MONETARY POLICY TRANSNISSION MECHANISM IN ETHIOPIA: STRUCTURAL VAR ANALYSIS

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This is to certify that the thesis prepared by Berhanu Berihun Engida, entitled ―Structural VAR Analysis on Monetary Policy transmission Mechanism in Ethiopia" and submitted in Partial fulfillment of the requirements for the degree of master of science in Development Economics complies with the regulations of the university and meets the accepted standards with respect to originality and quality.

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Abstract

Monetary Policy is increasingly important to maintain price and exchange rate stability and support sustainable economic growth. The main objective of this paper was to study and identify the main transmission mechanism of monetary policy in Ethiopia. To achieve the objective, secondary source of data was collected using quarterly time series data from 2000/01Q1 to 2020/21Q4. Small open economy structural Vector Auto Regression (SVAR) model with two vectors of variables. All the variables are tested for unit roots using Augmented Dickey Fuller and the Phillips–Perron test and model stability and other necessary tests was conducted. The results of Structural impulse response and structural variance decompositions derived from Structural VAR show that direct monetary transmission which is the Reserve Money in case of output and reserve money, domestic credit and nominal effective exchange rate have significant impacts on price level in short term. The monetary aggregate (M2), the average lending rate, the reserve requirement and nominal effective exchange rate have significant impacts on output and price level in medium term in Ethiopia indicating that monetary policy transmission channel is effective in influencing macroeconomic variables in the Ethiopian economy. However, the results of interest rate channel-which is represented by the average lending rate in affecting output and price is not effective in short run relative to other channels. while the study also illustrates that the monetary aggregate contains important additional information in the transmission process of monetary policy shocks in Ethiopia.

Key Words: Impulse, Monetary, Policy, Response, Decompositions, Ethiopia

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Abbreviations and Acronyms

ADF: Augmented Dickey Fuller

ALR: Average Lending Rate

AIC: Akaike Information Criteria

CBE: Commercial Bank of Ethiopia

CPI: Consumer Price Index

DC: Domestic Credit

ECM: Error Correction Mechanism

DRI: Ethiopian Development Research Institute

HQ: Hannan Quinn information criteria

RFs: Impulse Response Functions

LR: Likelihood Ratio

MoF: Ministry of Finance

M2: Monetary Aggregate

NBE: National Bank of Ethiopia

NEER: Nominal Effective Exchange Rate

OLS: Ordinary Least Square

PNG: Papa New Guiana

pp: Phillips–Perron

RGDP: Real Gross Domestic Product

RM: Reserve Money

SC: Schwartz-Bayesian criteria

TYDP The Ten-Year Development Plan

USD: United States Dollar

VAR: Vector Autoregression

VDCs: Variance Decompositions

VECM: Vector Error Correction Model

WOP: World Oil Price

CHAPTER ONE

1. INTRODUCTION

The targets of monetary policy in Ethiopia are to maintain price and exchange rate stability and support sustainable economic growth. In achieving these objectives, the NBE sets money supply as an intermediate target. It should be noted that intermediate targets are not directly controlled by the central bank. Monetary policy has increasingly played a central role in the planning and implementation of national macroeconomic policies (Mishkin 1995). Monetary policy which has the determinations to control the monetary conditions of the economy with the purpose to stabilize price, create favorable conditions for economic growth and improve life of the society, hence it's one of the most important macroeconomic policies (Bernanke and Gertler,1995).

Monetary policy has major influences on the macroeconomic variables of the economy, still it might be accompanied by undesirable significances. To achieve the goals of regulating monetary policy and avoid unanticipated effects, the Central Bank will need to relay on a full or proper assessment of the timing and impacts of the use of monetary policy tools on the economy, hence it's requiring inclusiveness (Cheng, 2006).

For instance, the change in the official interest rate is usually transmitted to the economy via four different but interconnected channels – market rates, expectations, asset prices, and exchange rates. So, understanding of the transmission mechanism of monetary policy through main channels such as interest rates, exchange rates, asset prices, and expectations channel, etc and determining of appropriate and most efficient transmission channel to the economy is often required. Adequate knowledge in the transmission mechanism enable us to answer a series of monetary policy questions (Mishkin,1995). Yet there are multiple

different perspectives among economists on this issue, especially on the importance of each channel. Under different conditions or levels of financial markets, the impacts of monetary policy on the economy through each channel are not the same. In the developing countries, the monetary transmission mechanism is somewhat unstable and less efficient than in developed countries (Mishra et al, 2010). In many cases, the responses of monetary policy have followed market movements rather than the orientation nature with the aim to short-term economic stability due to the underdeveloped financial system which is dominated by the unofficial sector. In addition, the study of the transmission mechanism of monetary policy in these countries is less focused, which makes it more necessary to study the transmission mechanism of monetary policy in a developing country like Ethiopia, to advance the arrangement and regulating of monetary policy, particularly to achieve long-term targets.

Financial and monetary policy reforms are ongoing in Ethiopia to improve financial intermediation efficiency and contribute to private sector growth. The reforms aim to attract long-term finance, especially from insurance firms, social security agencies and the private sector. These include measures to deepen the money markets and create a functional capital markets framework. Supported by the NBE, weekly Treasury bills auctions are conducted and have resulted in increased yield rates from 2% in 2019 to almost 10% in 2021. The capital markets law approved by Parliament in June 2021 paves the way for establishment of a securities exchange in Ethiopia. Directives on Open Market Operations and Standing Facilities were approved in June 2021, paving the way for market-based monetary policy. In April 2021, the NBE raised commercial banks' minimum paid up capital ten-fold to ETB5bn (about US$120m) from ETB500m (US$12m) set in 2011; and in August 2021, doubled the

cash reserve ratio from 5.0% to 10.0% and raised its lending rate from 13% to 16% in a bid to strengthen financial sector stability.

1.1 Background of The Study

The principal objectives of monetary policy are controlling inflation, managing employment levels, and maintaining long-term interest rates. The monitory authority implements monetary policy through open market operations, reserve requirements, discount rates, the federal funds rate, and inflation targeting. In case of Ethiopia, the main aim of monetary policies are to maintain price/ inflation and exchange rate stability and support sustainable economic growth. In achieving these objectives, the NBE sets money supply as an intermediate target. It would be noted that intermediate targets are not directly controlled by the central bank. In addition, the central bank of Ethiopia has been tried to maintain single digit inflation to foster economic prosperity and social welfare. Part of the mission given to the NBE is to keep prices stable–that is, to keep prices from rising or falling too quickly and to reduce the excess liquidity in the banking system. The inflation level for the year 2019/20 was to 21.5 percent (NBE-2020). NBE seeks to control inflation by influencing the money supply requirement because, it might be interest rate does not stimulate the economy and move inflation higher/lower in case of Ethiopia.

As the National Bank of Ethiopia still, continues to reform its monetary policy framework, a deeper understanding of the observed inferences of conducting active monetary policy tools are crucial. The transmission mechanism of monetary policy has been an area of rich economic research in many countries. Therefore, the study of the structural VAR analysis of monetary policy transmission mechanism in less developed countries needs more focus,

which makes it more essential to study the mechanism to improve the procedure and regulating of monetary policy, in particularly to achieve long-term objectives.

1.2 Statement of The Problem

Ethiopia has recorded robust economic growth since 2005, averaging 10% annually, underpinned by public sector-led investments in infrastructure which propelled rapid growth in industry, agriculture, and services, with some structural transformation. However, growth tapped off to 7.8% annually during 2016-2021 due to rising macroeconomic imbalances (foreign currency scarcity, debt inflation), and structural bottlenecks, conflict, and the COVID-19 pandemic. Poverty declined from 29.6% in 2011 to 23.5% in 2016 and was projected at 19% in 2020 before COVID-19 and conflict. Poverty reduction is supported by robust economic growth and pro-poor public spending. However, the creeping inequality underscores the need to strengthen the quality of growth, expand the reach and quality of social services and economic opportunities. Structural imbalances, civil activism, conflict and shocks and the desert locust invasion, are threatening to reverse this growth record Ethiopia (AfDB,2021).

Ethiopia is a low-income country with income per capita of US$936 in 2021, up from US$700 in 2016. Since 2001, a public sector-led growth model has been implemented to spur growth. The public sector-led growth model largely financed by external borrowing has led to macroeconomic challenges, including foreign currency scarcity, mounting debt, and widening current account deficit. The model resulted in limited job opportunities an unfair income distribution despite declining poverty. Reforms are ongoing since 2018 to transition towards a private sector-led growth model. The Ten-Year Development Plan (TYDP) (2021-2030 underscores the need to address the macroeconomic imbalances and structural issues

that constrain supply side performance to improve the quality of growth for shared prosperity as its first pillar (AfDB,2021).

It is generally accepted that monetary policy has an important role in the real sector of the economy. The mechanism through which monetary policy influences the economy- through which monetary policy impulses are transmitted to the real sector, however, is still disputable. Theoretically, the explanations of monetary policy transmission vary across various schools of thoughts and identify several different channels of transmission mechanism of monetary policy (AfDB,2021).

Firstly, inflation is complicated and becomes a worrying economic phenomenon in Ethiopia. Inflation averaged 15% annually during 2016-2021, driven by an accommodative monetary stance, fiscal deficit financing and structural constraints (AfDB). In 2021, inflation reached 25.5% driven by growth in money supply, supply constraints related to the COVID-19 and conflict. Money supply grew at 24% annually during 2016 and 2021. A 2021 study by the Bank, notes that agricultural output gaps explain Ethiopia's inflation in the short-run while money market disequilibrium and volatility in global commodity prices explain inflation in the long-run. The National Bank of Ethiopia (NBE) steadily devalued the Ethiopian birr (ETB) from about 23.5/ US$1 in 2016 to ETB 47/US$1 in 2021 (100% devaluation), as part of the reforms to gradually transition to a market-clearing exchange rate. However, the gap between the official and parallel market exchange rates remains at about 20-25% and the real effective exchange rate is overvalued by 5.1% in 2020/21. Shocks such as the COVID-19 pandemic, desert locust invasion and insecurity added to the volatility of inflation.

Secondly, there has been a slice decline in output. the Ethiopian economy recorded 8.2 percent average growth rate per annum during the GTP II period (2015/16-2019/20) which

was 2.8 percentage point lower than the average growth target set for the plan period. Current balance continues deficit, the overall balance of payments worsened as it recorded a deficit of USD 1.2 billion in 2019/20 compared to USD 941.6 million deficit a year earlier because of a decline in net private transfers, official transfers and capital account balances despite improvements in deficits of both merchandise trade and net service payments.

Besides, Ethiopia's Homegrown Economic Reform Agenda is a well-coordinated response and blueprint to propel the country's economic progress. This agenda, crafted through a process of taking stock of the country successes; an in-depth review of key bottlenecks and design of adequate remedies, outlines macro-economic, structural, and sectoral reforms. The reform believed that will pave the path for jobs and inclusive growth the economic health based on the new homegrown economic reform agenda must enhance on financial liberalization and instituting market fundamentals of credit and capital markets finance sector including digital finance. The financial repression school argues that state ownership of finance sector not only distorts the financial market, but also depresses savings and leads to inefficient investment. The reform may also pave competition, efficiency and transparency and broadens financial intermediation in the banking system.

There have been many changes in financial market, particularly the budget deficit rises highly, and the investment efficiency is low. All these factors create macroeconomic instability and decline of confidence in the conduct of monetary policy transmission mechanism of the Government particularly on the National Bank of Ethiopia. In addition, the transmission mechanism of monetary policy has not been formed with many shortcomings in interest rate management. The system of the ultimate targets, intermediate targets and operational targets might not be tight enough and lacks empirical evaluation on

the transmission mechanism of the monetary policy. Furthermore, regulatory role of the interest rate of the monetary policy tools is now very indeterminate. The Bank's has not selected the mainstream interest rate and has not built an effective method of determining the types of interest rate, including the refinancing interest rate, rediscount interest rate, open market interest rate, and basic interest rate to ensure the close the relationship among administered interest rates, Treasury bills' interest rates and the market interest rates. Thus, the tagged interest rate movement hardly affects market interest rates, and the interest rate liberalization cannot be performed. As a result, in consideration of both theory and practice of monetary policy transmission mechanism in Ethiopia, especially in new conditions of home grown economic reform and Digital finance initiative, a carefully done research on the transmission mechanism of monetary policy is crucially necessary for the country to determine which policy framework is more effective with the new conditions and if it is necessary to switch from mechanism based on the volume- Money supply to the mechanism based on the price (interest channel).

Besides, despite the accessibility of studies both for developing and developed countries, the literature in Ethiopia is limited. Alemayehu (2011) tried to examine the monetary policy transmission mechanism in Ethiopia using VAR approach using quarterly data from 1970Q3 to 2004Q2 and found that monetary aggregate and credit channels as the best channel and exchange rate channel does not work in Ethiopia. Whereas Nuru (2013) using the same methodology and quarterly data from 1998Q3 to 2010Q2 found effective direct monetary aggregate and exchange rate channels, weak credit channel and inactive interest rate channel. This indicates, inconsistency in terms of the findings they had. So far, with my understanding, since 2013, there has been no recent empirical study in Ethiopia. In addition,

all the studies in Ethiopia use the VAR Models which explain the endogenous variables solely by their own history, usually impossible to disentangle what impact a sudden change on one variable will have on the other variables in the model, apart from deterministic regressors. In this way, my study was differed from past empirical studies that investigate the transmission mechanism of Ethiopian monetary policy using structured SVAR and seeks to fill the gap by undertaking an empirical study of Ethiopia 's monetary policy transmission mechanism from 2000/01 to 2020/21.

1.3 Objectives of The Study

1.3.1 **The General Objective of The Study**

The general purpose of the study was to determine the effectiveness of the different monetary transmission channel and attempted to produce some empirical results and policy outcomes.

1.3.2. **The Specific Objective of The Study**

The specific objective of this study was to evaluate the strengths of different instruments and intermediate foreign and domestic target variables to the moratory goals.

1.4 Research Questions

With the purpose of evaluating, analyzing the effectiveness of monetary policy through the transmission mechanisms to propose development and selection of operating method based on a more effective transmission channel in the changing economic monetary condition, the study was focused on answering the following research questions:

Q1. What Channel of Monetary Transmission Mechanism influences the economy through which Monetary Policy impulses are transmitted to the Real Sector?

Q2. Which monetary-policy-operating model should Ethiopia choose, and which transmission channel should be focused on – is it the price channel or Money supply channel?

1.5 Significance of The Study

By implementing effective monetary policy, the monitory authority can maintain stable prices, thereby supporting conditions for long-term economic growth and maximum employment. The adequate acquaintance of the transmission mechanism could lead to identify a feasible choices of policy instruments and targets, which in turn would improve the effectiveness of policy. This enables monetary authorities to understand the distribution consequences of their monetary policy decisions. Proper identification of monetary shocks on the real sector will be important not only to enable the monetary authority to monitor the consequences of its actions, also for the design of appropriate monetary policies.

Moreover, investigation on which monetary-policy-operating model should Ethiopia choose, and which transmission channel should be focused on – is it the price channel or Money supply channels lead to a feasible alternative of targets; for instance, if the credit channel is an important part of the transmission mechanism, bank portfolios should be the focus of more attention. On the other hand, if the interest rate channel is crucial, then the National bank may need to focus on an interest rate target. Therefore, the significance of the study is:

1. To identify an effective channel of monitory transmission instruments and their relative importance of various channels of monetary transmission
2. To extend the scope of knowledge about the transmission mechanism could lead to identify a feasible choices of policy instruments and targets.

3. To provide basis for other similar studies, our results provide useful information more generally within the context of modelling monetary policy in small open economies.

1.6 Scope and Limitation of The Study

1. The scope of the study was confined to the investigation of monetary policy transmission mechanisms in Ethiopia by using structured vector autoregressive technique (SVAR) and decomposition procedure will be used to evaluate the relative strengths of different transmission channels. The study employed quarterly data which cover a period of 20 years (2000/01- 2020/21). The analysis of monetary transmission mechanisms usually requires availability of many years 'data. However, in Ethiopia, the data on most of monetary variables only found since 1994. As a result, the study compelled to use Quarterly data. Some of the variable like GDP also, very challenging to find quarterly data.

2. In most developing countries including Ethiopia, it was difficult to find a quarterly data on gross domestic product. To overcome this problem different researcher uses different method to obtain quarterly estimates of GDP through interpolating annual GDP data by various available procedures including cubic spline and Chow-Lin methodology (Abeysinghe and Lee, 1998; Jayaraman, 2010).

In case of Ethiopia Haile (2001) and Zerayehu (2006) both tried to generate quarterly figure of GDP by studying the behavior of seasonality function of each sector in its contribution to annual GDP based on seasonality adjustment coefficients. Regarding this study, since it was the academic exercises, i preferred to generate the quarterly data based on the seasonality adjustment to annual agriculture, service, and industry component of the RGDP. I disaggregated the annual contribution to the RGDP into 75 percent to quarter two since it was the main harvesting season, 15 percentiles to fourth quarter and the remaining 10 precent

allocate equally to the remaining two quarters base on the statistic on agricultural studies. The remaining components service and industry disaggregated equally among the quarter.

1.7 Organization of The Study

The rest of the study was organized as follows; section two presented a review of theoretical and empirical literature on monetary transmission, and then discuss the overall monetary framework of the country. Section three presented model and econometric methodology used to estimate the transmission channels relevant to Ethiopian economy. Then chapter three was presented Research Methodology and Model specification. Chapter four concentrated on empirical finding and analysis. the final chapter presented conclusion and recommendations.

CHAPTER TWO

2.REVIEW OF RELATED LITERATURES

2.1 Theoretical Literature

The independence and credibility of the central bank influence not only the formulation of monetary policy but also, public expectations as to the effectiveness of the policy. Its credibility is a key ingredient of monetary policy effectiveness and can be described as the degree to which various economic agents believe that the central bank will act to ensure that it meets its key policy objective(s), especially inflation (Mishra et al., 2010).

