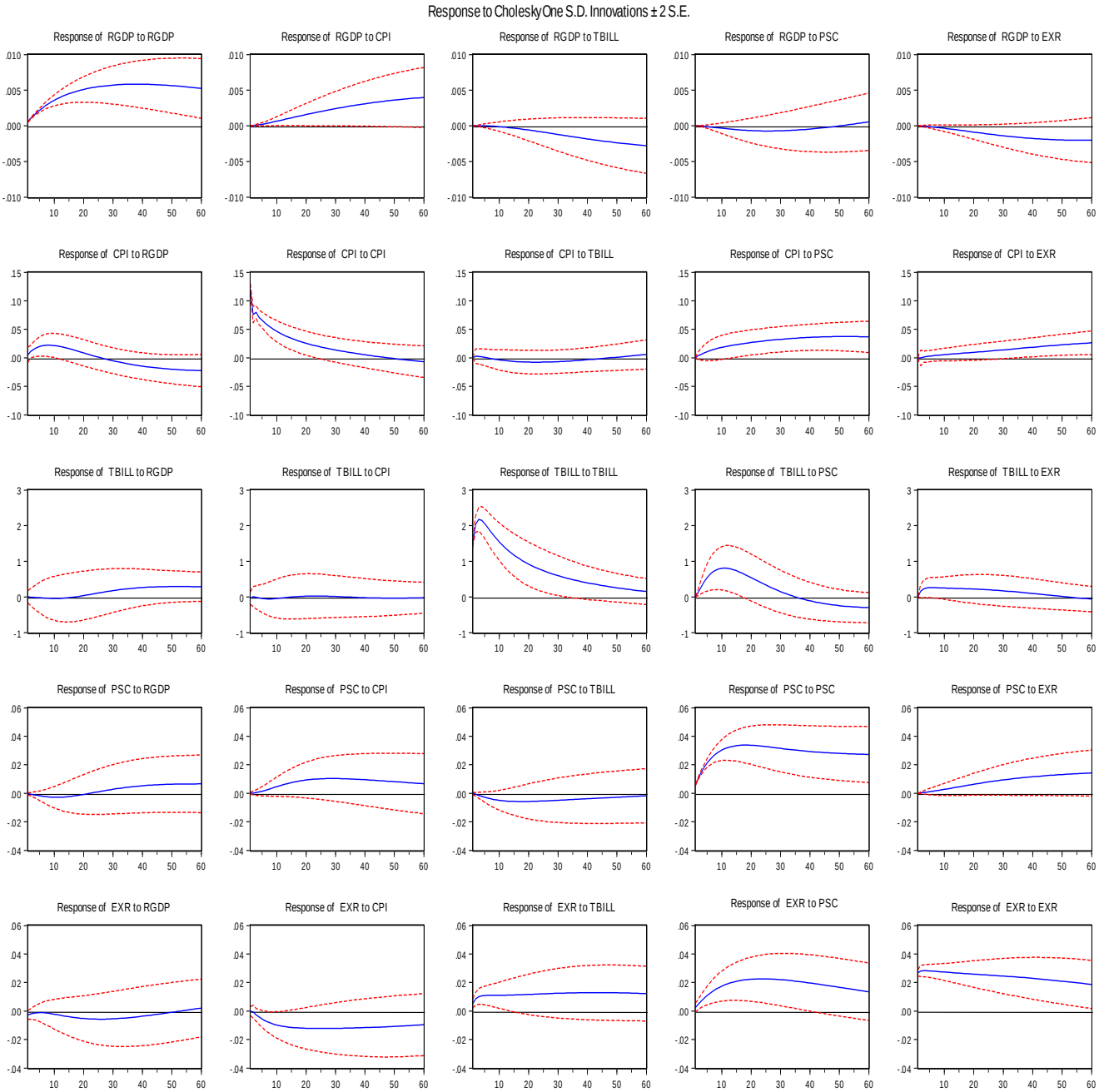
