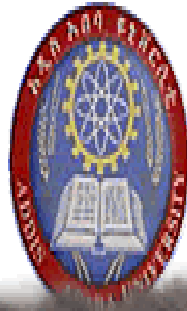


Addis Ababa  
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**The Economy Wide Impact of the Devaluation of Ethiopian  
Currency: A Recursive Dynamic Computable General  
Equilibrium Approach**

**By: Aklilu Abebe Aleto**

**Thesis Submitted to the Department of Economics**

**Presented in Partial Fulfilment of the Requirements for the  
Award of the Degree of Master of Science in Economic Policy  
Analysis**

**Addis Ababa University**

**Addis Ababa, Ethiopia**

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# Addis Ababa University

## School of Graduate Studies

This is to certify that the thesis prepared by Aklilu Abebe Aleto, entitled: *The Economy Wide Impact of the Devaluation of Ethiopian Currency: A Recursive Dynamic Computable General Equilibrium Approach* and submitted in partial fulfillment of the requirements for the Degree of Master of Science in Economic Policy Analysis complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Chair of Department or Graduate Program Coordinator

## **DEDICATION**

This thesis is dedicated to my parents Abebe Aleto and Kahana Katale for their indispensable support and enormous love throughout my life. Without them this achievement is yet unthinkable. They were being with me and behind me through thick and thin.

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## LIST OF ACRONYMS

BOP	Balance of Payments
CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CGE	Computable General Equilibrium
CPI	Consumer Price Index
DCGE	Dynamic Computable General Equilibrium
EDRI	Ethiopian Development Research Institute
EPRDF	Ethiopian Peoples' Revolutionary Democratic Front
EV	Equivalent Variation
EXR	Exchange Rate
FCU	Foreign Currency Units
FSAV	Foreign savings
GDP	Gross Domestic Production
GTAP	Global Trade Analysis Project
IFPRI	Institute of Food Policy Research Institute
IMF	International Monetary Fund
NBE	National Bank of Ethiopia
ROW	Rest of the World
SAM	Social Accounting Matrix
US	United States of America
VAR	Vector Auto Regression
WB	World Bank
WDI	World development Indicators
WTO	World Trade Organization

## **ABSTRACT**

*In recent times, Ethiopia has experienced far-reaching economic growth and development changes. Despite this growth, the country has been chronically running a trade deficit. Devaluation is one of the most important but controversial trade policies recommended by the IMF for most of the developing countries in restoring the trade balance and increasing real GDP growth. To this end, this study analyzes the economy-wide impact of the devaluation of Ethiopian currency (birr) using Dynamic Computable General Equilibrium (DCGE) Model. The model used an updated version of 2009/10 Ethiopian SAM developed by Ethiopian Development Research Institute (EDRI). Three different simulation scenarios have been simultaneously used to evaluate the real impact of devaluation on the economy; 15%, 25% and 35% increase in exchange rate respectively. The findings of the study reveal that devaluation results in a decline in the overall GDP growth and domestic absorption. On the other hand, the trade balance has been improved under all simulation scenarios. Moreover, the productions of agriculture and service sectors expand whereas that of the industrial sector shrinks at a higher rate. By and large, real consumption, fixed investment, GDP, government revenue and household welfare are all adversely affected justifying that devaluation has contractionary effects on the Ethiopian economy. Based on the findings, the researcher suggests the monetary authority to stick to its managed floating policy stance and make changes in cautious and predictable manner. Moreover, there is an obvious need to combine monetary policy measures with fiscal policy in order to promote sustained economic development.*

*Key Words: Devaluation, Exchange rate, DCGE, SAM, Ethiopia, GDP, Export, Import.*

*Trade balance, Welfare, household, government, Deficit*

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

In recent times, Ethiopia has experienced far-reaching economic growth and development changes. According to the World Bank report, the country has achieved remarkable economic growth averaging 11.2 percent for almost half a decade since 2004, which is twice the continental average (Mwanakatwe & Barrow, 2010). According to the report, the expansion of the service sector and agricultural growth contributed most, while the contribution of the manufacturing sector was relatively modest.

Despite the growth in GDP, Ethiopia has been chronically running a negative balance of payments/trade deficit/, rendering the country highly dependent upon foreign aid and loans to finance its imports. The trade deficit was about 20.9% and 19.8% of GDP in 2015 and 2016 respectively (WDI, 2016). The trade deficit was driven by a decline of productive capacity and the incapability of local producers to satisfy local demand, which increased reliance on imported consumer goods, mainly from China and Saudi Arabia.

In order to restore the trade balance, the government has been perused three major devaluations since 1992. One is among the first policy moves by the newly inaugurated Ethiopian Peoples' Revolutionary Democratic Front (EPRDF) took in 1992 where the official exchange rate of the nation jumped from 2.07 birr/dollar to five birr/dollar. When stated in terms of percentage points the devaluation has amounted to 142% which is the highest devaluation rate in Ethiopian history. The other one took effect in September 2010 and had the rate jumping from 13.6 birr/dollars to 16.3 birr/dollars amounting to 16.7 percent. The latest one is the official devaluation of birr against US dollar by 15% in November 2017, which moved up the exchange rate from 23.3 birr per dollar to 27 birr per dollar (NBE, 2017).

In theory, currency devaluation is a tool for enhancing the exports sector of the economy. Devaluation increases the price of a country's imports relative to that of its exports; therefore exporters obtain higher domestic currency revenues from a particular export quantity while imports contract due to the higher domestic currency price of imports. Thus, devaluation

performs similar to a tax on imports and a subsidy to exports. That causes the trade balance to improve which increases output in the economy. Though, devaluation has expansionary effects on output and aggregate demand, there are also reasons why devaluation could be contractionary. Devaluation would affect the supply side of the economy by increasing the cost of imported inputs used in production, resulting in a decline of the aggregate supply in the economy. By increasing the value of transfers from the rest of the world, devaluation may increase the prices and thereby increase the cost of production of exportable goods and domestic goods, adding to the overall rate of inflation. The net effect derives from the combined effects of both the aggregate demand and the aggregate supply shift (Kandil et.al, 2007).

Today, in many countries, especially the developing ones, the weakening of their domestic currency has become a central growth issue. These currency changes can have either expansionary or contractionary effects on economic growth. Many development organizations like IMF and World Bank support the idea of devaluation of currency as one means of economic growth besides the financial aid and loans to their member countries for the development of domestic firms. It will increase the competitiveness of firms and increase the production of domestic products and output. However, some researchers focusing on developing countries (Krugman & Taylor, 1978) shed light on the negative effect of devaluation on output. Despite ambiguous results from empirical studies devaluation of currency has been used and being in use as a growth strategy by many developing countries.

To answer the question whether devaluation has contractionary or expansionary effects on Ethiopian economy, this study attempts to analyze the economy-wide impact of devaluing the exchange rate of Ethiopian currency, the birr.

## **1.2 Statement of the problem**

Devaluation of the domestic currency is one of the major components of the orthodox stabilization strategy. Especially for developing countries, it has been supposed that devaluation is an appropriate macroeconomic policy measure to support the export sector and thereby improving the trade balance. In these regards, higher exports and lower imports will increase the trade surplus of a country and also increases the aggregate demand and which will further increases the overall real GDP. Surprisingly, developing countries like Ethiopia are frequently devaluing their currencies and still, they have a negative trade balance (Acharya, 2010)

Theoretically, devaluation of a local currency is good for the export sector. It would increase the competitiveness of export goods in foreign markets. Consequently, the price of imported commodities will be higher. However, the higher import price would bring inflationary pressure especially for those who import a lot of industrial needs and consumer goods like Ethiopia. Hence, the overall economic impact of devaluation will not be easy to conclude. Therefore, it is mandatory to look at the consequences of devaluation (Mengistu, 2014).

Moreover, the existing partial analyses on the effects of devaluation on real economic activities are mixed, some suggest expansionary effects and others contractionary effects. Connolly (1983) analyzed the effect of a nominal exchange rate on the rate of economic growth. The coefficient obtained was positive and marginally significant, providing some support to the hypothesis of expansionary devaluation. The study by Gylfason and Risager (1984) suggests that devaluations are generally expansionary in developed countries and likely to be contractionary in developing countries. Haile (1999) used a macro simulation approach to study the impact of devaluation on macroeconomic performance of Ethiopia and found that devaluation would improve the current account balance, while it decreases output and employment. Yilkal (2014) studied the short and long run effects of currency devaluation on output growth in Ethiopia using a vector auto-regression model. The findings show that currency devaluations are contractionary in the long run and neutral in the short run.

In addition to the partial analysis mentioned above, some general equilibrium analyses of the effects of devaluations are also available. Taylor and Rosensweig (1984) simulated the effect of a 10% devaluation of the Bhat in real exchange using CGE model for the Thai economy, and demonstrated an increase in real output by 3.3%. Siddig (2011) applied a computable general equilibrium model to investigate the possible economy-wide effects of devaluating the overvalued Sudanese pound as per the IMF recommendation. The results show that devaluation of Sudanese pound reduces absorption, private consumption, total imports, and GDP; while improving exports. Acharya (2010) measured the Potential impacts of the devaluation of Nepalese currency using a Computable general equilibrium approach. To this typical developing economy, he found that devaluation is expansionary but mostly benefits the rich, thus leading to a more uneven income distribution. Eltalla et.al (2013) analyzed the impacts of the devaluation on the Palestinian economy using a computable general equilibrium model. They found that a 15% devaluation of the exchange rate results in a lower real gross domestic product, lower import and low export, lower private consumption and higher inflation.

As discussed so far, several partial analyses in measuring the impacts of the devaluation of the currencies of developing economies are apparent, while studies that followed the general system approach are quite limited. The latter has not yet covered the economy-wide impact of the devaluation of Ethiopian currency at all. Hence, this study tries to fill this gap.

The rationale behind this study is that the devaluation of the domestic currency has been one of the most important policy levers among different components of the conventional structural adjustment programmes of the IMF and World Bank in developing countries such as Ethiopia. The major goal of this policy was to promote exports, reduce imports and thus narrow the deficit in the balance of payments. Accordingly, Ethiopia did devalue its currency by about 15% with reference to the currencies of major trading partners in 2017. However, its explicit impact on the overall economy has seldom been assessed. Therefore, the researcher examined such effects using a recursive dynamic computable general equilibrium (DCGE) model.

### **1.3 Research Questions**

This study attempts to answer the following questions:

- ❖ What are the effects of devaluation of Ethiopian birr on major macroeconomic indicators?
- ❖ How do devaluations affect the sectoral output growth?
- ❖ Does devaluation results in fair distribution of income across households?
- ❖ Do devaluations improve the welfare of the households?

### **1.4 Objectives of the study**

The general objective of the study is to investigate the economy wide impact of Devaluation of Ethiopian currency.

**The specific objectives of the study are:**

- ❖ To estimate the effect of the devaluation of Ethiopian currency on major macroeconomic indicators.
- ❖ To estimate the effect of the devaluation of Ethiopian currency on sectoral output.
- ❖ To examine the distributional effects of the devaluation of Ethiopian currency.
- ❖ To examine the effect of the devaluation of Ethiopian currency on the welfare of households.

## **1.5 Scope/ Delimitation of the study**

The study concentrated mainly on estimating the economy-wide impact of devaluing Ethiopian birr against the US dollar. National Bank of Ethiopia has been devalued the exchange rate of Ethiopian birr against US dollar by 15% from the initial rate of 23ETB per dollar to 27 ETB per dollar in October 2017. Thus, the researcher uses the updated 2009/10 Social Accounting Matrix (SAM) of Ethiopia to investigate the real economic effects following the devaluation.

## **1.6 Significance of the Study**

This study was expected to provide the following importances:

- ❖ It will enable the Ethiopian people to have detailed information regarding the effects of devaluation on the country's economy.
- ❖ It helps policymakers to look for appropriate monetary policy measures which would help to achieve economic stability and thereby cleaning the path for moving towards the middle-income countries.
- ❖ It enables the government to follow appropriate fiscal policy schemes that would match with the current economic situation of the country.
- ❖ Even though the study is conducted on Ethiopia, the results from this study may also hold for other developing countries, especially for most Sub-Saharan countries.
- ❖ The paper might serve as a reference material for other researchers who will conduct related researches.

## **1.7 Organization of the Paper**

This research paper is organized in to six chapters. The first chapter is the introduction part of the study, which includes the background of the study, statement of the problem, research questions and objectives, scope of the study and significance of the study. The second chapter reviews the related literature and empirical works. The theoretical and methodological framework of the study is presented in the third chapter. In the fourth chapter the Ethiopian SAM 2009/10 is characterized and explained in detail. The Dynamic CGE simulation results and their analysis were presented in the fifth chapter. The last chapter winds the study by conclusion and policy recommendations.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Exchange rate and Exchange Rate systems

Exchange rate can simply be defined as the current market price of the home currency exchanged for foreign currency. In other terms, it is a rate at which one country's currency is exchanged for another (Obstfeld & Rogoff, 1995). The nominal exchange rate between two currencies, x and y, can be expressed as  $E(x/y)$ . This expression refers to the price of one unit of currency y in terms of currency x (the number of units of x per one unit of y). This exchange rate is nominal because it is not adjusted for changes in prices. It is bilateral because it is an expression of two currencies in terms of one another (Moosa, 2005).

Exchange rates are determined by demand and supply. But governments can influence those exchange rates in various ways. The extent and nature of government involvement in currency markets define alternative systems of exchange rates. In this section we will examine some common exchange rate systems and explore some of their macroeconomic implications.

According to (Klein & Shambaugh, 2009) there are three main types of exchange rate regimes such as free floating or flexible exchange rate regime, pegged or fixed exchange rate regime, and pegged floating or managed floating exchange rate regime. In free floating system, exchange rates are set purely by private market forces (the supply of and demand for currencies) with no government involvement. In pegged/managed floating system, currency values are allowed to change, but governments participate in currency markets in an effort to influence those values. Finally, governments may seek to fix the values of their currencies, either through participation in the market or through regulatory policy; therefore fixed/pegged exchange rate regime. Let us discuss the three regimes one by one.

##### 2.1.1 Free Floating (flexible) Exchange rate Systems

It is a type of exchange rate in which the value of a nation's currency is allowed to fluctuate based on the demand and supply of the foreign exchange market. The price is determined by market forces of the demand and supply of the foreign currency without any intervention by the government. Therefore, there is a probability of getting different prices for one currency

in terms of the other currency with in specific time interval, following fluctuations in the demand and supply of foreign currency. These fluctuations will lead us to say that there is either depreciation or appreciation of domestic currency (Klein & Shambaugh, 2009).

Currency depreciation is the loss of value of a country's currency with respect to one or more foreign reference currencies, typically in a floating exchange rate system in which no official currency value is maintained. Currency appreciation in the same context is an increase in the value of the currency. In a floating exchange rate system, a currency's value goes up (or down) if the demand for it goes up more (or less) than the supply does. In the short run this can happen unpredictably for a variety of reasons, having to do with trade flows, speculation, or other factors in the international capital market. For example, a surge in purchases of foreign goods by home country residents will cause a surge in demand for foreign currency with which to pay for those goods, causing a depreciation of the home currency. A longer-run trend of appreciation (or depreciation) is likely to be caused by home country inflation being lower (higher) on average than inflation in other countries, according to the principle of long-run purchasing power parity (Pettinger, 2017).

The concept of a completely free-floating exchange rate system is a theoretical one. In practice, all governments or central banks intervene in currency markets in an effort to influence exchange rates. Some countries, such as the United States, intervene to only a small degree, so that the notion of a free-floating exchange rate system comes close to what actually exists in the United States (University of Minnesota, 2016).

According to (Frankel, 2003), floating exchange rate regime has its own advantages for the practicing nation especially if both domestic and international markets for currency are well-developed. First, the system automatically ensures the BOPs equilibrium. In a floating regime the exchange rate automatically adjusts to ensure continues equilibrium between the demand for and supply of the currency. The purchasing power parity theory assumes floating exchange rates adjust until a unit of currency can buy the same basket of goods and services as a unit of another currency. Second, floating exchange rates insulate the domestic economy from foreign price shocks. If there is an increase in foreign prices, provided the exchange rate moves roughly in line with purchasing power parity the domestic currency would merely appreciate so preventing the country from importing foreign inflation. Third, the system ensures monetary autonomy- It gives independence to the monetary policy. Therefore, if the nation faces some shocks from the demand side, the monetary authority will be flexible to

employ any kind of monetary policies to alleviate the ongoing demand deterioration problem (Pilbeam, 2006).

Despite these all advantages, the system is not free from criticism and the three main disadvantages of the system are Uncertainty, high volatility and unpredictability. Since there is no guarantee for both importers and exporters in floating exchange rate regime where the values of exchange rate is changing as the demand and supply of foreign currency changes, investors are not certain about the real earnings from exports and the real costs of imports. This makes investors not to fully employ their resources and produce what they are potentially able to produce. Moreover, due to the existence of speculators and the increase in the supply of Dollar, free floating exchange rate regime increases the volatility of foreign exchange. Lastly, the unpredictable nature of the system may hinder international investors from going to invest in different sectors of the nation. Since the system is highly vulnerable for shocks, both local and international business men should take the risk when they are planning to invest in the nation's economic sectors. This is due to the nature of high dynamism of exchange rate in the floating regime (Moosa, 2005).