Transmission mechanisms based on interest rates are better than direct controls on bank credit; a system based on large reserve requirements be part of the transition away from direct controls to reliance on interest rates. Well-functioning secondary markets help the central bank influence the value of financial market variables such as the interbank market interest rate and the money stock (Mishra et al ,2012).

Competition in the banking sector is necessary if changes in the policy rates are to have an impact on market rates; banks in a non-competitive market might not pass-on changes in policy rates to the lending or deposits rates of customers. The existence of long-term bonds is a prerequisite for the establishment of a market-based term structure; it also helps to hedge uncertainty about future short-term rates. A substantial degree of international financial integration is also required to influence the arbitrage between domestic and foreign financial asset (Mishra et al, 2012).

The monetary regimes have developed in emerging market economies (EMEs) in other regions of the world. In EMEs outside Africa, three broad trends can be distinguished: first, a trend towards independent monetary policy regimes with greater emphasis on inflation

control and inflation targeting; second, development of financial markets with less government intervention and reduced fiscal dominance; and third, greater economic (especially trade) and financial market integration with the global economy (BIS ,2008). On the other hand, in low-income countries, by contrast, one would expect the lack of developed financial markets to weaken the interest rate channel, and the lack of a secondary market for equities and real estate to weaken the asset channel (BIS ,2008).

The exchange rate channel would depend on the actual flexibility of the exchange rate. Some specific features of African economies that have constrained the effectiveness of monetary policy in the past like – the level of financial depth, measured in terms of the ratio of banks' liquid liabilities to GDP; dollarization, usually happens when a country's own currency loses its usefulness as a medium of exchange, due to hyperinflation or instability (BIS 2008). I.e., the greater the dollarization of an economy, the less scope there is for an independent monetary policy. Fiscal dominance - is pressing problem as it can contribute to inflation and macroeconomic instability, and increasingly so as fiscal deficits and public debt are rising in many African countries, generally crowds out private sector credit and excess liquidity more than required reserves (or required liquidity) due to the lack of money market instruments in which banks can invest (B I D).

The larger the liquid reserves on commercial bank balance sheets, the less sensitive the banks are to interest rate or reserve ratio increases and the stronger any central bank tightening measure must be to have the desired effect (Mankiw,2012).

This lack of consensus is evidenced by the many studies that have emphasized the importance of different channels through which policy shocks are propagated through the economy.

2.1.1 The Interest rate Channel

The interest rate channel is a mechanism of monetary policy, whereby a policy-induced change in the short-term nominal interest rate by the central bank affects the price level, and subsequently output and employment.

The interest rate channel of transmission of monetary policy was clearly defined in Keynes ‘s General Theory. The present value of capital and durable consumption goods is negatively related to the real interest rate (marginal efficiency of capital function). The traditional Keynesian approach to the monetary transmission mechanism works directly through the interest rate. The proposition is based on the belief that monetary policy (e.g., a change in the short-term official interest rate) has an impact on (short and long term) nominal as well as real interest rates that in turn affect consumer and investment spending, aggregate demand and output (Mishkin, 1996).

The central bank provides funds to the banking system and charges interest. Given its monopoly power over the issuing of money, the central bank can fully determine this interest rate. The change in the official interest rates directly affects money-market interest rates and, indirectly, lending and deposit rates, which are set by banks to their customers. Expectations of future official interest-rate changes affect medium and long-term interest rates. Longer-term interest rates depend in part on market expectations about the future course of short-term rates.

Monetary policy can also guide economic agents' expectations of future inflation and thus influence price developments. A central bank with a high degree of credibility firmly anchors expectations of price stability. In this case, economic agents do not have to increase their prices for fear of higher inflation or reduce them for fear of de Change in official interest rates.

Change in interest rate affects asset prices and the impact on financing conditions in the economy and on market expectations, triggered by monetary policy actions may lead to adjustments in asset prices (e.g., stock market prices) and the exchange rate (Mishkin, 1996). Changes in the exchange rate can affect inflation directly, in so far as imported goods are directly used in consumption, but they may also work through other channels.

It also affects saving and investment decisions. Changes in interest rates affect saving and investment decisions of households and firms. For example, everything else being equal, higher interest rates make it less attractive to take out loans for financing consumption or investment (Mishkin, 2012). Change in interest rate affects the supply of credit. For example, higher interest rates increase the risk of borrowers being unable to pay back their loans. Banks may cut back on the amount of funds they lend to households and firms. This may also reduce the consumption and investment by households and firms respectively. It's also leads to changes in aggregate demand and prices. Changes in consumption and investment will change the level of domestic demand for goods and services relative to domestic supply. When demand exceeds supply, upward price pressure is likely to occur. In addition, changes in aggregate demand may translate into tighter or looser conditions in labor and intermediate

product markets. This in turn can affect price and wage-setting in the respective market (Mishkin, 2012).

The changes in policy rates can affect banks' marginal cost for obtaining external finance differently, depending on the level of a bank's own resources, or bank capital (Mishra ,2010). This channel is particularly relevant in bad times such as a financial crisis, when capital is scarcer, and banks find it more difficult to raise capital. In addition to the traditional bank lending channel, which focuses on the quantity of loans supplied, a risk-taking channel may exist when banks' incentive to bear risk related to the provision of loans is affected. The risk-taking channel is thought to operate mainly via two mechanisms. First, low interest rates boost asset and collateral values. This, in conjunction with the belief that the increase in asset values is sustainable, leads both borrowers and banks to accept higher risks. Second, low interest rates make riskier assets more attractive, as agents search for higher yields. In the case of banks, these two effects usually translate into a softening of credit standards, which can lead to an excessive increase in loan supply (BID).

2.1.2 Asset price channel

The asset price channel is the monetary transmission channel that is responsible for the distribution of the effects induced by monetary policy decisions made by the central bank of a country that affect the price of assets. These effects on the prices of assets will in turn affect the economy. As pointed out by Mishkin (2004) is the asset price channel which relies on Tobin 's q theory. This theory explains how monetary policy can affect the economy through its effect on the valuation of equities or stocks.

(Tobin ,1969) as mentioned by (Mishkin ,2004) defines q as the market value of firms divided by the replacement cost of capital. The market price of firms is high relative to the replacement cost of capital and new plant and equipment capital is cheap relative to the market value of firms, if Tobin‘s q is high. Companies can then issue stock and get a high price for it relative to the cost of the facilities and equipment they are buying. Since firms can buy a lot of new investment goods with only a small issue of stock, Investment spending will rise.

The idea of this mechanism is an increase in money supply led to an increase in household spending and demand for assets. That means the price of assets rise relative to the real cost of reposition capital. Consequently, Tobin‘s q increase and firm‘s acquire more capital by issuing low equities. The higher Tobin‘s q induce a higher real investment spending and an increase real output.

In addition, the asset price mechanism also produces a wealth effect that increase consumption and aggregate demand (Mishkin, 2004). Modigliani, in his famous life cycle hypothesis, was the pioneer to look the effect of consumer ‘s balance sheet on their spending decision. The basic argument of Modigliani ‘s theory is that consumers smooth out their consumption over time. Therefore, their consumption spending is determined by lifetime resources of consumers rather than their income today. An important component of consumers 'lifetime resources is their financial wealth, a major component of which is common stocks. When stock prices raise, the value of financial wealth increases, thereby increasing the lifetime resources of consumers, and consumption should rise.

The wealth and Tobin‘s q channels allow for a general definition of equity, so the Tobin q framework can also be applied to the housing market, where housing is equity. An increase in house price, which raises their prices relative to replacement cost, leads to a rise in Tobin‘s q for housing, thereby stimulating its production. Similarly, housing and land prices are extremely important components of wealth, and so rise in these prices increase wealth, thereby raising consumption. Monetary expansion, which raises land and housing prices through the Tobin‘s q and wealth mechanisms described here, thus leads to a rise in aggregate demand (Mishkin, 2004).

The effect of the change in real estate prices is very similar to the effect of the change in equity prices on firms and consumers. There is a wealth effect working in two ways. On the one hand changes in the value of housing wealth affect consumption and on the other hand they change the value of collateral, which influences investment spending. Finally, there is the direct effect of the price change on housing expenditure (Mishkin, 2001).

2.1.3 Exchange Rate Channel

The exchange rate channel postulates that when the economy is open, a monetary contraction will increase the domestic interest rate up to the foreign one and, thereby, appreciates domestic currency in nominal and/or real terms. It works conventionally through uncovered interest rate parity that relates interest rate differentials to expected exchange rate movements. Although in the end the exchange rate is determined by factors such as purchasing power parity, its short run behavior is the result of asset equilibrium. In many developing countries those with only undeveloped markets for bonds, equities and real

estate, the exchange rate is probably the most important asset price affected by monetary policy (Agenor and Montiel, 2008).

When the exchange rate is floating, a tightening of monetary policy increases interest rates, raises the demand for domestic assets, and hence leads to an appreciation of the nominal and the real exchange rate (Agenor and Montiel, 2008). According to Mishkin (2004), after monetary contraction when domestic real interest increase, depositing domestic currency become more attractive than depositing foreign denomination currencies, which in turn leading to the appreciation of the domestic currency (a rise in the value of domestic currency relative to other currencies). The higher the value of domestic currency means the more expensive will be the domestic good compared to foreign good, thereby, leading to a decline in net export which in turn causing a fall in aggregate output. This is what we call the relative price effect.

The change in the exchange rate affects the price competitiveness of the country thereby affecting net exports (Kuttner and Mosser, 2002). However, the degree and direction of the exchange rate channel depend on many conditions such as the elasticity of demand for exports and imports, openness of the economy and exchange rate pass-through. Mishkin (2001) points out that the exchange rate channel also works through the balance sheet effect. It is the case when a substantial amount of domestic debt is denominated in foreign currency, resulting in a change in the debt burden through the change in the

exchange rate.

2.1.4 The Credit Channel

The credit channel mechanism of monetary policy describes the theory that a central bank's policy changes affect the amount of credit that banks issue to firms and consumers for

purchases, which in turn affects the real economy. It focuses on financial market imperfections, namely asymmetric information phenomena, as an essential factor of propagation and amplification of initial monetary policy shocks Bernanke and Gertler (1995),

Bernanke and Gertler (1995), as advocator of this mechanism, points out the basic premise of their conception about the channel. The premise states that wherever there is a problem of information asymmetry and costly enforcement of contracts which interrupt the smooth functioning of financial market, there will be imperfect substitutability between different sources of financing (the cost of external funds and opportunity cost of internal funds). This cost spread between self-financing and credit, called the external finance premium. The difference between the two funds reflects the dead weight cost associated with principal agent problem that exist between lenders and borrowers. Lenders expected cost of evaluation, monitoring and collection; the information advantage of the borrower than the lender about its prospect; cost of distortion in the behavior of borrowers that arise from moral hazard-are some of the factors reflected in the external finance premium and Gertler, 1995). The higher the external finance premium (cost due to financial imperfection), the lower will be the investment and consumption spending.

According to Bernanke and Gertler (1995), monetary policy affects not only general level of interest rates, but also the size of external finance premium. There are two transmission mechanisms under the credit view which arise because of credit market imperfection: the bank lending channel and the balance sheet (net-worth) channel.

Bank lending channel supposes that monetary tightening which drains deposits from the banking system has a direct effect on banks 'loan supply. The bank lending channel is based on the idea that banks play a special role in the financial system since they are especially well suited to solve asymmetric information problems in credit markets. The special role of banks allows certain borrowers who do not have access to the credit markets to get loan from banks. According to Mishkin (2004), if there is no perfect substitutability of retail bank deposits with other sources of funds, the bank lending channel of monetary transmission operates as follows. Expansionary monetary policy, which increases bank reserves and bank deposits, increases the availability of bank loans. since many borrowers finance their activities by using bank loan, this increase in loans will cause investment (and possibly consumer spending) to rise.

An important implication of the credit view is that monetary policy will have a greater effect on expenditure by smaller firms, which are more dependent on bank loans, than it will on large firms, which can access the credit markets directly through stock and bond markets (and not only through banks). Apart from being forced to cut their loans supply, banks generally increase their lending rate which in turn raises external finance premium and lower output. In this case, increase in lending rates is a way in which banks try to compensate for borrower's inclination to exhibit stronger adverse selection and moral hazard behavior during monetary contraction.

Balance sheet channel looks at credit channel of monetary transmission from a borrowers 'perspective. Monetary policy expansion for example, strengthens borrowers 'net worth by a rise in equity, house and land prices or by a rise in firms 'cash flow caused by a decline in nominal interest rates. External finance premium declines at this point because higher net

worth reduces opportunistic behavior by borrowers so that banks are willing to lower lending rates, thus affecting aggregate spending decisions.

2.1.5 Expectation channel

The monetary policy can get involved in expectation channel of transmission mechanism by affecting the process of expectations formation. Because the results of policies to be implemented vary according to the expectations, the main challenge in monetary policy is to correctly manage expectations. According to Mishkin (2004) the shock of monetary policy depends on the degree to which they have been anticipated by economic agents. Since unanticipated changes will have relatively strong effects, monetary authorities 'control over monetary conditions is determined by their ability to influence inflationary expectations. The formation of expectations crucially depends on policy credibility, which takes a long time to build.

In recent years there has been a growing recognition of the importance of expectations about the future stance of monetary policy in improving monetary policy effectiveness in stabilizing inflation and output. Since there are costs in changing prices and renegotiating contracts, agents show forward-looking behavior in their setting of prices and wages (Mishkin, 2004).

Therefore, this proposal suggested, the effectiveness of the Monitory Transmission Mechanism through its five key channels: interest rates, lending rate, exchange rates, asset prices, and expectations (Mishkin, 1995).

2.2 Empirical Literatures

Studies in transmission mechanisms are mainly used the VAR approach and focused primarily on the reduced-form relationships between monetary policy and output using a small number of variables such as, real output, inflation (consumer price index), interest rate, credit , exchange rate and stock index. It is important to examine some of the studies both from the developed and developing nations in greater detail to obtain a better idea about their methods and findings, even though only little done in most of the underdeveloped world.

2.2.1 Study on Monetary Policy Transmission Mechanism in Developed Countries

Wang (2020), studies how low interest rates weaken the short-run transmission of monetary policy and contract the long-run supply of bank credit. As U.S. bond rates have fallen, the pass-through of monetary shocks to loan and deposit rates has weakened while the spread on U.S. bank loans has risen. The study builds a model in which banks earn deposit and loan spreads, deposits compete with money, and banks' lending capacity depends on their equity. The short-run transmission of monetary policy is dampened at low rates, because deposit spreads act as a better hedge for bank equity against unexpected monetary shocks. In the long run, persistent low rates decrease banks revenue from deposit spreads, hence bank equity and loan supply contract, and loan spreads increase.

Reyes (2002) analyzes the monetary transmission mechanism in USA by employing VAR approach. He found empirical evidence that support the four channels of transmission mechanism surveyed by Mishkin (1996). The result of his study showed that real interest rate, asset price, real expenditure and money are the major variables affecting the dynamic of output. However, real exchange rate, real net export, real bank loans, real

deposit have a weak influence on output. Based on the results, the author suggested that policies that induce to stimulate the US economy at the study period by expanding credit or improving the exchange rate might have lower probability of being succeeded.

Borsa Istanbul review (2020), studied how monetary transmission works in Turkey under an explicit inflation-targeting regime implemented since the beginning of 2006. They build various vector autoregression (VAR) models and show that the central bank's main policy tool, interest rates, and the nominal exchange rate are determinant of output and the inflation rate, respectively. Among the external variables selected, the federal funds rate seems to have an impact on Turkish output, while asset prices and liquidity explain majority of the fluctuation in output over time. The study demonstrates that monetary policy is effective in Turkey, an emerging country, and broadens the current literature on monetary transmission in Turkey and other emerging markets. In addition, the study employs a new approach by exploiting various VAR techniques, including SVAR, to understand and shed light on the functioning of monetary transmission channels in a more comprehensive framework.

2.2.2 Study on Monetary Policy Transmission Mechanism in less Developed Countries

Some studies have been done to evaluate the effectiveness of the transmission mechanism of monetary policy in developing countries. Using the VAR model, Disyatat and Vongsinsirikul (2003) used the VAR approach with quarterly, seasonally adjusted data from 1993Q1 to 2001Q4 with two lags to analyze the monetary transmission mechanism in Thailand. Their basic model included real output, price level, and the fourteen-day repurchase rate, which they assumed to be the measure of monetary policy since they used short term interest rates as monetary policy stance for Thailand. They found that tightening

monetary policy led to a decrease in output and the aggregate price level initially responded very little, but ultimately started to decline after about a year. Moreover, investment appeared to be the most sensitive component of gross domestic product (GDP) to monetary policy shocks.

Cheng (2006) also studied the impact of a monetary policy shock on output, prices, and the nominal effective exchange rate for Kenya using monthly data during 1997–2005. As he uses VAR approach, the main results suggest that an exogenous increase in the short-term interest rate tends to be followed by a decline in prices and appreciation in the nominal exchange rate but has insignificant impact on output. Furthermore, the paper finds that variations in the short-term interest rate account for significant fluctuations in the nominal exchange rate and prices, while accounting little for output fluctuations. He concluded that he found a weak transmission mechanism from monetary policy stance to real variables and a strong link between monetary policy and nominal variables. Even if the study by Cheng (2006) uses monthly data which is adjusted seasonally, the time span of the sample period is very short. As a result, it will be difficult to believe that the study gives a precise analysis of the long-run behavior of the economy.