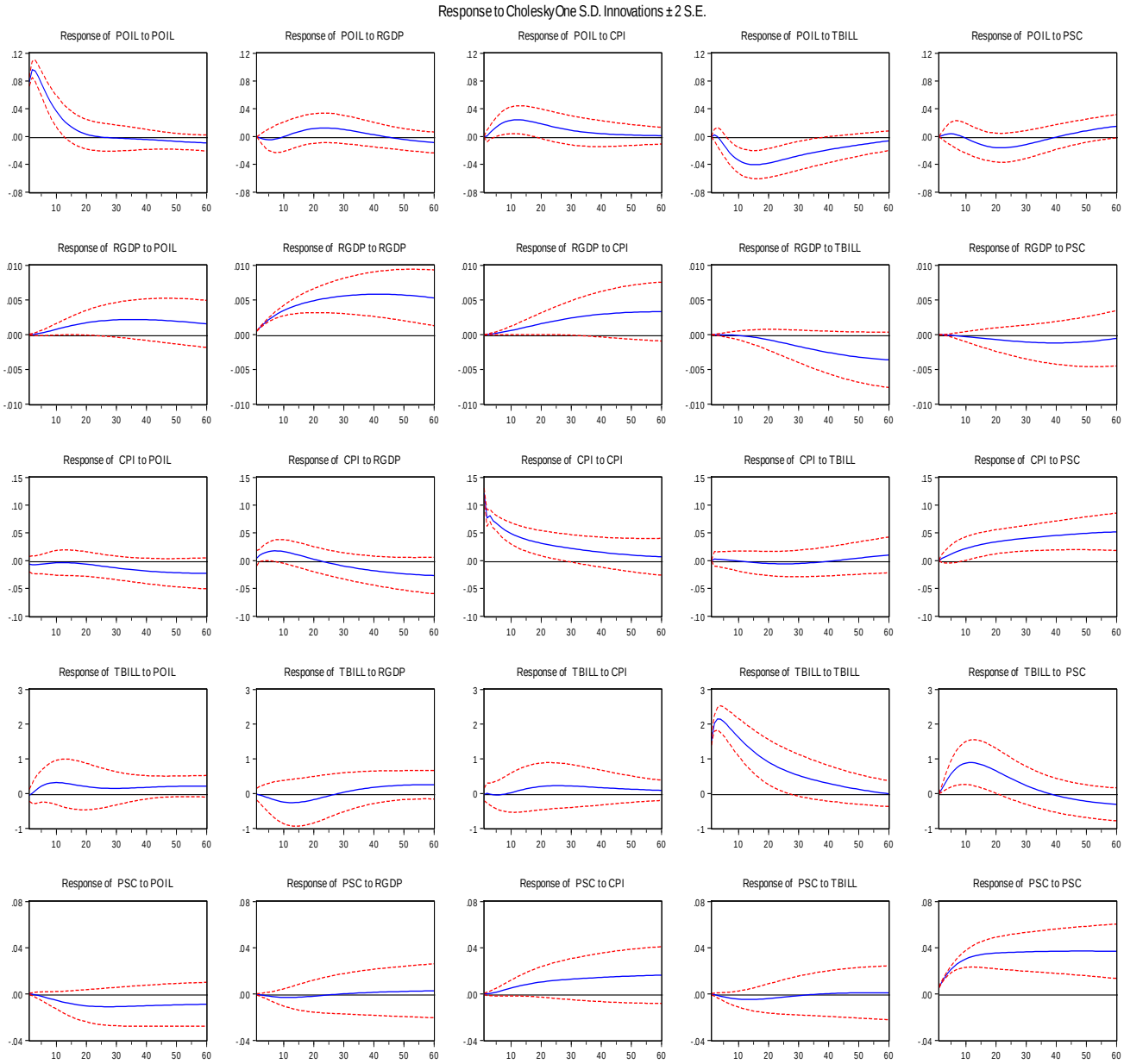