### **2.1.2 Fixed (pegged) exchange rate regime**

In a fixed exchange rate system, the exchange rate between two currencies is set by government policy. It is a system in which government plays a significant role in deciding the worth of its currency in terms of either a fixed weight of gold, or a fixed amount of another currency. In other words, Conventional fixed peg arrangements are exchange rate regimes where a country formally pegs its currency at a fixed rate to another currency or a basket of currencies (University of Minnesota, 2016).

The main arguments advanced in favour of the system of fixed or stable exchange rates are as follows. First, fixed exchange regime provides the best environment for the conduct of international trade and investment. This is because of the fact that if the nation uses fixed exchange rate system, it could be easy for merchants and investors to predict about the nation's economy and the outcome of their business as well. Secondly, fixed exchange rates eliminate the speculative activities in the international transactions. Hence, there is no possibility of panic flight of capital from one country to another in the system of fixed exchange rates. Third, fixed exchanges rates are necessary and desirable for the developing countries for carrying out planned development efforts since fluctuating rates disturb the smooth process of economic development and restrict the inflow of foreign capital. Fourth,

uncertainty is no longer a problem in fixed exchange rate system since exchange rate is predictable and non volatile. Therefore, fixed exchange rates ensure certainty about the foreign payments and inspire confidence among the importers and exporters. This helps to promote international trade. Fourth, fixed foreign exchange rate ensures internal economic stabilization and checks unwarranted changes in the prices within the economy. Lastly, fixed exchange rate system is anti-inflationary in character. If exchange rate is allowed to decline in value, import goods tend to become dearer. High cost import goods then fuels inflation. Such a situation can be prevented by making the exchange rate fixed (Calvo & Mishkin, 2003; Pilbeam, 2006).

Though, fixed exchange rate system has many advantages, it has been criticized on the following grounds. First, the system cannot automatically adjust itself. Fixed exchange rate mainly aims to adjust the balance of trade but when a trade deficit occurs, there will be more demand for the hard (foreign) currency which will lead the price of the foreign currency to increase in terms of the domestic currency. Second, in order to keep the exchange rate stable, central bank has to withdraw hard currencies from its reserves since appreciation or depreciation is not allowed in the system. This may create some financial inconveniences especially in the case of LDCs. Third; the system cannot function in the places where the financial and the banking system are not well developed. The absence of strong financial, monetary and banking institutions may make pegged exchange rate system difficult for emerging countries. Since the system needs much more hard currency reserve in order to adjust and maintain the exchange rates stable, the central bank needs to hold stocks of both foreign and domestic currencies at all times. However, developing countries find it difficult to maintain an adequate volume of foreign exchange reserves. Lastly, pegged exchange rate mostly narrows the scope of the flexibility of the monetary policy. Under the fixed exchange rate system, the monetary authority is deprived of its monetary independence (Calvo & Mishkin, 2003).

### **2.1.3 Managed (Dirty) floating exchange rate regime**

Managed floating exchange rate system is a system which combines (in between) both fixed and floating exchange rates. On one hand, it allows the market to adjust the exchange rate and arrives at its equilibrium level. On the other hand it allows the government to intervene in to the exchange market whenever intervention is needed so as to protect the domestic currency,

trade balance and nation's economy from external shocks. Hence, a managed float is halfway between a fixed exchange rate and a flexible one.

The managed float is basically a flexible exchange rate system in which rates are permitted to float, but the central bank intervenes on a regular basis to keep the rate within some agreed upon limits. Government can influence exchange rates, usually through the Central Bank by buying and selling both domestic and foreign currency. In an increasingly integrated world economy, the currency rates impact any given country's economy through the trade balance. In this aspect, almost all currencies are managed since central banks or governments intervene to influence the value of their currencies. However, because most floating currencies manage their regimes with occasional central bank involvement, the term applies mainly to frequent or dramatic interventions (MacDonald, 2007).

Most nations of the world currently use a managed floating exchange rate policy. With this alternative an exchange rate is free to rise and fall, but it is subject to government control if it moves too high or too low. The Ethiopian government is also one of the countries following this system since 1990's.

Like floating exchange rate regime where fluctuations in the demand for and supply of foreign currency lead to depreciation and appreciation of domestic currency, there are official changes in the price of a currency in a fixed and managed floating exchange rate systems. When the price of the domestic currency in terms of foreign currency is officially decreased, the exchange rate is said to be devalued. Revaluation in the same context is an official increase in the value of the domestic currency within a fixed or managed floating exchange rate system (Salvatore, 2013).

As a system, managed floating has its own advantages and drawbacks. The main advantage of managed floating exchange rate system is that, it assures some sort of stability both in the financial market and in the economy as a whole since the government occasionally intervenes in to the foreign exchange market. Therefore, the regime is able to avoid a dramatic currency fluctuations and financial speculations in domestic market. Moreover, it assures some sort of exchange market independence therefore the regime promotes better allocation of resources and improvement of the BOP account (Bofinger & Wollmershäuser, 2001).

There are also some drawbacks of managed floats. Primarily, whenever the central bank does not pre-announce the exchange rate path, the private sectors wouldn't predict about the future

economic situations by using current exchange rate specially when there is disinflation in the economy. This creates uncertainty and discourages investment. Secondly, if the control over the exchange rate is asymmetric or mismatch with the needed rate of exchange, and huge amount of capital out flow taken place following the misalignment, the central bank may lose its control over the macroeconomic situation. Third, as long as the central bank or the government is able to decide autonomously over the exchange rate, there is a serious risk that managed floating is misused for a **beggar-my-neighbour policy**- a kind of policy that makes countries to promote their economy at the expense of their neighbours, which undermine the aims of the WTO (Bofinger & Wollmershäuser, 2001).

Even though the above mentioned ones are basic types of exchange rate regimes, there are also other exchange rate regimes such as **dollarization**- a situation where a country, either officially or unofficially, uses a different country's currency as legal tender for conducting transactions; which usually occurs in developing countries with a weak central government or an unstable economic environment (Plate & Herrero, 2008). The best example is Zimbabwe. However, the main concern of this paper is on currency devaluation in Ethiopia and Ethiopian exchange rate regime is among the basic exchange rate regimes discussed so far it is not required to go in to more details.

## **2.2 Devaluation and its Theories**

Devaluation of a currency is a deliberate act by the central bank of a country to reduce the value of its currency in relation to other countries currency. In other words, **devaluation** is an official downward adjustment to the value of a country's currency relative to another currency, group of currencies or standard. For example, the National Bank of Ethiopia has recently devalued the Ethiopian birr against the US dollar by 15% from its initial rate of 23 ETB per US dollar. This means that you would give 27 ETB instead of 23 ETB for the same dollar.

Often, people are confused with the terms devaluation and depreciation; also some used interchangeably. Both devaluation and depreciation causes the value of one country's currency to decline. However, they have two different causes. Devaluation is a deliberate act by the central bank of a country following fixed or managed floating exchange rate regimes to reduce the value of its currency in relation to other countries currency, where as depreciation is the fall in the value of a country currency in relation to other countries

currency resulting from the forces of demand and supply of the currency. Devaluation can occur either in fixed or managed floating exchange rate regime whereas, depreciation occurs only in free floating exchange rate regime.

**Devaluation** is a monetary policy tool used by countries that have a fixed exchange rate or semi-fixed exchange rate. In theory, currency devaluation is a tool for enhancing the exports sector of the economy. Devaluation increases the price of a country's imports relative to that of its exports; therefore exporters obtain higher domestic currency revenues from a particular export quantity while imports contract due to the higher domestic currency price of imports. Thus, devaluation performs similar to a tax on imports and a subsidy to exports. That causes the trade balance to recover. This tends to improve the foreign sector, which increases output in the economy (Kandil et.al, 2007).

There is a debate on the effectiveness of devaluation in improving the nation's trade balance based on their theoretical and empirical researches. Bahmani-Oskooee and Niroomand (1998) described that the effect of devaluation on trade balance could be determined by the sum of elasticity of demand for import and export in absolute value. If the sum of the absolute value of elasticity of demand for import and export is greater than 1, devaluation results improvement for the nation's trade balance and if it is less than 1, the trade balance gets more worsen as devaluation adopted as a policy. However, there are also groups who believe that the elasticities do not matter, and the trade balance improves only if the nation's GDP increases faster than domestic spending.

Monetarists, by contrast, argue that only money demand and supply matter, and devaluation always improve the trade balance. Accordingly, devaluation or depreciation decreases the real supply of money, resulting in an excess demand for money. This leads to hoarding and an increase or improvement in the trade balance (Salvatore, 2013).

Devaluation has its own effect on the nation's trade balance and different countries would like to adopt devaluation as a monetary policy, so as to overcome their economic constraints caused by over valuation of their own currency but the effect of devaluation on developing countries is quite different from that of the developed ones.

This reality leads economists to come up with three different approaches of devaluation namely the elasticity approach, the absorption approach and the monetary approach.

### 2.2.1 Elasticity Approach to Devaluation

The elasticity approach to Devaluation provides an analysis of what happens to the current account balance when a country devalues its currency. The approach is associated with the Marshall-Lerner condition which was worked out independently by these two economists. It studies the conditions under which exchange rate changes restore equilibrium in BOP by devaluing a country's currency. This approach is related to the price effect of devaluation.

The elasticity approach to devaluation based on the Marshall-Lerner condition rests on several restrictive assumptions. First, the analysis is founded upon partial equilibrium in the sense that it considers only the effect of exchange-rate variations in the market for exports and imports, and everything else is held constant. In practice everything else will not remain constant. Exchange rate changes will have price effects elsewhere in the system which will shift the demand curves for exports and imports. Income will also change, affecting the demand curves for exports and imports. A second restrictive assumption is that all relevant elasticities of supply of output are assumed to be infinite so that the price of exports in the home currency does not rise as demand increases, the price of foreign goods that compete with exports does not fall as demand for them falls, the price of imports in foreign currency does not fall as the demand for imports falls, and the price of domestic goods competing with imports does not rise as the demand for import substitutes increases. Third, the elasticity approach ignores the monetary effects of exchange-rate changes. Finally, it is assumed that trade is initially balanced and that the change in the exchange rate is a small one. The Marshall-Lerner condition is easily modified to cover the case where trade is initially unbalanced, but the small-change assumption is necessary so that second-order interaction terms arising from changes in multiplicative variables can be ignored (*Thirlwall, 1982*).

Given these assumptions, when a country devalues its currency, the domestic prices of its imports are raised and the foreign prices of its exports are reduced. Thus devaluation helps to improve BOP deficit of a country by increasing its exports and reducing its imports. But the extent to which it will succeed depends on the country's price elasticities of domestic demand for imports and foreign demand for exports. This is what the Marshall-Lerner condition states: when the sum of price elasticities of demand for exports and imports in absolute terms is greater than unity, devaluation will improve the country's balance of payments, i.e.  $e_x + e_m > 1$ , where  $e_x$  is the demand elasticity of exports and  $e_m$  is the demand elasticity for imports. On the contrary, if the sum of price elasticities of demand for exports and imports in absolute

terms is less unity,  $e_x + e_m < 1$ , devaluation will worsen (increase the deficit) the BOP. If the sum of these elasticities in absolute terms is equal to unity,  $e_x + e_m = 1$ , devaluation has no effect on the BOP situation which will remain unchanged (*Pilbeam, 2006*)

The central message of the elasticity approach is that there are two direct effects of a devaluation on the current balance, one of which works to reduce a deficit, whilst the other actually contributes to making the deficit worse than before. Let us consider these two effects in detail.

The current account balance when expressed in terms of the domestic currency is given by:

$$CA = PX_v - E \cdot (P^*M_v) \text{----- (1)}$$

Where P is the domestic price level,  $X_v$  is the volume of domestic exports, E is the exchange rate (domestic currency units per unit of foreign currency),  $P^*$  is the foreign price level and  $M_v$  is the volume of imports. Setting the domestic and foreign price levels at unity; the value of domestic exports ( $PX_v$ ) is given by X; while the foreign currency value of imports ( $P^*M_v$ ) is given by M. Using these simplifications equation (1) becomes:

$$CA = X - E \cdot M \text{----- (2)}$$

Differencing equation (2) with respect to E, we obtain:

$$\frac{dCA}{dE} = \frac{dX}{dE} - E \frac{dM}{dE} - M \frac{dE}{dE} \text{----- (3)}$$

Recall that the price elasticity of demand for exports  $\eta_x$ , is defined as the percentage change in exports over the percentage change in price as represented by the percentage change in the exchange rate, giving:  $\eta_x = \frac{dX/X}{dE/E}$ ,

$$\text{So that, } dX = \frac{\eta_x dE X}{E} \text{----- (4)}$$

Likewise, the price elasticity of imports  $\eta_m$ , is defined as the percentage change in imports over the percentage change in their price as represented by the percentage change in the exchange rate (we place a negative as we wish to express elasticity as a positive number):

$$\eta_m = - \frac{dM/M}{dE/E} ,$$

$$\text{So that, } dM = - \frac{\eta_m dE M}{E} \text{----- (5)}$$

Substituting equations (4) and (5) in to equation (3) we obtain:

$$\frac{dCA}{dE} = \frac{\eta_x X}{E} + \eta_m M - M \text{ ----- (6)}$$

Dividing equation (5) by M, we obtain,

$$\frac{dCA}{dE} \frac{1}{M} = \frac{\eta_x X}{E M} + \eta_m - 1 \text{ ----- (7)}$$

Assuming that we initially have a balanced trade,  $X/EM = 1$ , and rearranging equation (7) we obtain:

$$\frac{dCA}{dE} = M(\eta_x + \eta_m - 1) \text{ ----- (8)}$$

Equation (8) is known as the Marshall- Lerner condition and says that starting from a position of equilibrium in the current account, devaluation will improve the current account, that is  $dCA/dE > 0$  only if the sum of the foreign elasticity of demand for exports and the home country elasticity of for imports is greater than unity; that is,  $\eta_x + \eta_m > 1$ . If the sum of these two elasticities is less than unity, then devaluation will lead to a deterioration of the current account (*Pilbeam, 2006*).

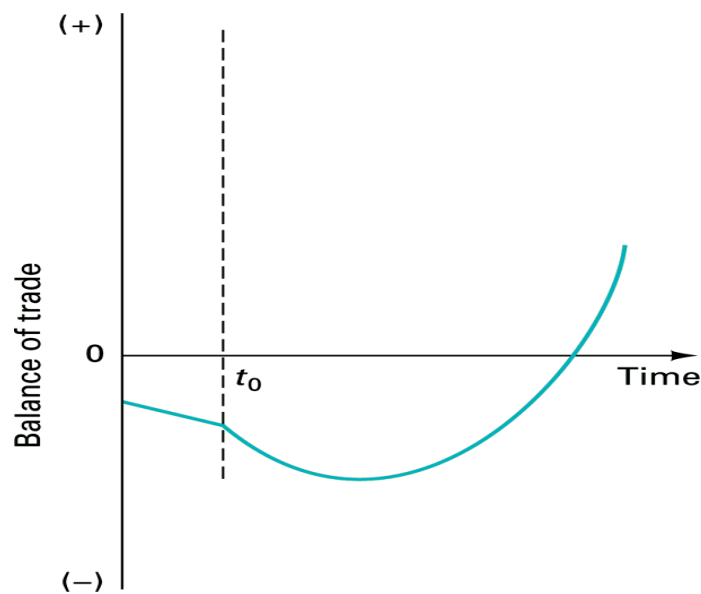
The possibility that devaluation may lead to a worsening rather than improvement in the balance of payments led to much research in to empirical estimates of the elasticity of demand for exports and imports. Economists divided in to two camps popularly known as ‘elasticity optimists’ who believed that these elasticities tended to exceed unity, and ‘elasticity pessimists’ who believed that these elasticities tended to less than unity. It was argued that devaluation may work better for industrialized countries than for developing countries. The main reason is that, many developing countries are heavily dependent up on imports, and their price elasticity of demand for imports was likely to be very low. However, for industrialized countries that have to face competitive export markets the price elasticity of demand for their exports is more likely to be elastic. The implication of the Marshall-Lerner condition was that devaluation may be a cure for some countries’ balance of payments deficits but not for others (*Pilbeam, 2006*).

A general consensus accepted by most economists is that elasticities are lower in the short run than in the long run, in which case the Marshall- Lerner conditions may not hold in the short run but may hold in medium to long run. Goldstein and Kahn (1985) is an excellent survey of the empirical literature conclude that, in general, long run elasticities (greater than

two years) are approximately twice as great as short run elasticities (less than a year). In simple terms, the short run elasticities generally fail to sum to unity, while the long run elasticities almost always sum to greater than unity (*Pilbeam, 2006*).

This possibility that the Marshall- Lerner condition may not be fulfilled in the short run although it generally holds over the long run leads to the phenomenon of what is popularly known as the J-curve effect of devaluation. The explanation is that when a country's trade balance is plotted on the vertical axis, the response of the trade balance to devaluation looks like letter **J** (*Petrović and Gligorić, 2010*). This is demonstrated in Figure 2.1 below.

**Figure 2.1: The J- Curve effect of Devaluation**



**Source: - Husted & Melvin, 2009**

The idea underlying the J-curve effect is that in the short run export volumes and import volumes do not change much so that the country receives less export revenue and spends more on imports leading to deterioration in the current balance. However, after a time lag export volumes start to increase and import volumes start to decline, and consequently the current deficit starts to improve and eventually moves in to surplus (*Pilbeam, 2006*).