2.2.3 Study on Monetary Policy the Transmission Mechanism in Ethiopia

The issue of empirical research on monetary policy transmission is still very new, some major research may include**,** Nure (2013) study investigates empirically the monetary transmission mechanism in Ethiopia to better inform monetary policy, which is currently dedicated to price and exchange rate stability. The study analyses long-run equilibrium relationships, adjustment mechanisms and short run influences between the output, price level and transmission channels: namely, the exchange rate; the interest rate; money supply;

and credit channel. The study analyzed the transmission mechanisms of monetary policy using vector autoregression and vector error correction mechanism (VECM). In addition, impulse response functions (IRF) and variance decompositions (VDC) techniques are employed to assess the relative strength of each channel. The results of the study suggest that monetary policy in Ethiopia had a relatively significant influence on the real activity through the direct monetary transmission and exchange rate channel. Besides, the results of statistical tests suggest that the interest rate channel is not active. Although the cointegration analysis showed that domestic credit has significant impact in the long run, both the VDC and IRFs implies weak existence of the credit channel.

In general, the study attempted to overview of empirical evidence on different transmission channels in developed and less developed countries. The evidence concerning monetary transmission mechanism in euro area countries reveals that the interest rate channel emerges as clearly and exclusively dominant but a weak existence of the exchange rate channel due to the implementation of common currency in the region.

The empirical studies of other advanced countries like USA, UK, Australia, and Canada suggest that the Interest rate channel and exchange rate channel, rather than the Credit channel and asset price channel, have a prominent role in monetary transmission in open advanced economies.

Empirical evidence from the group of less developed countries provides no clear-cut implications. On the one hand there are some countries, where the interest rate channel seems to play an important role in the transmission process of monetary policy. On the other hand, there exists like Kenya, where the role of the Interest rate channel tends to be rather limited.

The same pattern of mixed evidence across different countries also applies to the Credit channel and exchange rate channel.

Generally, the above studies indicated that not only one channel does matter to the monetary policy transmission mechanism in one country, but also many channels may be simultaneously playing a vital role. Furthermore, the review also showed that it is very hard to find any empirical evidence in the context of developing countries. This is not a surprise since there is no apparent implementation of monetary policy among the developing countries.

In Ethiopia, as such, a few empirical studies undertook in monetary transmission mechanisms in the country, at least which is published. As a result, this paper will be a good motivation investigating empirically the monetary transmission mechanism in Ethiopia.

2.3 Monetary Policy Framework in Ethiopia

The principal objective of the monetary policy of the National Bank of Ethiopia is to maintain price & exchange rate stability and support sustainable economic growth of Ethiopia (NBE Birritu, No.128).

Price stability is a proxy for macroeconomic stability which is vital in private sector economic decision on investment, consumption, international trade and saving. The macroeconomic stability fosters employment and economic growth. Maintaining exchange rate stability on the other hand is considered as the principal policy objective of NBE so as to be competitive in the international trade and to use exchange rate intervention as policy tools for monetary policy to affect both foreign reserve position and domestic money supply.

More generally, monetary policy in Ethiopia actions and regulatory stances taken by the central bank including setting minimum interest rates on deposits or the rediscount rate charged to Commercial banks borrowing reserves, setting reserve requirements on various classes of deposits, Increasing or decreasing commercial bank reserves through open market purchases or sales of government securities, regulatory actions to constrain commercial bank financial activity or to set minimum capital requirements, intervention in foreign exchange markets to buy and sell domestic currency for foreign exchange and decide on level of required reserve of commercial banks total deposit.

2.3.1. Monetary Policy Instruments

Monetary policy guides the Central Bank 's supply of money in order to achieve the objectives of price stability (low inflation), full employment, and growth in aggregate income. Monetary policy targets, as distinct from objectives, are proximate goals. They are not objectives in and of themselves, but if attained will work directly toward achieving the longer-term objectives of policy. Monetary policy targets are classified as either operating targets or intermediate targets. Intermediate targets are variables that affect the ultimate objectives of monetary policy but are not controlled directly by the central bank. They include various monetary aggregates and long-term interest rates. In contrast, operating targets are tactical goals that the central bank can influence in the short run. Although central banks cannot use monetary policy instruments directly to affect intermediate targets, they can use them to affect operating targets, such as reserve money and short-term interest rates, which influence the intermediate targets.

2.3.2. Reserve Requirement

The Central Bank may require Deposit Money Banks to hold a fraction (or a combination) of their deposit liabilities (reserves) as vault cash and or deposits with it.

Fractional reserve limits the amount of loans banks can make to the domestic economy and thus limit the supply of money. By this, the central bank can control the amount of liquidity in the economy. The assumption is that Deposit Money Banks generally maintain a stable relationship between their reserve holdings and the amount of credit they extend to the public. Reserve requirements are set and changed according to regulation and thus contain an element of direct control. However, since the effect of changes in reserve requirements is a function of the demand for reserve money, they can be classified as an indirect policy instrument (NBE,2009).

2.3.3. Open Market Operations

Open Market Operation has generally been used by countries as one of the main instruments for the development of money markets. It is an activity of selling and purchasing bonds or securities issued by governments. Trading in these instruments smooth the financial system in particular and the national economy in general and increases financial intermediation among market participants. One such security is Treasury Bills. When the Central Bank sells securities, it reduces the supply of reserves and when it buys securities-by redeeming them-it increases the supply of reserves to the Deposit Money Banks, thus affecting the supply of money. In light of this, the NBE will use open market operations as one of its monetary policy instruments. In the absence of its own securities, certain amount of government treasury bills needs to be allocated to NBE by the government for its monetary policy purpose (NBE, Birriru No 128).

2.3.4. Standing Central Bank Credit Facility

It is another instrument used to enhance the financial capacity of commercial banks and to promote financial intermediation and efficiency. The main benefits of such standing credit facility are inapparency and predictability of accessing central banks ‘resources to cover

short-term needs. This credit facility gives banks an assurance that, when confronted with problems of shortfall in the clearing and a lack of alternatives for raising immediate funds in the inter-bank market, they can settle the clearing with the central bank ‘s funds at a reasonable interest rate which has a clear relationship with short term market interest rates. The NBE will use this facility as one of its monetary policy instruments NBE, 2009).

2.4 Theoretical Framework

2,4.1 The Direct Money view

The quantity theory of money is a framework to understand price changes in relation to the supply of money in an economy. It argues that an increase in money supply creates inflation and vice versa. The Irving Fisher model is most used to apply the theory. The model was developed from the Fisher ‘s Quantity theory of money; The Classical (particularly pigou) suggests money is just a veil; on which the real variables are concealed (Mishkin 2004). Therefore, monetary changes are transmitted directly into price movements. In this respect, monetary policy should not be therefore geared to control real variables, but its goal should be price stability as suggested by the Classicals.

2.4.2 The Classical Model

According to the quantity theory of money, the general price level of goods and services is proportional to the money supply in an economy—assuming the level of real output is constant, and the velocity of money is constant. The quantity theory of money implies that aggregate spending is determined solely by movements in the quantity of money since they assume a constant velocity of money.

$$MV = PY \quad \text{.....(4.1)}$$

Where V, Y, P and M represented velocity of circulation of money, aggregate output, price level and quantity of money respectively. V and Yare constant, there is linear relationship between quantity of money and price.

According to classical if velocity of money is assumed to be constant and the constant Y assumption relaxed, a change in the quantity of money (M) must cause a proportionate change in nominal GDP (PY). In other word, if velocity is fixed, the quantity of money determines the dollar value of the economy ‘s output (Mishkin, 2004).

The monetary aggregate chosen in this study is Broad money (M2) rather than narrow money1. Even if a recent study on Fiji (Jayaraman and Choong,2008) indicate, holding of liquid assets in a developing country plays a much larger role in the transmission of monetary policy, this study uses broad money to extend the scope by acknowledging the role of saving deposit. However, this study and so many others (Jayaraman, Choong and Budhoo,2009) find similar result irrespective of using broad and/or narrow money.

2.4.3 The Money view (Keynesian Model)

Keynesian economists believe the economy is best controlled by manipulating the demand for goods and services. However, these economists do not completely disregard the role the money supply has in the economy and its effect on the gross domestic product (GDP). The money view proposed by the traditional Keynesians places emphasis on the change in monetary aggregate affecting output (y) through interest rate channel. The mechanism can be traced by using the following systematic mechanism (Mishkin, 1996).

$$M \downarrow \; r \uparrow I \downarrow \Rightarrow Y \downarrow$$

The mechanism states that a contractionary monetary policy (m) leads to a rise in real interest rates(r), which raises the cost of capital, thereby causing a decline in investment goods (I). Further, this leads to a decline in aggregate demand and hence, fall in output.

According to this view, in the long run the relationship between inflation and money growth depends on the demand for money and money supply. The most important factor affecting the demand for money is real income (output) and the forgone interest income from holding money instead of other assets.

This relationship can be written as: f (r, y)

$$\frac{M}{p} = f(r, Y)$$

Where M is money supply, P is domestic price r is interest rate and y is growth rate of output.

To incorporate the impact of the interest, rate many empirical research in different countries use different types of interest rates. Some studies use the Treasury bill rate, and some others work with the interbank money market rate. However, in Ethiopia it is unreliable to use such rates because in most cases the Treasury bill is issued to provide finance for temporary shortfalls in government revenue rather than as monetary policy instrument. The inter-bank money market transaction also not conducted for most of the review periods since the banking sector have huge excess liquidity. As a result, this study obliged to use the average lending rate to represent the interest rate. However, policy interest rate considered in the monitory framework is Treasury bill rate.

2.4.4 The Credit view (Bank lending channel

The bank lending channel suggests that banks play a special role in the transmission of monetary policy. In this theory, monetary policy influences banks' cost of funds in addition to the change in the risk-free rate, leading to an additional response in bank lending. Bernanke and Gertler (1992) introduced a credit channel and gave a new insight to the conventional transmission mechanisms. A decrease in money supply leads to a decrease in bank deposits, which further decreases the volume of money that banks must loan out. This, in turn, decreases investment and aggregate demand. This channel allows monetary policy to operate without interest rate, meaning that decreasing interest rates may not be sufficient to increase investment. The schematic for the bank lending channels as follows:

$$M \downarrow \Rightarrow Bank\ deposits(D) \downarrow \Rightarrow\ Bank\ loan(L) \downarrow \Rightarrow I \downarrow \Rightarrow Y \downarrow$$

Consequently=f (M, D, L, I)

In order to capture the credit channel, the study employed the total domestic credit data which consist of credits provided to the government as well as to the private sectors.

2.4.5 The Exchange Rate Channel

The exchange rate channel postulates that when the economy is open, a monetary contraction will increase the domestic interest rate up to the foreign one and, thereby, appreciates domestic currency in nominal and/or real terms. Both the Taylor paper (1995) and the study by Obstfeld and Rogoff (1995) emphasize the importance of the exchange rate channel of monetary policy. In the context of the Managed float exchange rate regime, the study decided to consider exchange rate as one of variables, which is the nominal one. The exchange rate (E) refers to the domestic currency (Ethiopian Birr) units per unit of foreign currency (US dollar). The relationship between the nominal exchange rate and the real sector can be seen

through Mundell-Fleming model which describes the market for goods and services by incorporating net exports. In particular, the goods market is represented with the following equation:

$$Y = C + I(r*) + G + NX\left(E\left(\frac{p}{p}*\right)\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.3)$$

This equation states that aggregate income Y is the sum of consumption C, investment I, government purchases G, and net exports NX. Investment depends negatively on the interest rate, which equals the world interest rate r*. Net exports depend negatively on the exchange rate E. when the nominal exchange rate appreciates, foreign goods become cheaper compared to domestic goods, and this causes exports to fall and imports to rise.

The exchange rate channel established from a fall in domestic interest rate following an expansionary monetary policy, domestic dollar deposits become less attractive relative to deposits denominated in foreign currencies. As a result, the value of birr deposits relative to other currency deposits falls, and the birr depreciates (E↓). The lower value of the domestic currency makes domestic goods cheaper than foreign goods, thereby causing a rise in net exports (NX↑) and hence in aggregate output (Y↑).

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

Therefore Y=f (M, E, r, NX)

The argument for using the nominal exchange rate over the real one is that we can isolate changes in the nominal exchange rate on real economic activity separately from changes in prices, since the real exchange rate is already adjusted for changes in prices and using this

variable would make it stiff to isolate price changes (inflation) from exchange rate changes (Jayaraman and Choong, 2008).

In most of empirical analysis which include exchange rate as a variable argument arise whether to use the official rate or the parallel market rate. Based on the information from Ethiopian macroeconomic Handbook (2010) the clearest and most readily observable indication of the near to proper value of an exchange rate is its going rate in the parallel market, especially in a setting such as Ethiopia where banks do not have full flexibility to move their rates.

Generally, the three theorists (classicals, Keynes, monetarists) and Taylor and Rogoff's empirical evidence produce the following model;

$$Yt = f\,(Mt, DCt, Rt, Et, Pt) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots .. (4.4)$$

Where: Y, M, DC, R, E and P represent Output, monetary aggregate, domestic credit, interest rate(ALR), nominal exchange rate and consumer price index (price) respectively.

CHAPTER THREE

3. RESEARCH DESIGN AND METHODOLOGY

3.1. Research Approach

The empirical analysis and research of how a monetary policy shock or changes in monetary policy variables affect monetary goal variables, as well as other key economic variables has been conducted in the context of a structured vector autoregression (SVAR) framework pioneered by Sims (1980). Structural VAR models allow us to examine the causal relationships between variables, use economic theory to add structural restrictions to the VAR model and can be used to examine the impact individual shocks will have on other variables. It used to capture the dynamics and interaction between multiple time series in which the current level of each variable in the system depends on past movements in that variable and all other variables in the system. In SVAR approach all the variables are treated symmetrically, and the dependent variable in each equation is explained by lags of all the variables in the model, including the dependent variable itself.

3.2 Data Source and Types

3.2.1 Data Source and Constraints

This study uses seven different macro variables to study the transmission mechanisms of monetary policy in Ethiopia namely real gross domestic product, consumer price index, domestic credit, broad money supply, reserve money, nominal exchange rate, average lending rate and world oil price shock.

The data for broad money supply (M2), domestic credit (DC), consumer price index (P), average lending rate (ALR) and nominal exchange rate (NEER) are collected from various issues of annual and quarterly bulletins of National bank of Ethiopia. The Quarterly real

gross domestic product (RGDP) data is constructed using the quadratic-sum approach of E-views 10 software was applied.

The study employed a quarterly data which covers a period from 2000/01 Q1 to 2020/21 Q4 since the work on transmission mechanisms need a high frequency data. The period chosen for this study influenced by the availability of quarterly data and government proclamation of 1994 to reorganize the National bank of Ethiopia according to the market based economic policy. In most developing countries including Ethiopia, it is difficult to find a quarterly data on gross domestic product. To overcome this problem different researcher uses different method to obtain quarterly estimates of GDP through interpolating annual GDP data by various available procedures including cubic spline and Chow-Lin methodology (Abeysinghe and Lee, 1998; Jayaraman, 2010).

In case of Ethiopia Haile (2001) and Zerayehu (2006) both tried to generate quarterly figure of GDP by studying the behavior of seasonality function of each sector in its contribution to annual GDP based on seasonality adjustment coefficients. Regarding this study, since it was the academic exercises, i preferred to generate the quarterly data based on the seasonality adjustment to annual agriculture, service, and industry component of the RGDP. i disaggregated the annual contribution to the RGDP into 75 percent to quarter two since it was the main harvesting season, 15 percentiles to fourth quarter and the remaining 10 precent allocate equally to the remaining two quarters base on the statistic on agricultural studies. The remaining components service and industry disaggregated equally among the quarter.

World oil price will be obtained from World Bank database. All the variables will be transformed to natural logs except for average lending rate which is in percentage Exogenous variables such as World oil price (PC) a needed to be made comparison among similar SSA

developing countries in region are available from public sources - the IMF's Financial Statistics (IFS), the World Bank and AfDB (annually indicators).

3.3 Model Specification

3.3.1 Econometric Framework

In this paper, the study chooses to estimate a SVAR model with contemporaneous restrictions to analyze the monetary transmission mechanism in the case of Ethiopia as pioneered by Sims (1986) and Bernanke (1986). It is useful to examine the relationship between forecast errors and structural innovations in an n-variable VAR. In a modeling sense, an SVAR has the following general form:

$$A0Yt = A1(L)yt + B\varepsilon t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where: Yt is a (n×1)vector of endogenous variables; A0 and B are vector of parameters, A1(L) = ∑in=1 A1i LI -is a matrix polynomial in the lag operator and (εt) is a (n ×1)vector of vector of structural shocks. A SVAR model is put into a reduced VAR form by multiplying both sides of (1) by the inverse matrix

$$Yt = C(L)Yt + et \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2))$$

Where: C(L) = A0−1A1(L) and et represents a vector of reduced-form residual, that is A0-1Bε_t

The structural form or compact form, an SVAR system relates to the following relations:

$$Aoet = B\varepsilon t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

Equation (3) is known as the AB model (Amisano and Giannini, 1997). Where: A0, is (n× n)matrix of contemporaneous relations between endogenous variables, B is (n × n) matrix that linearly elates the SVAR residuals to the structural innovations, et is vector of reduced-form residual, and εt is vector of structural shocks.

The residual et in the reduced form is presumed to be white noise. Therefore, we can estimate the AB model by OLS (Ordinary Least Squares). The restrictions imposed on the matrix should come from the results of reliable empirical macroeconomic models and based on the

theory. The more common approach in this regard is to impose a set of identification restrictions that are broadly consistent with economic theory that expects to provide sensible outcomes. Kim and Roubini (2000) created a template of identification in SVAR while evaluating the monetary policy of OECD economies and it later became the standard approach in modeling the monetary policy framework for a small open economy, and then applied by Rokon (2008) in Canada, Raghavan et al. (2010) in Malaysia, and Thanabalasingam (2013) in Sri Lanka and others.

