Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies

MASTER THESIS

Exchange Rate Transmission
In the case of Ethiopia

Author: Muhammed Muhammed

Supervisor: Doc. Mgr. Tomáš Holub, Ph.D.

Academic Year: 2011/2012

Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

The author grants to Charles University permission to reproduce and to distribute copies of this thesis document in whole or in part.

Prague, July 31, 2011

Signature

Acknowledgments

I would like to express my gratitude especially to Tomas Holub, Ph.D. for his unreserved advice during my work. Further, I would like to thank prof. Michal Mejstřík, Tomáš Havránek, Ph.D, and Zuzana Havránková, Ph. D for their consultations.

Last but not least, I also appreciate the help from Amin Abdella (EEA) and Muhaba Muhammed for the support in data collection.

Abstract

This study examines the pass through of exchange rate shocks to Ethiopian domestic inflation. The baseline analysis carried out with the VAR/SVAR model, using four endogenous and three exogenous variables, employing quarterly data for the period 1993Q1 to 2011Q4. The pass through effect is quantified by means of impulse response. The finding of the full sample estimate shows that, although statistically insignificant, the ERPT to consumer prices is fairly large, but incomplete. Moreover, a sub sample analysis reveals that although the pass through for the two periods has been substantially large and complete, it is higher for the relatively low inflation periods (1993Q1-2002Q4) than for the high inflation period (2003Q1-2011Q4); which contradicts with other empirical studies. On the other hand, the variance decomposition function results show that the external factors such as world oil price fluctuations and foreign prices have a greater role in explaining the domestic inflation for the period 2003Q1-2011Q4 than for the period 1993Q1-2002Q4. The high share of imported goods to the total CPI, the market structure of the economy and the openness of the economy to the international market are the determining factors of the pass through. The supply side shocks, the money supply growth, shocks of world oil price and the foreign prices have a significant contribution to the domestic inflation of Ethiopia.

Keywords ERPT, domestic inflation, VAR/ SVAR, Ethiopia

Author's e-mail jemasir2010@yahoo.com

Supervisor's e-mail Tomas.Holub@cnb.cz

Contents

List of Tables

List of Figures

Acronyms

CPI-Consumer Price Index

NBE –National Bank of Ethiopia

ERM – Exchange Rate Mechanism

ECM- Error Correction Model

ERPT – Exchange Rate Pass Through

EX - Exchange Rate

GDP – Gross Domestic Product

GNP – Gross National Product

IFS - International Financial Statistics

IMF – International Monetary Fund

IRF – Impulse Response Function

NBE- National Bank of Ethiopia

SVAR model – Structural vector autoregressive model

OECD – Organization for Economic Cooperation and Development

PPI- Producer Price Index

VAR model – vector autoregressive model

WB - World Bank

VECM – Vector Error Correction Model

WFP- World Food Program

Master Thesis Proposal

Author:	Bc. Muhammed Muhammed
Supervisor:	Doc. Mgr. Tomáš Holub, Ph.D.
Defense Planned:	September 2012

Proposed Topic:

Exchange Rate Transmission In The Case Of Ethiopia

Topic Characteristics:

The thesis will focus on exchange rate pass-through (ERPT) in case of Ethiopian economy. The principal objective of the monetary policy of the National Bank of Ethiopia (NBE) is to maintain price and exchange rate stability and support sustainable economic growth of Ethiopia. Price stability is a proxy for macroeconomic stability which is vital in private sector economic decision on investment, consumption, international trade and saving. Maintaining exchange rate stability on the other hand is considered as the principal policy objective of NBE so as to be competitive in the international trade and to use exchange rate intervention as policy tools for monetary policy to affect both foreign reserve position and domestic money supply. The managed floating exchange rate regime is being practiced in Ethiopia since 1992. Thus, examining the channels of exchange rate transmission mechanism (ERTM) is of great importance to determine the potential effects on the general macroeconomic variables, like on price stability, GDP, Interest rate, etc. The effects much depends on the openness of the domestic economy, hence, the more open the economy to the world markets, the stronger the influence of exchange rate transmission on real domestic economic activity through changes in import and export.

In general the paper tries to assess the dynamics and magnitude of exchange rate pass-through. Given the high interdependence of economic factors, the transmission mechanism of an exchange rate shock into the domestic economy does not appear simple, and the results greatly vary across studies and countries.

Hypotheses:

1. The inflationary environment of the economy has a matter for exchange rate transmission.
2. As like any developing agricultural dominated economy, the exchange rate variation has low contribution to the price level development, it works Ethiopia too.

3. Exchange rate shocks have a significant effect on macroeconomic variables on Ethiopian economy.
4. The literature on exchange rate pass-through comes to a consensus that in small open economy the pass-through to domestic inflation is incomplete, it works Ethiopian too.
5. The speed of exchange rate shock transmission to all prices is quite high, which is usual for a small open economy.

Methodology:

The paper mainly will use the most commonly and widely applied method known as Vector Auto Regression (VAR) or structural VAR (SVAR). This approach captures the evolution and the interdependencies between multiple time series. Hence it provides, impulse response functions and forecast error variance decompositions, which is important to know the effect of exchange rate shocks on domestic inflation. In general the paper will use different econometric models if it is necessary and helpful.

The study will employ quarterily data covering the time period of 1993 Q1- 2011Q4. The period was chosen because of two reasons, the first one is to make all in the period of managed floating exchange rate regime which adopted in Ethiopia since 1992. The second important is to explain how the inflationary environments of the economy matters for exchange rate transmission by dividing the sample as relativily low inflation period (1993Q1-2002Q4) and high inflation period (2003Q1-2011Q4). Quarterly data has been used in order to incorporate more observations in order to improve the strength and reliability of the results.

Outline:

Outline of the paper:

1. Introduction and background of the study
2. Review of Literature

2.1. Theoretical background

2.2. Empirical Literature Review

3. The General Model Data Set Information
4. Result Estimations

4.1. Exchange rate pass through for full sample estimate

4.2. Exchange rate pass through for sub sample estimate

4.3. Response of price on other macroeconomic variables

4. Summary and Conclusion

Core Bibliography:

1. Oxana Babetskaia-Kukharchuk (2007): “Transmission of Exchange Rate Shocks into Domestic Inflation: The Case of the Czech Republic” Czech National Bank Working Paper series 12.

2. Tomáš Holub (2008): “Causes of Deviations from the CNB’s Inflation Targets: An Empirical Analysis” Czech Journal of Economics and Finance, 58, , no. 9-10, pp 425-433.

3. Choudhri, E. and D. Hakura (2001): “Exchange Rate Pass–through to Domestic Prices: Does the Inflationary Environment Matter?”, IMF Working Paper No. 01/194 (Washington: International Monetary Fund).

4. Jonas Stulz (2007): “Exchange rate pass-through in Switzerland Evidence from vector autoregressions” Swiss National Bank Economic Studies, No. 4, 2007

5. Krugman, P. (1986): “Pricing to Market When the Exchange Rate Changes, “NBER Working paper No. 1926 (Cambridge, Massachusettes: National Bureau of Economic Research).

6. Sanusi, Aliyu Rafindadi (2010): “Exchange rate pass-through to consumer prices in Ghana: Evidence from structural vector auto-regression”, Department of Economics, Ahmadu Bello University, Zaria, Nigeria

7. McCarthy, Jonathan (2000): “Pass-through of exchange rates and import prices to domestic inflation in some industrialized economies”, Federal Reserve Bank of New York Staff Reports 111.

8. Siaw Frimpong and Anokye M. Adam (2010): “Exchange Rate Pass-Through in Ghana”, School of Business, University of Cape Coast, Cape Coast, Ghana

9. Taylor, J. B. (2000): "Low Inflation, Pass-through, and the Pricing Power of Firms ", European Economic Review 44(7): 1389-1408.

Author **Supervisor**

1 Introduction

1.1. Background

Better macroeconomic management, including better monetary policy, has a significant contribution to improving the macroeconomic performance of the economy, lowering inflation and its volatility, and thus ultimately fostering the real GDP growth and lower unemployment level. Monetary policy is the process by which the monetary authority of a country controls the monetary instruments, to achieve the short term as well as long term goals of the state such as stabilizing inflation, promoting economic growth, etc. In line with this, the central goals of many countries usually try to achieve relatively stable prices and low level of unemployment parallel to other objectives. To sum up, the main purpose of the monetary theory is providing an insight for monetary authorities about how to use the optimal monetary policy in different economic situations.

Many developing countries may have problems in establishing an effective monetary policy which is mainly due to high government debt and underdeveloped financial markets. Moreover, there is a difficulty in forecasting money demand and fiscal pressures to levy the inflation tax via expanding money supply as well as other problems. In general, the central banks of many developing countries, and especially Sub Sahara African countries, are poor in managing monetary policy. The reason is that the monetary authority of these countries is not independent of government, i.e. it is mostly used for political benefits of the government and other non monetary goals.

Now a day, one of the central issues in international economics is analyzing the exchange rate pass through (ERPT) for different countries with a different monetary policy framework. ERPT can be defined as the percentage change in domestic prices caused by one percent change in the exchange rate. Understanding of the exchange rate transmission into the domestic inflation has a key role for the implementation of a country’s monetary and exchange rate policies. For a significant exchange rate shock, it is essential to know how strongly domestic prices will react to this shock, it means, by how much the inflation might move away from the target level and how fast prices return back to the equilibrium level. Under different monetary policy framework, to maintain price stability, the monetary authority should reduce the exchange rate volatility. In general, understanding ERPT could be a useful element for prediction of real sector behavior, particularly, for inflation prediction.

This study explores the influence of a change of exchange rate on the domestic inflation for Ethiopian economy. It must be noted from the outset, however, that although exchange rate are a notable determinant of price movements in Ethiopian economy, a number of other factors are also noteworthy. These include money supply growth, wages, and exogenous shocks in the domestic food supply, petroleum prices, and government fiscal policy among others. The researcher aims to deliver a little deeper into how the exchange rate transmission works in Ethiopia economy. It would also attempt to relate its empirical results with other countries like the Czech Republic and Ghana.

1.2. Statement of the Problem

It would certainly be an exaggeration to say that all economic problems are the result of malfunctions in the monetary system, but we can for sure say that some of the most prominent are related to the monetary system. Inflation is a monetary problem in the obvious sense that it means that our monetary unit, which is the birr (Ethiopian currency), is losing value, hence, deterioration of the purchasing power of the currency. In other words, substantial and sustained inflations have occurred due to different monetary policy problems, such as when quantity of money has risen at a fast rate, depreciation of domestic currency, low real interest rate, etc.

Many of the empirical studies on ERPT have focused on the industrialized countries. It is challenging for developing countries such as small open economy of Ethiopia to clearly understand the ERPT. For instance, in the conduct of monetary policy, the ability of a central bank to respond effectively and efficiently to different shocks requires an understanding of the transmission mechanism of the monetary policy.

Therefore, assessing the ERPT for Ethiopian economy has a vital role for monetary authorities for the following three reasons. First, there is no much evidence for this economy in terms of exchange rate transmission, it is worthwhile to contribute and update previous results using an econometric technique such as vector auto regression (VAR). Second, currently there is high inflation in the economy relative to the past five years which may be due to successive depreciation of domestic currency and high money supply growth. Third, it is important to know how different macroeconomic variables shocks (such as GDP, money supply, foreign price, oil price, foreign interest rate, and other macroeconomic variables) affect the domestic inflation of Ethiopia. It is important to keep in mind that due to the high interdependence of economic factors, the transmission mechanism of an exchange rate shock into the domestic economy does not appear simple, and the results may vary across studies and countries.

In general, the study provides answers for the following questions: how fast and to what extent a change of exchange rate transmits to domestic inflation? How the magnitudes of exchange rate pass-through differ with relatively low inflation and high inflation periods in managed floating exchange rate for Ethiopia economy? Lastly, it answers the question, how much each macroeconomic variable, such as GDP, money supply, world oil price, foreign price, foreign interest rate affect Ethiopian inflation.

1.3. Description of The Study Area

Ethiopia is located in eastern Africa in the southern Red Sea region with the total size of 1,127,127 square kilometres. It borders Sudan on the west, Eretria on the north, Djibouti and Somalia on the east, and Kenya on the South. Ethiopia's population is currently estimated around 87,331,561 with a growth rate of 2.7 % per annum. The population structure is typically developing with about 43% below the ages of 15. About 16% of the population lives in urban localities according to the population and housing census conducted in 2007. GDP growth is about 8-11% per annum with inflation rate between 20-40%. Ethiopian's economy revolves around subsistence agriculture which accounts 50% of GDP and also employs about 50% of the work force. Life expectancy rate is around 53 years[1]. Ethiopia's currency is called birr, which is divided into 100 cents. In October 1992, the government initiated a long, gradual devaluation of the birr, allowing its value to decline from the old rate of 2.07 birr per US$1 to an average of 8.78 birr per one US dollar in 2003. As of late December 2011, the exchange rate was 17.28 birr per one US dollar.

1.4. Objectives of the Study

The main objective of the study is to assess the dynamics and magnitude of exchange rate transmission to the consumer price for Ethiopian economy. The ERPT to the domestic inflation is complex (i.e. it does not apper simple), due to high interdependence of economic factors. The specific objectives of this paper are:

- ✓ To assess how fast and in what extent the exchange rate shocks transmits to domestic inflation in case of Ethiopian economy.
- ✓ To analyze how domestic inflation respond for a shocks of the macroeconomic variables

[1] Population Reference Bureau UNICEF, Info By Country: Ethiopia Statistics

- ✓ To examine the exchange rate pass through with different inflationary environment using sub sample period.
- ✓ To provide some factors that affects the exchange rate pass through to Ethiopian economy

1.5. Hypothesis

Based on theoretical literature and empirical evidence the thesis evolves around the following hypothesis:

I. The exchange rate has a significant role as an instrument of adjustment to various shocks in the economy. Theoretical as well as empirical studies proved that an appreciation (depreciation) of the exchange rate is thought to penalize (promote) exports and increase (decrease) imports, leading to a deteriorating (improving) trade balance. In other words, monetary policy is able to bring about changes in the level of the exchange rate and provoke changes in prices, trade volume and investment. Moreover, it has a significant effect on the macroeconomic variables such as on inflation, GDP, interest rate, and on the other macroeconomic variables in Ethiopian economy.

II. The literature on ERPT comes to a consensus that the pass-through to domestic inflation for a small open economy is incomplete. Many empirical studies for developed countries proved that the pass through depends on the goods what we are used to assess. In other words, the pass through is higher for imported goods than producer goods and consumer prices. In addition to this, it also largely depends on the pricing behavior of importing firms, whether the price setting is in domestic currency or foreign currency. Lastly, as we mentioned above it is also depends on the exchange rate policy as well as the trade openness of the country. Based on this fact, we hypothesze that the ERPT to the Ethiopian economy is incomplete.

III. Although we haypotisize the high pass through, the effect of exchange rate to the Ethiopian inflation may be insignificant.

IV. With low inflation environment, the pass through is relatively lower than with higher inflation. This may hold true for Ethiopian economy, too.

V. The speed of exchange rate shock transmission to the domestic prices is quite high if there is high share of imported goods in the CPI, which is usual for a small open economy. The more the country is open to international trade, the higher the speed of pass through.

1.6. Methodology

Different researchers used different models to measure the ERPT for different economies and the results significantly vary across studies and countries. To examine the pass-through of exchange rate to domestic inflation the researcher has been used the most commonly and widely applied method known as Vector Auto Regression (VAR) or structural VAR (SVAR). This approach captures the evolution and the interdependencies between multiple time series. Hence, it provides, impulse response functions and forecast error variance decompositions, which is important to analyses and explains the effect of different macroeconomic variables, such as real GDP, exchange rate, foreign prices, etc. on the domestic inflation.

The study covered the time period from 1993 up to 2011 with quarterly data that totally have 76 observations. The period was chosen because of two reasons; first, to make all the data in the range of managed floating exchange rate regime, the country applied this since 1992, and second important is to assess how the inflation environments matter for the transmission by taking two relatively lower and higher inflation periods, hence, 1993Q1 to 2002Q4 and 2003Q1 to 2011Q4, respectively. We employed quarterly data to incorporate more observations in order to improve the strength and reliability of the results.

1.7. Significance of the Study

It is not surprising to say not many empirical studies have been done related to the exchange rate transmission for developing countries, particularly Ethiopian economy. It tells us the value relevance and importance of this study on different aspect especially for Ethiopian monetary policy makers. The study will contribute to the clarification of exchange rate transmission to the domestic inflation, in other words, it provides theoretical as well as empirical results about how the exchange rate transmission works in the economy for the concerned policy makers. The monetary authorities should have a clear understanding about pros and cons of the policy decision before implementation. As its objective the study brings some insights about how a change of exchange rate affects the real macroeconomic variables of the economy or how domestic inflation reacts on different macroeconomic variable shocks.

The study has also a significant contribution for those who are interested to know how the exchange rate transmissions work in developing countries with monetary targeting framework especially for Ethiopian economy.

1.8. Organization of the Paper

The study contains five chapters. The first chapter of the paper addresses background of the study, problem and objective of the study, and significance of the study along with a short description of the methodology part. The second chapter deals with the related literature of the study that is collected from various sources. Theoretical or conceptual framework and empirical studies are overviewed under this chapter. The third chapter explains the estimation methods (the general model of the study), the data that are used, and some model test. The main results of our study are discussed under the fourth chapter. In this chapter a brief explanation of the specific objectives are assessed. Chapter five is the last and represents summary and conclusions of the study. The main empirical findings are summarized under this chapter.

2 Literature Review

In this chapter, we describe the theoretical literature and empirical evidences related to our studies, which focus on the ERPT. The general overview of monetary policy and its instruments, Ethiopian monetary authority practices, are also overviewed in this section.

2.1 Theoretical Literature

2.1.1 Theoretical Overview of Monetary Policy and Transmission Channels

A central bank of an economy can be used one or more monetary policy frameworks to achieve its objectives, especially to maintained price stability. Inflation targeting, price level targeting, monetary targeting, exchange rate targeting and others are among the monetary policy framework.

Inflation targeting monetary policy framework works in which a central bank attempts to keep inflation with the target range which used interest rate to its adjustment. It is introduced in New Zealand in 1990, and very successful, which currently more than 30 industrialized and non-industrialized countries adopted it as their monetary policy framework. On the other hand monetary targeting is on the basis of the theoretical framework of quantity theory. It means the main task of monetary policy is to increase the money supply over time in accordance with the trend in the rate of real growth. However, the price stability can be attained only under the condition of money demand stability which is often problematic, especially in the short run. Furthermore, even if the money demand were stable, the control of monetary growth tends to be difficult.

Exchange rate affects inflation in two ways – directly via the purchasing power parity theory and indirectly vie the expectations channel. The relationship in relative purchasing power parity (PPP), which is used under the exchange rate targeting, means that either the exchange rate compensates the difference in the inflation rates of the two countries, or in case that the exchange rate target is fixed vis-à-vis the currency of a country with low inflation, this relationship is used to import price stability.

The most prominent transmission channels are expectations channel, real interest rate channel, nominal interest rate channel, asset price (wealth) channel and exchange-rate channel. Open economy assumes more complex structure of the monetary policy transmission process. It is more difficult to control inflation in open economy, since

exchange rates play important role in determining the price level (through PPP and expectations channel).

Bernanke and Gertler (1995) explained the complexity of the monetary policy transmission to the real economic variables as black box. Even in industrial economics the transmission channel is not well understood which is mainly due to importance of channels change overtime, various channels have different speeds and all channels interact each other. For emerging economies the evaluation is particularly difficult because the theory is developed for industrialized economy and also the transmission channels some time behaves differently. This study made more focus on the exchange rate transmission channel for the case of Ethiopian economy.

2.1.1.1 Definition and Conditions of Exchange Rate Pass Through

Exchange rate pass-through can be defined as degree of sensitivity of import prices to a one percent change in exchange rates between exporting and importing countries (Goldberg and Knetter, 1997). This is closely related with the term “pricing-to-market”, which is defined as the percent change in prices in the exporter’s currency due to a one percent change in the exchange rate. An economy may have complete or incomplete exchange rate pass through. In other words, if the import price changes by the same proportion as the change in exchange rate, it is called complete or full ERPT. On the other hand, if the import price changes by less than the change in exchange rate is called incomplete or partial ERPT. The distribution cost and substitution away from the imports to lower quality local goods can contribute for the incomplete pass through of the exchange rate (Eichenbaum and Rebelo, 2002).

According to Taylor (2000) the pass through for developing countries is higher than the industrialized countries. The reasons of his argument are the macroeconomic environment, particularly the level and variability of inflation rates which is higher in the developing countries. In line with this, Choudhri and Hakura (2001) assessed the association between inflation and exchange rate pass through using two-stage approach for a large number of countries. They confirm that the association of inflation to the ERPT is significantly positive. It means that, the high inflation environment in the economy is much conducive to perfect pass-through, and it is often associated with complete pass-through.

There are three channels that exchange rate shock transmitted to domestic prices. These are (1) prices of imported consumption goods, (2) prices of imported intermediate goods, and (3) domestic goods priced in foreign currency. The speed of transmission is much higher on imported consumption goods and domestic goods priced in foreign currency which directly

affects the domestic price in exchange rate shocks relative to intermediate imported goods. The exchange rate shock through imported intermediate goods has a lower speed and indirect effect to the domestic prices.

Chen, Imbs, and Scott (2004), examines the role of globalization for the pass through process i.e. the recent entry of China, India and Eastern Europe into the global trading system. They claim that globalisation and higher competition have contributed to the substantial decline in global inflation in the 1990s. Due to globalisation, firms now operate in a more competitive environment than in previous decades. This implies higher aggregate multifactor productivity (because of marginal exits of low-productivity firms) and downward pressure on markups. In a high competition environment of this kind, the firms' ability to pass on cost increases is reduced. Also, by holding down the unit costs of production, productivity gains enhance the capacity of firms to absorb exchange-rate-related cost increases. All in all, globalisation and higher competition impose downward pressure on the degree of pass-through.

In general, the financial market structure of the country, size of the export market and/ or import market, degrees of competition among exporters or importers, composition of import products and/ or export products, inflation environment of the economy, openness of the country for international trade are among the most important factors that determine the exchange rate pass through in the economy.

Ethiopia has a number of trade partners to import and export different tradable commodities over the world, particularly, Germany, United State, Japan, Italy, China and India. The main export items of Ethiopia are agricultural products, such as Coffee, Vegetable products, Oilseeds, hides and skins and cotton. On the other hand, its import items are consumption and capital goods, such as, Cereals, Fuel, Machinery, Vehicles, and Iron and steel. The high import volume (i.e. high in its value) with agricultural export product (irrelevant in its value), the balance of payment is always negative and has experienced large current account deficits since at 1990s. Due to this, the deficit in most cases is covered by credits and loans from international lending institutions and debt forgiveness[2].