### **Criticisms of Elasticity Approach**

The elasticity approach based on the Marshall-Lerner condition has many defects. Some of the limitations of the approach are the following. First, the elasticity approach has been criticized because it uses partial elasticities which exclude all factors except relative prices

and quantities of exports and imports which make it unrealistic. This is applicable only to single-commodity trade rather than to a multi-commodity trade. Second, the Marshall-Lerner condition assumes perfectly elastic supplies of exports and imports. But this assumption is unrealistic because the country may not be in a position to increase the supply of its exports when they become cheap with devaluation of its currency. Thirdly, the elasticity approach ignores the effects of devaluation on income distribution. Devaluation leads to the reallocation of resources. It takes away resources from the sector producing non-traded goods to export and import-competing industries sector. This will tend to increase the incomes of the factors of production employed in the latter sector and reduce that of the former sector. Fourth, elasticity approach ignores the feedback effects of a price change in one product on incomes, and consequently on the demand for goods. This is a serious defect of the elasticity approach because the effects of devaluation always spread to the entire economy. Fifth, the J-curve effect of devaluation shows that the Marshall-Lerner condition is applicable in the long-run and not in the short run. This is because it takes time for consumers and producers to adjust themselves when there is devaluation of the domestic currency. Lastly, under elasticity approach devaluation can have an inflationary impact, on the economy. Even if it succeeds in improving the balance of payments, it is likely to increase domestic incomes in export and import competing industries. But these increased incomes will affect the BOP directly by increasing the demand for imports, and indirectly by increasing the overall demand and thus raising the prices within the country (Micro Economics Notes, 2018).

### **2.2.2 Absorption Approach to Devaluation**

This approach was developed by Sidney Alexander in his paper “Effects of devaluation on a trade balance”, published in IMF Staff Papers in the year 1952. This approach relaxes the assumption taken by elasticity approach and laid emphasis on the macro economics (income) effects of devaluation. The paper focuses on the fact that a current account imbalance can be viewed as the difference between domestic output and domestic absorption. The term absorption in economics means that the total demand for all consumer goods and services by all the economic agents’ residing in an economy, nevertheless of the creation of all the goods and services themselves (Kaur, 2012).

Alexander began with the identity that national income (Y) is sum of consumption (C), domestic investment (Private investment-I and Government spending-G) and foreign investment or trade balance (Export minus Import):

$$\text{Hence, } Y = C + I + G + (X - M) \text{ ----- (1)}$$

Taking the national income equation  $Y = C + I + G + X - M$ , and labelling domestic absorption A, we have:  $A = C + I + G$ ,

Equation (1) can be rearranged as follows:

$$CA = X - M = Y - (C + I + G) = Y - A \text{ ----- (2)}$$

Equation (2) says that current account balance represents the difference between domestic output and domestic absorption. A current account surplus means that domestic output exceeds domestic spending, while a current account deficit means that domestic output is less than domestic spending.

Differencing equation (2) yields:

$$dCA = dY - dA \text{ ----- (3)}$$

This equation implies that the effects of devaluation on the current balance will depend up on how it affects national income relative to how it affects domestic absorption which is the central issue of absorption approach to devaluation. If devaluation raises domestic income relative to domestic spending (absorption) current account improves. On the other hand, if devaluation raises domestic absorption relative to domestic income, the current account deteriorates (*Pilbeam, 2006*)

Absorption can be divided up in to two parts: a rise in income will lead to an increase in absorption which is determined by the marginal propensity to absorb,  $\alpha$ , but there will also be a ‘direct effect’ on absorption resulting from devaluation denoted by  $A_d$ . Thus the change in total absorption  $dA$  is given by:

$$dA = \alpha dY + dA_d \text{ ----- (4)}$$

Substituting equation (4) in to equation (3) yields:

$$dCA = (1 - \alpha)dY - dAd \text{ ----- (5)}$$

From Equation (5) we can understand that there are three factors that need to be examined when considering the impact of devaluation. Devaluation can affect the current balance only by changing the marginal propensity to absorb,  $\alpha$ , changing the level of income  $dy$ , and by changing direct absorption. The condition for a devaluation to improve the current account is  $(1 - \alpha)dY > dAd$ , that is, any change in income not spent on absorption must exceed any change in direct absorption. These factors, in turn, are influenced by the existence of unemployed or idle resources and fully employed resources in the devaluing country (*Pilbeam, 2006*).

If there are some unemployed resources in the economy which further results in the improvement in the balance of current account, there will be an increase in net exports following a devaluation which will lead to an increase in national income. If there are already full employment resources in the economy because of national income cannot be increased, devaluation may cause inflation in the economy. Moreover, if the devaluation reduces direct absorption, then devaluation will lead to an improvement in the current balance, whereas if direct absorption increases then the effect on the current balance will lead to a deterioration of the current account.

### **Criticisms of Absorption Approach**

The absorption approach to devaluation has been criticized on the following grounds. First, it neglects the price effects of devaluation which are very important. The approach places more emphasis on the level of domestic consumption than on relative prices. Second, it ignores effects on other countries. The absorption approach is weak in that it relies too much on policies designed to influence domestic absorption. It does not study the effects of devaluation on the absorption of other countries. Third, the absorption approach fails as a corrective measure of balance of payment deficit under a fixed exchange rate system. When prices rise with devaluation, people reduce their consumption expenditure. With money supply remaining constant, interest rate rises which brings a fall in output along with absorption. Thus, devaluation will have little effect on the balance of payment deficit (*Micro Economics Notes, 2018*).

### 2.2.3 Monetary Approach to Devaluation

The Monetary approach to devaluation was started toward the end of the 1960s by Robert Mundell and Harry Johnson and became fully developed during the 1970s. The monetary approach represents an extension of domestic monetarism (stemming from the Chicago school) to the international economy in that it views the balance of payments as a monetary phenomenon. That is, money plays the crucial role in the long run both as a disturbance and as an adjustment in the nation's balance of payments (Salvatore, 2013).

The focus of the monetary approach to devaluation is on the balance of payments as a whole (the current and the capital account) so that balance of payments disequilibrium is equivalent to a change in the level of international reserves. Accordingly, the balance of payments disequilibrium is the outcome of stock disequilibrium between the supply of and demand for money. According to this approach, "a balance of payments deficit is always and everywhere a monetary phenomenon." Therefore, it can only be corrected by monetary measures (Thirlwall, 1982).

In the following sections, we will examine the monetary approach under fixed exchange rates and flexible exchange rates.

#### 2.2.3.1 Monetary Approach under Fixed Exchange Rate Regime

The monetary approach begins by postulating that the demand for nominal money balances is positively related to the level of nominal national income and is stable in the long run. Hence, the equation for the demand for money can be written as:

$$M^d = kPY \text{ ----- (1)}$$

Where,  $M^d$  = Quantity demanded of nominal money balances

$K$  = the proportion of nominal money supply that people demand

$P$  = the price level prevailing in the domestic economy

$Y$  = the full employment level of output of the domestic economy

$PY$  = the nominal national income or output (GDP)

Equation (1) shows that the total amount of money demanded in the nation is a stable fraction of the nominal output of the economy and vary inversely with the velocity of money.

Mathematically, it is usually written as:  $k = 1/V$ , where  $V$  is the Velocity of money (the number of times a unit of money is circulated to conduct transactions during a given time period, usually a year). The velocity of money is assumed to be determined by institutional factors such as the payment modes which generally stay unaltered for a long period of time, making 'V' almost stable or constant. Thus, Money demand is expressed as a positive function of the nominal output in an economy.

Likewise, the nation's supply of money is given by

$$M^s = m (D + F) \text{ ----- (2)}$$

Where,  $M_s$  = the nation's total money supply

$m$  = money multiplier

$D$  = domestic component of the nation's monetary base

$F$  = international or foreign component of the nation's monetary base

The domestic component of the nation's monetary base ( $D$ ) is the domestic credit created by the nation's monetary authorities or the domestic assets backing the nation's money supply. The international or foreign component of the nation's money supply ( $F$ ) refers to the international reserves of the nation, which can be increased or decreased through balance of payments surpluses or deficit, respectively. The ( $D + F$ ) is called the monetary base of the nation, or high-powered money. It is this money that ultimately determines the stock of money supply that will prevail in a nation based on the money multiplier (Salvatore, 2013).

For simplicity, assume that the money multiplier ( $m$ ) is constant over time. Starting from a condition of equilibrium where  $M^d = M^s$ , an increase in the demand for money can be satisfied either by an increase in the nation's domestic monetary base ( $D$ ) or by an inflow of international reserves, or balance-of-payments surplus ( $F$ ). If the nation's monetary authorities do not increase  $D$ , the excess demand for money will be satisfied by an increase in  $F$ . On the other hand, an increase in the domestic component of the nation's monetary base ( $D$ ) and money supply ( $M_s$ ), in the face of unchanged money demand ( $M_d$ ), flows out of the nation and leads to a fall in  $F$  (a deficit in the nation's balance of payments). Thus, a surplus in the nation's balance of payments results from an excess in the stock of money demanded that is not satisfied by an increase in the domestic component of the nation's monetary base, while a deficit in the nation's balance of payments results from an excess in the stock of the

money supply of the nation that is not eliminated by the nation's monetary authorities but is corrected by an out flow of reserves (Salvatore, 2013).

The nation, therefore, has no control over its money supply under a fixed exchange rate system in the long run. Only a reserve-currency country, such as the United States, retains control over its money supply in the long run under a fixed exchange rate system because foreigners willingly hold dollars (Salvatore, 2013).

### **2.1.3.2 Monetary Approach under Flexible Exchange Rates**

Under a flexible exchange rate system, balance-of-payments disequilibria are immediately corrected by automatic changes in exchange rates without any international flow of money or reserves. Thus, under a flexible exchange rate system, the nation retains dominant control over its money supply and monetary policy. Adjustment takes place as a result of the change in domestic prices that accompanies the change in the exchange rate. A deficit in the balance of payments resulting from an excess money supply leads to an automatic depreciation of the nation's currency, which causes prices and therefore the demand for money to rise sufficiently to absorb the excess supply of money and automatically eliminate the balance of payments deficit. Likewise, a surplus in the balance of payments resulting from an excess demand for money automatically leads to an appreciation of the nation's currency, which tends to reduce domestic prices, thus eliminating the excess demand for money and the balance-of-payments surplus (Salvatore, 2013).

The actual exchange value of a nation's currency in terms of the currencies of other nations is determined by the rate of growth of the money supply and real income in the nation relative to the growth of the money supply and real income in the other nations. Thus, according to the monetary approach, currency depreciation results from excessive money growth in the nation over time, while a currency appreciation results from inadequate money growth in the nation (Salvatore, 2013).

Under a managed floating exchange rate system of the type in operation today, the nation's monetary authorities intervene in foreign exchange markets and either lose or accumulate international reserves to prevent an "excessive" depreciation or appreciation of the nation's currency, respectively. Under such a system, part of a balance of payments deficit is automatically corrected by a depreciation of the nation's currency, and part is corrected by a loss of international reserves. As a result, the nation's money supply is affected by the

balance of payments deficit, and domestic monetary policy loses some of its effectiveness (Salvatore, 2013).

### **Criticisms of the Monetary Approach**

The monetary approach to devaluation has been criticized on several grounds. First, the demand for money is not constant as assumed; yet the automatic self adjustment mechanism highlighted in the approach is not feasible in the short run for the real sectors of the economy. Second, there is a direct link assumed between money supply and equilibrium in the balance of payments account. The direct link assumes that the central monetary authority has control over the inflow and outflow of foreign exchange reserves in the country in consonance with surplus or deficit in the balance of payments' accounts. However, it has been argued by economists that such sterilization measures are not feasible in the present era of globalization where financial markets are highly integrated and the countries are following an approach of flexible exchange rates. Lastly, the approach completely disregards the factors other than monetary ones like expansion or contraction of domestic credit that may create disequilibrium in the balance of payments account (Sachdeva, 2012).

Despite these criticisms, however, the monetary approach is realistic in that it takes into consideration both domestic money and foreign money.

## **2.2 Empirical Literature on the effects of Devaluation**

### **2.2.1 Studies in Developing Countries**

The existing partial analyses on the effects of devaluation on real economic activities are mixed, some suggest expansionary effects and others contractionary effects.

Connolly (1983) analyzed the effect of a nominal exchange rate on the rate of economic growth. The coefficient obtained was positive and marginally significant, providing some support to the hypothesis of expansionary devaluation.

The study by Gylfason and Risager (1984), using the imputed parameter data, suggests that devaluations are generally expansionary in developed countries and likely to be contractionary in developing countries. The reason behind the contractionary devaluation in developing countries is the rise in the prices of imported intermediate products. This causes a decline in aggregate demand in the economy in both final consumption and intermediate consumption. Furthermore, this contraction is also reinforced by debt servicing. This is due to

the price effect of devaluation. In the case of developed countries, this contraction also applies, but the force to raise aggregate demand is strong as well. The developed countries are able to reap the benefit of devaluation by export growth which they can enjoy with a fuller utilization of their production potential. On the other hand, developing economies face the resource crunch rather than enjoy the widened foreign markets when they undergo contraction. Likewise, the simulation model of Gylfason and Radetzki (1985) suggested that devaluation results in a decline in output and the extent of contraction increases in the presence of indexed wages.

Christopoulos (2004), using panel data unit root tests and panel co-integration tests, examined the effect of currency devaluation on output expansion in a sample of 11 Asian countries over the period 1968–1999. The results suggest that, in the long run, output growth is affected by currency devaluation in the majority of countries in the panel as a whole. This finding stands at variance with other recent studies, which concluded that devaluation does not exert any important influence on aggregate output.

In the distributional ground, Ripoll (2004) demonstrates that in the long-run real devaluation redistributes income towards unskilled labour, while real appreciation favours skilled labour.

Miteza (2006) tests the effect of devaluation on output in a group of five transition economies: Poland, Hungary, Czech Republic, Slovakia, and Romania. The researcher used panel unit root and panel co-integration test. Based on the results, devaluation has a contractionary effect on output in the long run.

P. K. Narayan & S. Narayan (2007) used the bounds testing approach to co-integration to investigate the relationship between devaluation and output for Fiji. Accordingly, they supported the IMF strategy that encourages the devaluation of the domestic currency to increase economic growth. Their study on Fiji indicated that 10% devaluation of currency increased output with 2.3% and 3.3% in the short and long run respectively. Likewise, a 10% increase in money supply increases output by 2.3 and 3.4%, in the short run and long-run respectively. Thus, devaluation has a similar and equal effect on output as an increase in money supply.

El-Ramly and Abdel- Haleim (2008) studied the effect of devaluation on output in the Egyptian economy using annual data for Egypt over the period 1982-2004 by applying a

VAR model. The results of the study indicate that devaluations have contractionary effects on output in the short run, whereas the effects are expansionary in the long run.

Galebotswe and Andria (2011) tried to test the contractionary devaluation hypothesis in the context of a small open import-dependent economy using an error-correction model. They found that currency devaluations are contractionary in the long run and expansionary in the short-run.

In addition to the partial analysis mentioned above, some general equilibrium analyses of the effects of devaluation are also available.

The study by Branson (1986) supports the findings of Gylfason and Risager (1984) which have been discussed earlier. On the other hand, Taylor and Rosensweig (1984), using a large computable general equilibrium (CGE) model for the Thai economy, simulated the effect of a 10% devaluation of the Bhat in real exchange and demonstrated an increase in real output by 3.3%. A more comprehensive study in this regard was conducted by Edwards (1986). This study, using the data of 12 developing countries for the period 1965–1980, showed that the immediate effect of devaluation is contractionary, after one year it is expansionary, and in the long run it is neutral. A similar finding was reported by Upadhyaya (1999). He estimated the effect of currency devaluation on the aggregate output level in six Asian countries. The estimated results suggest that devaluation, in general, is neutral in the long run. Upadhyaya et al. (2004) studied the effect of currency depreciation using panel data and found that while the exchange rate depreciation is expansionary in the short run, it is neutral in the medium and long run.

According to the CGE analysis conducted by Nu San et al. (2000) to study the real effect of devaluation on growth, production, deforestation, and income distribution in the Sumatra region of Indonesia, regional exports increase mainly from the non-agricultural sectors, and imports decline. The agricultural terms of trade and agricultural prices relative to non-agricultural prices decline due to the smaller share of agricultural exports compared to other exports. Deforestation is likely to increase because the demand for forestry products increases, both as final products and as intermediate products for the wood processing industry, both of which are sold in international markets. An export tax on processed wood proved to be essential to discourage further deforestation in the region.

Wobst (2001) used a computable general equilibrium model of the Tanzanian economy to analyze the importance of an exchange rate devaluation to eliminate the existing trade deficit through export-oriented economic growth. He finds that currency devaluation benefits agricultural more than industrial sectors. The elimination of the trade deficit through devaluation has to come from the export side.

Lay et al. (2004), in their analysis of the effects of major external shocks and policy reforms of Bolivia to achieve pro-poor growth, concluded that the shocks have not only contributed to the economic crisis, but that they are also likely to impair Bolivia's medium-term development prospects, leading to marked increases in both urban and rural poverty. If the reform projects were implemented, their impact on growth would be large enough to slightly over compensate the impact of the negative external shocks. The poverty increase caused by the shocks would be more than offset for urban households but reinforced for rural households.

Fagnäs (2004) examined the likely income distribution impacts of alternative policy instruments for stabilizing the economy, specifically for eliminating the current account deficit, viz. devaluation or fiscal adjustment. This paper shows that devaluation is likely to be contractionary for GDP in all sectors except agriculture and export-oriented sectors. Profits and labour incomes in a commercial farming rise, but fall in other sectors.