Based on the reviewed theoretical and empirical literatures, Seven-variable non-recursive identifications SVAR model has been established to investigate the monetary policy transmission channel in Ethiopia. Non-recursive identification, which contains one or more „feedback loops" or „reciprocal" effects is more flexible and more appropriate for modeling the economy.

$$Yt = [WOPt, RGDPt, CPIt, RMt, DCt, M2, ALRt, NEERt] \dots\dots\dots\dots\dots\dots\dots\dots (4)$$

There were one international variable and six domestic variables in the above equation. World oil price (wop) accounted for external shocks or international variables, in which oil was the non-policy external inflationary pressure and the fed was the proxy for external foreign monetary policy pressure. Domestic variables included real gross domestic product (rgdp) and consumer price index (cpi), which were the targets of monetary policy; money supply (M2) and the policy interest rate (in this case Average Lending Rate), which were considered monetary policy instruments; and the nominal effective exchange rate (neer), which accounted for the market information force.

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a21 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a31 & a32 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & a42 & a43 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & a53 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & a63 & a64 & a65 & 1 & 0 & 0 \\ 0 & 0 & 0 & a64 & a65 & a66 & 1 & 0 \\ a81 & a82 & a83 & a84 & a85 & a86 & a87 & 1 \end{bmatrix} \begin{bmatrix} \mu wop \\ \mu rgdp \\ \mu cpi \\ \mu m2 \\ \mu alr \\ \mu rm \\ \mu dc \\ \mu neer \end{bmatrix} = \begin{bmatrix} b11 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b22 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b33 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b44 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b55 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b66 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b77 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & b88 \end{bmatrix} \begin{bmatrix} \varepsilon wop \\ \varepsilon rgdp \\ \varepsilon cpi \\ \varepsilon m2 \\ \varepsilon alr \\ \varepsilon rm \\ \varepsilon dc \\ \varepsilon neer \end{bmatrix} \dots\dots\dots (5)$$

Where εwop, εrgdp, εcpi, εM2, εlr, εrm, εdc, εneer respectively are the structural innovations of the shocks from the world oil price, real gross domestic product, consumer price index, money supply, policy interest rate proxied by average lending rate, Reserve money, domestic credit supply, and nominal effective exchange rate. It is noticeable that vector Y_t consists of three different blocks of variables that have inter-linkages with each other, which are, the foreign block (wop), representing the exogenous shocks from international economy, the non-policy block/MP goals (rgdp, cpi), describing the goods market equilibrium, and the policy block, (alr, rm m2) and (dc, neer) describing the money market equilibrium.

The inclusion of foreign variables was essential for correct model specification, improved identification of contemporaneous relationships, and to capture the underlying impulse responses of variables to various shocks. In addition, Ethiopia is oil importer and the assumption that oil might exert an effect on all other variables contemporaneously.

In addition, Certainly, the shocks originating from Ethiopia are unlikely to have any significant impact on the rest of the world, since Ethiopia is small open economy, thus oil price is not contemporaneously affected by domestic variables of Ethiopia, those exogenous (Raghavan&Silvapulle,2012).

non-policy block these are the targeted economic variables, which are assumed to receive contemporaneous influence from foreign variables and lagged impacts from other domestic variables. Specifically, GDP is influenced by oil price. The rationality behind this assumption is that domestic firms must respond immediately to oil price shocks due to the important role of oil in all sectors. However, they are unlikely to adjust outputs and prices within a month in response to unexpected shocks from domestic monetary policies. Moreover, Policy block, this block consists of NBEs regular monetary instruments, which

are, money supply (M2), policy interest rate which is proxied by average lending rate and reserve money. The domestic credit supply and nominal effective exchange rate are an indication of risk in money market.

Furthermore, in the identification, it is assumed that GDP and CPI contemporaneously impact M2, meaning that while adjusting for the current level of money supply, the NBE also monitors the growth level of output and price level, as well as other monetary indicators. Domestic Credit is assumed to not be influenced by foreign variables but is impacted by all domestic variables, except GDP. However, this model had to ignore the asset price channel due to the lack of data and the fact that the financial asset market in Ethiopia is in its infancy stage.

3.2.2 Stationarity and Non-Stationarity

Although the classical regression model assumes that both the dependent and independent variables to be stationary over time, most economic variables exhibit long run trend movement and only become stationary after they are differenced (Alemayehu, Daniel and Ndung'u, 2009). Thus, empirical literature for unit root shows that almost all macro variables are non-stationary in level while their difference is stationary. Applying the standard regression techniques to the levels of variables leads to a spurious correlation, which may give very high R2 value and significant t-ratio even without true relationship among the variables.

Therefore, Ordinary Least Squares (OLS) may lead to inconsistent and less efficient parameters as they may show that there is a strong relationship whilst in actual fact there is no relationship at all and hence the results obtained from such regressions will not have

a meaningful economic interpretation. Hence, prior to estimation of the long run models the time series properties of the variables, unit root test, should be conducted

3.2.3 The Unit Root Test

Several tests are usually employed to test whether time series variables are stationary or non-stationary: The Dick-Fuller (DF), the Augmented Dick-Fuller (ADF) test, Ng peron test and Phillips-Peron test (PP). In this study the researcher is going to employ the ADF test to determine the existence of a unit root. By incorporating the autoregressive process of order p, this model becomes superior to DF. Basically, this test has been chosen for its consistency, accuracy, and resourcefulness**.** The general form of the ADF equation where only an intercept is included is as follows:

$$\Delta Yt = Ao + \rho Yt + \Sigma \beta i \Delta Yt\, i + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

For the case where the auto regression includes the intercept and a trend, the equation is of the following form:

$$\Delta Yt = Ao + A\, t + \rho Yt + \Sigma \beta i \Delta Yti + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

Where, *Yt* is any variable in the model to be tested for stationary, A1 is coefficient of a trend,εt is an error term, Δ is the first difference operator and A0 is a constant. The null hypothesis of ADF is $\rho = 0$ against alternative hypothesis that $\rho < 0$. A rejection of this hypothesis means that the time series is stationary, or it does not contains a unit root while not rejecting means that the time series is non-stationary (Enders,2004). We have to be care full also in determining p of the lagged variables because too few lags will leave autocorrelation in the errors and distort the test and too many lags will reduce the power of the test.

3.2.4. Lag Length and VAR Stability Check

To determine the lag length of the reduced form (VAR), the study used different lag-length selection criteria, including LR, FPE, AIC, SC, and HQ. The entire lag length section test suggests appropriate lag length for the VAR model is one (1) Before using the optimal lag length to estimate the parameters of the SVAR, it is necessary to check the conditions of VAR stability using the AR roots. if the results of all the eigenvalues in the proposed model lay in the unit circle, that is there value less than one or unity. So, the VAR/SVAR model satisfies the stability condition.

3.2.5 Impulse Response and Variance Decomposition

Impulse response is a method of assessing the interaction among the variables in the VAR. This method can be used either to assess the dynamic behavior of the VAR or to investigate the policy impact of the variables that constitute the VAR (Alemayehu, Daneil and Ndung‘u 2009).

The coefficients of VAR models only reveal the direct and ceteris paribus effect without taking in to account the fact that the lagged explanatory variables in each equation are inter linked. That is both with a lag and contemporaneously and therefore do not reflect the full impact of one variable on another. As a result, the analysis relies to a great extent on impulse response functions to estimate the total short and long run impacts of an increase in one variable on another variable.

Fundamentally impulse response demonstrates how one variable, say price level, responds over time to a shock in another variable (exchange rate, interest rate, etc.) and compares this response to shocks from other variables. Impulse response function just traces out time path of the effects of shocks of other variables contained in the VAR model on a particular

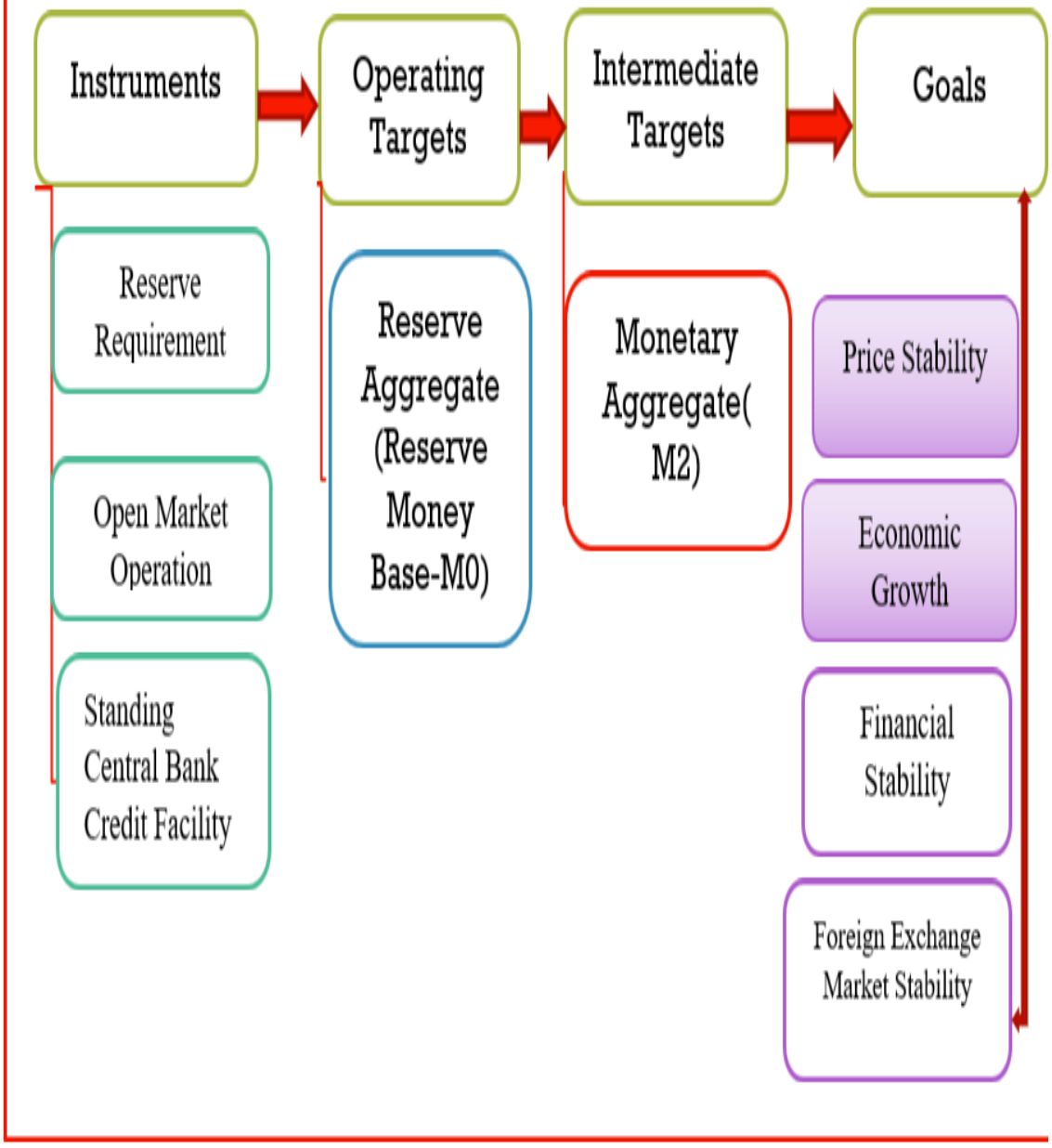
variable. In other words, this approach is designed to determine how each variable responds over time to an earlier shock in that variable and to shocks in other variables. (Lutkepohl and Kratzig, 2004) While impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR, variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR.

The variance decomposition helps in identifying the degree to which one variable influences the other. According to Brooks (2002), Variance decompositions trace out the proportion of the movements in the dependent variables that are due to their own shocks versus shocks to the other variables. It shows the components of variances of dependent variables clearly.

This study was used variance decomposition to break down and ascertain the degree to which change in one policy variable influence target variables in the system and vice versa. Variables in a system will have a forecast error and the error in forecasting can be attributed to the present and past values of the variable in question and the past and present values of all other variables in the system. So, by breaking down this forecast error it is possible to determine the degree to which the variable in question is being influenced by its past and present values and to the other variables in the system (Handa, 2009). The variance decomposition determines how much of the n-step ahead forecast error variance of a given variable is explained by innovations (shocks) to each explanatory variable.

Monetary Policy Linkage-Monetary Target in Ethiopia

Operating Framework



3. 3 Variable Description, Measurements and Research Hypotheses

The period also reflects the true post-structural adjustment performance of the study's macroeconomic variables of interest. In our empirical analysis, we took the natural logarithm of Rea Gross Domestic Product, Reserve Money, consumer price level, nominal effective exchange rate, Domestic Credit, and Broad money.

Apart from aiding interpretation and compactness of results presentation, this form of transformation tends to reduce heteroskedasticity significantly (Enders, 2004). Average lending Rate (ALRt) enters the SVAR model primarily as the MP control instrument. In our analysis, experimentation with other forms of interest rates reveals no significant difference between the empirical results emanating from the use of other rates. Reserve Money (M0t) is also employed as an instrument target of MP in the SVAR. Components of (RMt) are identified as total cash reserves held by the central bank, vault cash in commercial banks and currency held by the non-bank public. The variable (DCt) captures commercial bank loans and advances to the private sector and Government, and it enters the SVAR as an intermediate target of MP. Similarly, Nominal effective exchange rate (NEERt) enters the SVAR as an intermediate target of MP. Nominal effective exchange rates of the Ethiopia Birr vis-à-vis the United States Dollar (US$) are used as a proxy. Aggregate money supply is measured by the sum of currency in circulation, demand deposits plus savings and time deposits (M2). This variable also enters the SVAR as an intermediate target of MP an alternative of Reserve money to see the robustness of the model. Consumer prices (CPIt) are measured by all items of national composite consumer price index. Variable enters the SVAR as a MP goal. The Real Gross Domestic Product, (RGDPt) , which we adopt as a measure of output enters the SVAR as a MP goal as well.

Table 1 Summary of Definition of the Variables

Var. Label	Variable definition	Source
WOP	World oil price proxied by price of Crude oil	W/ Bank
RGDP	Real Gross Domestic product (2011=100)	MoF/NBE
CPI	Consumer price index (2011=100)	MoF/NBE
RM	Reserve money defined as total cash reserves held by the central bank, vault cash in commercial banks and currency held by the non-bank public Money.	NBE
DC	commercial bank loans and advances to the private sector and Government	NBE
M2	Aggregate money supply is measured by the sum of currency in circulation, demand deposits plus savings and time deposits.	NBE
ALR	An average of the minimum and maximum bank credit lending rate	NBE
NEER	Nominal effective exchange rate between Birr and USD	NBE

In answering the research questions, the study postulating the following hypostasis based on the literature and empirical studies reviewed.

H1: The money policy instruments channels has no significant impacts on output and price level in Ethiopia indicating that monetary policy transmission channel is not effective in influencing macroeconomic variables in the Ethiopian economy.

H2: External shock (World oil price) has no significant impact on output and price level in Ethiopia indicating that monetary policy transmission channel is not effective in influencing macroeconomic variables in the Ethiopian economy.

H3: The price Channel or the money supply channel has no significant impact on transmission of monetary policy in Ethiopia

CHAPTER FOUR
EMPIRICAL FINDINGS AND ANALYSIS

4.1 The Unit Root Test for Stationary

To resolve the problem of choosing the most appropriate unit root test, Enders (1995) opines that a safe choice is to use both types of unit root tests—the Augmented Dickey–Fuller (ADF) (1981) and the Phillips–Perron (PP) (1988) tests. Reinforcing this way bolstered our confidence in the results. Using both tests, the unit root tests were performed at level and at first difference for both with the intercept, and with intercept and trend term. The optimum lag was selected by using the Schwartz Information Criterion (SIC) as suggested by Pesaran and Shin (1997).

From the summary of the unit root test result in Table 1, the two tests' result shows that all the variables are non-stationary at levels, but rather at first difference.

Table 2 ADF and PP unit root tests results for stationarity of the variables

Phillips-Perron test statistic (ADF Test)									
	With Intercept				Trend and Intercept				
	ADF		PP		ADF		PP		
Var.	Level	1st difference	Level	1st difference	Level	1st difference	Level	1st difference	Dec
LWOP	-1.889208	-7.720169***	-1.959201	-7615578***	-1.819942	-7.695558***	-1922412	-7.590643***	I (1)
LRGDP	0.291688	-4.777289***	0.544179	-4.776893***	-2.550328	-4.852450***	-2.043334	-4.861926***	I (1)
LCPI	0.636766	-5.992905***	0.805674	-7.432179***	-2.480129	-6.071776***	-2.374783	-7.501037***	I (1)
LRM	-1.952304	-7.621414***	-3.458086	-8.881941***	-2.854901	-7.884162***	-2.578226	-10.58940***	I (1)
LDC	0.367215	-9.360418***	0372345	-9.355502***	-2.743994	-9.325159***	-2.8275589	-9.321144***	I (1)

LALR	-0.601003	-8.970756***	-0.610786	-8.970756***	-3.569962	-9.289249***	-3.586131	-9.295775***	I (1)
LNEER	2.107128	-6.066889***	1.999351	-6.180639***	-1.339023	-6.770703***	-1.403439	-6.888812***	I (1)
LM2	1.180580	-3.028738**	3,228944	-9.013082***	-2.263067	-3.298716*	-4.811345	-9.867695***	I (1)

Notes: (i) The automatic lag selection box which sets the maximum number of lags at 12 is chosen.
ii.*, **, *** indicates significant level at 10%, 5% and 1% level of significance
(iii) Critical values at:
Level (with intercept) at 1 per cent and 5 per cent for ADF statistic are -3.511262 and -2.896779 while for PP are- 3.512290 and -2.897223 Level (with intercept and trend) at 1 per cent and 5 per cent for ADF statistic are -4.072415 and -3.464865 while for PP are -4.05340 and -3.466248.
First difference (with intercept) at 1 per cent and 5 per cent for ADF statistic are -3.513344and -2.87678 while for PP are -3.512290 and –2.897223.
First difference (with intercept and trend) at 1 per cent and 5 per cent for ADF are -4.072415 and -3.464865 while for PP -4.075340 and -3.466248.

