ADDIS ABABA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF ECONOMICS

The Effect of Shocks to Ethiopia's Monetary Policy on Price and Output: SVAR Approach

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A Thesis Submitted to the Department of Economics in Partial Fulfillment of the Requirement for the Award of MSc Degree in Economics

June, 2022

Addis Ababa, Ethiopia

Addis Ababa University

School of Graduate Studies

Approval Sheet

This is to certify that the thesis prepared by Gemechu Daba, entitled: *The Effect of Shocks to Ethiopia's Monetary Policy on Price and Output: SVAR Approach* and submitted in Partial Fulfillment of the Requirements for the award of Master of Science Degree in Economics (Economic Policy Analysis) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

This study investigated the effect of Ethiopia's monetary policy shocks on price and output using quarterly time series data over the period 2008Q1 to 2020Q4. Structural Vector Autoregressive (SVAR) model was used to this end. We built two SVAR models. Foreign variables were also included to account for the rest of the world economy. In the first model, we considered USA as a proxy for the rest of the world following literatures, and in the second model we assumed China as world's economic representative basing our assumption on the strong economic linkage between China and Ethiopia. The study's result generally indicates that domestic monetary policy instruments are more consistent with standard monetary theory and they have stronger impact on domestic economy in the second model than in the first model. In the first model, none of the domestic monetary policy instruments are effective in changing the output level, but monetary and exchange rate channels are effective in changing the price level. On the other hand, monetary and interest rate channels are potent in changing the output and price levels in the second model. Therefore, the monetary, the foreign exchange market and the interest rate channels have to be enhanced and monitored to design effective monetary policies. Specifically, in designing policy targeted at changing the output level, policymakers have to use monetary and interest rate channels making use of more China's than USA's variables as information set. In designing policy targeted at changing the price level, they have to use monetary and exchange rate channels making use of more USA's than China's variables in addition to world commodity price as information set.

Key word: output, price, monetary policy, Ethiopia, USA, China

ACKNOWLEDGMENT

I don't have a word to express my praise and adoration to the Omnipotent God for his grace, love, strength, comfort and forgiveness. He is the Alpha and Omega in my life.

I would like to extend my deepest gratitude to my advisor Dr. Fantu Guta. His insightful and constructive comments are more than enough to accomplish this study. His warm welcoming, his kindness and his bright faces when I frequently went to his office are like a fuel in conducting this study. Also, I have to acknowledge Dr. Mengesha Yayo for his constructive comments, suggestions and discussions.

I would like to thank my classmates Eng.Tolasa Abara for his moral and material support as well as for his important discussions, and Bizuayehu Samuel from National Bank of Ethiopia for his continuous support in sending me data.

Lastly, but not the least, I would like to thank my family for their continuous moral support especially my mother, Birritu Urgessa Lemu, for her blessing.

CONTENTS

List of Tables

List of Figure

List of Acronyms and Abbreviations

ADF: Augmented Dickey Fuller Test

AIC: Akaike Information Criteria

GDP: Gross Domestic Product

GLS: Generalized Least Squares

IMF: International Monetary Fund

KPSS: Kwiatkowski, Phillips, Schmidt, and Shin

NBE: National Bank of Ethiopia

NCM: New Consensus Model

RBC: Real Business Cycle

SVAR: Structural Vector Autoregression

UNCTAD: United Nations Conference on Trade and Development

VAR: Vector Autoregression

VECM: Vector Error Correction Model

WB: World Bank

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

The need for stabilizing macro economy goes as far back as the origin of economics, and it has been the challenging issue for economists and policymakers at large. Nevertheless, the fact of running unstable macro economy is common for many developing countries in particular and developed countries in general though the depth and extent of the problem differs across countries. The source of the problem may be traced largely to foreign and domestic variable shocks; particularly, in the era of globalization, large degree of economic integration increase complexities and open up the door of domestic economy to foreign shocks. Moreover, natural factors and political instabilities may also contribute to macroeconomic imbalances. The problem of macroeconomic instability was increasing in intensity, persistent in duration and wider in covering many sectors. So, countries had been striving to stabilize their macroeconomic imbalances using various policy instruments in order to foster their economic growth. However, any attempt to correct this problem is not a simple exercise rather it requires a massive work so as to build a suitable environment for investment and public confidence (Jose, 2002).

According to the Washington consensus, macroeconomic stability is the necessary and prerequisite condition to achieve all other policy goals which is achieved through following liberalization policy. However, the pro-poor argue against this condition on the ground that in most African countries that pursued the liberalization policy failed to bring economic progress. These contending views became a lasting debate between scholars. The supporters of pro-poor concluded that setting policy rules and prior conditionality impede pro-poor investment (John and Sharuti, 2007).

Ethiopia is a typical developing country showing an increasing GDP growth, particularly since the 2000s, along with unstable macroeconomic condition (Alemayehu and Kibrom, 2020). With the country's regime change in 1991 from socialist to market based economic system, the economic reform policy of IMF and WB were introduced. Since then, monetary authority has tried to implement basic financial liberalization programs gradually like establishment of indirect

or market-oriented policy tools such as inter-bank money markets, treasury bills auction market, and as a move for open market operation, lifting up ceiling interest rates restriction and radically depreciating exchange rate were the major changes (Zerayehu, 2014). Domestically, promoting price and exchange rate stability for assisting sustainable economic growth is the major objective and target of Ethiopian monetary policy (NBE, 2009). Unfortunately, despite taking measures to implement the economic reform policies of IMF and WB in addition to the country's domestic policies to achieve the targets, the success is far below from the target owing largely to the weak financial instruments, lack of independence, inexistence of secondary markets, and the less monetized economy (Zerayehu, 2014). Also, the monetary authority loses its controlling power over commercial banks' credit and interest rate level (Equare,1994; Haile, 2001). This indicates that monetary policy instruments are ineffectual with this environment.

Moreover, due to the inherent supply side constrients and low level of aggregate demand in developing countries economy, any positive shock to money supply would be largely transferred to inflation than rising output (Kandil, 2014). For instance, the increase in money supply in Ethiopia following the 2005 failed election, to bring economic growth, was a strong evidence of being inflationary in this regard (Alemayehu and Kibrom, 2020). Househods and firms are unresponsive to interest rate which makes monetary transmission channel via interest rate instrument ineffective (Equare,1994; Haile, 2001). Also, inflation had been increasing along with economic growth which indicates that there is a kind of direct relationshp between economic growth and macroeconomic instabilty.

Using monetary policy, therefore, is recommendable for stabilizing the macroeconomic instabilities especially for developing countries basically characterised by weak financial and capital market development, fiscal dominance and so on (IMF, 2010). Ethiopia has been using monetary policy to bring exchange rate and price stability for fostering economic growth (NBE, 2009); however, inlation has been incresing in tandem with nominal income growth since the 2000's impliying the existence of direct relationship between economic growth and macroeconomic instability, which deserves for examining Ethiopia's monetary policy effectiveness. Hence, the purpose of this study is to investigate the effects of Ethiopia's monetary policy shocks on price and output using time series data over the period 2008Q1 to 2020Q4 by employing Structural Vector Autoregression (SVAR) model.

1.2 Statement of the Problem

Ethiopia has been recording an impressive economic growth for the last two decades in the context of unstable macroeconomic environment in general and double digit inflation in particular. The fast growth in real GDP, since the 2000s, was alleged to be because of the government's termination of the programs of International Monetary Fund (IMF) and World Bank (WB) in 2004/05, which requires the government to follow conservative monetary and fiscal policies. The government, believing that such economic performance is the result of rejecting the neo-liberal policies, followed a less stringent monetary and fiscal policy stance continuously (Alemayehu and Kibrom, 2020).

Despite this growth performance, macroeconomic instability has been increasing overtime in Ethiopia. The problem is increasing in intensity, harming the livelihood of the people at large and widening overtime in covering many macroeconomic variables. The recent double digit inflation, the trade deficit problem, and the rising unemployment are some of the instances. Consequently, many of the country's population were living under absolute poverty and it has also indirect implication for the country's recent political crisis.

To be more specific, consumer price index, which is used as a proxy for measuring macroeconomic instability, has been increasing at an increasing trend for the last three decades with lower average growth rate of 7 percent from 1990/1-1999/00; an average growth rate of 10.9 percent from 2000/1-2009/10 and an average growth rate of 12.62 percent from 2010/11-2020/21. The increase in consumer price index may be due to (1) the 2005 failed election that resulted in injecting huge quantity of printed money to the economy and high level of borrowing from China to finance the growth objective so as to calm down the public discontent (Alemayehu and Kibrom, 2020) and (2) the decline in the productivity of agriculture and hence food supply decline, which causes inflation as the growth process would result in a higher income to be spent on fixed supply of food (see Kalecki, 1954). Also, the growth rate of real per capita GDP was 7.6% from 2005-2009; 6.9% from 2010-2014 and 7% from 2015-2019, on average, indicating that there is no real change in real income of individuals. Inflation is increasing, but real income is not growing indicating that macroeconomic instability has been harming peoples' livelihood. The country's external balance is deteriorating over time; for instance, from 1992 to 2001 the

average growth rate of trade deficit was 21.5%; from 2002-2011 it was growing at 26.1% and from 2012-2021 the growth rate was 19.1% implying that trade deficit is increasing continuously (NBE, 2021). All these together indicate that there were intense macroeconomic problems, which has implication for questioning Ethiopia's monetary policy effectiveness. i.e., if the very purpose of monetary policy is to correct macroeconomic imbalances, then how these severe macroeconomic instabilities exist?

Some studies were done on this area; for example, by (Antene, 2014; Nuru, 2013; Temesgen, 2014, and Abate et al., 2019). Antene (2014) found reserve money using SVAR model as effective channel; Nuru (2013) found money supply and exchange rate as important policy instrument using VECM; Temesgen (2014) found exchange rate as the important policy instrument using tri-variate VAR, and Abate et al. (2019) indicated exchange rate, credit to the private sector, and monetary aggregate as the effective monetary policy channnels. We can underestand from their results that there were inconsistencies as to their findings. Some of these studies included only oil price index and federal funds rate as a proxy for foreign variables; however, these variables are not sufficient to proxy the effect of foreign variables on domestic monetary policy. Futhermore, no study used the Cushman and Zha (1997) approach of SVAR model, which best suits small open economy, to build Ethiopia's monetary policy framework to the best of our knowledge. Also, they conducted these studies in the context of very weak financial and capital market development, less monetized economy relative to the current period in which there is relative improvement. So, these studies are too outdated to describe the current context. Lastly, no study included Chinese variables into the model while there is strong economic linkage between Ethiopia and China. For instance, China shares about 37.3 percent of total import to Ethiopia from Asia's total import share of 61.3 percent (NBE, 2021).

This study contributes to existing literatures in the following ways. First, as the small open economy is very sensitive to several foreign variables (Cushman and Zha, 1997), we will include enough foreign variables both from USA and China, which were not included in Ethiopian SVAR model in the earlier studies. Specifically, taking China as a proxy for the rest of the world economy in building Ethiopia's SVAR model is an innovation in methodology and it is a new research idea. Second, our study follows the Cushman and Zha (1997) approach of SVAR model to build Ethiopia's SVAR model, which allows both block exogeneity and identification

restrictions to be imposed and enough foreign variables to be included while minimizing the number of parameters to be estimated (Raghavan and Silvapulle, 2015). Third, since there are disagreements as to the potency of monetary policy in developing countries in general and inconsistencies of results at the country level study in particular, our study will contribute to the existing literature so that policymakers can choose the potential monetary policy instrument(s). Lastly, as our study covers the period of relative financial and capital market development as well as the period of relative monetized economy, it will also fill the time gap. The study, therefore, investigates the effect of shocks to Ethiopia's monetary policy on price and output using secondary data over the period 2008Q1 to 2020Q4 by employing Structural Vector Autoregressive (SVAR) model.

1.3 Research Questions

The following are the major research questions that this study will attempt to address at the end. These include;

I. What are the effects of shocks to USA's and China's macroeconomic variables on domestic economy?
II. What are the effects of shocks to T-bill rate on price and output?
III. What are the effects of shocks to monetary aggregate on price and output? and
IV. What are the effects of shocks to nominal effective exchange rate on price and output?

1.4 Objective of the Study

The overall objective of the study is to empirically examine the dynamic effects of Ethiopia's monetary policy shocks on price and output using Structural Vector Autoregression (SVAR) model.

The specific objective of the study includes;

I. To examine the effect of shocks to USA's and China's macroeconomic variables on domestic economy;
II. To assess the effect of shocks to monetary aggregate on price and output;
III. To analyze the effect of shocks to T-bill rate on price and output, and
IV. To assess the effect of shocks to nominal effective exchange rate on price and output.

1.5 Significance of the Study

As this study is the first of its kind to build two SVAR models using USA and China's macroeconomic variables separately by applying the Cushman and Zha(1997) SVAR model, the study gives interesting insights for the National Bank of Ethiopia, Policymakers and academicians in general. The significance of this study centers, therefore, on revealing the dynamic effects of innovation in monetary policy on output and price. Thus, it serves as guiding framework for future researchers in particular interested on this area. Also, as it will identify the effective monetary policy instrument(s), it will help policymakers choose the effective monetary instrument(s). Since there is lasting debate as to the effectiveness of monetary policy in developing countries, it will contribute to the existing literature. The publics at large will be benefit at the end of the day.

1.6 Scope of the Study

Basically, this study examines the macroeconomic impacts of three discretionary monetary policy instruments in Ethiopia namely change in interest rate approximated by Treasury bill rate, change in monetary aggregates represented by narrow money, and change in nominal effective exchange rate. To account for the effect of foreign monetary shock on the domestic monetary policy, we will take USA and China as a proxy for the rest of the world separately to build two SVAR models. Accordingly, shocks to world commodity price index, USA industrial production index, USA federal funds rate and USA consumer price index will be taken from USA. From China, we will take output, consumer price index and policy interest rate of China. The key respondent variables under investigation are RGDP and prices. The study examines the effects of monetary policy shocks on these non-policy variables based on quarterly data over the period 2008Q1 to 2020Q4.

1.7 Organization of the study

Having this chapter done, the second chapter deals with theoretical issues and empirical literatures. The third chapter discusses model specification and methodological framework. In the fourth chapter, monetary policy and macroeconomic environments of Ethiopia will be discussed. The fifth chapter is devoted to discussing the results from the empirical analysis. Chapter six concludes the paper.

CHAPTER TWO

2. LITERATURE REVIEW

This chapter is devoted to literature review. Accordingly, concepts and definitions of monetary policy will be discussed first. We will also discuss several theories related to this area in the next section. Furthermore, we will review empirical evidences both from other developing countries and Ethiopia. Finally, we will identify the research gaps and build conceptual framework from our review of literatures.

2.1 Concepts and Definitions of Monetary Policy

Defining monetary policy, in a standard manner, is a difficult task because of the variations in objectives and targets depending on the country's context. For instance, according to European Central Bank, monetary policy is all about an action taken by Central Banks to influence the cost and availability of money in an economy. Specifically, in the Euro zone, the European Central Bank's most important decision in this regard focuses on key interest rates. Any change it introduces to these rates influences in turn the interest rates commercial banks charge their customers for borrowing money. Stating differently, the decision influences consumer spending and business investment (European Central Bank, 2015). However, one may formally define it as the designing of policy to control money supply and manage credit, which is crucial measure for adjusting aggregate demand in order to stabilize prices. It has to do with monitoring money supply, lending rates and interest rates, and is often regulated by Central Banks or National Banks. In the case of Ethiopia, the objective of monetary policy is to keep prices and exchange rate stable so as to promote economic growth (NBE, 2009). Clearly, there is variation as to the objectives of monetary policy which makes defining monetary policy in a standard manner a bit difficult.

2.2 Theoretical Literature

2.2.1 The Traditional Classical Frameworks

This theory is a formal monetary theory, which is exalted in the Fishers quantity theory of money, laid the ground for the inherent relationship between monetary aggregates and economic variables. The very assumption of this theory is that both velocity and output are constant and

any change in money supply will be directly transferred to a proportionate increase in prices. Money supply is impotent both in the short and long run; only real factors can change output (Gali, 2008; Mankiw and Taylor, 2007).

2.2.2 Keynesian Framework

In contrast to the Classical school, Keynes partly contented the assumption of constant and stable velocity of money. For the quantity theory of money, there is no inverse relationship between output and inflation (Keynes, 1936). As such, Keynesians hypothesized the rigidity of prices and assumed the instantaneous adjustment of the quantity of money. Moreover, they portrayed money demand to be endogenously determined mainly by income and interest rate as posited in the quantity theory of money. Based on the liquidity preference theory (LM), this school also assumed a direct relationship between output and interest rate.

The IS-LM version of Keyne's general theory basically assumed a constant price level, and therefore this model is useless to forecast inflation but useful for output analysis in the short run horizon (Hicks, 1937). According to this theory, a combination of the demand for money together with the quantity of money supplied by the Central Bank clears the market for money_the equilibrium level of money. So, such equilibrium causes interest rate simply monetary phenomena (endogenously determined). Clearly, money is exogenous and that any rise in the supply of it would decrease interest rate at which the demand and supply for money clear. A positive response from marginal efficiency of capital and investment is obtained with lower interest rate as it reduces the cost of capital which resultantly indicates output growth. However, there were empirical objections to Hicks IS-LM view of Keyne's general theory (see Robinson, 1962; Leijonhufvud, 1968; Backhouse and Bateman, 2011).

Keynes's generalization was that at times when an economy is trapped in liquidity problem, monetary policy is ineffectual owing to the inherent financial markets uncertainty. During this time, the time of liquidity trap and economic depression, what is effective is fiscal policy. Recently, the very assumption of exogenous money supply considered in both classical and Keynesian theory was equally subjected to a serious objection and were discarded in modern theories (Romer, 2006). The long run effect of Keynes's theory of persisting low interest rates

causes unsustainable asset price spikes (Schwartz, 2009). This change in asset prices comes without change in economic fundamentals; for instance, aggregate demand.

2.2.3 Monetarists Framework

This theory becomes dominant in the 1950s backing its basis from the quantity theory of money. It assumes velocity of money to be generally constant indicating that national income is determined basically by money supply (Friedman and Schwartz, 1963; Friedman 1968, 1970). They advocated the tenet of inverse proportionality between inflation and output which was reformulated as the Philips curve in terms of real wage not in nominal wages (Gottschalk, 2005). More importantly, they assumed the precedence of sticky wages over prices and also the clearing of labor market at the natural rate. The implication of nominal wage and price rigidity is that monetary policy is effectual in the short run horizon indicating that an increase in the quantity of money would temporarily increase output, but impotent in the long run period due to offsetting effect of an increase in prices. The theory emphasized the neutrality and inflationary impact of money in the long run. Empirics support this even recently (see for example Bernanke and Mihov, 1998; Bullard, 1999; Nogueira, 2009).

However, monetarism was objected on the ground of disregarding technological advancements and the dynamism of money demand function (White, 2013). It was also challenged both theoretically and empirically for assuming money supply as exogenous (Romer, 2006). The assumption of constant velocity of money was also subjected to equal critics (Mishkin F. S., 2007). Still more, Evans (1996) criticized that money is not neutral especially if growth is not endogenous.

There were post-monetarism theories such as the New Classical Model, New Classical Real Business Cycle (RBC), New Keynesian Model and the New Consensus Model. Actually, the slight difference in these theories lies how they treat nominal rigidities of wages and prices in addition to their view of demand (Goodfriend and King, 1997; Palley, 2007).

2.2.4 The New Classical Framework

In addition to assuming neutrality of monetary policy on real variables, the New Classical monetary theory also assumes the perfect competition market setting and full flexibility of prices. To be more specific, this model has four core assumptions such as the natural rate hypothesis,

continuous market clearing, the rational expectation hypothesis, and imperfect information. While monetary policy is useless to determine the equilibrium level of employment, output, and real interest rate, technological dynamism was assumed to be the only determinant of these variables.

2.2.5 New Classical Real Business Cycle (RBC)

The four assumptions raised herein before, provided a basis for this school, which has two tenets. The first of their tenet was the little uses of money, and the second was the upholding that business cycles were the results of rational agents responding to optimal real shocks in a market setting featured by perfect competition and smooth markets. The anticipated part of monetary policy is ineffective on real GDP as far as the assumptions of market clearing and rational expectation hypothesis were concerned. Only the unforeseen part of monetary policy will have short run effect on real variables (Mankiw, 2006).

