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EXCHANGE RATE PASS-THROUGH IN ETHIOPIA

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This is to certify that the project paper Prepared by Mohammednur Behru, entitled: Exchange Rate Pass-Through in Ethiopia and submitted in partial fulfillment of the requirements for the Degree of Masters of Arts (Applied Trade Policy Analysis) compiles with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Advisor	Signature	Date
Nasse Behru		12/06/12

ABSTRACT:

Exchange Rate Pass-Through in Ethiopia

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The recent sharp devaluation by the central bank aggravates the inflation rate from single inflation rate of 5.3% in August 2010 to 10.6% in October 2010 following only a month after the devaluation occurred and 40.1% in September 2011 after a year. Initiated from this fact, this paper investigates the exchange rate pass-through to inflation and other macroeconomic variables in Ethiopia for monthly data ranging from July 2002(the beginning of Ethiopian fiscal year 2002/03) to June 2011(the end of Ethiopian fiscal year 2010/11). The study apply Six-Variable unrestricted VAR model to estimate the impulse response functions (IRFs) and variance decompositions (VDCs). In order to measure the pass-through coefficient to CPI, the study applies standardization of the exchange rate shock which helps to transform the shock from one standard Deviation to one percent. Hence the result shows that, on average a percentage chan ge in exchange rate will increase the consumer price by 4.75% percent in the first year. The exchange rate pass-through to inflation almost dies out after two years of the exchange rate shock. The result also support Taylor's hypothesis which states that: high inflation leads to high level of exchange rate pass-through. Hence, the study concludes that, exchange rate change has prominent effect on Ethiopian inflation environment.

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Table of Contents

Acronyms

CPI - Consumer Price Index

CSA - Central Statistics Agency

EDRI - Ethiopian Development Research Institute

ERCA - Ethiopian Revenue and Customs Authority

ERPS - Exchange Rate Pass-Through

GTP - Growth and Transformation Plan

IP - Import Price

IRF - Impulse Response Function

LCP - Local Currency Pricing

LOP - Law of One Price

MS - Money Supply

NBE - National Bank of Ethiopia

NEER - Nominal Effective Exchange Rate

OECD – Organization for Economic Cooperation and Development

OPI - Oil Price Index

PCP - Producer Currency Pricing

PPI - Producers Price Index

PPP - Purchasing Power Parity

VAR - Vector Autoregressive

VDC - Variance Decomposition

CHAPTER ONE

1 Introduction

1.1 Background of the Study

In the contemporary world- where international trade plays a crucial role for development- countries more often depreciate or devalue their currency to be more competitive and grasp the fruit of bilateral and multilateral trade with their partners. Therefore it is important to look through the exchange rate movement which is one of the instruments applied to observe countries competitiveness in world market. At the same time it is essential to maintain domestic inflation rate that may perhaps come along with the exchange rate movement.

Hence it is curtail to analyze the impact of exchange rate on inflation for policy perspective in order to know the appropriate monetary policy which considers the effect of exchange rate movement on inflation. This can be analyzing through Exchange Rate Pass-Through. There are different definitions for exchange rate pass-through. For instance, according to Mumtaz et al. (2006) Exchange Rate Pass-Through is defined as "the percentage change in local currency import prices following a 1% change in the exchange rate between importing and exporting countries". According to Aliyu *et al.* (2008) Exchange rate pass-through refers to the effect of a change in the exchange rate on domestic prices. This study applies the later definition i.e. the change in inflation as a result of a change in exchange rate. If 1% change in exchange rate result the same percentage (1%) change in inflation, it is called a complete exchange rate pass-through. However, if it is diverse from one-to-one response, it is known as partial or incomplete exchange rate pass-through (Aliyu *et al.*, 2008).

Understanding the rate at which exchange rate pass-through to prices is important for different reasons. If Exchange Rate Pass-Through is low it gives a freedom for the monetary authority to apply its monetary policy independently (Choudhri and Hakura, 2001). According to Bussière (2007), since the change in exchange rate affect the price of import, in return, import prices will affect the domestic inflation. Hence it is crucial to see

the magnitude and/ or elasticity of the Exchange Rate Pass-Through to domestic inflation. In addition to this, Bussière suggests that it is important to investigate the reaction of trade quantity towards exchange rate and hence to manage the balance of payment. Since monetary policy transmission to inflation is faster through exchange rate than interest rate, it is important to analyze the exchange rate pass-through to inflation (Holmes, 2009).

There are numerous literatures on Exchange Rate Pass-Through (ERPS) have been developed especially in the context of developed country[1]. For instance, Taylor (2000) argues a low inflationary economy will entertain low Pass-Through of exchange rate which is also known as "Taylor hypothesis". Marazzi et al (2005) observed that Exchange Rate Pass-Through to import price in US and found the pass-through rate decline in 1990s compared to the previous decade. Mihaljek and Klau (2001) have shown that the most external shocks are transmitted to an economy through exchange rate movements. Mumtaz et al. (2006) found incomplete exchange rate pass-through to UK import prices.

Recently, there are also growing literatures on exchange rate pass-through applied to developing countries[2]. Most developing countries focus on inflation targeting monetary policy after the mid-1990s exchange rate crises (Nogueira, 2007). Majority of empirical literatures justify Taylor's hypothesis – positive relationship between inflation rate and exchanger rate pass-through – for emerging economies (see Choudhri and Hakura, 2006). The hypothesis can be articulated according to Ca' Zorzi *et al.* (2007) as follows: "The more persistent inflation is, the less exchange rate movements are perceived to be transitory and the more firms might respond via price-adjustments". Authors, like Calvo and Reinhart (2000) and Schmidt- Hebbel and Tapia (2002), have shown that exchange rate pass-through is higher in developing countries compared to developed countries. On the other hand, Aliyu *et al.* (2009) found exchange rate pass-through rate to Nigerian

[1] Anderton (2003), Campa and Goldberg (2004), Campa et al. (2005), Gagnon and Ihrig (2004), Hahn (2003) and McCarthy (2000)

[2] Choudhri and Hakura (2006), Ca' Zorzi *et al.* (2007), Akofio-Sowah (2009), Mihaljek and Klau (2001) and Aliyu *et al* (2009).

economy contrary to the conservative understanding which states pass-through rate is much higher in developing countries than developed countries.

Even though, there are several ERPS studies done for emerging economies, little has been done in the case of Ethiopia. To the best of my knowledge the paper by Choudhri and Hakura (2006) is the only one that incorporates the exchange rate pass-through for Ethiopia along with other 70 countries. Hence, this paper tries to examine what is the effect of the exchange rate change on Ethiopia's inflation rate and other macro variables.

1.2 Statement of the Problem

In Ethiopia inflation is measured by percentage change in CPI. Hence Exchange rate change may transmit to inflation in two ways. First, it may transmit directly if the imported item is part of basket of goods in the CPI. On the other hand, it may pass-through indirectly if the imported item is used as an intermediate input for the production of those products in the CPI.

If purchasing power parity (PPP), defined as prices of identical goods between two countries should be equal once prices have been converted to a common currency, holds the exchange pass-through is full or complete. But in most literatures the Pass-Through is incomplete. For instance Bussière (2007) explains the reason behind the incomplete Pass-Through by arguing that firms are operating in imperfect market structure. Hence, when there is depreciation/devaluation, they will not increase their price by the same amount that the currency depreciates rather they will increase price by lower proportion. Choudhri and Hakura (2003) scrutinize Exchange Rate Pass-Through to domestic inflation for 71 countries. They found a positive relationship between exchange rate pass through and average inflation for Sub-Saharan African counties. Furthermore, the Pass-Through is incomplete and even close to zero in the Ethiopian case.

Calvo and Reinhart (2000) argue that Exchange Rate Pass-Through is high in emerging countries vis-à-vis developed countries. On the other hand a study by Ca'Zorzi et al (2007) conveys Exchange Rate Pass-Through decline across price chains i.e. it is higher in import price than consumer prices. In addition, Ca'Zorzi et al refutes the conventional

consideration to some extent by arguing that, in emerging counties with single digit inflation (mainly Asian countries) Exchange Rate Pass-Through is fairly low and not that much deviate from that of developed countries.

When we come to the Ethiopian case, in recent years the birr has been devalued around three times. Two of which are step devaluation of around 10 %. Moreover, in September 2010, the central bank – National Bank of Ethiopia – introduced a devaluation of surprisingly around 20%. At the same time inflation started to accelerate from single digit in 2009 to double digit in 2011. Within two years inflation increased from around 7% in December 2009 to 40% in October 2011 with 33% percentage points.

In Ethiopia the issues of the link between Exchange Rate Pass-Through and inflation have not been adequately and explicitly discussed except by Choudhri and Hakura (2006). Yet Choudhri and Hakura did not focus only on Ethiopia and not suggest possible recommendation for Ethiopia particularly. Therefore, this paper attempt to contribute and to some extent try to fill the gap in the area of the relationship between Exchange Rate Pass-Through and inflation in Ethiopia.

It is hypothesized here there is incomplete exchange rate pass-through to domestic inflation. The rationale behind this is that, first consumers expect there will be devaluation in near future and hence they try to smooth their consumption by consuming more today. Therefore, this will create higher inflation as a result of increase in demand. Second, producers assume the devaluation is persistence and will increase their cost of production (around 53 percent of row material cost is imported in Ethiopian manufacturing sector). For this reason, they will adjust their price in response to exchange rate devaluation. Third, since there is less competition in the market, importers are willing to pass the exchange rate change burden directly to the consumers. Finally, given that Ethiopia is a small economy, the Exchange Rate Pass-Through to inflation tends to be higher. This is because foreign exporters are keen to maintain their market share in large economies compared to small economies like Ethiopia.

1.3 Objective of the Study

The primary objective of the study is to examine the relationship between exchange rate and the inflation environment of Ethiopian economy.

The specific objectives are:

- To investigate the effect of exchange rate change on inflation in Ethiopia,
- To examine the consequence of other macroeconomic variables on inflation.
- To analyze the extent to which the monetary policies affect inflation rate,
- To draw recent policy conclusions

1.4 Methodology and Data Source

This paper use Vector Autoregressive (VAR) analysis to estimate the effect of Exchange Rate Pass-Through on inflation in Ethiopia. The study set up a Six-Variable VAR model .The baseline Unrestricted-VAR model includes; world oil price index (OPI), Nominal Effective Exchange Rate Index (NEER), Import Price (IP), Producers Price Index (PPI), Money Supply (MS) and Consumer Price Index (CPI).

In organizing the study and mainly to come up with empirical results, the paper utilizes secondary data. The data range from July 2002 (the beginning of Ethiopian fiscal year 2002/03) to June 2011(the end of Ethiopian fiscal year 2010/11). The monthly data used in this study are collected from different sources. Date on broad money supply (MS) is obtained from National Bank of Ethiopia (NBE). Producer price index (PPI) and Consumer Price Index (CPI) are taken from Central Statistics Agency (CSA) of Ethiopia. Nominal Effective Exchange Rate Index (NEER) is acquired from Ethiopian Development Research Institute (EDRI).

World oil price index (OPI), which is calculated from average of U.K. Brent, Dubai, and West Texas Intermediate, is obtained from international monetary fund (IMF) Primary Commodity Prices database. Finally, Import price (IP) – the ratio of import value to import volume - is taken from Ethiopian Revenue and Customs Authority (ERCA). This part will be briefly explained in chapter three of this paper.

1.5 Organization of the Paper

This paper is organized in four chapters. Following the introduction in this chapter, Chapter Two provides review of literature about the theoretical and empirical work that has been done in the field of exchange rate pass-through and inflation. This chapter also discusses major developments in exchange rate movements and inflation in Ethiopia. Chapter Three focuses on data description, methodology of the paper and analyzes the econometric results. Based on the results and evidence explored in Chapter Three, Chapter Four presents conclusions and policy implications of the study.

CHAPTER TWO

2 Review of the Literature

2.1 Theoretical Literature

According to Campa and Goldberg (2002), exchange rate pass-through measures the degree in which exchange rate movement transmitted in to traded goods. Beirne and Bijsterbosch (2009) in another study define it as: "*Exchange rate pass-through reflects the extent to which exchange rate changes are passed on to the local currency prices of traded goods. A one-to-one response of import prices to exchange rates is deemed as 'full' or 'complete' ERPT, while a less than one-to-one response is known as 'incomplete' or 'partial' exchange rate pass-through*". Furthermore, according to Aliyu *et al.* (2009) Exchange rate pass-through refers to the effect of a change in the exchange rate to domestic prices. This paper applies the later definition i.e. the change in inflation as a result of exchange rate movement.

The theoretical foundation for exchange rate pass-through mainly begins from the law of one price (LOP).The LOP states that assuming free trade with perfectly competitive market which excludes transaction cost such as tariffs, taxes, and transportation costs, the price of internationally traded good in one country should have identical price in another country, once the price is adjusted to a common currency. This implies that there is complete exchange rate pass-through because the mark-up is zero in perfectly competitive market (Krugman and Obstfeld, 2003). However several empirical studies found the LOP is not working at least in the short to medium run[3]. One of the arguments, according to Herzberg *et.al* (2003), if the importing country is large enough that can affect the world price, there will be incomplete pass-through. This also neglects the impact of transaction cost like distribution costs. Furthermore firms use pricing-to-market strategy which refers to the various pricing behavior of firms exporting their products to a destination market following an exchange rate change. Hence they will adjust their mark-

[3] Bailliu and Fujii (2004)

up according to domestic competition in the importing country which leads to incomplete exchange rate pass-through. (Herzberg *et.al*, 2003).