Source: Author's estimation

4.2. Lag Length and VAR Stability Check

To determine the lag length of the reduced form (VAR), the study used different lag-length selection criteria, including LR, FPE, AIC, SC, and HQ. In Table 2 the lag length selection criterion is tabulated. The entire lag length section test suggests appropriate lag length for the VAR model is seven (7).

Table 3 VAR Lag Order Selection Criteria

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	886.5963	NA	1.26e-20*	-23.12095	-22.87561*	-23.02290*
1	940.8806	95.71178*	1.64e-20	-22.86528	-20.65721	-21.98283
2	987.1396	71.82323	2.75e-20	-22.39841	-18.22762	-20.73156
3	1023.456	48.73989	6.57e-20	-21.66988	-15.53638	-19.21864
4	1077.871	61.57495	1.13e-19	-21.41765	-13.32142	-18.18200
5	1130.278	48.27032	2.60e-19	-21.11259	-11.05364	-17.09255
6	1203.118	51.75421	5.18e-19	-21.34520	-9.323525	-16.54076

7	1357.910	77.39619	2.41e-19	-23.73448*	-9.750076	-18.14563

* 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

Source: Author's estimation

Before using the optimal lag length to estimate the parameters of the SVAR, it is necessary to check the conditions of VAR stability using the AR roots. The results, presented in table 3, show that all the eigenvalues in the proposed model lay in the unit circle, that is there value less than one or unity. So, the VAR/SVAR model satisfies the stability condition.

Table 4 Roots of Characteristic Polynomial

Roots of Characteristic Polynomial	
Root	**Modulus**
0.133180 + 0.957492i	0.966710
0.133180 - 0.957492i	0.966710
-0.933829 - 0.233211i	0.962509
-0.933829 + 0.233211i	0.962509
0.948080 - 0.153337i	0.960400
0.948080 + 0.153337i	0.960400
-0.553527 + 0.784513i	0.960132
-0.553527 - 0.784513i	0.960132
0.566627 + 0.771300i	0.957064
0.566627 - 0.771300i	0.957064
-0.312299 + 0.898944i	0.951647
-0.312299 - 0.898944i	0.951647
0.674670 - 0.662187i	0.945342
0.674670 + 0.662187i	0.945342
0.763295 + 0.555345i	0.943943
0.763295 - 0.555345i	0.943943
-0.936820 - 0.096886i	0.941817
-0.936820 + 0.096886i	0.941817
-0.025051 - 0.937753i	0.938088

-0.025051 + 0.937753i	0.938088
-0.242062 - 0.903545i	0.935408
-0.242062 + 0.903545i	0.935408
0.817123 + 0.450446i	0.933055
0.817123 - 0.450446i	0.933055
-0.871650 + 0.329646i	0.931902
-0.871650 - 0.329646i	0.931902
-0.788405 + 0.488897i	0.927687
-0.788405 - 0.488897i	0.927687
0.250456 - 0.890011i	0.924580
0.250456 + 0.890011i	0.924580
0.449643 + 0.794483i	0.912897
0.449643 - 0.794483i	0.912897
-0.072658 - 0.908794i	0.911694
-0.072658 + 0.908794i	0.911694
-0.440400 - 0.794494i	0.908391
-0.440400 + 0.794494i	0.908391
-0.622235 + 0.640203i	0.892769
-0.622235 - 0.640203i	0.892769
0.275509 - 0.839185i	0.883254
0.275509 + 0.839185i	0.883254
0.832116 + 0.286690i	0.880119
0.832116 - 0.286690i	0.880119
0.859753 + 0.092739i	0.864740
0.859753 - 0.092739i	0.864740
-0.821343	0.821343
-0.627228 + 0.503304i	0.804195
-0.627228 - 0.503304i	0.804195
0.546094 - 0.574679i	0.792764
0.546094 + 0.574679i	0.792764
-0.310778 - 0.692791i	0.759304
-0.310778 + 0.692791i	0.759304
-0.619540 + 0.315632i	0.695308
-0.619540 - 0.315632i	0.695308
0.663523	0.663523
0.486121	0.486121
0.350209	0.350209
No root lies outside the unit circle.	
VAR satisfies the stability condition.	

Source: Author's estimation

We estimated the VAR and SVAR models with seven lags, as preferred by Disyatat and Vongsinsirikul (2003), which allows us to demonstrate broader fluctuations in the impulse

responses. As it passes to the diagnostic tests, the VAR and SVAR models appear to be valid.

Restriction has been made to the SVAR model to be identified. since in our case the number of variables is 8, we need 64 restrictions for matrix A and B to be just identified. Out of them, 56 restrictions are given by matrix B -diagonal matrix. Consequently, 36 restrictions are required in A for the system to be just identified. The model specified in equation 5 is over identified and were rejected at the 1% level (see table 5). The LR test for the over-identification restriction of the contemporaneous SVAR model found valid, with the probability value of 0.64.74321(see table 5). That is likelihood ratio test does reject the null hypothesis of over-identified restrictions and accept the alternative that the model well identified. The Chi-square (8) test for Ethiopia is 64.74321, with the corresponding p-value of 0.000.

Table 5 Identification of SVAR

Log likelihood	904.1050		
LR test for over-identification:			
Chi-square (6)	64.74321	Probability	0.0000

4.3. Impulse Response of Structural VAR Innovation

Impulse response Figure 1 shows the results of the impulse response functions. The dotted lines represent 95% bootstrapped confidence intervals and the responses up to 3 years ahead are considered. The values on the vertical line correspond to the deviation from the baseline level of the variable in response to a considered shock. The values on the horizontal line represent the time passed after the occurrence of the shock. Each column corresponds to the effects of one shock on the variables, whereas each line reflects the effects of different shocks on the same variable.

Reference to the below figures, each individual row reflects the impacts of a specific shock. The first row demonstrates the impacts of a World oil Price (WOP) shock. Each individual column contains the impacts of shocks to each variable on a specific variable. The first column demonstrates the impacts of shocks to World oil price, RGDP, CPI, Reserve Money, Domestic Credit, Average lending rate, Aggregate Money, and Effective nominal Exchange rate to world oil price.

If there is a shock to all variables at period 0, there is no instantaneous impact on world oil price except its own shock, it is consistent with our granger causality testing and short-run restrictions. After an initial shock to reserve money, board money and nominal effective exchange rate bounces sharply after the first two quarters before landing to zero. After 6 to 8 quarters, it is slightly lower than it started. the impact of the other shock, smoothly decreases with little up and down for the entire periods.

To address one of the specific objectives and to answer the research question my analysis focused on the results on the real variable. The Figure on one and two focused on the Responses of output and price to Domestic and Foreign Variables Shock.

Shock1 in figure one and two shows the response of output and price for world oil price shock (WOP). After an initial shock to wop, the real GDP, instantaneously decrease a very small amount and start to increase in the third quarter followed by a sharp decline in the next three quarters to the seven quarter periods. It eventually returns to a longer-run path of smooth decline. After 12 quarters it is closer to it started. After an initial shock to price, instantaneously decreases as expected like output decreases in response to WOP (shocks1). The increase in world oil price is expected to transfer to domestic economy through increase in price of exported commodity, which in turn affects domestic output and price. Undesirable

responses of GDP and CPI explained by the rising cost of production due to an increase in world oil price and its common to oil importing country like Ethiopia.

Shock2 in figures 1 and 2 indicate, after an initial shock, RGDP instantaneously and sharply decreases for the first ten periods. It eventually returns to a longer-run path of smooth increase. After 10 quarters, it is slightly star to pick up. The variation in RGDP accounted for by own shock diminished over time.

After an initial shock to the RGDP, inflation has slice instance decline up to two periods before bounces sharply in the next two quarters before landing on a long-run path of decreasing. After 4 quarters of decline, it bounces again sharply for two period and start to decline in recurring manner.

The price changes in goods and services purchased out of pocket by consumers affect the CPI and it ultimately captured by the GDP price index in which the implicit price deflator measure price changes in goods and services purchased by consumers, businesses, government, and foreigners, but not importers. One possible explanation for an increase in inflation is demand-pull which can be caused by an expanding economy, increased government spending, or overseas growth. Whereas the decline in CPI can be explained by the effectiveness of the monetary authority in achieving its objective.

The effectiveness of the monetary instrument could be manifested the element of direct control by the impulse response of RGDP and CPI to the shock 4(Reserve money), in which the central bank decrease/increases its requirement can increase the money supply by lowering the reserve requirements for banks. It allows them to lend more money. Conversely, by raising the banks' reserve requirements, the authority can decrease the size

of the money supply. The result is consistent with the restriction and economic theories that output, and price do not respond contemporaneously to changes in domestic monetary policy variables.

Shock5 in figure 1 and 2 shows the estimated impulse responses of output and price to positive domestic credit growth shocks, respectively. Output tends to progress slightly for two period only in response to a positive credit shock. Even though, domestic credit expansion is an important source of economic growth by a crucial role in a country's development by sanctioning loans to developing industries and trade banks provide them with the necessary aid for improvement. This leads to increased production, employment, profits and encouraging investment and then aggregate demand and economic growth, The result is inconsistence with the theory.

As suggested by Mishkin (1995), the credit channel operates through two main components—the balance sheet channel and the bank lending channel. Theory suggests that increasing money supply increases the total credit that banks can supply to the economy and, through the bank lending channel, will in turn boost aggregate demand and output.

In analyzing the balance sheet channel, Bernanke and Gertler (1995) focused on the external finance premium, which they defined as the wedge between the cost of funds raised externally and the opportunity cost of internal funds. However, in Ethiopia this channel may be insignificant because, until recently, most credits were given to large, state-owned enterprises according to government directives without consideration of their financial positions.

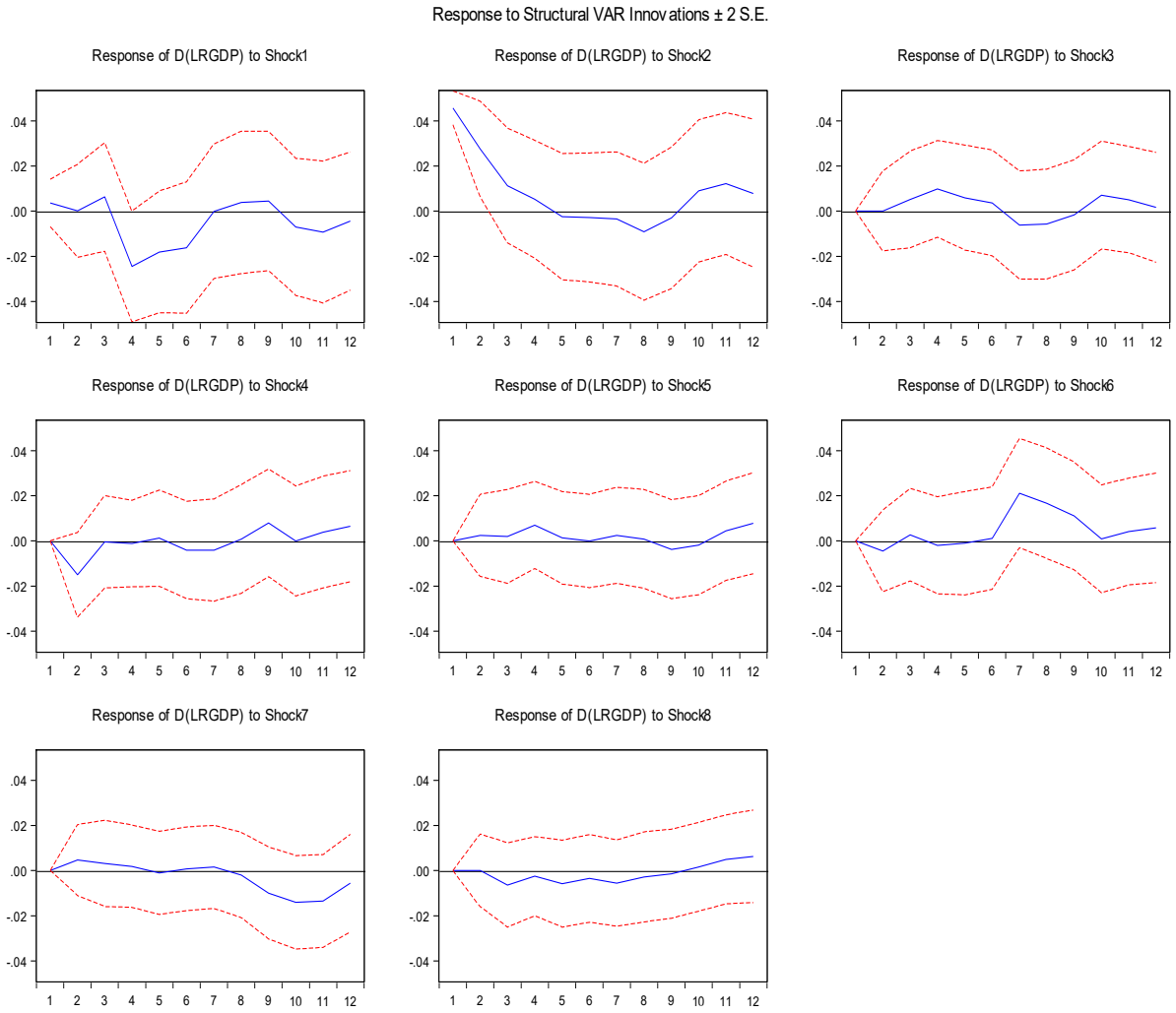
Based on the assumption that an increase in the money supply will lead to an increase in credit and eventually to an increase in aggregate demand and output. The impulse response of RGDP to the shock show slice positive increment after the third period, the Granger causality test indicates that credit does Granger cause output and price.

The impulse repose of CPI to credit shock indicates a negative association between them. After an initial shock to the credit, CPI smoothly increases for roughly 3 periods and starts to smoothly decreases for two continuative period. It eventually returns to a longer-run path of smooth increase. After 11 quarters it is slightly lower than it started.

despite that fact that, the lack of bank loans has constrained the level and efficiency of investment in the country, it has an inflationary pressure to the total output. The negative effects of inflation on private credit and economic growth as well as the hypothesis stated by the finance and growth literature in the sense that financial depth, as proxied by domestic credit especially private sector credit, encourages both the level and rate of long-run real output. According to the impulse response an increase in credit generates a rise in the long-run rate of economic growth despite the inflation rate has a negative impact on output for every percentage increase in prices.

The Positive credit shock doesn't affect RGDP as expected while at the later period CPI positively, which is not in line with our expectations and the theories. That is the increases in credit create more demand for goods and services and hence increase the output and price level. These results show that there is no as such an effective credit channel of monetary policy transmission specifically considering the role and contribution of credit to the private sector to the real output.

Figure 1 Impulse Response of RGDP to Different Variable Shock



Shock6 in figure 1 and 2 shows the estimated impulse responses of output and price to positive money growth shocks, respectively. Output responds gradually to a positive monetary shock after the sixth period and price decline contrary to the shock as expected after the seventh period.

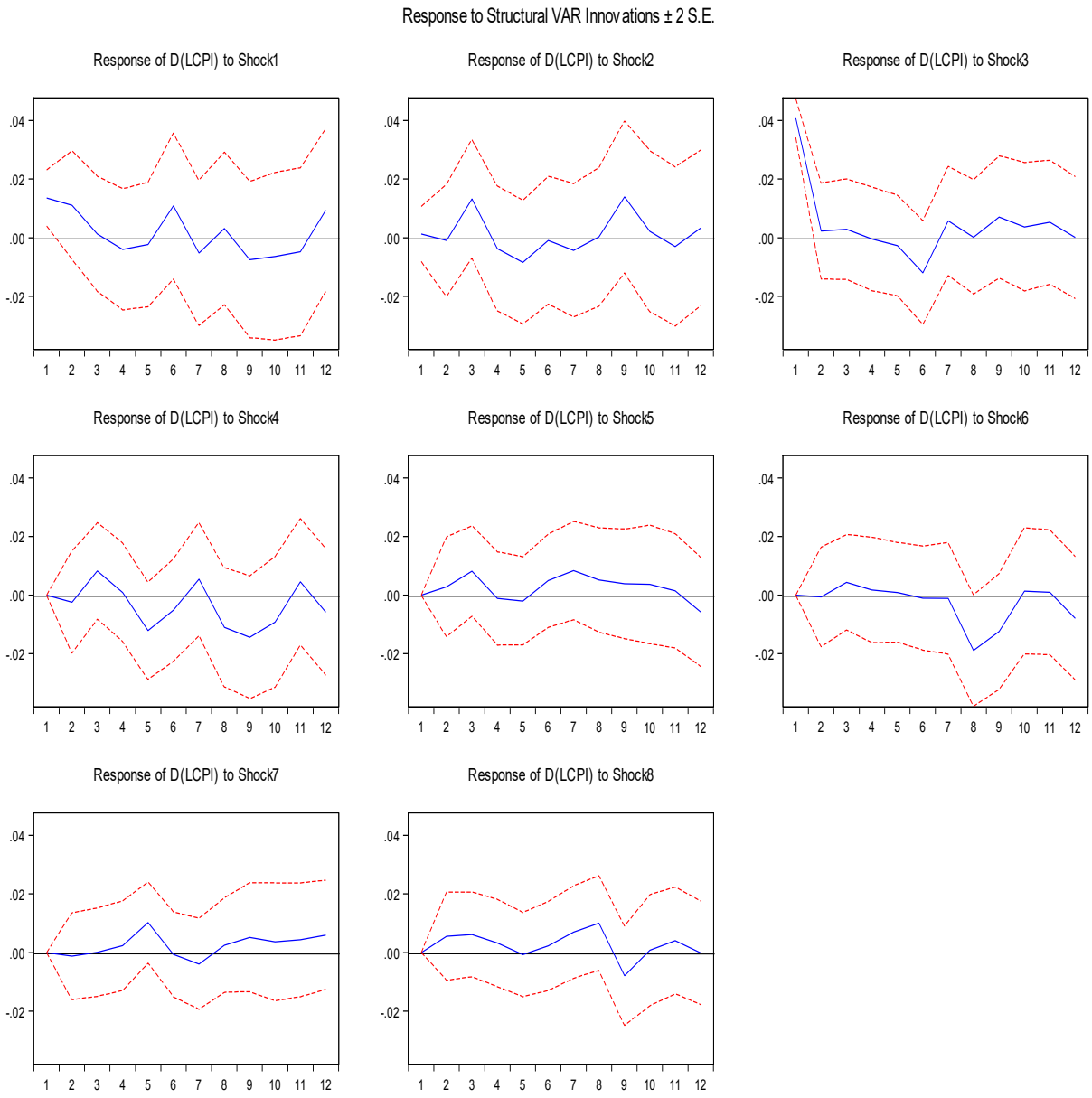
The monetary expansion is an important source of economic growth by reducing cost of investment and encouraging investment and then aggregate demand and economic growth,

which is in line with the theory while, the expected response of a transitory impact of monetary policy, output converges slowly. The effect of a shock to aggregate money supply (Shock6) on prices is negative (as can be seen from figure 2). price kept steady until the seventh period and start to decline then after. The result might be the effectiveness of the monitory control instrument (reserve money) by the authority. The granger causality result show that, money supply granger cause RGDP growth and consistence to the impulse response, money supply does not granger cause CPI at 5 percent level of significances.