Schweickert et al. (2005) simulated the macroeconomic and distributional effects of exchange rate policy in the highly dollarized economy of Bolivia. Accordingly, dollarization appears to matter more through real than through financial sector effects. Furthermore, the potential of nominal devaluation to smooth the adjustment path after a negative shock primarily depends on the absence of wage indexation. Regarding the distributional effects, nominal devaluation in no circumstance reduces the poverty effect of the external shock.

Acharya (2010) measured the Potential impacts of the devaluation of Nepalese currency on growth, distribution, price changes in factor and product markets, and on selected macroeconomic features using a Computable general equilibrium approach. To this typical developing economy, they found that devaluation is expansionary but mostly benefits the rich, thus leading to a more uneven income distribution. They also found that devaluation causes an improvement in saving, investment and export-import ratios, whereas the budget deficit widens.

Siddig (2011) applied a computable general equilibrium model to investigate the possible economy-wide effects of devaluating the overvalued Sudanese pound as per the IMF recommendation. The results show that devaluation of Sudanese pound reduces absorption, private consumption, total imports, and GDP; while improving exports.

Eltalla (2013) analyzed the impacts of the devaluation on the Palestinian economy using a computable general equilibrium model. They investigate the effect of a 15% devaluation of the exchange rate on output growth of Palestine. They found that a 15% devaluation of the exchange rate results in a lower real gross domestic product, lower import and low export, lower private consumption and higher inflation. Overall devaluation has a contractionary effect on the Palestinian economy.

Momodu and Akani (2016) investigated the impact of currency devaluation on economic growth of Nigeria. The study shows that in the short run currency devaluation leads to increase in output and improves the balance of payments but in the long run, the monetary consequence of the devaluation ensures that the increase in output and improvement in the balance of payment is neutralized by the rise in prices. Their study therefore, supports the monetarists' view of currency devaluation.

### **2.2.2 Studies in Ethiopia**

The empirical studies regarding the effects of devaluation on the economy that focuses on Ethiopia have been very limited. To the extreme, there are no studies based on the general equilibrium approach.

Haile (1994) has attempted to estimate the effect of devaluation on the trade balance using the elasticity approach. According to him, the sum of elasticities of export and import is greater than one. Since the Ethiopian trade balance was initially in deficit the Marshall-Lerner condition is not satisfied and is not enough. He concluded that although devaluation has an inflationary potential, it will have at least a positive effect on the trade balance.

Befekadu and Kibre (1994) in their study on the possible effect of the 1992 devaluation on the Ethiopian trade balance, argued that in the short-to-medium term both imports and import substitute goods are unlikely to respond to price changes given the structure of the Ethiopian economy. According to them if devaluation of birr succeeds in decreasing imports, it is likely to reduce capacity utilization and therefore output growth. Thus, the decrease in the current account deficit would be at the cost of the growth of the economy. For them, though the

increases in domestic currency prices are necessary, they are definitely not sufficient to increase the volume of exports. Furthermore, they argued that the greater foreign exchange availability from higher exports and from easier access to foreign capital made it possible to translate the increase in demand into actual imports.

Haile (1999) used a macro simulation approach to study the impact of devaluation on macroeconomic performance of Ethiopia. The simulation results indicate that devaluation would help improve the current account balance but would be stagflationary. The result also reveals that devaluation reduces import and increase export, while it decreases output and employment.

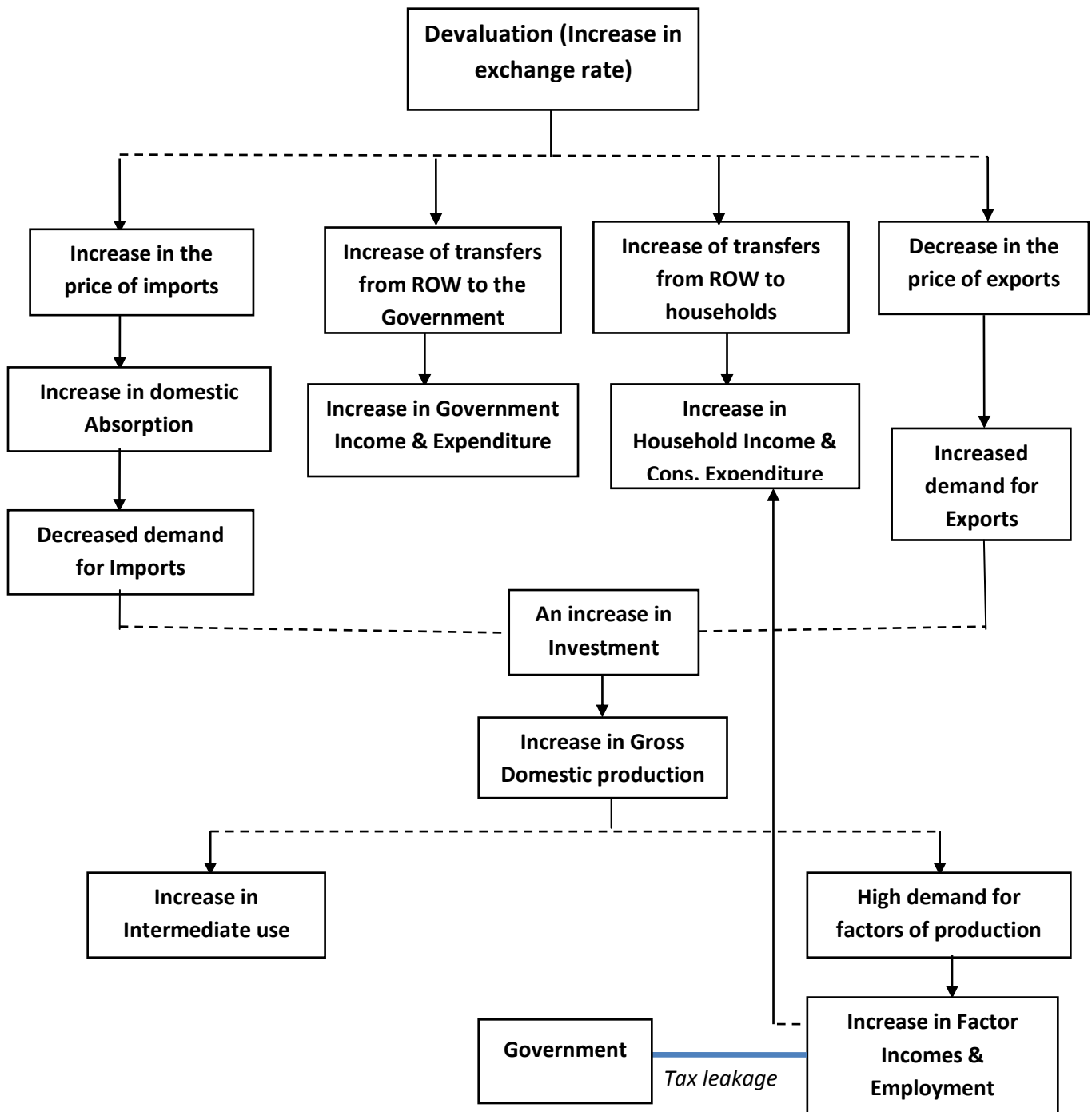
Yilkal (2014) studied the short and long-run effects of currency devaluation on output growth in Ethiopia using a VAR model. The researcher found that currency devaluations are contractionary in the long run and neutral in the short run. The argument for the negative effect of devaluation, in the long run, is that Ethiopian economy is import oriented while its export is dominated by primary agricultural products which are insensitive for the change in exchange rates. Hence, devaluation increases the cost of imported items and thereby negatively affects the real GDP.

In general, the empirical studies regarding the effects of devaluation on the Ethiopian economy based on the general equilibrium approach are totally absent, except the limited studies by partial analysis. Since economic stability is the goal of every nation (specifically, Ethiopia), policymakers should aware of the economy-wide impact of devaluation on the nation's economy. In doing so, dynamic computable general equilibrium (DCGE) models have an advantage over partial equilibrium analysis in that they offer an economy-wide assessment of policies, including the concurrent effects of policy-changes on production, employment, poverty and income inequality. Therefore, studies should be better conducted on general equilibrium bases.

## 2.3 Conceptual Framework

The conceptual framework for this study is constructed in line with the CGE model developed by Lofgren et.al (2002) on the basis of the theoretical backgrounds. The figure below shows how the devaluation effect is systematically moving throughout the entire economy.

Figure 2.2 Conceptual frameworks



Source: Author, 2018

## CHAPTER THREE

### THEORETICAL AND METHODOLOGICAL FRAMEWORK

#### 3.1 Theoretical Framework

##### 3.1.1 Computable General Equilibrium (CGE) Model

The computable general equilibrium methodology is a powerful methodological tool for examining the impacts across multiple markets of changes in policy variables or exogenous shocks and an instrument for policy analysis. Computable general equilibrium models represent the direct and indirect interactions between all sectors of the economy. They provide an economy wide framework for policy analysis to assess a broad range of policy issues. This economy wide, multimarket approach captures all sectoral and inter-sectoral price linkages simultaneously rather than analyzing each commodity market separately. The computable General equilibrium framework provides a theoretical quantification that combines the general equilibrium structure introduced by Arrow and Debreu with real economic data- provided by a **social accounting matrix** to solve numerically for the quantities of supply, demand and price that preserve equilibrium across all markets (Shoven & Whalley, 1984).

The computable general equilibrium model that we use is neoclassical. Its framework is developed from the microeconomic foundations of optimization behaviour of rational economic agents. Consumers demand commodities and supply their endowments to maximize their utility, subject to their endowments. Producers demand inputs and supply outputs to maximize their profits, subject to production technologies. The optimizing assumptions emphasize the role of commodity and factor prices in affecting consumption and production decisions by households and producers. The model is formulated on a Walrasian system with the assumption of general equilibrium, which can be obtained when supply equals demand across all connected markets in the economy at a matrix of relative prices (Dervis et al., 1982).

Computable general equilibrium models are specified in a set of mathematical equations. The core of CGE models is the multi-sectoral intermediate input links (Input-Output), and equations that describe the economic behaviour of agents and the endogenous prices.

Computable general equilibrium models allow any degree of sectoral disaggregation appropriate for the analysis of inter-sectoral shifts (Shoven & Whalley, 1984).

Computable general equilibrium (CGE) modelling provides an economy wide evaluation of policies and a framework. The sectoral and institutional detail of the CGE model allows for a more detailed analysis of policies, and it has an advantage over partial equilibrium analysis because it offer an economy wide evaluation of policies. To undertake Computable general equilibrium analysis, an Ethiopian Computable general equilibrium (CGE) model has built based on the standard CGE model used by the International Food Policy Research Institute (Lofgren et al., 2002).

### **3.1.2 Social Accounting Matrix**

CGE model is usually based on a Social Accounting Matrix (SAM) database, which is an extension of the Input-Output matrix.

A social accounting matrix is a comprehensive, economy wide data framework, representing the economy of a country. Social accounting matrix is a matrix of balanced expenditure and income accounts. In the SAM, the column entries represent expenditures to payments made by economic agents, while the row entries represent receipts of income to agents. All receipts are equal to all expenditures, since it is built on a walrasian general equilibrium framework that income of one economic agent is expenditure of the other. A social accounting matrix accounts for the economy wide circular flow of incomes and payments in the economy. It represents the structure, internal and external links of the economy, and the roles of agents and sectors in the economy. The sources of data for the social accounting matrix are an input-output matrix, national income accounts and household income and expenditure statistics. Thereby, it is wider than an input-output matrix and national accounts. These data are from different time periods, but they still provide a good indication of the structure of the economy and the interactions among social and economic entities (King, 1985; Roland Holst, 2008).

A social accounting matrix contains most of the data required to implement a computable general equilibrium model analysis. The computable general equilibrium model has to be based on recent relevant available data to be credible for policy analysis. When historical data are used for policy analysis, it should be demonstrated that the structure of the economy has not substantially changed for the evaluation and analysis of policies to be credible and

valuable. To do so, the updated version of 2009/10 Ethiopian SAM has been used as the initial data for the calibration of the Ethiopian CGE model.

## 3.2 Model Formulation

The dynamic Ethiopian CGE model is an extension of the static CGE model described in Lofgren *et al* (2002). The model is recursive dynamic and is solved in two stages. First, the model determines within-period equilibrium, given parameters and exogenous variables. Second, some parameters and exogenous variables change over time.

The model belongs to the recursive dynamic strand of the dynamic CGE literature, which implies that the behavior of its agents is based on adaptive expectations, rather than on the forward-looking expectations that underlie alternative inter-temporal optimization models. Since a recursive model is solved one period at a time, it is possible to separate the *within-period* component from the *between-period* component, where the latter governs the dynamics of the model. In the following sections, we will present the general overview of the model.

### 3.2.1 Within Period (Static) Computable General Equilibrium Model

The within-period component describes a one-period static CGE model. The model is specified into 41 equational sets, divided into four blocks; namely, price block, production and commodities block, institutions block, and the system constraints block. It is built on the basis of the standard CGE model used by the International Food Policy Research Institute (Lofgren *et al.*, 2002). Although a detailed mathematical description can be found in *Appendix II*, a brief outline for each block of equations is presented as follows.

**PRICES BLOCK:** This refers to the structure of prices of goods and services ranging from producer price to the final price. The price block consists of equations in which endogenous model prices are linked to other prices (endogenous or exogenous) and to non price model variables.

This study uses four different types of prices of commodities; these are import and export prices prevailing on the international market, activity prices applicable at the domestic production levels, domestic supply prices of domestic productions inclusive of indirect taxes, and composite prices of commodities inclusive of domestic productions and imports. The Consumer's Price Index (CPI) is measured after each simulation to get an over view of the

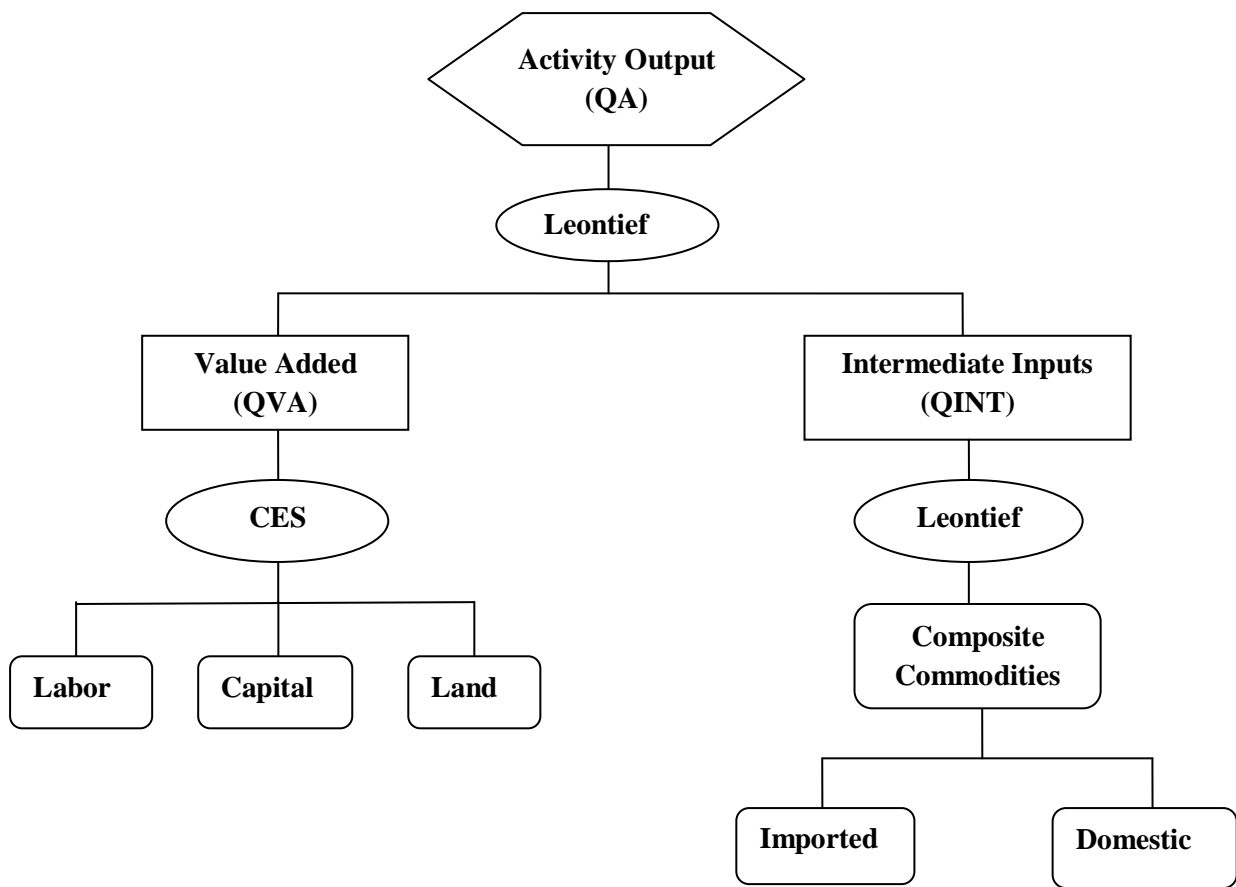
overall price movement. To do so, the composite price of commodities has been used to calculate the CPI index.