The empirical contradiction of the LOP by many literatures forces to analyze another theory about incomplete pass-through of exchange rate. Taylor (2000) put forward a theory with imperfect competition which gives firms some control over price. Taylor explains the link between inflation and pass-through using a model of firm behaviour based on staggered price setting and monopolistic competition. He states that: "If prices are set for several periods in advance, then the lower persistence will result in smaller pass-through (less matching of the price and cost increases), which is characteristic of reduced pricing power". This Taylor's explanation is applicable whether the change in cost is from exchange rate change or commodity price change. Hence the pass-though is directly related to the inflation i.e. the higher the inflation thus tends to increase the exchange rate pass-through and the reverse is true for low inflation environment.

Choudhri and Hakura (2001) follow similar path to the one in Taylor (2000) and derived a pass-through relation based on new open economy macroeconomic models with imperfect competition and staggered pricing. They found a negative correlation between the pass-through to CPI and the extent in which monetary regime offsets short-run price deviation from its long-run track. This is because the pass-through reflects the extent to which monetary shocks affect the current and future cost. Hence, the pass-through rate is lower in regimes that respond insistently to price deviations by weakening the expected future effect of monetary shocks. Bailliu and Fujii (2004), also support Taylors' (2000) hypothesis of positive relationship between inflation and exchange rate pass-through. They explained that the decline in exchange rate pass-through is as a result of low inflation environment which brought by a change in monetary policy regime. Explicitly producer, consumer and import prices decline following inflation stabilization as a result of credible monetary policy regime. Moreover, the pass-through is incomplete because producers adjust their mark-up to compensate the change in price because of exchange rate change.

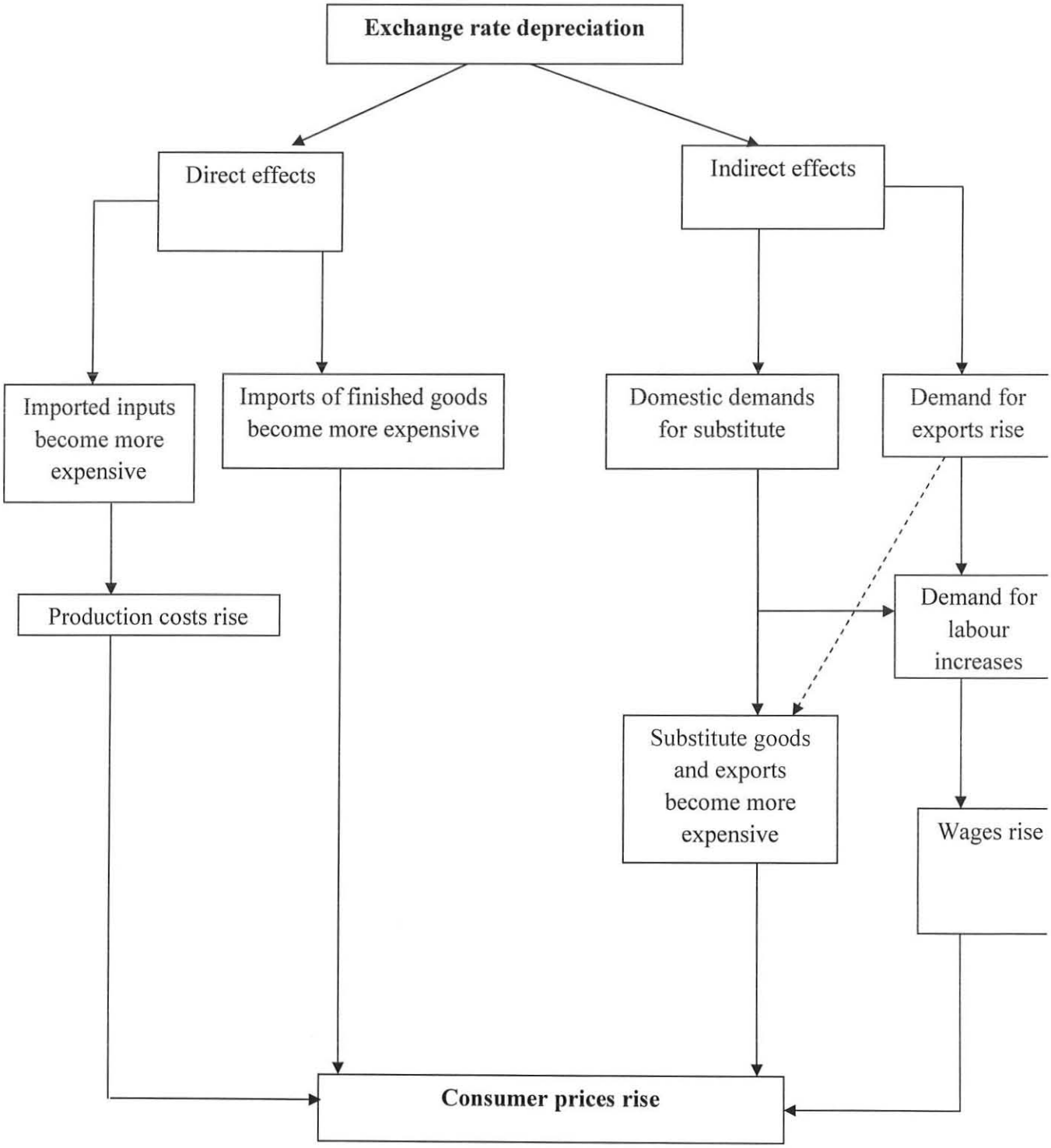
Various theoretical literatures examine both law of one price and pricing-to-market and exchange rate policy effectiveness. For instance, Betts and Devereux (2000) develop a general exchange rate model and justify that if law of one price holds, the expenditure-switching effects of exchange rate changes reduces the overall exchange rate movement. On the other hand, market segmentation by country and price setting in local currency of sale which is referred to as pricing-to-market will change the scenario. Subsequently in the presence of pricing-to-market (pricing characteristics of exporting firms for exchange rate movement) the expenditure switching effects will go away. Hence, the presence of pricing-to-market increases exchange rate volatility, compared to a situation where the law of one price holds. According to the paper, monetary policy is a ''beggar-thy-neighbour'' (increasing once welfare at the expense of others) instrument in the presence of a high degree of pricing-to-market.

In support of the above pricing strategy effects on exchange rate pass-through, Engel (2004) analyze different pricing strategy and effects of these pricing behaviours on pass-through rate. As discussed by Engel exchange rate pass-through depends on different pricing strategies, such as whether the firm practices producer currency pricing (PCP) which refers to the case where exporters set their prices in their own currency or local currency pricing (LCP) which refers to the situation where exporters set their prices in the currency of the importing country. According to the paper, if prices are preset in the currency of the producer, then the home country price of the foreign good will move one-for-one with changes in the nominal exchange rate; thus there is complete exchange rate pass-through. On the other hand, if a firm applies LCP, then prices are preset in the local currency, and changes in the nominal exchange rate will have no short-run impact on prices faced by consumers. Hence, there is no exchange rate pass-through in the short run. As a compliment of the above argument, Bailliu and Fujii (2004) stated that, if the economy is best characterized by a combination of firms - some of them practice LCP and some of which follow PCP - then the aggregate degree of pass-through will be partial or incomplete in the short-run.

Unlike the theories which demonstrate pricing strategies as the main determinant of exchange rate pass-through rate, there are other theories which argue monetary policy is the core determinant of exchange rate pass-through. To mention, Reyes (2004) analyzed the relationship between exchange rate pass-through in inflation targeting regimes. Reyes argues that lower pass-through rate to inflation is a result of the monetary authority intervention in foreign exchange market. The study justified "under Inflation targeting, result in lower/higher rates of currency depreciation that compensate inflationary/deflationary pressure arising from the non–traded good sector". The other worth mentioning is Devereux and Yetman (2002) work on exchange rate pass-through. They develop a model of small open economy with sticky price and illustrate exchange rate pass-through is endogenous to the monetary regime and there is a positive relationship between the pass-through rate and inflation rate. Furthermore, Devereux *et.al* (2004) explained that monetary policy stability is the core determinant of exchange rate pass-through. Given endogenous exchange rate pass-through, countries with low monetary policy volatility have lower pass-through rate than countries with high level of monetary policy volatility.

Lafleche(1997) demonstrated the direct and indirect exchange rate pass-through using a simple and comprehensive schematic presentation. The direct effect of exchange rate depreciation works in two different ways; first it affects the consumer price by affecting the price of imports of finished commodities, on the other hand it affects the consumer price through production cost by affecting the price of imported inputs. The indirect channel of exchange rate depreciation applies through demand for substitute and demand for export (see figure 1). The rate of exchange rate pass-through, according to Lafleche, is incomplete in the short-run while it is complete in the long-run since both import and consumer price adjust to a change in exchange rate.

Figure 1; Pass-through from Exchange rate depreciation to consumer prices



Source; Lafleche (1997) as cited in Aliyu et al. (2008)

2.2 Empirical literature

There are several empirical literatures about exchange rate pass-through on import and inflation. Most of the empirical literatures are in-line with the Taylor's hypothesis at list in the short-run, that is, low inflationary environment achieve partial or incomplete exchange pass-though rate. For instance, Choudhri and Hakura (2001) examine the pass-through rate for 71 countries between the years 1979–2000. They divide the countries in three category based on the inflation rate (low, moderate and high) and also present the date in quarterly basis to examine the effect of the pass-through in the short, medium and long run. They found that, the exchange rate pass-through increase as the time increase and also argue the exchange rate pass-through is high for countries with high inflation rate like for Argentina, Brazil and Peru. In contrast, closes to zero pass-through rates for countries in low inflation categories like Australia, Canada and Denmark.

Campa and Goldberg (2004) also found incomplete pass-through. They studied a cross-country analysis of exchange rate pass-through for 23 OECD countries with a time series span from 1975 to 2003. The study reported a partial exchange pass-though for the OECD countries especially in the manufacturing sector, which is 0.46 in the short-run and 0.65 in the long-run. They also found direct correlation between exchange rate volatility and exchanger rate pass-through and report macroeconomic variables have negligible effect on exchange rate pass-through as well. In contrast to Campa and Goldberg, a study conducted by Bailliu and Fujii (2004) present evidence – from a panel-data set of 11 industrialized countries over the period from 1977 to 2001 – a decline in exchange rate pass-through because of a shift to a low inflation environment that appeared as a result of a change in perceived monetary regime. For example, the average short-run exchange rate pass-through rate decline from 0.86 to 0.71 for import price, from 0.18 to 0.08 for producer price and from 0.11 to 0.05 for consumer price following the change in the inflation environment in the 1990s.

Most of the empirical works are done for industrialized countries and reported very low exchange rate pass-through rate. For example, Mumtaz et al. (2006) scrutinized the exchange rate pass-through to UK import price for the years 1984-2004 on quarterly

basis and disaggregated level for 57 industries. They found cross-sectional heterogeneity of exchange rate pass-through among industries; for instance, when they use aggregate import price index they found exchange rate pass-through rate of 0.44 and 0.66 in the short-run and long-run respectively. On the other hand, when they apply disaggregated date they obtained exchange rate pass-through rate of 0.38 and 0.43 in the short-run and long-run respectively and proposed using an aggregate date may result a wrong impression of exchange rate pass-through on economic wide level. In addition, they found incomplete pass-through for food and manufacturing sector in short-run and long-run as well. In another paper Fujii (2004) analyze the extent of exchange rate pass-through to Japan import focusing on deflationary period assuming imperfectly competitive market. The study found that exchange rate pass-through to import decline significantly in the long-run.

China's exchange rate policy has its own contribution in Chinese international trade especially in US-China trade relationship. Auer (2011) analyze the impact of Chinese Yuan appreciation to US domestic competition and inflation using monthly panel date covering 110 sectors from 2005 to 2008. The study found 0.8% exchange rate pass-through for import price of US and 0.56% exchange rate pass through for producer price and it also found heterogeneous pass-through rate across sectors. The study concludes that exchange rate pass-through is higher than the rest of the world because china takes the lion share of US import. Jin (2010) provided some empirical evidence on Chinese economy confirming fixed exchange rate regime has more exchange rate pass-through rate to consumer price index (CPI) and there exist an inverse relationship between exchange rate pass through rate in the long-run. The paper estimate exchange rate pass-through to CPI and producer price index (PPI) for Chinese economy using single equation (OLS) model and found that 1 percent increase in NEER (1% appreciation) leads to 0.016% and 0.012% of CPI and PPI deflation respectively in the short-run and 0.132% and 0.495% CPI and PPI inflation respectively in the long-run. The difference between the CPI and PPI rate – according to Jin – comes as a result of the difference in basket of goods and weight of the indexes.

Marazzi *et al.* (2005) present exchange rate pass-through of US import and found that the pass-through decline from 0.5 in 1980s to 0.2 in 1990s. Even if they cannot precisely describe the reason for the decline, yet they try to point out some factors. The first factor is, a fall in industrial supply which is commodity intensive and obtain comparatively high pass-through in 1980s. Competition from Chinese companies in the US is the second factor that plays a role in pass-through decline in 1990s. Finally, the increased exchange rate sensitivity mainly for Asian country (Hong Kong, Korea, Singapore, and Taiwan) and Canada export prices are the reasons for the decline in exchange rate pass-through.