Shock7 in figure 1 and 2 shows the estimated impulse responses of output and price to the average lending rate shocks, respectively. After an initial shock to output gradual increases for two period before landing on a long-run path of decreasing. After eighth quarters it is lower than it started. An increase in the lending rate now has two effects. The first effect is the direct effect on investment, A higher interest rate leads to a decrease in investment, a decrease in the demand for domestic goods and a decrease in output. After an initial shock to lending rate, the CPI instantaneously increases a very small amount followed by a sharp increase in the first five periods. It eventually returns to decline for three period. After eighth quarters it is higher than it started and then a longer-run path of smooth rise.

The impulse response of CPI to the lending rate shock is consistence with the theory that, high cost of financing lead to the price changes in goods and services purchased out of pocket by consumers that ultimately bear by it.

Figure 2 Response to Structural VAR Innovation



Shock8 shows the responses of output to nominal effective exchange rate shock. Positive NEER shocks, representing an increase in nominal effective exchange (appreciation) increase real income (RGDP). Ethiopia is an import dependent country where its imports are mainly composed of capital goods and raw materials which a country cannot afford now. Thus, devaluation makes the price of these essential imported goods more expensive and thereby discouraging domestic investment activities which will affect output level. this fact

shown in the impulse response of both output and CPI. After an initial shock to NEER, output response by decline sharply until third period and start to bounce to the baseline until tenth period before being pushed to a gradual, smooth path of increasing for roughly after the tenth quarters. After 10 quarters it is higher than it started.

4.4 Forecast Variance Error Decomposition Estimation Results

The Forecast error variance decomposition (FEVD) "decomposes" the variance of the forecast error into the contributions from specific exogenous shocks. Intuitively this is useful because it demonstrates how important a shock is in explaining the variations of the variables in the model. and also how that importance changes over time. For example, some shocks may not be responsible for variations in the short run but may cause longer-term fluctuations. Variance decomposition of output (Q) and prices (P) is carried out to look at the strengths of each channel of monetary transmission mechanism. This is achieved by using forecast horizons of 1 through 24 quarters. The first column lists the quarters ahead, whereas the second column refers to standard error (SE), which is the forecast error of the variable at different quarters. Shock represents each variables Shock: Shock1 (WOP), Shock2 (RGDP), shock3 (CPI), shock4 (Rm), shock5 (DC), shock6 (M2) and Shock7 (ALR) and Shock 8 NEER). Moreover, the decomposition values for the 1st, 4th ,8th 12th,16th, and 20th horizon into the future are displayed in table 6a and b.

Table 6 Variance decomposition using Structural VAR Factor

a). **RGDP**

Period	S.E.	WOP-Shock	RGDP-Shock	CPI-Shock	RM-Shock	DC-Shock	M2-Shock	ALR-Shock	NEER-Shock

1	0.207721	0.635448	99.36455	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4	0.263675	15.64946	71.81354	2.964357	5.431396	1.419851	0.747816	0.845476	1.128110
8	0.284954	21.40901	52.92994	4.163028	4.470849	1.151497	12.90690	0.742465	2.226308
12	0.304721	19.35860	46.03450	4.399820	5.185078	2.257432	12.56875	7.491693	2.704123
16	0.313219	18.11633	43.81740	4.296359	5.452530	2.641328	14.61639	7.244638	3.815020
20	0.324028	18.46962	43.32282	4.239293	5.458211	2.945446	14.20284	7.108861	4.252913
24	0.334373	18.44166	42.06946	5.191746	5.934217	3.104515	13.78946	7.168340	4.300613

b). CPI

Period	S.E.	WOP-Shock	RGDP-Shock	CPI-Shock	RM-Shock	DC-Shock	M2-Shock	ALR-Shock	NEER-Shock
1	0.045917	9.923775	0.084461	89.99176	0.000000	0.000000	0.000000	0.000000	0.000000
4	0.064644	13.18199	7.686059	68.52896	3.030957	3.116595	0.922965	0.289193	3.243281
8	0.076633	12.14608	7.026191	46.86820	10.00124	5.067786	9.643610	3.359179	5.887709
12	0.086020	13.05089	9.329522	36.94276	14.02590	5.002813	11.39041	4.321860	5.935836
16	0.089890	13.08054	9.528363	32.69807	14.93115	5.596484	12.65943	4.919268	6.586695
20	0.092415	12.78091	9.753744	31.10729	14.58891	6.763372	12.14173	5.318408	7.545629
24	0.093949	14.05799	9.615871	29.74425	14.31498	7.593519	11.56083	5.410022	7.702540

Factorization: Structural

When the impulse response functions pin down the impact of a shock of a given variable on the remaining variables in the VAR model, the variance decomposition gives information about the relative importance of each shock hitting the VAR in explaining the variability of each variable in the model at different horizons. Table 6 shows the variance decomposition of output and prices computed at forecast horizons up to 3 years. It is clear from this table that the variation in output and prices come mainly from their own shocks. After two months,

99.36% and 89.99% respectively of the variance of output and prices are explained by their own shocks. In addition, 42.07% and 29.74% of the variability of these variables is sourced from their own shocks after three years.

The fluctuations in output are mostly accounted for by reserve money and world oil price. RM accounts for 5.43% and WOP accounts for 15.65 silently CPI 2,97% of the variations in output in short and medium term. Aggregate money and average lending rate (13.78 & 7.18) medium term. We have noticed that the contribution of aggregate money and average lending rate a raise after the one-year lag of its shock. This suggests that the money still plays an important role in the monetary policy strategy.

The fluctuations of output are mainly explained by its own shocks (Shock 2), reserve money shock (Shock4), wop (shock1), Money supply (shock6) and CPI shock (shock 3) over the short and medium period. In terms of transmission channels, nominal effective exchange rate shocks (Shock 8) explain more output fluctuations than credit shocks (Shock 5) and average lending rate (Shock 7).

The impacts of two channels (average lending rate, money supply) are effective transmission channels of monetary policy in affecting output, while the influences of the effective exchange rate and the credit channel are ineffective as can be seen its contribution in affecting output in table 5. The contribution of world oil prices (Shock 1) and reserve money (Shock 4) are enormous. It indicates, in both the short and medium period, internal as well as external factors play a crucial role in the fluctuations of output in Ethiopia.

subsequently, the money supply explains 13.73% of variance of output after two years. This result supports the significant and transitory impact of monetary policy on output as

highlighted by the impulse response functions. The domestic credit and exchange rate channels are weak. The proportion of output variations attributable to the shock to these variables is 1.15 and 2,22% after eight quarters.

Regarding the variance decomposition of prices, the reserve money shocks, monetary aggregate shocks, and the world oil price shock accounts for 14.37%, 11.56% and 14.05% of the fluctuations in consumer prices after three years. the credit shocks and the effective exchange rate shock also accounts 7.5% and 7.7 percent of the fluctuations in consumer price including its own shock of 29.74%. The world oil price along with the shocks in monetary aggregate and reserve money are an important source of inflation in Ethiopia. The real Gross domestic product also plays an active role in explaining the fluctuations in prices since it accounts for 7.6 % to 9.6% sequential contribution for three years, involving the effectiveness of the shock as shown by impulse response analysis. Likewise, a non-negligible part of variance in prices is sourced from a shock on exchange rate which amount to 7.7% after progressive growth from 3 % indicating a significant exchange rate pass-through. The Ethiopia monetary authorities should consider this result due to its significant effect on prices stability, defined as a primary goal of NBE. At last, the contribution of shocks to average lending rate and bank credit are limited.

CHAPTER FIVE

5.1 CONCLUSION

While the monetary transmission mechanisms have been widely studied in developed countries, such studies in developing countries like Ethiopia are scarce. As for most of the empirical works on the transmission channels, we estimate an SVAR model to investigate four transmission channels of monetary policy, with an economic interpretation to each of the structural shocks. The presence of external constraints on monetary policy in developing countries necessitates a model specification, unlike that of developed economies.

The study examines the transmission mechanism of monetary policy in Ethiopia using quarterly time series data from 2000/21Q1 to 200/21Q. Small open economy structural Vector Auto Regression (SVAR) model with two vectors of variables. The first one contains the endogenous domestic variables while the second encompass the exogenous foreign variables was used to examine the effectiveness of the different monetary transmission channel. All the variables are tested for unit roots using ADF and PP test and model stability and other necessary tests was conducted.

We imposed restrictions on contemporaneous effect of the endogenous variables. The results of Structural impulse response and structural variance decompositions derived from Structural VAR show that direct monetary transmission which is the Reserve Money in case of output and reserve money, domestic credit and nominal effective exchange rate have significant impacts on price level in short term. The monetary aggregate (M2), the average lending rate, the reserve requirement and nominal effective exchange rate have significant impacts on output and price level in medium term in Ethiopia indicating that monetary policy

transmission channel is effective in influencing macroeconomic variables in the Ethiopian economy. However, the results of interest rate channel-which is represented by the average lending rate in affecting output and price is not effective in short run relative to other channels. while the study also illustrates that the monetary aggregate contains important additional information in the transmission process of monetary policy shocks in Ethiopia.

The analysis provides some policy implications. First, it is important to consider the effect of externals shocks on monetary policy when analyzing the transmission mechanisms in Ethiopia. Considering the external constraints on monetary policy and controlling for international shocks allows one to better appreciate the effect and the functioning of the transmission channels. Second, since the monetary authority prepare its transition to an interest rate strategy as an alternative for inflation targeting strategy through the direct control, the functioning of the interest rate channel is a good argument. However, additional efforts are needed to develop a more resilient, competitive, and dynamic financial system, to further diversify the financing alternatives for the private sector, and to establish more flexible exchange rate. This can enhance the functioning of the four channels studied and reduce the dependence of the national economy on the bank's credit.

In general, we found that monetary policy shocks have a delayed and gradual effect on the price level and a small temporary effect on output. We also use the model to examine the effects of shocks to the Ethiopia economy and the role of monetary policy in response to these shocks. Generally, we find that monetary policy has served to dampen both output and price fluctuations.

5.2 POLICY RECOMMONDATIONS

It is, therefore, recommended that monetary authorities target monetary aggregate as a policy variable for effective monetary policy implementation, because the interest rate channel is ineffective. This implies that national Bank of Ethiopia is Effective in choosing intermediate monetary policy target. Moreover, since the credit channel is important mechanisms through which monetary policy is transmitted in Ethiopia, bringing the informal sector that extends credit into the formal system will increase the benefit to the economy by channeling fund to the more productive sector and key economic sectors which remain less financed by the banking sector.

Furthermore, to make the interest rate channel effective the National bank of Ethiopia and other stakeholders will need to support the current trends in the development of financial markets to increase the participation of households and non-bank institutional investors in treasury bills of different maturities; substitution between bank lending and other types of external finance like equity or bond markets by developing capital markets.

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APPENDIES

Appendix 1: Pairwise Granger Causality Tests

Pairwise Granger Causality Tests
Date: 06/03/22 Time: 16:57
Sample: 2000Q3 2021Q2
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LRGDP does not Granger Cause LWOP	82	0.81641	0.4458
LWOP does not Granger Cause LRGDP		0.31281	0.7323
LCPI does not Granger Cause LWOP	82	1.23410	0.2968
LWOP does not Granger Cause LCPI		2.32752	0.1044
LRM does not Granger Cause LWOP	82	1.14714	0.3229
LWOP does not Granger Cause LRM		0.73379	0.4834
LDC does not Granger Cause LWOP	82	0.32355	0.7246
LWOP does not Granger Cause LDC		2.88886	0.0617
LM2 does not Granger Cause LWOP	82	2.15330	0.1230
LWOP does not Granger Cause LM2		2.79189	0.0675
ALR does not Granger Cause LWOP	82	0.33623	0.7155
LWOP does not Granger Cause ALR		1.76184	0.1786
LNEER does not Granger Cause LWOP	82	1.71581	0.1866
LWOP does not Granger Cause LNEER		1.04314	0.3573
LCPI does not Granger Cause LRGDP	82	2.27228	0.1099
LRGDP does not Granger Cause LCPI		0.58606	0.5590
LRM does not Granger Cause LRGDP	82	3.10257	0.0506
LRGDP does not Granger Cause LRM		2.27592	0.1096
LDC does not Granger Cause LRGDP	82	4.08169	0.0207
LRGDP does not Granger Cause LDC		0.46233	0.6316
LM2 does not Granger Cause LRGDP	82	5.62408	0.0053
LRGDP does not Granger Cause LM2		0.18815	0.8289
ALR does not Granger Cause LRGDP	82	3.55398	0.0334
LRGDP does not Granger Cause ALR		9.74374	0.0002
LNEER does not Granger Cause LRGDP	82	0.89885	0.4113
LRGDP does not Granger Cause LNEER		1.37078	0.2600
LRM does not Granger Cause LCPI	82	3.05026	0.0531
LCPI does not Granger Cause LRM		1.78340	0.1749

LDC does not Granger Cause LCPI	82	3.66815	0.0301
LCPI does not Granger Cause LDC		1.20541	0.3052
LM2 does not Granger Cause LCPI	82	2.73598	0.0711
LCPI does not Granger Cause LM2		2.27951	0.1092
ALR does not Granger Cause LCPI	82	0.33006	0.7199
LCPI does not Granger Cause ALR		7.55807	0.0010
LNEER does not Granger Cause LCPI	82	0.73057	0.4849
LCPI does not Granger Cause LNEER		3.08041	0.0516
LDC does not Granger Cause LRM	82	2.86892	0.0628
LRM does not Granger Cause LDC		3.98383	0.0226
LM2 does not Granger Cause LRM	82	2.10284	0.1291
LRM does not Granger Cause LM2		3.82538	0.0261
ALR does not Granger Cause LRM	82	0.89028	0.4147
LRM does not Granger Cause ALR		10.1464	0.0001
LNEER does not Granger Cause LRM	82	0.97532	0.3817
LRM does not Granger Cause LNEER		1.95329	0.1488
LM2 does not Granger Cause LDC	82	0.10594	0.8996
LDC does not Granger Cause LM2		2.28294	0.1088
ALR does not Granger Cause LDC	82	2.46456	0.0917
LDC does not Granger Cause ALR		9.81674	0.0002
LNEER does not Granger Cause LDC	82	0.08706	0.9167
LDC does not Granger Cause LNEER		3.49909	0.0351
ALR does not Granger Cause LM2	82	0.08028	0.9229
LM2 does not Granger Cause ALR		9.45813	0.0002
LNEER does not Granger Cause LM2	82	1.52428	0.2243
LM2 does not Granger Cause LNEER		1.51366	0.2266
LNEER does not Granger Cause ALR	82	5.38465	0.0065
ALR does not Granger Cause LNEER		5.53509	0.0057

Appendix 2: Structural VAR Estimation

Structural VAR Estimates
Date: 06/05/22 Time: 04:47
Sample (adjusted): 9 84
Included observations: 76 after adjustments
Estimation method: Maximum likelihood via Newton-Raphson (analytic derivatives)
Convergence achieved after 11 iterations
Structural VAR is over-identified

Model: Ae = Bu where E[uu']=I

A =

1	0	0	0	0	0	0	0
C(1)	1	0	0	0	0	0	0
C(2)	C(4)	1	0	0	0	0	0
0	C(5)	C(7)	1	0	0	0	0
0	0	C(8)	C(11)	1	0	0	0
0	0	C(9)	C(12)	C(15)	1	0	0
0	0	0	C(13)	C(16)	C(18)	1	0
C(3)	C(6)	C(10)	C(14)	C(17)	C(19)	C(20)	1