2.2.6 New-Keynesian Framework

The New Keynesian theorists rejected the assumptions of continuous market clearing and flexibility of wage and prices in tandem with the automatic adjustment of the economy to its long run equilibrium position (Mankiw, 2006). Many empirics also refute the significance of this theory (Gottschalk, 2005). The synthesis of sticky prices and monopolistic competition into the line of RBC became the unique character of New Keynesian Economics (Goodfriend and King, 1997). According to this model, prices and wages are rigid so that in response to exogenous shocks quantities adjust when monetary and fiscal policy changes. Both firms and households act monopolistically with the former setting price in the product market and the latter setting wage in the labor market. The model is attempting to build a microeconomic basis for the traditional Keynesians. According to this theory, monetary policy is effective in the short run and ineffective in the long run. Empirics wise, the usefulness of New Keynesian models remains little and its theory is criticized in part due to giving few explanation of the role of money (Arestis and Sawyer, 2008).

2.2.7 The New Consensus Model

This model is the integration of the New Classical and the New Keynesian model in considering the rational expectations of the former and regarding the wage and price inflexibility of the latter. Price stability was the prime objective while other objectives such as growth became secondary

objectives. The only monetary policy instrument is interest rate. The model recommends that monetary policy should have to be applied on temporary output stabilization and long-run price stabilization. There is no long run change in economic activities, owing to the clearing tendency of markets because of rational expectation; only short run changes are expected due to ad hoc nominal inflexibility. The concept of stabilizing output is raised in the New Consensus Model (NCM) of aggregate demand with a trade-off between output and interest rate indicating that short term dynamics of monetary policy can influence the demand side of the economy which then converges to the long run supply side of equilibrium (Fontana and Palacio-Vera, 2007).

However, the very assumptions and the practicability of the NCM were not without critics. There is little empirical evidence to support the theory (Chari et al., 2008; Arestis and Sawyer, 2008). Specifically, it failed to explain the role of money and exchange rates, undertreating of all markets, the focus on only interest rate instrument and independent central banks discounts its operation importance especially for developing economies as well as open economies (Arestis, 2009; Arestis and Sawyer, 2008; Fontana and Palacio-Vera, 2007). The model is unworkable for inflation as it was mainly backed by supply side and its assumption of inflation responsiveness into other variables is under question (Arestis and Sawyer, 2008; Fontana and Palacio-Vera, 2007).

In addition to activating the debate on the earlier theories, the refutation of the NCM intensified consensus crisis on the significance of monetary policy on output (Fontana, 2010).

2.2.8 Transmission Channel of Monetary Policy

The first channel through which monetary policy is supposed to affect output and prices is through interest rate. It was the core transmission channel in the old Keynesian in affecting the real economy. Specifically, a decrease in money supply would increase interest rate, which makes capital expensive leading to a decrease in the amount of the economy's investment. Because investment is one of the components of aggregate demand, aggregate demand would decline eventually leading to a decline in output. The other channel is the exchange rate channel, which basically involves the interest rate effects. This is mainly due to the fact that when domestic interest rate rises, the value of domestic currency relative to other currencies increases. This would appreciate the local currency. Higher value of domestic currency makes domestic

goods more expensive than before to the foreigners leading to a fall in net export and hence output (Mishkin, 1995).

Furthermore, monetary policy might be transferred to output through the asset price effects. The Tobin's *q* theory of investment and wealth effects on consumption as a monetary transmission channel are frequently raised by monetarists. In the Tobin's *q* theory, monetary policy affects output through its effects on the valuation of equities. q is simply the market value of firms divided by its replacement cost of capital. The market price of firms is high relative to the replacement cost of capital if the value of *q* is high implying that new plant and equipment capital is cheap relative to the market value of business firms. In order to obtain high price for their asset relative to the cost of the plant and equipment they are buying, companies then issue equity. Because firms can buy a lot of new investment goods with only a small issue of equity, investment spending will rise resultantly (Mishkin, 1995).

The other channel that monetarists gave special importance is the wealth channel. With tightening monetary policy, stock price will decline making wealth to decline. Since the value of land and other property's values that households hold decline, their wealth would decline and thereby reducing their consumption which consequently ends up the economy with lower output (Mishkin, 1995).

The last, but not the least, is the credit channel. Monetary transmission works through two channels due to agency problems in credit markets: the bank lending channel and the balance-sheet channel. The bank lending channel works since they are in a good position to screen the type of borrower particularly small firms where there is largely the problem of asymmetric information. Hence, tightening monetary policy that reduces bank reserve and deposit will have an effect through reducing the loans available. This would decrease investment and thereby output. Coming to the balance sheet channel, we understand that monetary policy can affect firms' balance sheet in various ways. To discuss one of it, a tightening monetary policy through causing a decline in equity prices lowers the value of firms leading to a decline in investment and aggregate output due to the increase in adverse selection and moral hazard. Also, a contractionary monetary policy that causes interest rate hike harts the firm balance sheet as it

reduces cash flow. Because of the increase in adverse selection and moral hazard, lending level declines leading to a decline in investment and thereby output (Mishkin, 1995).

2.3 Empirical Evidences

Several works were done up to date basically targeted at knowing how effective monetary policy was both in developing and developed countries especially targeted at identifying which of the instrument(s) is/are effective. Generally, the empirical evidences concerning the efficacy of monetary policy in developing countries are grouped into two: the first evidences in support of monetary policy potency in affecting real and nominal variables and the other is the one that claims monetary policy's impotency in developing countries. According to IMF (2010), monetary policy was found to be effectual in sub-Saharan Africa which is contrary to the common perception. The second one is based on the view that monetary policy is ineffective in stabilizing prices and changing the real variables mainly due to structural weaknesses and underdeveloped financial markets that are weakly connected to the global markets (Nicholas and Twinoburyo, 2017). Moreover, the effectiveness of monetary policy under flexible exchange rates is quite low even if capital flows are perfectly elastic because of higher import shares and lower trade elasticities in developing countries (Weeks, 2009). This section, therefore, discusses empirics related to monetary policy both from Ethiopia and other developing countries.

2.3.1 Evidences from other Developing Countries

In Nigeria, a study was conducted by Chuku (2009) to examine the effects of the country's monetary policy shocks on prices and output employing a controlled experiment of Structural Vector Autoregression (SVAR) model. The experiment was conducted using policy instruments such as minimum rediscount rate, broad money and the real effective exchange rate. The findings indicate that monetary policy shocks carried out on the quantity-based nominal anchor has medium effects on output and prices with a very fast speed of adjustment. On the other hand, innovations on the price-based nominal anchors have neutral and short run effects on output. Accordingly, the study concluded that the alteration of the quantity of money in the economy is the most effective instrument for monetary policy implementation.

The study conducted by IMF (2010) geared towards examining the effectiveness of monetary policy in SSA revealed that monetary policy is more effective in sub-Saharan Africa than is

commonly perceived. Also, nominal exchange rate flexibility has served as a shock absorber during the base money and policy interest shocks which thereby facilitated current account improvement. For countries with fixed exchange rates, financing current account deficits is done through reserve buffers. In many Sub-Saharan African countries, there were many challenges to the monetary transmission mechanism including high level of excess liquidity in the financial system, low financial markets, and high level of fiscal financing.

In Sri Lanka, an attempt was made by Vinayagathasan (2013) to identify the monetary policy channels that describe the country's monetary policy transmission mechanism using a structural VAR model. The finding revealed that interest rate shocks play a key role in describing the dynamism of economic variables than monetary aggregate or exchange rate shocks The study also indicated the ineffectiveness of foreign monetary policy shocks and oil price shocks on domestic economy.

Using annual data for a sample of developing countries, a study was conducted by Kandil (2014). The result showed that any shocks to monetary policy would be shared to price inflation and output growth. Specifically, the higher the elasticity of aggregate demand with respect to monetary shocks, the larger will be the real effects of monetary policy on the economy. Contrastingly, in the prevalence of capacity constraints, the output adaptation to monetary shocks increases price inflation making monetary shock to be largely transferred to inflation.

A study was conducted by Raghavan and Silvapulle (2015) to empirically investigate how Malaysia's economy responds to money, interest rate, exchange rate and foreign shocks using two sample period of post and pre financial crisis of East Asia, and they employed SVAR approach to this end. There was a substantial difference of results between the pre and post crisis analysis. To be specific, in the pre-crisis period, monetary policy and exchange rate shocks have larger effect on output, price, money, interest rate and exchange rate. Nonetheless, it is only money stock that has significant effect on output in the post-crisis period. Also, in the post crisis period domestic monetary policy was found to be highly susceptible to foreign shocks particularly to the world commodity price shock and output shock than the pre-crisis period.

In Thailand, a study was conducted by Jiranyakul (2016) to identify the effects of monetary policy shock on output and price level covering the period from 2005Q1 and 2016Q2 using

SVAR model. The finding of the study indicates that a shock to monetary policy drives cycles for both real GDP and the inflation rate.

A study was conducted on the theoretical evolution of the relationship between monetary policy and economic growth (Nicholas and Twinoburyo, 2017). Overall, their study indicates that the majority of the results support the significance of monetary policy in enhancing economic growth largely in financially developed economies with fairly independent Central Banks while in developing economies the effectiveness is low because of structural weaknesses and underdeveloped financial markets that are weakly connected into global markets.

2.3.2 Evidence from Ethiopia

Coming to evidences from Ethiopia, a study was conducted to investigate the effect of monetary policy shock on price and output using SVAR model by (Antene, 2014). Domestic variables like gross domestic product, consumer price index, reserve money, T-bill rate and foreign variables like oil price index and world price index were included in the study. The study made contemporaneous restriction as a way to organize SVAR model. Findings of the study show that a positive shock to reserve money has significant positive effect on output for a lag period of one quarter; the effect on price is negative for one and half period after which it showed a positive influence. The study also uncovered that the variability of price and output due to reserve money was more pronounced than T-bill rate in both the short and long run horizon.

Another study was done by Nuru (2013) to empirically investigate monetary policy transmission in Ethiopia using Vector Error Correction for the short and long run model analysis, and impulse response function and variance decomposition analysis for evaluating relative effects of changes in monetary variable on the non-policy variables. The VECM indicated that it requires reasonably long period of time for inflation and output to return back to their long run equilibrium ones shock occurs to them. Domestic credit and exchange rate were found to have a positive and larger effect on output in the short run while in the long run it is money supply and domestic credit that was found to influence output positively according to the study's finding. The study also disclosed that money supply and exchange rate channel have a significant effect on real activity than credit and interest rate channels.

A study was conducted by Temesgen (2014) to investigate the impacts of monetary policy shocks on Ethiopian economy, and the channels through which these shocks might be transferred to the overall economy using annual data spanning from 1981/82-2011/12. The researcher used VAR technique to this end and tested co-integretion and causality between the variables using tri-variate Vector Autoregressive model (VAR). The results of the error correction model and the Wald Granger causality disclosed the existence of short run bidirectional causality between money supply and price level, and unidirectional causation running from output to price level indicating that price level is monetary phenomenon in the short run. Also, exchange rate was found to be important channel of monetary policy instrument.

Moreover, an attempt to examine the relative importance of the different monetary policy transmission channels and its effect on key macroeconomic variables using quarterly time series data covering from 1994/95Q1 to 2017/18Q4 was conducted by (Abate et al., 2019). To this end, Structural Vector Autoregressive model (SVAR) was employed. The finding of the result reveals that exchange rate, credit to the private sector and monetary aggregate were the effective channels of monetary policy in Ethiopia. However, interest rate was found to be ineffective channel according to the study's finding.

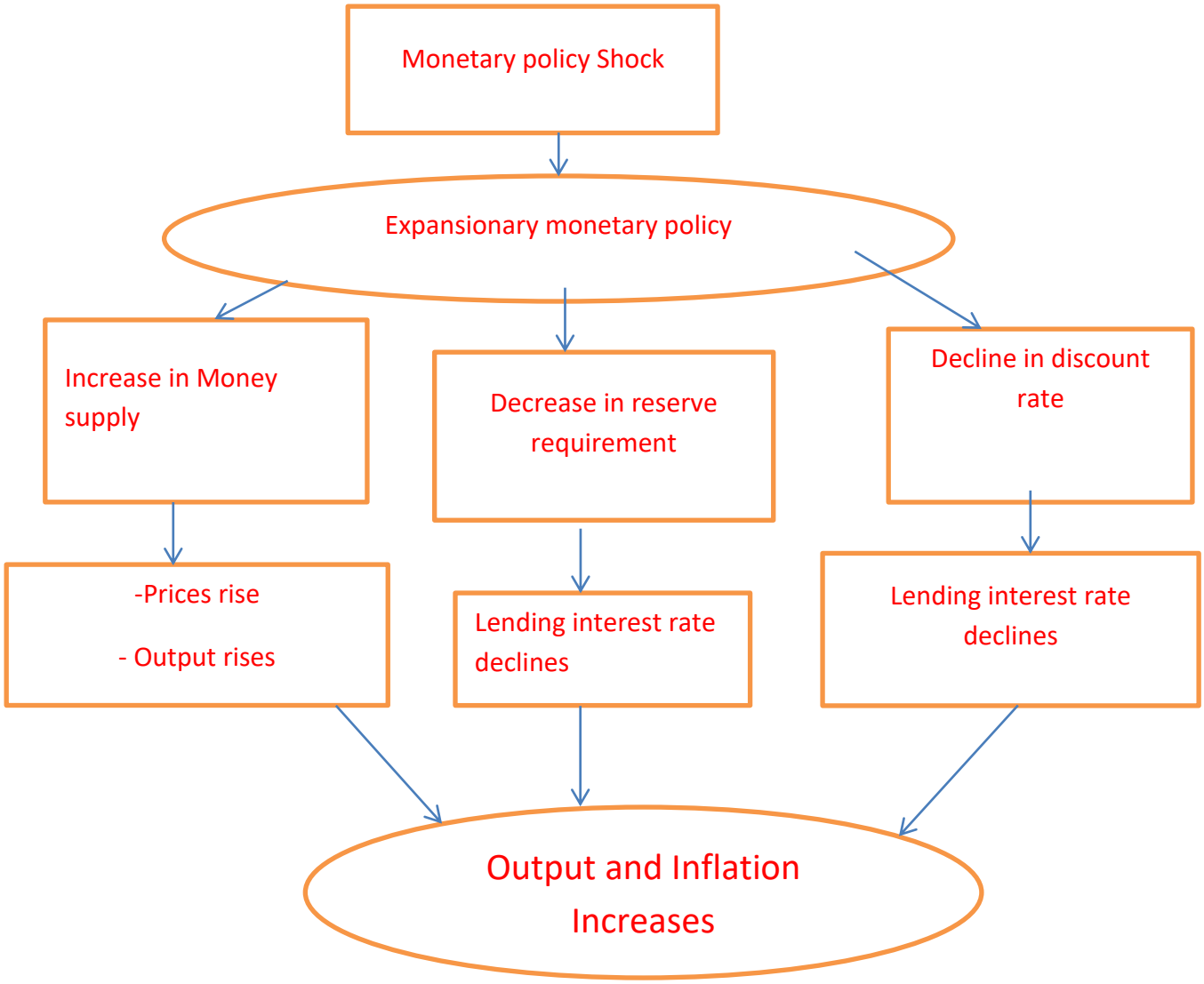
2.4 Conceptual Framework

Both theories and empirics indicate mixed results. There is no clear evidence as to which monetary policy instruments are effective consistently; it varies from country-to-country even within countries. Specifically, there were theories which uphold the effectiveness of monetary policy in the short run and neutrality of it in the long run; in contrast, there were also views which suggest the potency of monetary policy in the long run. Empirics wise, some literatures posits potency of monetary policy in changing output while others evidenced its impotency in developing countries mainly due to the weak capital and financial market, and supply side constraints (any increase in money supply simply increases prices) (Kandil, 2014).

Conceptual diagram provided below in figure 2.1 restate that an expansionary monetary policy increases both prices and. And decrease in reserve requirement would cause a decline in lending rates. In the discount rate case, a decline in the discount rate would bring a decline in lending

interest rate. The combined effect of this expansionary activity will end up with higher prices and output.

Figure 2.1 Conceptual Framework Diagram



Source: Author's construction

CHAPTER THREE

3. METHODOLOGY

3.1 Research Design

This study will be conducted using secondary time series data over the period 2008Q1-2020Q4. We will use foreign variables (both from China and USA) and domestic variables to investigate the effect of monetary policy shocks on price and output. Also, descriptive statistics and econometric methods of analysis will be used to this end. Econometrically, we will use the Structural Vector Autoregression (SVAR) model.

3.1.1 Data Type and Sources

The study will use secondary data to empirically characterize the dynamic effects of Ethiopian monetary shocks on price and output. The source of all foreign variables is International Financial Statistics (IFS) while domestic variables are obtained from National Bank of Ethiopia (NBE) and International Financial statistics (IFS) (for Ethiopian consumer price index). With regard to the commencing period of the data, our study period spans from 2008Q1 to 2020Q4 since this period is the period where global financial crisis has changed the world economy in general and a period of relative financial sector performance which is good as a starting point for investigating the effect of monetary policy on the economy. The reason for using quarterly data is to have sufficient degrees of freedom. All variables are in log except USA Federal Funds rate, China's interest rate and Ethiopian T-bill rate. Also, all variables, which are described in monetary terms, are expressed in terms of USA dollar.

3.1.2 Description of Variables and Model Specification

To examine the dynamic effects of monetary policy shock on output and price, the study included both foreign and domestic variables. We have chosen and ordered variables similar to those used by (Cushman and Zha, 1997; Fung, 2002; Raghavan and Silvapulle, 2015). Accordingly, the foreign variables come first followed by domestic variables. To be specific, the variables are ordered as Pc, yu, Pu, iruu; ye, Pe, Me, Exe and Tbe when considering USA as a proxy for the rest of the world and Pc, ych, Pch, irch; ye, Pe, Me, Exe and Tbe when China is taken as a representative of world economy. The definition of each variable is given below.

Table3.1: Variables included in the Ethiopian SVAR system

Variable	Definition	Abbreviation
Commodity prices	Word commodity price index(SA), Logs	Pc
US		
Output	Industrial production Index (SA), Logs	Yu
Prices	Consumer price index (SA), Logs	Pu
Interest rate	Federal funds rate (SA), percent	Iru
China		
Output	Real GDP (SA), Logs	Ych
Prices	Consumer price index (SA), Logs	Pch
Interest rate	Policy interest rate, percent	Irch
Ethiopia		
Output	Real GDP (SA), logs	Ye
Price	Consumer price index (SA), logs	Pe
Money	Narrow money (SA), logs	Me
Interest Rate	Treasury bill rate, percent	Tbe
Exchange rate	Nominal effective exchange rate (SA), Logs	Exe

Source: International Financial Statistics and National Bank of Ethiopia

Domestic Variables: includes monetary aggregates measured by M1, which is narrow money, consumer price index (Pe), real GDP (Ye), nominal effective exchange rate (EXe) and T-bill rate (TBe). The detail description of each variable is provided as follows.

Real GDP of Ethiopia (ye): it is defined as the market value of goods and services produced domestically each year in terms of US dollar (expressed in billons scale), and the base year 2008 was used in its computation. It is a non-policy variable or it is a response variable. We included this variable as it measures the growth performance of the economy in real terms. We converted annual data into quarterly series using quadratic conversion method as there is no quarterly RGDP data.

Consumer Price Index (Pe): it is a proxy variable for measuring the aggregate price level. It is taken as the target variables of monetary policy and is said to be non-policy variable (Abate et al., 2019). Inflation being a proxy for macroeconomic stability, we included this variable just to investigate whether monetary policy is effective in stabilizing price and hence the macro economy.

Narrow Money (Me): includes currency outside banks and net demand deposit. It is the most liquid form of asset. It is expressed in dollar terms in thousands of scales. It was found to be the most reasonable variable for monetary policy instruments among the several monetary aggregates investigated (Tang, 2006).

Treasury Bill Rate (Tbe): it is a weighted average T-bill rate. This variable is used as a proxy variable for policy interest rate because of the lack of interbank market rate in Ethiopia (Antene, 2014). Since this data is not available in quarterly form, we converted it into quarterly series using quadratic conversion method on Eviews-12 software.

The Nominal Effective Exchange Rate (Exe): is a measure of the value of a currency against a weighted average of several foreign currencies. An increase in nominal effective exchange rate indicates an appreciation of the local currency against the weighted basket of currencies of its trading partners and vice versa. It is an indicator of a country's international competitiveness in terms of the foreign exchange market. Specifically, an increase in the price of domestic currency relative to foreign currencies would increase the price of export which thereby reduce export and hence output. Also, it serves as the market information force (Abate et al., 2019).

Foreign Variables: includes world commodity price index (Pc), and the three USA variables namely the consumer price index (Pu), USA industrial production index (Yu) and the federal funds rate (IRu). These variables will be used as a means to proxy for foreign variables and they are exogenous to domestic variables. In a VAR model, the usefulness of foreign variables in the context of an open economy is important for correct specification, clear identification of contemporaneous relationships and for capturing underlying impulse responses of variables to several shocks (Raghavan and Silvapulle, 2015).