2.1.1.2 Type and Impact of the Exchange Rate

According to their economic benefit, countries have a possibility to choose an exchange rate regime. The range of choice goes from clean floating or flexible exchange rate to fixed (hard

[2] Source: http://www.mongabay.com/reference/new_profiles/215.html

pegged) exchange rate regime. In between this, there are a number of exchange rate regimes such as managed float, pegs, target zones, etc.

Free floating or flexible exchange regimes system means country's exchange rate is determined by the interaction of the market forces of supply and demand of foreign exchange. In this case, the monetary authorities thrust the market to manage the exchange rate. The degree of flexibility of the exchange rate depends on the nature of government intervention. It means that, if there is government intervention on the foreign exchange market then it is called managed floating, otherwise it will be clean floating. The advantage of this regime is that if prices move slowly, it is faster and less costly to move the nominal exchange rate in response to a shock that requires an adjustment in the real exchange rate. The free floating system applied in many developed and emerging countries with inflation targeting framework although many of them have an intervention to manage the exchange rate, especially during the crises.

In line with this, Canales and Kriljenko (2003) argued that the foreign exchange intervention may be in favor for emerging countries than in well established industrialized countries. The motivation behind their argument is that in emerging market; the central bank interventions are not always fully sterilized, the size of interventions is large relative to market turnover in narrow foreign exchange markets, market organization and the regulatory framework may be more conducive to interventions, moral suasion may play a bigger role, and central banks have a greater informational advantage over market participants.

On the other hand, a fixed exchange rate system means a country maintained its exchange rate at fixed levels. In other words, a country has its currency fixed against another currency. It may seldom be changed (hard peg) or changed occasionally (adjustable peg). In the post World War II period, the world economies maintained fixed exchange rates under the Bretton Woods monetary system until that system collapsed in the early 1970s. Hard pegs tended to become increasingly popular in the aftermath of the East Asian financial crises. Less transaction costs, avoiding uncertainty for international traders arising from exchange rate change and providing credible nominal anchor for monetary policy are among the reasons and merits of a country to implement fixed exchange rate.

Exchange rate shock has an influence on the real economic variables of the economy. For example, an appreciation (depreciation) of the exchange rate is thought to penalize (promote) exports and increase (decrease) imports, leading to a deteriorating (improving) trade balance. In other words, a weakening of the exchange rate will lead to a positive effect on the net export by encouraging the exports and discouraging imports. However, experiences show

that, it may take time before exchange rate changes have an impact on foreign trade. In the short term, due to a change of exchange rate, the imported price will raise which results a negative initial effect of a weaker exchange rate on net exports. However, for a slight longer period producers and consumers adapt and export and import volumes are affected. When the exchange rate weakens, exports increase while imports decline, as domestically-produced goods and services become relatively cheaper. In the long term a depreciation of exchange rate will lead to increased net exports, which in turn has a positive effect on total production of the economy.

2.1.2 Monetary Policy And Exchange Rate Development In Ethiopia

Like in any other least developed countries, the Ethiopian economy also characterized by the coexistence of the modern sector and the traditional sector. The traditional sector associated with the non-monetized sector while the modern sector identified with the monetized sector.

The monetized sectors are composed of the informal and formal financial markets. The size of the informal financial market is difficult to measure in the country; however, it provides a considerable amount of credit. The formal financial market consists of the central bank, commercial banks, insurance companies, pension fund and other credit and saving institution.

2.1.2.1 Monetary Policy Developments

The first legal tender currency of Ethiopia issued on 23 July 1945 by defining the monetary unit as the Ethiopia dollar (E$) with a value of 5.52 grains which is equivalent to 0.355745 grams of pure gold which was determined in accord to 1944 agreement of the Bretton Woods monetary system. After the proclamation of the national currency particularly, between the years 1945-1950 the money supply (which is M1 in this case) of the country was determined by the balance of payment which reflected the volume of currency issued and supply of domestic credit. However, the effect of domestic credit on money supply was small when there was government budget surplus, which observed on underdeveloped financial market system in the economy (limited private credit, consumer credit was unknown, industries were not established). Similarly, during the 1950–1963 periods the supply of money also explained by balance of payments and domestic credit. Due to, growth of economic activities on different field such as expansion of housing construction, transportation and communication, manufacturing sectors, etcpure, enhanced the impact of domestic credit on money supply.Monetary policy strategy of a central bank depends on a number of factors that are unique and contextual to the country. Given the policy objective, any good strategy depends on the macroeconomic and the institutional structure of the economy. For instance,

the more open the economy is, the more the external sector plays a dominant role in monetary management. Within a country's monetary management framework, there are basically three targets: the ultimate or final target, the intermediate target and the operating target.

The ultimate or the final target monetary policies in Ethiopia are to maintain price and exchange rate stability and support sustainable economic growth. To achieve these objectives the NBE sets money supply as an intermediate target. It should be noted that intermediate targets are not directly controlled by the central bank. Traditionally, we can define money supply from narrow (M1) and broad sense (M2). Narrow money (M1) can be defined as a measure of money stock primarily for transaction purposes which consists currency held by the public, traveler's checks, demand deposits and other checkable deposits. Broad Money (M2) is a measure of the domestic money supply that includes M1 plus Quasi-money (savings and time deposits), overnight repurchase agreements, and personal balances in money market accounts. Basically, M2 includes money that can be used for spending (M1) plus items that can be quickly converted to M1. NBE takes the broader definition of money or M2 as the money supply. The current target is to ensure that the money supply growth is in line with nominal GDP growth rate.

The operational target is an economic variable that the central bank wants to influence, largely on a day-to-day basis, through its monetary policy instruments. They can be used to link instruments of monetary policy to intermediate targets set by the central bank and represent the first impulse in the transmission process of monetary policy. The growth of base money/reserve money is being used as operational target of the National Bank of Ethiopia. Reserve money (Base money) is defined as the sum of currency in circulation and deposits of commercial banks at NBE. Like any other monetary targeting country, the practice of targeting reserve money is based on the assumption of money demand stability. If the money demand happens to be unstable over the medium to long term, then the NBE will shift its targeting in to another workable framework such as interest rate targeting or multiple indicator approach[3]. In addition, the Bank shall maintain the international reserves at a level which, in its opinion, is adequate for Ethiopia's international transactions. In this regard, a

[3] Reserve Bank of India uses multiple indicator approach to monetary policy that provides a broad indicator of the stance of liquidity conditions. It uses indicators such as interest rate, exchange rates, fiscal and external positions and flow of financial resources for purpose of monetary management. Multiple indicator approach has the advantages of basing monetary policy operations on a large set of information and providing flexibility in the conduct of monetary management.

minimum threshold at which foreign reserves are considered adequate is set at three months of imports of goods and services.

Currently, the principal objective of the National Bank of Ethiopia (NBE) is to maintain price and exchange rate stability and support sustainable economic growth of the economy. Controlling inflation is a proxy for macroeconomic stability which has a vital role in private sector economic decision on investment, consumption, international trade and saving. It further initiates to increase the employment and economic growth of the country. On the other hand, maintaining exchange rate stability is used to be competitive in the international trade and to use exchange rate intervention as policy tools for monetary policy to affect both foreign reserve position and domestic money supply. The specific objectives of the monetary policy which is specified by the NBE are[4]:

- Foster monetary, credit and financial conditions conducive to orderly, balanced and sustained economic growth and development.
- Preserve the purchasing power of the national currency – ensuring that the level of money supply is generally consistent with developments in the macro- economy and intervening in the foreign exchange rate market for the purpose of stabilizing the rate when conditions necessitate.
- Encourage the mobilization of domestic and foreign savings and their efficient allocation for productive economic activities through the implementation of a prudent market driven interest rate policy.
- Facilitate the emergence of financial and capital markets that are capable of responding to the needs of the economy through appropriate policy measures. These measures would ensure the gradual introduction of trading instruments on a short-term basis.

2.1.2.2 Exchange Rate Development

The choice of exchange rate regime is determined by various factors, such as the objectives pursued by the policy makers, the sources of shocks hitting the economy and the structural characteristics of the economy. But once the choice is made, the authorities are presumed to adjust their macroeconomic policies (especially fiscal and monetary policies) to fit the chosen exchange rate policy.

Almost for half a century (1945-1992) the exchange rate of Ethiopia currency (birr) against the US dollar was determined by the government decree. After the collapse of the Bretton Woods System in 1971, the birr was settled at 2.30 birr per US dollar on 21 December1971.

[4] NBE's Monetary Policy Framework, February 2009

From February 1973 to October 1992, the Ethiopian currency was pegged to the US dollar at the rate of 2.07 birr per dollar. This means that for two consecutive decades the official exchange rate of Ethiopia was fixed despite a floating exchange rate of the major world currencies including the US dollar. This leads over valuation of birr in terms of the US dollar as well as many other foreign currencies which confirmed by empirical studies.

Haile Kibret (1994) analyzed the over valuation of Ethiopian currency against US dollar using indicator of exchange rate misalignment, particularly the prevalence of a significant parallel premium. He suggests that, the Ethiopian birr has been overvalued since 1970s. As a result, the trade policy of Ethiopia became increasingly inconsistent which has long been characterized by controlled foreign exchange allocation, import quotas, high tariffs, state owned marketing exports, export prohibitions, export subsidies and export taxes (Naude and Abu Girma, 1994). It was also confirmed that the over-valuation of Ethiopian birr also reduced the competitiveness of legal exports which in turn results a significant smuggling on the economy (Stefan Dercon and Lulseged Ayalew, 1994).

According to Dordunoo (1994) a persistence of higher premium in informal exchange market is one disequilibrium indicator in the foreign exchange market and which may be a cause to rise the auction exchange rate, it motivate to shift the people from official exchange auction to parallel market, it discourage export production, encourage smuggling or contraband activities, and it propel capital flight. Between the year 1973-1993, Ethiopia was among those countries that had high parallel premium for foreign exchange.

Realizing the underlying economic situation of the country (the negative effect of an over valuation of the birr on balance of payment), the Transitional Government of Ethiopia (TGE) devalued the official exchange rate from 2.07 to 6.25 birr per US dollar. Moreover, in May 1993, TGE also established the auction for foreign exchange to liberalize the foreign exchange rate market which attracts parallel foreign exchange market to back to the official line, which in turn strengthens the official reserves of the country (IMF survey, 1993). Since 1995 up to the present day, the exchange rate of the birr against the US dollar and other currencies has determined only through the auction system. Since 1992, Ethiopia has practiced managed floating exchange rate regime.

2.1.2.3 Operational Instruments and Ethiopian National Bank Practice

Each type of monetary policy targeting has its own intermediate targets and operational instruments to achieve country’s goal. A wide range of monetary instruments makes the life of the central banks somehow easy and efficient through broaden the financial intermediation

in the banking system. It also promotes liquidity management of commercial banks and gradually leads to the development of well functioning money and financial markets which could serve as catalysts for economic growth and development. The most common instruments are interest rate, open market operation, discount rate / reserve rate and money supply. Before 1970s, due to the underdevelopment of the money market and non existence of the financial market, the use of such instruments in Ethiopia has been extremely limited. After wards, with some development in banking system the NBE used a mix of diversified monetary policy instrument so as to hit its goals effectively and efficiently.

Open Market Operation is an instrument of central banks by selling and buying of securities of issued by the government. For example, selling the government securities means that the central bank collects money from the public which in most case used to control the excess money that that may leads inflation on the economy. It also used to finance government debts and the reverse is true when the central bank buys the security. Indeed, to prepare the ground for enhanced open market operations, the yield on government securities should be at least close to the minimum interest rate and needs to established secondary market for government securities. Based on this, Ethiopian NBE will use open market operations as one of its monetary policy instruments.

The second instruments are a standing central bank credit facility which is used to enhance the financial capacity of commercial banks and to promote financial intermediation and efficiency. This instrument is much advantageous to transparency and for prediction of accessing centar banks' resource to cover short needs. In general, Ethiopian National bank will or will be use the following monetary policy instruments as well, such as reserve requirement, setting of floor deposit interest rate (until interest rate is deregulated, direct borrowing/ lending in the interbank money market and introducing re-purchase agreement(repo/reverse repo operations), use of selected credit control when necessary and moral suasion.

2.2 Empirical Literature Review

In this part, a review of empirical works on the relationship between exchange rate and other real economic variables, especially inflation has done. We provide this empirical evidences using three sections. The first section provides the literature review of some European, Asian countries and literatures which attribute to money countries will be made. In the second part, the literature on African countries will be reviewed. Lastly, a review of literature of Ethiopian inflation will be made.

2.2.1 Literature from European, Asian and Other Countries

MacDonald et al (2006) analyzed the possible interrelations between different channels and their impact on prices and the real economy for Central and Eastern Europe countries using the instantaneous long run model. They found that, the ERPT to imported goods are almost complete for Estonia (0.83), Hungary (0.87) and Poland (0.84) and Slovakia (1.03). Moreover, they confirmed that there is higher pass through for producer price index than the consumer price index for all countries except Croatia and Russia, even for the Czech Republic, which has the lowest pass-through to the CPI, roughly 40% of exchange rate changes are passed in to producer prices. The result also similar with Zorzi et al (2007) who found substantially large elasticity pass through for different countries such as 0.56 for Poland, 0.77 for China and Czech Republic, 0.91 for Hungary and 1.39 for Mexico. Moreover, McFarlane (2002) found 0.80 pass through for Jamaica; Ito et al (2005) fund the pass through of 1.4 for Indonesia after one year.

Oxana Babecka (2007) assessed the dynamics and completeness of the exchange rate pass-through for the Czech Republic by applying alternative specifications and econometric procedures using two datasets m-o-m changes and y-o-y changes. The result shows that, the speed of the pass through to all prices is quite high, which is usual for a small open economy while the maximum impulse response is 25% and the total reaction to the exchange rate shock estimated for the whole sample is likely to be less than 30%. She also found that due to shorter time series and the volatility of data, the pass-through was insignificant between the period 2002 and 2006. She also finds that, the reaction is higher for tradable goods than for non tradable goods to the exchange rate shocks. Concerning to the magnitude of the pass-through, the result shows a decreases from the initial stage of production to final goods but there is high pass through to consumer price than producer prices. Similarly, Holub (2008) examined the causes of deviations from Czech National Bank inflation targeting using the VAR model covering the period of 1998Q1 to 2007Q4 for the variables of real exchange rate, agricultural producer prices, world crude oil prices, foreign and domestic economic activity, and real interest. Based on Hodrick filtring generating of gap, he confirmed that, the real exchange rate gap is statistically significant and larger contribution to the deviation of inflation from the CNB’s inflation targeting about 35%, which is more than other variables have. He also found a 28%-38 % the real ERPT to Czech inflation.

Leigh and Rossi (2002) assessed the exchange pass through for Turkey using a recursive vector auto regression model for a period January 1994 to April 2002. They found out higher pass through for the first four years and over after a year. The speed of pass through to wholesale prices much faster than to consumer prices which is 60 and 45 percent after a year

transmission, respectively. Moreover, they confirm the magnitude and speed of pass through in Turkey is larger and quicker than other key emerging market countries. Similarily, Nombulelo Duma (2008) examines the external shock pass through to the inflation using VAR model for Sri Lanka. The result showed that, due to existence of administered price, high content of food in consumption basket, low persistence and volatility of exchange rate, the pass through was low and incomplete. Moreover, the consumer variation to the external variables is low that amount 25% for Sri Lanka economy.

Sahminan (2002) analyzed the ERPT for Southeast Asian countries (Thailand, Singapore and Philippines) using quarterly data of import price, exchange rate, domestic PPI, foreign PPI and foreign industrial production covering the period 1974:1 to 2000:3. He used co integration analysis and Error Correction Model (ECM) to estimates the relationship of the variables. The co integration analysis results showed that a complete long run ERPT for Philippines (1.43) and incomplete pass through for Thailand (0.6) and Singapore (0.408).On the other hand, the Error correction model result revealed that, for the short run the Thailand and Singapore import prices are highly influenced by foreign price and foreign demand rather than exchange rate, while it has a significant adverse effect for Philippines economy.

McCarthy (1999) analyses the pass- through of exchange rates and import prices on domestic inflation (consumer and producer prices) for six industrialized OECD countries using vector auto regression (VAR) model over the period of 1976:1-1998:4. He revealed that the exchange rate has a modest effect on the aggregate consumer prices for most of sample countries. He also finds that the ERPT tends to be more correlated with the degree of openness of the economy. According to Laflèche, (1997) the main factors that affect pass through are proportion of imports in the CPI basket or a higher proportion of imported inputs in the production process, the degree of competitiveness of different sectors and the microeconomic environment of the country has play a key role in explaining the pass-through to the domestic inflation.

Maliszewski (2003) examined the determinant of inflation in Georgia using error correction model over a period from January 1996 to February 2003 with monthly data. The model includes a short run ECM and long run co integration. From the short run model the result shows that exchange rate and imported oil price are the main significant factors that determine the inflation level of Georgia economy. Similarly, the result from the long model shows that in the long run the inflation determined by money supply, exchange rate and output but the exchange rate variable still is found to be dominant in explaining inflation.

2.2.2 Literature from African Countries

Bawumia and Abradu-Otoo (2003) analyzed the relationship between money supply, exchange rate and money supply based on monthly data over the period of (1983-1999) using co-integration and error-correction techniques for Ghanaian economy. They found out an existence of long term relationship between inflation, money supply, exchange rate and the real income for the economy. Specifically, they revealed 1 percent increase in money supply (M2+) will raise inflation by 0.41 percent, and a 1 percent depreciation of the cedi will increase inflation by 0.29 percent; and a 1 percent increase in real income will reduce inflation by 0.25 percent. Moreover, they confirm that in some extent exchange rate has persistent effects on inflation which takes a short period of transmission (a one month delay), while the effect of real income and money on inflation takes place with a 2 and 4-month delay, respectively.

Frimpong and Adam (2002) examined the ERPT for the Ghana economy using the model of Vector Auto Regression (VAR). They used monthly data for the period of 1990 to 2009. In the short run, the result shows that the ERPT to domestic inflation is incomplete and declining through time horizons. Moreover, using the Johansen co integration approach they try to determine the long run relationship of inflation with exchange rate, and they revaled that, there is positive, but statistically insignificant relationship between Gahanian inflation and exchange rate, which indicates nil long-run ERPT. An impact of increased openness and tighter monetary policy pursue by the central bank over the period are the reasons of the low pass through for Gahanaian economy. However, their result is contradicted with Sanusi (2010) results, who found a pass through of 0.79 for Gahanna economy, using 1983Q3 to 2006Q3 time period.

Nkunde Mwase (2006) analyzed the exchange rate pass through to the inflation of Tanzania. He has been used structural Vector Autoregrassion (VAR) models with data set covering the period of 1990 to 2005. The result shows that, there is low ERPT to inflation, and declined through time, even though a depreciation of the currency in time. He finally concludes that, the macroeconomic and the structural reforms during this period attributes for the result of declining of the pass through but not necessarily mean the fluctuation of exchange rate has insignificant in explaining macroeconomic fluctuations of the economy.

2.2.3 Literature from Ethiopian Economy

It is not surprising to say no much literature on Ethiopian inflation and exchange rate with VAR/ SVAR model estimation because of the past experience of low level inflation in the country. However, the following literature was undertaken related to inflation and other macroeconomic variables using different methodology.

Choudhri and Hakura (2001) assessed the matter of the inflation environment in influencing the exchange rate pass through using different stable and high inflation countries. They confirmed that, lower pass through for countries that have low and stable inflation than high inflation countries. For many African countries including Ethiopia they found zero pass through for the period 1997 – 2000. Forinstance, they found 0.1 for Ethiopia, Baharian and Tunisia, a 0.13 for Thailand, Singapore and Germany economy which has relativily low and stable inflation in the country. On the other hand, for relative high inflation countries, they found high pass through, for instance, 0.54 for Ireland, 0.57 for Costa Rica, 0.62 for Uruguay and 0.68 for Ecuador after 20 periods. They conclude that, the association between the pass through and inflation is positive and significant.

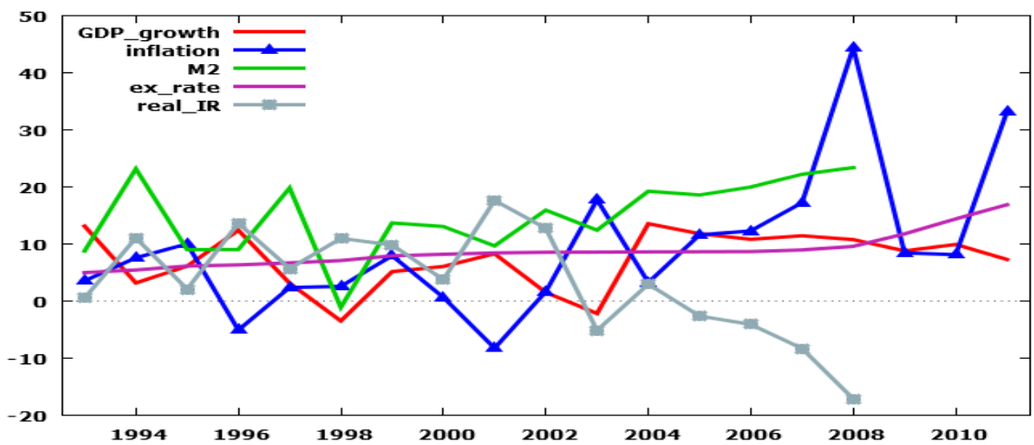
Getachew (1996) analyzed factors that determine inflation in Ethiopia for short run and long run. For short run money supply has a significant factor that determines inflation in the economy while in the long run inflation in Ethiopia is determined by supply factors. Finally he concludes that inflation in Ethiopia case is more associated with the supply bottlenecks in the crucial sector of the economy, particularly, agriculture. Similarly, Sisay Menji (2009) assessed the determinant factor of inflation for Ethiopian economy. He has been using the Co integration model to find the long run determinant factors covering quarterly data for the period from 1997/98 up to the second quarter of 2007/08. He finds inflation in Ethiopia is structural it is the fact that the output is incapable of growing at a rate that can satisfy the rapidly rising population. However, it does not imply monetary phenomenon insignificant for inflation. He confirmed that money supply and lending interest rate has a positive significant impact while the exchange rate has a negative and insignificant impact on the consumer price index. The stability of the exchange rate, the restriction of exports of agricultural product and the import of cheap products had contributed for exchange rate insignificances.

According to Yohannes (2000) investigates the source of inflation for Ethiopian economy using three econometrics models such as quantitative theory model (monetarist), demand and supply model and the structuralism Model. The first and second model result shows that, in the short run, the money supply and actual world inflation significantly affects the domestic inflation. The last model result shows that, in the long run the effect is insignificant. He finally recommended that, the Ethiopian policy maker should give priority to the supply side and take demand side as secondary important rather than controlling the inflation.