**PRODUCTION AND TRADE BLOCK:** The production and trade block covers four categories: domestic production and input use; the allocation of domestic output to home consumption, the domestic market, and exports; the aggregation of supply to the domestic market (from imports and domestic output sold domestically); and the definition of the demand for trade inputs that is generated by the distribution process. Production is carried out by activities that are assumed to maximize profits subject to their technology, taking prices as given. The CGE model includes the first-order conditions for profit-maximization by producers. Typically in CGE modelling, a two-stage production structure is used. Two alternative specifications are permitted at the top level of the technology nest: the activity level (final output) is either a CES or a Leontief function of the quantities of value-added and aggregate intermediate input use.

In this paper, the activity output level (top-level) is defined as a Leontief function, in which case quantity of value-added and quantity of intermediate inputs are used in fixed proportions. The use of fixed-shares reflects the belief that the required combination of intermediates per unit of output, and the ratio of intermediates to value-added, is determined by technology rather than by the decision-making of producers. This is true in the Ethiopian context, in that the country couldn't attain sustainable growth by substituting one input for the other since there is high technology constraint. Rather, the inputs should be better used in fixed proportions.

At the second level of the nest, value added is a function of the primary inputs. This function is defined as a CES function of the factor inputs. On the other hand, disaggregated intermediate input demand is defined as a Leontief function of the various individual intermediate inputs (commodities), i.e. it is assumed that firms use different intermediate inputs in fixed proportions. Thus, individual inputs are simply increased in fixed proportions as the demand for intermediate inputs increases. The nesting of the production structure is shown by figure 3.1 as follows.

**Figure 3.1 Production Nesting Structure**



Source: Lofgren et.al (2002)

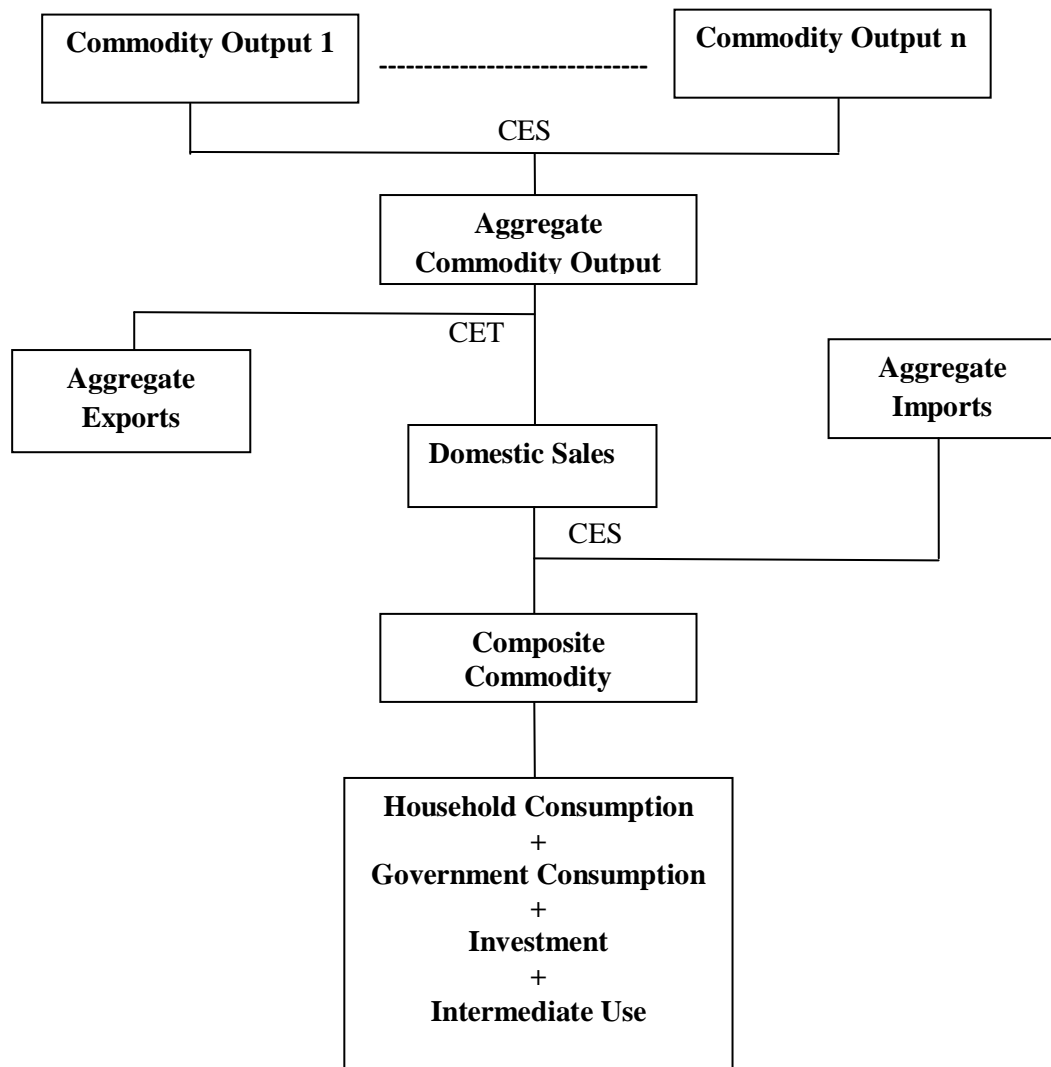
In addition to its multi-sector specification, the model also distinguishes between activities and the commodities that these activities produce. This distinction allows individual activities to produce more than a single commodity and conversely, for a single commodity to be produced by more than one activity. For instance, although the agricultural sector's primary output is agricultural products, this sector might also produce some processed food products. Conversely, since food is also produced by the processed food sector, the combination of agricultural and processed food production suggests that some commodities can also be produced by more than one activity.

Figure 3.2 below traces the flow of a single commodity from being supplied to the market to its final demand. As shown by the figure, the supply of a particular commodity from each producer is combined to derive aggregate commodity output. This aggregation is governed by a CES function which allows demanders to substitute between the different producers supplying a particular commodity, in order to maximize consumption subject to relative supply prices.

This decision of producers to produce for the sale in the domestic markets or foreign markets is governed by a CET function, which distinguishes between exported and domestic goods. By doing so, producers capture any time or quality differences between the two products. Profit maximization drives producers to sell in those markets where they can achieve the highest returns. These returns are based on domestic and export prices.

Domestically produced commodities that are not exported are supplied to the domestic market. Substitution possibilities exist between imported and domestic goods under a CES specification which can take place both in final and intermediates usage.

**Figure 3.2: Commodity Flow**



Source: Thurlow, 2004

**INSTITUTION BLOCK:** Ethiopian CGE model has four institutional accounts: households, firms, the government and the ROW. Households have factor income and transfer income from the government and the rest of the world. Likewise, household expenditure consists of consumption expenditure and the tax to the government. The difference between income and expenditure of households goes to national saving. Households and firms have fixed marginal propensities to save. However, contrary to the household sector, firm's income only consists of profits from its investment in industrial activities and commercial services. Firm's income goes to investment to a full extent.

Government revenue is collected basically from the import tariff, direct tax and sales tax from the firms and households at a fixed rate to their total income, and net transfer income from the rest of the world. Export tax is virtually absent in Ethiopia. Likewise, government expenditure consists of consumption expenditure and transfer to households. The difference between revenue and expenditure goes to national saving.

The final institution is the rest of the world. As noted, transfer payments between the rest of the world and domestic institutions and factors are all fixed in foreign currency.

## **SYSTEM CONSTRAINTS AND MARKET CLOSURES**

The Ethiopian Dynamic CGE model used in this study is the extension of the standard CGE model; therefore, the researcher selects the adjustment rules accordingly. Thus, the model has two system constraints: commodity and total absorption. The composite commodity constraint justifying the equilibrium in the goods market requires total commodity supply balances to its total demand in the economy. Thus, composite supply is equal to the summation of composite demand for intermediate use, household consumption, government consumption; fixed investment, stock change and demand for trade input use. Total nominal absorption is measured as the total value of domestic final demands, which equals GDP at market prices plus imports minus exports. It is equal to the summation of household market consumption, household home consumption; government consumption, fixed investment, and stock change.

Moreover, the CGE model includes factor market closure and three macroeconomic closures: the government closure, foreign exchange closure, and saving-investment closure. The standard CGE model provides different alternative closures for the factor market, savings-investment, the government and the rest of the world. The most applicable closure may then

be used for this application. The discussion below provides details of the selected closure rules for this study.

**Factor Markets closure:** The factor market closure requires the equality between factor demand and factor supply. This equality is based on how the relationship between factor supply and wages is defined. Equilibrium in the factor market is, therefore, specified as:

$$\sum_{a \in A} QF_{f a} = QFS_f$$

Where,  $QF_{f a}$  = factor demanded by activity a.

$QFS_f$  = quantity supplied of factor

Different closures for the labor market are used for different simulations. The first closure assumes capital and high skilled labor are fully employed and activity specific. In this case the quantity of factors demanded as well as the economy-wide wage is fixed, while the activity specific wage and the supply variable are flexible. Therefore this closure assumes full employment and that the factors are activity specific. The second closure assumes that semi-skilled and low-skilled labor is unemployed and mobile across activities. This force the model to take the quantity supplied of each factor as fixed. The economy-wide wage variable is then allowed to vary so that the quantity of factors demanded is equal to the quantity of factors supplied while the activity specific wages will remain fixed as these factors experience high levels of unemployment. The only factor that would change for semi- and unskilled labor is employment. This closure therefore assumes unemployment with factor mobility. The last alternative closure has been specified to impose segmented factor market. In this case labor employment is assumed to be sector specific. In this case, sector employment is fixed while sector specific wage is flexible.

In this CGE model, the researcher selected the second closure which allows unemployment and factor mobility across activities. The reason for selecting this closure is that in Ethiopia the semi-skilled and unskilled labor is highly unemployed and mobile across activities. Moreover, land is also mobile across sectors implying that it can be employed in different activities. The impact of this closure is that for capital and high-skilled labor total employment will not change. The only change here would be the activity specific rental price of capital and the wage of high skilled labor. However, in Ethiopian current context, even a large number of skilled labor is not satisfied by the wage rates paid for their labor supply.

High-skilled labor is, therefore, similarly mobile across activities. Therefore, it is only capital which is immobile across sectors implying that it is activity specific and sector-specific wages adjust to ensure that demand for capital is equal total supply of capital.

**Current-Account Balance for the Rest of the World, in Foreign Currency:** The current-account balance, which is expressed in foreign currency, imposes equality between the country's spending and its earning of foreign exchange.

The current account balance equation is specified as:

$$\sum_{c \in CM} p_{wm_c} \cdot Q_{M_c} + \sum_{f \in F} trnsfr_{row\ f} = \sum_{c \in Ce} p_{we_c} \cdot Q_{E_c} + \sum_{i \in INSD} trnsfr_{i\ row} + FSAV$$

[Import spending] + [factor transfers to RoW]

$$= [\text{Export revenue}] + [\text{institutional transfers from RoW}] + [\text{foreign savings}]$$

Where,  $p_{wm_c}$  = Import price (foreign currency),  $Q_{M_c}$  = Quantity of imports of commodity  $c$ ,  $trnsfr_{row\ f}$  = Transfer from factor  $f$  to RoW,  $p_{we_c}$  = Export price (foreign currency),  $Q_{E_c}$  = Quantity of exports of commodity  $c$ ,  $trnsfr_{i\ row}$  = Transfer from RoW to institution  $i$ , and  $FSAV$  = Foreign savings (FCU)

Two basic market-clearing closures may be used for the rest of the world. Foreign savings may be fixed, while the exchange rate equilibrates the current account. Alternatively, the exchange rate may be fixed while foreign savings fluctuate to determine equilibrium.

In this model version, exchange rate (EXR) is set fixed; and the foreign savings serves the role of equilibrating variable to the current-account balance. The main reason for choosing this closure is that exchange rate is the simulation variable. Hence, it should be set fixed in order to see the real effect of the exogenous shocks on different variables.

**Government Balance:** The government balance imposes equality between current government revenue and the sum of current government expenditures (not including government investment) and savings. Savings may be negative.

Thus, the government balance closure is formulated as:

$$YG = EG + GSAV$$

Where: YG = government revenue, EG = government expenditure, and GSAV = government savings

The closure rules for the government account are slightly trickier because they are important components of the model that are used to investigate fiscal policy considerations. Different closures for the government are used for different simulations. The first closure assumes flexible government savings, with fixed direct tax rates. Government savings are treated as a residual. The second closure assumes fixed government savings. Direct tax rates of domestic institutions are adjusted endogenously to generate a fixed level of government savings. Here, the same number of percentage points adjusts the base-year tax rates of selected domestic non-government institutions endogenously. The third closure is similar to the second one in assuming the government savings are fixed. However, the tax rates are multiplied by a fixed scaling of the base year tax rates of each taxpaying institution (i.e. scaled direct tax changes). In all the closures government consumption is fixed either in real terms or as a share of nominal absorption.

In this study, the researcher preferred the closure for the government account in which tax rates and real government consumption expenditure is held constant and government savings are flexible. The main reason is that in Ethiopia direct tax rates are fixed throughout a year. So, government savings should be flexible to play the role of equilibrating the government revenue with government consumption and savings.

**Savings–Investment Balance:** This closure states that total savings and total investment have to be equal. Total savings is the sum of savings from domestic nongovernment institutions, the government, and the rest of the world, with the last item converted into domestic currency. Total investment is the sum of the values of fixed investment (gross fixed capital formation) and stock changes.

$$\sum_{i \in \text{INSDNG}} \text{MPS}_i (1 - \overline{\text{TINS}}_i) Y_{I_i} + \text{GSAV} + \text{EXR.FSAV} = \sum_{c \in C} P Q_c \cdot \text{QINV}_c + \sum_{c \in C} P Q_c \cdot \text{qdst}_c$$

$$[[\text{Non-gov. t savings} + \text{gov. t savings} + \text{foreign savings}] = [\text{fixed inv. t} + \text{stock change}]]$$

Where,  $\overline{\text{TINS}}_i$  = rate of direct tax on domestic institutions  $i$ ,

$\text{MPS}_i$  = 0-1 parameter with 1 for institutions with potentially flexed direct tax rate, and

$\text{qdst}_c$  = Quantity of stock change

To ensure that aggregate savings equal aggregate investment, the determinants of either savings or investment must be fixed. To do so, five market clearing closures which are grouped under two basic closures may be used: investment-driven and savings-driven closures.

The first closure assumes that investment is fixed and savings play the role maintaining equilibrium between the value of savings and the fixed value of the investment. In this case, investment is made fixed by fixing the investment adjustment factor and all non-government savings is let flexible. Hence, the level of investment determines savings.

The second closure which is used in this paper assumes that savings are fixed and investment serves the role of equilibrating variable to the Savings–Investment balance, hence savings driven closure is appropriate. This is because of the fact that in developing countries like Ethiopia where savings are very low, the amount of savings should be fixed to some level hence investment will be improved. Under this closure, all non-government savings are made fixed by fixing the marginal propensity to save for all non-government institutions and apital formation (investment) is let flexible. Hence, the level of savings determines investment.

### **Price Normalization**

Here, the consumer price index is chosen as a numeraire (fixed index) such that all prices in the model are relative to the weighted unit price of households’ initial consumption bundle.

Hence, the equation for CPI can be specified as:

$$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwts_c$$

**Where:** Where,  $cwts_c$  = weight of commodity  $c$  in the consumer price index,

$PQ_c$  = Composite commodity price, and

$\overline{CPI}$  = consumer price index (exogenous variable).

Given this price normalization, all simulated price changes can be directly interpreted as changes vis-à-vis CPI.

### **3.2.2 Between Period (Dynamic) Computable General Equilibrium Model**

Though the static model described above is detailed in its representation of the Ethiopian economy within a particular time-period, its inability to account for second-period considerations limits its assessment of the full effect of policy and non-policy changes.

In attempting to overcome these limitations, the static model is extended to a recursive dynamic model in which selected parameters are updated based on the modelling of inter-

temporal behavior and results from previous periods. In this case the linkages between periods are introduced. The static model is solved for a specific year; and then the capital stock, population, domestic labour force and factor productivity parameters are updated. The updated model is then solved again for the following year, and so on.

### **A. Capital Accumulation Equation**

The process of capital accumulation is modelled endogenously, with previous-period investment generating new capital stock for the subsequent period. In every period the capital stock is updated with the total amount of new investment and depreciation. Although the allocation of new capital across sectors is influenced by each sector's initial share of aggregate capital income, the final sectoral allocation of capital in the current period is dependent on the capital depreciation rate and on sectoral profit-rate differentials from the previous period. Sectors with above-average capital returns receive a larger share of investible funds than their share in capital income. The converse is true for sectors where capital returns are below average (Thurlow, 2004).

Available capital stocks in time period  $t$  ( $K_t$ ) are equal to new net investment plus depreciated capital left from the previous time period: Thus, the capital accumulation equation is specified as:

$$K_{i,t} = K_{i,t-1}(1 - \delta) + I_{i,t}$$

From this equation we can understand that in each period, capital stock used in each sector varies with the sectoral rate of investment and the rate of depreciation of capital stock,  $\delta$ .

### **B. Population Growth**

Population growth is adjusted exogenously with the rate of population growth imposed on the model based on separately calculated growth projections. It is assumed that a growing population generates a higher level of consumption demand and therefore raises the super numerary income level of household consumption. It is assumed that there is no change in the marginal rate of consumption for commodities, implying that new consumers have the same preferences as existing consumers (Thurlow, 2004).