World commodity price index (Pc) is included to account for inflation expectations, basically to consider the non-policy driven changes in inflationary pressure to which the National Bank may respond when setting monetary policy (see Sims, 1992; Cushman and Zha, 1997; Raghavan and Silvapulle, 2015). The three US variables are included to represent the open economy component of the model, and were chosen as a proxy for foreign variables in the Ethiopian SVAR system for the first model. The industrial production index is an economic indicator that measures the real production of manufacturing, mining, and utilities. Production indices are computed with the

weights based on annual estimates of value added. The federal funds rate is the policy interest rate at which depository institutions (banks and credit unions) lend reserve balances to other depository institutions overnight on an uncollateralized basis. The definition for US consumer price index is the same with Ethiopia's consumer price index given above. The year 2010 was taken as the base year in the computation of industrial production index and price level.

However, one may raise question how USA can be a better proxy for Ethiopia as the rest of the world given the relatively low level of trade relationships with Ethiopia compared to Asian countries like China and other European countries? Our answer is this. We considered USA as a proxy for the rest of the world not because of trade relationships but due to (1) the country's dependence on USA's economy through aid, grant, credit, and other development assistance programs and (2) the dominant status of USA economy in the world in influencing the world economy in many ways like imposing sanctions, dominating international financial institutions and so on which in turn affects the Ethiopian economy directly or indirectly. It is also common in monetary literatures of small open economies to include these USA variables as proxy for foreign variables (see Cushman and Zha, 1997; Dungey and Pagan, 2000; Fung, 2002).

China's variables: we also included China's variables because of the strong economic relationship between the two countries. For instance, China shares about 37.3 percent of total import to Ethiopia from Asia's total import share of 61.3 percent (NBE, 2021). Specifically, we included real GDP, consumer price index and lending interest rate to build the second SVAR model. The definitions for the first two variables are similar with what we did above for Ethiopia, and the base year used in computing these values is 2010. China's interest rate is the one-year lending rate, which is the official interest rate of the Chinese Central Bank and the 7-day money market rate. It serves as a policy interest rate for China (UNCTAD, 2008).

3.1.3 Method of Analysis

In this study, we will use both descriptive and econometric method of analysis in order to make our results more robust. In the descriptive part, we will use tables and graphs to describe the trends, development, diversification, and the like of monetary indicators. In the econometrics part, we will use the SVAR model and that we will the OLS estimation technique for estimating the reduced form VAR and employ the maximum likelihood estimation technique for estimating

the contemporaneous structure. Finally, based on the parameter estimates of the SVAR model, we will estimate the impulse response function and variance decomposition.

3.2 Seasonal Adjustment of the Data

In time series data the trend, cyclical, seasonal and irregular part may be included. The trend is the general long-term movement persisting for many years. The cycle is a quasi-periodic oscillation persisting for more than a year around the long- term trend characterized by alternating periods of expansion and contraction. The irregular component is nothing but random variations that are unforeseeable movements associated with events of all kinds and which cannot be attributed to the trend-cycle component and the seasonal component. The time series which undergoes repetitive and predictable movement around the trend line in one year or less is said to be seasonal variation. The causes of these movements may be attributed to the multiple effects of phenomenon related to the climate, institutional decisions or modes of operation changes which occurs with certain regularity within the year. Thus, it is quite important to seasonally adjust data to get rid-off these effects that can be forecasted to repeat at definite periods each year under normal conditions (Lütkepohl, 2005).

Seasonally adjusting a time series involve pre-adjustment that can be carried out manually. This is followed by estimation of the trend-cycle component of the preadjusted series through calculating centred moving average. This requires prior decision on whether the model should take multiplicative or additive form. In the multiplicative model, the time series is assumed to be the product of its four components mentioned above and the original series is divided by the estimated trendcycle. The additive model, on the other hand, is the sum of the four components of the original series and the estimated trend-cycle component would be subtracted from the original series. In a multiplicative decomposition, the seasonal effects change proportionately with the trend. If the trend rises, so do the seasonal effects, while if the trend moves downward the seasonal effects diminish too. In an additive decomposition the seasonal effects remain broadly constant, no matter which direction the trend is moving in. In practice, most economic time series exhibit a multiplicative relationship and hence the multiplicative decomposition usually provides the best fit.

Prior to seasonally adjusting the data, the series should be examined for the presence of seasonality through statistical tests. In other words, one has to check whether the increase in the seasonal factors from year to year is too large to introduce distortion in 35 the model. For

seasonality to be identifiable, the series should be identified as seasonal by using the "Test for the Presence of Seasonality Assuming Stability" and "Nonparametric Test for the Presence of Seasonality Assuming Stability." Also, since the presence of moving seasonality can cause distortion, it is important to evaluate the moving seasonality in conjunction with the stable seasonality to determine if the seasonality is identifiable.

Formally, we can clearly state the hypothesis as:

H_0: there is no significant seasonal component in the time series

H_1: there is significant seasonal component in the time series

The procedure that has to be followed next to identifying the existence of seasonality is to find estimation mechanism so as to seasonally adjust the series. In this study, X-13 and its variants are used as a technique for seasonally adjusting data.

3.2.1 Stationarity and Unit Roots

A series is considered stationary (weakly or covariance) if its mean and auto-covariances are finite and independent of time. Non-stationary series are those that do not satisfy this property.

Non-stationary series are illustrated by random walk series, for example, as:

$$y_t = y_{t-1} + \varepsilon \quad \text{.....(3.1)}$$

Where ε_t denotes white noise. The forecast value based on the preceding series is clearly time dependent. Furthermore, the series' variance rises over time. However, through differencing the above series results in a stationary process, as shown below.

$$y_t - y_{t-1} = \Delta y_t = \varepsilon \quad \text{.....(3.2)}$$

Because ε_t is white noise, it implies that Δy_t is also white noise and became stationary after differencing it. A difference stationary series is the case where a variable becomes stationary after differencing d times which is written as I(d). Where, *d* denotes the order of integration. The order of integration denotes the number of differencing operations required to make a non-stationary series stationary. For the random walk series above, there is one unit root, so it is stationary at first difference, I(1) series. Also, a series may be stationary series at level or without differencing, I(0). The economic intuition behind distinguishing between the I(0) and I(1) series is that the former has a limited memory of its previous behavior, whereas the latter has an

infinitely long memory. To put it another way, specific random shocks in the I(0) and I(1) series have temporary and permanent effects, respectively (Verbeek, 2008).

Estimating a model using non-stationary data can result in spurious regression in that case the estimated regression has a high R^2 and significant t-values having no economic relationship between the variables, and thus the existing relationship may be due to correlated time trends rather than a true economic relationship (Granger and Newbold, 1974). Therefore, as a way to prevent the seemingly nice spurious regression results, various stationarity testes are available. The several available tests are Augmented Dickey-Fuller Test (1979) (ADF), Phillips-Perron (1988) test (PP), the GLS detrended Dickey-Fuller (Elliot, Rothenberg, and Stock, 1996), Kwiatkowski, Phillips, Schmidt, and Shin (KPSS, 1992), Elliott, Rothenberg, and Stock Point Optimal (ERS, 1996) and Ng and Perron (NP, 2001). We will use ADF, PP and KPSS in this study as a method of testing stationarity. Given the Autoregressive model of first order, AR(1), as follows:

$$y_t = \theta y_{t-1} + \varepsilon_t \quad \text{.....(3.3)}$$

When $|\theta| \geq 1$, the series is said to be non-stationary. In the AR(1) model, a well-known test of non-stationarity investigates whether the series is non-stationary, i.e., whether $\theta = 1$. Equation (3.3) is the key equation and from that equation three equations are derived to allow for different non-stationarity possibilities. Before deriving these equations, we should transform the AR(1) model by deducting y_{t-1} from both sides and allowing $\delta = \theta - 1$. As such, we define the null hypothesis for unit root as $\delta = 0$. The three equations are written as follows:

$$\Delta y_t = \delta y_{t-1} + \varepsilon_t \quad \text{.....(3.3}a\text{)}$$

$$\Delta y_t = \beta_1 + \delta y_{t-1} + \varepsilon_t \quad \text{.....(3.3}b\text{)}$$

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \varepsilon_t \quad \text{.....(3.3}c\text{)}$$

The null hypothesis of unit root, i.e., $\delta = 0$ is shared by all scenarios, whereas the alternative is less than zero, indicating that the series is stationary. The first scenario is a clear random walk under the null hypothesis, which excludes any kind of trend. The series in the second scenario

has a stochastic trend or a drift parameter, whereas the third specification has both deterministic and stochastic trend.

According to Dickey and Fuller (1979), the value of δ is estimated based on the τ (tau) statistic and the critical values are calculated depending on Monte Carlo simulations. Said and Dickey (1984), augmented lagged changes and re-formulated the model to consider for the likelihood of serial correlation in the preceding specifications as:

$$\Delta y_t = \beta_1 + t\beta_2 + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.3d)$$

Where, $\Delta y_{t-1} = \Delta y_{t-1} - \Delta y_{t-2}, \Delta y_{t-2} = \Delta y_{t-2} - \Delta y_{t-3},$ and so on.

Thus, the ADF test based on (3.3d) is quite important, especially when the presumption of uncorrelated error term is not reliable. Phillips and Perron (1988) used a non-parametric statistical method that takes into account the existence of serial correlation in the error term, t, without including lagged changes like in the ADF test. The Phillips-Peron (PP) test has almost the same asymptotic distribution as the ADF test (Gujarati, 2004).

Failing to reject the null hypothesis of a unit root simply indicates that there is no enough information to reject the null hypothesis (Verbeek, 2008). To prevent the problem of low power of the test, Kwiatkowski et al. (1992) developed an alternative test called KPSS. According to this testing mechanism, stationarity is the null hypothesis and the existence of a unit root is the alternative. This test decomposes a given time series into deterministic time trend, random walk and error term (not necessarily a white noise). As such, it tests trend stationarity under the null hypothesis that the random walk part has zero variance. This test is a Lagrange Multiplier (LM) test. The test statistic is computed from a regression of the series on the time trend. From the residual, the following test statistic is computed.

$$KPSS = \sum_{t=1}^{t} St^2/\hat{\sigma}^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .(3.4)$$

Where, $S_t = \sum_{i=1}^{t} e_i$ is the partial sum of the residual computed from the OLS regression of the series on intercept and time trend and $\hat{\sigma}^2$ is an estimator of the error variance. If the computed value is smaller than the given critical value, then the series is stationary and vice versa.

3.3 Model Specification and the Justification for using SVAR

The dominance and popularity of monetary policy since the 1990s has resulted in an equal importance in the application of the VAR model pioneered by Sims (1980) which is designed to investigate an economy's monetary policy framework. From time to time, the development of structural VAR (SVAR) technique more sophisticated the analysis of various economic issues and problems associated with the identification of the contemporaneous and dynamic relationships between macroeconomic variables and the policy instruments. In this part, we have given a through description of the SVAR model.

SVAR model is the solid channel between economic theory and multivariate time-series regression analysis, which is used for determining the time path, and thus, the dynamic responses of variables to various disturbances or shocks that occur within the economy (Isedu, 2013).

To give more justification for using SVAR model, the SVAR estimation gives reliability in the response of policy targets to monetary policy shocks. Thus, it is used for illuminating monetary policy innovations on the macroeconomic variables and thereby, for forecasting and policy analysis. Still more, the SVAR is very effective in describing the interactions and interrelationships between economic variables in the model while retaining theoretical coherence (Serven and Solimano, 1991). Very importantly, it has the advantage of identifying the system errors which are understood as linear combinations of exogenous shocks rather than identifying the autoregressive coefficients (See Sims, 1981; Bernanke, 1986; Shapiro and Watson, 1988; Mugume, 2011).

To model the relationships among the macroeconomic variables, we can write using the SVAR model as:

$$A_0 y_t = A_1 y_{t-1} + A_2 y_{t-2} + ... + A_p y_{t-p} + \varepsilon_t \quad (3.5)$$

Specifically, we formally specify our model when USA and China's variables are included into the model, respectively, as:

$$y_t = (Pc, y_u, P_u, ir_u, y_e, p_e, M_e, Tb_e, ex_e)'$$

$$y_t = (Pc, y_{ch}, P_{ch}, ir_{ch}, y_e, P_e, M_e, Tb_e, ex_e)',$$

Where, y_t is (N×1) vector of endogenous variables at time t, A_i a (N × N) matrix of parameters for $i = 0,1,2, \ldots, p$ while ε_t is a $(N \times 1)$ multivariate white noise error process with the following properties:

$$E(\varepsilon_t) = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.5a)$$

$$E(\varepsilon_t \varepsilon_\tau) = \begin{cases} \Sigma \ldots\ldots\ldots\ldots t = \tau \\ 0 \ldots\ldots\ldots\ldots otherwise \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.5b)$$

In this approach, the structural innovations ε_ts' are assumed to be orthogonal and in addition, the structural disturbances are uncorrelated and the variance-covariance matrix $\sum$ is constant and diagonal. The contemporaneous matrix A_0 described in (3.5) is normalized across the main diagonal so that each equation in the SVAR system has a respective explained variable.

The parameters of the SVAR model are estimated in two stages. The first stage is to get the following reduced form equations, which is obtained from expression (3.5) by pre-multiplying both side of the equation by A_0^{-1}:

$$y_t = A_0^{-1} A_1 y_{t-1} A_0^{-1} A_2 y_{t-2} + \ldots + A_0^{-1} A_p y_{t-p} + A_0^{-1} \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.5c)$$

$$y_t = B_1 y_{t-1} + B_2 y_{t-2} + \cdots + B_p y_{t-p} + v_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.5d)$$

Where, $B_i = A_0^{-1} A_i$, $i = 1,2,\ldots p$ and $v_t = A_0^{-1} \varepsilon_t$. The expression described in (3.5d) is the reduced form VAR, and v_t is the innovation vector associated with the reduced form, which has zero mean and constant variance, $v_t \sim N(0, \Omega)$. 'N' equations in the VAR model of (3.5d) are estimated by OLS technique and the VAR residuals v_t is obtained in the process. The innovations in structural models in (3.5b) are linked to the reduced form innovations as:

$$E(v_t v_t') = A_0^{-1} (\varepsilon_t \varepsilon_t') A_0^{-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.5e)$$

$$\Omega = A_0^{-1} \Sigma (A_0^{-1})^{-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.5f)$$

The second stage in estimating the SVAR model is to identify the contemporaneous matrix A_0 and the variance-covariance matrix Σ which maximizes the likelihood function contingent on the parameter estimates of the VAR obtained in the first stage. The log likelihood function is computed by using Newton-Raphson analytic derivatives method.

In the SVAR, A_0 has N^2 parameters, while Ω has only N(N +1)/2 distinct values, which results in an identification problem as the structural model requires $2n^2 - (n+1)/2$ number of restrictions to be imposed on the system in order to form exact identification conditions, if not the system is under identified[1]. Moreover, the residuals from the reduced VAR are transformed into a system of structural equations by imposing restrictions based on a prior theories and empirical findings about policy reaction functions rather than depending on the commonly used Choleski's decomposition technique. This method of orthogonalizing the reduced form residuals to recapture the underlying shocks is suggested by (Bernanke, 1986; Sims, 1986; Blanchard and Watson, 1986).

3.4 Model Structure and Identification Issues

This section is devoted to the identification of the Ethiopian SVAR model. Applying identification restrictions requires restrictions that are in line with economic theory and prior empirical research findings, which are the commonly used approach in the literature (see for example Buckle et al, 2007; Christiano et al, 1992; Dungey and Fry, 2003; Dungey and Pagan, 2000). To establish the identification conditions, the results of Ethiopian VAR studies and those of the SVAR studies of other small open economies are quite important for guiding us in setting the appropriate restrictions to be imposed on the contemporaneous structure of the Ethiopian SVAR model.

3.4.1 Block Exogeneity Restrictions

It is obvious that shocks to small open economies have insignificant impact on major foreign countries, and hence it is appropriate to consider the foreign variables as exogenous to domestic economic variables (Raghavan and Silvapulle, 2015). As a way to account for this, we divided

[1] Since the numbers of variables are nine, 9, we need to impose $2n^2 - (n+1)/2 = 2(9)^2 - (9+1)/2 = 117$ number of restrictions on the system for exact identification.

the Ethiopian SVAR system into foreign and domestic blocks. To describe the reduced VAR system for a small open economy first, the set of variables y_t is divided into two blocks as below:

$y_t = (y_{1,t}, y_{2,t})'$……...(3.6)

$y_{1,t} = (PC_t, y_{u,t}, P_{u,t}, IR_{u,t})'$……..(3.6a)

$y_{2,t} = (y_{e,t}, P_{e,t}, M_{e,t}, TB_{e,t}, EX_{e,t})'$……....(3.6b)

Where, $y_{1,t}$ represents the foreign block, $y_{2,t}$ represents the domestic block. The VAR in (3.5d) can now be represented as follows:

$$y_t = \begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} \qquad B(L) = \begin{bmatrix} B_{11}(L) & B_{12}(L) \\ B_{21}(L) & B_{22}(L) \end{bmatrix} \qquad \nu_t = \begin{bmatrix} \nu_{1,t} \\ \nu_{2,t} \end{bmatrix} \text{……(3.6c)}$$

The B_{11} (L) and B_{12} (L) blocks contain the matrix of lag polynomials that correspond to the foreign economy while B_{21} (L) and B_{22} (L) contain the matrix of lag polynomials that represent the domestic economy. Similarly, the A_0 matrix in equation (1) can be decomposed as below:

$$A_0 = \begin{bmatrix} A_{0,11} & A_{0,12} \\ A_{0,21} & A_{0,22} \end{bmatrix} \text{……..……(3.6d)}$$

It is assumed that the foreign variables in the Ethiopian VAR system are exogenous and the domestic variables do not Granger causes the foreign variables. So, a block exogeneity is imposed by excluding all domestic variables from the foreign block of equations in contemporaneous structure of the reduced form VAR, which is done through imposing the restrictions that, $A_{0,12} = 0$. In the framework of a small open economy, the block exogeneity restrictions has key role as it allows a larger set of foreign variables to be included into the model, while minimizing the number of parameters to be estimated (Raghavan and Silvapulle, 2015).

3.4.2 Restrictions on Contemporaneous Dynamics and Expected Outcomes

Imposing restrictions on the contemporaneous matrices are also needed besides foreign block exogeneity restrictions imposed in the model. Restrictions on contemporaneous matrix (the A matrix) are presented in appendix B. In imposing restrictions on the variables, we followed the non-recursive restriction approach. This is because the recursive assumption is subject to

objection when trying to describe actual National Bank behavior. As per the supporters of the non-recursive approach, the identification of the National Bank's behavior should be based on the information that is available at the time of the policy shock (Raghavan and Silvapulle, 2012).

In the table below, we have provided the expected responses of domestic variables to both foreign and domestic shocks.

Table 3.2: The response of domestic variables to monetary policy shocks

	Expected responses				Puzzles
Variables	ir_u/ir_{ch}	M_e	Tb_e	Ex_e	
y_e	-	+	-	+	-[2]
P_e	-	+	-	+	-[3]
M_e	-	+	-	+	-[4]
Tb_e	+	-	+	-	+[5]
Ex_e	+	-	+	-	+[6]

We are speaking of positive shocks to all variables except nominal effective exchange rate. Shock to the nominal effective exchange rate is negative shock, which is devaluation. And that a positive shock to the interest rate is a contractionary move by the government, while a positive shock to monetary aggregate is an expansionary measure taken by the government.

3.4.3 Identification of the Foreign Variables

The foreign block includes Pc, Yu, Pu and Iru when USA is taken as a proxy for the rest of the world and Pc, ych, pch, and irch when China is considered as world's economic representative. These variables are described by the block exogeneity assumption discussed in section 3.4.1. The world commodity price index is assumed to be fully exogenous to all other variables in both models. Moreover, the three US and China's variables are identified recursively. Specifically, USA and China's output are contemporaneously exogenous to all other variables in the model. The foreign price level is assumed to be contemporaneously affected only by demand based

[2] output puzzle- output decreases instead of increasing in response to expansionary monetary policy shocks
[3] price puzzle-price decrease instead of increasing in response to expansionary monetary shock
[4] liquidity puzzle-money decreases instead of increasing in response to expansionary monetary shock
[5] Interest rate puzzle-interest rate increases instead of decreasing in response to expansionary monetary shock
[6] Exchange rate puzzle-exchange rate appreciates instead of depreciating in response to expansionary monetary policy shock

fluctuations in output. Also, foreign interest rate is contemporaneously affected by output and price shocks (Raghavan and Silvapulle, 2015). Federal Reserve's monetary policy specification is assumed to follow the "Taylor Rule" where its very aim is to obtain output growth and price stability (see Taylor, 2000; McCauley, 2006).