Figure 5: Impulse Response Functions of Base VAR Extended for Price of Crude Oil



Appendix 5: Variance decompositions

Table 1: Variance Decomposition of Base VAR for 1990 to 2001 Sub-sample

a) Variance Decomposition of RGDP

Month	S.E.	RGDP	CPI	TBILL	PSC
1	0.000221	100.0000	0.000000	0.000000	0.000000
12	0.003305	91.91223	1.509907	6.549955	0.027909
24	0.005665	78.33517	9.577605	11.67797	0.409254
36	0.007447	63.44271	18.63697	16.92599	0.994321
48	0.008978	53.09131	23.77913	21.94019	1.189368
60	0.010322	46.83190	25.77767	26.24112	1.149298

b) Variance Decomposition of CPI

Month	S.E.	RGDP	CPI	TBILL	PSC
1	0.010246	0.873911	99.12609	0.000000	0.000000
12	0.094408	3.176215	83.40884	9.623375	3.791570
24	0.126490	5.343764	72.74094	17.20601	4.709294
36	0.136258	4.822343	67.13583	23.89940	4.142433
48	0.141983	5.579072	62.58698	27.97200	3.861948
60	0.146133	6.875115	59.51871	29.94333	3.662843

c) Variance Decomposition of TBILL

Month	S.E.	RGDP	CPI	TBILL	PSC
1	1.644476	2.024572	1.049109	96.92632	0.000000
12	7.068732	7.723042	5.500395	78.96036	7.816201
24	7.860097	11.59532	7.253542	73.65048	7.500664
36	8.026644	11.33412	7.069630	74.06574	7.530512
48	8.098247	11.19210	7.307218	73.85395	7.646728
60	8.119841	11.19032	7.481090	73.65238	7.676205

d) Variance Decomposition of PSC

Month	S.E.	RGDP	CPI	TBILL	PSC
1	0.007199	5.745323	2.967923	0.076114	91.21064
12	0.072929	4.516920	19.60574	5.764454	70.11289
24	0.096127	3.390149	37.93957	6.137799	52.53248
36	0.107888	5.966191	44.32317	6.821267	42.88937
48	0.118688	8.868472	44.29762	11.04438	35.78953
60	0.128917	11.42417	42.49665	15.59994	30.47924

Table 2: Variance Decomposition of Base VAR for 2002 to 2015 Sub-sample

a) Variance Decomposition of RGDP

Month	S.E.	RGDP	CPI	TBILL	PSC
1	0.000686	100.0000	0.000000	0.000000	0.000000
12	0.012273	93.05274	2.392864	2.122057	2.432343
24	0.024627	86.54817	4.811939	4.961650	3.678245
36	0.032885	82.04524	6.340091	8.564070	3.050600
48	0.037609	76.82907	7.067687	13.68271	2.420526
60	0.040625	70.00997	7.050186	19.96500	2.974841

b) Variance Decomposition of CPI

Month	S.E.	RGDP	CPI	TBILL	PSC
1	0.163929	0.068846	99.93115	0.000000	0.000000
12	0.297817	4.602854	94.48029	0.457508	0.459343
24	0.313319	5.154018	91.24450	2.285986	1.315499
36	0.337166	11.83992	78.93614	3.805126	5.418822
48	0.369181	20.45462	66.41372	4.305091	8.826572
60	0.390003	25.30264	60.22384	4.359439	10.11408

c) Variance Decomposition of TBILL

Month	S.E.	RGDP	CPI	TBILL	PSC
1	1.420165	0.364742	0.080256	99.55500	0.000000
12	5.372438	0.103622	0.031270	97.84907	2.016036
24	5.975252	0.771953	0.036602	97.03708	2.154362
36	6.161321	3.156478	0.160194	94.31074	2.372590
48	6.310406	6.063726	0.410814	90.53392	2.991541
60	6.402833	7.938043	0.643860	88.06683	3.351266

d) Variance Decomposition of PSC

Month	S.E.	RGDP	CPI	TBILL	PSC
1	0.003240	0.255059	0.022463	0.008069	99.71441
12	0.043183	1.277607	0.403120	8.717554	89.60172
24	0.074881	1.638595	0.217008	28.45429	69.69011
36	0.097121	1.076170	0.139448	43.95003	54.83435
48	0.114405	1.569447	0.200802	53.41954	44.81021
60	0.129050	2.738815	0.367920	58.83074	38.06252

Table 3: Variance Decomposition of Base VAR Extended for Exchange Rate

a) Variance Decomposition of RGDP

Month	S.E.	RGDP	CPI	TBILL	PSC	EXR
1	0.000528	100.0000	0.000000	0.000000	0.000000	0.000000
12	0.009697	95.73470	2.705350	0.082316	0.736180	0.741455
24	0.020636	89.03896	6.750907	0.866040	1.278897	2.065197
36	0.030627	82.10671	10.79505	2.437075	1.167164	3.494010
48	0.039442	75.39806	14.59293	4.504994	0.811469	4.692548
60	0.047086	69.12632	18.02049	6.754039	0.621582	5.477573