Ca' Zorzi *et al.* (2007) examine exchange rate pass-through to prices for 12 emerging markets in Asia, Latin America and Central and Eastern Europe by applying vector auto regression (VAR) models. The result verified that exchange rate pass-through is higher in import prices than consumer prices because of variation across the pricing chain. Furthermore, it disproved the contemplation that exchange rate pass-though is high in developing countries compared to that of developed counties by arguing that for emerging countries with single digit inflation rate entertained low rate of exchange rate pass-through which is not that far from developed world. The paper also concluded a positive relationship between exchange rate pass-though and inflation rate which is in-line with Taylors hypothesis. For instance, for set of countries with average inflation rate of 10% or less, the exchange rate pass-though was generally less than 10%, however, the exchange rate pass-through was around 40% for countries that included in average inflation rate between 10% and 20%.

Akofio-Sowah (2009) examined the exchange rate pass-through for 15 Sub-Saharan Africa countries and 12 Latin American countries over the period 1980–2005 and found an incomplete pass-through. Moreover Akofio-Sowah supported the Taylor proposition of low inflation environment has low level of exchange rate pass-through. By applying VAR model, Belaisch (2003), found partial exchange rate pass through in Brazil. He found exchange rate pass-through of 6% and 17% for consumer price, 34% and 120% for whole sale price and 27% and 53% for general price for the first and fourth quarter respectively. The reason for the decline in pass-through rate are; firms preferred to shrink

there mark-up instead of completely passing the exchange rate burden to consumers, availability of substitute for imported items and the perception of temporary depreciation. Mihaljek and Klau (2001) also examine exchange rate pass-through for 13 emerging market economies during 1980s and 1990s using simple OLS. The study reveals that, inflation highly influenced by exchange rate change than import price changes. Hence exchange rate pass-through to inflation is higher than import price pass-through to inflation. Furthermore the paper finds wide range of differences in exchange rate-pass through across country (ranging from 0.97 in Brazil to 0.02 in Philippines) and the reason behind was different inflation history of the countries. The note concludes that even if the exchange rate pass-through is declining, it is the main channel of transmission for external shocks.

The pass-through rate is not only incomplete in most empirical reviews it also depends on the types of items imported and amount of imported items i.e. openness of the country. In support of this argument, Campa and Goldberg (2002) analysis suggested that there is an incomplete pass-through in the short-run and the pass-through vary across the country's import bundles. For instance, in developed country the pass through is higher in energy and raw material imports (close to complete pass-through) relative to manufacturing and food products. This is mainly due to the shift in import from energy and raw material to manufacturing and food products. Therefore, since the exporters want to maintain their market share in developed countries in which case they face a stiff competition, they are willing to reduce their mark-up instead of fully pass the exchange rate burden to their customers. Furthermore as opposed to Engel (2004) and Bailliu and Fujii (2004) argument, they evidenced that the pass-through rate did not depend on whether the price of the product set in local currency pricing (LCP) or producer currency pricing (PCP) at least in the short-run.

The study conducted by Minh (2009) argues that the exchange rate pass-through to import price is higher than pass-through to inflation as a result of price chain. The study examines pass-through rate for Vietnam from 2001 until 2007 and found average exchange rate pass-through rate of 0.61 and 0.08 to import prices and inflation rate

respectively, which implies incomplete pass-through. The two main rationales behind the incomplete pass-through - according to the paper- are; low inflation environment as Taylors proposition and low level of commodity indexation as a result of low level of dollarization. Using Structural VAR framework, Winkelried (2011) as well substantiate a decline in exchange rate pass-through in Peru as an outcome of a decline in inflation. The paper found that; a decline in both producer and import prices pass-through leads to a considerable reduction of exchange rate pass-through to inflation from 60% to 10% for Peruvian economy.

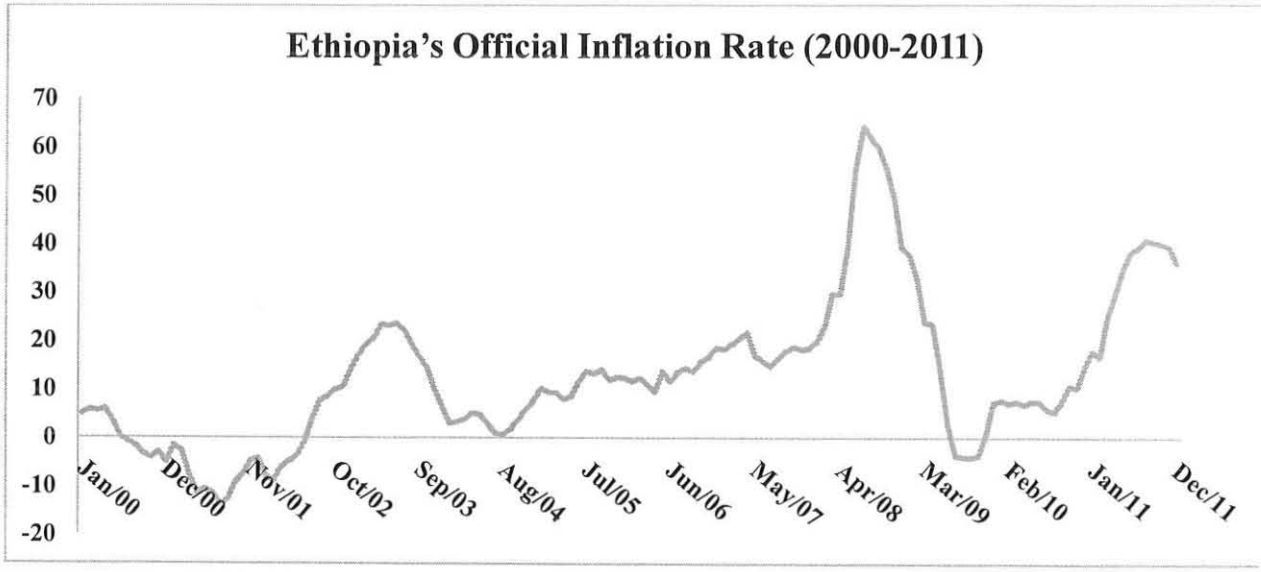
In Nigeria, Aliyu *et al.* (2009) found exchange rate pass-through rate contrary to the conventional wisdom which states pass-through rate is much higher in developing countries than developed countries which is 14.7% and 10.5% for import and consumer prices respectively. They use Vector Error Correction method to analyze the pass-through rate for both import and consumer price for a data between 1986 and 2007 on quarterly basis. They found slightly higher pass-through rate for import price compared to consumer price which substantiated that pass-through declines along the pricing chain in Nigeria. The study by Frimpong and Adam (2010) validated the work of Aliyu. According to Frimpong and Adam, exchange rate pass-through to inflation was partial and declining in Ghana. The article used vector auto regression (VAR) model using time series data set covering the period 1990–2009 on quarterly basis. The pass-through rate increased to 0.09 after eight quarter from 0.025 in the first quarter then decrease to 0.07 after twelve quarters of its initial impact and stay around 0.07 to the periods afterwards. The reason behind low but persistence exchange rate pass-through, according to the analysis, is the result of openness of the economy and the tight monetary policy the central bank applied over the period.

From the above theoretical and empirical literature review, we can observe that there is some ambiguity about what determine the relationship between inflation rate and exchange rate pass-through. For instance, some scholars express pricing strategies and competition are the driving factor for the relationship and monetary policy do not have as such reasonable impact on the correlation between inflation rate and exchange rate pass-

through. On the other hand, other scholars argue monetary and exchange rate policy are the core reasons for the relationship between inflation rate and exchange rate pass-through. Hence this paper tries to examine which factors or combination of factors affects the relationship between inflation and exchange rate in Ethiopian economy by applying VAR model to exchange rate pass-through analysis.

2.3 Review of Inflation and Exchange Rate in Ethiopia

Inflation is one of the main concerns for Ethiopia's economy in recent years. Until 2002 the inflation rate in Ethiopia was negative or at least close to zero value and was not as such a concern in policy making. However, starting from 2002, rate of inflation starts to soar and reach the maximum of 64.2 percent in July 2008. According to Geda and Tafere (2008) inflation expectation, growing money supply (expansionary monetary policy) and monopoly power are the driving factors for the flying inflation in Ethiopia. Furthermore, the widening of the gap between aggregate demand and aggregate supply accompanied by the increase in import price was the main reason for the record inflation (Teshome, 2011).

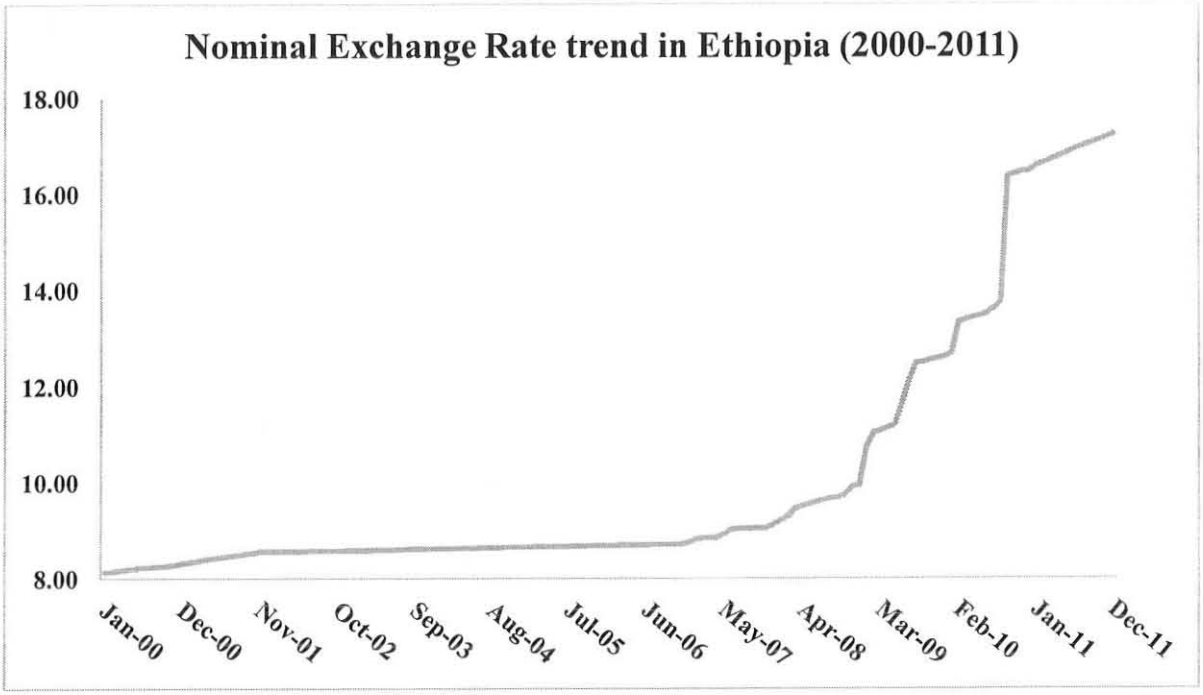


Source; Central Statistics Agency (CSA) Ethiopia

However, the galloping inflation starts to decline from mid 2009 until September 2010 i.e. kept in single digit. The possible explanation for decline in inflation, according to Access Capital's inflation updater (2009), are large amount of wheat import by the government which not only reduces the price of wheat but also the price of other substitute since food item take the line share of Ethiopia's consumption which is 57%. Moreover, according to the report, the decline in oil price from 121 USD per barrel to 50 USD per barrel assisted for the reduction in inflation.

This single digit inflation rate was not long lasting and it started to grow and reached 40.63% in August 2011. It is very high even in world standard the inflation rate in Ethiopia was the highest in Africa and the second in the world following Belarus in 2011 (Access Capital, 2011). The probable reasons for the recent mounting of inflation are; the increase in government expenditure, increasing aggregate demand that in not accompanied by supply (demand-push inflation) and excess money supply. Inflation expectation and the recent Devaluation are also worth mentioning.

When we draw attention to devaluation as possible cause of inflation in Ethiopia, it is reasonable to analyze the exchange rate system of Ethiopia. The Ethiopian exchange rate system is characterized by managed floating. Managed floating exchange rate defined as: the central bank interferes and buy and sell foreign exchange to influence the exchange rate. The recent exchange rate trend of Ethiopia is characterized by monthly depreciation of 4.5 cents. However NBE sometimes made some exchange rate adjustment for different reasons. For instance, in the past three years the NBE made three step devaluations i.e. 10 % in January 2009, 10 % in July 2009 and 5 % in January 2010.



Source; National Bank of Ethiopia (NBE)

In September 2010, the national bank of Ethiopia devalued the exchange rate by around 20%. The main rationale for the devaluation according to the central bank is to promote export performance of the country by increasing the competitiveness of exportable commodities. Furthermore, the national bank devalued the exchange rate to encourage import substitution strategy of the government and also to have reasonable foreign exchange reserve (Access Capital Exchange Rate Review—September 2010).