3.4.4 Identification of the Domestic Sector

The domestic block is classified into two sub-blocks. The first sub-block, known as the non-policy block is described by domestic output and prices. Domestic output is unaffected by all domestic variables. Moreover, we assumed Ethiopian price level to be contemporaneously affected by domestic output (see Abate et al., 2019).

The second sub-block, known as the policy block is represented by the central bank's policy instruments of money, T-bill rate and nominal effective exchange rate. Very importantly, the domestic monetary aggregate is affected by domestic output, price and T-bill rate (see Abate et al., 2019; Raghavan and Silvapulle, 2015). Coming to the domestic T-bill rate, it is contemporaneously affected by world commodity, foreign interest rate, domestic output, domestic price and domestic money demand (see Abate et al., 2019). The contemporaneous inclusion of output and prices is due to the fact that monetary authorities use these variables as information set in setting policy interest rate (Antene, 2014). Lastly, we assumed nominal effective exchange rate to be contemporaneously affected by all variables in both models (see Raghavan and Silvapulle, 2015). It serves as market information force (Abate et al., 2019). Through the exchange rate equations, foreign variables are allowed to indirectly influence the domestic variables.

3.5 Impulse Responses and Variance Decomposition

The potency of monetary policy and the roles of various transmission channels in transmitting the policy shocks can be observed through the responses of the target variables to unexpected shocks. The estimated SVAR system is used to examine the dynamic characteristic of the model by estimating the impulse response functions and forecast variance decompositions. The derivation of these empirical methods is briefly described as of below.

3.5.1 Impulse Response Functions

The Impulse response function is derived and used to examine the dynamic responses of the variables to various shocks within the SVAR system. Using the lag operator L, model (3.5d) can be written as follows:

$$B(L)y_t = \nu_t \quad \text{.....(3.7)}$$

Where $B(L) = I - B_1L - B_2L^2 - \cdots - B_PL^P$

For a covariance stationary VAR, the effect of any shock given by ν_t (the reduced form innovations) in (3.7) dies out at some point in time in the future. In this case (3.7) can be re-parameterized to express the endogenous variables in y_t as a function of the current and past values of ν_t. Thus, the vector moving average (VMA) is written as:

$$y_t = \nu_t + C_1\nu_{t-1} + C_2\nu_{t-2} + ... = C(L)\nu_t \quad \text{.....(3.8)}$$

Where $C(L) = (I - B_1L - B_2L^2 - \cdots - B_pL^p)^{-1} = I + CL + C_2L^2 + \cdots C_pL^p$

The impulse response function derived from the VMA traces the path of the response for the i^{th} variable over time, following an innovation to ν_t from the j^{th} variable, while holding all other reduced form innovations constant. However, the MA model in (3.8) may not have the tendency to attribute the response of a certain variable to an economically intuitive shock, because ν_t by its construction reflects the combination of all the fundamental economic shocks and does not correspond only to a particular shock. One way to avoid this problem is to transform innovations ν_t to recover the set of orthogonal structural innovations ε_t defined in the original SVAR model (3.5).

The SVAR approach assumes that the structural innovations ε_t are orthogonal, i.e, the structural disturbances are uncorrelated. The (3.8) can be transformed as:

$$y_t = C^*(L)\varepsilon_t \quad \text{.....(3.9)}$$

Where, $C^*(L) = C(L)A_0^{-1}$ generates the impulse response functions of y_t to the structural shocks ε_t. As the structural innovations are orthogonal, the covariance between the primitive shocks will

be restricted to zero. The effects of monetary policy shocks on other domestic variables, especially on the target variables of income and price can be captured more effectively by calculating the initial impulse response function given in (3.9). The disturbances ε_t has economic meaning and therefore the impulse response functions can be interpreted intuitively (Raghavan and Silvapulle, 2015). For instance, the transmission mechanism of monetary policy shock can be analyzed by observing the response of other variables in the system to monetary policy shocks.

3.5.2 Variance Decomposition

Forecast error variance decomposition describes what proportion of a shock to a specific variable is related to either its own innovations or those associated with other dependent variables at various forecast time horizons in the system. The s-period-ahead forecast error is expressed as:

$$y_{t+s} - \hat{y}_{t+s/t} = U_{t+s} + C_1 + C_1 U_{t+s-1} + C_2 U_{t+s-2} + ... + C_{s-1} U_{t+1} \quad (4)$$

The mean squared error of the s-period forecast is:

$$MSE(\hat{y}_{t+s/t}) = \Omega + C_1 \Omega C_1^{'} + C_2 \Omega C_2^{'} + ... C_{s-1} \Omega C_{s-1}^{'} \quad (4a)$$

$$MSE(\hat{y}_{t+s/t}) = A_0^{-1} \Sigma (A_0^{-1})' + C_1 A_0^{-1} \Sigma (A_0^{-1})^{'} C_1^{'} + ... + C_{s-1} A_0^{-1} \Sigma (A_0^{-1})^{'} C_{s-1}^{'} \quad (4b)$$

Where, $\Omega = A_0^{-1} \Sigma (A_0^{-1})^{'}$. Expression (5b) characterizes the orthogonal innovation's contribution to the MSE of the s-period-ahead projections of variables in y_t.

3.6 Pre-estimation and Post-estimation Diagnostic Tests of the VAR Model

3.6.1 Lag Length Selection Criteria

Prior to actually estimating the VAR model, it is essential to choose a number of lags that generates a good model and thereby a precise forecast. The optimal amount of lags to be included in the VAR model can be specified by the lag order of the VAR model. This implies that over-fitting (choosing a higher order lag length than the true lag length) tends to increase the mean-square prediction error of the VAR and that under-fitting the lag length frequently results in auto-correlated errors (Lütkepohl, 2005).

Several tests and information criteria are there that allow you to select the best lag. The Likelihood

Ratio (LR) test, Akaike Information Criterion (AIC), Hannan and Quinn Information criterion (HQ), Final Prediction Error (FPE), and Schwartz Information Criterion (SIC) are examples of information criteria. The information criterion which has the minimum value from all criteria is selected as the optimal lag length.

3.6.2 Stability of VAR Model

This test of stability of VAR model is another test of the post estimation diagnostic tests done prior to using the estimates of the baseline VAR model for policy analysis and prediction. The test determines if the roots of the characteristic polynomial are within the unit circle. If the characteristic polynomial lies inside the unit circle, the VAR model satisfies the stability condition (Leijonhufvud, 1962).

3.6.3 Residual Autocorrelation

Residual autocorrelation is the other post estimation test that is used for detecting whether the current value residual is correlated with any of its lagged values. The Lagrange Multiplier test is conducted for this purpose. This requires specifying the order of serial correlation which is consistent with that employed in estimating the VAR model. The null hypothesis of the LM test for autocorrelation says that the residuals are serially uncorrelated, while the alternative is that the residuals are serially correlated. P-value of less than 0.05 enables us to reject the null hypothesis (Harris, 2005).

3.6.4 Multivariate Normality of the Residuals

It is another post estimation diagnostic test used to check whether the residuals are normally distributed. Testing this distributional assumption is useful in establishing up forecast intervals. The third and fourth central moments (skewness and kurtosis) are used to develop the test for normal distribution. More formally the multivariate version of the Jarque-Bera test is conducted in this study, which under the null hypothesis of normally distributed errors has a test statistic that follows a Chi-Square distribution. As such, significance of Jarque-Bera statistic or p-value being less than 5%, enables us to reject the null hypothesis of normality at the 5% level of significance (Lütkepohl, 2005).

3.6.5 Heteroscedasticity Test

This test determines whether or not the variance of the errors is constant. The null hypothesis in the White (1980) test for heteroscedasticity claims that the residuals are homoscedastic and independent of the regressors and there is no misspecification problem. If the test statistic is significant or the P-value is less than 0.05, the null hypothesis of homoscedasticity and no misspecification is rejected.

CHAPTER FOUR

4. MONETARY POLICY AND FINANCIAL SECTOR DEVELOPMENT IN ETHIOPIA

4.1 Evolution of Monetary Policy Framework in Ethiopia

The nature and type of government shape the framework of domestic monetary policy as was the case in other Sub-Saharan African countries. To begin, the birth of monetary policy can be traced back to 1943, when the Ethiopian state bank was established, with two departments performing separate functions of commercial bank and an issuing bank. As per proclamation number 206/1963, the National Bank of Ethiopia was established and given administrative autonomy and juridical personality on the mandate of regulating money and cost of money and credit, managing and administering the country's international reserves, supervising and licensing banks and holding commercial banks reserves and lending money for commercial banks. Furthermore, it regulates interest rate and supervises loans of commercial banks, and controls and fixes foreign exchange rates (Nuru, 2013).

After the imperial regime was toppled out by the derg regime, monetary and banking proclamation No.99/1976 was enacted to change the bank's responsibility to the socialist economic principles that the country transplanted, and that the scope of its jurisdiction extended to comprise other financial institutions such as insurance and credit cooperatives. The 1976 proclamation also increased the domestic borrowing limit of the government to 25%, which is against 15% of the 1963. Abolishment of financial markets, the fixing of exchange rate, controlling of capital and price regulation were the dominant financial features in that period. With the demise of the derg regime by EPRDF, Monetary and Banking proclamation No.83/1994 was issued to shape the National Bank according to the pro-market economic policy so as to bring monetary stability, a sound financial system and other credit and exchange rate conditions, which enhances the economic performance of the country. The proclamation also empowered the bank to regulate the supply and availability of money and credit and fix interest rates in order to set limits on the net foreign exchange position and on the terms and amount of external indebtedness of banks and other financial institutions and to make short and long term refinancing facilities available (Nuru, 2013).

Very importantly, the government amended establishment of National Bank of Ethiopia with

proclamation No.591/2008. As a result, the proclamation empowered the bank to coin, print, and issue legal tender currency, as well as act as the government's banker, fiscal agent, and financial advisor; regulate and determine the supply and availability of money and credit, as well as the level of interest rate and other cost of money charges; formulate, implement, and monitor the country's exchange rate policy, and manage and administer the country's international reserves, and so on (Nuru, 2013).

4.1.1 Monetary Policy Instruments

Monetary policy instruments are generally classified as direct and indirect instruments. Direct instruments are governed by regulations that have a direct impact on either the interest rate or the amount of credit; for example, officially setting interest rate ceilings, individual bank credit ceilings, and directed lending. Nevertheless, as the level of financial and money market progresses, the potency of direct instruments of monetary policy declines and also create distortions such as financial repression and increase financial disintermediation and fiscal dominance. On the contrary, the indirect instruments or market-based instruments basically affects the market determined price of bank reserves since the central bank transact with both financial and non-financial institutions. Three types of indirect instruments are there including central bank lending policies, reserve requirements, and open-market operations (NBE, 2009).

Reserve Requirement: Central Bank may require Commercial Banks to hold a proportion of their vault cash to deposit with it. The purpose of the fractional reserve limit was to restrict the amount of loans that banks could make to borrowers, thereby determining the supply of money and, as a result, the level of liquidity in the economy. Money deposit banks manage their reserve holdings and the amount of credit they extend to borrowers in this manner. Because reserve requirements are guided by regulation, they also have some direct control. The demand for reserve money determines the impact of changes in reserve money; there is a stronger reason to categorize them as indirect monetary policy instrument. The National Bank of Ethiopia uses this rate to vary the level of liquidity of banks in line with the targets. Rising the level of reserve requirement is a contractionary measure which decreases the liquidity and hence the lending capacity of banks (NBE, 2009).

Open Market Operation: it is the act of buying and selling government issued bonds and securities. The significance of using these instruments sophisticates the functioning of financial

system and increases financial intermediation between economic agents. Treasury Bills rate is one of such instruments. Selling of securities by central bank reduces the supply of reserves and buying of securities increases the supply of reserves to the commercial banks and thereby determining the level of money supply (NBE, 2009).

Standing Central Bank Credit Facility: it is yet another tool used to improve commercial banks' financial potential and improve financial intermediation and efficiency. The transparency and predictability of obtaining central banks' assets to support short-term credit needs are key benefits of it. This credit facility guarantees banks that they will be able to settle clearing with the funds of the National Bank at a reasonable interest rate that is specifically linked to short-term market interest rates. This is required when banks face difficulties with clearing shortfalls and a lack of options for raising immediate funds in the money markets. This instrument is used as one of monetary policy tools by the National Bank of Ethiopia (NBE, 2009).

4.1.2 Growth in Monetary Indicators and Macroeconomic Trends

Since the last two decades, the Ethiopian economy has showed an impressive growth performance though macroeconomic problems such as inflation, trade deficit, public debt and budget deficit are growing continuously. The 2005 Ethiopian failed election brought about an increase in money supply basically to politically impress the public discontent through promising economic growth. That increase in money supply comes through money printing and borrowing from China. However, this monetary development was turned to be the source of inflationary problem than bringing the promised economic growth (Alemayehu and Kibrom, 2020).

As a monetary indicator, broad money supply has showed average growth rate of 29.4 percent during 2009/10-2012/13 from 18.9 percent average growths during 2004/05-2008/09, and it continued to grow by 24.4 percent during 2014/15-2019/20. Narrow money showed an average growth rate of 17.3 percent during 2004/05-2008/09; 26.4 percent during 2009/10-2013/14 and 18.3 percent during 2014/15-2019/20. The increase in such monetary indicators might be due to the increase in economic growth, which increases the demand for money (money supply has to increase to match the increase in demand owing to income increase) and because of the expansion of banks, which may increase the quantity of money in the process of accepting

deposit and giving credit. All other monetary indicators showed a positive average growth rate in all interval periods except net foreign asset showing negative 8.0 percent average growth during 2014/15-2019/20, which might be because of the political turmoil that might hinder the inflow of foreign asset.

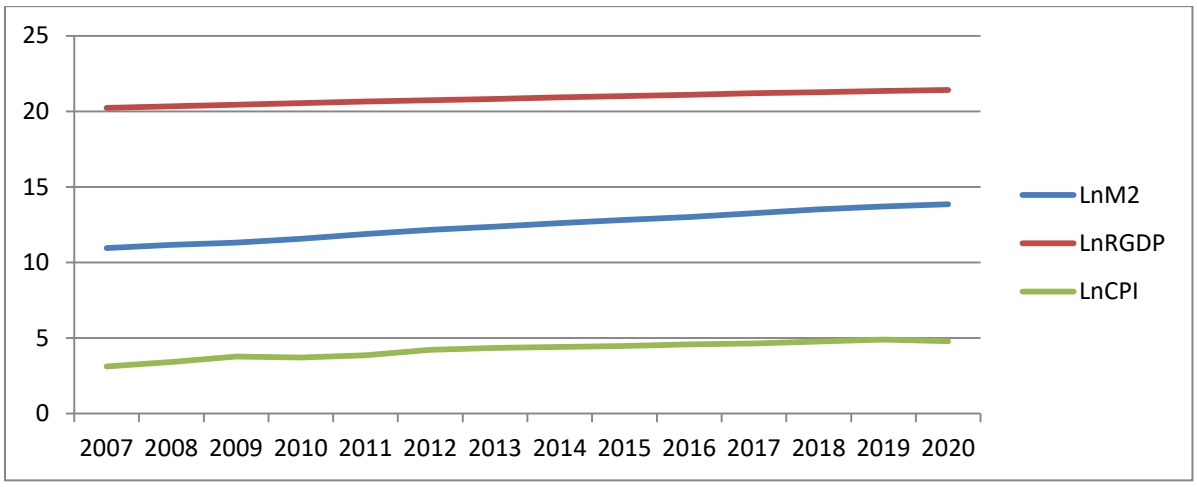
Table 4.1: Average percentage growth rate of monetary indicators

Indicators	2004/5-2008/9	2009/10-2013/4	2014/5-2019/20
Broad money	18.9	29.4	24.4
Narrow money	17.3	26.4	18.3
Net foreign asset	11.0	28.5	-8.0
Reserve requirement	66.0	9.5	25.4
Net domestic credit	23.6	27.6	26.3

Source: Authors computation based on NBE data

During the study period, inflation has followed common trend of growth with broad money supply confirming the general perception that an increase in money supply would bring about price rise. Because money supply has increased following the 2005 failed election, inflation has increased overtime following that change. Real GDP growth has also followed the same pattern of increment with broad money supply. This enables one to understand that money supply has effect on both nominal and real variables.

Figure 4.1: Trends in broad money supply (M2), RGDP and consumer price index



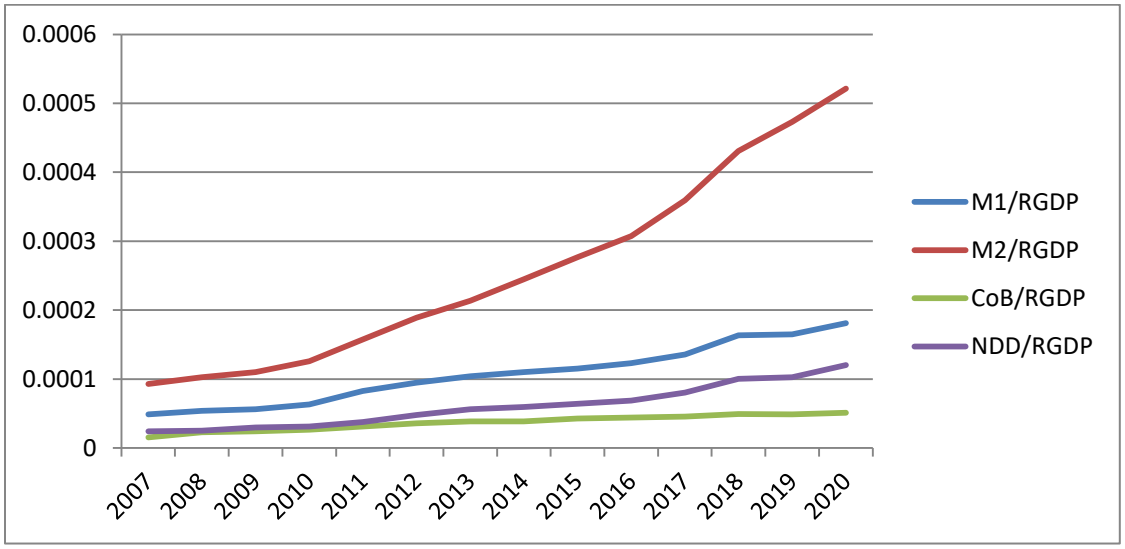
Source: Authors computation based on data from NBE

4.2 Indicators of Financial Sector Development in Ethiopia

Financial reform is expected to increase the effectiveness of the financial system in motivating individuals to hold more assets in financial form. (M2), which consists of currency held outside the banking sector, demand deposits held in local currencies and savings accounts held in local currency, is used to measure financial deepening/development. Figure 2 shows currency outside the banking sector as a proportion of gross domestic product (CoB/GDP), narrow money as a ratio of GDP (M1/GDP), broad money as a ratio of gross domestic products (M2/GDP), and net demand deposit to gross domestic products (DD/GDP).

The result of the trend shows that the ratio of M2 to GDP has increased at an increasing trend over the study period. Other indicators have also increased continuously though not at the same trend with broad money. Generally, the financial sector development indicators have showed a general increasing trend during the study period; specifically, broad money being a better indicator of financial development, financial deepening has been increasing during the study period. This might be partly because of the expansion of banks and credit institutions in the country in addition to the increase in economic growth that has been registered since the last two decades which makes individuals to hold asset in financial form.