### C. Labour Force Growth Equation

In most dynamic CGE models, labor supply is exogenously updated by the population growth rate (i.e. as population grows, the total labor supply increases at the same rate) expressed as:

$$LS_{t+1} = (1 + ng) \cdot LS_{h,t}$$

Where,  $LS_t$  is the total labor supply and  $ng$  is an exogenous variable representing population growth rate.

However, in this study, labour is assumed to be unemployed at a fixed real wage in the factor market closure. All categories of labour: the skilled, semi-skilled, and unskilled labour supply within a particular time period is infinitely elastic at a fixed real wage. Therefore the exogenous adjustment of labour supply ( $QFS_f$ ) is unnecessary since there are no constraints on factor supply. Rather it is necessary to exogenously adjust real wages between periods (Thurlow, 2004).

### 3.3 Exchange Rate in the Model

The Ethiopian CGE model is built on the Lofgren et al. (2002) framework. The exchange rate impacts the economy through the following equations: the price of imports, the price of exports, and transfer incomes from abroad.

The import price (PM) is a price paid by domestic consumers for imported commodities including import tariffs and transaction costs per import unit. The import price is in local currency units. The world price of imports transforms in to the import price through the exchange rate (EXR) along with import tariffs and transaction costs. The domestic import price is flexible, where as the tariff rate and the world import price are fixed, which follows from the small country assumption. The equation of the import price of a given commodity ( $PM_c$ ) is specified as:

$$PM_c = PWM_c (1 + tm_c) EXR + \sum PQ_c \cdot icm_{c,c}$$

Where, PM is the import price including transaction costs (domestic currency), pwm is the world market import price (foreign currency), PQ is the composite price (the market price paid by domestic commodity consumers), tm is the import tariff rate and icm is the quantity of commodity as trade input per imported unit.

Likewise, the export price (PE) is the price received by domestic producers for their exports. The world price of exports transforms to the domestic export price through the exchange rate and export tariffs plus transaction costs. The domestic export price is flexible whereas tariff rate is fixed. The world export price is fixed, which follows from the small country assumption. The equation of the export price of a given commodity ( $PE_c$ ) is specified as:

$$PE_c = PWE_c (1 - te_c) EXR - \sum PQ_c \cdot ice_{c,c}$$

Where, PE is the export price (local currency), pwe is the world market export price (foreign currency), te is the export tax rate and ice is the quantity of commodity c as trade input per exported unit of c.

Total household income (YI) is the sum of payments received from factors, and transfers from other institutions (households), government and the rest of the world. The equation of the income of households (YH) is specified as:

$$YH = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{i, gov} \cdot CPI + trnsfr_{i, row} \cdot EXR$$

Where,  $YIF_{i,f}$  is the income to domestic institution i from factor f, TRII is the transfers from institution i to i', and trnsfr is the transfer from factor f to institution i.

Total government revenue (YG) is defined as shown in the following equation as the sum of revenues from taxes, factors, and transfers from the rest of the world.

$$\begin{aligned} YG = & \sum_{i \in INSDNG} TINS_i \cdot YI_i + \sum_{f \in F} tf_f \cdot YF_f + \sum_{a \in A} tva_a \cdot PVA_a \cdot QVA_a + \sum_{a \in A} ta_a \cdot PA_a \cdot QA_a \\ & + \sum_{c \in CM} tm_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum_{c \in CE} te_c \cdot pwe_c \cdot QE_c \cdot EXR + \sum_{c \in C} tq_c \cdot PQ_c \cdot QQ_c \\ & + \sum_{f \in F} YIF_{gov f} + trnsfr_{gov row} \cdot EXR \end{aligned}$$

Where, TINS is the direct tax rate for institution, tf is the direct tax rate for factor f, tva is the rate of Value added tax for activity a, ta is the rate for activity, QA is the quantity of activity, QVA is the quantity of aggregate value added, QINTA is the quantity of aggregate intermediate input, PVA is the price of aggregate value added, and PA is the activity price.

## CHAPTER- FOUR

### ETHIOPIAN ECONOMY AS CHARACTERIZED BY THE (2009/10) SOCIAL ACCOUNTING MATRIX

In this section, we will describe the Ethiopian economy using the 2009/10 Ethiopian SAM developed by EDRI, which is also the main source of data for the analysis. For a detailed Macro SAM, see *Appendix I* at the end of the paper.

Social Accounting Matrix (SAM), which is a representation of an economy for a particular year, is the main database used to calibrate a CGE model. While the SAM provides insight into the sectoral and institutional structure of the economy, it does not contain information on the behavior of the country's economic agents or the process of dynamically updating the model across time. In such cases, information is taken from additional data sources like GTAP database and literatures (Thurlow, 2004).

The Ethiopian 2009/10 SAM consists of 113 activities disaggregated into 77 agricultural, 25 industrial and 11 service sub-activities. It has also 64 commodities disaggregated to 24 agricultural, 29 industrial and 11 service sub-commodities. To account for the variations in factors of productions, labor is disaggregated into skilled, sub-skilled, unskilled and agricultural labor. Agricultural labor is further disaggregated into four based on the agro-ecological zones. Capital which accounts for the non-agricultural capital is put in aggregate terms. Agricultural capital is disaggregated into land and livestock. Again land and livestock are further disaggregated into four (each) by Agro-ecological zones. There is one marketing margin account which records the sum of transportation costs.

The SAM also consists of institutions such as households, the government and the rest of the world. Households are disaggregated into rural poor, rural non-poor, urban poor, and urban non-poor. The rural poor and non-poor households each are further disaggregated into four categories. The SAM also included three major tax components: direct tax, import tax, and sales tax.

The SAM has also included the savings-investment (S-I) account representing the amount of savings collected from various sources which will be spent on capital goods (Investment). The rate of depreciation of Capital stock (which refers to a fall in the value of fixed capital

due to normal wear and tear, a passage of time or expected obsolescence) is also depicted in the SAM (EDRI, 2009).

#### 4.1 Structure of Gross Domestic Production (GDP)

Table 4.1 disaggregates gross domestic product (GDP) into its demand components. The total GDP of the country at market prices in 2009/10 is 383.4 billions of Ethiopian birr. The largest component of this final demand is private consumption, which accounts for 88 percent of total GDP at market prices. Gross investment and government consumption account for 22% and 8% of total GDP at market prices respectively. Government consumption had the lowest share with a total amount of 31.8 billion birr, or 8.3 percent. The trade balance is -74.4 billion birr which shows the country is running a trade deficit.

**Table 4.1: Structure of GDP and GDP Composition (2009/10)**

	Value (in billions birr)	Share of GDP (Market Prices)
<b>Private Consumption</b>	338.6	88.3
<b>Fixed Investment</b>	85.5	22.3
<b>Inventory (Stock) Changes</b>	1.8	0.5
<b>Government consumption</b>	31.8	8.3
<b>Exports</b>	52.1	13.6
<b>Imports</b>	-126.5	-33.0
<b>GDP (Market Prices)</b>	383.4	100.0
<b>Net indirect taxes</b>	28.4	7.4
<b>GDP (factor cost)</b>	355.0	92.6

Source: Own computation from 2009/10 Ethiopian SAM

If we subtract the value of net indirect taxes from GDP at market prices, we get GDP at factor cost. GDP at factor cost is the summation of the factor incomes of all producing units generated in the domestic economy in a year; in the form of rent, wages, interest, and profit for their productive services. Accordingly, the total GDP of Ethiopia in the year 2009/10 was 355 billion birr.

## 4.2 Sectoral Production (Value Added)

As mentioned above, the Ethiopian 2009/10 SAM identifies 113 productive sectors or activities which combine factors and intermediates to arrive at a total level of output. Total Value added represents the earnings received by factors of production, such as employee compensation and gross operating services (EDRI, 2009). This value is also known as Gross Domestic Product (GDP) at factor cost. In 2009/2010 (2002, Ethiopian Fiscal Year) GDP at factor cost was 355 billion birr. Table 4.2 below shows the share of GDP generated by the three major sectors.

**Table 4.2: Sectoral Production (2009/10)**

Sectors	Sectoral GDP (in Billions birr)	Share of GDP (%)
<b>Agriculture</b>	174.3	49.1
<b>Industry</b>	36.2	10.2
<b>Service</b>	144.5	40.7
<b>Total GDP at factor cost</b>	355.0	100.0

Source: Own computation from 2009/10 Ethiopian SAM

As shown in table 4.2, 174.3 billion birr of the total GDP is contributed by agriculture and related activities, which is almost half (49%) of the total. This shows that the Ethiopian economy is agrarian.

Services are the second dominant sector in the Ethiopian economy with a total amount of 144.5 billion birr, which is 40.7 percent of GDP at factor cost. Industry has the lowest share of GDP at factor cost with a value of 36.2 billion birr, which accounts for 10.2% of the total GDP.

## 4.3 Trade Shares

Table 4.3 shows the composition and structure of Ethiopia's trade with the rest of the world. Accordingly, the total export earnings of the country for the year 2009/10 were 52.1 billion birr. On the opposite direction, imports account for about 126.5 billion birr. This shows that Ethiopia runs a trade deficit of 74.4 billion birr in 2009/2010 fiscal year.

**Table 4.3 Trade share by the major sectors (2009/10)**

	<b>Export contribution (in billions birr)</b>	<b>Sectoral share of Exports</b>	<b>Import contribution (in billions birr)</b>	<b>Sectoral share of Imports</b>
<b>Agriculture</b>	13.9	26.7	8.8	7.0
<b>Industry</b>	12.1	23.2	86.5	68.4
<b>Service</b>	26.1	50.1	31.2	24.6
<b>All Sectors</b>	52.1	100	126.5	100

Source: Own computation from 2009/10 Ethiopian SAM

Table 4.3 shows that the country mainly exports primary commodities. In terms of quantity, about 67% of the total exports of the country are agricultural commodities. However, as shown in table 4.3 above, the total export earnings of the country from agriculture are only 13.9 billion birr, which accounts for 26.7% of total export earnings. The service sector takes a lion share of total export earnings, with 26.1 billion birr, which is 50.1 percent of the total. Industry sector only contributes 23.2% (12.1 billion birr) to the total export earnings.

On the other hand, the major import items of the country are machinery, transport, electronic and other equipment, petroleum products, Chemicals, rubbers and plastic products, metals and metal products. Imports of these industrial products amount to 86.5 billion birr, which is 68.4 percent of the total imports. The country also paid 31.2 billion birr for service imports and 8.8 billion birr for agricultural imports, which accounts for 24.6 and 7 percent of total imports respectively.

#### **4.4 Factor Markets**

Table 4.4 shows the distribution of factors across the three economic sectors and the returns from each factor. Accordingly, the total factor income from all sectors amounts to 355 billion birr which is equal to the GDP at factor cost. We have identified four aggregated factors of production; labor, capital, land, and livestock. Labor is further disaggregated into skilled, semi-skilled and unskilled sub-groups in order to show the disparity of labor intensity across sectors.

**Table 4.4 Factor shares by sectors (2009/10)**

	Labor			Total Labor	Capital	Land	Livestock	Total factor Income
	Skilled	Semi Skilled	Unskilled					
<b>Agriculture</b>	-	3.4	87.9	91.2 (52.4)	12.4 (11.2)	39.8	30.9	174.3 (49.1)
<b>Industry</b>	1.8	12.9	2.8	17.5 (10.1)	18.7 (17)	-	-	36.2 (10.2)
<b>Service</b>	18.6	40.8	5.8	65.2 (37.5)	79.3 (71.9)	-	-	144.5 (40.7)
<b>All sectors</b>	20.4	57.1	96.5	174.0	110.3	39.8	30.9	355.0

\*The values in the parenthesis indicate the percentage shares of each factor income by sector

Source: Own computation from 2009/10 Ethiopian SAM

The agriculture sector employs about 52.4% of the total labor supplied, followed by service sector which employs about 37.5 percent. This shows that the agricultural sector of the country is highly labor intensive. Industry sector only employed 10.1% of the total factor supplied.

On the other hand, almost three fourth (72%) of capital is employed by the service sector. The remaining capital employment is shared by industry and agriculture sectors, 17% and 11.2% respectively. Factor incomes from land and livestock totally go to the agriculture sector, which is amounted to be 70.7 billion birr.

Moreover, labor is grouped as skilled, semi-skilled and unskilled based on a ranking of occupations according to assumed skill intensity. Accordingly, more than half (55.5%) of the total labor employed by the sectors is unskilled followed by semi-skilled labor which accounts for 32.8 percent of total labor supply. Only 11.7% of the total labor employed by all sectors is skilled.

In general, almost half (49.1%) of the total factor income goes to the agricultural sector, while the service and industry sectors employ 40.7% and 10.2% of the factors respectively. This shows that agriculture is the most dominant sector in the Ethiopian economy in terms of factor employment.

## 4.5 Households

Total household income includes the factor income and transfer payments from the government and rest of the world. By contrast, households spend their income on the consumption of goods, tax payment, and savings.

**Table 4.5: Income and Expenditure patterns of the households (2009/10)**

Income Sources	Household Income (billions)		Share of Income by households		Expenditure Items	Household Expenditure (in billions)		Share of Expenditure by households	
	Poor	Non Poor	Poor	Non Poor		Poor	Non Poor	Poor	Non Poor
<b>Factors</b>	73.0	282.1	93.9	95.1	<b>Consumption</b>	73.6	265.00	94.6	89.4
<b>Government transfers</b>	0.5	0.0	0.6	0.0	<b>Direct tax</b>	0.0	5.6	0.0	1.9
<b>Foreign receipts</b>	4.3	14.6	5.5	4.9	<b>Savings</b>	4.2	26.0	5.4	8.8
<b>Total Income</b>	77.8	296.6	100.0	100.0	<b>Total Expenditure</b>	77.8	296.6	100.0	100.0

Source: Own computation from 2009/10 Ethiopian SAM

As shown in table 4.5, the most important sources of income for both poor and non-poor households are the returns to factors and transfers from the rest of the world. The government transfer to households largely refers to the government pension and is paid entirely to the poor households accounting for 0.6 percent of the total income earned by poor households. Both of the households; the poor and non-poor earn 93.9 and 95.1 percents of their income from factors respectively. Foreign receipts account for about 5.5 and 4.9 percent of the total income of the poor and non-poor households respectively.

In aggregate, high-income households earn 296.6 billion birr which accounts for 79.2 percent of total household income. Conversely, low-income households earn a total income of 77.8 billion birr which accounts for only twenty-one percent of the total income. Hence, income earned by non-poor households is almost four times that of the poor ones. This shows that there is high-income inequality among the poor and non-poor households in the country.

Households spend their income on the consumption of goods, tax payment, and savings. Over 90 percent of the household income is spent on consumption of goods. This share of consumption spending is highest for poor households, where it accounts for almost all of the total disposable income. High-income households only pay a direct tax to the government, which accounts for 2 percent of their total consumption spending. These households also have the highest savings rates and generate 86.1 percent of total household savings in the economy.

## 4.6 Government

Government policies will affect its revenues, which in turn may influence the level of government spending. Government income comes from tax revenue and foreign receipts. By contrast, the government spends its income on consumption of goods and services, transfers to households and savings.

**Table 4.6 Income and Expenditures patterns of the Government (2009/10)**

<b>Income Sources</b>	<b>Government income (billions birr)</b>	<b>Share of government income</b>	<b>Expenditure Items</b>	<b>Government Spending (billions birr)</b>	<b>Share of government spending</b>
<b>Direct-tax</b>	5.6	8.3	<b>Consumption</b>	31.8	46.9
<b>Import tax</b>	9.6	14.2	<b>Household Transfers</b>	0.5	1.4
<b>sales tax</b>	18.8	27.7	<b>Savings</b>	35.5	52.4
<b>RoW</b>	33.8	49.9			
<b>Total income</b>	67.8	100.0	<b>Total spending</b>	67.8	100.0

Source: Own computation from 2009/10 Ethiopian SAM

As shown in table 4.6, the largest source of revenue for the government is receipts from the rest of the world in the form of transfers, loan, and grants, which accounts for about 50% of the total income. Governments also receive their income from taxes; 5.6 billion birr from direct tax, 18.8 billion birr from sales tax and 9.6 billion birr from import tax which accounts for about 50 percent of the total government income in aggregate. Sales taxes account for around one-fourth of total government income. By contrast, direct tax from households and

corporations generate only a small share of income for the government amounted to 8.3 percent.

On the other hand, total current government expenditure was 32.3 billion birr. From this amount, 31.8 billion birr was used for consumption of goods and services while transfers only valued to half billion birr. Government savings amount to 35.5 billion birr, which accounts for 52.4 percent of the total government income.

#### 4.7 Savings, Investment and the Current Account

Table 3.18 shows the composition of the savings-investment relationship. Accordingly, savings comprises of government, household and foreign savings. By contrast, investment encompasses final demand for investment and inventory changes representing the capital depreciation.

**Table 4.7 Composition of the savings-investment Account (2009/10)**

<b>Savings</b>	<b>Value in billions birr</b>	<b>Share of total savings</b>	<b>Investment</b>	<b>Value in billions birr</b>	<b>Share of total investment</b>
<b>Government</b>	35.5	40.6	<b>Final demand</b>	85.5	97.8
<b>Household</b>	30.2	34.6	<b>Inventory changes</b>	2.0	2.2
<b>Foreign Saving</b>	21.7	24.8			
<b>Total savings</b>	87.4	100	<b>Total investment</b>	87.4	100

Source: Own computation from 2009/10 Ethiopian SAM

Government savings is clearly the largest source of national savings in Ethiopia amounting to about 40.6 percent of the gross savings and followed by household savings which account for 34.6% of the total savings. Foreign savings are only amounted to 21.7 billion birr and account for about 25% of the total savings.