The recent inflation condition of Ethiopia is worsening time to time, especially to the past five years. According to WFP (2011), between the year 2010 and 2011 the inflation of

Ethiopia economy was increased by 29.9%, which the largest proportion constitutes to food inflation (about 32.2 %) and 25.6% for non food inflation. On the base year of 2006 of CPI, food has a lion share from the total basket of goods which is about 57 %. Out of 57% of food share, the imported products have a share of 30.78 percent. High money supply, increase of world market price, frequent drought and famine in the horn of Africa and the exchange rate devaluation are among the reasons for this high inflation level. In order to stabilize the economy government takes a measure of setting prices on main commodities for wholesaler and retailer suppliers in the market. In addition to this, the government starts selling and distributing this products such as sugar, edible oil, etc. to consumers and retailers through public institutions and consumers association. Moreover, for some time the government also restricts the private importer not to import the palm edible oil and sugar. According to the government the restriction was made for the purpose of controlling the rent seeker investors that want to make high profit with the expense of the poor people. However, with low level and unorganized controlling and distributional system it is difficult to fully address peoples demand throughout the country. Moreover, with limited financial resource the government also unable to subsidizing this product for long time. Furthermore, the restriction policy plus to high demand of the product with poor government distribution system results parallel / black/ market that aggravate the problems further.

Figure (2.1) Growth relationships among the Ethiopian macroeconomic variables



Source: World Bank (2011) yearly data computed using Gretl.

According to World Bank (2011) indicated in the above figure for the period between 2005 and 2011 the level of Ethiopian inflation grows continuously with an average of 12% and reaches maximum in the period of 2008 with an inflation level of 44%. Money supply together with exchange rate and GDP has positive growth as inflation for the same period while the real interest rate has continuously decline after 2001 and gets minimum in 2008 at the level of -18 percent as a result of high inflation in the economy. The data trend also revealed that, the growth rate of M2 is higher than that of real GDP almost for all period but

the gap is higher after 2001. This implies that more money is injected into the economy than is needed which would create new potential demand and finally result high inflation.

Furthermore, it is worthwhile to provide the share of each component in the total consumer index for the Ethiopian economy.

Table (2.1) Weights of major Consumer Price Index components (CPI) for Ethiopian economy.

No.	Major group	Weights in percentage (%)	
		2000 based CPI	2006 based CPI
1	Food	60.08	57.01
2	Non - Food	39.92	42.99
3	Beverages	2.01	2.02
4	Cigarettes and Tobacco	0.51	0.48
5	Clothing and Footwear	9.26	8.32
6	House Rent, Construction Materials, Water and Fuel and Power	15.44	20.56
7	Furniture, Furnishing, Household Equipment and Operations	4.94	3.75
8	Medical Care and Health	1.20	1.11
9	Transport and Communication	1.99	2.49
10	Recreation, Entertainment and Education	1.01	1.09
11	Personal Care and Effects	0.92	0.83
12	Miscellaneous Goods	2.64	2.34
	Total	100	100

Source: Central Statistics Authority of Ethiopia (CSA) may 2008.

The consumer index computation is based on the Laspeyres Weighted Price. As can we observe from the above table, food has the largest share followed by non- food and House Rent, Construction Materials, Water and Fuel and Power with 57.01%, 42.99% and 20.56%, respectively. High share of food component in the CPI index reflects country's low level development; hence, the total people in the country largely expend its income on food components. From the total CPI basket the import constitutes 54-57%.

3 General Model and Data Analysis

This section provides the data set and the econometric setup of the study. Before discussing the model, it is motivated to explain first the choice of the information set. After this, we introduce the baseline VAR model and the identification strategy for relevant shocks.

3.1 Data set Information

The main aim of this study is to shed light on the transmission of a percentage change of the exchange rate (Ex) to the domestic inflation (i.e. consumer prices (CPI)). It is assumed that the consumer price index is a basket of goods and services that contain imported and domestically produced goods and services. It implicitly known that the shocks exchange rate initially passed to imported prices then affects the total CPI. Due to unavailability of import price data we restricted our analysis to the total consumer prices. Therefore, the two variables nominal exchange rate and the consumer price index in this respect are the center of our empirical analysis. The precise definition of the exchange rate measure is the nominal effective exchange rate (increase indicates ETB depreciation, ETB/$). Similarly, we can define the CPI as the overall consumer price index which provides the broadest measure of inflation at the consumer level. Furthermore, the study would also assess the reaction of consumer price index on different macroeconomic variables shocks like GDP, Money Supply, etc.

As far as the output variables concerned, we used the real GDP (rgdp) and the real output gap (ygap) to control the domestic economic activity. According to Girodani (2004), for this kind of exercise real time output gap would be better than traditional real GDP. The real GDP and the output gap of Ethiopia are only available at annually frequencies and we interpolate it at quarterly frequencies using the moving average procedure by considering the rain fed agricultural production that almost 50% of Ethiopian GDP. Hence, the main agricultural system of Ethiopia is dominated by the smallholder farmers with cereal production under rain fed conditions (World Bank (2006)). We thus gave special consideration in seasonally adjusting before we made interpolation. Generally, agricultural production has a lion share (40-50%) contribution to Ethiopian GDP followed by industrial production (15-30%) and Service sectors (10-20%). At last, we seasonally adjusted the real GDP by means of the Census-X- 12 procedure.

Next, the monetary policy instrument is represented by money supply as an alternative of short term interest rate. Mostly, it would apply in case when a country has a low level and a weak financial market system like Ethiopian economy. In other words, in low level and unstructured/unorganized financial market economy the macroeconomic variables are less reactive for the change of interest rate. For this and other reasons we employed a money supply instead of interest rate as a monetary instrument. The money supply is measured by M2, which is the M1 plus quasi money.

Finally, we used three exogenous variables which are not affected by a small open economy like Ethiopia. These variables are Germany's consumer price index (dcpi_g) and short term interest rate (SR_g), and world oil price (dloil_p). The Germany's variables are chosen based on its economic size and on its trading parteners of Ethiopia. According to Kibre Moges (2008), Germany has a leading position among other countries that imports Ethiopian products and seventh in rank by exporting its product to Ethiopia. The world oil price is represented by a crude oil price index denominated in US dollars.

We restrict our sample to the data from 1993 onwards i.e. all the data we used are after managed floating exchange rate adopted by the National Bank of Ethiopia (previously, it operated a fixed exchange rate regime until the first quarter of 1992). In short, the sample span is chosen so as to exclude the period of fixed exchange rate regime. Therefore, the analysis of this study is based on 76 quarterly observations covering the period from 1993Q1 to 2011Q4.

The source of the endogenous variables data is the IFS (except the real GDP which is only available at the Ministry of Finance and Economic Development of Ethiopia (MoFED)) and the exogenous variables are at OECD and IMF database. A detailed description of the data and Graphs for relevant transformations is provided in Appendix A.

3.2 ECONOMETRIC SET UP

The one common approach in estimating the monetary policy transmission in many literatures is using VAR / SVAR model (for instance, McCarthy (1999), and Hahn (2003)). The model was first introduced by Sims (1980) and considered as a benchmark in assessing the pass- through. Thus, under this section we discussed the theoretical and empirical explanation of the VAR framework that we employed.

Different studies follow different type of channels with different variable specification in using the VAR model. However, this study follows the distribution chain which is proposed

by McCarthy (2000) with few differences in variable specifications. Thus, we used four endogenous and three exogenous variables to assess the exchange rate pass through for the Ethiopian economy and the model can be written in the following reduced form:

$$\boldsymbol{D(L)\, Y_t = a + \varphi(l)\, X_t + \varepsilon_t} \qquad \boldsymbol{E(\varepsilon_t, \varepsilon_t') = \Sigma} \quad \ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{1})$$

Where Y_t and X_t represents the endogenous and exogenous variables, respectively. Hence, y_t=[outputgap,dlms,dlex,dlcpi][5] is the vector of n = 4 endogenous variables and X_t=[dlcpi_g,dloil_p,sr_g][6] is the three exogenous variables which unlikely affected by the small open Ethiopian economy. D (L) and φ(L) are matrix and vector polynomials in the lag operator expressed in written form as

D (L) = (I + $D_1L + D_2L^2 \ldots . + D_pL^p + D_sL^s$) and φ (L) = ($\varphi_0 + \varphi_1L + \cdots \varphi_qL^q$). The symbol a is a vector of constants and ε_t is a vector of residuals which its product Σ given as covariance matrix. Moreover, the small letter l and d represents the log and first difference of the variables, respectively. Furthermore, the time period t corresponds to one quarter. Therefore, in our base line model all data series (except the output gap) are entering as log difference to account for the non-stationary of the level data.

We more focused on in estimating and analyzing the reduced form of the model (1) with two lags of endogenous variables and only one exogenous variables effect. We do not allow the endogenous variables to affect the exogenous variables but these exogenous variables have one shock effect to the endogenous variables (i.e. as block erogeneity)[7]. Before discussing the identification procedures it is worthwhile mentioning that results are very similar when we used real GDP (dlrgdp) in the model instead of output gap.

[5] The endogenous variable symbols outputgap is the output gap of the real GDP which includes in order to capture the demand shocks, dlms is the first difference of log money supply (M2) which allow to monetary policy shocks, dlex is the first difference of log nominal exchange rate, dlcpi is the first difference of the Ethiopian consumer price index .

[6] The symbols meaning which are involved as exogenous variable in the model expressed as, dlcpi_g is the first difference of log consumer price index of Germany, sr_g is short term interest rate and dloil_p is the first difference of log oil price index. These variables are much important to capture the effect of the external (international) shocks to the Ethiopian economy.

[7] The lag length to Estimating the VAR model is depend on different selection criteria such as AIC, SIC, . The selection procedures can be found under section of variable transformation and sensitivity analysis.

Most likely, the inflation developments are made by adaptive expectations with agents for most of the period expecting the control on inflationary pressure to be maintained due to the strong record of fiscal and monetary discipline. Thus, we are assumed that the conditional expectations are equally likely to the linear projection of the lags of the endogenous variables in the VAR model. Consequently, we can write as follows:

$$\mathbf{D(L)y_t = e_t}^{8} \quad , \quad \mathbf{where} \quad \mathbf{D(L)} = \sum_{\mathbf{j=0}}^{\mathbf{p}} \mathbf{D_j L^j}, \qquad \mathbf{E(\boldsymbol{\varepsilon}_t, \boldsymbol{\varepsilon}'_{t'}) = \Sigma} \quad \dots \quad \mathbf{(2)}$$

Given D (L)[9] is an invertible and can be expressed as C(L)=$D(L)^{-1}$ and C_0=I, then we can transform equation (2) as

$$\boldsymbol{y_t = C(L)\varepsilon_t = \sum_{k=0}^{\infty} C_k \varepsilon_{t-k}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \mathbf{(3)}$$

As may be seen from the non- diagonal covariance matrix Σ = {δ_ij,i,j=1,2,..n}, the residuals ε_(i,t) are correlated each other. Thus in accordance with the above reduced form of the model we can also expressed in the following structural VAR model.

$$\boldsymbol{B(L)y_t = u_t} \qquad , \qquad \boldsymbol{E(u_t\, u'_t) = I} \dots\dots\dots\dots\dots\dots\dots\dots \mathbf{(4)}$$

The vector u_t contains mutually uncorrelated shocks, hence, the variance covariance matrix of these shocks can be normalized to identity (I) without loss of generality. With similar step as reduced form, B(L) is an invertible and can be written as follows,

$$\boldsymbol{y_t = H(L)u_t = \sum_{k}^{\infty} H_t u_{t-k}} \qquad\qquad \boldsymbol{E(u_t u'_t) = I} \dots\dots\dots\dots \mathbf{(5)}$$

Where, $H(L) = B^{-1}(L)\ and\ u_t$ denotes as structural shocks which are not directly observable; however it needs to be identified. Thus, we made identification by using two steps. First, the reduced form of the first model is estimated by OLS, and doing the same for other equations one after another. The second step is expressing the structural residuals (u_t)

[8] For simplicity the notation from equation (2) to (4) the deterministic terms (i.e. the constant (a) and the exogenous variable (X_t)) are suppressed.

[9] D(L) is a 4x4 matrix polynomial in the lag operator L

in terms of the reduced residuals (ε_t) using equation 3 and 5. Thus, the relationship between these two residuals can be written as:

$$\mathbf{H_0 u_{t=} \varepsilon_t \leftrightarrow u_t = H_0^{-1} \varepsilon_t = B_0 \varepsilon_t} \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where H_0 is the coefficient matrix of on L^0 in H(L) which is the contemporaneous coefficient matrix of the structural form and it is also called the impact matrix.

The general form of equation (6) can be written in the following alternative way;

$$\begin{bmatrix} \varepsilon_{ygap,t} \\ \varepsilon_{dlms,t} \\ \varepsilon_{dlex,t} \\ \varepsilon_{dlcpi,t} \end{bmatrix} = H_0 \begin{bmatrix} u_{ygap,t} \\ u_{dlms,t} \\ u_{dlex,t} \\ u_{dlcpi,t} \end{bmatrix} \quad , where\ H_0 = \begin{bmatrix} 1 & \theta_1 & \theta_2 & \theta_3 \\ \alpha & 1 & \theta_4 & \theta_5 \\ \beta & \tau & 1 & \theta_6 \\ \delta & \gamma & \vartheta & 1 \end{bmatrix} \quad \ldots\ldots.(7)$$

As we have seen from equation (7), clearly, there is an identification problem. In other words, there are less estimated parameters in reduced VAR model than structural form. Because of this reason we need to impose some restriction in the system. Therefore, in order to identify the whole structural system the knowledge of H_0 matrix is required. We have four (n=4) endogenous variables that require n^2=4^2=16 independent restrictions on parameters of the structural form. To set the variance covariance matrix of the structural shocksu_t, we need to have n (n+1)/2 =10 restrictions. Additionally, n (n-1)/2 = 6 restriction is needed on matrix H_0. However, in our study analysis we only used the short run restrictions which are directly imposed on matrix H_0 that determines the contemporaneous reactions of the variables to structural innovations. To sum up, the structural shocks are covered from the VAR residuals using the most straight forward approach which is called Cholesky recursive scheme. Note that in the short run restriction, we can also impose on B_0 matrix which is inverse of H_0. In recursive identification scheme the H_0 is a lower triangle. The main reason that we gave preference for this scheme than a non recursive VAR approach is that we are more interested in the effects of shocks in the exchange rate in general rather than in the effect of strictly identified exchange rate shocks. Applying this way is not only used for the pass through issues but also it widely employs in other fields[10].

In accordance to McCarthy, 2000 and Hahn, 2003, we have chosen the following variables orders for the baseline model,

Output gap ➔ Broad Money Supply ➔ Exchange Rate ➔ Domestic Price (CPI)

[10] Cf. e.g. Kugler and Kaufmann (2005) for an application to the role of money as an indicator for future inflation

The main motivation ordering the exchange rate before consumer prices reflects the idea that prices are set along the distribution chain. In other words, it allows for exchange rate shocks to impact on prices immediately via pass-through effects. Furthermore, the output gap is ordered first, followed by money. The underlying assumption is in the spirit of Peersman and Smets (2001): Real activity reacts only with a lag to monetary innovations (i.e. innovations in money and the exchange rate), while the exchange rate, as an asset price, responds immediately to real and monetary innovations.

Therefore, our recursive cholesky decomposition model is,

$$\begin{bmatrix} \boldsymbol{\varepsilon}_{\mathbf{ygap,t}} \\ \boldsymbol{\varepsilon}_{\mathbf{dlms,t}} \\ \boldsymbol{\varepsilon}_{\mathbf{dlex,t}} \\ \boldsymbol{\varepsilon}_{\mathbf{dlcpi}} \end{bmatrix} = \begin{bmatrix} \mathbf{1} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \propto & \mathbf{1} & \mathbf{0} & \mathbf{0} \\ \boldsymbol{\beta} & \boldsymbol{\tau} & \mathbf{1} & \mathbf{0} \\ \boldsymbol{\delta} & \boldsymbol{\gamma} & \boldsymbol{\vartheta} & \mathbf{1} \end{bmatrix} \begin{bmatrix} \mathbf{u}_{\mathbf{ygap,t}} \\ \mathbf{u}_{\mathbf{dlms,t}} \\ \mathbf{u}_{\mathbf{dlex,t}} \\ \mathbf{u}_{\mathbf{dlcpi}} \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{8}$$

The equal expression of the above cholesky order decomposition is

$$\boldsymbol{\varepsilon_{ygap,t}} = \boldsymbol{u_{ygap,t}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{9})$$

$$\boldsymbol{\varepsilon_{dlms,t}} = \boldsymbol{\alpha u_{ygap,t}} + \boldsymbol{u_{dlms,t}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{10})$$

$$\boldsymbol{\varepsilon_{dlex,t}} = \boldsymbol{\beta u_{ygap,t}} + \boldsymbol{\tau u_{dlms,t}} + \boldsymbol{u_{dlex,t}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{11})$$

$$\boldsymbol{\varepsilon_{dlcpi,t}} = \boldsymbol{\delta u_{ygap,t}} + \boldsymbol{\gamma u_{dlms,t}} + \boldsymbol{\vartheta u_{dlex,t}} + \boldsymbol{u_{dlcpi,t}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{12})$$

Generally, according to the Cholesky ordering, the second equation is contemporaneously affected by some part of the first equation shocks and by its own shocks, but not the other way round. Similarly, the third equation is contemporaneously affected by some part shocks of first and second equation, in addition to its own shocks, and so on.

Finally, it is worthwhile to mentioning that while the above ordering is likely to be economically appealing for this study; different ordering can produce different results. As a result, we perform the sensitivity analysis by including the exogenous variables as endogenous variables using the order of oil price; Germany CPI, short term Germany's interest rate, output gap, money supply, exchange rate and Ethiopian CPI which also used as a second baseline model (see Appendix D).

3.3 Transformation of Variables and Diagnostics Test

The estimated VAR results are highly dependent on the specification of the underling model; as a result we examine the robustness of the estimated pass-through with modification of our baseline model. We conduct this analysis in the following two important cases. First, we test the robustness to the identification scheme which is important to check the sensitivity of recursive impulse response of VARs from its chosen ordering. Hence, the recursive identification schemes do not allow for simultaneous determinations of the variables, due to this, we test our baseline model with respect to the alternative recursive ordering and non-recursive identification scheme.

Second, we estimate our VAR model with and without taking in to account the non-stationarity condition of our time series data to examine how our result is sensitive for the choice of data transformation. As far as our baseline model, we only used the stationary endogenous and exogenous variables by successively differencing the non -stationary variables till we achieved the stationarity of the variables. This approach is standard in different pass - through literature, such as McCarthy (2000), Hahn (2003), and Choudhri, Faruqee, and Hakura (2005). However, there is a lot of disagreement in the literature whether stationarity of each variables are required or not. However, there is a common agreement on the possibility of estimating the VAR model if the overall system of the model is stationary[11].

The process of variable transformation from non stationary to stationarity condition is explained under this section. The ADF and KPSS test has been chosen to test the existence of unit root in our time series data. Table (3.1) gives the complete test statistics for the unit root tests. As we have seen from table (3.1), both the ADF and KPSS test confirms that at 5 % significance level all endogenous and exogenous variables are non stationary (except output gap and short term Germany interest rate). Hence, ADF test do not reject the null but it rejected by the KPSS test which both has the same statistical meaning and interpretation. Thus, we conclude that all variables in levels are indeed not stationary (except output gap and Germany short term interest rate which both excluded from log and first differences). Consequently, we proceed to transform the variables in to the first differences. For all first

[11] Sims (1980) , Lutkepohl (2006) are against the differencing even if there is unit root in the data. What matters for the robustness of the VAR result is the overall stationarity condition of the system.

difference endogenous and exogenous variables the ADF test and the KPSS test confirms stationary at 5 % significance level. Therefore, we estimate our VARs model using the stationary data series.

Table (3.1), Univariate Unit root test for levels and first difference of the variables

Variables	Log in use	symbole	levels		First difference		Order of integration
			ADF	KPSS	ADF	KPSS	
Real GDP	✓	dlrgdps	1.71	1.14***	-8.55***	0.52	I(1)
CPI	✓	dlcpi	1.31	1.02***	-5.18***	0.65	I(1)
Money Supply (M2)	✓	dlms	1.81	1.18***	-8.24***	0.93	I(1)
Exchange rate	✓	dlex	0.42	1.04***	-2.42***	0.28	I(1)
Output gap	×	ygap	-3.49	0.05	-	-	I(0)
Germany Interest rate	×	sr_g	-2.9	0.65**	-	-	I(0)
World Oil price	✓	dloil_p	-0.43	1.1***	-6.95***	0.089	I(1)
Germany CPI	✓	Dlcpi_g	-0.56	1.19***	-9.21***	0.091	I(1)

Note: In the ADF test, the null hypothesis is that the time series is non stationary while in the KPSS test the null is that of stationarity. The critical value in the ADF test for 1% ,5% and 10% are -3.43, -2.86 and 2.57 respectively (see Davidson, R. and MacKinnon, J. (1993). While the KPSS critical values for 1%, 5% and 10% are 0.739, 0.463 and 0.347 respectively, from Kwiatkowski et al (1992). ***, **, and * indicates significance levels at the 1%, 5% and 10% levels respectively. For ADF test AIC criteria with 5 lag length were taken, where as the Newey - West Bandwidth was used for the case of KPSS.

By and large, all the variables (except the output gap and short term interest rate) are non-stationary in levels and stationary at first differences. The output gap is stationary by construction. Thus, all variables are now stationary and our estimation of VAR model would be composed of the integrated stationary variables and levels[12]. Note that throughout this study our VAR model estimated with a constant.

Moreover, we test the optimal lag length using different lag selection criteria. This is because that the VAR estimation results can vary with different lag estimation. In other words, the estimated results are much sensitive for its number of lags. We perform the traditional lag selection criteria (AIC, SIC, HQ, LR, FPE)[13] obtained from the empirical VAR in first-

[12] Levels are the output gap and the short term Germany interest rate

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

difference. It is important to know that the three main criteria i.e. AIC, HQC and SWC have different asymptotic properties. If the model has many variables, in this case both HQC and SWC would be strongly consistent while AIC would be inconsistent due to its penalty function which does not follow the same passion when number of observations goes to infinity. In our selection process, the application of the Schawarize and Hannan Quein Criterion would result in preference of one lag order while final prediction error and Akaike information criterion has a minimum error at 5 lag order. On the other hand, the LR test statistics would require the application of 4 time lags. Taking many lags may face limitations because of short time series and which may also create additional noise in the impulse response functions that would complicate our result interpretation. To compromise the specification criteria, thus we select two lags for both full and sub sample data estimation. However, we perform the Wald test to make sure whether the lags that have significant information content are excluded or not. The result confirms that two lags are jointly significant for all equations in our VAR system. Therefore, we made our estimation based on the two lags. Further information related to lag selection criterion can be found in Appendix A (table A3 and Table A4).

In order to check the long run association among the endogenous variables of output gap, money supply, exchange rate and consumer price we run cointegration test (using Johansen cointegration test). This test is important to determine the appropriate approach in estimating our data set that may be VAR or VCEM. Therefore, we made this test and both the maximum eigenvalue and trace statistics test result confirms that there is no long run association among variables (see table (3.2)). The reason can be explained as the possible fractional cointegration, the limited sample size, or the possible non-linearity of the relationship. Thus, this absence of cointegration would suggest us to use the VAR/SVAR approach rather than VECM. It also means that there is no information about the long – run behavior among the given variables.