Figure 4.2: Financial Sector Development Indicators

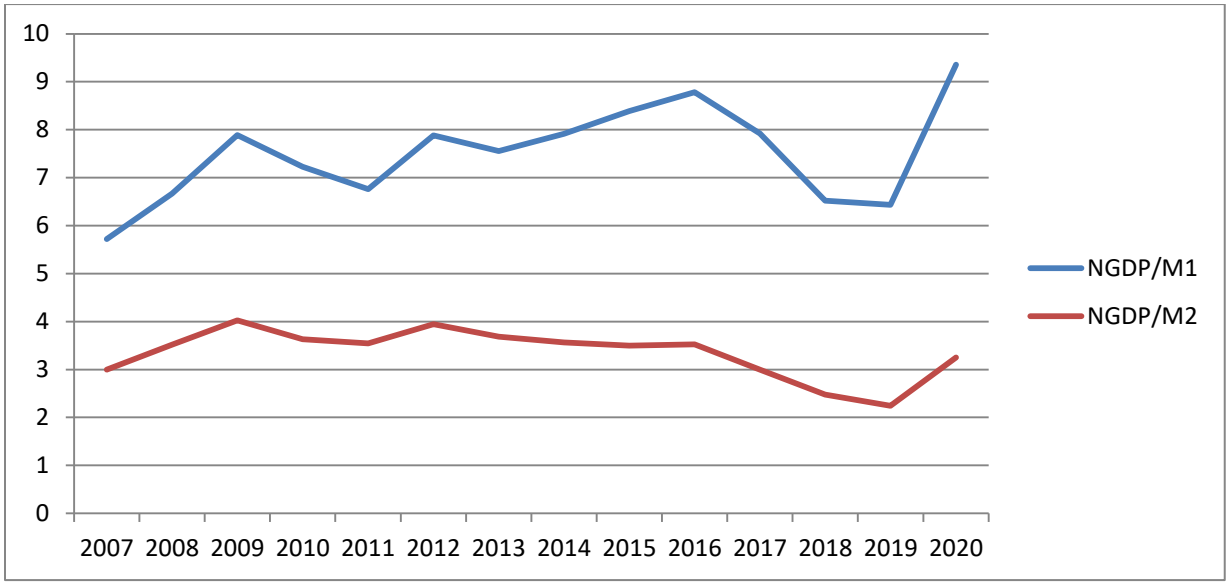


Source: Author's computation based on NBE data

4.2.1 Income Velocity of Money

Velocity of money, the ratio of nominal income to the stock of money, lies at the center of the relationship between money, income and price and assumes vital significance in monetary policy formulation. Because when velocity of money is unpredictable, money demand function is also unstable so the income velocity of money plays the key role in ensuring the potency of monetary policy. Figure 3 displays the income velocity of money for both M1 and M2 of Ethiopia during 2006/07 to 2019/20. The velocity of M1, in nominal terms, has increased overtime on average indicating that there is still lower degree of monetization of the economy. Velocity of M1 has been fluctuating more than the Velocity of M2 in the study period. It is clear from the figure presented below that the VM2 seem to be relatively more stable and constant than VM1. The rise in the income velocity VM1 and the stable nature of VM2 indicates that there is still low level of financial transactions, advancement in loans distribution techniques, financial innovation, service automation and so on (Abate et al., 2019).

Figure 4.3: Income velocity of Narrow (MV1) and broad money (MV2)



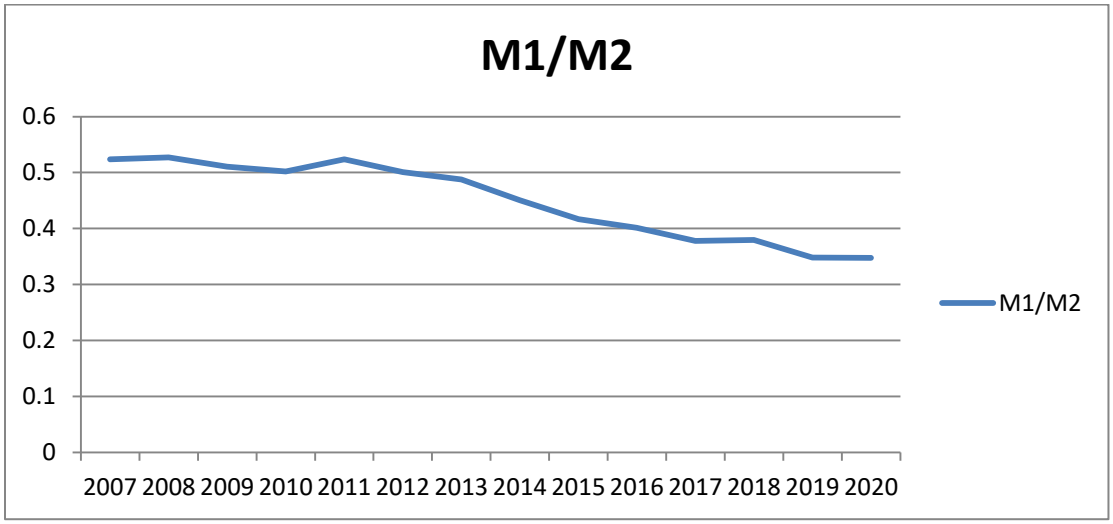
Source: Author's computation based on NBE data

4.2.2 Money Liquidity Ratio

The ratio of narrow money to broad money is another indicator of financial development. A slight decline in the ratio implies the progress to diversification of financial institutions and a somehow increase in the availability or use of bank deposits as a medium of exchange. The

declining trend of this ratio also implies the accessibility and ease of use of non-currency forms of transaction media and a relative diversification of financial institutions. Figure 4 below implies that M1/M2 has decreased as financial innovation has progressed in Ethiopia.

Figure 4.4: Money Liquidity Ratio (M1/M2)



Source: Author's computation based on NBE data

CHAPTER FIVE

5. RESULTS OF THE ANALYSIS

5.1 Seasonal Adjustment

Because we used quarterly data in our model, it is susceptible to seasonal variation. Seasonal variation is a disturbing factor that economic models do not take into consideration most of the time. So, this study uses x-13 quarterly seasonal adjustment method that is a variant of X-11 installed on eviews-12 software.

Table 5.1: Stable Seasonality Test Result

Name of Variable		Sum of Squares	Degrees of Freedom	Mean Square	F-value
Pc	Between quarters	3.1061	3	1.03535	2.215
	Residual	35.5234	76	0.46741	
	Total	38.6295	79		
Yu	Between quarters	0.2463	3	0.08209	1.760
	Residual	3.5452	76	0.04665	
	Total	3.7915	79		
Pu	Between quarters	0.3283	3	0.10945	40.507**
	Residual	0.2053	76	0.00270	
	Total	0.5337	79		
Iru	Between quarters	6110.6604	3	2036.88680	1.904
	Residual	81298.9196	76	1069.72263	
	Total	87409.5800	79		
Ych	Between quarters	9.3438	3	3.11459	148.114**
	Residual	1.5981	76	0.02103	
	Total	10.9419	79		
Pch	Between quarters	0.9366	3	0.31218	94.665**
	Residual	0.2506	76	0.00330	
	Total	1.1872	79		
Ye	Between quarters	0.0001	3	0.00003	0.241
	Residual	0.0079	76	0.00010	
	Total	0.0080	79		

Pe	Between quarters	9.1073	3	3.03578	14.670**
	Residual	15.7268	76	0.20693	
	Total	24.8341	79		
Me	Between quarters	0.3829	3	0.12765	3.734
	Residual	2.5980	76	0.03418	
	Total	2.9810	79		
Exe	Between quarters	0.2607	3	0.08689	0.998
	Residual	6.6176	76	0.08707	
	Total	6.8783	79		

** Stable seasonality is present at the one percent level.

The above table indicates that there is a strong evidence of stable seasonality at one percent significance level for variables such as USA consumer price index, Chinese output, Chinese consumer price index, and Ethiopian consumer price index. There is no evidence of stable seasonality for other variables.

Table5.2: Moving Seasonality Test Result

Name of Variable		Sum of Squares	Degrees of Freedom	Mean Square	F-value
Pc	Between years	8.7591	19	0.461008	2.158
	Error	12.1790	57	0.213666	
Yu	Between years	2.2231	19	0.117005	7.541**
	Error	0.8844	57	0.015516	
Pu	Between years	0.0895	19	0.004709	4.174**
	Error	0.0643	57	0.001128	
Iru	Between years	37078.4488	19	1951.497307	3.104**
	Error	35835.6181	57	628.695055	
Ych	Between years	0.1861	19	0.009792	0.849
	Error	0.6573	57	0.011531	
Pch	Between years	0.0607	19	0.003196	1.154
	Error	0.1578	57	0.002769	
Ye	Between years	0.0022	19	0.000114	2.081*

	Error	0.0031	57	0.000055	
Pe	Between years	5.6375	19	0.296711	1.845*
	Error	9.1657	57	0.160801	
Me	Between years	0.3155	19	0.016604	1.205
	Error	0.7856	57	0.013782	
Exe	Between years	1.6177	19	0.085141	1.871
	Error	2.5941	57	0.045511	

**Moving seasonality present at the one percent level

*Moving seasonality present at five percent significance level

When we come to the moving seasonality test result, there is strong evidence of moving seasonality at the one percent significance level for variables such as USA output, consumer price index and federal funds rate. Also, there is evidence of moving seasonality at the five percent significance level for Ethiopian output and consumer price index. There is no evidence of moving seasonality for other variables.

As a way of summary, we provided the combined test for identifiable seasonality test.

Table 5.3: Result of the Combined Test for Identifiable Seasonality

Name of Variables	**Remark**
World commodity price index, pc	Identifiable seasonality not present
US industrial production index, yu	Identifiable seasonality not present
US consumer price index, pu	Identifiable seasonality present
US federal funds rate, iru	Identifiable seasonality not present
Chinese output, Ych	Identifiable seasonality present
Chinese consumer price index, Pch	Identifiable seasonality present
Ethiopian output, ye	Identifiable seasonality not present
Ethiopian consumer price index, Pe	Identifiable seasonality present
Ethiopian narrow money, Me	Identifiable seasonality not present
Ethiopian Nominal effective exchange rate, Exe	Identifiable seasonality not present

Source: Authors estimation

5.2 Test Results for Stationarity

Before going to the estimation part, we checked stationarity using ADF, PP and KPSS methods, and the results are given below.

Table 5.4: Stationarity Test Result Using ADF and PP Tests

H_0:Variable has unit roots	Augmented Dickey Fuller Test P-values				Philps-Perron Test P-values			
	Level	1st diff.	Intercept	Trend	Level	1st diff.	intercept	Trend
Pc_SA		0.0000	✓			0.0000	✓	
Yu_SA		0.0000	✓			0.0000	✓	
Pu_SA		0.0000	✓			0.0000	✓	
Iru_SA		0.0046	✓			0.0000	✓	
Ych_SA		0.0000	✓			0.0000	✓	
Pch_SA		0.0001	✓			0.0001	✓	
Irch_SA		0.0001	✓			0.0000	✓	
Ye_SA		0.0000	✓			0.0001	✓	
Pe_SA		0.0001	✓			0.0001	✓	
Me_SA		0.0000	✓			0.0001	✓	
Tbe_SA	0.0000		✓		0.000		✓	
Exe_SA		0.0000	✓			0.0000	✓	

*the numbers in the table indicates p-values corresponding to the order of integration
**the check mark indicates the included exogenous term
***the null hypothesis of non-stationarity is rejected for p-values less than 5%

To check the existence of low power of test, we conducted the KPSS test statistic which is basically based on the Lagrange multiplier (LM) test. The result of KPSS shows that all the variables are stationary implying that the test results of ADF and PP are also reliable and efficient.

Table 5.5: Stationarity Test Result Using KPSS

H_0:Variable is Stationary	Kwiatkowski, Phillips, Schmidt and Shin LM Test statistic			
	Level	1st diff	Intercept	Trend
Pc_SA		(0.061)*	✓	
Yu_SA		(0.078)*	✓	

Pu_SA		(0.061)*	✓	
Iru_SA		(0.186)*	✓	
Ych_SA		(0.500)***	✓	
Pch_SA		(0.063)*	✓	
Irch_SA		(0.035)*	✓	
Ye_SA		(0.326)*	✓	
Pe_SA		(0.180)*	✓	
Me_SA		(0.500)***	✓	
Tbe_SA	(0.187)*		✓	
Exe_SA		(0.419)**	✓	

*indicates that the variable is stationary at 10% significance level
** indicates that the variable is stationary at 5% significance level
***indicates that the variable is stationary at 1% significance level
The value in parenthesis indicates KPSS test statistics

5.3 Lag Length and VAR stability Test Results

To determine the optimal lag length of the reduced form VAR, the study uses different lag-length selection criteria such as LR, FPE, AIC, SIC, and HQ. In table 5.6 and 5.7, we presented the Eviews-12 result of optimal lag length. Except the SIC criteria, the entire lag length selection criteria tests suggests optimal lag length for the VAR model to be two (2) in the case of including US variables into the model (model 1)[7]. The LR and AIC selected the optimal lag length of two (2) for the model that include Chinese variables (model 2)[8].

Table 5.6: VAR lag order selection criteria for model 1

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	289.6742	NA	1.08e-16	-11.22697	-10.88281	-11.09591
1	618.2784	525.7667	5.65e-21	-21.13114	**-17.68950***	-19.82054
2	741.4929	**152.7859***	**1.43-21***	**-22.81971***	-16.28060	**-20.32958***

Source: Author's estimation

Table 5.7: VAR lag order selection criteria for model 2

[7] Model 1 refers to the case of considering US as a proxy for the rest of the world
[8] Model 2 refers to the case of considering China as a proxy for the rest of the world

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	186.9465	NA	1.11e-14	-6.590610	-6.259113	-6.462765
1	528.8883	557.2385	**7.33e-19***	-16.25512	**-12.94015***	**-14.97667***
2	610.4785	**105.7651***	9.15e-19	**-16.27698***	-9.978532	-13.84792

Source: Author's Estimation

Before proceeding to estimate the parameters of the SVAR and the resulting impulse response functions, it is of important to check the VAR stability using AR roots. The results provided in tables 5.8 and 5.9; indicate that moduli of all the eigenvalues for both models lie in the unit circle. So the VAR/SVAR model fulfills required stability condition.

Table 5. 8: Roots of characteristic polynomial for model 1

Roots	Modulus
0.979801	0.979801
0.881462-0.088217i	0.885865
0.881462-0.088217i	0.885865
0.791468+0.345316i	0.863519
0.791468-0.345316i	0.863519
-0.769211	0.769211
-0.259344-0.611298i	0.664037
-0.663278	0.664037
0.032470-0.643139i	0.663278
0.032470+0.643139i	0.643958
0.415040-0.465095i	0.643958
0.415040+0.465095i	0.623355
0.435056-0.260045i	0.623355
0.435056+0.260045i	0.506850
0.505820	0.506850
-0.453037	0.453037
-0.237993	0.237993
No root lies outside the unit circle	
VAR satisfies the stability condition	

Source: Author's estimation

Table 5. 9: Roots of Characteristic Polynomial for model 2

Root	Modulus
0.991414	0.991414
0.924916	0.924916

0.774400-0.254419i	0.815122
0.774400+0.254419i	0.815122
0.670340-0.368329i	0.764867
0.670340+0.368329i	0.764867
0.608658	0.608658
0.180366-0.520954i	0.551294
0.180366+0.520954i	0.551294
-0.518274+0.186632i	0.550854
-0.518274-0.186632i	0.550854
-0.142262-0.489488i	0.509742
-0.142262+0.489488i	0.509742
-0.348590-0.290569i	0.453812
-0.348590+0.290569i	0.453812
0.175521-0.191120i	0.259489
0.175521+0.191120i	0.259489
-0.133698	0.133698
No root lies outside the unit circle	
VAR satisfies the stability condition	

Source: Author's estimation

For the SVAR model to be just identified, the model requires $2n^2 - n(n+1)/2$ number of restrictions. Because the number of variables in our model is 9, based on this formula, we need 117 number of restriction for the system to be just identified. Of this, 72 are assigned to the matrix B. So, about 45 number of restriction are just required in matrix A for the system to be identified. Moreover, the identifying restrictions were not rejected at the 5% significance level (see table 6.1 and 6.2).The LR test for the over-identification restriction of the contemporaneous SVAR model finds the additional restrictions to be valid with the probability value of 0.399. Thus, to test the validity of the identifying restrictions imposed in the model, we need to conduct the over-identifying restriction test. Accordingly, the corresponding p-values are 0.2590 and 0.4716 for models that includes USA and China's variables respectively, indicating that the likelihood ratio test doesn't reject the over-identified restrictions.

Table 5.10: Estimated Results of SVAR for model 1

Log likelihood	628.3104
LR test for over-identification:	
Chi(9) 11.24879	probability 0.2590

Source: Author's estimation

Table 5.11: Estimated Results of SVAR model for Model 2

Log likelihood	500.7872
LR test for over-identification:	
Chi(9) 8.635400	probability 0.4716

Source: Author's estimation

5.3.1 Estimated Results of Contemporaneous matrix

The estimated contemporaneous matrix is reported in table 5.12 and 5.13 in both scenarios (when considering USA and China as a proxy for the rest of the world economy). The estimation technique is done using scoring method with analytic derivatives. The bolded value indicates that these coefficients are significant at 5 percent significance level.

Table 5.12: Estimated Results of Contemporaneous Coefficients for model 1

Variables	Pc	Yu	Pu	Iru	Ye	Pe	Me	Mbe	Exe
Pc	1.00								
Yu		1.000							
Pu		-0.017	1.000						
Iru		0.665	7.210	1.000					
Ye					1.000				
Pe					**15.**77	1.000			
Me					-6.594	10.646	1.000	-1.436	
Tbe	0.255			**-0.198**	3.988	**1.168**	0.095	1.000	
Exe	4.437	-6.447	-6.476	-0.217	-2.462	**1.821**	0.008	2.296	1.000

Source: Author's estimation

Table 5.13: Estimated Contemporaneous Coefficients for Model 2

Variables	Pc	Yu	Pu	Iru	Ye	Pe	Me	Tbe	Exe
Pc	1.000								

Yu		1.000							
Pu		0.027	1.000						
Iru		**2.934**	0.395	1.000					
Ye					1.000				
Pe					1.104	1.000			
Me					1.105	**1.408**	1.000	0.276	
Tbe	-0.435			0.115	-2.317	-4.138	1.791	1.000	
Exe	0.011	-0.218	0.123	**-0.055**	-0.135	**0.429**	-0.035	-0.105	1.000

Source: Author's estimation

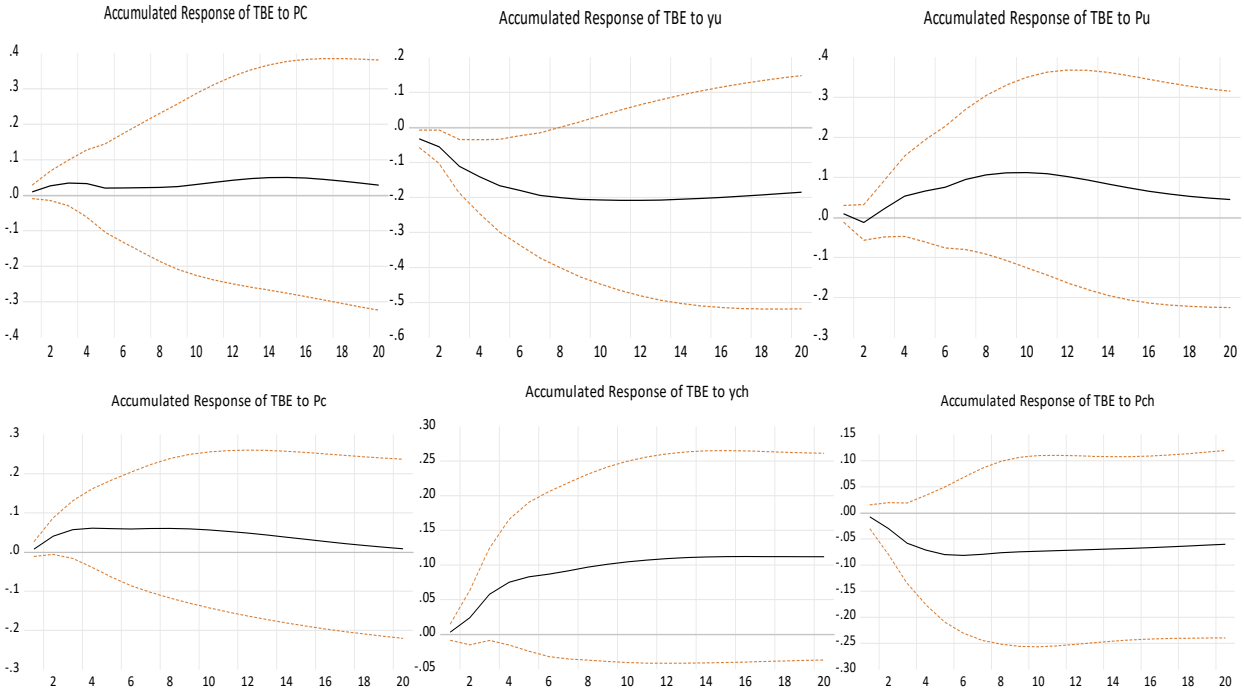
5.4 Impulse Response Function

The estimated results of contemporaneous matrix estimated above help to estimate impulse response functions. Analytic (asymptotic) standard errors are used to provide accumulated responses of domestic variables over 20 quarters (five years) to structural VAR innovations. Taking this period is important as it is equivalent to Ethiopia's medium term socio-economic development plan, and hence the effect of any shock to economic variable is supposed to be well identified both in direction and magnitude over this period. Moreover, each of the dashed lines represents the 95% confidence band. The values on the vertical line represent the deviation from the baseline level of the variable in response to a given shock on the policy variable. The results on the horizontal line represent the time passed after the introduction of the shock.