On the other hand, the final demand for investment is about 85.5 billion birr and accounts for about 98 percent of the gross investment. Inventory changes account for about 2 percent of the gross capital formation.

**Table 4.8: The Current Account (2009/10)**

<b>Receipts</b>	<b>Value in billions birr</b>	<b>Payments</b>	<b>Value in billions birr</b>
<b>Exports</b>	52.1	<b>Imports</b>	126.5
<b>Household remittances</b>	18.9	<b>Factor remittances</b>	-0.1
<b>Government Receipts</b>	33.8		
<b>Deficit</b>	<b>21.7</b>		

Source: Own computation from 2009/10 Ethiopian SAM

As table 4.8 shows the total payments on the current account of the balance of payments are more than the total receipts, hence the current account is said to be in deficit. About half of the country's foreign receipts come from exports followed by government receipts. On the other hand, imports cover all of the country's foreign payments.

The total deficit in the year 2009/10 was about 21.7 billion birr. The deficit in the current account of the balance of payments means that the country has spent more than what it earned in the form of foreign exchange during a year. Hence, this deficit in current account has been filled by borrowings and foreign grants from United Nations Organization, China and other developed countries.

## CHAPTER FIVE

### SIMULATION SPECIFICATION AND MODEL RESULTS

This section presents the results of dynamic CGE based simulations of the impact of birr devaluation on the overall Ethiopian economy using different simulation scenarios. The analysis is done in line with the objective; attempt was made to investigate the effect of devaluation of birr on major economic variables like its impacts on macroeconomic indicators (real GDP, absorption, investment, private consumption, real export and real import), sectoral growth effect (agriculture, industry and service), income and consumption expenditures, factor income and welfare effects.

The model solves the system of equations for all endogenous variables for consecutive periods of time. The simulation is applied over each scenario from 2018 up to 2023. Regarding calibration, all parameter values are taken from IFPRI model in addition to the 2009/10 SAM.

#### 5.1 Simulation Specification

In this section, a series of different scenarios are specified, each representing the exogenous change in exchange rate conditions, which are used to analyze the effect of devaluation on the Ethiopian economy. The simulations carried out are based on the realistic situation of the Ethiopian economy.

Accordingly, three different simulation experiments of exchange rate shocks other than the baseline scenario have been put into effect.

**Baseline Scenario:** It assumes that the status quo continues. Thus, the result of the baseline simulation is used as the benchmark value so as to compare the values of different variables after the policy shocks.

In static CGE model, comparative analysis is made with respect to the base run which is the initial SAM. However, in dynamic models since the economy can grow even without a policy shock, the analysis should be made with respect to the growth path in the absence of any shock. This is what we called baseline scenario. The baseline scenario in this study assumes that business continues as usual with a continuation of historical growth trends of 2010-2017 for additional six years, from 2018-2023 with no specific changes made to policies.

The model is calibrated under the baseline scenario for the simulation period to generate a 10% real GDP growth which was the average for the years 2010-2017. All other simulations are evaluated by taking the baseline scenario as a reference point.

**EXRIN15:** In this scenario, the latest exchange rate increment (devaluation) taken by the National Bank of Ethiopia (NBE) is considered. By the end of the year 2017, NBE has devalued the country's currency by 15 percent, following repeated reactions from IMF and World Bank. Hence, a 15 percent increment in the exchange rate is considered in this scenario in order to examine the effect of the policy action on the country's economy.

**EXRINC25:** In this scenario, the nominal exchange rate is assumed to be increased (devalued) by 25 percent. This is a middle scenario case in between the previous and the next simulation experiments which is purposively set by the researcher.

**EXRINC35:** IMF's latest report indicated that Ethiopia's birr is overvalued by over 30 percent. The IMF Chief Executive Director, Christine Lagarde, pointed that the price effect of devaluation should help increase the supply of foreign currency. The export price in birr becomes cheaper thereby attracting more buyers for Ethiopian exports while the birr import prices increase which lowers import demand. Hence, a 35 percent increment in the exchange rate (devaluation) is considered to justify whether devaluation has contractionary or expansionary effects on the Ethiopian economy.

## **5.2 Simulation Results and Discussion**

### **5.2.1 Effect of Devaluation on Macroeconomic indicators**

In this section, we present the summary of the results from our simulation experiments for the major macroeconomic variables. These variables are real GDP at factor cost (GDPFC2), fixed investment (FIXINV), private consumption (PRVCON), government consumption (GOVCON), real exports and real imports. Table 5.1 shows the summary of the simulation results for these variables. Notice that the results of EXRINC1, EXRINC2, and EXRINC3 represent the percentage deviations from the baseline scenario.

**Table 5.1: Impact on major macroeconomic indicators (average % change from baseline Scenario)**

	<b>INITIAL</b>	<b>BASE</b>	<b>EXRINC15</b>	<b>EXRINC25</b>	<b>EXRINC35</b>
<b>ABSORP</b>	457.74	6.46	-0.36	-0.56	-0.68
<b>PRVCON</b>	338.61	7.29	-0.03	-0.04	-0.03
<b>FIXINV</b>	85.49	1.49	-2.46	-3.94	-5.00
<b>GOVCON</b>	31.82	9.40	0.00	0.00	0.00
<b>EXPORTS</b>	52.14	23.89	0.43	0.63	0.75
<b>IMPORTS</b>	-126.51	9.33	-0.45	-0.71	-0.90
<b>GDPMP2</b>	383.36	8.88	-0.12	-0.19	-0.22
<b>GDPFC2</b>	354.95	9.25	-0.08	-0.13	-0.15

Source: Own computation from Simulation Results

As we observe from table 5.1, in all simulations, the macroeconomic variables are negatively responding to the exchange rate shocks except the real exports which show moderate improvements compared to the baseline scenario. Government consumption expenditure is constant across the period since it is set fixed in the government closure.

The growth rate of real GDP at factor cost was declining in all the three simulations. Devaluation of birr results in the real GDP of the country to decline by 0.08, 0.13 and 0.15 percentage points when exchange rate increases by 15%, 25%, and 35% respectively. This decline in real GDP is mainly due to the rise in the prices of imported intermediate inputs which further causes a decline in aggregate demand in both final consumption and intermediate consumption.

Absorption, which is the total demand for all final marketed goods and services by all economic agents in an economy, indicates that there is a 0.36%, 0.56% and 0.68% decline in simulation scenarios 1, 2 and 3 respectively as compared to the base case. The decline in the domestic absorption is mainly due to the decline in fixed investment and private consumption expenditure.

Private consumption expenditure is slightly reduced by 0.03%, 0.04% and 0.03% under the three simulation scenarios respectively. Private consumption has been declined due to the

reduction of the purchasing power of household disposable income following the increment of the exchange rate.

Gross fixed investment, which is defined as the total business spending on fixed assets has shown a big reduction throughout all simulation scenarios. It has been reduced by 2.46%, 3.94% and 5% as compared to the baseline scenario. A decline in fixed investment may have been the result of two consequences of exchange rate increment. First, exchange rate increment results in increased import prices. As a result, fixed investment in imports by private sector generally decline. Second, given that fixed investment accounts a significant share of the total government expenditure and massive investment are being implemented by the government on public services exchange rate increment reduces governments financing capacity. Consequently, the government may reduce public investments and hence fixed investment will be declined.

Moreover, real exports are boosted by 0.43%, 0.63% and 0.75%, while real imports are declined by 0.45%, 0.71% and 0.90% under the three simulation scenarios respectively. The real exports tend to rise mainly because of a significant increase in the price of exported commodities and real imports fall due to the decline in domestic demand triggered by the reduction in the purchasing power of income following devaluation. This will lead to improvements in an average growth rate of the trade balance. However, this increment in current account balance is less enough to offset the decline in private consumption and fixed investment for real GDP to boost up.

### **5.2.2 Sectoral Effects of Devaluation**

Here, the researcher has aggregated activities into three major economic sectors: agriculture, industry and service sectors to see the impact of devaluations on the sectoral contributions of each sector to GDP. Average percentage change in sectoral GDP from baseline simulation for the years 2018 to 2023 is depicted in Table 5.2.

Accordingly, among the sectors, the largest expansion is shown by the service sector. It has increased by 0.08%, 0.12% and 0.14% in 1st, 2nd, and 3rd simulations respectively. This is due to the fact that service sector productivity is becoming higher than that of agriculture and industrial sectors in recent times. Moreover, services are the most exportable commodities for the country by the year 2009/10. Hence, an increase in exchange rate motivates exporters of the service and consequently, the contribution of the sector to GDP will boost up.

In terms of percentage change of sectoral output, the Agricultural sector is the second with the percentage change of 0.01%, 0.02% and 0.06% in 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> simulations respectively. The increase in the productivity of agriculture sector is mainly due to an increase in activity prices of the sectors outputs. This, in turn, enhances incentive of production in the agricultural sector.

Devaluation, on the other hand, has a negative impact on the industrial sector. The sector's GDP contribution declines by 0.15%, 0.18% and 0.26% in simulations 1, 2 and 3 respectively. This is because of the fact that industrial sector highly uses imported commodities as an intermediate input in its production processes. If exchange rate of birr increases, the price of these imports will consequently increase which further results in an increase in the price of industrial commodities. Consequently, the demand for the industrial commodities will be declined resulting in a decrement of the sectoral contribution to the overall GDP growth.

**Table 5.2 Impact of devaluation on sectoral production (average % change from baseline scenario)**

	INITIAL	BASE	EXRINC15	EXRINC25	EXRINC35
<b>Agriculture</b>	174.3	4.23	0.01	0.02	0.06
<b>Industry</b>	36.2	13.76	-0.15	-0.18	-0.26
<b>Service</b>	144.5	14.46	0.08	0.12	0.14

Source: Own computation From Simulation Result

### **5.2.3 Impact of devaluation on Import and Export Prices**

The primary impact of devaluation is on the prices of imported and exportable commodities. Theories indicated that devaluation results in increase in the price of imports and a decline in the price of exports. This will further increase the demand for exports while reducing the demand for imports, and thereby improving the trade balance. Accordingly, table 5.3 shows the impact of devaluation on import and export prices in Ethiopia.

**Table 5.3 Impact of devaluation on the price of Imports and Exports (average % change from baseline scenario)**

	Price of Imports			Price of Exports		
	EXRINC15	EXRINC25	EXRINC35	EXRINC15	EXRINC25	EXRINC35
<b>Agriculture</b>	0.13	0.21	0.30	0.18	0.12	0.11
<b>Industry</b>	0.10	0.17	0.25	0.28	0.17	0.14
<b>Service</b>	0.15	0.25	0.35	0.15	0.10	0.10

Source: Own computation From Simulation Result

Results in Table 5.3 reveal that import prices of the tradable commodities for all sectors significantly rise as the policy of deteriorating birr is introduced. The price increases by 0.13%, 0.21% and 0.3% for the agriculture exports, 0.1%, 0.17% and 0.25% for the industrial exports and 0.15%, 0.25% and 0.35% for the service exports in simulations 1, 2 and 3 respectively. Of all the three sectors, the prices of service imports are increasing at a fastest rate being equal with the exchange rate increment. The final effect will be on the quantity of imports, which will be negative for all commodities.

Moreover, the average export prices of the commodities in all the three sectors are increasing following the devaluation of birr. Consequently, export income will most probably be increased. However, the export prices are increasing at a decreasing rate unlike the theoretical expectations. The increment may probably be null in the long run. The main reason is that Ethiopian exports are primary agricultural commodities for which the demand in the world markets is highly stable (less price elastic). In other words, Ethiopian exports are less sensitive (insensitive) for the changes in exchange rates.

Over all, devaluation undoubtedly brings more domestic inflation as Ethiopian importers will rise prices on their imported commodities. Rising general prices in turn increases input prices. As a result of input price increase, manufacturers cut back on their productions, which further results more unemployment.

#### **5.2.4 Effect of devaluation on Factor Income Distribution**

Regarding the returns to the factors of production, the simulation results are provided in Table 5.4. Accordingly, the factors are grouped into labor, capital, land and livestock sub-

components. Labor is further disaggregated into skilled, semi-skilled and unskilled in order to see the separate effect of devaluation on different labor groups.

**Table 5.4 Impact of devaluation on factor income (average % change from baseline Scenario)**

	<b>INITIAL</b>	<b>BASE</b>	<b>EXRINC15</b>	<b>EXRINC25</b>	<b>EXRINC35</b>
<b>Labor skilled</b>	20.47	-0.11	0	0.01	0.01
<b>Labor semi-skilled</b>	57.04	-0.35	-0.01	-0.02	-0.03
<b>Labor unskilled</b>	96.5	0.35	0.02	0.04	0.05
<b>Capital</b>	110.41	-0.29	-0.04	-0.06	-0.07
<b>Land</b>	39.77	0.18	0.03	0.02	0.04
<b>Livestock</b>	30.86	0.22	0.01	0.01	0.01

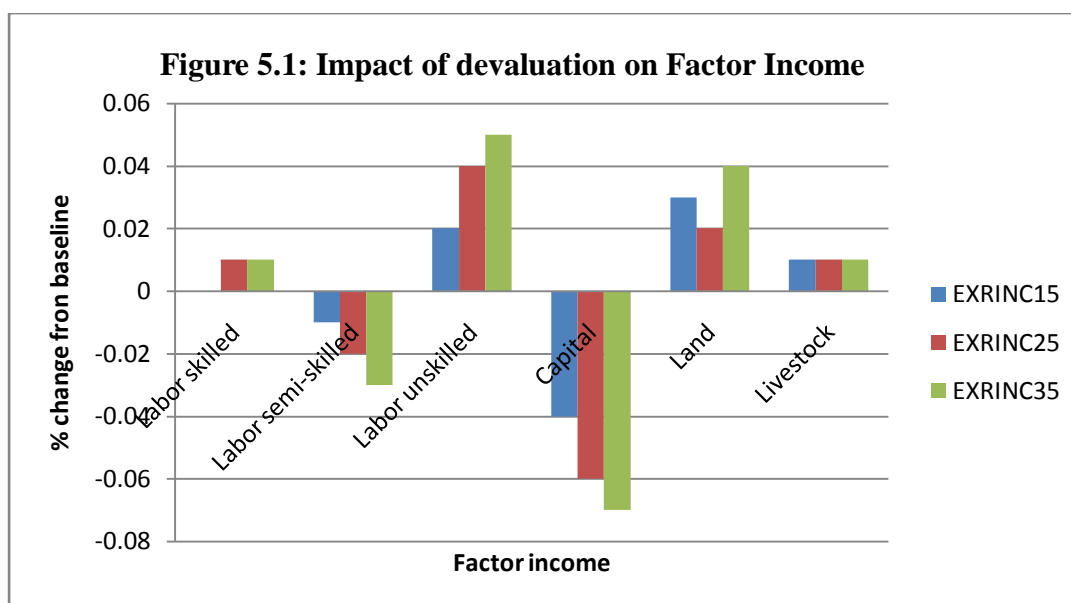
Source: Own computation from Simulation Result

Accordingly, factor incomes for all factors except, semi-skilled labor and capital have shown moderate increments. There is a small change to the skilled labor, which can be said none. Factor income of the semi-skilled labor has declined by 0.01%, 0.02% and 0.03% in the three simulations respectively. The decline in the returns for the semi-skilled labor may emanate from the decline in the productivity of industrial sector since most of this labor group is employed in the sector.

On the other hand, factor income to the unskilled labor has been increased by 0.02%, 0.04% and 0.05% under simulation scenarios 1, 2 and 3 respectively. Returns for land increase at rate of 0.03%, 0.02% and 0.04% in simulations 1, 2 and 3 respectively. Moreover, livestock returns rise at a constant rate of 0.01% in all simulations. This is due to the fact that increases in the productivity of agricultural sector result in more increase in income of unskilled labor, land, and livestock.

Among the factors of production, the return of capital declines at the fastest rate. It has been reduced by 0.04%, 0.06% and 0.07% in simulations 1, 2 and 3 respectively. The reason could emanate from the declining industrial productions that are relatively more capital intensive.

Figure 5.1 below shows the percentage change of factor income of each factor groups from the baseline scenario more clearly.



Source: Own computation from simulation results

## 5.2.5 Distributional Effects of devaluation

### 5.2.5.1 Impact of devaluation on Household Income

On the socio-economic front, the most profound outcome of devaluation is its impact on the distribution of income. The main sources of income for households are factor payments, transfers payments from the government and receipts from the rest of the world. Table 5.5 summarizes the average percentage changes to the household income compared to the baseline as a result of birr devaluation.