However the sharp devaluation by the central bank aggravates the inflation rate from single inflation rate of 5.3% in August 2010 to 10.6% in October 2010 following only a month after the devaluation occurred and 40.1% in September 2011 after a year. Even if it is difficult and not plausible to conclude that the devaluation is the sole culprit for inflation in Ethiopia prior to the analysis, yet there is some relationship between inflation rate and exchange rate. Therefore, this study attempts to find the exact relationship between inflation rate and exchange rate by investigating exchange rate pass-through to inflation for Ethiopia. The study also endeavours to find the magnitude of exchange rate pass-through to inflation which is important to the policy makers to know the extent of their freedom to apply monetary policy. The latter is justified as: if the exchange rate

pass-through is incomplete and very low, it gives more freedom to the policy makers to apply monetary policy since inflation rate is less responsive to exchange rate movement. But if not; it limits the extent to which the policy makers apply monetary policy since it is very sensitive to inflation.

CHAPTER THREE

3 Methodology and Data Analysis

3.1 Methodology

The theoretical underpinning for Exchange Rate Pass-Through is closely related to Purchasing Power Parity (PPP). According to Krugman and Obstfeld (2003), PPP states that an exchange rate between two countries should be equal to the ratio of the price level in one country to the price level in the other country i.e. relative prices. Akofio-Sowah (2009) explain it mathematically by

$P=EP^*$ ..... (1)

Where P is the domestic price, P* is foreign currency price and E is exchange rate defined as the ratio of domestic currency to foreign currency. The regression of the above equation by taking the natural log of the above variables gives;

$p = \alpha + \beta p* + \lambda e + \varepsilon$ ..... (2)

Where: p, e and p^* are the natural logarithm of P, E and P* respectively.

If we assume that PPP holds in equation (2), $\alpha=0$, $\beta=1$ and $\lambda=1$. Hence there will be a complete Exchange Rate Pass-Through. But in most cases this will not hold i.e. there is incomplete pass though. One possible explanation is there is a product differentiation the other justification might be imperfect market competitions were producers want to maintain their market share. Dornbusch (1987) justifies the incomplete Pass-Through is because of that firms not only adjust the cost structure (prices) but also their mark-up when there is an exchange rate shock.

This paper employed the unrestricted vector auto regression (VAR)[4] model- as stated in Eq. (3) - to estimate the impulse response functions (IRFs) and variance decompositions (VDCs).

$$Y_t = \alpha + \sum_{i=1}^{p} \beta_i Y_{t-1} + \varepsilon_t \quad \ldots\ldots (3)$$

Where Y_t represents the vector of endogenous variables (Oil Price Index (OPI), Nominal Effective Exchange Rate Index (NEER), Import Price (IP), Producers Price Index (PPI), Money Supply (MS) and Consumer Price Index (CPI)). α is a vector of constants, β_i refers to the matrices of autoregressive parameters and ε_t is a vector of white noise processes. Identification of the structural shock is obtained by applying Cholesky decomposition to the variance covariance matrix of the reduced form VAR residuals with a certain ordering of variables to calculate the impulse response. Moreover, the impulse response functions will help to trace out the time path of the effect of shocks on the dependent variables of the model. On the other hand, variance decompositions tell us how much of a change in a variable is due to its own shock and how much due to shocks to other variables.

The application of recursive identification, *also called causal chain identification,* which implies that the identified shocks contemporaneously affect their corresponding variables and those variables that are ordered at a later stage, but not the other way around. For this reason, the appropriate ordering of the variables is important to carefully identify structural shocks Ca'Zorzi et al (2007). Hence it is prudent to order first the most exogenous variable in the system. Oil price is included to identify the supply shock and ordered first because oil price affect the other variables but not contemporaneously affected by the other shocks. The money supply incorporated in the VAR model to demonstrate the response of monetary policy to a shock in exchange rate and ordered second next to oil price. Nominal effective exchange rate (NEER) is applied rather than bilateral exchange rate vis-à-vis the US dollar. Thus to be consistence with the definition of Exchange Rate Pass-Through in literature – a ratio of domestic currency to foreign

[4] Following McCarthy (2000), Ca'Zorzi et al (2007), Belaisch (2003) and Ito and Sato (2007).

currency- this study apply the reciprocal of NEER (1/NEER)[5] . NEER placed above other prices.

Most literatures place price variables in the bottom of the VAR model, for instance, Leigh and Rossi (2002), Hahn (2003), Belaisch (2003) and Takatoshi and Kiyotaka (2007). This study follows the league of other studies and prices are order at bottom and are thus contemporaneously affect by all the above mentioned variables. The import price ordered on top of producer price index and consumer price index allowing for a contemporaneous effect of import price shock on producer price index and consumer price index but not vice versa. Finally producer price index and consumer price index ordered last respectively.

Along with the analysis of the impulse response of the NEER shock to prices, it is essential to see the magnitude and/or the extent to which the Exchange Rate Pass-Through affect the consumer price. Therefore, following the work Leigh and Rosi (2002) and Van Minh (2009) the pass-through coefficients calculated as follows:

$$PT_{t,t+i} = {}^{P_{t,t+i}}/_{E_i} \quad \ldots\ldots (4)$$

Where $P_{t,t+i}$denotes the change in indices in period i in response to the initial shock in NEER, E_i is the accumulated impact change of exchange rates to their own shocks.

The rationale behind using VAR model- unlike simultaneous equation model- is that it does not oblige to impose a-priori restriction on the data which associated with the notion of "let the data speak for themselves!" and 'arbitrary' constraints to ensure identification are not required (Sims 1980). The other motive of using VAR model is that; the variables believed to interact each other hence they should incorporate in the economic system. Which in fact close to the real world economic scenario (Pecican 2010). Verbeek (2004) state that analyzing the components of the model simultaneously may be more parsimonious and involves fewer lags, and that more precise forecasting is possible, because the information set includes the past history of the other variables. Hence a VAR

[5] Akofio-Sowah (2009) and Campa and Goldberg (2002) follow the same procedure

model approach is important to allow endogenous interaction between exchange rate and other prices including macroeconomic variables.

3.2 Data Description

In estimating Exchange Rate Pass-Through, the study set up a Six-Variable VAR model following several previous studies like Ca'Zorzi et al (2007), McCarthy (2000) and Hahn (2003). The baseline VAR model includes; Oil Price Index (OPI), Nominal Effective Exchange Rate Index (NEER), Import Price (IP), Producers Price Index (PPI), Money Supply (MS) and Consumer Price Index (CPI).

The monthly data range from July 2002 (the beginning of Ethiopian fiscal year 2002/03) to June 2011(the end of Ethiopian fiscal year 2010/11). World oil price index (OPI), which is calculated from average of U.K. Brent, Dubai, and West Texas Intermediate, is obtained from international monetary fund (IMF) Primary Commodity Prices database and included to identify the supply shock. The money supply incorporated in the VAR model to demonstrate the response of monetary policy to a shock in exchange rate and other variables. Data on broad money supply (MS) is obtained from National Bank of Ethiopia (NBE).

Nominal effective exchange rate Index (NEER) is applied rather than bilateral exchange rate vis-à-vis the US dollar and this is because, first the bilateral exchange rate in Ethiopia is not flexible and not allow for a enough variation to estimate its effect on consumer prices and other variables of interest. The second reason for using Nominal effective exchange rate is it could capture better the change in the cost of import that would affect the domestic price. Third motive for applying NEER is that, almost all countries in the world engage in trade with more than one country i.e. multilateral trade rather than bilateral trade, hence bilateral exchange rate capture only the effect of one currency on price therefore it is vital to see the effect of how changes in the country's currency vis-à-vis the currencies of its trading partners affect consumer prices. Since the NEER is expressed as a ratio of foreign currency to domestic currency, an increase in NEER explains an appreciation of the domestic currency. Thus to be consistence with the definition of Exchange Rate Pass-Through in literature – a ratio of domestic currency to

foreign currency- this study apply the reciprocal of NEER (1/NEER)[6] . The data for Nominal Effective Exchange Rate Index (NEER) is acquired from Ethiopian Development Research Institute (EDRI).

Producer price index (PPI) and Consumer Price Index (CPI) are taken from Central Statistics Agency (CSA) of Ethiopia. Finally, Import price (IP) is taken from Ethiopian Revenue and Customs Authority (ERCA). Since import price is not available for Ethiopia, the study uses a simple ratio of import value to import volume for respective months as a proxy for import price.

Table 3.1: Summary statistics

Variable	Observation	Mean	Standard Deviation	Minimum	Maximum
PPI	108	122.23	61.19	47.69	288.23
CPI	108	121.29	51.54	60.07	253.68
NEER	108	65.14	13.44	36.00	83.30
MS	108	60.48	30.10	27.93	145.38
OPI	108	116.63	49.20	46.49	249.66
IP	108	10.77	4.84	2.60	28.92

3.3 Data analysis

As mentioned in the methodology section, VAR system consisting of six variables will be estimated under the assumptions of residuals from the VAR are orthogonalised and apply Cholesky decomposition to identify the shocks. Moreover, the study deploy EViews software version 7.1 to test and forecast.

3.3.1 Tests for Stationarity

In time series analysis, most economic series are non-stationary. In order to be stationary: a stochastic process requires the variances and autocovariances are finite and independent of time. In contrast to stationary process there are spoirious regressions. According to Gujarati (2004) "*Sometimes we expect no relationship between two variables, yet a*

[6] Akofio-Sowah (2009) and Campa and Goldberg (2002) follow the same procedure

regression of one on the other variable often shows a significant relationship. This situation exemplifies the problem of ***spurious****, or nonsense, regression*". Hence, it is crucial weather the variables under consideration have a real economic relationship or not.

In VAR models all variables must be stationary in order to resolve spurious regression problem. Besides most economics variables are not stationary at level rather they are stationary after first differencing which is called integrated of order one and denoted by *I* (1).

To test for stationarity the study uses the Augmented Dickey Fuller (ADF) Unit Root Test. According to the test, all variables except money supply (MS) are stationary at first difference. Therefore they are Integrated of order 1 or I (1) (D (*) denotes stationary after first differencing). But money supply (MS) is stationary at level. The result of ADF unit root test is presented in Appendix I.

3.3.2 Optimal Lag Length Selection

Selection of the optimal lag length is important for parsimonious of the results. *"Too few lags in the model lead to rejection of the null hypotheses too easily, while too many lags in the model decrease the power of the tests. This indicates that there is some optimal lag length*" (Verbeek, 2004). According to the result presented in Table 3.2, Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ) suggest the same optimal lag length of 1 on the other hand Akaike information criterion (AIC) choose optimal lag length of 12. Final prediction error (FPE) and LR test statistic tends to select the same optimal lag length of 8. Since too few and too many lag length reduce the precision of the estimation, the study select optimal lag length of 8 following FPE and LR criterion.

Table 3.2 VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1444.812	NA	741287.6	30.54340	30.70470	30.60858
1	-1046.800	737.3683	363.7455	22.92211	24.05119*	23.37835
2	-1006.835	68.99224	337.5594	22.83864	24.93550	23.68593
3	-966.6434	64.30695	316.0550	22.75039	25.81504	23.98874
4	-938.1002	42.06370	386.1379	22.90737	26.93981	24.53678
5	-897.0306	55.33586	373.1519	22.80064	27.80087	24.82111
6	-854.7318	51.64910	365.4920	22.66804	28.63604	25.07956
7	-801.8087	57.93689	301.5632	22.31176	29.24755	25.11434
8	-735.9976	63.73281*	203.2538*	21.68416	29.58774	24.87780
9	-697.2558	32.62464	265.6934	21.62644	30.49780	25.21113
10	-639.2946	41.48804	263.1027	21.16410	31.00324	25.13985
11	-583.8370	32.69080	329.1106	20.75446	31.56139	25.12127
12	-519.6740	29.71762	450.6862	20.16156*	31.93627	24.91943

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

3.3.3 Granger Causality Tests

It is important to note that; in time series analysis correlation does not mean there is a causal relationship between variables. Hence it is essential to test weather the past value of one variable affect significantly the prediction of other variables in the model. Granger causality test is commonly used test to observe the relationship between variables. According to Granger (1969) as sited in Ozturk et.al (2008)

"Y is said to "Granger-cause" X if and only if X is better predicted by using the past values of Y than by not doing so with the past values of X being used in either case. In short, if a scalar Y can help to forecast another scalar X, then we say that Y Granger-causes X. If Y causes X and X does not cause Y, it is said that unidirectional causality exists from Y to X. If Y does not cause X and X does not cause Y, then X and Y are statistically independent. If Y causes X and X causes Y, it is said that feedback exists

between X and Y. Essentially, Granger's definition of causality is framed in terms of predictability. In other words, this technique helps to determine whether certain time series is useful in forecasting another one."

The VAR Granger Causality/Block Exogeneity Wald Test examines whether the lags of excluded variables affect the endogenous variables. The result suggests that money supply and nominal effective exchange rate have Granger causality of each other, which indicate Feedback, or bilateral causality between them. From Granger Causality/Block Exogeneity Wald Test we can also infer that:

- Producer price index and exchange rate have important impact on the inflation environment. Furthermore, money supply movement has influence on inflation rate but change in inflation rate has no effect on money supply.

- CPI has no effect in determining future value and MS. Which implies that the monetary authority do not consider the inflation rate when it sets its money supply in the economy.

- Inflation, Producer price index and money supply have impact on the future nominal effective exchange rate. However, oil price and import price do not have effect in exchange rate determination. This indicates foreign supply shock and balance of payment do not considered in exchange rate determination.