Table (3.2) Johnsen cointegration test with constant in the CE

No. of CE(s)	Trace (λ_{trace})			
	None*	At most 1	At most 2	At most 3
Eigenvalue	0.349	0.027	0.086	0.171
λ_{trace} Statistics	53.507	22.192	8.540	2.013
Critical Value (0.05)	47.856	29.797	15.495	3.8415
Prob.**	0.0134	0.2880	0.4096	0.1560
Trace test indicates no cointegration at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
	Maximum Eigen Value (λ_{max})			
No. of CE(s)	None	At most 1	At most 2	At most 3
Eigenvalue	0.348822	0.170562	0.085535	0.027199
λ_{max} Statistics	31.31500	13.65150	6.527364	2.013027
Critical Value (0.05)	27.584	21.132	14.265	3.8415
Prob.**	0.0158	0.3943	0.5465	0.1560
The Max - eigenvalue test indicates no cointegration at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				

Note that the null hypothesis for these two tests here is that the data generating processes under consideration are not cointegrated.

Finally, we checked the causal relationships among the specified endogenous variables using the granger causality test. Granger, (1969), defines the causality; " X granger causes Y if and only if Yt is predicted better by using the past history of X, together with the past history of Xt itself, rather than by the using just the past history of Y". The full test statistics for our variables is given in table (3.3) below.

Table (3.3) Results from the VAR Pair wise Granger Causality Tests, 1993 Q1–2011Q4

Variables	Output gap		Money SS		Ex_Rate		CPI	
Output gap			1.97	(0.37)	0.26	(0.88)	2.88	(0.24)
Money SS	4.25	(0.09)			1.21	(0.54)	5.33	**(0.07)**
Ex_Rate	0.43	(0.80)	1.36	(0.51)			0.63	(0.73)
CPI	0.12	(0.94)	7.73	**(0.02)**	4.67	**(0.09)**		
All	5.27	(0.50)	11.7	**(0.07)**	5.1	(0.50)	8.26	(0.21)

Note that, we perform this test statistics using 2 lags for the respective variables. Under this test, the null hypothesis states that "there is no granger causality". The p-values are provided in parentheses.

From the above table we can observe that, the causality test does not identify any effect of the output gap and exchange rate on the consumer prices, while the money supply has a causal effect on domestic inflation (at 10% significance level). At the same time, the null hypothesis of no granger causality test from money supply to the output gap is rejected at 10% significance level which can be interpreted as a demand side effect, hence, an increase of money supply in the economy will increase the real balances and causes demand to exceed the supply side. As dependent variables, both the money supply and exchange rate have significant causal effect from the consumer price. The reason may be sustained increase money supply may cause high inflation which in turn can lead exchange rate depreciation. On the other hand, the high inflationary economy needs high money demand for transaction and precautionary purpose, which then result depreciation of exchange rate. It is easily happen to the economy that has weak and underdeveloped financial system; hence, an increase of money supply affects other macroeconomic variables within short period of time. In short, the change in the money supply cause to change inflation that in turn causes to change in the exchange rate.

4 Estimation Results

Under this section, we first estimate our baseline VAR model for the full sample and its exchange rate transmission. After the full sample analysis, we proceed to investigate the changes of the pass-through over time, using the sub sample data covering the relatively low and high inflation period. This pass through analysis will help us to identify the link between the degree of pass through to consumer price and the inflation environment. To achieve this aim, we took the period 1993Q1 - 2002Q4 and 2003Q1 to 2011Q4, as relatively low and high inflation periods for the Ethiopian economy, respectively. In order to account the current high level inflation, we select the time period starting 2003Q1 and ending 2011Q4 as relatively high inflation period. Currently, the inflation level of Ethiopia is around 20 - 40%, which has never seen in the history of Ethiopian economy for the last three decades. The growth of broad money supply in the economy, fluctuation of foreign prices, Gas and oil subsidy removal by the government, high demand of construction materials in the economy and frequent drought in the horn of Africa's are among reasons for the recent high inflation of the economy. Due to this and other reasons, we used 2003Q1 to 2011Q4 as a relatively high inflation period. Therefore, after full sample analysis, we would assess the ERPT for the two sub sample periods. Moreover, we attempt to establish a link between the sizes of the ERPT with this sub sample groups. Furthermore, we identify the possible determinant factors of the exchange rate pass through in case of Ethiopian economy.

4.1 VAR (SVAR) Estimation Results

Before directly proceed to the ERPT, it is motivated to discuss about our baseline estimated VAR model. The model was estimated with two lags of endogenous and only with one time shocks of the exogenous variables. The unrestricted VAR results revealed that, the output gap, money supply, Germany's and world oil price flactuation has a significant effect on the domestic inflation at 5% significance level (except the oil price at 10%). However, both exchange rate and Germany's short term interest rate are statistically insignificant in affecting the Ethiopian inflation. As long as concerning to the world oil price impact to the domestic price, it has less impact for relatively low inflation period (1993Q1-2002Q4) than for high inflation period (2003Q1-2011Q4), which may be due to subsidy given by the government and low fluctuation of world oil price in the former period than in the latter. This result is almost similar with other studies IMF (2000) and Sisay menji (2008). The full statistical

result of the unrestricted VAR model is reported in appendix B, table B1 and appendix C, table C1, for full sample and sub sample estimate, respectively.

Following this, we made stability and diagnostics test with two lags for the overall system of our VAR model, and the result shows that the calculated root of the characteristics polynomial are located within the unit circle which means the overall system is stable i.e. stationary (see appendix B all stability and diagnostics analysis test).

The system of the structural shocks can be derived from the unrestricted VAR residuals using the SVAR model (i.e. through equation 9 to 12). The estimated result is given below in the table from equations 10 to 13. The value in apparentness is the p value and the coefficient of the structural shocks u_t , are their respective standard deviations.

$$\boldsymbol{\varepsilon_{ygap,t} = 0.021 * u_{ygap,t}} \quad \text{.....13}$$
$$\textbf{(0.00)}$$

$$\boldsymbol{\varepsilon_{dlms,t} = 0.123 * u_{ygap,t} + 0.028 * u_{dlms,t}} \quad \text{.....14}$$
$$\textbf{(0.43)} \qquad \textbf{(0.00)}$$

$$\boldsymbol{\varepsilon_{dlex,t} = -0.017 * u_{ygap,t} + 0.070 * u_{dlms,t} + 0.028 * u_{dlex,t}} \quad \text{.....15}$$
$$\textbf{(0.91)} \qquad \textbf{(0.54)} \qquad \textbf{(0.00)}$$

$$\boldsymbol{\varepsilon_{dlcpi,t} = -0.395 * u_{ygap,t} + 0.092 * u_{dlms,t} + 0.122 * u_{dlex,t} + 0.035 * u_{dlcpi,t}} \quad \text{.....16}$$
$$\textbf{(0.04)} \qquad \textbf{(0.52)} \qquad \textbf{(0.41)} \qquad \textbf{(0.00)}$$

From the above equation result, we can observe that all the residuals (except the output gap and its own residual shocks of CPI) are insignificant, however; their coefficients are almost correctly signed. It means that, the contemporaneous relationship among the variables in the system is captured in a proper way. As our special interest, we focused on the domestic price equation; the result revealed that the output gap has negatively significant in affecting the domestic inflation at 5 % significance level. It means that a positive output shock has an impact to lower the domestic inflation in the economy. As mentioned before, almost 50% of Ethiopian GDP is contributed by agricultural production which is largely dominated by smallholder farmers. High production and competition among those large farmers in accordance with a high share of food in the consumer price basket may result lower price. On the other hand, both the money supply and exchange rate has a positive effect on the domestic inflation even though both residuals are insignificant. According to the monetarist theory, inflation is a monetary phenomenon; hence, an increase of new money to the economy will increase the price level of the commodities. Therefore, the result shows as the theory holds true for Ethiopian economy too (keep in mind that the coefficient is insignificant even at 10 %).

Furthermore, the exchange rate has a positive impact on the domestic inflation. This means that, the depreciation / an appreciation of Ethiopian birr would result an increase / decrease

the inflation level of the country. In other words, when the exchange rate depreciates the imported price will be increase, this in turn results an increase of the consumer price index. Note that an appreciation of the domestic currency will encourage/ discourage the importers / exporters and results a decrease/ increase the price of the product in the country through imported commodities. The full impact of the fluctuation of exchange rate on domestic inflation, given by the accumulated IRFs, is discussed in the next section.

4.2 Exchange Rate Pass Through to Inflation

The main goal of our study is assessing the ERPT to the domestic inflation in case of Ethiopian economy, thus this section would provide the empirical analysis in detail. Different empirical literature estimates the pass through of exchange rate to inflation using different methodologies. Before applying the VAR model, Campa and Goldberg (2005) used the single equation model (ordinary least square (OLS)) for estimating the pass through. Following Choudhri, Faruqee, and Hakura (2005) and others, this study relies on vector autoregressive (VAR) models, which account for endogeneity of the variables. Hence, the VAR model is vital in identifying the statistical and economic significance of the individual variables using the impulse response and Variance decompositions functions. Based on the impulse response function (IRF), we can possibly determine the effect of a shock emanating from one endogenous variable to the other variables through the dynamic structure of the VAR model. Hence, IRF has a key role to quantify the degree of pass through at different time horizons.

On the other hand, the Variance decomposition functions are important to measure the percentage of the forecast variance in one variable that possibly attributed to various shocks. In our special interest it helps to assess the main external shocks in explaining the domestic inflation of Ethiopia given to the sample period.

Consequently, we used the accumulated impulse response function (IRF) to measure the effect of the exchange rate fluctuation on the domestic consumer price level. Therefore, the pass through to domestic prices over T periods can be defined as the accumulated effect of a structural one standard deviation shocks to the exchange rate in period ***t*** on domestic price in period ***T***. In order to make easy the interpretation of our result, we used the following dynamic pass through elasticity formula using exchange rate and domestic inflation ratio.

$$\text{The Exchnage Rate Pass through Elasticity at period}_{\,t} = \frac{\%\Delta\, \mathbf{CPI_t}}{\%\Delta\, \mathbf{Ex_0}} \quad \ldots \mathbf{17}$$

Where the numerator $\%\Delta\ CPI_t$, is the percentage change of consumer price level between the time periods of 0 i.e. the initial exchange rate shock hits and time t; and the denominator $\%\Delta\ Ex_0$ is the percentage fluctuation of the nominal exchange rate shock at initial period 0.

We can also use this computation for measuring other variables elasticity pass through. Thus, throughout our analysis part we used this method in explaining the pass through effect.

4.2.1 FULL SAMPLE PASS - THROUGH ANALYSIS

As mentioned above, the impulse response function helps in determining the extent to which a shock that hits the one variable affects the other variables in the VAR system. Thus, in this section we estimate the point and accumulated impulse response functions for our VAR/SVAR model using the full data sample. The point impulse and accumulated response of the consumer prices to structural one standard deviation shocks are emanates from the Cholesky ordered endogenous variables i.e output gap, money supply (M2), exchange rate and consumer price index. Note that the data are entered as first difference of logarithms (except output gap), the IRFs may be interpreted as a percentage point changes in the domestic price due to a one percent shock in nominal exchange rate like the pass through elasticites. The time period of 1, 3, 6, 9 and 12 quarters after shocks are used for our analysis. The immediate (Point) and the accumulated response of domestic price and the dynamic elasticity of the pass through results from our estimation are given in the following table.

Table (4.1) Point, accumulated impulse response of consumer price to structural one standard deviation shocks and the dynamic elasticity of the pass through for the period 1993Q1-2011Q4

Variables		Quarter after shocks					Structural SD
		1	3	6	9	12	
Real Output Gap	Point	-0.008	-0.005	-0.0003	0.0001	0.00006	0.0211
	Accu	-0.0081	-0.0237	-0.0283	-0.0283	-0.0280	
	PT	0.384	1.123	1.341	1.341	1.327	
Money Supply (M2)	Point	0.0028	0.0122	0.0015	0.0002	0.000007	0.0281
	Accu	0.0028	0.0206	0.0280	0.0294	0.0295	
	PT	0.100	0.733	0.996	1.046	1.050	
Exchange Rate	Point	0.0034	0.0033	0.0016	0.0009	0.0003	0.0276
	Accu	0.0034	0.0088	0.0155	0.0190	0.0202	
	PT	0.123	0.319	0.562	0.688	0.732	
Consumer Price Index (CPI)	Point	0.035	0.0032	0.0005	0.00001	-0.00006	0.0350
	Accu	0.0350	0.0528	0.0580	0.0583	0.0581	
	PT	1	1.509	1.657	1.666	1.660	

Note that point represents the response of the consumer price at the given period; Accu represents the accumulated (sum) responses of the domestic price and PT represents the dynamic pass through elasticity.

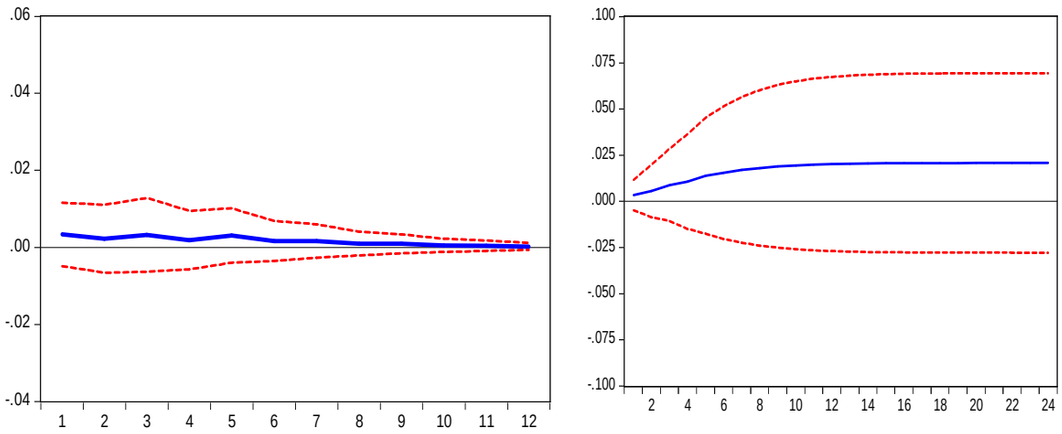
It is clear from the above table that, the immediate impact of a structural one SD shock to the nominal exchange rate, hence 0.0276 point increases or 2.76 % depreciation would result an increase in the domestic price level by 0.0034 point or 0.34%. This initial effect (i.e. first quarter) has 0.123 (12.3%) pass through elasticity. The point effect of the exchange rate shocks to the consumer prices decline and comes to nil after 12 quarter periods. The full impact of the exchange rate shock (i.e. 0.0276) are realized after 12 quarters (3 years) which increase the price level by 0.0202 point or 2.02 % and it has 0.732 dynamic elasticity pass - through. It implies that, the response of the domestic price to exchange rate shocks is slow. Therefore, based on this IRFs result, we can conclude that; although it has statistically insignificant in affecting the price level, the elasticity of pass through (the pass through magnitude) is substantially large, but incomplete. The finding is similar with other countries empirical studies. For instance, Zorzi et al (2007) found substantially large elasticity pass through for different countries such as 0.77 for China and Czech Republic, 0.91 for Hungary and 1.39 for Mexico. Moreover, McFarlane (2002) found 0.80 pass through for Jamaica, Sanusi (2010) found a pass through of 0.79 for Gahanna; Choudhri and Hakura (2001) also found a pass through of 0.54 for Ireland, 0.57 for Costa Rica, 0.62 for Uruguay and 0.68 for Ecuador after 20 quarters. On contrary to this, Choudhri and Hakura (2001) found 0.1 pass through elasticity for Ethiopian economy, the difference may come out from the data covering and the recent high inflation in the economy. The high share of the imported goods (especially, high share of consumption imported goods) in the totral consumer price index may have great contribution for this high pass through results. The bigger size of the import market compared to the agraraian export market in the economy has alos an important factor for the high pass through for Ethiopian economy. Moreover, the less competitiveness of financial market in the economy, the openness of the economy to the international market, has also a crucial role in determining the ERPT to the Ethiopian domestic inflation.

As far as concerning the other macroeconomics variables, a structural one standard deviation positive shock of the output gap (2.11%) has an initial impact of 0.8% in decreasing the price level. The point effect of this shock reaches maximum at second quarter and declining gradually and becomes positive after 6 quarter. The full positive output shocks (2.11%) have an effect to decrease the price level by 2.83% after 5 quarters period. The shock has an elasticity of the pass through between 0.38 and 1.34 for the initial period and at 6 quarters, respectively. Thus, its pass through to the price level is fast and complete. We can intereprate it as supply shocks that, as any agrarian economy with traditional and rain fed production system, the real GDP grows would have a good contribution in explaining the domestic inflation. It means, as output increase, agriculture will hold the higher share which in turn leads an increase of food item in the CPI (food account 57% of CPI, 2006 base year) which

finally result a decrease of price in the market. Moreover, the agricultural product market structure of the Ethiopian economy is more or less competitive and difficult to make coalition and/ or to control the price; hence there are many producers (large smallholder) farmer who fight for market in Ethiopia, even though less information access. Therefore, the positive output shocks have an immediate and higher pass through effect to decrease the price level for Ethiopian economy.

Similarly, a one standard deviation shock of money supply (2.8%) has a 0.28% initial and a 2.95% full effect in increasing the domestic price level. As real output the money supply shock also has a fast and complete elasticity of the pass through, which reaches 1.05% after 6 quarter. The low level of financial institutions' development, weak saving tradition of the people and other reasons made the money supply to have an immediate impact on the price level. Therefore, as monetarist theories, the more we inject new money in the economy morethan the economy needed, the higher the impact to the inflation of the economy. We thus can conclude, the Ethiopian inflation is also a monetary phenomenon. The point and accumulated impulse responses of the variables are found in Appendix B, figure B4 and B5, respectively.

Figure 4.1, the point and accumulated Impulse Response of Domestic Prices to a Structural SD Shock to Exchange Rate (With Two Standard Error Band)[14], respectively.

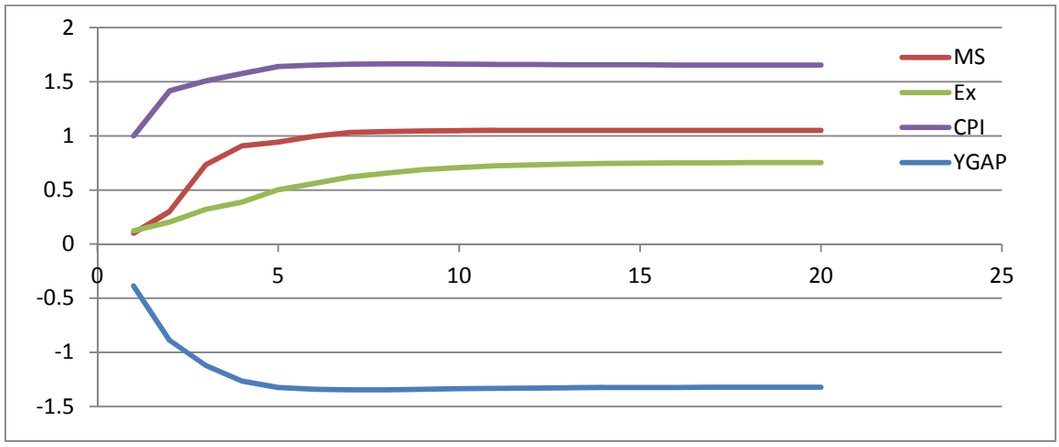


In the figure above, we can observe that although it is statistically insignificant, a positive exchange rate shocks (depreciation of Ethiopian currency) has a positive effect to the inflation. However, after maximum first effect it declines gradually and dies after 8 quarters. The narrow standard error band also suggested that in the long run the effect comes nil. On the other hand, the accumulated response of prices increases at decreasing rate up to 8 quarters and constant afterwards. As confirmed by Getachew (1997), the Ethiopian inflation

[14] Note that the dotted line reflects two standard error bands. The exchange rate shocks refer to a depreciation of in the exchange rate.

is more associated with the supply bottlenecks in the crucial sector of the economy (i.e agriculture), this may a reason for low contribution of the exchange rate shock to the price level development. The ban of the export of agricultural produce of cerals like teff, wheate, etc which has huge share in CPI (22.54% in 2006 base), and importing main consumption goods by the government like palm oil, suger, etc has helped in the stabilization of their prices which inturn results insignificant to affect the consumer price index. The cost effectiveness of the international firms that made importes cheaper has also a contribution to made exchange rate shock ineffective in explaining the price level. Due to this and other reasons, we can thus conclude that the exchange rate shock has lower impact to the price level development, which hits one of our hypotheses. We can show the exchange pass through in figure (4.2) in comparison with other variables.

Figure (4.2) accumulated dynamic Elasticity of Pass-Through for our endogenous Variables to CPI



In the above figure, one can show that, the output shock and the shock of inflation itself have a significant effect on the price development of the country. It confirmed that, the supply side effect is crucial in determining the inflation of the country. As output increases, agricultural will hold the greater share of the increase; hence, food accounting More than half of the CPI (57% in 2006 base year) which finally result lower the inflation level of the economy. On the other hand, money supply and exchange rate have a positive effect on the price level, in addition to its own shocks even though difficult to identify in statistical manner. Concerning the magnitude and speed of the pass through, it is higher both for the output gap and money supply then for the exchange rate, in addition to the shock to inflation itself has a more than proportional impact after fourth quarters, hence, the pass through is complete and fast. On the other hand, the consumer prices react slowly to the exchange rate shocks with an elasticity which amounts to 0.73 after 12 quarters. All in all, we conclude that the ERPT to the

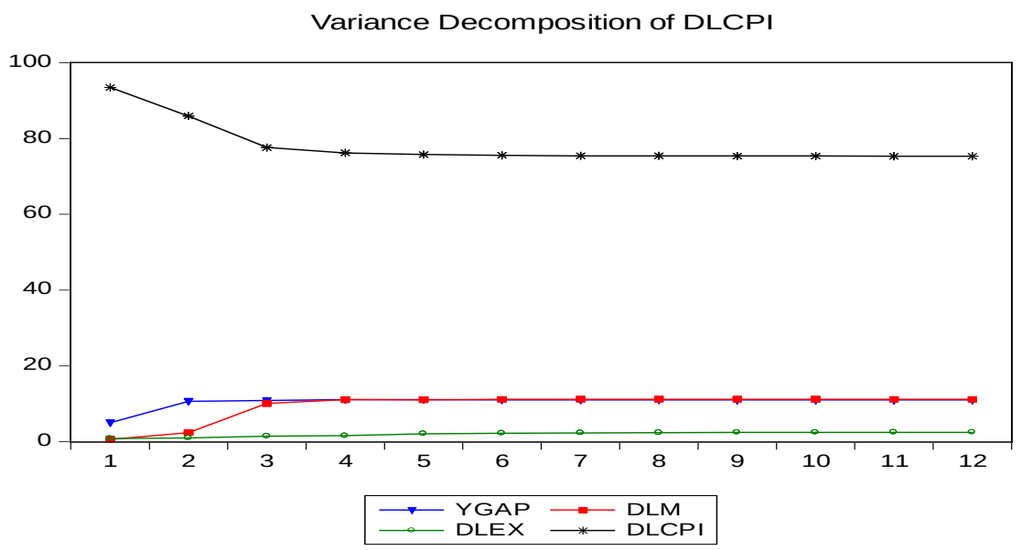
consumer price is hard to identify in a statistically significant manner, but is likely to be substantially large eventhough incomplete.