B =

C(21)	0	0	0	0	0	0	0
0	C(22)	0	0	0	0	0	0
0	0	C(23)	0	0	0	0	0
0	0	0	C(24)	0	0	0	0
0	0	0	0	C(25)	0	0	0
0	0	0	0	0	C(26)	0	0
0	0	0	0	0	0	C(27)	0
0	0	0	0	0	0	0	C(28)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.017621	0.025275	-0.697158	0.4857
C(2)	-0.064810	0.022626	-2.864466	0.0042
C(3)	0.004448	0.016170	0.275071	0.7833
C(4)	-0.027337	0.102355	-0.267075	0.7894
C(5)	-0.108338	0.223302	-0.485162	0.6276
C(6)	-0.059304	0.067837	-0.874200	0.3820
C(7)	-0.080469	0.238156	-0.337885	0.7354
C(8)	-0.366040	0.082387	-4.442928	0.0000
C(9)	0.026827	0.058405	0.459320	0.6460
C(10)	0.079894	0.076903	1.038891	0.2989
C(11)	0.068623	0.039644	1.730980	0.0835
C(12)	-0.037265	0.025529	-1.459734	0.1444
C(13)	0.638617	0.226250	2.822611	0.0048
C(14)	0.063289	0.032916	1.922726	0.0545
C(15)	-0.229262	0.072451	-3.164377	0.0016
C(16)	-0.317409	0.608914	-0.521271	0.6022
C(17)	0.035541	0.093691	0.379347	0.7044
C(18)	1.453688	1.010067	1.439200	0.1501
C(19)	-0.339469	0.133688	-2.539260	0.0111
C(20)	0.060784	0.021003	2.894091	0.0038
C(21)	0.207721	0.016848	12.32883	0.0000
C(22)	0.045770	0.003712	12.32883	0.0000

C(23)	0.040842	0.003313	12.32883	0.0000
C(24)	0.089255	0.007240	12.32883	0.0000
C(25)	0.030895	0.002506	12.32883	0.0000
C(26)	0.019514	0.001583	12.32883	0.0000
C(27)	0.172068	0.013957	12.32883	0.0000
C(28)	0.022288	0.001808	12.32883	0.0000

Log likelihood	904.0851		
LR test for over-identification:			
Chi-square(8)	64.78299	Probability	0.0000

Estimated A matrix:

1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
-0.017621	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
-0.064810	-0.027337	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	-0.108338	-0.080469	1.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	-0.366040	0.068623	1.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.026827	-0.037265	-0.229262	1.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.638617	-0.317409	1.453688	1.000000	0.000000
0.004448	-0.059304	0.079894	0.063289	0.035541	-0.339469	0.060784	1.000000

Estimated B matrix:

0.207721	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.045770	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.040842	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.089255	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.030895	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.019514	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.172068	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.022288

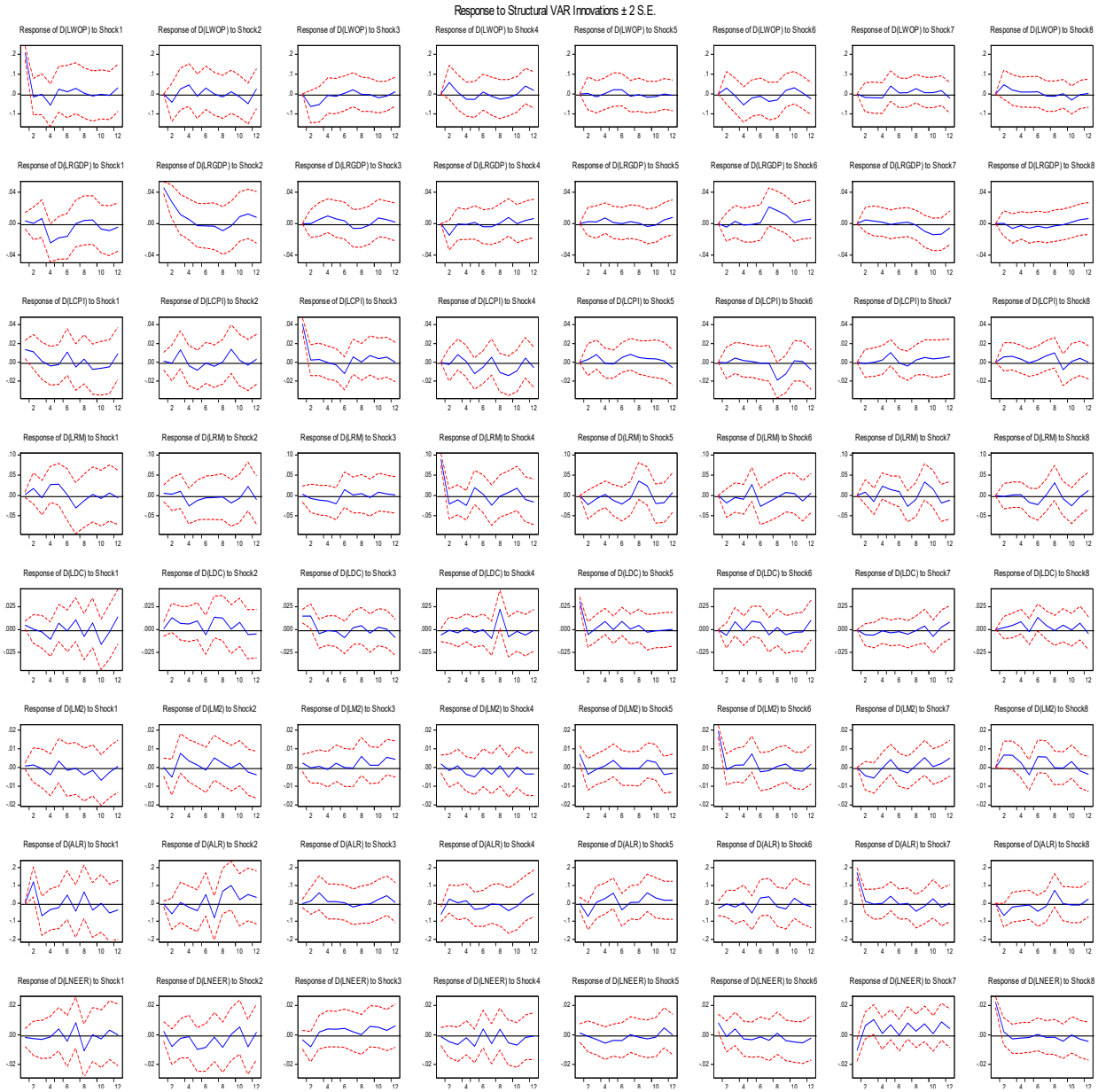
Estimated S matrix:

0.207721	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.003660	0.045770	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.013563	0.001251	0.040842	0.000000	0.000000	0.000000	0.000000	0.000000
0.001488	0.005059	0.003286	0.089255	0.000000	0.000000	0.000000	0.000000
0.004862	0.000111	0.014724	-0.006125	0.030895	0.000000	0.000000	0.000000
0.000806	0.000180	0.002403	0.001922	0.007083	0.019514	0.000000	0.000000
-0.000579	-0.003458	-0.000918	-0.061738	-0.000490	0.028367	0.172068	0.000000
-0.001748	0.002562	-0.003123	-0.001026	0.001336	0.008349	0.010459	0.022288

Estimated F matrix:

0.200210	0.058084	-0.156827	0.030317	-0.000701	0.066379	0.009557	0.048169
-0.074440	0.079141	0.052971	-0.026184	0.016125	0.066130	0.014376	0.001543
0.022373	0.024000	0.043937	-0.023970	0.030101	0.028781	0.024917	0.013204
0.051286	-0.025772	-0.054998	0.058770	-0.038660	0.034370	0.006676	0.024488
-0.004041	0.046034	0.025308	-0.017515	0.040731	0.006216	0.010865	0.027040
-0.022455	0.008624	0.034060	-0.028041	0.011859	0.019985	0.012432	0.013543
-0.052152	0.085896	0.099461	-0.081563	0.058802	0.042715	0.102553	0.066466
-0.019191	-0.025100	0.024493	-0.033467	-0.006962	0.013021	0.040268	0.002950

Appendix 3: Response to Structural Var Innovations ± SE



Appendix 4: Variance decomposition using Structural VAR Factor

Variance Decomposition of D(LWOP):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	0.207721	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.236225	77.65807	3.059542	7.187439	6.173491	0.014144	1.541333	0.483280	3.882697
3	0.245487	71.91002	3.882775	11.16531	5.820579	0.369986	1.533039	1.049479	4.268813
4	0.263675be rry	66.89496	6.316261	9.766114	5.960019	0.330476	5.441971	1.467077	3.823121
5	0.271381	63.91067	6.148454	9.376921	6.659852	0.951320	5.697811	3.496940	3.758033
6	0.274767	62.53178	7.162645	9.167416	6.616269	1.517734	5.734099	3.444312	3.825743
7	0.280237	61.18006	6.886040	9.390957	6.521069	1.632893	7.213640	3.363408	3.811930
8	0.284954	59.19164	6.915324	9.085915	7.121564	1.595137	8.133460	4.124349	3.832614
9	0.287152	58.41997	6.978570	8.961366	7.425499	1.877949	8.427472	4.134210	3.774967
10	0.291706	56.61521	6.976147	9.073349	7.200724	2.020739	9.334585	4.074334	4.704913
11	0.299341	53.83137	9.303599	8.727563	8.664532	1.918987	8.904674	4.171070	4.478209
12	0.304721	53.00346	9.742597	8.576608	8.713694	1.912584	9.231933	4.487007	4.332117
13	0.307330	52.82769	9.770473	8.525400	8.605236	2.231068	9.313639	4.465345	4.261146
14	0.309685	52.71408	9.703020	8.430062	8.507929	2.229008	9.223609	4.744812	4.447480
15	0.311285	52.18410	10.24269	8.381307	8.609977	2.207169	9.142654	4.817335	4.414767
16	0.313219	51.55989	10.13542	8.333874	8.653554	2.946094	9.133503	4.766995	4.470664
17	0.315286	50.89289	10.02781	8.224997	9.296072	2.980719	9.042854	4.800342	4.734315
18	0.318431	50.16562	9.892530	8.063350	9.116439	3.710721	9.119457	4.875262	5.056618
19	0.321109	49.36013	9.768128	8.106428	9.378853	4.562755	8.988119	4.838347	4.997235
20	0.324028	48.62994	9.684826	8.092607	9.959224	4.860773	8.828706	4.766223	5.177701
21	0.326948	48.45752	9.794079	8.021969	10.01775	4.856124	8.718611	5.021590	5.112356
22	0.329476	47.80161	9.648505	8.084065	9.870564	5.181853	8.644316	5.038799	5.730283
23	0.332161	47.68839	9.500896	8.285489	9.947423	5.133670	8.818442	4.957723	5.667963
24	0.334373	47.55151	9.383321	8.184831	9.820971	5.250370	8.945629	4.949637	5.913735

Variance Decomposition of D(LRGDP):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	0.045917	0.635448	99.36455	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.055978	0.427931	90.84704	0.000212	7.193742	0.194336	0.635519	0.700875	0.000350
3	0.058232	1.578097	87.72968	0.793543	6.653485	0.294827	0.808060	0.938601	1.203707
4	0.064644	15.64946	71.81354	2.964357	5.431396	1.419851	0.747816	0.845476	1.128110
5	0.067720	21.38170	65.57485	3.476900	4.982446	1.332574	0.705691	0.794223	1.751626
6	0.069993	25.35194	61.54485	3.526557	5.004228	1.247538	0.687675	0.754139	1.883070
7	0.073830	22.78554	55.51654	3.879584	4.805239	1.228708	8.803562	0.726263	2.254563
8	0.076633	21.40901	52.92994	4.163028	4.470849	1.151497	12.90690	0.742465	2.226308
9	0.078762	20.59065	50.23286	3.984739	5.262066	1.314334	14.17031	2.305763	2.139280
10	0.081179	20.13225	48.52648	4.509255	4.953545	1.292854	13.35251	5.178834	2.054275
11	0.084315	19.87643	47.06872	4.539992	4.803010	1.480074	12.61336	7.362954	2.255464
12	0.086020	19.35860	46.03450	4.399820	5.185078	2.257432	12.56875	7.491693	2.704123
13	0.087534	18.74252	45.43939	4.307119	5.426242	2.279204	12.84223	7.403479	3.559809
14	0.088227	18.49665	45.34138	4.267419	5.349094	2.644112	12.95843	7.385005	3.557905
15	0.089266	18.30873	44.43176	4.318716	5.401687	2.645863	13.91885	7.301971	3.672426
16	0.089890	18.11633	43.81740	4.296359	5.452530	2.641328	14.61639	7.244638	3.815020
17	0.090261	18.07258	43.94341	4.279903	5.460353	2.675584	14.57037	7.193782	3.804023
18	0.091277	18.68098	43.52733	4.321540	5.339599	2.923202	14.24806	7.238749	3.720541
19	0.091755	18.66913	43.50364	4.300434	5.496466	2.897003	14.10171	7.211120	3.820500

20	0.092415	18.46962	43.32282	4.239293	5.458211	2.945446	14.20284	7.108861	4.252913
21	0.092920	18.75017	42.95358	4.208062	5.554379	2.928137	14.06829	7.224342	4.313048
22	0.093325	18.58801	42.59294	4.476429	5.778892	3.114513	13.94895	7.193861	4.306405
23	0.093672	18.46229	42.31268	4.841716	5.957529	3.105104	13.86238	7.176819	4.281481
24	0.093949	18.44166	42.06946	5.191746	5.934217	3.104515	13.78946	7.168340	4.300613

Variance Decomposition of D(LCPI):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	0.043053	9.923775	0.084461	89.99176	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.045036	15.08739	0.124534	82.49098	0.284802	0.400153	0.020550	0.080089	1.511500
3	0.049021	12.79902	7.290514	69.96481	3.061099	3.127463	0.815137	0.067688	2.874267
4	0.049535	13.18199	7.686059	68.52896	3.030957	3.116595	0.922965	0.289193	3.243281
5	0.052855	11.77431	9.258635	60.45346	7.922193	2.881256	0.839951	4.002257	2.867931
6	0.055795	14.34583	8.341300	58.87069	7.945330	3.373619	0.785679	3.605083	2.732465
7	0.057948	14.10079	8.328901	55.55663	8.259646	5.215358	0.764076	3.795582	3.979013
8	0.063092	12.14608	7.026191	46.86820	10.00124	5.067786	9.643610	3.359179	5.887709
9	0.068865	11.38545	9.896162	40.40570	12.74734	4.562229	11.34780	3.393441	6.261879
10	0.070105	11.81413	9.637799	39.26961	14.01305	4.676014	10.99081	3.543112	6.055483
11	0.070953	12.00213	9.595078	38.88153	14.08997	4.607635	10.74671	3.830092	6.246853
12	0.072791	13.05089	9.329522	36.94276	14.02590	5.002813	11.39041	4.321860	5.935836
13	0.073791	12.80735	10.00588	36.33798	13.78738	4.873868	11.48108	4.210730	6.495731
14	0.074870	13.90096	10.24937	35.30079	13.40869	4.895996	11.21916	4.711014	6.314024
15	0.076105	13.67679	9.931808	34.18086	15.60838	4.742595	10.92229	4.686133	6.251137
16	0.077836	13.08054	9.528363	32.69807	14.93115	5.596484	12.65943	4.919268	6.586695
17	0.078412	12.96965	9.390978	32.23675	14.83176	5.969638	12.52119	5.107489	6.972537
18	0.079559	12.78506	9.837109	31.56012	14.79243	6.594019	12.28230	5.205211	6.943758
19	0.080074	12.95007	9.887477	31.43965	14.63402	6.688692	12.12775	5.282445	6.989903
20	0.080628	12.78091	9.753744	31.10729	14.58891	6.763372	12.14173	5.318408	7.545629
21	0.081199	12.85641	9.775685	31.05055	14.54624	6.723326	11.98555	5.390032	7.672214
22	0.082344	14.09784	9.505866	30.19732	14.17033	7.302154	11.65584	5.394139	7.676508
23	0.082735	13.96517	9.449734	29.92643	14.40049	7.629083	11.59372	5.374708	7.660667
24	0.082988	14.05799	9.615871	29.74425	14.31498	7.593519	11.56083	5.410022	7.702540

Variance Decomposition of D(LRM):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	0.089471	0.027656	0.319759	0.134927	99.51766	0.000000	0.000000	0.000000	0.000000
2	0.098765	3.088037	0.406906	0.646779	86.39291	5.185422	3.542365	0.687556	0.050025
3	0.102432	3.197916	1.462841	1.933034	81.49108	5.472430	3.567913	2.810748	0.064035
4	0.115592	8.005257	6.448872	2.853658	68.60479	4.350448	3.501318	6.164750	0.070912
5	0.128140	11.09881	6.051964	4.952960	58.08745	4.443162	7.309643	6.236787	1.819223
6	0.135820	9.903956	5.567580	5.489098	51.76826	6.418988	10.47447	6.027914	4.349734
7	0.145165	13.28304	4.999959	4.808130	48.11749	5.892975	10.34069	8.746411	3.811307
8	0.153747	12.56509	4.541319	4.366969	42.90313	10.67056	9.313838	8.197680	7.441413
9	0.160761	11.51246	5.573619	4.105639	39.43561	11.84050	8.717056	11.75383	7.061291
10	0.166274	10.94429	5.358850	4.087139	38.00780	12.49819	8.228785	11.89066	8.984279
11	0.170767	10.50111	6.775791	3.935761	36.37395	12.97087	8.448000	12.42875	8.565763
12	0.173114	10.33449	6.979088	3.832304	36.30460	12.79799	8.351102	12.56156	8.838868
13	0.179003	14.12676	6.543964	4.217223	34.06536	12.46160	8.192365	11.91509	8.477628
14	0.181471	13.98547	6.377657	4.251709	33.70662	12.17225	8.074961	11.81246	9.618871
15	0.184483	14.04906	6.205616	4.148888	33.58020	12.55138	7.874604	12.18822	9.402028
16	0.190479	14.39913	7.635757	4.065493	31.52768	11.78343	8.081907	12.69068	9.815911
17	0.194852	14.47211	7.571538	4.541843	31.06525	12.12181	7.732225	12.13275	10.36247
18	0.197617	14.13190	7.422880	4.565381	30.89739	12.42842	7.764644	12.65207	10.13732
19	0.199298	13.97595	7.305771	4.527830	30.42008	12.82137	7.641922	12.67781	10.62926
20	0.201970	14.45818	7.253172	4.566649	29.75673	13.03517	7.694161	12.79147	10.44446
21	0.202898	14.34696	7.238571	4.550785	30.06423	12.92268	7.663278	12.72461	10.48889