3.3.4 Impulse Response Analysis

The impulse response function (IRF) traces out the effect of shock emanating from an endogenous variable to other variables. According to EViews (2010),

"A shock to the i-th variable not only directly affects the i-th variable but is also transmitted to all of the other endogenous variables through the dynamic (lag)

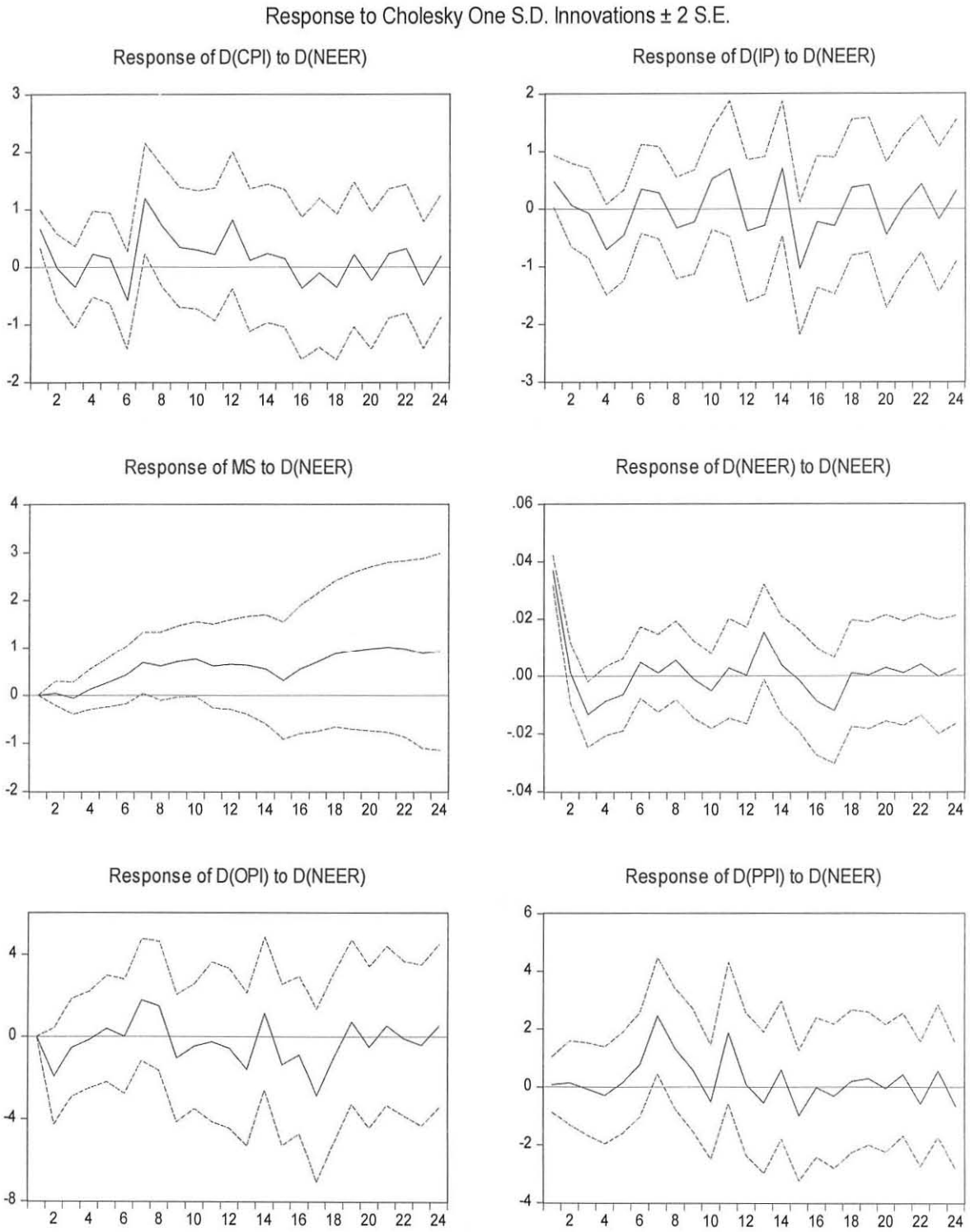
structure of the VAR. An impulse response function traces the effect of a one-time shock to one of the residuals on current and future values of the endogenous variables."

In this study, Cholesky decomposition method is applied for identification of impulse responses. The method assumes that the shock contemporaneously affects the corresponding variables that come later, but does not contemporaneously influence variables that are ordered before. Hence the study uses Cholesky Ordering of:

D (OPI) → MS → D (NEER) → D (IP) → D (PPI) → D (CPI)

The result in figure 2 below shows that, the response of CPI to one standard deviation of NEER shock after a month is 66%. The response reached almost 100% after seven month of the shock in NEER and highly decline after a year and onwards. Import price response. One standard deviation of NEER shock leads to 47% increase in import price after a month and attain it pick after 11 month (70%) and start to decline after wards. The money supply response to exchange rate is zero at the first month but it start to increase and reached 65% after a year. Exchange rate pass though to its self is not that much high. It is 3 % at the first month then decline subsequently. The response of producer price to Exchange rate shock is high after six month of the shock and it reach its pick at the seventh month and decline afterward.

Figure 2: The Impulse Response Functions (IRFs) for exchange rate shock



In order to measure the pass-through coefficient to CPI, the study apply the method called standardization of the exchange rate shock[7] which helps to transform the shock from one standard Deviation to one percent.

Table 3.2: Standardized Exchange Rate Pass-Through to Inflation Coefficient

Month	Coefficient	Month	Coefficient
1	6.89	13	1.59
2	-0.40	14	3.79
3	-7.65	15	2.59
4	4.46	16	-7.37
5	2.86	17	-2.10
6	-9.10	18	-5.85
7	19.96	19	3.70
8	10.99	20	-3.78
9	5.98	21	3.94
10	5.52	22	5.06
11	3.59	23	-5.40
12	13.84	24	3.12
Year Average	**4.75**	**Year Average**	**-0.06**

From table 3.2, a one percent change in exchange rate will result in an increase of inflation by 4.75 percent on average in the first year and almost die out after two years after the shock.

Responses to a Consumer price Shock: the response of variables to one standard deviation of CPI shock display in figure 1 of appendix III. The response of consumer price to CPI shock is high at the first period and starts to decline and almost vanish after the twenty third period. Import price response is relatively low even zero at the first period and then oscillates around zero. Money supply responses negatively to CPI shock

[7] Following the work of Van Minh (2009) and the calculation of the pass-through coefficient is presented in Appendix V

which related to theories. Tight monetary policy is applicable at the time of inflation. Like the central monetary authority introduce credit ceiling to the private commercial banks in Ethiopia.

Responses to Import Price Shock: Figure 2 in Appendix III presents the impulse responses due to a one standard deviation shock of D (IP). Import price and consumer price has a direct relationship. The response of the money supply is positive most of the periods. It can infer that, the government increase money supply either by printing or lending to cover the import bill instead of financing by export. Even if exchange rate response to the shock is positive yet it is too small because the central bank applied managed floating exchange rate.

Responses to Money Supply Shock: a one standard deviation shock of money supply increases the inflation rate. Since expansionary monetary policy increase aggregate demand of the economy, this will leads to increase in inflation. Import price and producer price also increase as the result of the shock on average in the period under consideration. Since Ethiopia is small country – which can not affect world price - oil price response is inconclusive. Given that the central monetary authority managed the exchange rate, Exchange rate response is also inconclusive. The impulse responses due to a one standard deviation shock of money supply is presented in figure 3 of Appendix III.

Responses to oil Price Shock: given that Ethiopia is oil importing country, oil price has a positive shock on average on consumer and producer price. But oil price shock is uncertain when it comes to import price, which oscillate around zero. Money supply has a positive effect to oil price shock. As Ethiopia current account balance is in deficient, the government exercise expansionary monetary policy to pay for the increased oil price. Like for most of the shocks, exchange rate response to oil price is inconclusive since it is managed floating. The impulse responses due to a one standard deviation shock of oil price is depicted in figure 4 of Appendix III.

Responses to Producer Price Shock: Figure 5 in Appendix III presents the impulse responses due to a one standard deviation shock of D (PPI). Even if a shock in producer price increase consumer price on average, it decline significantly. The impulse responses due to a one standard deviation shock of producer price are inconclusive in exchange rate, import price and oil price. Money supply still response positively to producer price shock.

3.3.5 Variance Decomposition Analysis

While the impulse response function (IRF) traces out the effect of a shock originated from an endogenous variable to other variables, variance decomposition (VDC) highlight the percentage share of the movements in the dependent variables that are the outcome of their own shocks, against shocks from the other variables. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR. (Karoro, 2007)

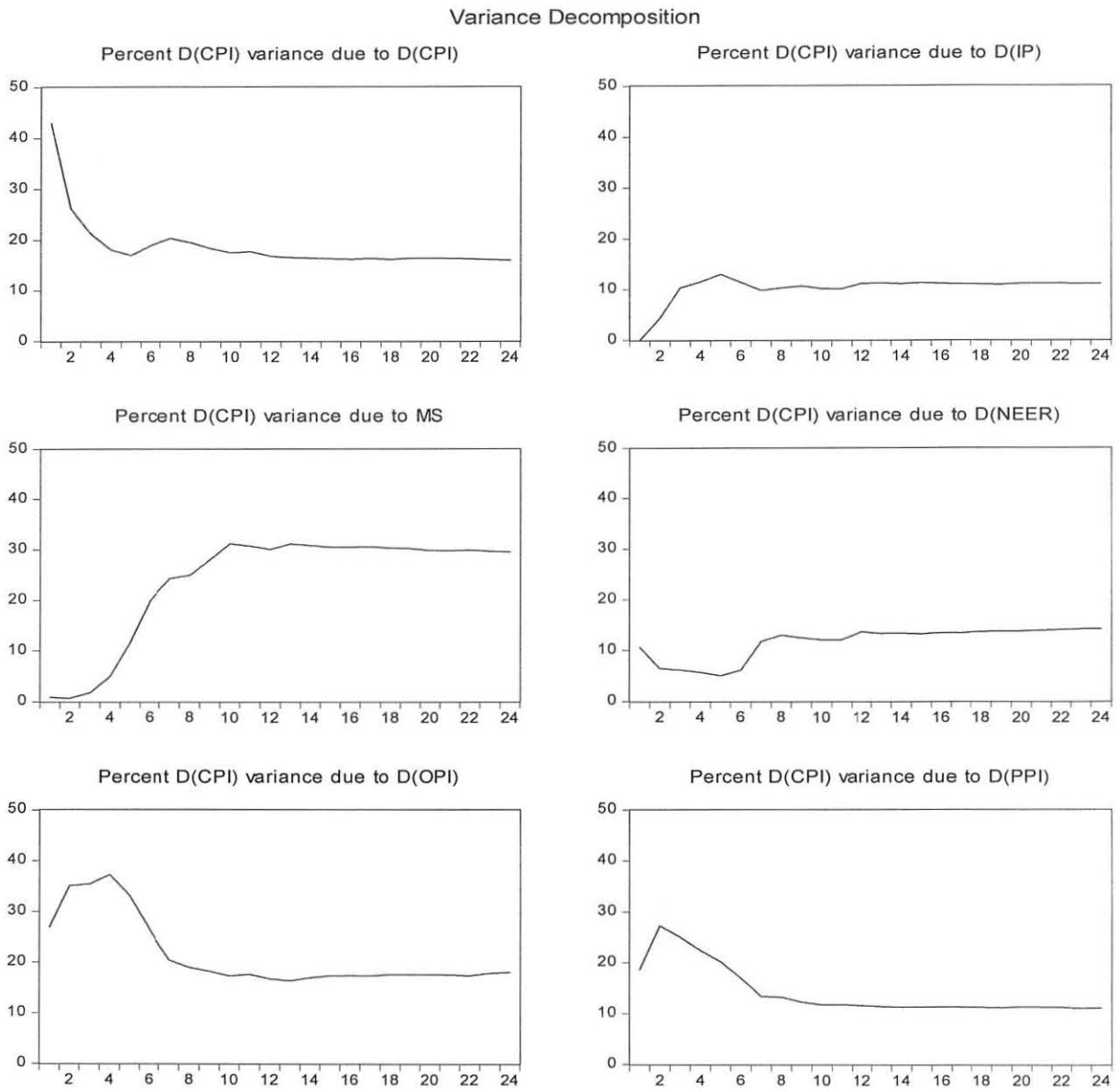
The study use Cholesky decomposition for variance decomposition similar to impulse response function. Furthermore, the estimation applies Cholesky Ordering of:

D (OPI) → MS → D (NEER) → D (IP) → D (PPI) → D (CPI)

The result in figure 3 below shows that show that exchange rate shocks explained 10 percent of the variation in CPI in the first period, decrease to 6% percent on average from second to sixth period. Then increase to 12% in the seventh period and also increase thereafter. The results also show that the variation in CPI is high (approximately 43%) to its own innovation in the first period - which indicates that the significant role price expectation - then decline afterwards. Import price does not explain variation of CPI in the first period. In the second period import price shocks explained only 4 percent of the variation of CPI, which increases to 10 percent and 11 percent in the third and twelfth periods respectively. Money supply shocks are also important in explaining CPI variance especially after the fourth period. Money supply shocks explained 12 percent of the variation in CPI in the fifth period then increase to 30% in the twelfth period. On the

other hand oil price shock explains the highest variance in CPI after its own shock in the first period (27%) and increase to 37% in the fourth period then decline subsequently. The result shows the effect of producer price shock to CPI as well. PPI shock explains 18 percent of the variation in CPI in the first period then increase to 27% in the second period then decline after wards.