As we indicate earlier, the variance decomposition can be used to explore the relative contribution of different variables to the consumer prices. Table (4.2) and figure (4.3), thus shows attributions of each variable shocks to the price level.

Table (4.2), Variance Decomposition of DLCPI for the period 1993Q1 -2011Q4

Period	S.E.	YGAP	DLM	DLEX	DLCPI
1	0.036211	5.02	0.61	0.86	93.52
3	0.043219	10.86	10.08	1.44	77.63
6	0.043962	11.05	11.15	2.2	75.60
9	0.044025	11.02	11.17	2.43	75.39
12	0.044032	11.01	11.17	2.46	75.36

Figure (4.3) Variance decomposition of consumer price index



Both table (4.2) and figure (4.3) shows that the contribution of the output gap and the money supply to the consumer price volatility is 5% to 11% and 0.6% to 11%, respectively. The contribution of the exchange rate to the price level development is low i.e. between 0.9% to 3%. This result is consistent with our impulse response function results that we discussed before. The largest contribution to the inflation comes out of its own shocks, which is about 75%. The result suggests the presence of cost push shocks that have significant contribution to the price level developments. For instance, the world oil price and the foreign price shocks

have 11.6% to 12.48 and 13.8% to 15.3% contributions to the volatility of the price level, respectively (See Appendix D table D1). The supply shock with high demand growth mainly on food, building materials and the world oil price shocks has tended to play a significant role in explaining Ethiopian domestic inflation, particularly for the past five years.

4.2.2 Sub sample Pass – Through Analysis

Under this section our objective is to shed more light on the specific case of Ethiopian economy using the lower and more stable inflation period (i.e. 1993Q1-2002Q4) and relatively high inflation period (2003Q1-2011Q4). We thus, carry out the sub-sample analysis and test for the significance of changes in the baseline pass through elasticities before and after the change in the inflation environment.

While the extent and speed of exchange rate pass-through are important, we are also interested in the VAR/ SVAR estimation result for the two sub sample period. The result suggests that the output gap together with Germany's short term interest rate and exchange rate are a statistically significant in affecting the price level while the world oil price, foreign price and money supply are insignificant for the relatively low inflation period. On the other hand, the exogenous variables such as world oil price and foreign price with the money supply and the output gap are significant to affect the price level for relative high inflation period. The openness of the economy to the international market, high fluctuation of the world oil price (with subsidy removal by the government in Oct, 2008), the world financial crises, raise of foreign prices, high money supply growth in the economy are among factors to raise inflation for the relatively high inflation period. The unrestricted VAR results also supported by the SVAR estimation result (see Appendix C).

The impulse response function and the variance decomposition functions were also used to analyze the ERPT for both sub sample periods. As can be seen from the table (4.3) below, the magnitude of the exchange rate shock is grater for the high inflation period than for the low inflation period (which is 0.034 and 0.016, respectively). However, the elasticity pass through is relatively higher for the low inflation period than the high inflation period. In accordance to the low inflation period, structural one SD innovations of exchange rate (1.6%) have an initial impact of increasing the price level by 1.18% with an elasticity pass through of 0.74 and the full effect passes after 12 quarters that have an impact of increasing the price level by the 2.2% with an elasticity pass through of 1.4. Under this period, the first quarter is the most effective, hence; the speed of pass through is fast and its effect comes to end (nil) after 12 periods. On the other hand, the relatively high inflation period is associated with an initial effect of 0.26% and a full effect of 3.88% to increase the price level in the first and 12 quarters, respectively. The ERPT elasticity of this period is in between 0.08 and 1.15, at

initial quarter and after 12 quarters, respectively. Although the pass through is complete, it has low speed. Therefore, for both relatively low and high inflation periods, we can conclude that, the passes through elasticity are substantially large and complete in both periods even though difficult to identify in statistical significance manner. However, this result is contradicted with the finding of Calvo and Keinnart (2000) and Choudhrid Hakura (2001) that confirmed a significant positive association between ERPT and inflation. It means that, although substantially large and complete pass through for the two periods, the speed and the magnitude of the pass through is faster and higher for the relative low inflation period than the high inflation period, it may be due to, the high magnitude of exchange rate shock to the high inflation period, the competitiveness of the financial structure or the globalization effect, or the openness of the economy to the international market.

Table (4.3), the daynamic elasticity pass through of macroeconomic variables to the domestic inflation for relatively low and high inflation period[15].

Quarter after shocks	Output gap		Money supply		Ex_Rate		Consumer price	
	low	high	low	high	low	high	low	high
T=1	-0.60	0.86	0.19	0.01	0.74	0.08	1	1
T=3	-1.33	1.59	0.60	0.73	0.91	0.43	0.07	1.87
T=6	-1.79	2.70	0.55	0.87	1.18	0.90	0.22	2.16
T=9	-2.04	2.92	0.53	0.68	1.33	1.14	0.17	1.78
T=12	-2.17	2.68	0.54	0.50	1.38	1.15	0.15	1.42
Structural SD	0.0266	0.0135	0.030	0.0198	0.016	0.0338	0.0199	0.0291

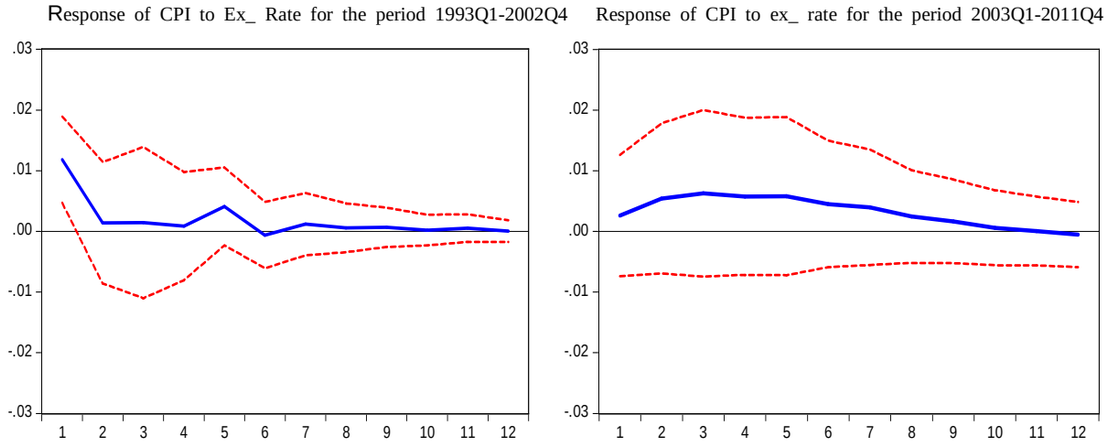
As long as the other variables' pass through is concerned, the real output gap has a negative effect on the domestic prices for the low inflation period, but has positive effect for the high inflation period. Even though both periods have a complete pass through after three quarters, the relative high inflation period has substantially higher elasticity of the pass through and faster speed than the low inflation period. For the period 1993Q1 to 2002Q4 the real output shocks has an initial and full impact of 1.6% and 5.8 % in decreasing the price level with the

[15] Low represents the period of 1993Q1 to 2002Q4 and high represents the period of 2003Q1 to 2011Q4.

time horizon of 1 and 12 quarters, respectively. On the other hand, the period 2003Q1 to 2011Q4 has 1.16% and 3.95% effect to the increase the price level at the initial and at 9 time horizon, respectively. The high magnitude effect of the 1993Q1 to 2002Q4 period is also supported by the variance decomposition that has 31% to 36.3% contribution for the variation of consumer price level. The low and rain fed traditional farming system, the agrarian export structure, the war between Ethiopian and Eritrean (1998 to 2000), frequent drought and famine in the horn of Africa are the major sources of the cause to the inflation. For the period 2003Q1 to 2011Q4, the contribution of the real output gap to the inflation level are in between the 13% to 15% and it has a positive relationship with inflation which may happen when there is high demand due to monetary expansion and/ or high investment level in the country that has inflationary pressures with high production level in the short run.

The Quantity theorists assume that inflation is always and everywhere a monetary phenomenon. Similarly, the money supply has a significant role for the period of 1993Q1 to 2002Q4 compared to the other period, but it is seems unrealistic (it is expected major source of the current inflation condition of Ethiopia. For our baseline model, during the period 1993Q1 to 2002Q4 a 3% shock to broad money supply has an immediate effect of increasing the price level by 0.5%. However, after the third quarter it increases the price level by 1.8%, which is fast but not complete. For the high inflation period, there is almost no effect in terms of of increasing the domestic inflation initially, but after 6 quarters the effect reaches 1.73%.

Figure (4.4) The Impulse Response of Domestic Prices to a Structural SD Shock to Exchange Rate (With Two Standard Error Band) for both relatively low and high inflation period.



The above two figures show that for the period 19993Q1-2002Q4, the exchange rate has higher immediate impact than in the second period. Although initially low, there is an increase impact in the period 2003Q1-2011Q4 for the consecutive four quarters, which is not

observed for the low inflation period when the effect declines immediately after the first quarter. All in all, due to the strong association of inflation and agricultural out put in the economy, restriction on main export and import of goods (that has higher share to the CPI) by the government in both periods, the cost effectiveness of the international firms that made importes cheaper with globalization effect have made insignificant of exchange rate shocks in explaining the domestic inflation of Ethiopia.

Figure (4.5) The accumulated impulse response of the domestic price to a structural one SD innovations of exchange rate (With Two Standard Error Band) for both relatively low and high inflation period.

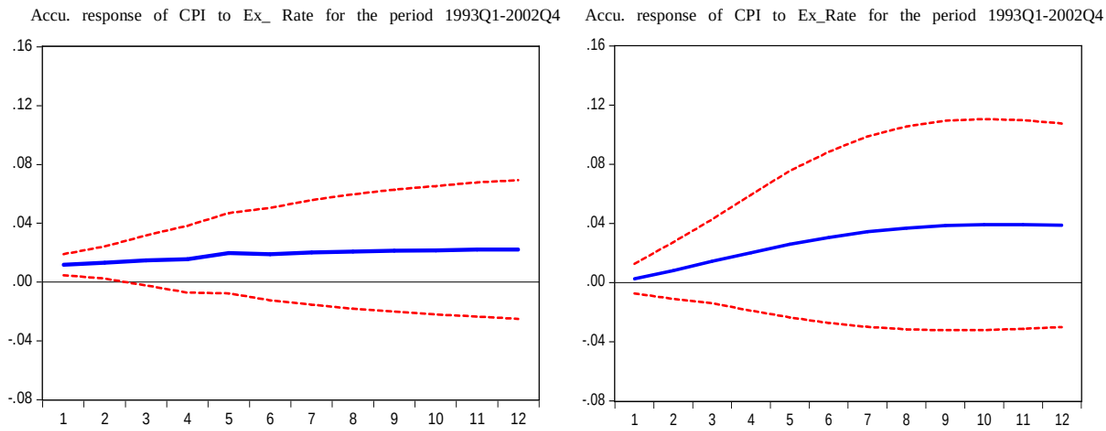


Figure (4.6) the dynamic pass through elasticity for the two high and low sub sample period

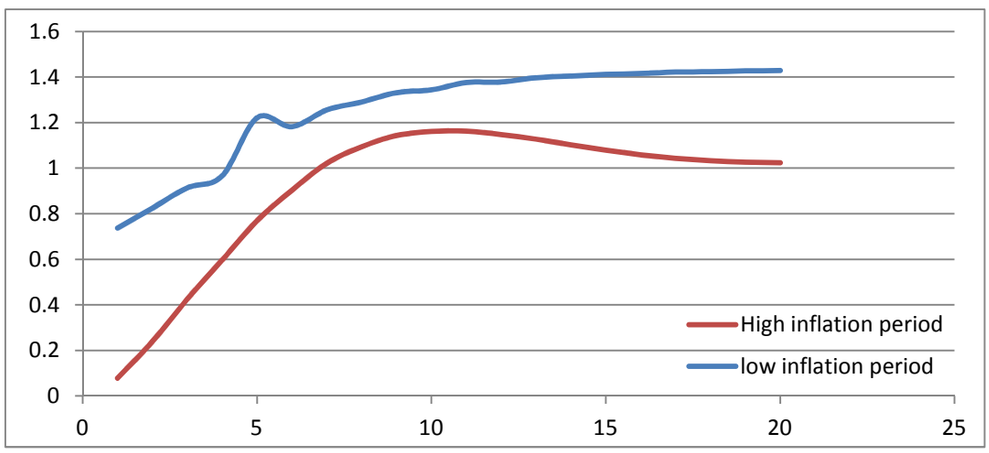


Figure (4.6) displays the ERPT elasticities to the consumer price index for the two periods. In the low inflation period the responses of consumer prices to exchange rate shocks is relatively high, amounting to 0.74 in the first quarter and reaching a maximum after 12 quarters with a 1.4 elasticity of the pass through. On the other hand, the relatively high inflation period exhibits a more gradual effect which complete after 9 quarters. In both cases, the pass through are substantially large and complete. Similar to the full sample estimate, the

openness of the economy to the intranational market, the high share of imported and exported goods in the total CPI, the financial market structure of the economy, etc, are the main causes of high pass through for both periods.

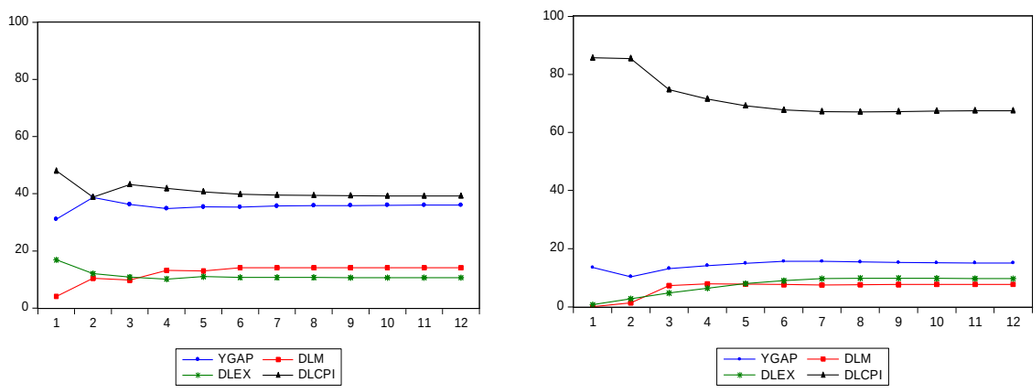
By contrast, for the low and stable inflation environment the exchange rate pass-through in many countries has decreased. Choudhri and Hakura (2001) found a low pass through for relatively stable and low inflation countries, including Ethiopia. Similarly, Gagnon and Ihrig (2004) found low exchange rate pass through for many industrialized countries which have lower and more stable inflation environment. Unlike to our haypotheses and those empirical evidences, we found higher ERPT for relativily low inflation period than for the high inflation periods. The globalization and higher competition have a key role in for the declining of the pass through since 1990s (Chen, et al (2004)). This may be one of the reasons for the lower pass through for the recent period (2003Q1-2011Q4) than the eairler period (1993Q1-2011Q4). Increasing the share of raw materials from imported goods due to for the increasing munfacturing inputs, an increase of infrastructure facilities, such as telecommunication and road network can also reasons for lower pass through for recent period than the eairler period.

According to Taylor (2000), the change of the degree of pass through has important policy implications, i.e. a change in the pass through influences the inflation forecast that is a key element in conducting the monetary policy. Moreover, the relatively low pass through is important to easily control the inflation level of the economy and provides greater freedom for pursuing an independent monetary policy, mostly in developed nations. From this, the relativie high pass through to Ethiopian economy may have some difficulties in controlling the inflation and persiuing an independently policy with greater freedom (eventhough it is statistically insignificant).

Table (4.4), the Variance decomposition of consumer price index

	Variables	Period				
		1	3	6	9	12
Relatively Low inflation Period estimation (1993Q1-2002Q4)	Inflation	47.98	43.20	39.88	39.31	39.21
	Output gap	31.12	36.27	35.34	35.89	36.04
	Money ss	4.04	9.74	14.09	14.13	14.09
	Ex_Rate	16.86	10.80	10.69	10.67	10.66
	S.E.	0.029	0.0365	0.039	0.0392	0.0392
Relatively High inflation Period estimation (2003Q1-2011Q4)	Inflation	85.73	74.76	67.78	67.23	67.53
	Output gap	13.57	13.16	15.63	15.24	15.08
	Money ss	0.0068	7.32	7.64	7.66	7.71
	Ex_Rate	0.698	4.77	8.95	9.87	9.68
	S.E.	0.0314	0.040	0.043	0.0438	0.0443

Figure (4.7) the Variance decomposition of the consumer price for the period 1993Q1 – 2002Q4 and 2003Q1 – 2011Q4, respectively.



As can we have seen from table (4.4) and figure (4.7), at the horizon of 6 quarter or longer the highest, and by far the most prominent, factor for the period 1993Q1 – 2002Q4 is the real

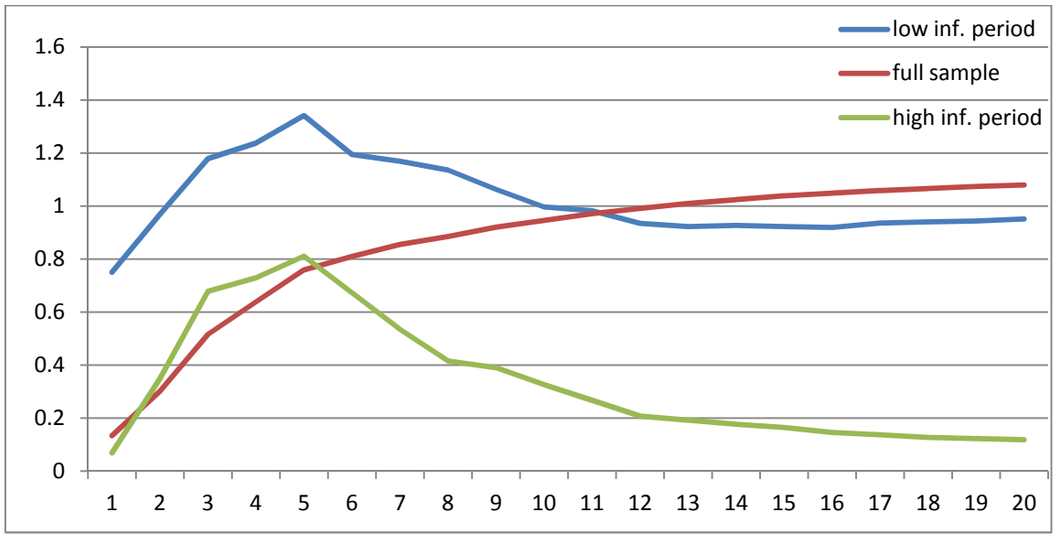
output gap, which explains a substantial portion of the variance of inflation that amounts to 30%-36.3 %. Although there is high magnitude of difference, the real output gap also significantly contributes to inflation for the period of 2003Q1 -2011Q4. The money supply and exchange rate have relatively higher contribution to the price level developments for the period 1993Q1 – 2002Q4 than 2003Q1 – 2011Q4. The exchange rate has contributions of 10%-17% and 0.6% to 10% for the period 1993Q1 – 2002Q4 and 2003Q1 – 2011Q4, respectively. This result is in line with the impulse response function results that the period 1993Q1 – 2002Q4 is associated with a higher pass through, implaying a relatively larger contribution to inflation compared to the period 2003Q1 – 2011Q4.

4.2.3 The Sensitivity Model Estimation Result

In order to make sure for our model result, we made a sensitive analysis using all variables in the Cholesky order of world oil price, foreign price, foreign short term interest rate, output gap, money supply, exchange rate and the domestic price. From the structural VAR full sample estimate, we found that, all variables (except the exchange rate and money supply) are statistically significant in affecting the domestic inflation at 5% and 10% significance level and almost all the sign of the variables are fairly captured. This result almost similar with our main baseline model, the shocks of foreign prices followed by the oil prices has a significant contribution to the domestic inflation accounting 13.8%-15.3% and 11.7%-12%, respectively. The output gap and the money supply shocks also have a contribution of .6%-6.5% and 0.1%-7.3% to the variation of domestic inflation, respectively. As the assumption of traditional Keynseian Philips curve, there is a positive relationship between the output gap and inflation. Hence, the monetary expansion can increase the employment level of the country and increase country's production for the short run. However, the new demand is much higher than the output produce, which leads excess demand to the economy that would result an increase of inflation in the economy. In short, a positive output gap implies an overheating economy and upward pressure on inflation. On the other hand, the foreign short term interest rate and exchange rate have insignificant contribution to the consumer price index of Ethiopa, that amounting 3.8% and 0.7%-3.5%, respectively. This implies that, the robustness of the result is correctly estimated by the baseline model. Concerning to the ERPT, we found a substinially large and complete pass through which is about 1.1 after 20 quarters for the full sample estimate. Moreover, we found a 1.3 ERPT with high initial effect for the low inflation period after 5^{th} quarters, while for the same time horizon; we found a 0.8 pass through elasticity for the high inflation period. Hence, the pass through for the relativily high inflation period has found to be incomplete and has low intial impact on the domestic price. Although a littile bit difference, both the baseline model and the sensitivity model

showed that, there is higher pass through for the low inflation period than for the high inflation period. Given to the statistical insignificancies, once again we can conclude that there is an inverse relationship for Ethiopian domestic inflation and the pass through for these two periods.

Figure (4.8), the daynamic of ERPT to the domestic inflation for full and sub sample period.



As long as the sub sample model concerned, the SVAR estimation result shwed that, the real output gap together with exchange rate and foreign interest rate have a significant contribution to the Ethiopian inflation for the period 1993Q1 – 2002Q4, which accounted for 23%-25%, 8%-15%, 8%-14%, respectively. In this period the impact of money supply, world oil price and foreign prices are insignificant. On the other hand, the world oil price together with money supply and foreign prices have a significant contribution to consumer prices, amounting a 22%-32%, 0.5%-22% and 7%-9% during the period of 2003Q1 – 2011Q4, respectively. The impulse response of this model also suggests that the money supply with real output gap have a positive and immediate pass through to the consumer prices for the period 2003Q1 – 2011Q4. The positive output gap for this period indicates that the economy has been operating above its current potential which results in inflationary pressures to the economy. Hence, the new injected money create high short term production through increasing the employment level which in turn leads to high demand in the economy that finally results in increase of the inflation level.