5.4.1 Impulse Responses of Ethiopia's Interest Rate to Foreign Shocks

Figure 5.1 below shows the impact of foreign shocks namely world commodity price (Pc), USA output, USA Price (Pu), China's output and China's price on Ethiopia's monetary policy instrument (Tbe) when USA and China are taken as world's economic representative separately.

Figure 5.1: Responses of Tbe to Pc, yu, Pu, ych and Pch shocks



Source: Author's Estimation

As expected, a positive shock to world commodity price increased domestic interest rate continuously in both model 1 and 2 (model 1 and model 2 are when USA and China are taken as world economic representative, respectively). A positive shock to USA output tends to have a negative effect on domestic interest rate while the impact of positive shock to China's output on domestic interest rate is positive. This implies that China's output shock has the theoretically expected sign on domestic monetary policy instrument. This might be due to the strong economic linkages between the two countries that can easily transfer the effect of output growth to the domestic monetary policy instrument.

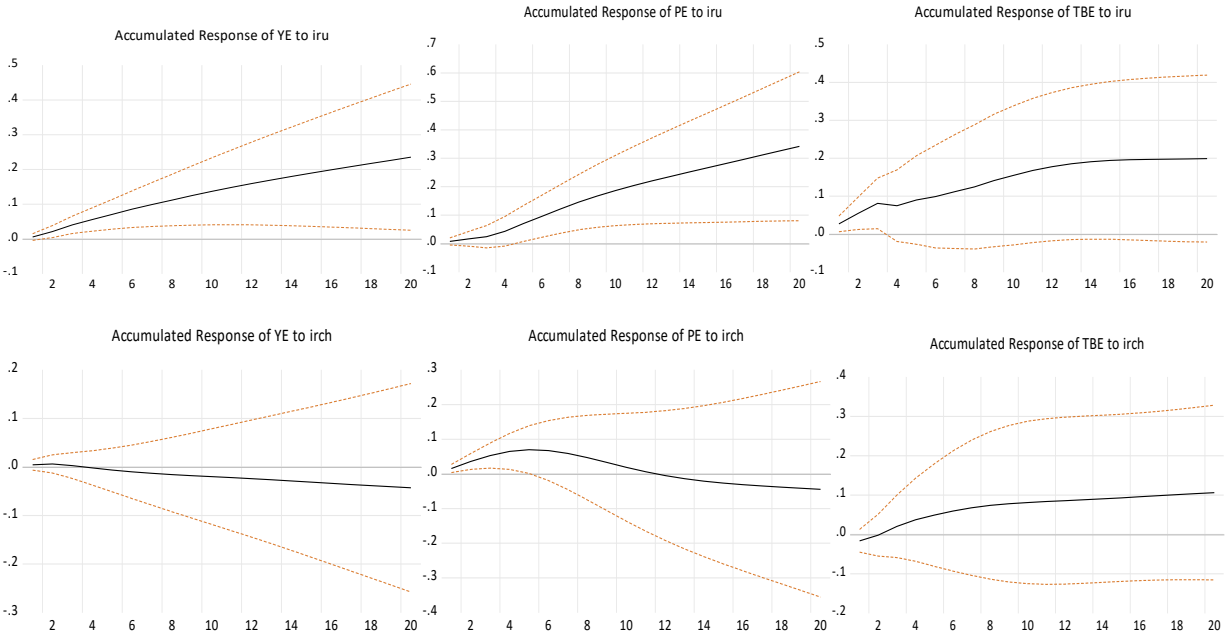
Moreover, the response of domestic interest rate to positive USA price shock is positive while the impact of China's positive price shock on domestic interest rate is negative. The effect of shocks to USA's Price on domestic interest rate is what we have expected and it is consistent with economic theories; however, the impact of output shock on domestic interest rate is unexpected result. On the other hand, the impact of shock to China's output on domestic interest rate is what we have expected and it is consistent with economic theories; however, the impact of price shock on domestic interest rate is unexpected. This implies that domestic monetary policy

is more vulnerable to USA's shocks in price regard and to China's shocks in output regard. This is because since USA's currency is hard currency, any shock to USA price level influences the domestic interest rate through changing the relative exchange rate between the two countries currency; on the other part, since Ethiopia relays largely on China's output through import trade, domestic interest rate is more responsive to China's output because of the strong economic linkage between the two countries. Overall, the result indicates that Ethiopian monetary policy is susceptible to foreign inflationary and output shocks.

5.4.2 Responses of Domestic Output, Price and Interest Rate to Foreign Interest Rate

Figure 5.2 below depicts the responses of domestic output (Ye), price (Pe) and interest rate (Tbe) to positive USA's interest rate (iru) and China's interest rate (irch) shocks respectively.

Figure 5.2: Responses of ye, Pe, and Tbe to USA and China's monetary shock



Source: Author's Estimation

A positive shock to USA's interest rate brought about an increase in domestic output, which is said to be output puzzle. In contrast, output has declined in response to China's positive interest rate innovation, which is consistent with economic theories and empirical evidences. Moreover, price has increased in response to USA's interest rate shock, which is said to be price puzzle. This puzzle is common in many literatures (Raghavan and Silvapulle, 2015). As Sims (1992) argued, the price puzzle is the consequence of the SVAR model not reflecting accurately the information set the

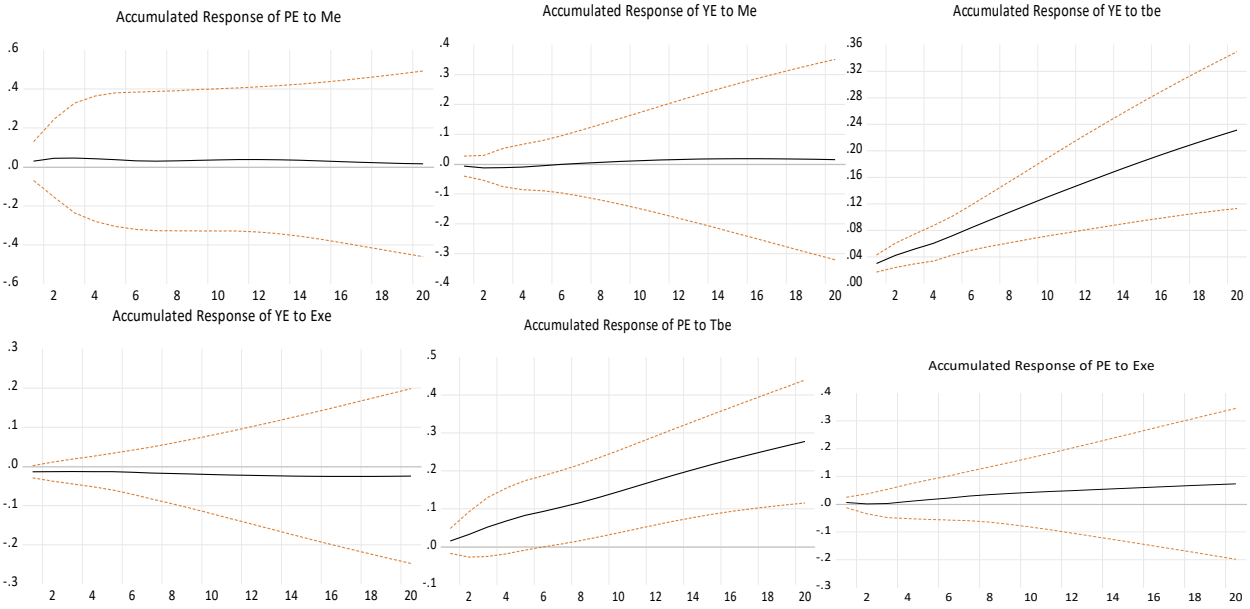
National Bank possesses about the future inflation and it is unknown to researchers. Conversely, price increased initially then it declined continuously in response to China's positive interest rate innovation, which is significant and theoretically consistent.

Furthermore, the response of domestic interest rate to both USA and China's positive interest rate shocks is positive and it is what we have expected. This is because when both countries interest rate increase domestic interest rate has to increase until interest rate differential is removed through capital outflow mechanism which in turn increases domestic interest rate. Generally, the result indicates that the impact of China's monetary policy on domestic output and price is more potent and meaningful than USA monetary policy shocks. This might be because of the strong economic linkages between Ethiopia and China that can easily transfer the effect of foreign shocks to the domestic economy.

5.4.3 Responses of Ethiopia's non-Policy Variables to Policy Variables in Model One

Figure 5.3 below depicts the responses of domestic output (Ye) and Price (Pe) to domestic monetary (Me), interest rate (Tbe) and nominal effective exchange rate (Exe) shocks when USA is taken as world's economic representative. The shock we are saying is positive shocks to money supply and interest rate while we are referring to devaluation for nominal effective exchange rate shock.

Figure 5.3: Responses of ye and Pe to Me, Tbe and Exe in model 1



Source: Author's estimation

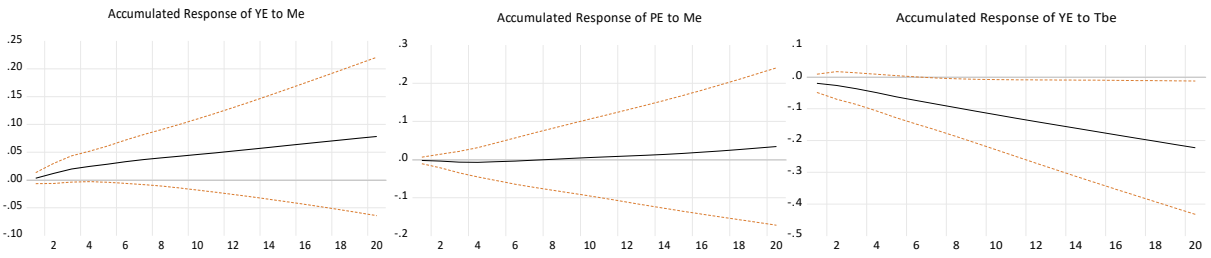
When USA is taken as world's economic representative, the impact of positive domestic money supply shock on domestic price is positive with moderate impact. The effect of domestic money supply shock on output is negative up to the second period and then it becomes positive thereafter asymptotically with very low level of impact, which is almost insignificant. The result is in line with the Classical's neutrality theory of money both in the short and long run (See Gali, 2008; Mankiw and Taylor, 2007). This means that monetary aggregate is ineffective in affecting the real variable when policymakers use USA's variables as information set in their designing of economic policy.

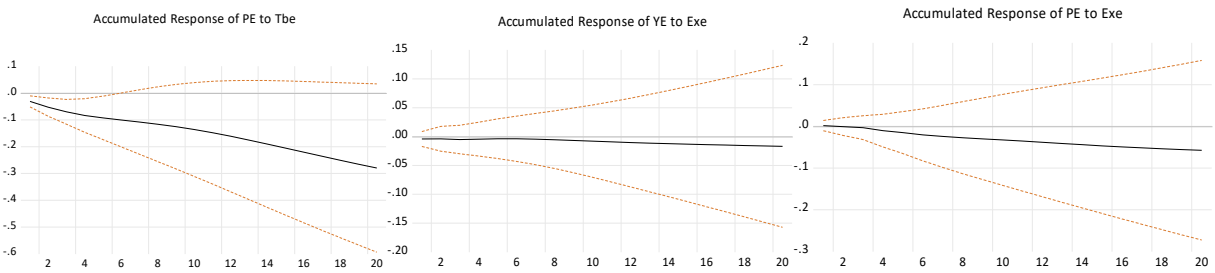
Also, the response of domestic output to positive domestic interest rate shock is positive, which is the output puzzle. This result is contrary to the case when China is taken as world's economic representative. Moreover, the response of domestic price to domestic interest rate shock is positive, which is the price puzzle. According to Cushman and Zha (1997), puzzles arise from the failure of policymakers to consider the effect of foreign shocks. The response of output to nominal effective exchange rate shock (devaluation) is negative with very low size of impact indicating that the nominal effective exchange rate channel is insignificant in changing the output level. However, the response of price to nominal effective exchange rate is positive and significant, which is what we have expected. This result is more realistic in that the current devaluation move by the government has become inflationary (Alemayehu and Kibrom, 2020).

5.4.4 Responses of Ethiopia's non-Policy Variables to Policy Variables for Model Two

Figure 5.4 below shows the responses of domestic output (Ye) and Price (Pe) to domestic monetary (Me), interest rate (Tbe) and nominal effective exchange rate (Exe) shocks when China is taken as world's economic representative. The shock we are saying is positive shocks to money supply and interest rate while we are referring to devaluation for nominal effective exchange rate shock.

Figure 5.4: Responses of Ye and Pe to Me, Tbe and Exe shocks in model 2





Source: Author's Estimation

When China is taken as a proxy for the rest of the world, the impact of positive money supply shock on domestic output is positive and significant. The response of price to positive money supply shock is also positive. This implies that monetary channel is effective in changing price and output level when China is taken as a proxy for the rest of the world.

The impulse response result also indicates that the impact of positive domestic interest rate innovation on output and price is negative and significant. These results are in line with economic theories and in contrast to the case when USA is taken as world's economic representative indicating that the interest rate channels of monetary policy is potent when China is regarded as world economic representative. The consistency of results with economic theory and most empirical results when China is taken as a proxy for the rest of the world is due to the fact that the effect of foreign monetary policy shock will be transferred to the domestic economy because of the strong economic ties (through trade, investment, loans, etc) between the two countries which increases interest rate responsiveness.

Moreover, the response of output to nominal effective exchange rate shock (devaluation) is negative with very low size of impact (it is insignificant). Intuitively, this is because Ethiopia is an import dependent country where its imports are mainly composed of capital goods and raw materials. Thus, devaluation makes the price of these essential imported goods more expensive and thereby discouraging domestic investment activities which would negatively affect output level (Abate et al., 2019). Also on the export side, the volume and value of export wouldn't increase in response to devaluation because of the price inelastic nature of Ethiopian export trade. Hence, the gain from the export side is lower than the loss from the import side making the effect of devaluation on output almost negative with insignificant impact. This indicates that the exchange rate channel is ineffective in changing the output level.

Lastly, the impact of nominal effective exchange rate shock on price is negative and significant, which is unexpected and contrary to our findings in model 1. This is because policymakers and the public at large are responsive to a change in the price of USA dollar than a change in the price of China's Yuan! Price puzzle happened because of the fact that policymakers might not use the relevant information set (China's variables) into account when setting economic policy (Cushman and Zha, 1997). Currently, the increase in inflation is claimed to be because of the increase in the price of USA dollar relative to the Ethiopian Birr (Alemayehu and Kibrom, 2020).

5.5 Estimated Results of Variance Decomposition Function

Variance decomposition of the non-policy variables namely output and price was carried out to look at the strengths of each channels of monetary transmission mechanism. This is achieved by using forecast horizons of 1 through 20 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. Table 5.14 and 5.15 depicts the variance decomposition result of output and price for model 1 while table 5.16 and 5.17 presents the variance decomposition result of output and price for model 2.

Table 5.14: Variance Decomposition Result of Output for model 1

Period	S.E.	Shock 1	Shock2	Shock 3	Shock 4	Shock 5	Shock 6	Shock 7	Shock 8	Shock 9
1	0.096	4.382	4.068	2.717	2.219	1.381	0.708	3.272	67.215	14.035
4	0.177	2.333	2.256	11.145	27.496	5.351	5.108	2.647	37.802	4.985
8	0.208	2.566	2.061	17.284	30.867	3.840	4.731	2.770	32.615	3.630
12	0.225	2.603	2.334	21.256	30.235	2.562	5.314	2.338	30.620	2.734
16	0.233	2.657	2.359	23.060	29.371	2.163	5.965	1.962	30.179	2.279
20	0.235	2.600	2.229	23.610	29.177	1.935	6.595	1.754	30.080	2.016

Source: Author's estimation

Table 5.15: Variance Decomposition Result of Price for Model 1

Period	S.E.	Shock 1	Shock 2	Shock 3	Shock 4	Shock 5	Shock 6	Shock 7	Shock 8	Shock 9
1	0.096	0.133	0.656	0.197	2.525	43.517	0.335	40.516	10.446	1.670
4	0.177	0.346	1.428	1.682	9.649	43.741	1.801	19.268	20.061	2.018

8	0.208	3.761	2.315	4.177	29.964	24.217	5.302	11.041	16.632	2.589
12	0.225	4.379	2.657	8.910	31.822	17.928	5.870	8.214	17.965	2.251
16	0.233	3.752	2.539	10.384	32.424	15.251	6.616	7.161	19.719	2.149
20	0.235	3.330	2.335	10.979	33.533	13.522	7.236	6.525	20.459	2.077

Source: Author's estimation

To start with, in the very short run, output is mainly explained by world commodity price, USA output, domestic interest rate and exchange rate in the model where USA is taken as a proxy for the rest of the world. In the medium and long run horizon, the variations of output are largely explained by USA price and federal funds rate on the foreign front while from the domestic variables side, T-bill rate and domestic price explains a larger proportion. Moreover, the variation of price is mainly explained by domestic output, domestic money supply and domestic interest rate in the short run. In the long run, price is mainly explained by USA price, federal funds rate, domestic output, domestic money supply and domestic interest rate.

Coming to the next scenario, in the short run, assuming China as a proxy for the rest of the world, output is mainly explained by China's interest rate shock, output itself, domestic price, and T-bill rate. In the long run, output is mainly explained by world commodity price, China's output, output itself, domestic price, domestic money supply and domestic interest rate. Moreover, change in price level is explained largely by China's interest rate, domestic output, domestic price and domestic interest rate in the short run. In the long run, shocks to world commodity price, China's price, China's output, China's interest rate describes variation of price mildly. On the domestic front, variation of price is largely explained by itself and domestic interest rate in the long run.

Table 5.16: Variance Decomposition Result of Output for Model 2

Period	S.E.	Shock 1	Shock 2	Shock 3	Shock 4	Shock 5	Shock 6	Shock 7	Shock 8	Shock 9
1	0.098	2.623	0.385	2.349	11.809	19.634	16.594	0.268	46.173	0.159
4	0.188	1.259	4.671	1.738	2.206	46.381	9.185	6.501	27.300	0.756
8	0.210	2.639	5.159	1.848	2.864	34.158	12.050	6.210	34.486	0.581
12	0.213	4.716	4.882	2.206	2.566	27.733	15.388	5.544	36.388	0.573
16	0.214	5.513	4.981	2.115	2.518	24.230	17.265	5.337	37.510	0.528
20	0.215	6.209	5.017	2.056	2.480	21.897	18.254	5.216	38.378	0.488

Table 5.17: Variance Decomposition Result of Price for Model 2

Period	S.E.	Shock 1	Shock 2	Shock 3	Shock 4	Shock 5	Shock 6	Shock 7	Shock 8	Shock 9
1	0.098	2.623	0.385	2.349	11.809	19.634	16.594	0.268	46.173	0.159
4	0.188	2.088	1.598	18.960	18.205	7.438	18.355	0.275	31.957	1.120
8	0.210	5.533	7.055	15.181	13.139	4.549	31.395	0.326	21.427	1.391
12	0.213	4.684	9.989	11.411	14.777	3.527	34.209	0.377	19.764	1.258
16	0.214	6.017	9.214	9.714	13.768	3.425	33.932	0.481	22.275	1.260
20	0.215	6.610	8.546	8.802	12.443	3.815	33.114	0.736	24.716	1.215

Source: Author's estimation

CHAPTER SIX

6. CONCLUSIONS AND POLICY IMPLICATIONS

6.1 Conclusions

In this study, we applied the Structural Vector Autoregressive method to model and examine Ethiopia's monetary policy. To uncover the dynamic effects of monetary policy on the domestic variables, we established identification conditions in both model 1 and 2. The orthogonal policy shocks retrieved from the SVAR model are used to analyze the potency of monetary policy and the significance of various transmission channels in affecting price and output in Ethiopia.

We built a nine-variables-SVAR model using quarterly data from 2008Q1 to 2020Q4. This sample period covers the period of the 2007/2008 global financial crisis which is very important for investigating the potency of monetary policy. Moreover, the foreign block exogeneity and the contemporaneous restrictions on the domestic block are imposed to establish economic framework to Ethiopian SVAR model.

Also, to complement the econometric results, we used descriptive analysis mainly to describe the trend, development and performance of monetary indicators. The descriptive result indicates that monetary and financial sector development indicators has generally increased during the study period, which are good for transmitting the effect of monetary policy shock to the economy. Money liquidity ratio has also showed a declining trend indicating the progress of financial diversification.

The empirical result of the two scenarios shows similarities on some cases and notable differences in many other cases. Generally, our econometric results show meaningful and expected outcomes when China is taken as a proxy for the rest of the world economy than USA. When the latter is taken as a proxy for the rest of the world economy, there are evidences of output and price puzzles in that positive domestic interest rate innovation has increased domestic price and output.