Figure 3: CPI Variance Decomposition



On average money supply shock with 24% followed by oil price (21%) and CPI own shocks (19%) are the highest which cause CPI variance. Which clearly show that: monetary policy, external factor (oil price) and price expectations are the main reasons behind the galloping inflation in Ethiopia.

Exchange Rate Variance Decomposition: Figure 1 in Appendix IV presents the variance decomposition of NEER. According to the result, most of the variation in exchange rate is due to its own shock which account 49 % on average. Money supply also share significant amount, with 20% of the exchange rate variance comes from money supply shock on average. CPI, OPI, PPI and IP shocks cause 11%, 8%, 8% and 3% of the variance in exchange rate on average respectively.

Import Price Variance Decomposition: Import price variances mainly appear from its own innovation which constitutes 53% of import price variance on average. This indicates that import price is highly sensitive to world prices. Money supply shock affect import price variance, on average, by 13% followed by exchange rate (11%) and oil price (9%). PPI shock take the slightest effect on import price variation i.e. 6% and CPI shock comprise 8% of import price variance on average. The IP Variance Decomposition is presented in figure 2 of Appendix IV.

Money Supply Variance Decomposition: Figure 3 in Appendix IV presents the variance decomposition of MS. Money supply shock on money supply is considerably high. 85% of the variance in money supply is the result of its own shock on average. Exchange rate innovations seize 9% of the variance in money supply followed by oil price shock which obtain 4% of the variance in money supply. CPI, PPI and IP shock almost do not have any effect on money supply variance.

Oil Price Variance Decomposition: The result in Figure 4 of Appendix IV displays the variance decomposition of OPI. On average, around half (49%) of the variance in oil price is arise from OPI shock itself. Since Ethiopia is a small country, oil price is set irrespective of observing the domestic prices. CPI and money supply shocks each cause

14% of oil price variance. 9% of variance in oil price is appeared from import price and PPI each on average, followed by exchange rate shock which brings the remaining 6% variance in oil price.

Producer Price Variance Decomposition: The result in Figure 5 of Appendix IV displays the variance decomposition of PPI. As the rest of the variables, variance in PPI is mainly arising due to its own innovation. Shocks in PPI cause 29% variation in PPI itself on average. Money supply shock also plays an important role in PPI variation. 23% of the variance in PPI is the result of money supply shock. This may due to the fact that production is affected by availability of fund/credit from the financial sector. The average variation in producer price from shocks from the rest of the variable is as follows; 21% from oil price shock, 12% from Import Price innovation, 9% from exchange rate shock and 6% from consumer price shock.

CHAPTER FOUR

4 Conclusions and Policy Recommendations

This paper investigates the exchange rate pass-through to inflation and other macroeconomic variables in Ethiopia for monthly data range from July 2002(the beginning of Ethiopian fiscal year 2002/03) to June 2011(the end of Ethiopian fiscal year 2010/11). The study apply Six-Variable unrestricted VAR model to estimate the impulse response functions (IRFs) and variance decompositions (VDCs). In order to measure the pass-through coefficient to CPI, the study applies standardization of the exchange rate shock which helps to transform the shock from one standard Deviation to one percent. Hence the result shows that, on average, a one percent change in exchange rate will increase the consumer price by 4.75 percent in the first year. The exchange rate pass-through to inflation almost dies out after two years of the exchange rate shock.

Money supply also has considerable effect on inflation environment of Ethiopia. According to variance decompositions (VDCs) result, 24% of variations in inflation occur as a result of money supply shock. Granger Causality/Block Exogeneity Wald Test also revealed that: CPI has no effect in determining future value and MS. Which implies that the monetary authority do not consider the inflation rate when it sets its money supply in the economy. The result also support Taylor's hypothesis which states that: high inflation leads to high pass-through, on the other hand, a country with lower inflation rate and low inflation volatility leads low pass-through. Hence, in Ethiopia, the inflation rate is one of the highest in the world in recent years hence this leads to a higher pass-through rate which support Taylor's hypothesis. On the other hand, oil price – proxy to external shock – as well affects the inflation rate. Oil price shock on average explains 21% of inflation variance. Furthermore Producer price and import price shock on average explain 14% and 10% of inflation variance respectively.

Since one of the mandate of the National Bank of Ethiopia (NBE) is to stabilize inflation in the country, in the contemporary souring inflation time the NBE should apply

contractionary monetary policy to reduce the inflation rate. Moreover, NBE has to consider Inflation when setting the exchange rate because - according to the findings - inflation is very sensitive to exchange rate movements. Therefore, the resent devaluation by NBE has to be seized to reduce the inflation rate. Price expectation also plays its part in propagating the inflation rate in Ethiopia. Hence, the government should work on changing the attitude of the citizens about high price expectation by avoiding abrupt policy changes. To achieve this, the increased role of NBE will definitely require a carefully developed monetary policy and a strengthening of its institutional capacity.

Oil price also contribute to the high inflation environment of the country. Therefore, the study recommends other source of energy which is cheap and applies endogenous inputs like biofuel. On the other hand foreign supply shocks are also sensitive to money supply so the monetary authority can use monetary tools to curb cost push inflation.

More than half of Import price variation is as a result of the import price itself. This might be the oligopoly nature of the import sector in which importer put much higher profit margin because of less competitiveness. Hence, the government should put some regulation to reduce this price escalation as a result of less competitiveness. In addition to this, Import substitution strategy can also apply to reduce the inflation

Although the study briefly explain the exchange rate pass-through to inflation and other macroeconomic variable, further study needed in this area. For future studies, more research should be applied to investigate whether macroeconomic factors or microeconomic factors have impact on the changes in exchange rate pass-through in Ethiopia.

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Appendices

APPENDIX I: Augmented Dickey-Fuller Test of Unit Root

1, CPI

Null Hypothesis: D(CPI) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic
Augmented Dickey-Fuller test statistic		-5.003922
Test critical values:	1% level	-3.493129
	5% level	-2.888932
	10% level	-2.581453

2, IP

Null Hypothesis: D(IP) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic
Augmented Dickey-Fuller test statistic		-10.05109
Test critical values:	1% level	-3.493747
	5% level	-2.889200
	10% level	-2.581596

3, MS

Null Hypothesis: MS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic
Augmented Dickey-Fuller test statistic		10.23668
Test critical values:	1% level	-3.492523
	5% level	-2.888669
	10% level	-2.581313

4, NEER

Null Hypothesis: D(NEER) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic
Augmented Dickey-Fuller test statistic		-7.785152
Test critical values:	1% level	-3.493129
	5% level	-2.888932
	10% level	-2.581453

5, OPI

Null Hypothesis: D(OPI) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic
Augmented Dickey-Fuller test statistic		-6.113992
Test critical values:	1% level	-3.493129
	5% level	-2.888932
	10% level	-2.581453

6, PPI

Null Hypothesis: D(PPI) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic
Augmented Dickey-Fuller test statistic		-5.511400
Test critical values:	1% level	-3.493129
	5% level	-2.888932
	10% level	-2.581453

APPENDIX II: Granger Causality Test

Dependent variable: D(CPI)

Excluded	Chi-sq	df	Prob.
D(IP)	7.207725	8	0.5144
MS	9.079422	8	0.3356
D(NEER)	24.04728	8	0.0023
D(OPI)	10.23784	8	0.2487
D(PPI)	25.33628	8	0.0014
All	161.0918	40	0.0000

Dependent variable: D(IP)

Excluded	Chi-sq	df	Prob.
D(CPI)	30.59936	8	0.0002
MS	30.32916	8	0.0002
D(NEER)	20.32053	8	0.0092
D(OPI)	26.41375	8	0.0009
D(PPI)	10.89572	8	0.2077
All	96.09186	40	0.0000

Dependent variable: MS

Excluded	Chi-sq	df	Prob.
D(CPI)	3.686862	8	0.8842
D(IP)	8.687415	8	0.3693
D(NEER)	13.95659	8	0.0829
D(OPI)	4.525571	8	0.8069
D(PPI)	7.369362	8	0.4974
All	45.77199	40	0.2450

Dependent variable: D(NEER)

Excluded	Chi-sq	df	Prob.
D(CPI)	22.15552	8	0.0046
D(IP)	3.617662	8	0.8899
MS	31.75239	8	0.0001
D(OPI)	5.824039	8	0.6669
D(PPI)	35.25497	8	0.0000
All	91.47668	40	0.0000

Dependent variable: D(OPI)

Excluded	Chi-sq	df	Prob.
D(CPI)	31.08790	8	0.0001
D(IP)	8.115337	8	0.4223
MS	22.70113	8	0.0038
D(NEER)	8.727504	8	0.3658
D(PPI)	18.11413	8	0.0204
All	83.17674	40	0.0001

Dependent variable: D(PPI)

Excluded	Chi-sq	df	Prob.
D(CPI)	7.496521	8	0.4841
D(IP)	11.39968	8	0.1801
MS	14.38601	8	0.0722
D(NEER)	12.53131	8	0.1290
D(OPI)	22.76977	8	0.0037
All	71.89284	40	0.0015

Appendix III: The Impulse Response Functions (IRFs)