In general, the external shocks appear to account for 32 % (12.5% from the oil price, 15.2% from foreign prices and 3.4% from the foreign interest rate) of the variation in the consumer price developments at the 12 quarter time horizon for the full sample estimate. For the period 1993Q1 – 2002Q4, it accounts only for 27% (9.6% oil price fluctuation, 8.7% from the

foreign prices and 8.6% from the foreign interest rate) of inflation variation. On contrary to the earlier period, the shock to this external variable have an immediate and significant contribution to the price variations which amount to 46 % (32.5% from the world oil price at first quarter, 8.9% from the foreign prices at first quarter, and 5.7 % from the foreign interest rate at 12 quarters) for the period of 2003Q1–2011Q4. This evidence suggests that the internal factors are more important factors to explain the domestic inflation for the period of 1993A1–2002Q4 than in the period 2003Q1–2011Q4, which was confirmed both by our main model and the sensitivity model. To sum up, the result of variance decomposition and impulse response functions are similar in both our models and one can conclude it is a plausible result to explain the current and the previous period of Ethiopian economic situation (see the full result in appendix D).

4.2.4 The Determinant Factors of ERPT

Although the reasons are different across the countries the following factors are important in influencing the exchange rate pass through for Ethiopian economy.

For all period the ERPT to the consumer price has found to be substantial. This could be the result of the following factors:

- **The share of export and imported goods from the total consumer price index**: Ethiopian exports are largely lies on the agricultural products and the import is heavily lies on the final consumption and capital goods. The speed of transmission is much higher on imported consumption goods and domestic goods priced in foreign currency which directly affects the domestic price in exchange rate shocks relative to intermediate imported goods. On the other hand, depreciation of Ethiopian Birr, indirectly affects the net exports which in turn influence the domestic prices through the change in aggregate demand putting upward pressure on domestic prices. The high the share of consumption imported goods, like cereals, to the total CPI would fasten the pass through process.

- **The government subsidy removal on the oil price:** In Ethiopia, oil subsidies may have significant impact on the pass through to the consumer prices. Even though the pass through was high during the government subsidy, the high world oil price fluctuation with subsidy removal leads an increase of domestic inflation which in turn results high exchange rate pass through. According to World Bank (2011) due to the oil subsidy removal the inflation rose from 11% at the beginning of 2002 to about 44 percent at beginning of 2003. That means the oil price has an immediate and significant contribution to the variation of the Ethiopian domestic inflation.

- **Relatively high volatility of the exchange rate:** Although its impact is insignificant, Exchange rate volatility in Ethiopia, as measured by the variance of residuals from the exchange rate equation particularly in the recent periods, is high. High volatility in Ethiopia's exchange rate, with the international shocks from through it major trade partners, could also result high exchange rate pass-through. Thus, the impact of the exchange rate volatility to the inflation, with number of other factors that result high inflation including external factors, expansionary fiscal policy and monetary policy is tight enough.
- **Relatively high persistence of the exchange rate**: According to McCarthy (2000) the response of the exchange rate to its own shock at long horizons can be used as a measure of exchange rate persistence. In Ethiopia, exchange rate persistence is relatively high given that the response of the exchange rate to its own shock dies out after 8 quarter. The main reason for this high persistence is the exchange rate system is strongly managed by the government. In fact, it is also the reason that creates a parallel market in the economy. The relative high persistence thus could be a reason to have high exchange rate pass through.
- **Market structure of the economy:** the degree of competitiveness of the different factors seems to be important factors in determining the pass through to the consumer prices. In the period 1993Q1-2002Q4 has relatively less competent market structure than the period 2003Q1-2011Q4 which result relatively high pass through for the former period. If companies are controlled by few owners, the price would heavily lies on the interest of those company owners. This would result high attribution to the inflation of the economy and the pass through become strongly large. In Ethiopia, the main companies like Telecommunication, Electric power companies, are still under the government control. These and other factors lead higher elasticity pass through than the competitive market.
- **Openness of the economy:** when the economy is largely open to the international market, then the pass through of different shocks to the domestic inflation could be high.However, there is an inverse between the globalization and pass through, the high the competitiveness and making costeffective product may lead low exchange rate pass through, that we observe at the relativily high inflation period.

5 Summary and Conclusion

In this study, we assessed the exchange rate transmission to the consumer prices for Ethiopian economy using a VAR/ SVAR model by applying alternative specifications. The speed and degree of pass-through to the consumer prices are identified through impulse response and Variance decomposition functions.

Evidence from the analysis, covering the period 1993Q1-2011Q4, reveals that the speed of pass through to consumer prices is quite low (only 12.3% of the shock is transmitted in the first quarter and it is fully transmitted after 12 quarters). Althugh it is statistically insignificant, the ERPT is fairly large 0.73 but incomplete, which is usual for a small open economy. This result is broadly in line to a number of other developed, and developing countries pass throughs, particularly for sub Saharan African countries. For instance, Sanusi (2010) found a pass through of 0.79 for Ghana after 16 quarters; Zorzi et al (2007) found a pass through elasticity of 0.77 for China and Czech Republic after 20 quarters. On contrary to our result, Choudhri and Hakura (2001) found a 0.1 pass through elasticity for Ethiopian economy in 20 quarters. At the aggregate level, high share of consumption and capital imported goods in the total CPI (about 54-57% of total CPI, 2006 base year), openness of the economy to the international market, the oil subsidy removal by the government since, 2008 are among the reasons for the high pass through of the whole period. However, the evidence from the variance decomposition revealed that, due to, narrow foreign exchange rate market, the high supply side shocks in the economy, bans of the export of agricultural produce of cereals like teff, wheat (which has 22.54% in 2006 base year), and importing and distributing the main consumption goods like palm oil and suger by the government, has insignificant of the exchange rate shock contribution to the inflation variation, accounting for 3% only after 6 quarters.

The real output gap, money supply, world oil price and foreign price have relatively higher contributions to explaining the domestic inflation. Moreover, the cost effectiveness of the international firms that made importes cheaper has also a contribution to made exchange rate shock ineffective for explaining the Ethiopian inflation.

To examine the impact of the inflationary environment on the pass through process, we carried out a sub sample analysis, dividing the data in to two perods, with relatively low and high inflation period, respectively. The relative low inflation period (1993Q1-2002Q4) is

found to be associated with ERPT elasticity at 1.4, which is large and complete after 6 quarters. In this period, a structural one standard deviation shock of exchange rate (which is a 1.6% depreciation of Ethiopian currency) has an immediate impact of increasing the price level by 1.18%. The evidence from the variance decomposition revealed that the internal economic factors have a more significant contribution to the domestic inflation variation than the external shocks in the low inflation period. Although the pass through is relatively lower compared to the earlier period, the pass through for the period of 2003Q1-2011Q4 is also found substantially large and complete after 5 quarters (elasticity of about 1.13 after 10 quarters), but it has a lower initial effect. In this period, the external shocks are the prominent factors that explain the variation of the Ethiopian inflation (they explain about 43% of the variation for the first quarter horizon). The fluctuation of world oil price, the shocks of forign prices, broad money supply growth and the supply side shocks have a significant contribution to the price level development for the relativily high inflation period. During the high inflation period, there was a strict administerd price on main consumption goods, ban of main exporting items, importing main consumption goods and distributing directly to the consumers by the government through public institutions. These and other reasons may result lower pass through for high inflation period than the low inflation period. All in all, the association between the inflation and exchange rate pass through has found negative for the two periods (even though it is insignificant). This result is contradicted with many empirical studies, such as Choudhri and Hakura (2001) that confirmed low pass through for low and stable inflationary countries and high pass through for relatively inflationary countries. Oxana (2009) also finds lower pass through for a low inflation environment compare to high inflation for the Czech Republic. As far as the robustness of the base line model estimation results concerned, it is more or less similar with the sensitivity model analyses, which fairly capture the true reperesentative of the economic situation.

In general, the variance decomposition analysis for both periods indicates that real output gap shocks dominate the other internal as well as external shocks in explaining the Ethiopian inflation for the period 1993Q1-2002Q4. It implies that, the supply shocks have relevant factors for the variation of Ethiopian domestic inflation. On the other hand, broad money supply and world oil price is the main potential attributers to the domestic inflation for Ethiopian economy in the period 2003Q1-2011Q4. Moreover, in both periods the money supply shock dominates the exchange rate shocks in explaining Ethiopian inflation. This provides some support to the claim in the literature that money supply has been the major cause of inflation in Ethiopia, especially for the recent period. The attainment of inflation to its low target level requires the policy maker to aim at stable exchange rates parallel to monetary stability. In fact, it is one of the objectives of Ethiopian national Bank. The

occasional government intervention to the foreign exchange to smoothing the short term fluctuations in the exchange rate is justified and enhances the price stability. Furthermore, the large ERPT to domestic inflation implies that shocks to the nominal exchange rate have a weak effect on the real exchange rate, which is relevant for the price competitiveness. This suggests that concerned body must remain vigilant in managing debt and other private outflows because the real devaluation of Ethiopian Birr would endanger its internal balance.

Bibliography

Ayalew Yohannes (2000): “The dynamics of inflation in Ethiopia. (Unpublished Master Thesis)” Addis Ababa

Ben S. Bernanke and Mark L. Gertler,(2004): “Inside the Black Box: The Credit Channel of Monetary Policy Transmission” The journal of Economic perspectives, Vol 9. No. 4, Autumn, 1995.

Belay W. Getachew (1996): “Economic Analysis of inflation from the short run and long run, perspectives (the case of Ethiopia)”. Vienna, Austria.

Campa, José M. and Linda S. Goldberg (2005): “Exchange rate pass-through into importprices”, Review of Economics and Statistics 87(4): 679-690.

Canales-Kriljenko, J. I. (2003): “Foreign Exchange Intervention in Developing and Transition Economies Results of a Survey”, IMF Working Paper No. 95.

Chen, Natalie, Jean Imbs, and Andrew Scott (2004): “Competition, globalization and the decline of inflation”, Centre for Economic Policy Research Discussion Paper 4695.

Choudhri, E. and D. Hakura (2001): “Exchange Rate Pass–through to Domestic Prices: Does the Inflationary Environment Matter?”, IMF Working Paper No. 01/194 (Washington: International Monetary Fund).

Daniel Leigh and Marco Rossi (2002): “Exchange Rate Pass- Through in Turkey”, IMF Working paper series WP/02/204

Derrese Degefa (2001), “The Parallel Foreign Exchange Market and Macroeconomic Performance in Ethiopia”, AERC Research Paper 107 African Economic Research Consortium, Nairobi May 2001

Dordunoo, C.K. (1994): “The Foreign Exchange Market and the Dutch Auction System in Ghana”, AERC Research Paper No.24.

Eichenbaum, M., A. Burstein, and S. Rebelo,(2002): Why are Rates of Inflation So Low After Large Devaluations? Rochester Center for Economic Research Working Paper No. 486 (January), (New York: University of Rochester).

Enders, Walter. (2004): “Applied econometric time series”, Second edition, New York: John Wiley & Sons.

Fabrizio Coricelli, Balázs Égert and Ronald MacDonald (2006): “Monetary Transmission Mechanism in Central &Eastern Europe: Gliding on a Wind of Change” William Davidson Institute Working Paper Number 850.

Gagnon, Joseph E. and Jane Ihrig (2004): “Monetary policy and exchange rate passthrough”, Board of Governors of the Federal Reserve System International Finance Discussion Papers 704 (revised version).

Goldberg, Pinelopi K. and Michael M. Knetter, (1997): “Goods prices and exchange rates: what have we learned?”, Journal of Economic Literature 35(3): 1243-1272.

Granger, C.W.J. (1969): “Investigating Causal Relations by Econometric Models and Cross Spectral Methods,” Econometrica, Vol. 37, pp. 428-38.

Hahn, Elke (2003): “Pass-through of external shocks to Euro area inflation”, European Central Bank Working Paper 243.

Haile Kibret (1994): “Is the Ethiopian Birr Overvalued?”, A Preliminary Assesment and Policy Implication in the Ethiopian Economy

IMF Survey (1993): “Parallel Currency Market in Developing Countries” Analyzed by IMF Economist, March 8, 1993, pp.66-68

Jonas Stulz (2007): “Exchange rate pass-through in Switzerland Evidence from vector autoregressions” Swiss National Bank Economic Studies, No. 4, 2007

Krugman, P. (1986): “Pricing to Market When the Exchange Rate Changes, “NBER Working paper No. 1926 (Cambridge, Massachusettes: National Bureau of Economic Research).

Laflèche, T., (1997): “The Impact of Exchange Rate Movements on Consumer Prices,” Bank of Canada Review, Winter 1996-97, pp. 20-32.

Lavern McFarlane (2002): “Consumer Price inflation and Exchange rate Pass-through in Ghana” Research Services Department, Bank of Jamaica.

Mahamadu Bawumia and Philip Abradu-Otoo (2003): “Monetary Growth, Exchange Rates and Inflation in Ghana: An Error Correction Analysis” working paper series.

McCarthy, J. (1999): "Pass-through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialised Economies" BIS Working Paper no. 79.

McCarthy, Jonathan (2000): “Pass-through of exchange rates and import prices to domestic inflation in some industrialized economies”, Federal Reserve Bank of New York Staff Reports 111.

Michele Ca’ Zorzi, Elke Hahi and Marcelo Sánchez (2007): “Exchange rate pass through in emerging market”, ECB Working Paper Series No 739 / March 2007.

Mike I. Obadan (2009): “Exchange Rate Regimes For Developing And Emerging Markets”, University of Benin.

National Bank of Ethiopia (2009) “Monetary Policy Framework of National Bank of Ethiopia” February 2009.

Naude, W.and Abu Girma (1994): “Exchange Rate Policy in the Transformation from Socialism to Free Markets: The Case of Ethiopia’s Foreign Exchange Auction”, Mimeo, Addis Ababa University.

Nkunde Mwase (2006): “An Empirical Investigation of the Exchange Rate Pass-Through to Inflation in Tanzania”, IMF Working Paper WP/06/150

Nombulelo Duma (2008) “Pass-Through of External Shocks to Inflation in Sri Lanka”,IMF Working paper WP/08/78

Oxana Babecka-Kucharcukova (2009): “Transmission of Exchange Rate Shocks into Domestic Inflation: The Case of the Czech Republic”, Czech National Bank Working Paper Series 12

Peersman, Gert and Frank Smets (2001): “The monetary transmission mechanism in the Euro area: more evidence from VAR analysis” European Central Bank Working Paper 91, 2001.

Sahminan (2002): “Exchange Rate Pass-Through into Import Prices: Empirical Evidences from Some Southeast Asian Countries” .The University of North Carolina at Chapel Hill Department of Economics

Siaw Frimpong and Anokye M. Adam (2010): “Exchange Rate Pass-Through in Ghana”, School of Business, University of Cape Coast, Cape Coast, Ghana

Sisay Menji (2008): “Determinants of recent inflation of Ethiopia”, Addis Ababa.

Stefan Dercon and Lulseged Ayalew (1994): “Coffee Prices and Smuggling in Ethiopia”, Ethiopian Journal of Economics, Vol.3, No.2

Sanusi, Aliyu Rafindadi (2010): “Exchange rate pass-through to consumer prices in Ghana: Evidence from structural vector auto-regression”, Department of Economics, Ahmadu Bello University, Zaria, Nigeria

Taylor, J. B. (2000): "Low Inflation, Pass-through, and the Pricing Power of Firms ", European Economic Review 44(7): 1389-1408.

Tomas Holub (2004): “Foreign Exchange Interventions under Inflation Targeting: The Czech Experience”, Czech National Bank Internal Research and Policy Note No. 1.

Wojciech Maliszewski (2003: “.Modeling Inflation in Georgia” IMFWP/03/212

World Bank (2011): http://www.worldbank.org/en/country/ethiopia

Appendix A: Descriptive test statistics of the Data and Lag selction process

Table A1, General test statistic of our endogenous and exogenous variables in log levels

	LCPI	LEX	LM	LRGDP	LOIL_P	SR_G	LCPI_G
Mean	4.61	2.13	10.39	9.94	3.51	3.39	4.57
Median	4.40	2.15	10.25	9.83	3.30	3.36	4.56
Maximum	5.85	2.85	12.03	10.71	4.81	8.32	4.71
Minimum	4.10	1.61	9.21	9.39	2.41	0.66	4.41
Std. Dev.	0.47	0.30	0.79	0.38	0.68	1.58	0.08
Skewness	1.10	0.68	0.40	0.51	0.32	0.56	0.07
Kurtosis	2.92	3.47	2.06	2.01	1.79	3.60	1.89
Jarque-Bera	15.39	6.49	4.81	6.42	5.91	5.10	3.97
Probability	0.00	0.04	0.09	0.04	0.052	0.08	0.14
Sum	350.20	162.05	789.86	755.72	266.46	257.38	345.00
Sum Sq. Dev.	16.45	6.57	46.50	11.11	35.10	186.80	0.52
Observations	76	76	76	76	76	76	76

Figure (A1) the plots of our main endogenous Variables in log levels (i.e. seasonally unadjusted log Real GDP), log Money supply (LMS), log Exchange Rate (LEX) and Consumer price Index (LCPI), respectively).

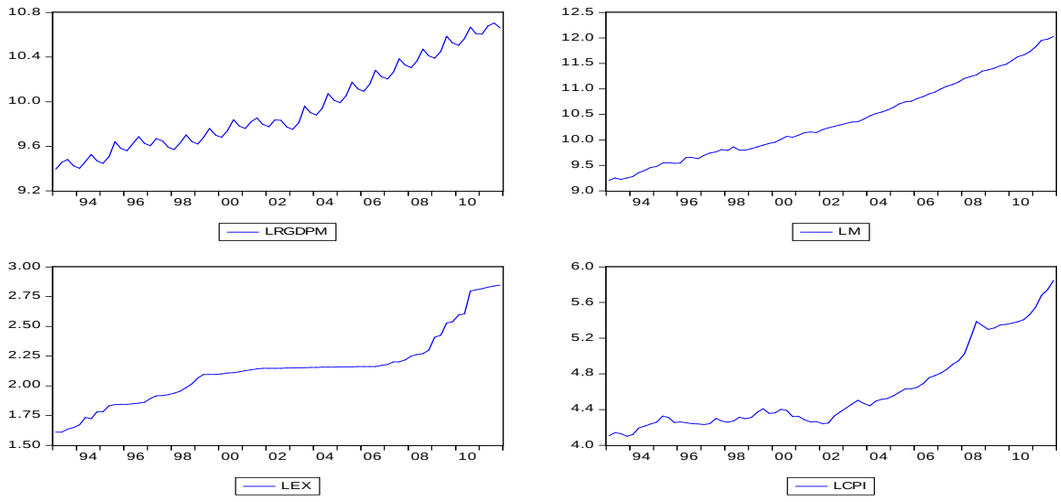


Figure (A2) plots of the three exogenous variables in log levels (log world oil price, log of Germany's consumer price index and Germany's short term interest rate, respectivly.)

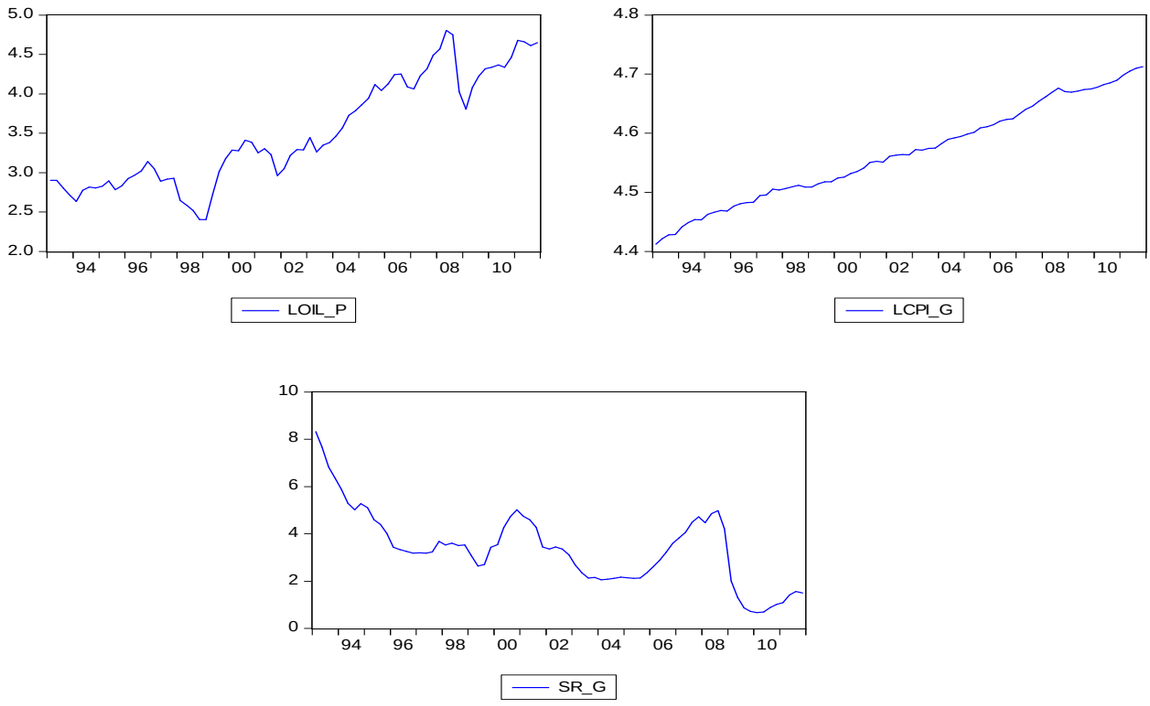


Figure (A3) Generating real output gap from the seasonal adjusted real GDP using Hodrick – Presccot filtering method.