b) Variance Decomposition of CPI

Month	S.E.	RGDP	CPI	TBILL	PSC	EXR
1	0.121057	0.171081	99.82892	0.000000	0.000000	0.000000
12	0.247031	7.031085	88.72605	0.146642	3.756731	0.339487
24	0.286938	7.309950	77.94637	0.833986	12.45151	1.458191
36	0.317580	6.519253	65.90258	1.186111	22.78809	3.603974
48	0.353300	7.812604	53.43179	1.029328	31.08534	6.640943
60	0.392871	9.819311	43.35847	0.931705	35.83955	10.05096

c) Variance Decomposition of TBILL

Month	S.E.	RGDP	CPI	TBILL	PSC	EXR
1	1.521414	0.002010	0.046771	99.95122	0.000000	0.000000
12	6.686850	0.024643	0.046248	88.15434	10.32013	1.454637
24	7.895698	0.062168	0.039545	83.31180	14.56479	2.021698
36	8.230392	0.660736	0.039796	82.95653	13.98480	2.358145
48	8.401962	1.896812	0.049267	81.83943	13.84038	2.374106
60	8.547418	3.211523	0.061996	79.80199	14.61230	2.312190

d) Variance Decomposition of PSC

Month	S.E.	RGDP	CPI	TBILL	PSC	EXR
1	0.005572	0.181952	0.066329	0.031893	99.71983	0.000000
12	0.085431	0.740933	1.716983	2.195981	94.71458	0.631523
24	0.149748	0.380133	4.616170	2.433112	90.50194	2.068644
36	0.192333	0.539795	6.204724	2.239968	86.83382	4.181689
48	0.224338	1.150597	6.579587	1.948503	83.80890	6.512410
60	0.250962	1.729597	6.333918	1.660350	81.51336	8.762771

e) Variance Decomposition of EXR

Month	S.E.	RGDP	CPI	TBILL	PSC	EXR
1	0.027537	0.952010	0.000198	3.675174	0.778759	94.59386
12	0.115330	0.350222	4.803325	9.702439	16.04621	69.09780
24	0.175226	1.077474	7.599455	9.426721	25.36018	56.53617
36	0.218046	1.414382	8.615000	10.00064	28.38355	51.58642
48	0.248154	1.277867	9.202941	10.95574	28.90027	49.66318
60	0.268909	1.109173	9.589395	11.94534	28.46575	48.89035

Appendix 6: Granger Causality Tests

Note: The values in the tables are the P-Values for the Wald Chi-square test

Table 1: Granger Causality Test for 1990 to 2001 Sub-sample

Dependent Variables	**Explanatory Variables**			
	RGDP	CPI	TBILL	PSC
RGDP	_	0.5640	0.1086	0.8116
CPI	0.0924	_	0.0512	0.5873
TBILL	0.1566	0.9792	_	0.1487
PSC	0.0230	0.0959	0.1305	_

Table 2: Granger Causality Test for 2002 to 2015 Sub-sample

Dependent Variables	Explanatory Variables			
	RGDP	CPI	TBILL	PSC
RGDP	_	0.4394	0.3548	0.3797
CPI	0.0639	_	0.8132	0.0757
TBILL	0.6926	0.7993	_	0.4683
PSC	0.1098	0.2973	0.0272	_

Table .3: Granger Causality Test for Base VAR Extended for Money Supply

Dependent Variables	Explanatory Variables				
	RGDP	CPI	TBILL	PSC	M2+
RGDP	_	0.4103	0.2492	0.3654	0.4620
CPI	0.0000	_	0.7574	0.8338	0.0009
TBILL	0.6173	0.7558	_	0.0159	0.3146
PSC	0.3050	0.4870	0.2585	_	0.0000
M2+	0.8077	0.6107	0.9891	0.8275	_

Table 4: Granger Causality Test for Base VAR Extended for Price of Crude Oil

Dependent Variables	Explanatory Variables				
	POIL	RGDP	CPI	TBILL	PSC
POIL	_	0.3205	0.0721	0.0003	0.2998
RGDP	0.0803	_	0.1913	0.9541	0.4934
CPI	0.8653	0.0008	_	0.8931	0.0006
TBILL	0.2006	0.9530	0.6308	_	0.0113
PSC	0.3711	0.1909	0.0906	0.2069	_