Figure 1: *Impulse Reponses to CPI Shock*

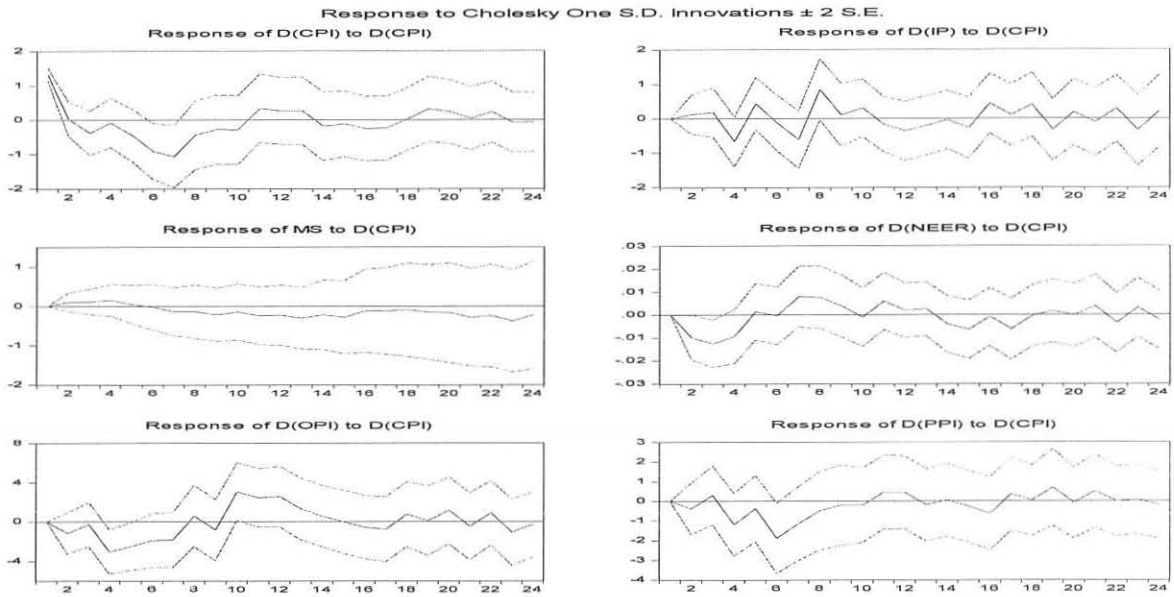


Figure 2: *Impulse Reponses to IP Shock*

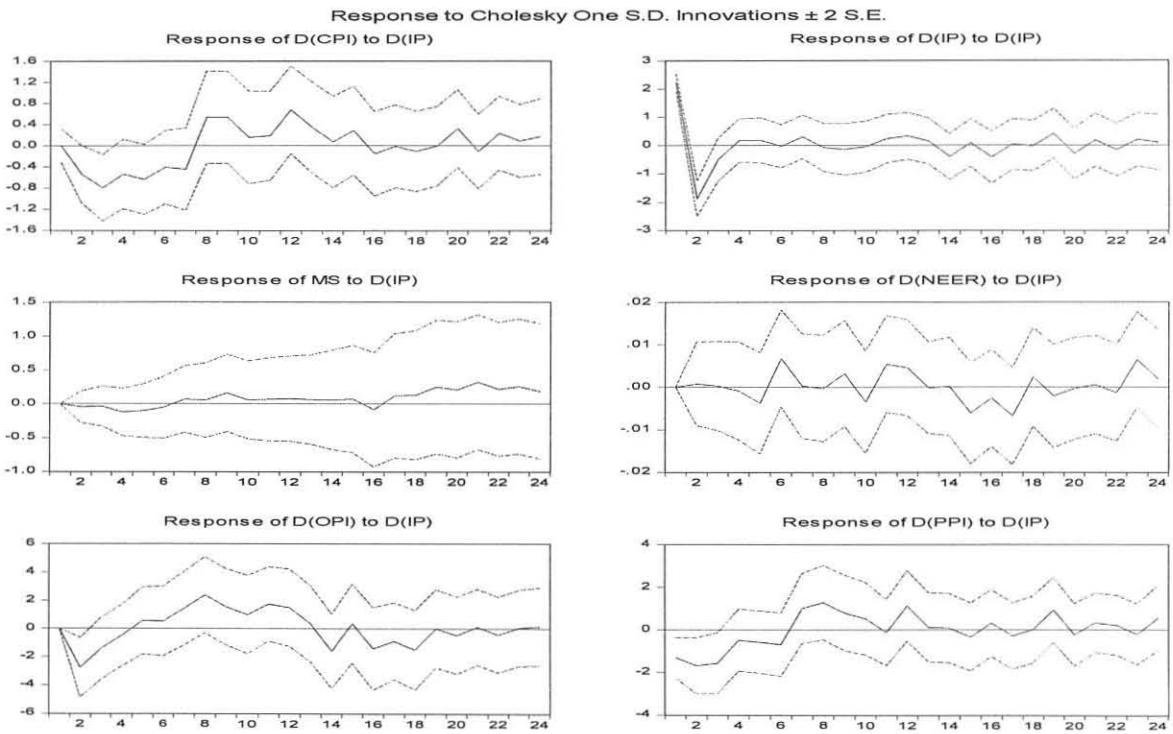


Figure 3: ***Impulse Reponses to MS Shock***

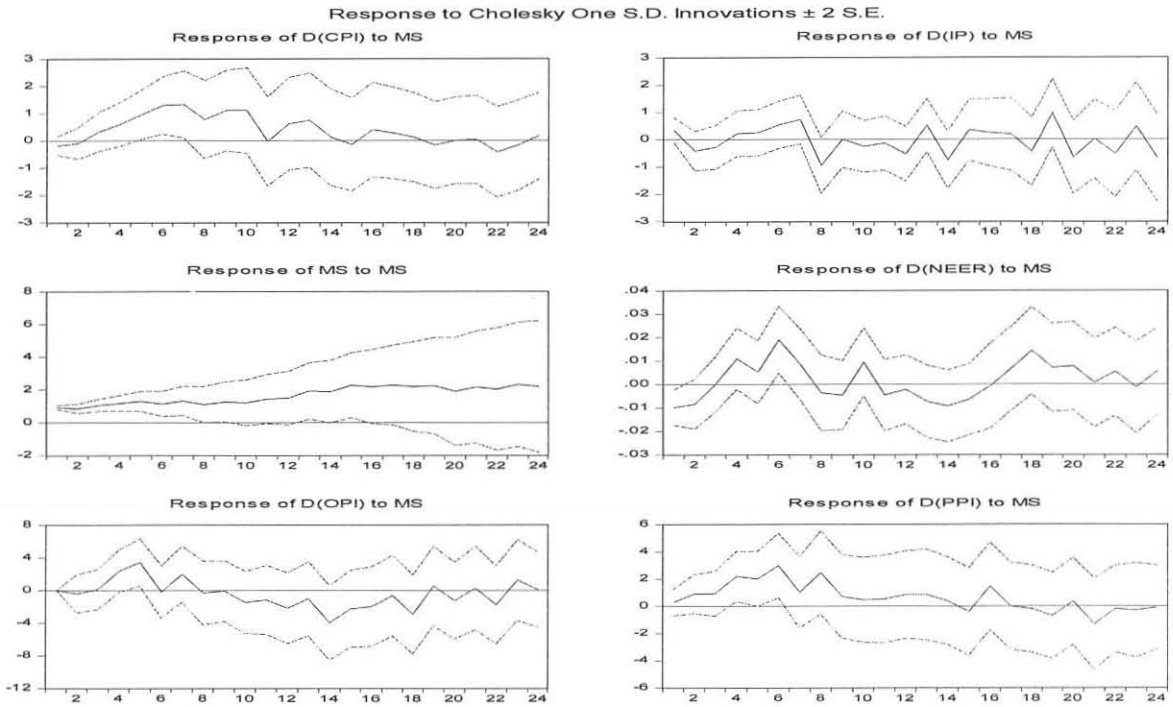


Figure 4: ***Impulse Reponses to OPI Shock***

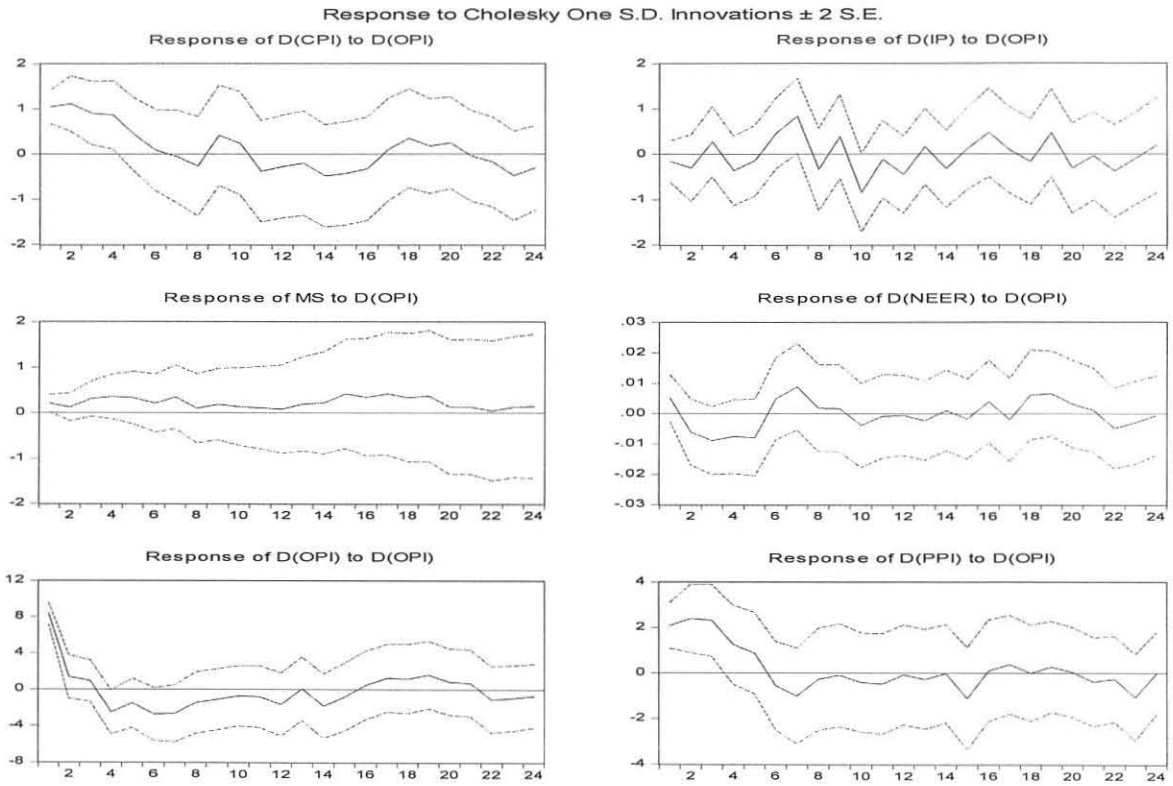
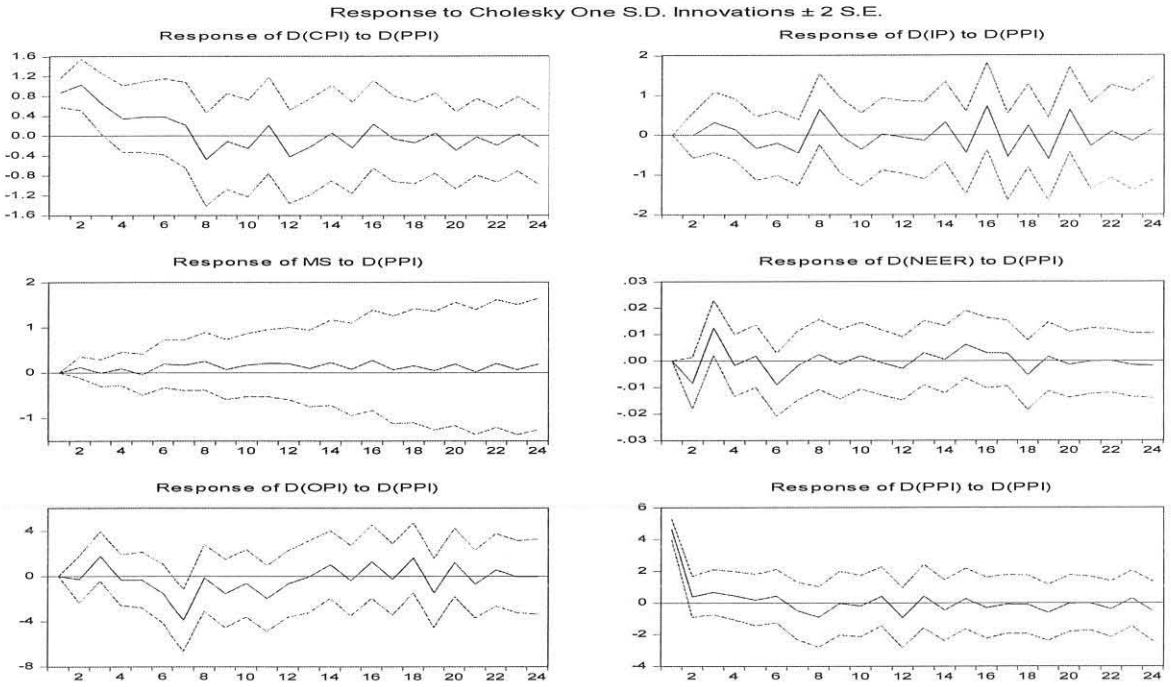


Figure 5: ***Impulse Reponses to PPI Shock***



Appendix IV: Variance Decompositions (VDCs)