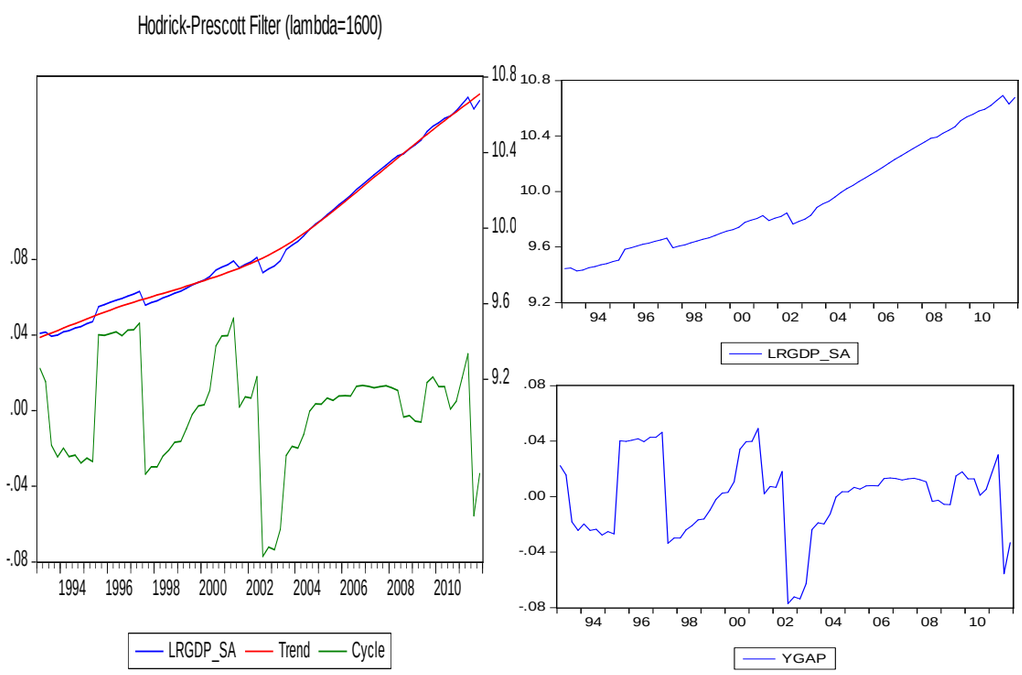


Table A2. Lag Order Selection

VAR Lag Order Selection Criteria Endogenous variables: YGAPM DLM DLEX DLCPI Exogenous variables: C DLCPI_G SR_G DLOIL_P Sample: 1993Q1 2011Q4 Included observations: 69	* indicates lag order selected by the criterion LR: sequential modified LR test statistic (each test at 5% level) FPE: Final prediction error AIC: Akaike information criterion SC: Schwarz information criterion HQ: Hannan-Quinn information criterion

Lag	LogL	LR	FPE	AIC	SC	HQ	
0	569.3459	NA	1.27e-12	-16.03901	-15.52096	-15.83348	
1	608.8808	69.90236	6.46e-13	-16.72118	-15.68508*	-16.31012*	
2	624.6811	26.10486	6.56e-13	-16.71539	-15.16123	-16.09881	
3	636.3497	17.92563	7.59e-13	-16.58985	-14.51763	-15.76773	
4	659.0898	32.29749*	6.46e-13	-16.78521	-14.19494	-15.75756	
5	678.9669	25.92669	6.08e-13*	-16.89759*	-13.78927	-15.66442	
6	693.6403	17.43794	6.83e-13	-16.85914	-13.23276	-15.42043	

Table A3. VAR Lag Exclusion Wald Tests

Sample: 1993Q1 2011Q4 Included observations: 72 Chi-squared test statistics for lag exclusion: Numbers in [ ] are p-values					
	YGAP	DLM	DLEX	DLCPI	Joint
Lag 1	38.95538	10.17898	3.040138	28.27036	77.39298
	[7.12e-08]	[0.037518]	[0.551131]	[1.10e-05]	**[4.89e-10]**
Lag 2	2.910444	4.549188	15.88557	6.506075	28.10542
	[0.572923]	[0.336755]	[0.003177]	[0.164408]	**[0.030715]**
Lag 3	9.873923	6.178476	0.693240	5.966038	21.51399
	[0.042606]	[0.186210]	[0.952160]	[0.201699]	[0.159589]
df	4	4	4	4	16

This lag exclusion Wald test tells us two lags are enough two have significant information for the overall our VAR system.

Appendix B: VAR Estimation Result and Residual Analysis

Table B1. **Full Sample Estimate of the Unrestricted VAR**

Vector Autoregression Estimates Sample (adjusted): 1993Q4 2011Q4 Included observations: 73 after adjustments				
	YGAP	DLM	DLEX	DLCPI
YGAP (-1)	**0.730117**	-0.020944	-0.075337	***-0.362377***
YGAP (-2)	0.021408	0.196680	0.020266	0.172906
DLM(-1)	-0.088336	-0.172560	0.131785	0.156402
DLM(-2)	-0.175640	-0.141314	0.010470	**0.342848**
DLEX(-1)	0.055171	-0.025877	0.027490	0.030422
DLEX(-2)	0.014641	0.132805	**0.466276**	0.117327
DLCPI(-1)	0.014264	**0.224631**	**-0.183853**	**0.417145**
DLCPI(-2)	0.014659	0.045579	0.065545	-0.106514
C	0.009124	**0.049750**	0.012821	-0.021615
DLOIL_P	0.012827	0.007112	***-0.049842***	*0.048992*
DLCPI_G	-0.261997	**2.770899**	-0.369191	**4.774825**
SR_G	-0.000178	**-0.005727**	-0.001400	-0.000920
R-squared	0.548561	0.264142	0.287663	0.487969
Adj. R-squared	0.467154	0.131446	0.159208	0.395635
Sum sq. resids	0.027100	0.048570	0.046635	0.079985
S.E. equation	0.021077	0.028217	0.027650	0.036211
F-statistic	6.738491	1.990581	2.239417	5.284850
Log likelihood	184.7199	163.4228	164.9066	145.2153
Akaike AIC	-4.732053	-4.148570	-4.189221	-3.649734
Schwarz SC	-4.355539	-3.772056	-3.812707	-3.273220
Mean dependent	-0.000269	0.038456	0.016581	0.023528
S.D. dependent	0.028875	0.030277	0.030154	0.046579
Determinant resid covariance (dof adj.)			3.27E-13	
Determinant resid covariance			1.60E-13	
Log likelihood			661.2047	
Akaike information criterion			-16.80013	
Schwarz criterion			-15.29407	

Note: Significant coefficients at 5% are **bold**, at 10%, ***in italics***

Figure (B1), Residuals for all variables [16]

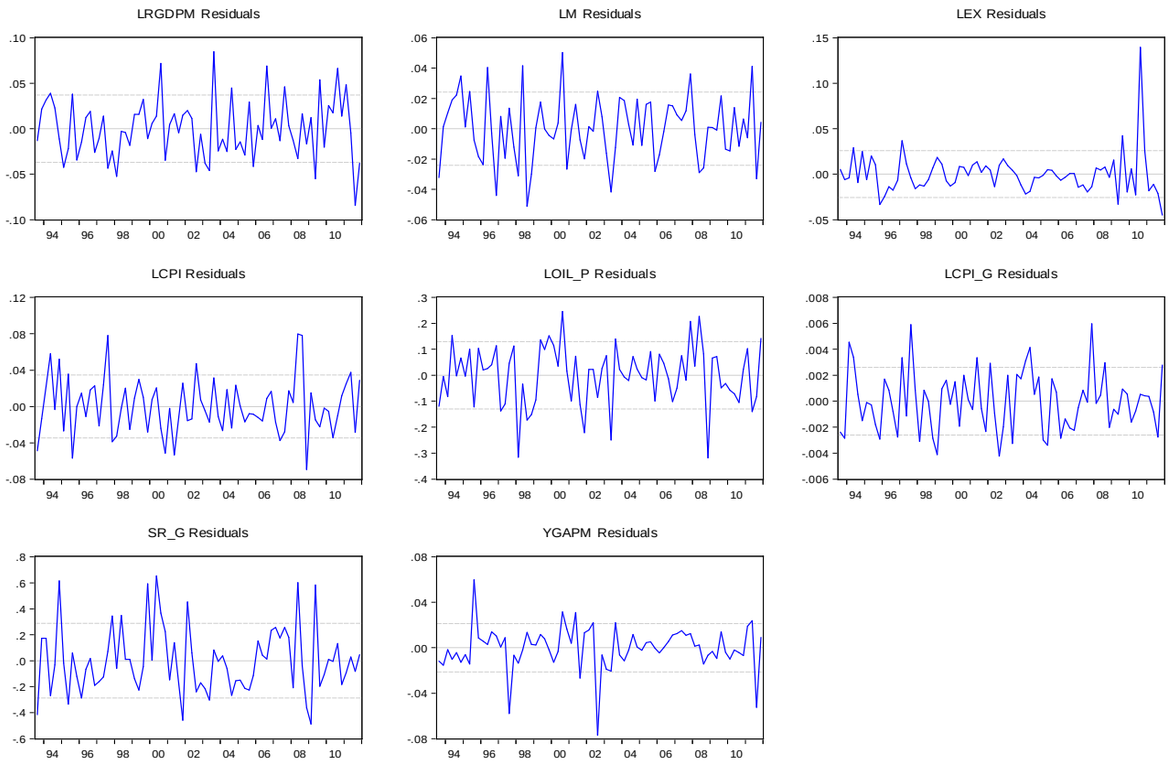
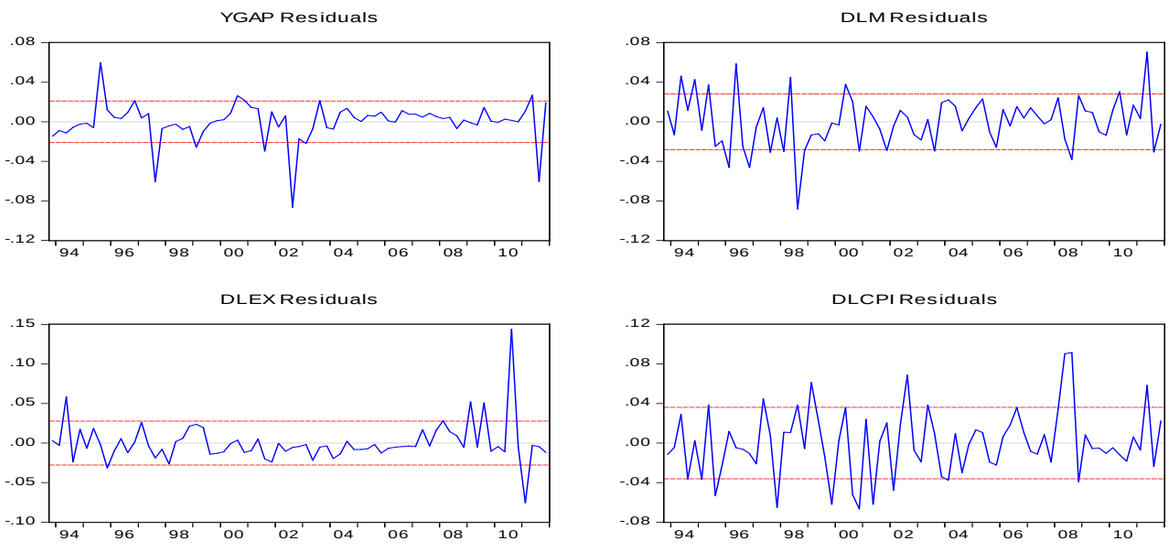


Figure (B2), Residual Analysis for our four endogenous variables.



[16] The variable names in the charts from here onwards, "d" refers to the first difference operator, and the first "l" refers to the log. Thus, dlms is the first difference of the log of money supply (broad money), ygap is the real output gap, dlex is the first difference of the log of the exchange rate and dlcpi is the first difference of the log of consumer price index of Ethiopia.

Table (B2), Residuals correlation matrix for the main endogenous variables for the period 1993Q1-2011Q4.

	YGAP	DLM	DLEX	DLCPI
YGAP	1.000000	0.091744	-0.006486	-0.223965
DLM	0.091744	1.000000	0.070135	0.057033
DLEX	-0.006486	0.070135	1.000000	0.099335
DLCPI	-0.223965	0.057033	0.099335	1.000000

Table (B3), Residuals covariance matrix for the full sample data

	YGAP	DLM	DLEX	DLCPI
YGAP	0.000444	5.46E-05	-3.78E-06	-0.000171
DLM	5.46E-05	0.000796	5.47E-05	5.83E-05
DLEX	-3.78E-06	5.47E-05	0.000765	9.95E-05
DLCPI	-0.000171	5.83E-05	9.95E-05	0.001311

Table (B4), Test of Stability for our VAR models.

Roots of Characteristic Polynomial
Endogenous variables: YGAPM DLM DLEX DLCPI
Exogenous variables: C DLOIL_P DLCPI_G SR_G

Lag specification: 1 2

Root	Modulus
0.694191	0.694191
-0.673858	0.673858
0.629269 - 0.063487i	0.632464
0.629269 + 0.063487i	0.632464
-0.157941 - 0.470873i	0.496655
-0.157941 + 0.470873i	0.496655
0.019601 - 0.190354i	0.191360
0.019601 + 0.190354i	0.191360

No root lies outside the unit circle.

VAR satisfies the stability condition.

Figure (B3), Inverse roots of AR Characterstics polynomial for our baseline model

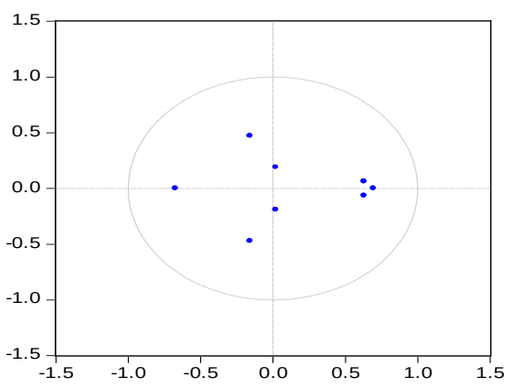


Figure (B4), Impulse Response of variables to Cholesky one S.D. Innovations ±2 S.E.

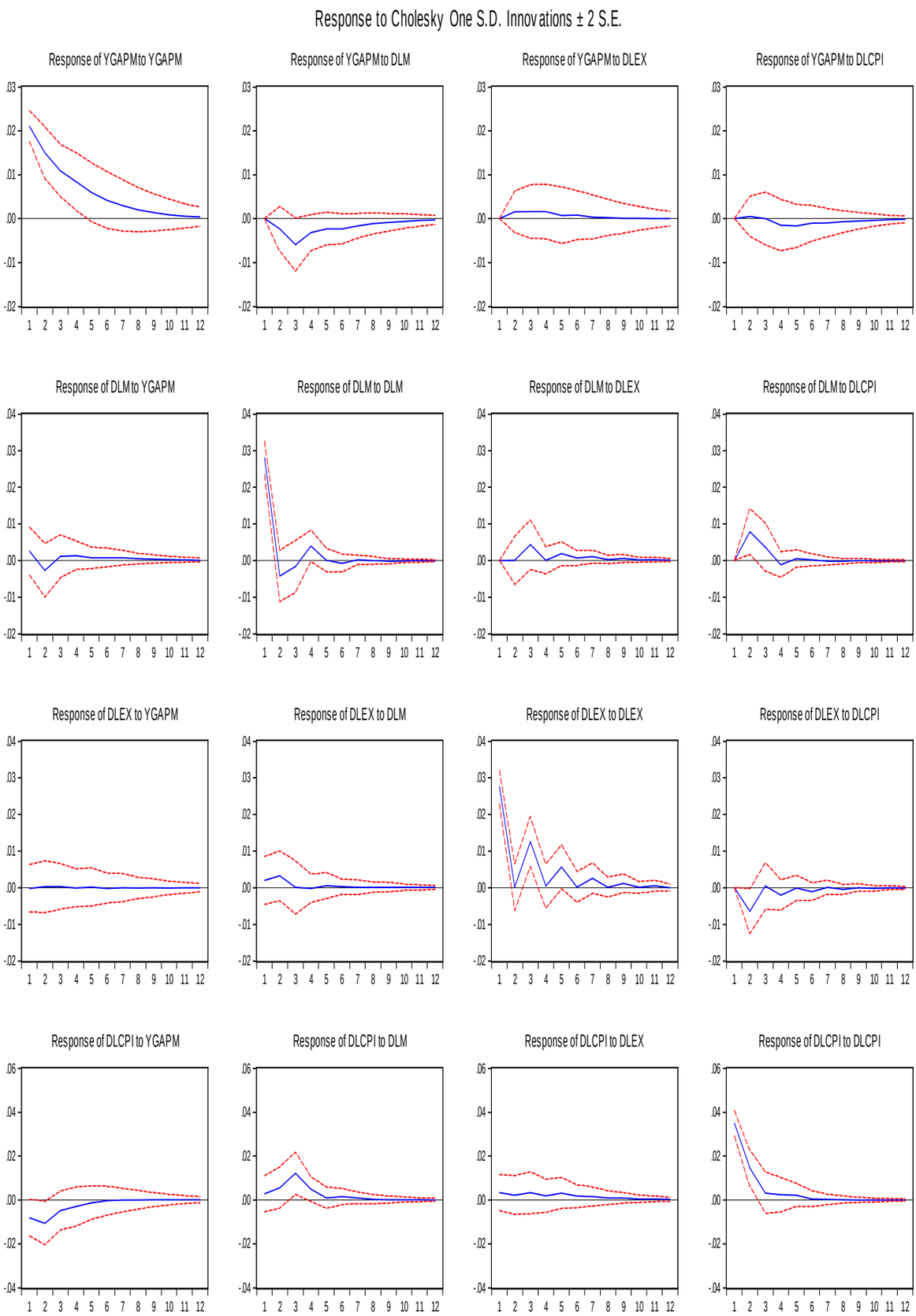
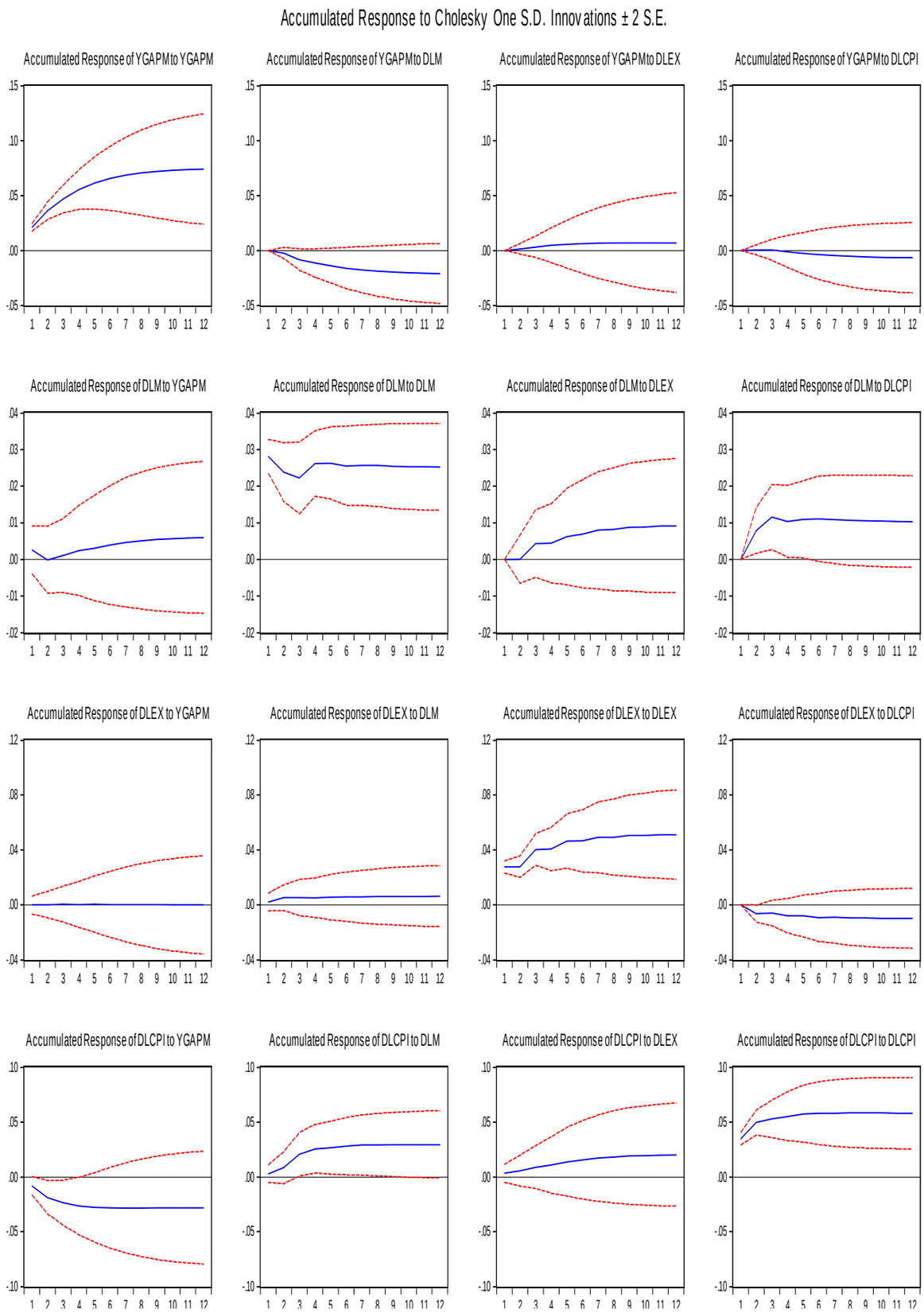


Figure (B5), Response of domestic price to Cholesky one S.D. Innovations ±2 S.E.