This study revealed that a positive shock to world commodity price has positive impact on domestic interest rate both in the model where USA is taken as a proxy for the world economy (model 1) and the case when China is taken as a proxy for the rest of the world (model 2). A positive shock to USA output tends to have a negative effect on domestic interest rate while the

impact of positive shock to China's output on domestic interest rate is positive. Also, the response of domestic interest rate to positive USA price shock is positive while the impact of China's positive price shock on domestic interest rate is negative. Overall, the result indicates that Ethiopian monetary policy is susceptible to foreign inflationary pressure and output shocks.

A positive shock to USA's interest rate brought about an increase in domestic output, which is said to be output puzzle. In contrast, output has declined in response to China's positive interest rate innovation, which is consistent with economic theories. Moreover, price has increased in response to USA's interest rate shock while it increased initially then it declined continuously in response to China's positive interest rate innovation. This result is also validated by the variance decomposition result. As we expected, the response of domestic interest rate to both USA and China's positive interest rate shock is positive.

When USA is taken as world's economic representative, the impact of positive domestic money supply shock on domestic price is positive with mild effects, which is verified by variance decomposition result. The effect of domestic money supply shock on output is positive, but insignificant. We found evidences of output and price puzzles in response to domestic interest rate shock. According to Cushman and Zha (1997), puzzles arise from the failure of policymakers to consider the effect of foreign shocks. The impact of nominal effective exchange rate shock (devaluation) on output is negative and insignificant. However, the response of price to nominal effective exchange rate is positive and significant, which is what we have expected. This is because the current inflation problem is claimed to the over devaluation of currency (Alemayehu and Kibrom, 2020).

When China is taken as a proxy for the rest of the world, the impact of positive money supply shock on domestic output and price is positive and significant. And the validity of impulse response result for output is corroborated by variance decomposition analysis. As expected, the impact of positive domestic interest rate innovation on domestic output and price is negative, which is also endorsed by the variance decomposition result. Moreover, nominal effective exchange rate channel is not effective in changing the output level; however, it has negative impact on price, which is unexpected and contrary to our findings in model 1.

To sum up, domestic monetary policy instruments are effective in affecting price and output when

China is taken as a proxy for the rest of the world economy than USA. This finding is realistic given the strong economic linkage between Ethiopia and China since the 2000's.

6.2 Policy Implications

Based on the results of our empirical analysis, the following policy directions are suggested.

First, policymakers have to give a due consideration to China's macroeconomic variables at first and to some extent USA variables like price level and interest rate when setting domestic monetary policy. Specifically, policy directed at changing domestic price level has to include USA's price and interest rate in addition to other foreign and domestic variables. When we see how USA price level is helpful, the public is very sensitive to a change in exchange rate between USA dollar and Ethiopian birr, which has implication on price. And policy directed towards changing domestic output level has to largely use China's key macroeconomic variables, as information set, in addition to other domestic and foreign variables. This is because the Ethiopian economy is highly interlinked with Chinese economy and that any change to China's monetary policy would be transferred to the domestic economy through affecting prices, output, export, import and so on. The consistency of our finding with economic theory with regard to China makes our suggestion more realistic. When setting economic policy, one of the information set policymakers would use is the domestic price level, which might be influenced by foreign monetary policy. So, policymakers have to look further at both China's and USA's key macroeconomic variables when they change the course of monetary policy stance.

Second, policymakers have to enhance domestic interest rate as this variable was found to be the effective channels for transmitting monetary policy into the economy especially when China is taken as world economic representative. This may be done through lowering the interest rate at which the public borrow from banks; reducing the amount of collateral requirements and expanding alternative assets as collateral requirements particularly allowing farmers to use land as a collateral asset; providing short-to-long term credit opportunities because short-term credits are not effective in changing output particularly in real production activities, animal rearing and so on; expanding banks so that it will increase the public responsiveness to interest rate shock; promoting financial innovation, deepening, diversification, and the like for the effect of interest rate shock to be transmitted to the economy. Also, policymakers have to use both China's and USA's

macroeconomic variables and world commodity price, as information set, whenever they set interest rate.

Third, since we found nominal effective exchange rate as the effective channel in affecting the price level, the government has to refrain from devaluing currency as it would increase prices. Ethiopia is following crawling pegged exchange rate system; however, the government is taking excessive discretionary power in devaluing currency. Alemayehu and Kibrom (2020) indicated that devaluation move by the government is the major source of inflation in Ethiopia. The National Bank adjusts up the exchange rate to remove the discrepancy between the formal and the informal foreign exchange market rate. Price of import increase and price of export declines resultantly, which can import foreign inflation. Also, domestic prices increase owing to such devaluation. Thus, devaluation ends up inflationary. So, the government has to enact laws and regulatory means to control the informal foreign exchange market in addition to refraining from devaluing currency.

Finally, the government has to use monetary aggregate in transmitting the effect of monetary shock to the economy. However, this doesn't mean that increasing the quantity of money would simply increase output! Rather the increase in the size of money has to be optimal in size, and that any change in money supply has to be invested on productive activities such as food production, infrastructures, and so on. If so, an increase in money supply may not be inflationary rather it would increase output. In the process of using this channel, as mentioned above, considering primarily China's macroeconomic variables and to some extent USA variables is very crucial. Thus, the government has to improve this channel.

Appendixes

Appendix A: Diagnostic Tests

A1.1. Autocorrelation Test in including USA Variables into the SVAR model

VAR Residual Serial Correlation LM Tests
Date: 05/26/22 Time: 13:39

Sample: 2008Q1 2020Q4
Included observations: 50

Null hypothesis:No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	Df	Prob.
1	99.27348	81	0.0820	1.280661	(81, 99.4)	0.1198
2	62.16770	81	0.9405	0.692777	(81, 99.4)	0.9561

A1.2 Autocorrelation Test in including China's Variables into the SVAR model

VAR Residual Serial Correlation LM Tests
Date: 04/27/22 Time: 13:53
Sample: 2008Q1 2020Q4
Included observations: 54

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	Df	Prob.
1	75.01886	81	0.6661	0.891804	(81, 125.3)	0.7087
2	91.75141	81	0.1944	1.152422	(81, 125.3)	0.2359

A2.1 Optimal Lag Length Selection Criteria in including USA variables into the model

VAR Lag Order Selection Criteria
Endogenous variables: PC YU PU IRU YE PE ME TBE EXE
Exogenous variables: C
Date: 04/27/22 Time: 13:58

Sample: 2008Q1 2020Q4
Included observations: 50

Lag	LogL	LR	FPE	AIC	SC	HQ
0	289.6742	NA	1.08e-16	-11.22697	-10.88281	-11.09591
1	618.2784	525.7667	5.65e-21	-21.13114	**-17.68950***	-19.82054
2	741.4929	**152.7859***	**1.43e-21***	**-22.81971***	-16.28060	**-20.32958***

A2.2 Optimal Lag Length Selection Criteria in including China's variables into the model

VAR Lag Order Selection Criteria
Endogenous variables: PC YCH PCH IRCH YE PE ME TBE
EXE
Exogenous variables: C
Date: 04/27/22 Time: 14:01
Sample: 2008Q1 2020Q4
Included observations: 54

Lag	LogL	LR	FPE	AIC	SC	HQ
0	186.9465	NA	1.11e-14	-6.590610	-6.259113	-6.462765
1	528.8883	557.2385	**7.33e-19***	-16.25512	**-12.94015***	**-14.97667***
2	610.4785	**105.7651***	9.15e-19	**-16.27698***	-9.978532	-13.84792

A3.1 VAR Residual Normality Test in including USA Variables into the model

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Date: 04/27/22 Time: 14:06
Sample: 2008Q1 2020Q4
Included observations: 50

Component	Skewness	Chi-sq	df	Prob.*
1	-0.813015	5.508282	1	0.0189
2	0.120683	0.121371	1	0.7276
3	2.150964	38.55539	1	0.0000
4	0.692754	3.999239	1	0.0455
5	-0.267101	0.594526	1	0.4407
6	0.669799	3.738585	1	0.0532
7	-2.835019	66.97778	1	0.0000
8	-0.319604	0.851223	1	0.3562
9	-0.216603	0.390975	1	0.5318
Joint		120.7374	9	0.0000

Component	Kurtosis	Chi-sq	Df	Prob.

1	2.835162	0.056608	1	0.8119
2	3.283270	0.167171	1	0.6826
3	10.96915	132.3071	1	0.0000
4	4.678176	5.867237	1	0.0154
5	2.866922	0.036895	1	0.8477
6	2.824056	0.064492	1	0.7995
7	17.99752	468.5949	1	0.0000
8	3.919949	1.763140	1	0.1842
9	2.886764	0.026714	1	0.8702
Joint		608.8842	9	0.0000

Component	Jarque-Bera	df	Prob.
1	5.564890	2	0.0619
2	0.288541	2	0.8657
3	170.8625	2	0.0000
4	9.866475	2	0.0072
5	0.631421	2	0.7293
6	3.803077	2	0.1493
7	535.5727	2	0.0000
8	2.614362	2	0.2706
9	0.417689	2	0.8115
Joint	729.6216	18	0.29000

*Approximate p-values do not account for coefficient Estimation

A4.1 VAR Residual Heteroscedasticity Test when including USA Variables into the model

VAR Residual Heteroskedasticity Tests (Levels and Squares)

Date: 04/27/22 Time: 14:34

Sample: 2008Q1 2020Q4

Included observations: 50

Joint test:

Chi-sq	Df	Prob.
1634.807	1620	0.3932

A4.2 VAR Residual Heteroscedasticity Test when including China's Variables in to SAVR

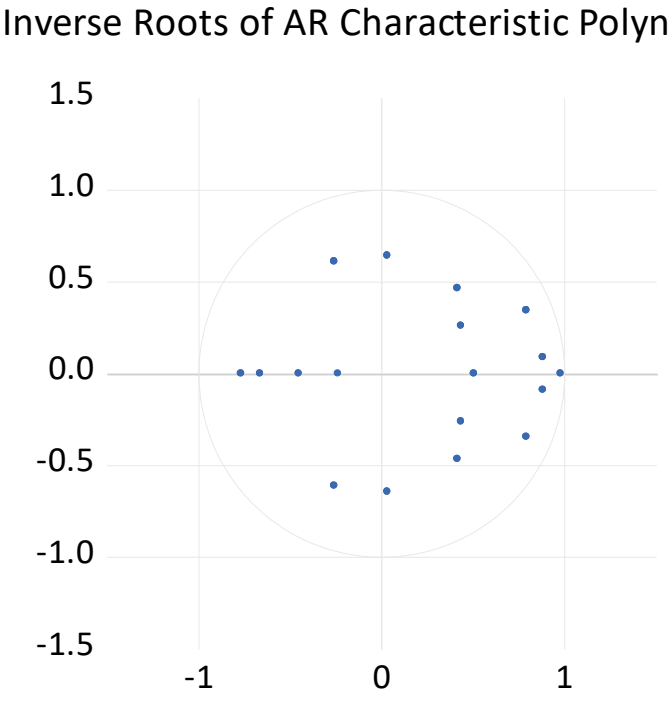
VAR Residual Heteroskedasticity Tests (Levels and Squares)
Date: 04/27/22 Time: 14:36
Sample: 2007Q1 2020Q4

Included observations: 54

Joint test:

Chi-sq	df	Prob.
1618.924	1620	0.5029

A5.1 Model Stability test when including USA variables into the model



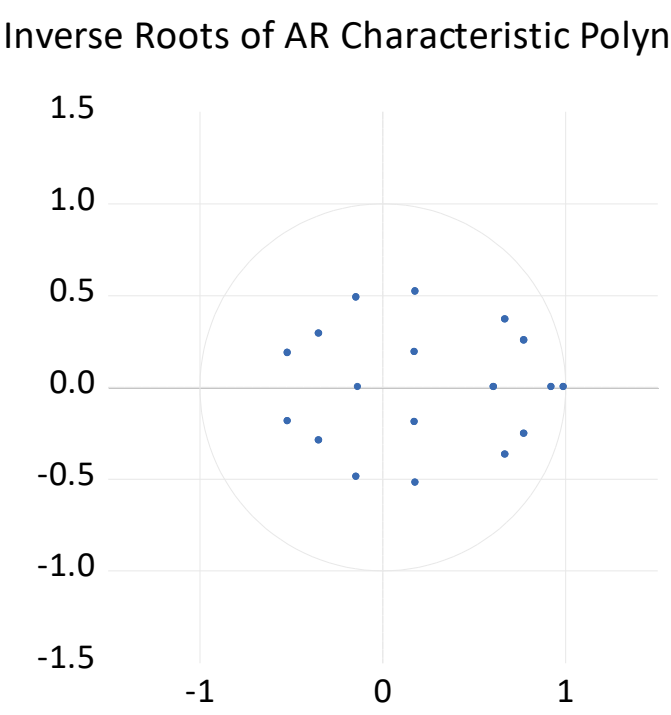
Roots of Characteristic Polynomial
Endogenous variables: PC YU PU IRU PE ME TBE EXE
Exogenous variables: C
Lag specification: 1 2
Date: 04/27/22 Time: 14:44

Root	Modulus
0.979801	0.979801
0.881462 - 0.088217i	0.885865
0.881462 + 0.088217i	0.885865
0.791468 + 0.345316i	0.863519
0.791468 - 0.345316i	0.863519
-0.769211	0.769211
-0.259344 - 0.611298i	0.664037

-0.259344 + 0.611298i	0.664037
-0.663278	0.663278
0.032470 - 0.643139i	0.643958
0.032470 + 0.643139i	0.643958
0.415040 - 0.465095i	0.623355
0.415040 + 0.465095i	0.623355
0.435056 - 0.260045i	0.506850
0.435056 + 0.260045i	0.506850
0.505820	0.505820
-0.453037	0.453037
-0.237993	0.237993

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

A5.2 Test Results of Model stability when including China's Variables into the Model



Roots of Characteristic Polynomial
Endogenous variables: PC YCH PCH IRCH YE PE ME TBE EXE
Exogenous variables: C
Lag specification: 1 2
Date: 04/27/22 Time: 14:47

Root	Modulus
0.991414	0.991414
0.924916	0.924916

0.774400 - 0.254419i	0.815122
0.774400 + 0.254419i	0.815122
0.670340 - 0.368329i	0.764867
0.670340 + 0.368329i	0.764867
0.608658	0.608658
0.180366 - 0.520954i	0.551294
0.180366 + 0.520954i	0.551294
-0.518274 + 0.186632i	0.550854
-0.518274 - 0.186632i	0.550854
-0.142262 - 0.489488i	0.509742
-0.142262 + 0.489488i	0.509742
-0.348590 - 0.290569i	0.453812
-0.348590 + 0.290569i	0.453812
0.175521 - 0.191120i	0.259489
0.175521 + 0.191120i	0.259489
-0.133698	0.133698

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

Appendix B: Contemporaneous Restrictions and Estimation Results

B1.1 Restrictions on the contemporaneous structure of Model 1 and 2, the A matrix

Dependent Variable	Explanatory Variables								
	PC	Yu	Pu	IRu	Ye	Pe	Me	Tbe	EXe
PC	1	0	0	0	0	0	0	0	0
Yu	0	1	0	0	0	0	0	0	0
Pu	0	A_{32}	1	0	0	0	0	0	0
IRu	0	A_{42}	A_{43}	1	0	0	0	0	0
Ye	0	0	0	0	1	0	0	0	0
Pe	0	0	0	0	A_{65}	1	0	0	0
Me	0	0	0	0	A_{75}	A_{76}	1	A_{78}	0
TBe	A_{81}	0	0	A_{84}	A_{85}	A_{86}	A_{87}	1	0

Exe	A_{91}	A_{92}	A_{93}	A_{94}	A_{95}	A_{96}	A_{97}	A_{98}	1

B1.2 the AB contemporaneous result when including USA variables into the SVAR model

Structural VAR Estimates
Date: 04/27/22 Time: 13:47
Sample (adjusted): 2008Q1 2020Q4
Included observations: 50 after adjustments
Estimation method: Maximum likelihood via Newton-Raphson (analytic derivatives)
Convergence achieved after 47 iterations
Structural VAR is over-identified

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

A =

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

B =

C(21)	0	0	0	0	0	0	0	0
0	C(22)	0	0	0	0	0	0	0
0	0	C(23)	0	0	0	0	0	0
0	0	0	C(24)	0	0	0	0	0
0	0	0	0	C(25)	0	0	0	0
0	0	0	0	0	C(26)	0	0	0
0	0	0	0	0	0	C(27)	0	0
0	0	0	0	0	0	0	C(28)	0
0	0	0	0	0	0	0	0	C(29)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.651290	1.241218	-0.524718	0.5998
C(2)	0.255807	0.362065	0.706524	0.4799
C(3)	-0.325240	0.421033	-0.772481	0.4398
C(4)	-0.017058	0.075250	-0.226683	0.8207
C(5)	0.665634	1.798155	0.370176	0.7113
C(6)	4.371083	4.016935	1.088164	0.2765
C(7)	7.210984	3.377617	2.134932	0.0328
C(8)	15.77730	27.42504	0.575288	0.5651

C(9)	-6.476911	4.559560	-1.420512	0.1555
C(10)	-0.198135	0.119346	-1.660166	0.0969
C(11)	-0.217011	0.204814	-1.059550	0.2893
C(12)	-6.594394	12.78799	-0.515671	0.6061
C(13)	3.988367	3.102671	1.285463	0.1986
C(14)	-2.462024	2.258357	-1.090184	0.2756
C(15)	16.29143	435.5207	0.037407	0.9702
C(16)	10.64644	30.30669	0.351290	0.7254
C(17)	1.168640	1.672835	0.698598	0.4848
C(18)	1.821142	1.882201	0.967559	0.3333
C(19)	-2.579292	61.78122	-0.041749	0.9667
C(20)	-0.133943	0.313981	-0.426595	0.6697
C(21)	0.095277	0.162662	0.585733	0.5581
C(22)	0.008306	0.108585	0.076492	0.9390
C(23)	-4.903245	126.7973	-0.038670	0.9692
C(24)	-1.436738	6.657463	-0.215809	0.8291
C(25)	2.296763	2.095364	1.096116	0.2730
C(26)	-5.498248	137.6414	-0.039946	0.9681
C(27)	-10.08678	17.13138	-0.588790	0.5560
C(28)	0.096859	0.009686	9.999999	0.0000
C(29)	0.022543	0.002254	10.00000	0.0000

Log likelihood	628.3104		
LR test for over-identification:			
Chi-square(9)	11.24879	Probability	0.2590

B1.3 the AB contemporaneous result when including China's variables into the SVAR model

Structural VAR Estimates
Date: 04/27/22 Time: 13:53
Sample (adjusted): 2008Q1 2020Q4
Included observations: 54 after adjustments
Estimation method: Maximum likelihood via Newton-Raphson (analytic derivatives)
Convergence achieved after 34 iterations
Structural VAR is over-identified

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

1	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0
0	C(3)	1	0	0	0	0	0	0
0	C(4)	C(6)	1	0	0	0	0	0
0	0	0	0	1	0	0	0	0

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

B =

C(21)	0	0	0	0	0	0	0	0
0	C(22)	0	0	0	0	0	0	0
0	0	C(23)	0	0	0	0	0	0
0	0	0	C(24)	0	0	0	0	0
0	0	0	0	C(25)	0	0	0	0
0	0	0	0	0	C(26)	0	0	0
0	0	0	0	0	0	C(27)	0	0
0	0	0	0	0	0	0	C(28)	0
0	0	0	0	0	0	0	0	C(29)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.161176	0.070839	-2.275248	0.0229
C(2)	-0.435485	0.530716	-0.820561	0.4119
C(3)	0.011262	0.065121	0.172938	0.8627
C(4)	0.027127	0.071003	0.382059	0.7024
C(5)	2.934123	2.001276	1.466126	0.1426
C(6)	-0.218834	0.114707	-1.907764	0.0564
C(7)	0.395300	3.830413	0.103200	0.9178
C(8)	-1.105449	1.959529	-0.564140	0.5727
C(9)	1.791227	1.694668	1.056978	0.2905
C(10)	0.123204	0.206882	0.595527	0.5515
C(11)	0.115555	0.082716	1.397009	0.1624
C(12)	-0.055038	0.008899	-6.184529	0.0000
C(13)	1.104858	1.718960	0.642748	0.5204
C(14)	-2.317155	3.313902	-0.699223	0.4844
C(15)	-0.135831	0.242729	-0.559600	0.5758
C(16)	-0.566774	0.478177	-1.185282	0.2359
C(17)	-1.408031	1.435297	-0.981003	0.3266
C(18)	-4.138427	3.431266	-1.206093	0.2278
C(19)	0.429099	0.215492	1.991252	0.0465
C(20)	-0.017070	0.023504	-0.726261	0.4677
C(21)	-0.035971	0.022535	-1.596177	0.1104
C(22)	1.620551	2.581042	0.627867	0.5301
C(23)	0.276426	0.564383	0.489783	0.6243
C(24)	-0.105808	0.097848	-1.081355	0.2795
C(25)	0.107594	0.250221	0.429996	0.6672
C(26)	0.170556	1.259444	0.135421	0.8923
C(27)	2.175834	1.537089	1.415555	0.1569
C(28)	0.098619	0.009490	10.39230	0.0000
C(29)	0.051337	0.004940	10.39230	0.0000