Figure 1: Variance Decomposition of NEER

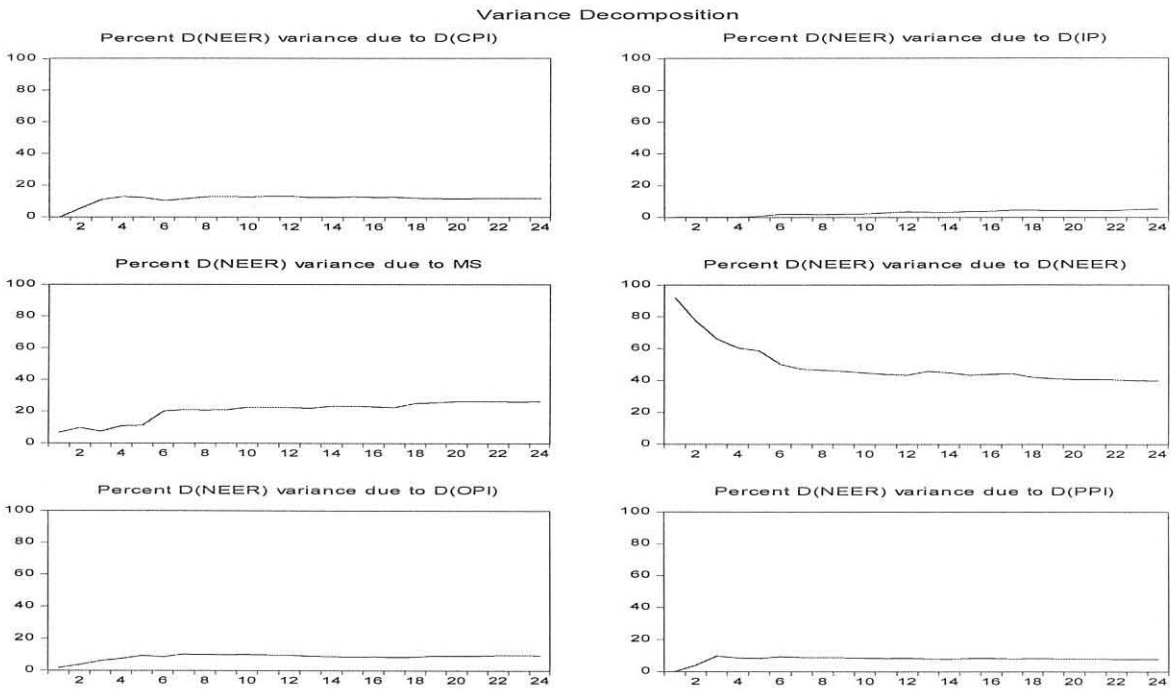


Figure 2: Variance Decomposition of IP

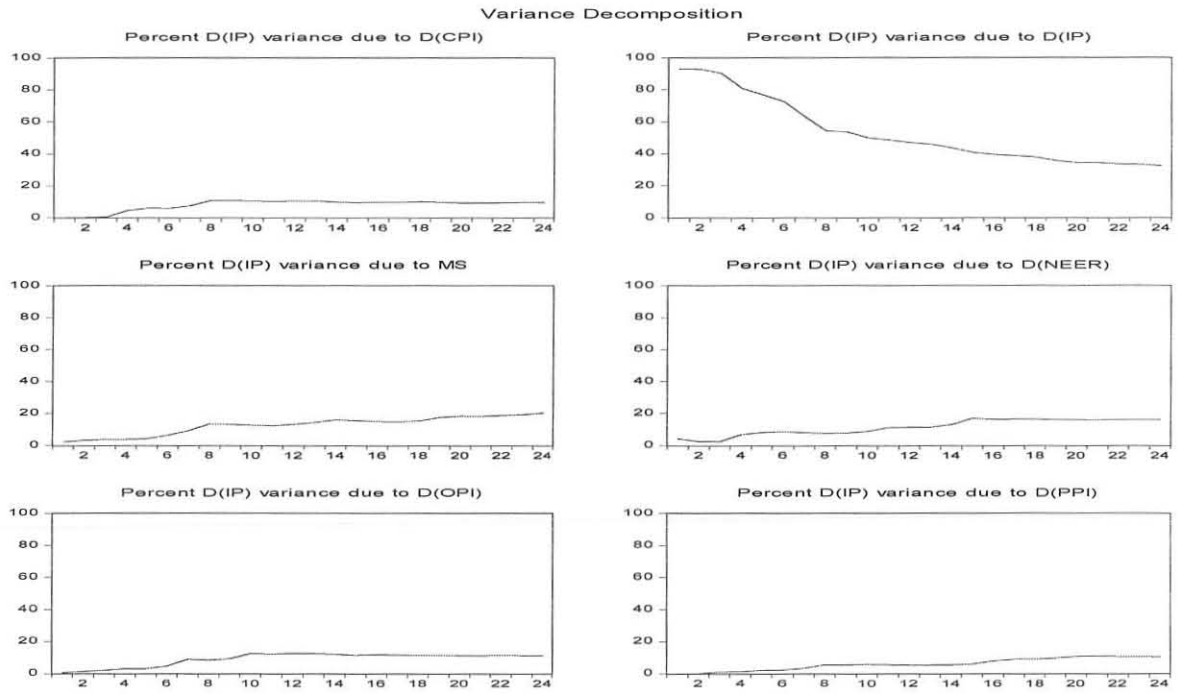


Figure 3: Variance Decomposition of MS

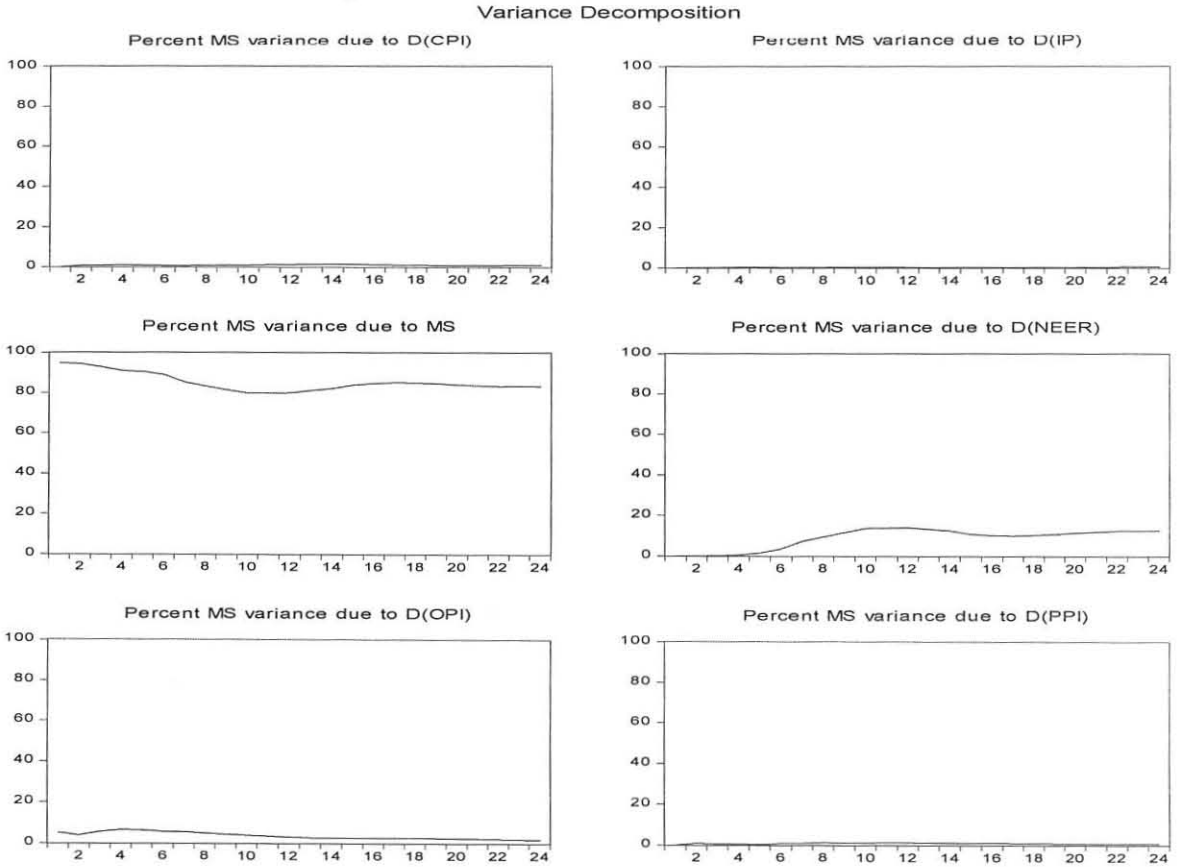


Figure 4: Variance Decomposition of OPI

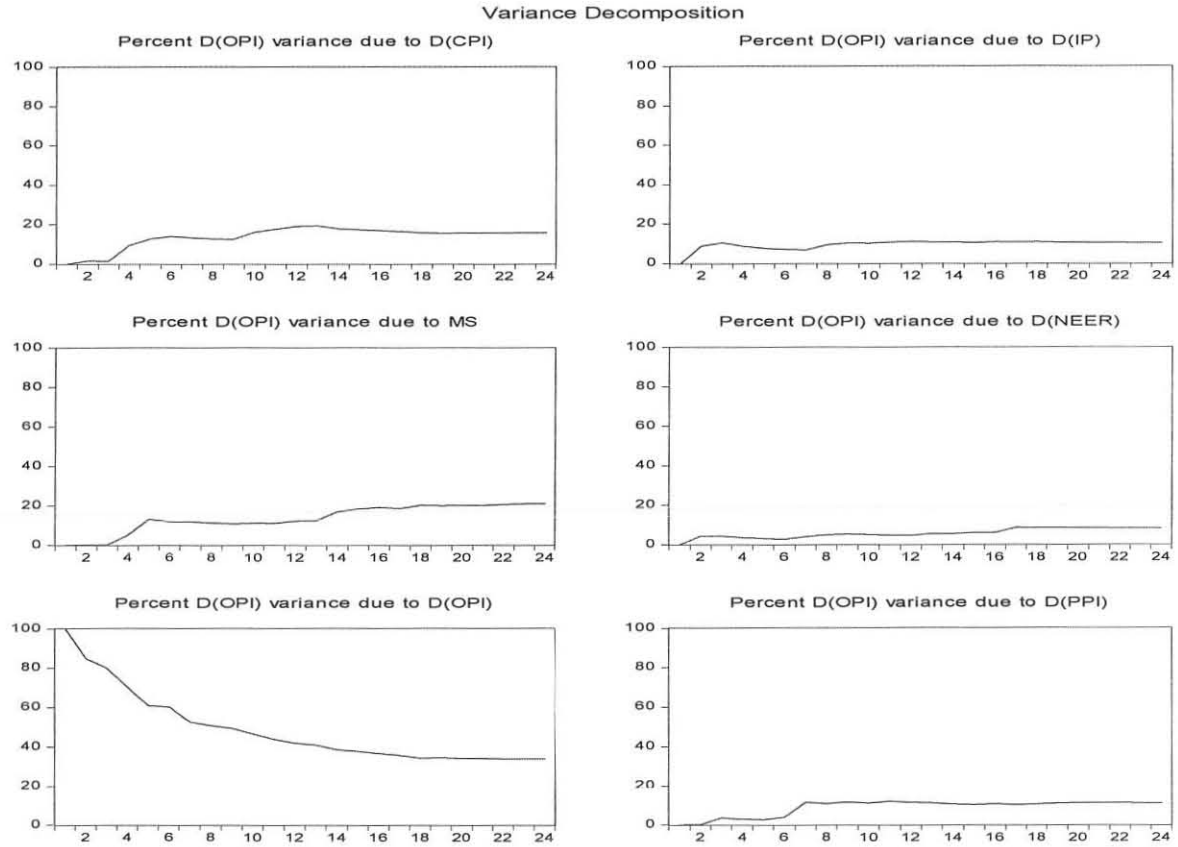
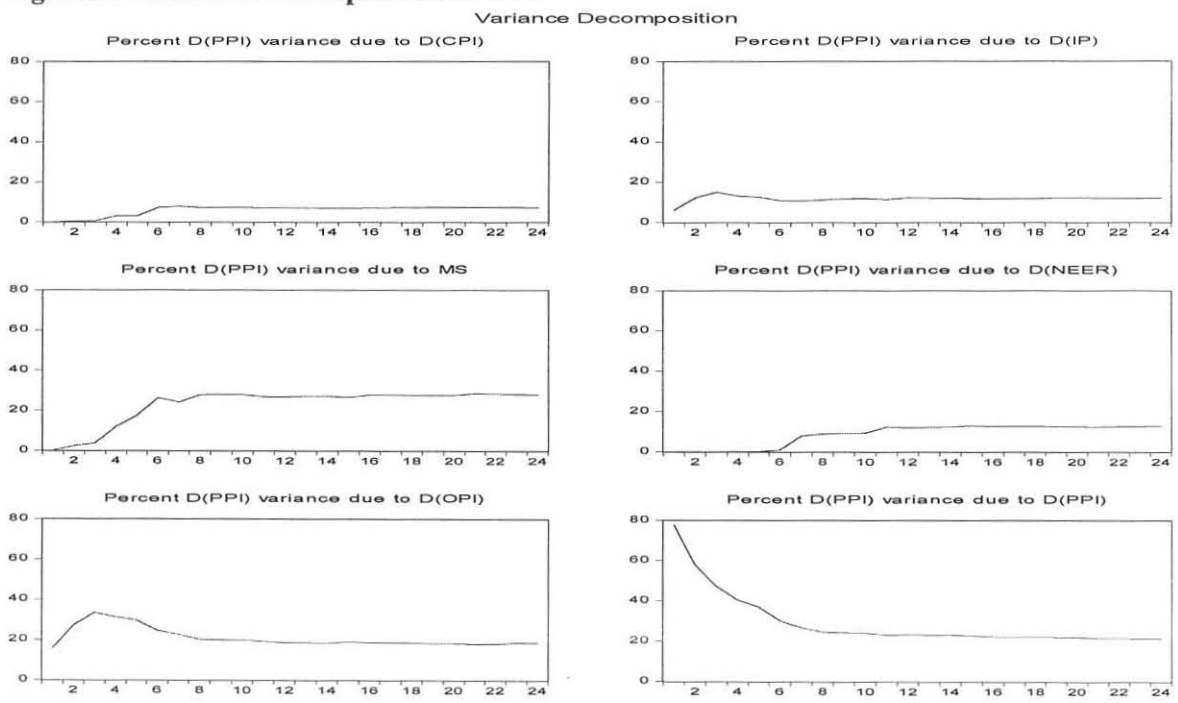


Figure 5: Variance Decomposition of PPI



Appendix V: Calculating the Pass-Through Coefficient for CPI:

Following to Van Minh (2009), the study translate the one standard deviation shock in exchange rate into one percent shock in exchange rate. The shock in one S.D. of D (NEER) is equivalent to 0.058504. The shocks at time t=0 also leads to the change in exchange rate in period i. The change in consumer price in period i as presented in the impulse response function is the result of one S.D. change of D (NEER) at time t=0 (ei) and change in D (NEER) at time t=i. hence, to break down the effect of one percent change in t =0, the accumulated changes of D (NEER) at time t=i is equivalent to Ei = ei+0.058504.

Therefore the Coefficients of Pass-through to consumer price is calculated like this:

$$PT_{t,t+i} = P_{t,t+i}/E_i$$

Where $P_{t,t+i}$denotes the change in indices in period i in response to the initial shock in NEER, E_i is the accumulated impact change of exchange rates to their own shocks (Leigh and Rosi (2002) and Van Minh (2009)).

Table: Exchange Rate Pass-Through Coefficients for Consumer Price

Period	D(NEER)	Ei	D(CPI)	D(CPI)/Ei
1	0.037004	0.095508	0.658071	6.890209
2	0.001310	0.059814	-0.024050	-0.402073
3	-0.013303	0.045201	-0.345612	-7.646177
4	-0.008682	0.049822	0.222359	4.463035
5	-0.006436	0.052068	0.148871	2.859170
6	0.004768	0.063272	-0.576036	-9.104116
7	0.001122	0.059626	1.190345	19.963504
8	0.005604	0.064108	0.704443	10.988361
9	-0.001104	0.057400	0.343102	5.977389

10	-0.005023	0.053481	0.295168	5.519114
11	0.002791	0.061295	0.220163	3.591852
12	0.000285	0.058789	0.813927	13.844778
13	0.015516	0.074020	0.117721	1.590397
14	0.003794	0.062298	0.236165	3.790907
15	-0.001427	0.057077	0.147615	2.586258
16	-0.008701	0.049803	-0.367204	-7.373207
17	-0.011965	0.046539	-0.097904	-2.103700
18	0.001085	0.059589	-0.348694	-5.851660
19	0.000408	0.058912	0.217868	3.698172
20	0.002955	0.061459	-0.232376	-3.781026
21	0.001117	0.059621	0.235150	3.944094
22	0.004085	0.062589	0.316671	5.059539
23	-0.000079	0.058425	-0.315518	-5.400422
24	0.002444	0.060948	0.190251	3.121503

Declaration

I, the undersigned, declare that this project is my original work and has not been presented for a degree in any other university, and that all sources of materials used for the study have been duly acknowledged.

Declared by:

Name: Mohammednur Behru

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Name: Wassie Berhanu (Ph.D)

Signature: _____

Date: _____

Place and date of submission:

_____