Appendix C: Sub Sample VAR/SVAR Estimation Result

Table C1: the unrestricted VAR estimation for the period 1993Q1-2002Q4 and 2003Q1 – 2011Q4, respectively

	Unrestricted VAR estimation for relatively low inflation period (1993Q1-2004Q4)				**Unrestricted VAR estimation for relatively high inflation period (2005Q1-2011Q4)**			
	YGAP	DLMS	DLEX	DLCPI	YGAP	DLMS	DLEX	DLCPI
YGAP(-1)	**0.972563**	0.045885	-0.054703	**-0.726815**	0.297622	-0.036709	0.158190	-0.577288
YGAP(-2)	-0.111682	0.094946	-0.131792	-0.074018	0.264280	0.432804	-0.191232	0.472181
DLMS(-1)	-0.127210	***-0.291518***	-0.077602	0.357159	-0.201705	-0.293818	0.546392	0.260426
DLMS(-2)	***-0.271148***	-0.245205	-0.148781	***0.331084***	**-0.280558**	**-0.440580**	0.511093	**0.322738**
DLEX(-1)	0.003229	-0.420133	-0.071526	0.370242	0.032490	0.023299	-0.024389	0.117353
DLEX(-2)	-0.317884	0.244441	**0.505332**	**0.812926**	0.045618	0.005703	**0.608491**	0.111708
DLCPI(-1)	0.179656	0.358465	-0.058221	***-0.383846***	-0.014778	0.137232	**-0.508322**	**0.567156**
DLCPI(-2)	0.100665	-0.219400	-0.079472	**-0.670215**	-0.072693	0.034791	-0.029389	-0.001759
C	-0.003488	-0.004337	0.003085	0.014196	*0.023110*	**0.084273**	-0.023303	***-0.056003***
DLCPI_G	0.004584	0.055445	-0.024621	0.023563	-0.006438	-0.065140	-0.091119	**0.129107**
SR_G	-0.744828	1.374336	-0.578080	1.447753	0.473979	**5.917447**	-3.814731	***5.019733***
DLOIL_P	0.004962	***0.010922***	0.003689	-0.010769	0.000843	***-0.011683***	0.008606	**0.006507**
R-squared	0.571550	0.423002	0.432985	0.555788	0.564790	0.462907	0.482019	0.753621
Adj. R-squared	0.383032	0.169123	0.183499	0.360335	0.347184	0.194360	0.223028	0.630431
Sum sq. resids	0.017665	0.022638	0.006602	0.020704	0.004023	0.010223	0.027238	0.021680
S.E. equation	0.026582	0.030092	0.016251	0.028778	0.013522	0.021557	0.035187	0.031392
F-statistic	3.031808	1.666156	1.735506	2.843587	2.595478	1.723747	1.861144	6.117566
Log likelihood	88.97080	84.38191	107.1778	86.03401	105.4727	89.61700	72.95739	76.83758
Akaike AIC	-4.160584	-3.912536	-5.144747	-4.001839	-5.498395	-4.565706	-3.585729	-3.813975
Schwarz SC	-3.638124	-3.390076	-4.622287	-3.479379	-4.959679	-4.026990	-3.047013	-3.275260
Mean dependent	0.001167	0.028895	0.013901	0.006566	0.002161	0.049452	0.020404	0.040763
S.D. dependent	0.033842	0.033012	0.017984	0.035981	0.016736	0.024016	0.039919	0.051638
Determinant resid covariance (dof adj.)			6.52E-14			6.93E-14		
Determinant resid covariance			1.36E-14			1.21E-14		
Log likelihood			380.6910			351.7302		
Akaike information criterion			-17.98330			-17.86648		
Schwarz criterion			-15.89346			-15.71162		

Equation C1. SVAR estimation for the period 1993Q1 to 2002Q4

ε_ ygap,t = 0.027*u_ygap,t ……..(18)

(0.00)

ε_dlms,t = -0.07*u_ygap,t + 0.03*u_dlms,t ……..(19)

(0.70) (0.00)

ε_dlex,t = -0.0164*u_ygap,t + 0.083*u_dlms,t + 0.016*u_dlex,t ……..…(20)

(0.86) (0.34) (0.00)

ε_dlcpi,t = -0.578*u_ygap,t + 0.131*u_dlms,t + 0.736*u_dlex,t + 0.02*u_dlcpi,t ….(21)

(0.00) (0.23) (0.00) (0.00)

Equation C2. SVAR estimation for the period 2005Q1-2011Q4

ε_ ygap,t = 0.0135*u_ygap,t ……..…..(22)

(0.00)

ε_dlms,t = 0.626*u_ygap,t + 0.02*u_dlms,t ….……..……..(23)

(0.01) (0.00)

ε_dlex,t = 0.529*u_ygap,t - 0.47*u_dlms,t + 0.034*u_dlex,t …… (24)

(0.25) (0.10) (0.00)

ε_(dlcpi,t)= 0.80*u_ygap,t + 0.05*u_dlms,t + 0.078*u_dlex,t + 0.029*u_dlcpi,t ….. (25)

(0.04) (0.84) (0.59) (0.00)

Appendix D: Second baseline model (Sensitivity Analysis)

The Sensitivity analysis (second baseline model) was undertaken in the Cholesky order of world oil price, Germany consumer price index, short term Germany interest rate, real output gap, money supply, exchange rate and consumer price index. We only analyzed for the consumer price index of Ethiopia.

$$\begin{bmatrix} \varepsilon_{oil,t} \\ \varepsilon_{cpi_g,t} \\ \varepsilon_{sr_g,t} \\ \varepsilon_{ygap,t} \\ \varepsilon_{ms,t} \\ \varepsilon_{ex,t} \\ \varepsilon_{cpi,t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \theta_1 & 1 & 0 & 0 & 0 & 0 & 0 \\ \theta_2 & \theta_3 & 1 & 0 & 0 & 0 & 0 \\ \theta_4 & \theta_5 & \theta_6 & 1 & 0 & 0 & 0 \\ \theta_7 & \theta_8 & \theta_9 & \theta_{10} & 1 & 0 & 0 \\ \theta_{11} & \theta_{12} & \theta_{13} & \theta_{14} & \theta_{15} & 1 & 0 \\ \theta_{16} & \theta_{17} & \theta_{18} & \theta_{19} & \theta_{20} & \theta_{21} & 1 \end{bmatrix} \begin{bmatrix} u_{oil,t} \\ u_{cpi_g,t} \\ u_{sr\_G,t} \\ u_{ygap,t} \\ u_{ms,t} \\ u_{ex,t} \\ u_{cpi,t} \end{bmatrix} \text{ … … … ….(26)}$$

D1. SVAR full sample estimation result

$$\varepsilon_{dlcpi,t} = 0.076*u_{oil,t} + 4.75*u_{cpi_G,t} - 0.026*u_{sr_G,t} - 0.385*u_{ygap,t} + 0.053*u_{ms,t} + 0.134u_{ex,t} + 0.034*u_{cpi,t} \quad \text{.(27)}$$

(0.03) (0.00) (0.09) (0.04) (0.75) (0.37) (0.00)

D2. SVAR estimation results for the period of 1993Q1-2002Q4

$$\varepsilon_{cpi} = 0.035*u_{oil,p} + 1.18*u_{cpi_G,t} - 0.028*u_{sr_G,t} - 0.558*u_{ygap,t} + 0.123*u_{ms,t} + 0.75*u_{ex,t} + 0.019*u_{cpi} \quad \text{… (28)}$$

(0.24) (0.30) (0.02) (0.00) (0.40) (0.00) (0.00)

D3. SVAR estimations results for the period of 2003Q1-2011Q4

$$\varepsilon_{cpi} = 0.122*u_{oil,t} + 4.82*u_{cpi_G,t} + 0.014*u_{sr_G,t} + 0.717*u_{ygap,t} + 0.204*u_{ms,t} + 0.068*u_{ex,t} + 0.029*u_{cpi,t} \quad \text{… (29)}$$

(0.06) (0.17) (0.51) (0.08) (0.46) (0.68) (0.00)

Figure D1; pass through comparison for the second model for the period of 1993Q1 – 2011Q4.

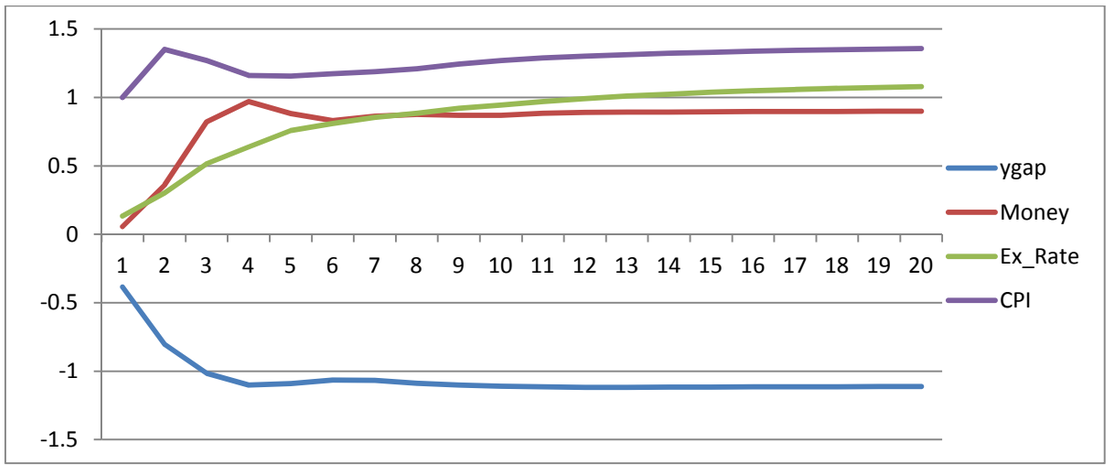


Figure D2; pass through comparison for the second model for the period of 1993Q1 – 2002Q4.

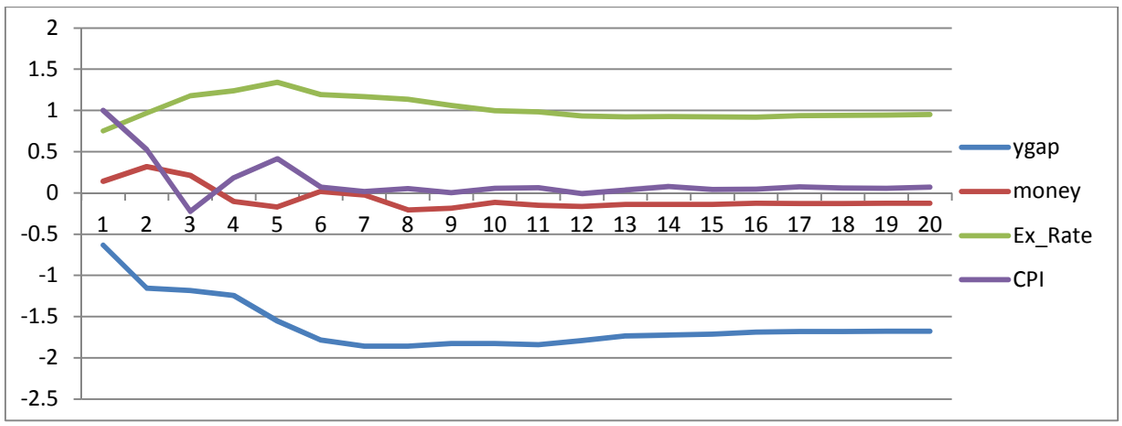


Figure D3; pass through comparison for the second model for the period of 2003Q1 – 2011Q4.

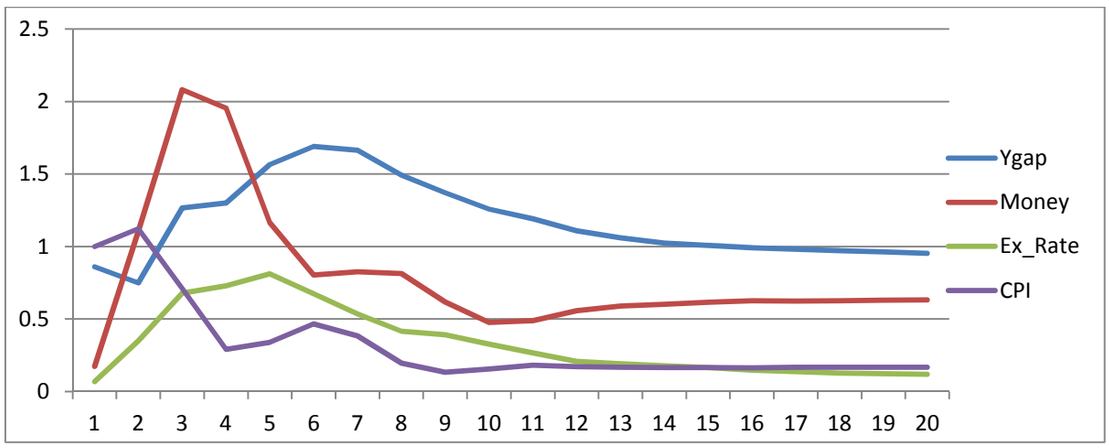


Table (D1), Variance decomposition of Consumer price with the Cholesky order of OIL_P, CPI_G, SR_G, YGAP, MS, EX_R and CPI

	Variables	Period				
Variance decomposition of consumer price index for the period 1993Q1-2011Q4		1	3	6	9	12
	CPI	66.31	53.53	51.92	51.60	51.53
	World Oil price	11.65	11.99	12.40	**12.48**	12.47
	Output gap	3.63	**6.47**	6.34	6.31	6.29
	Money supply	0.10	6.89	**7.29**	7.26	7.25
	Exchange rate	0.73	2.67	3.45	3.54	**3.58**
	Germany CPI	13.80	**15.33**	15.31	15.22	15.21
	SR_G	**3.77**	3.11	3.27	3.598	3.68
	S.E.	0.042	0.05	0.05	0.05	0.05
Variance decomposition of consumer price index for the period 1993Q1-2002Q4	CPI	37.42	39.4	36.91	36.02	35.90
	Oil_p	4.99	8.8	9.25	9.54	**9.62**
	Output gap	**25.48**	25.20	24.33	23.86	23.77
	Money supply	0.93	1.76	4.37	4.98	**5.07**
	Exchange rate	**14.80**	10.13	8.41	8.26	8.28
	Germany CPI	2.1	4.1	7.90	8.64	8.7
	SR_G	**14.24**	10.60	8.81	8.68	8.64
	S.E.	0.03	0.039	0.0448	0.045	0.045
Variance decomposition of consumer price index for the period 2003Q1-2002Q4	CPI	49.24	31.50	28.90	28.92	28.68
	Oil_p	**32.45**	25.20	23.26	22.79	22.72
	Output gap	7.911	5.88	5.03	5.07	**5.13**
	Money supply	0.58	19.62	**21.89**	21.51	21.52
	Exchange rate	0.33	**7.30**	6.60	7.38	7.63
	Germany CPI	**8.89**	7.71	8.78	8.57	8.58
	SR_G	0.60	2.82	5.55	**5.77**	5.74
	S.E.	0.042	0.057	0.064	0.065	0.065

Figure D4 Variance decomposition of consumer price index for the period 1993Q1 to 2011Q4

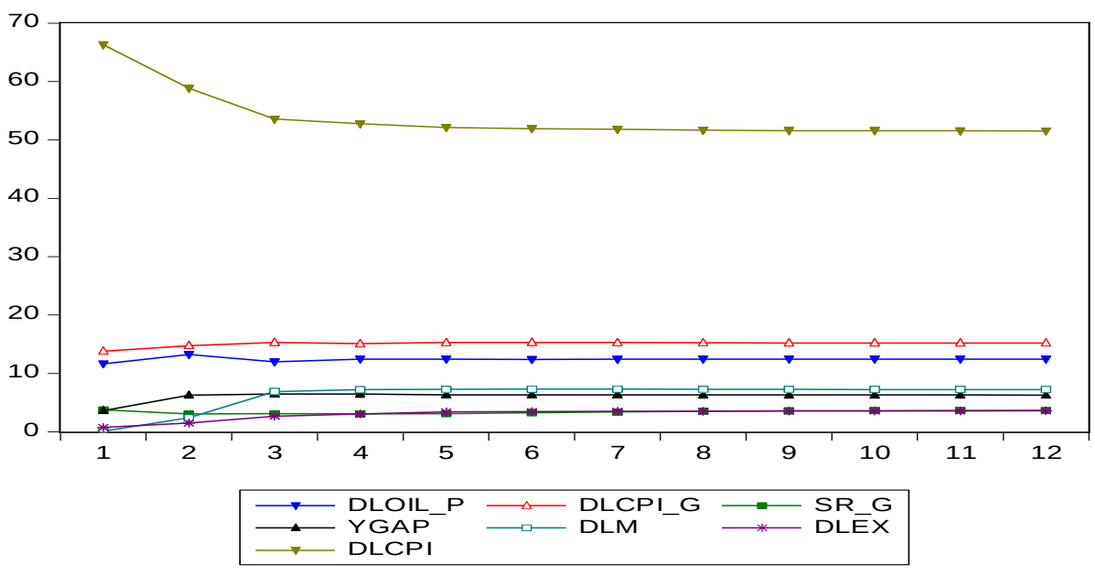


Figure D5, Variance decomposition of consumer price index for the period 1993Q1 to 2002Q4

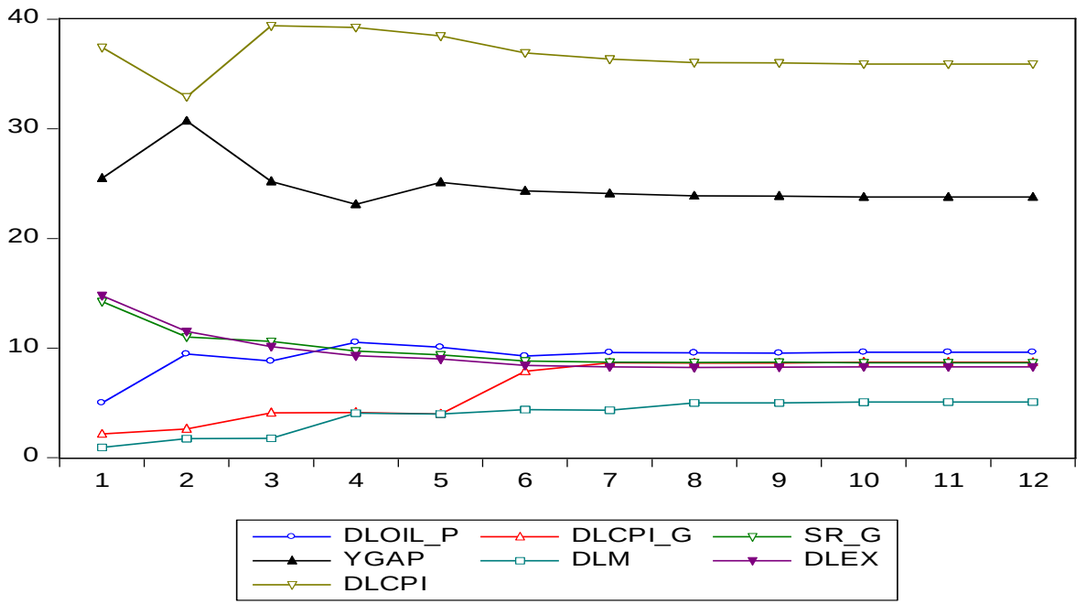


Figure D6, Variance decomposition of consumer price index for the period 2003Q1 to 2011Q4

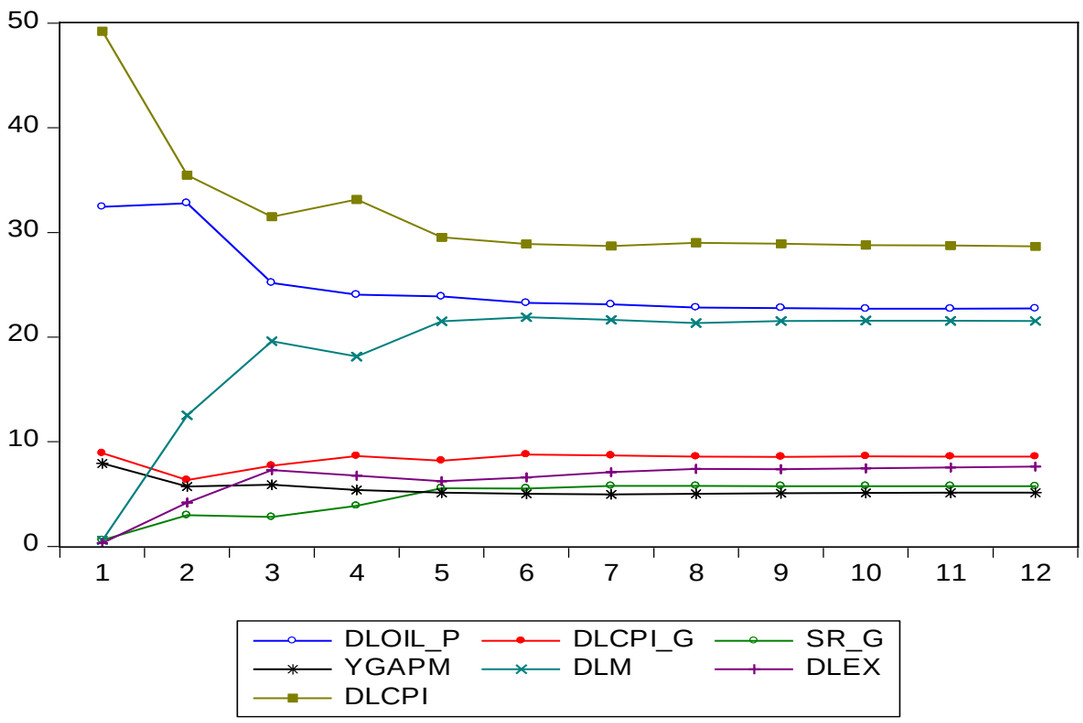


Figure D7) Accumulated impulse response for the sensitive analysis model

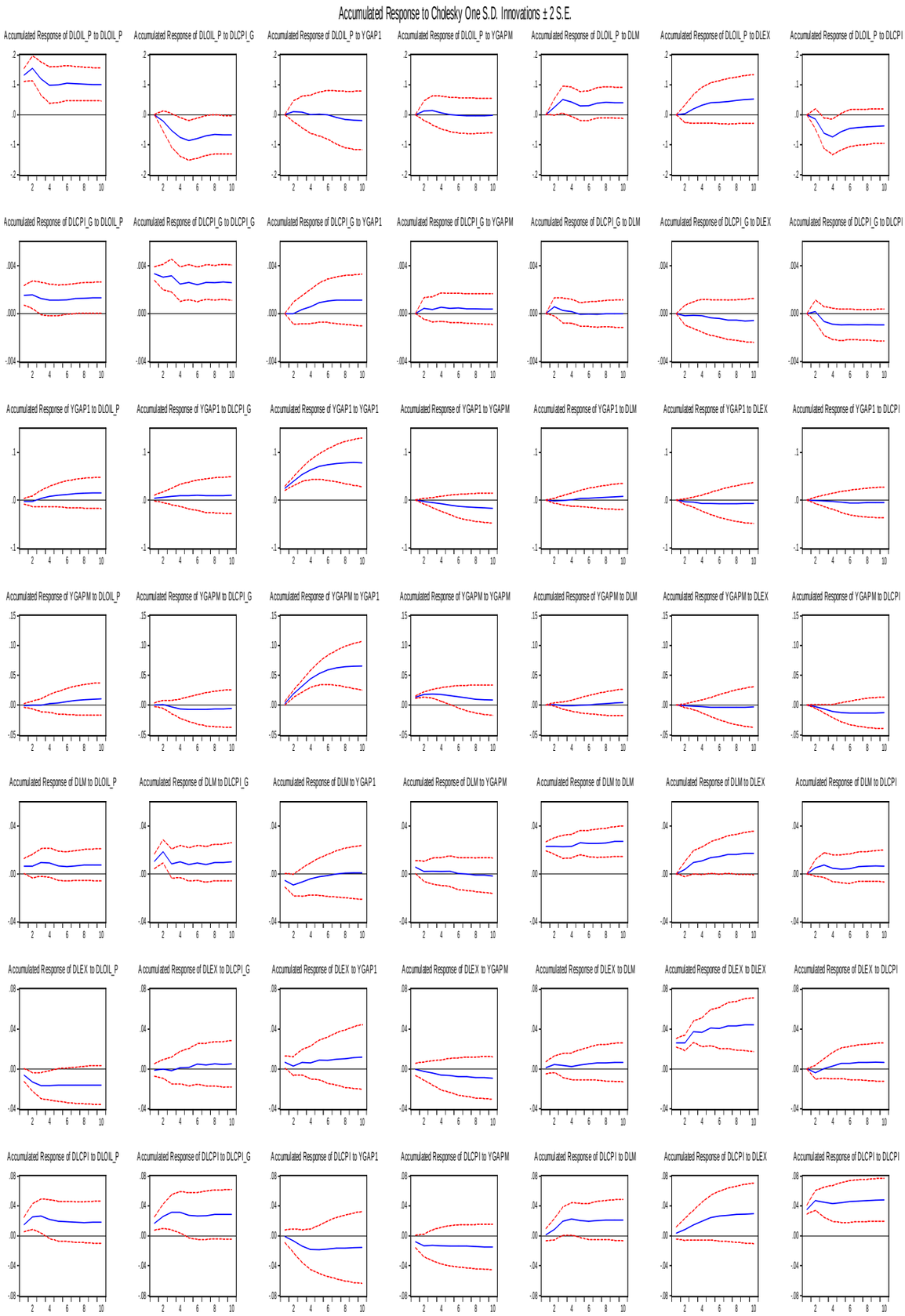


Figure D8) Impulse response for the sensitive analysis model