Log likelihood 500.7872

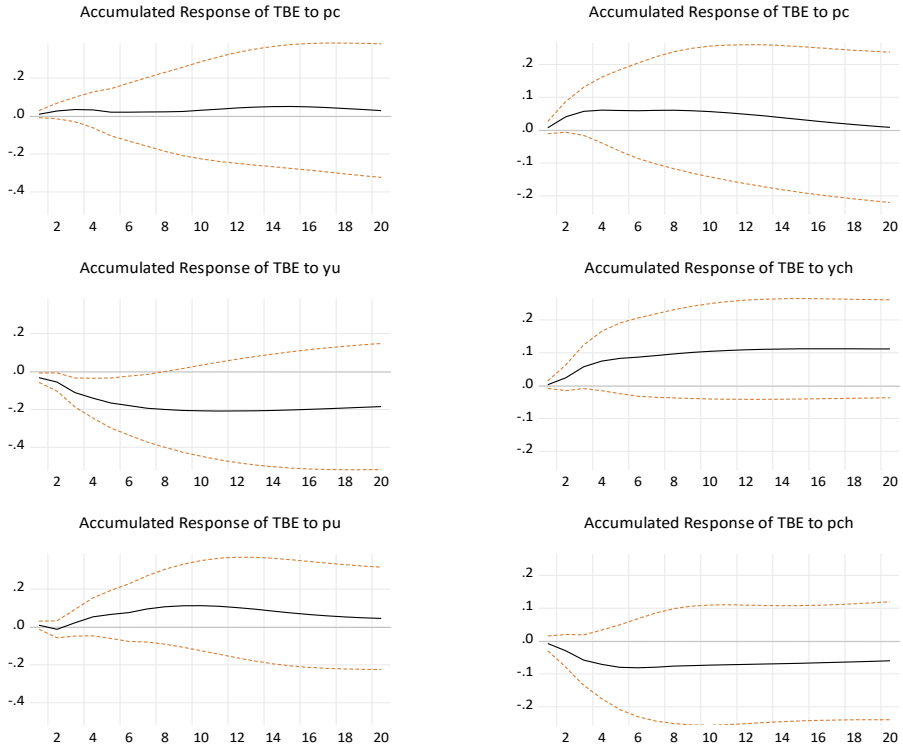
LR test for over-identification:

Chi-square(9)	8.635400	Probability	0.4716

Appendix C: Results of Impulse Response Using Structural Decomposition

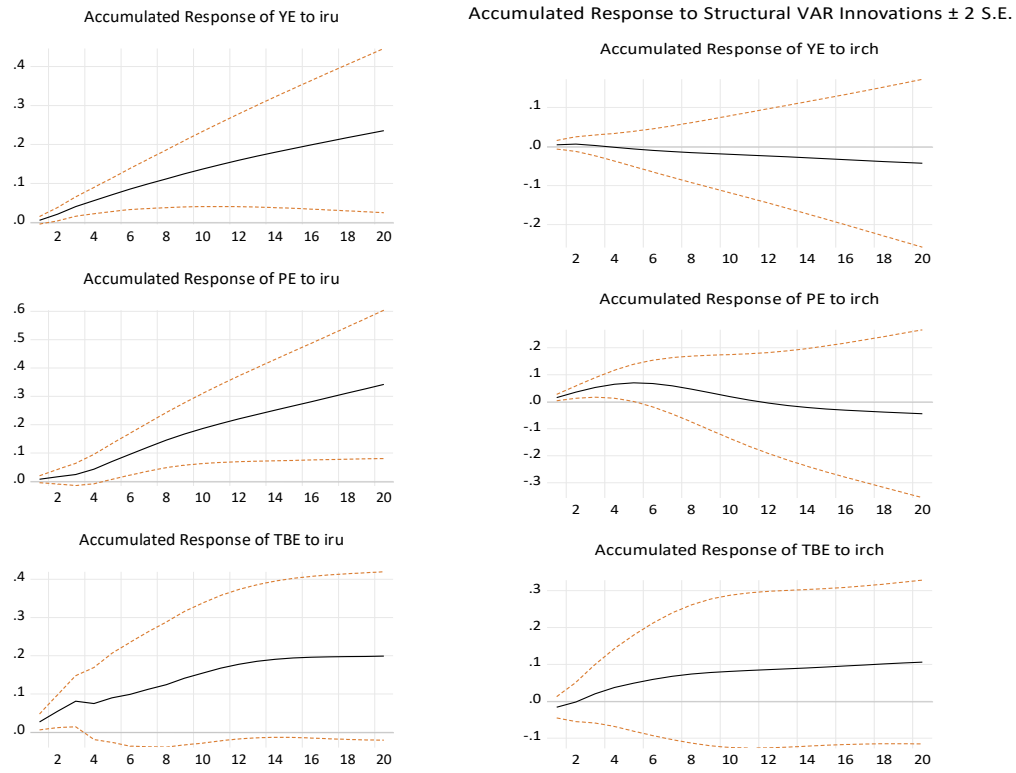
C1.1 Responses of Tbe to Pc, yu Pu, ych and Pch shocks

Accumulated Response to Structural VAR Innovations ± 2 S.E.Accumulated Response to Structural VAR Innovations ± 2 S.E.

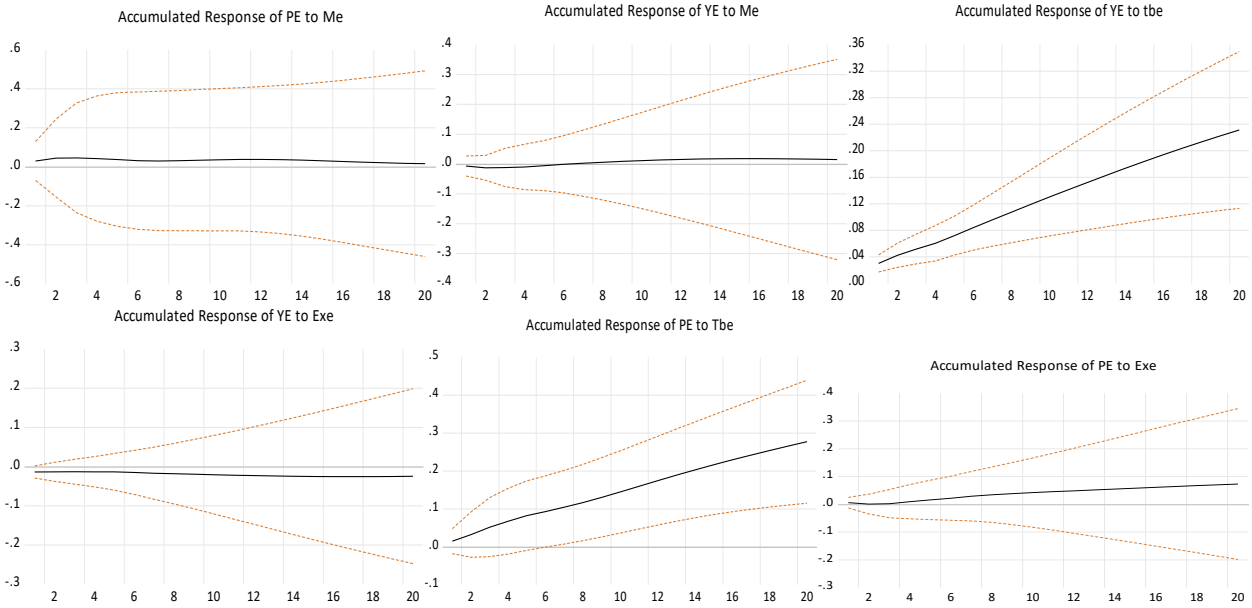


C1.2 Responses of Ye, Pe and Tbe to USA and China's monetary shock

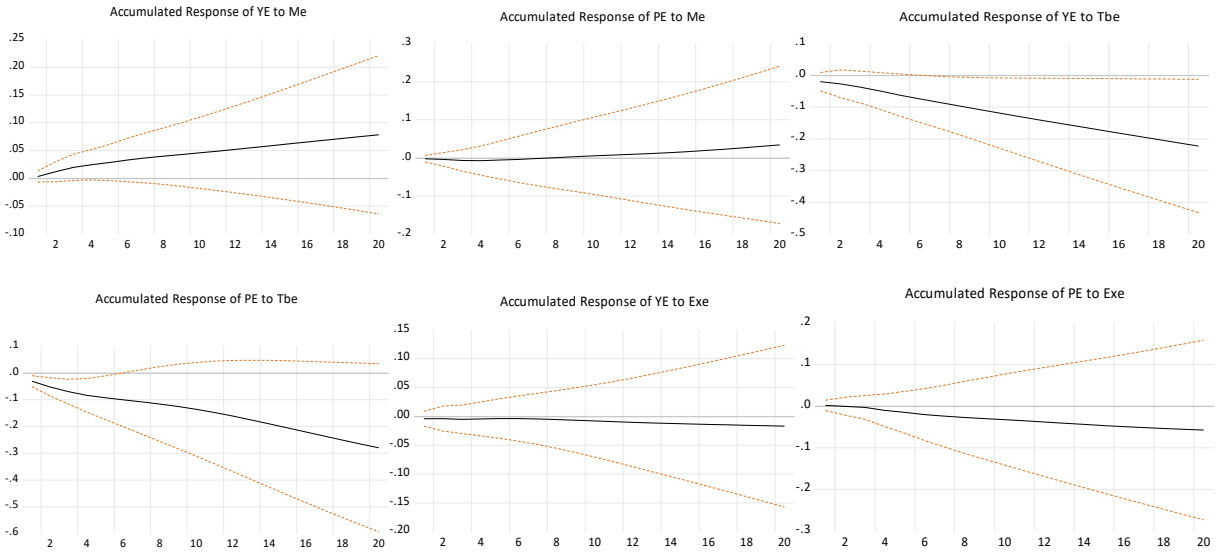
Accumulated Response to Structural VAR Innovations ± 2 S.E.



C1.3 Responses of Ye and Pe to Me, Tbe and Exe shocks for model 1



C1.4 Responses of Ye and Pe to Me, Tbe and Exe shocks for model 2



Appendix D: Results of Variance Decomposition

D1.1 Results of Variance in including USA variables into the model

Variance Decomposition of YE: Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8	
1	0.096859	4.382001	4.068082	2.717454	2.219067	1.381692	0.708235	3.272991	67.21500	1
2	0.134496	3.016199	3.044733	7.090165	13.74966	5.461670	1.802272	4.031304	52.42372	9
3	0.162537	2.336720	2.589292	9.526689	23.51416	6.143331	4.956601	2.956363	41.18529	6
4	0.177965	2.333765	2.256745	11.14553	27.49642	5.351801	5.108227	2.647188	37.80202	5
5	0.189381	2.513361	2.124129	12.75206	29.27391	4.811627	4.995422	2.786039	35.75819	4
6	0.197345	2.531545	2.016979	14.74566	30.29765	4.254231	4.727556	2.891684	34.16395	4
7	0.203707	2.503283	1.967866	15.91894	30.78672	3.840379	4.719248	2.853551	33.42427	3
8	0.208493	2.566443	2.061022	17.28428	30.86785	3.472612	4.731081	2.770440	32.61540	3
9	0.213000	2.571291	2.135269	18.60587	30.81258	3.150096	4.886824	2.682333	31.83788	3
10	0.217554	2.565499	2.218270	19.67064	30.69122	2.906264	4.988328	2.561180	31.30765	3
11	0.221912	2.576355	2.284080	20.48834	30.48904	2.716459	5.157933	2.448059	30.93928	2
12	0.225432	2.603454	2.334218	21.25654	30.23511	2.562469	5.314159	2.338954	30.62030	2
13	0.228206	2.617904	2.360865	21.87959	29.97065	2.433563	5.482975	2.233550	30.42572	2
14	0.230279	2.634919	2.375670	22.37985	29.72987	2.328408	5.633450	2.133265	30.30853	2
15	0.231850	2.648158	2.373314	22.76356	29.52672	2.239473	5.802681	2.042424	30.23236	2
16	0.233015	2.657259	2.359902	23.06026	29.37173	2.163434	5.965411	1.962805	30.17933	2
17	0.233898	2.656820	2.336738	23.27255	29.26184	2.096221	6.131976	1.895471	30.14839	2

18	0.234536	2.647805	2.306240	23.42780	29.19745	2.036786	6.291017	1.839578	30.12316	2
19	0.234977	2.628156	2.269606	23.53512	29.17116	1.983472	6.448045	1.793298	30.10185	2
20	0.235253	2.600272	2.229541	23.61052	29.17722	1.935629	6.595103	1.754961	30.08043	2

Variance Decomposition of PE:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8	
1	0.022543	0.133998	0.656160	0.197818	2.525206	43.51753	0.335017	40.51642	10.44699	1
2	0.033243	0.092346	1.152282	0.131203	3.541149	48.05661	2.152925	29.38088	13.85733	1
3	0.036324	0.275638	1.539452	1.550118	3.980786	48.66431	1.823892	22.44395	18.43813	1
4	0.037961	0.346908	1.428433	1.682091	9.649990	43.74194	1.801913	19.26895	20.06166	2
5	0.040906	1.260219	1.776923	2.009891	18.15198	36.02403	3.390151	15.89469	19.26362	2
6	0.044057	2.395948	1.962370	2.133249	23.56678	31.27204	3.964286	14.21412	18.13572	2
7	0.045974	3.161104	2.167953	2.690425	27.47616	27.31877	4.947319	12.43091	17.18486	2
8	0.046909	3.761246	2.315093	4.177168	29.96422	24.21763	5.302393	11.04100	16.63214	2
9	0.047339	4.323334	2.493516	5.467157	31.05971	21.92770	5.522442	10.04705	16.67832	2
10	0.047617	4.525579	2.581286	6.816969	31.53986	20.26789	5.586837	9.309253	16.98128	2
11	0.047947	4.511035	2.642157	7.994695	31.71783	18.93704	5.751396	8.698168	17.43339	2
12	0.048341	4.379127	2.657188	8.910885	31.82200	17.92867	5.870722	8.214536	17.96581	2
13	0.048728	4.206839	2.650338	9.512609	31.90621	17.10444	6.053356	7.838039	18.51605	2
14	0.049061	4.034890	2.622565	9.938449	32.03806	16.40626	6.230861	7.552707	18.99146	2
15	0.049322	3.883686	2.585925	10.20065	32.20503	15.79391	6.434145	7.334552	19.39710	2
16	0.049526	3.752499	2.539623	10.38432	32.42429	15.25197	6.616673	7.161182	19.71985	2
17	0.049696	3.633191	2.489627	10.52445	32.68155	14.75994	6.801715	7.000792	19.97345	2
18	0.049854	3.523529	2.437750	10.66142	32.96980	14.31251	6.962526	6.844779	20.16909	2
19	0.050005	3.422340	2.386274	10.80683	33.25907	13.90157	7.111086	6.685704	20.32752	2
20	0.050142	3.330018	2.335748	10.97960	33.53359	13.52211	7.236245	6.525609	20.45949	2

Factorization: Structural

D1.2 Variance Decomposition result in including China's Variables into the Model

Variance Decomposition of YE:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8	
1	0.098619	1.413165	0.319380	1.839270	1.212147	62.30212	6.178954	0.656604	25.00198	1
2	0.143605	1.416255	1.866062	1.526585	1.141551	59.03436	7.468259	4.163520	22.50894	0
3	0.171114	1.256691	4.185922	1.387345	1.527450	52.09147	7.903099	6.444958	24.36438	0
4	0.188909	1.259171	4.671758	1.738735	2.206045	46.38104	9.185207	6.501289	27.30016	0
5	0.198062	1.419428	4.629961	1.650138	2.608654	42.24855	10.06426	6.355493	30.33260	0
6	0.203894	1.616141	4.940752	1.582380	2.821152	39.23079	10.50014	6.461823	32.21248	0
7	0.207684	1.991771	5.159473	1.715679	2.896332	36.58340	11.13518	6.409040	33.51162	0
8	0.210189	2.639824	5.159041	1.848728	2.864289	34.15895	12.05041	6.210715	34.48695	0

9	0.211725	3.349615	5.058105	1.999417	2.782396	32.06960	12.99741	5.990245	35.17701	0
10	0.212681	3.943433	4.961879	2.118130	2.694528	30.34758	13.88372	5.797471	35.67487	0
11	0.213285	4.389049	4.903316	2.186195	2.619038	28.92898	14.68627	5.650419	36.05887	0
12	0.213694	4.716054	4.882224	2.206491	2.566040	27.73364	15.38883	5.544898	36.38872	0
13	0.214000	4.963750	4.891631	2.196336	2.535668	26.69952	15.98725	5.470149	36.69141	0
14	0.214253	5.164017	4.918007	2.171295	2.522453	25.78672	16.49025	5.415414	36.97887	0
15	0.214482	5.341940	4.950945	2.142212	2.518954	24.96910	16.91113	5.372965	37.25201	0
16	0.214702	5.513468	4.981482	2.115339	2.518325	24.23000	17.26531	5.337128	37.51029	0
17	0.214920	5.686592	5.004016	2.093191	2.515668	23.55930	17.56713	5.304288	37.75252	0
18	0.215138	5.862573	5.016584	2.076493	2.508472	22.95045	17.82753	5.273118	37.97792	0
19	0.215357	6.038447	5.020186	2.064747	2.496318	22.39828	18.05457	5.243700	38.18641	0
20	0.215573	6.209730	5.017252	2.056862	2.480072	21.89771	18.25433	5.216662	38.37875	0

Variance Decomposition of PE:

Period	S.E.	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7	Shock8	
1	0.053741	2.623200	0.385783	2.349940	11.80956	19.63446	16.59473	0.268534	46.17392	0
2	0.060331	2.827585	2.268059	2.804658	19.63496	13.38286	15.87141	0.244412	42.69380	0
3	0.064096	2.060689	1.964051	15.57220	19.63741	9.229923	15.16810	0.336028	35.71169	0
4	0.067872	2.088022	1.598540	18.96066	18.20539	7.438192	18.35595	0.275207	31.95713	1
5	0.071284	3.092057	2.160594	20.42738	15.85460	6.334191	22.28905	0.275937	28.28581	1
6	0.074393	4.365608	3.403806	18.99604	13.96930	5.586687	26.36791	0.271970	25.57201	1
7	0.077276	5.233811	5.329190	16.96516	13.08167	4.984996	29.43948	0.302753	23.21463	1
8	0.080303	5.533295	7.055444	15.18151	13.13941	4.549026	31.39531	0.326226	21.42794	1
9	0.083234	5.316119	8.510266	13.81774	13.66116	4.220931	32.57467	0.347730	20.21878	1
10	0.085920	4.935694	9.422897	12.81169	14.24801	3.955720	33.35981	0.361284	19.61600	1
11	0.088362	4.679875	9.877469	12.04026	14.64866	3.722087	33.89134	0.368957	19.50492	1
12	0.090596	4.684733	9.989746	11.41192	14.77779	3.527091	34.20914	0.377256	19.76408	1
13	0.092650	4.925159	9.892078	10.88188	14.66734	3.393904	34.33090	0.389228	20.26012	1
14	0.094558	5.295453	9.689624	10.42894	14.39612	3.337921	34.29097	0.409062	20.88950	1
15	0.096353	5.683788	9.450425	10.04259	14.04676	3.354848	34.14106	0.439304	21.57774	1
16	0.098062	6.017650	9.214760	9.714165	13.67828	3.425602	33.93251	0.481487	22.27518	1
17	0.099705	6.268246	9.001909	9.434730	13.32433	3.525074	33.70600	0.535034	22.95168	1
18	0.101296	6.438588	8.819682	9.195070	12.99925	3.631439	33.48703	0.597667	23.58902	1
19	0.102841	6.545964	8.668944	8.986673	12.70627	3.730332	33.28837	0.666013	24.17819	1
20	0.104345	6.610437	8.546971	8.802213	12.44335	3.815115	33.11424	0.736550	24.71610	1

Factorization: Structural

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Declarations

I, the undersigned, declare that this thesis is my original work, and prepared for the first time using our own knowledge and understanding. Besides all sources and information used in this paper are carefully acknowledged. I further confirm that the thesis has not been submitted either in part or full to any other higher learning institution for the purpose of earning any degree.

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