22	0.205322	14.19760	7.389376	4.706968	29.48511	12.83784	8.627077	12.44759	10.30844
23	0.207328	13.98515	7.988188	4.781292	29.48762	12.62238	8.583896	12.40767	10.14380
24	0.208728	13.97680	7.954119	4.772261	29.17427	12.93668	8.512315	12.38297	10.29058

Variance Decomposition of D(LDC):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	0.035107	1.918263	0.000996	17.59063	3.043881	77.44623	0.000000	0.000000	0.000000
2	0.041505	1.396227	9.637158	25.21724	2.208942	57.01637	2.423465	1.854537	0.246054
3	0.044100	1.581136	10.99002	23.36402	2.620026	50.67972	5.947143	3.574421	1.243511
4	0.047549	6.549680	11.00488	20.14839	2.411947	47.09743	5.194957	3.145478	4.447238
5	0.050201	7.926301	13.49520	18.24486	2.569024	42.25490	7.943579	3.359168	4.206974
6	0.054341	6.837917	12.71628	18.22431	2.192570	38.74515	8.752687	3.051252	9.479829
7	0.058613	9.314247	16.29077	15.78681	4.672748	33.30914	8.454646	3.377041	8.794598
8	0.064727	9.037010	17.05657	13.34826	15.66135	27.78443	7.072639	2.797467	7.242269
9	0.066320	9.822008	16.25314	13.05787	16.32466	26.67591	7.462492	2.999593	7.404321
10	0.069310	14.44713	16.20349	12.10750	15.01753	24.46137	7.018938	3.961919	6.782137
11	0.070305	14.16615	16.32889	11.77057	15.36791	23.78065	6.961905	3.999006	7.624917
12	0.073795	16.56572	15.21755	12.16403	13.95999	21.58539	8.393362	4.850044	7.263912
13	0.075967	17.01379	14.36971	12.21278	14.73760	21.00135	8.011064	5.180224	7.473481
14	0.077565	17.93186	13.85140	11.74057	14.82291	20.93110	7.869499	5.638417	7.214253
15	0.078158	17.66632	13.64277	11.64452	14.71034	20.68660	7.976449	5.885409	7.787591
16	0.079270	17.67847	13.99217	11.40532	14.35889	20.77817	7.760937	6.416048	7.609993
17	0.080460	17.43566	14.13340	11.08574	14.25907	20.21113	7.708409	7.360955	7.805625
18	0.081407	17.24064	14.17798	10.85182	13.97088	20.34220	8.132234	7.570760	7.713473
19	0.082271	17.33426	14.25313	10.78977	14.59605	20.04844	7.962408	7.427240	7.588709
20	0.083304	18.50631	13.93631	10.54406	14.54612	19.61717	7.844934	7.274774	7.730320
21	0.083978	18.29148	13.73711	10.41243	14.40654	19.37334	7.810197	7.562763	8.406141
22	0.084660	18.45876	13.69068	10.45729	14.41029	19.36067	7.697823	7.457783	8.466702
23	0.086525	19.64393	13.52075	10.43642	13.79585	18.53564	7.886400	7.840526	8.340486
24	0.087392	19.65445	13.33267	10.26861	14.32903	18.43408	7.785988	7.685800	8.509380

Variance Decomposition of D(LM2):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	0.021002	0.147406	0.007376	1.308559	0.837337	11.37372	86.32560	0.000000	0.000000
2	0.023466	0.424134	4.763972	1.051034	1.219524	11.51966	69.33741	3.509706	8.174555
3	0.026197	0.385585	12.14621	0.887064	1.099794	9.363486	55.82545	7.485094	12.80731
4	0.027135	2.415832	12.90468	0.981803	2.755816	8.856693	52.30280	6.983775	12.79860
5	0.029681	3.447885	10.97830	1.395097	5.059875	9.046948	49.69193	7.927989	12.45198
6	0.030439	3.502471	10.66119	1.326439	4.813580	8.617310	47.81837	7.743172	15.51747
7	0.031744	3.246155	12.39786	1.231336	5.702725	7.958516	44.22954	7.917574	17.31629
8	0.032654	4.519870	12.21427	4.446660	5.476674	7.552184	41.82652	7.596846	16.36697
9	0.033788	4.427456	11.42531	4.286653	7.412338	8.271141	39.36755	9.510758	15.29879
10	0.034843	7.964269	11.13939	4.156760	6.976386	8.394001	37.21256	8.966500	15.19014
11	0.035986	7.954794	10.87746	6.254513	7.473798	9.015965	35.17876	8.761992	14.48272
12	0.037320	7.428017	11.19803	7.250192	7.795170	9.036033	32.92928	9.941141	14.42213
13	0.037743	8.729759	11.04437	7.097303	7.631160	8.934877	32.25409	10.18202	14.12641
14	0.038201	9.621250	11.36175	6.927988	7.940184	8.732933	31.64637	9.979735	13.78979
15	0.038940	9.431764	11.30494	7.392042	9.209968	8.873430	30.85097	9.664604	13.27228
16	0.039562	9.231631	11.11496	7.698208	9.828305	8.636449	30.25324	9.850794	13.38642
17	0.039934	9.131014	10.91287	7.641559	10.39002	9.112377	29.77465	9.898655	13.13885
18	0.040163	9.289898	10.78880	7.976209	10.52071	9.036416	29.60179	9.786217	12.99997
19	0.041533	8.933553	10.09209	8.235743	12.97018	8.496994	29.80189	9.309776	12.15978
20	0.041880	8.821324	10.05015	8.111643	13.66545	8.606761	29.30944	9.351416	12.08382
21	0.042584	8.850957	9.886987	7.847191	13.57470	8.556863	29.71486	9.692881	11.87556
22	0.042845	8.784239	10.09451	7.783861	13.75267	8.744517	29.35328	9.589043	11.89788
23	0.043495	8.928061	9.944252	7.624785	13.86443	8.660013	29.87790	9.555485	11.54507

24	0.043805	8.805788	10.04914	7.519598	13.87805	8.939979	29.48206	9.839752	11.48563

Variance Decomposition of D(ALR):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	0.185032	0.000979	0.034927	0.002460	11.13286	0.000702	2.350331	86.47774	0.000000
2	0.249847	22.94076	5.239744	0.246567	7.022703	8.285699	1.302682	47.62839	7.333455
3	0.267838	26.79885	4.592398	5.030404	6.119914	7.281344	1.721469	41.48489	6.970729
4	0.273158	27.35241	5.063011	4.964881	6.150881	7.925698	1.669732	39.88534	6.988053
5	0.293232	24.38309	6.567866	4.420367	6.578831	10.65947	4.767064	36.45850	6.164808
6	0.309414	24.17468	8.575629	3.983855	6.777391	10.96464	5.215761	32.77882	7.529218
7	0.325804	23.59327	13.83457	3.983616	6.123965	9.917035	5.953130	29.56394	7.030476
8	0.350155	23.77644	15.66905	3.496658	5.359967	8.616002	5.444594	27.21374	10.42355
9	0.374183	21.81926	20.63444	3.069884	5.930924	9.952159	5.449249	24.01375	9.130330
10	0.378871	21.28273	20.40436	3.325104	5.950675	10.33524	5.882866	23.85379	8.965237
11	0.390154	21.94526	20.79321	4.341479	6.112078	9.936379	5.554080	22.80192	8.515605
12	0.398721	21.84616	20.56223	4.174806	7.837430	9.695041	5.542810	21.83372	8.507809
13	0.401327	21.84665	20.30142	4.187511	7.757236	10.06920	5.478202	21.95572	8.404061
14	0.410606	22.55837	19.40867	4.245753	7.827912	9.625076	7.319503	20.98340	8.031321
15	0.417257	22.09324	19.14791	5.579282	7.580552	9.406372	8.066242	20.33859	7.787811
16	0.429355	22.12776	18.08489	5.785058	9.408807	9.313257	8.241711	19.21482	7.823689
17	0.441980	20.89263	17.99773	6.104702	8.879183	10.80673	8.064235	19.85224	7.402544
18	0.451572	21.91198	17.28015	5.859333	9.005570	10.76215	7.989861	19.68541	7.505542
19	0.458198	21.29102	17.03665	5.698657	9.184020	11.58495	7.771041	19.22959	8.204083
20	0.462294	21.11326	16.83939	5.675254	9.186588	11.68520	8.029950	19.40979	8.060565
21	0.468435	20.65886	16.41301	5.815138	9.072931	12.69391	7.832750	19.21807	8.295332
22	0.471685	20.47098	16.36035	5.743899	9.285352	12.78388	7.754910	19.41910	8.181527
23	0.476851	20.52489	16.15222	5.641193	9.092774	12.75136	8.426487	19.04345	8.367626
24	0.480942	20.18319	17.29834	5.593573	8.994490	12.58207	8.311385	18.80907	8.227878

Variance Decomposition of D(LNEER):

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8
1	0.026420	0.437954	0.940082	1.397163	0.150826	0.255785	9.984884	15.67117	71.16213
2	0.030006	0.956171	7.562814	8.270808	2.499630	0.306531	7.851205	16.81513	55.73771
3	0.033230	1.623577	6.591192	7.076459	5.901074	1.066199	7.920542	23.75651	46.06445
4	0.034211	1.682796	6.317275	8.158247	5.867444	3.617145	8.028821	22.51672	43.81155
5	0.037802	2.524216	11.86641	7.792205	8.842602	3.821349	7.264057	21.80324	36.08592
6	0.039580	3.397303	15.15368	8.407204	9.103311	4.384889	6.734232	19.88965	32.92973
7	0.041941	7.019191	13.62114	7.775577	10.05319	3.911522	6.715506	21.41668	29.48720
8	0.044389	12.00219	15.72385	6.947072	9.735261	3.617208	6.064751	19.47546	26.43422
9	0.046136	11.11381	14.56468	8.077482	10.30277	3.686647	6.261629	20.67792	25.31506
10	0.047592	10.76431	14.94705	8.846329	11.75041	3.554161	6.878817	19.46869	23.79024
11	0.049919	10.21370	16.20697	8.459020	10.78800	4.164536	7.351103	20.89379	21.92288
12	0.050758	9.878839	15.82130	9.690786	10.45705	4.028205	7.267351	20.93255	21.92391
13	0.052426	11.41442	15.37469	9.752289	10.93173	3.788012	7.644497	19.91535	21.17900
14	0.053171	11.13879	15.13480	9.517052	11.46985	3.698029	8.178656	20.01288	20.84995
15	0.053518	11.65931	14.94231	9.404850	11.33067	3.787753	8.523589	19.75801	20.59351
16	0.053929	12.24518	14.72729	9.263002	11.19131	3.948983	8.398838	19.77701	20.44838
17	0.054315	12.75897	14.57148	9.165105	11.03337	4.006991	8.718820	19.50309	20.24218
18	0.055098	12.57360	15.99869	9.221080	10.74819	4.022798	8.626023	19.13507	19.67454
19	0.055555	13.00029	16.20886	9.133346	10.71595	4.182294	8.582257	18.82323	19.35377
20	0.055845	13.13045	16.04724	9.085623	10.96415	4.140839	8.506456	18.72773	19.39751
21	0.056277	12.93119	17.01465	9.023118	10.84039	4.078613	8.381606	18.61455	19.11588
22	0.056408	12.87276	16.94727	9.136844	10.79230	4.060053	8.461440	18.69507	19.03426
23	0.056531	13.12647	16.93809	9.134566	10.74693	4.045990	8.432857	18.61483	18.96027
24	0.056882	12.99756	17.16197	9.259684	10.83149	4.043724	8.533984	18.44361	18.72798

Appendix 5:

VAR Residual Serial Correlation LM Tests
Date: 06/05/22 Time: 04:10
Sample: 1 84
Included observations: 77

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	68.15672	64	0.3378	1.060490	(64, 81.5)	0.3984
2	64.20596	64	0.4693	0.979945	(64, 81.5)	0.5303
3	66.13717	64	0.4030	1.018964	(64, 81.5)	0.4646
4	47.77430	64	0.9354	0.673715	(64, 81.5)	0.9493
5	50.92699	64	0.8820	0.729055	(64, 81.5)	0.9054
6	68.40983	64	0.3300	1.065747	(64, 81.5)	0.3903
7	50.06112	64	0.8988	0.713701	(64, 81.5)	0.9194

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	68.15672	64	0.3378	1.060490	(64, 81.5)	0.3984
2	143.2199	128	0.1692	0.991263	(128, 48.8)	0.5289
3	1884.200	192	0.0000	NA	(192, NA)	NA
4	NA	256	NA	NA	(256, NA)	NA
5	NA	320	NA	NA	(320, NA)	NA
6	NA	384	NA	NA	(384, NA)	NA
7	NA	448	NA	NA	(448, NA)	NA

*Edgeworth expansion corrected likelihood ratio statistic.

Appendix 6:

VAR Residual Heteroskedasticity Tests (Levels and Squares)
Date: 06/05/22 Time: 04:29
Sample: 1 84
Included observations: 79

Joint test:

Chi-sq	df	Prob.
2226.458	2304	0.8740

Individual components:

Dependent	R-squared	F(64,14)	Prob.	Chi-sq(64)	Prob.
res1*res1	0.902122	2.016179	0.0730	71.26765	0.2489
res2*res2	0.866289	1.417246	0.2393	68.43686	0.3292
res3*res3	0.792908	0.837543	0.6981	62.63971	0.5247
res4*res4	0.523954	0.240765	1.0000	41.39238	0.9874
res5*res5	0.848679	1.226850	0.3499	67.04562	0.3731
res6*res6	0.728479	0.586897	0.9232	57.54985	0.7023
res7*res7	0.732338	0.598513	0.9155	57.85473	0.6922
res8*res8	0.783654	0.792364	0.7442	61.90870	0.5508
res2*res1	0.825230	1.032896	0.5052	65.19318	0.4350
res3*res1	0.754045	0.670640	0.8597	59.56955	0.6337
res3*res2	0.767710	0.722961	0.8125	60.64909	0.5957
res4*res1	0.703325	0.518589	0.9605	55.56267	0.7648
res4*res2	0.539485	0.256261	0.9999	42.61928	0.9818
res4*res3	0.607559	0.338659	0.9984	47.99718	0.9323
res5*res1	0.880033	1.604675	0.1640	69.52264	0.2969
res5*res2	0.839969	1.148170	0.4075	66.35753	0.3956
res5*res3	0.833817	1.097572	0.4485	65.87157	0.4119
res5*res4	0.715892	0.551203	0.9445	56.55546	0.7343
res6*res1	0.848624	1.226323	0.3502	67.04126	0.3732
res6*res2	0.835457	1.110693	0.4376	66.00114	0.4075
res6*res3	0.831720	1.081164	0.4624	65.70585	0.4175
res6*res4	0.721281	0.566090	0.9361	56.98119	0.7208
res6*res5	0.822992	1.017071	0.5197	65.01638	0.4411
res7*res1	0.843781	1.181526	0.3822	66.65869	0.3857
res7*res2	0.624469	0.363759	0.9969	49.33307	0.9117
res7*res3	0.845566	1.197715	0.3704	66.79973	0.3811
res7*res4	0.459068	0.185645	1.0000	36.26638	0.9980
res7*res5	0.632317	0.376192	0.9959	49.95307	0.9008
res7*res6	0.731850	0.597024	0.9165	57.81612	0.6935
res8*res1	0.736320	0.610855	0.9069	58.16930	0.6817
res8*res2	0.649616	0.405566	0.9925	51.31969	0.8738
res8*res3	0.739720	0.621689	0.8990	58.43784	0.6726
res8*res4	0.823738	1.022303	0.5149	65.07533	0.4390
res8*res5	0.721535	0.566807	0.9356	57.00129	0.7201
res8*res6	0.711778	0.540215	0.9502	56.23049	0.7444
res8*res7	0.696184	0.501257	0.9678	54.99850	0.7813

Appendix 7:

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Date: 06/05/22 Time: 04:22
Sample: 1 84
Included observations: 76

Component	Skewness	Chi-sq	df	Prob.*
1	-0.231271	0.677495	1	0.4105
2	1.333343	22.51885	1	0.0000
3	0.356477	1.609625	1	0.2045
4	1.243138	19.57497	1	0.0000
5	0.800626	8.119362	1	0.0044
6	0.888166	9.991948	1	0.0016
7	-0.083800	0.088952	1	0.7655
8	0.158988	0.320178	1	0.5715
Joint		62.90137	8	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	3.615558	1.199885	1	0.2733
2	6.359068	35.73057	1	0.0000
3	3.835069	2.208245	1	0.1373
4	6.095071	30.33497	1	0.0000
5	3.735924	1.715018	1	0.1903
6	7.600017	67.00715	1	0.0000
7	3.211784	0.142033	1	0.7063
8	2.642005	0.405842	1	0.5241
Joint		138.7437	8	0.0000

Component	Jarque-Bera	df	Prob.
1	1.877380	2	0.3911
2	58.24941	2	0.0000
3	3.817870	2	0.1482
4	49.90993	2	0.0000
5	9.834379	2	0.0073
6	76.99910	2	0.0000
7	0.230984	2	0.8909
8	0.726020	2	0.6956
Joint	201.6451	16	0.0000

*Approximate p-values do not account for coefficient estimation

Appendix 8: Inverse Roots of AR Characteristic Polynomial