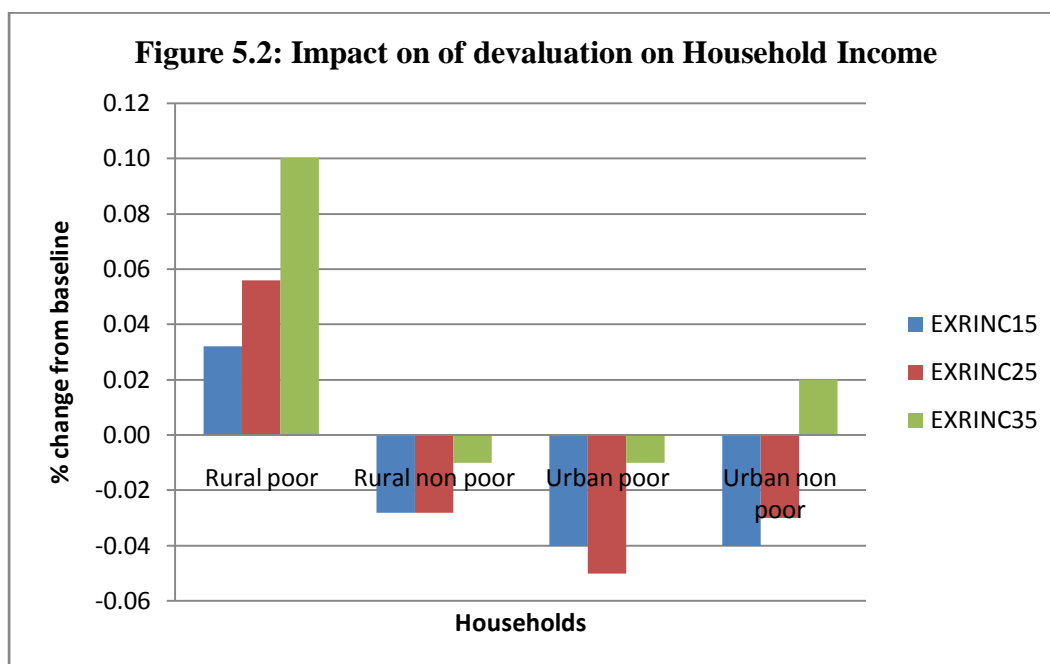
**Table 5.5 Impact on of devaluation on household income (average % change from baseline Scenario)**

	INITIAL	BASE	EXRINC15	EXRINC25	EXRINC35
<b>Rural poor</b>	73.93	9.704	0.03	0.06	0.10
<b>Rural non poor</b>	261.08	8.94	-0.03	-0.03	-0.01
<b>Urban poor</b>	3.83	7.79	-0.04	-0.05	-0.01
<b>Urban non poor</b>	35.54	7.21	-0.04	-0.03	0.02

Source: Own computation from Simulation Results

As shown in table 5.5, all households except poor rural households experienced a significant reduction in their real incomes compared to the base case. The poor rural household income increases by 0.03%, 0.06% and 0.1% under simulation scenarios 1, 2 and 3 respectively. This

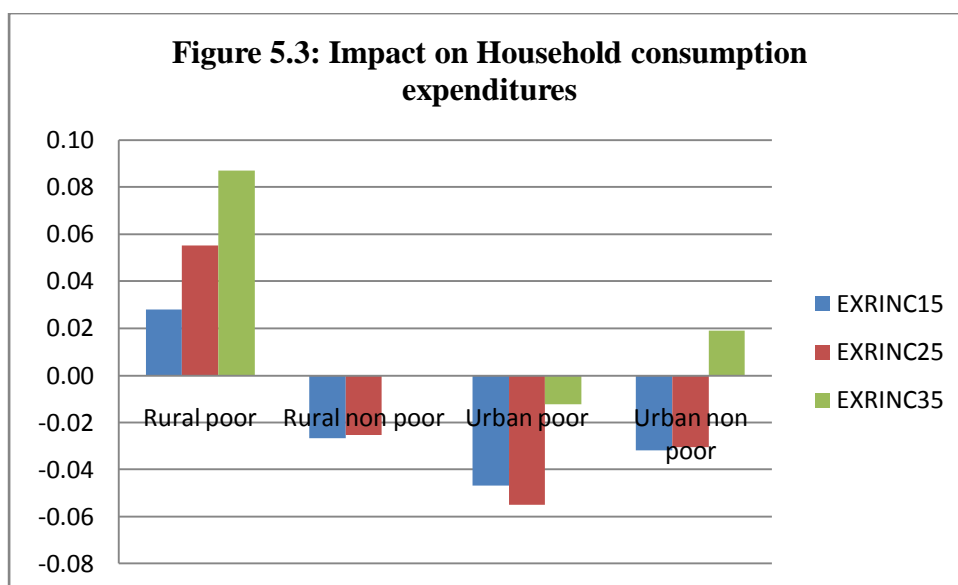
is due to the fact that poor rural households are mostly engaged in the agricultural sector and the improvement to the sector as a result of devaluation increases incomings to the households. Moreover, government transfers are highly distributed among the rural poor households than all other households. Hence, total incomes to the rural poor households would grow up as compared to the baseline. On the other hand, the decline in the income of other households is due to the diminishing of their purchasing power following the price hike resulted from devaluation. Figure 5.2 shows the percentage changes of the household incomes from to the baseline case due to devaluation in a clear manner.



Source: Own computation from Simulation Results

### 5.2.5.2 Impact of devaluation on Household Consumption Expenditure

Households spend their income on consumption, after paying taxes to the government, transfers to other institutions and save some portions. Figure 5.3 shows the percentage changes to the consumption expenditures made by households as a result of devaluation. Accordingly, all households groups except poor rural households have experienced a significant reduction in their consumption expenditures compared to the baseline. This emanates from the decline of income of the households since income and consumption expenditures are positively related.



Source: Own computation from Simulation Results

## 5.2.6 Impact of devaluation on government variables

Government obtains its income from tax and foreign receipts while spending this income on consumption of goods and services, transfers to households and foreign savings. Government consumption expenditure and transfer payments make up the total current government expenditure. Table 5.6 shows the percentage changes of total government income and expenditures from its baseline scenario as a result of devaluation.

**Table 5.6 Impact of devaluation on government income and expenditure patterns (average % change from baseline scenario)**

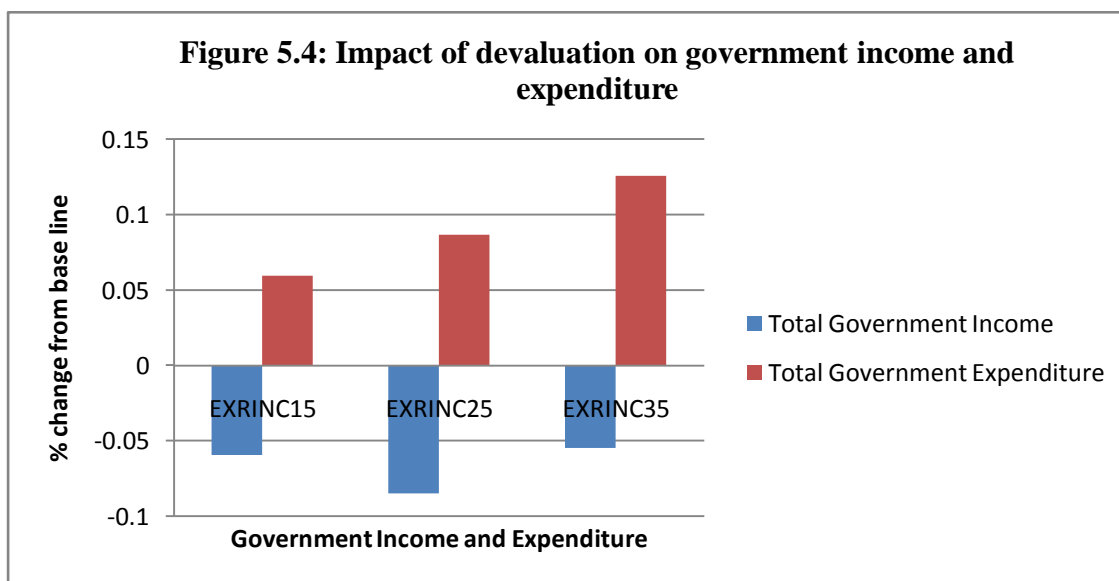
	INITIAL	BASE	EXRINC15	EXRINC25	EXRINC35
<b>Total Government Income</b>	67.78	7.31	-0.06	-0.08	-0.05
<b>Total Government Expenditure</b>	32.29	6.91	0.06	0.09	0.13

Source: Own computation from Simulation Results

As shown in table 5.6, government revenue has decreased by 0.06%, 0.08% and 0.05% in simulations 1, 2 and 3 respectively. The highest decline in government revenue is recorded in simulation 2 where the exchange rate is set to be increased by 25%. The decline in government income is highly attributed to the reduction in tax revenue from the industrial

sector. Some firms engaged in the industrial sector may be forced to shut down their business as a result of devaluation since it results in a decline of production and profitability of the industrial sector. This, in turn, reduces the total revenue of the government since industrial firms are the main tax providers to the government.

On the other hand, the total current government consumption expenditure is increased in all the three simulation cases. As shown in table 5.6, total government expenditure has risen by 0.06%, 0.09% and 0.13% in simulation scenarios 1, 2 and 3 respectively. The main reason is that Ethiopian government has currently undertaking huge projects in different regions of the country. Since devaluation results in the price of imports to increase, the government is forced to increase its spending to accomplish its public responsibility although revenue is declined. Of course, the government will finance the budget deficit through external borrowings which are another burden for the country. Figure 5.4 shows the impact of devaluation on government revenue and expenditure patterns in a clear and condensed way.

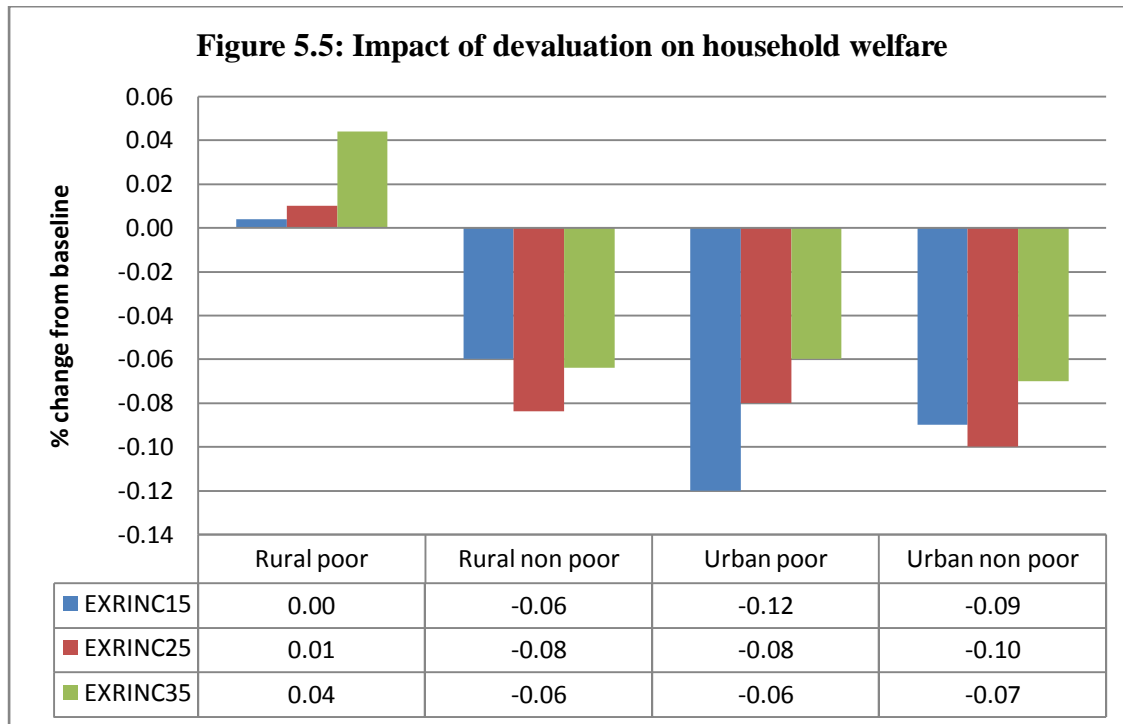


Source: Own computation from Simulation Results

### 5.2.7 Welfare effects of devaluation

Welfare can be measured by equivalent variation, income of households or consumption expenditure of households. However, literatures have widely employed the equivalent variation (EV) to measure the welfare impact of a policy shock in CGE models. Since policy shocks are usually followed by major price adjustments, the EV measures the level of income that the consumer needs to pay before the shock to leave him as well off at the equivalent level of utility after the price changes.

Accordingly, EV indicates that the increase in price leads to welfare loss by the amount equal to the loss of income (which equal to EV) if the price remained at the initial value. Therefore, negative EV changes represent welfare loss whereas positive EV changes represent welfare gain resulting from the policy shock. The effects of each of the simulations on the household's welfare are demonstrated using the following diagram.



Source: Own computation from simulation results

As shown in figure 5.5, the welfare of all households has deteriorated as a result of devaluation except for that of the rural poor. The EVs have declined for the rural non-poor, urban poor and urban non-poor as compared to the base case simulation, while EV for rural poor showed a small welfare gain. The welfare of the rural households rose by 0.002, 0.01% and 0.04% in the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> simulation scenarios respectively as compared to the baseline. The improvement in the welfare of rural poor is due to the fact that they are highly engaged in the agriculture sector which has shown moderate improvements as a result of devaluation. On the other hand, the welfare of rural non-poor, urban poor and urban non-poor households have been declined as a result of devaluation. This occurs due to the path through effect of inflation from firms to consumers as a result of increased input costs.

## CHAPTER SIX

### CONCLUSION AND POLICY IMPLICATIONS

#### 6.1 Conclusion

The benchmark of Ethiopian economy in 2009/10 indicated that agriculture is the most dominant sector in the Ethiopian economy followed by service sector contributing 49.1% and 40.7% of the overall GDP respectively. The industrial sector is at its infant stage contributing only about 10.2% of total GDP. Moreover, the country is running a trade deficit of 74.4 billion birr in the same year. IMF has recommended and has been recommending devaluation as a cure for these problems. This study has been undertaken in order to check out the reality of this policy measure.

In this study, attempts have been made to investigate the economy-wide impact of the devaluation of Ethiopian currency using a recursive DCGE model. The study used an updated version of the 2009/10 EDRI Social Accounting Matrix. Three different simulation scenarios have been simultaneously used to evaluate the impact of devaluation on the economy; 15%, 25% and 35% increment in exchange rate respectively.

The simulation results have shown that following devaluation most of the macroeconomic indicators have recorded a negative change unlike theoretical suppositions. The growth rate of real GDP at factor cost was declined in all the simulations as compared to the baseline case. It has been increased on average from its base case by 0.08%, 0.13% and 0.15% when birr exchange rate is devalued by 15, 25 and 35 percents respectively. This decline in real GDP at factor cost is due to the reduction of its components private consumption expenditure and fixed investment by firms. Gross fixed investment and private consumption expenditures are declined under all simulations due to the reduction of purchasing power of income and the increased price of imports following the increment of the exchange rate. This further resulted in a reduction of the nominal absorption. Moreover, the decline in investment causes unemployment to rise.

On the other hand, real exports have been risen up while imports are declined in all simulation scenarios as a result of an increase in both the import and export prices following devaluation. This helped in improving the trade balance of the country, which is the only good news of devaluation for the country. However, the increment is less enough to offset the

decline in private consumption and fixed investment for real GDP to boost up. Moreover, higher prices of imports will further bring inflationary situations on the economy which is another big headache for the government.

Regarding the impact of devaluation on sectoral output growth, the largest expansion is shown by the service sector since services are the most exportable commodities for the country by the year 2009/10 and feed up the fruits of export increase. Agriculture also showed improvements under all simulations mainly due to the increase in activity prices of the sectoral outputs, which in turn enhances incentive of production in the agricultural sector. Devaluation, on the other hand, has a negative impact on the industrial sector due to a decline in the demand for the industrial commodities.

Moreover, the impact of devaluation on factor payments had also been addressed. Accordingly, factor incomes for skilled labor, unskilled labor, land and livestock are increased while that of semi-skilled labor and capital has been declined. The decline in the returns for capital and semi-skilled labor is largely associated with the decline in the productivity of industrial sector. On the other hand, the improvements for the unskilled labor, land, and livestock emanates from the improvements to the agricultural sector. Among all, the return of capital declines at the fastest rate due to the declining industrial productions that are relatively more capital intensive.

The simulation results also revealed that devaluations adversely affect the income of most households. Only poor rural households have experienced a significant increment in their real incomes as a result of devaluation. This is due to the fact that poor rural households are highly benefited from improvements in agricultural productivity as well as the government transfers payments to them. A similar pattern has been seen over the expenditure patterns of the households since income and expenditure have a direct relationship.

Government revenue has decreased as a result of devaluation. This decline in government revenue is highly attributed to the downturns in the industrial sector which result in the reduction of tax revenue. On the other hand, the total current government consumption expenditure is increased implying that the government will finance the budget deficit through external borrowings which lets debt burden over the country.

Lastly, the impact of devaluation on household welfare is considered. Accordingly, the EVs have declined for the rural non-poor, urban poor and urban non-poor while that of the rural

poor showed a small welfare gain. Overall, the simulation results indicate that devaluation of birr results in a loss of the welfare of households.

## **6.2 Policy Implications**

Exchange rate devaluation is one of the most important trade policies recommended by the IMF and WB for most of the developing countries in Africa. Amazingly, this study has been realized that devaluation did not result in improvements to the economy of Ethiopia as theoretically supposed. Rather, it adversely affects the country's economic performance except a small improvement in the trade balance.

Based on the findings of the study the following policy implications have been forwarded by the researcher:

- ❖ Although devaluation helps the growth of agriculture and service sectors, the industrial sector which is a core of economic development is eventually deteriorating. The main reason is that the price of industrial products will be higher following devaluation which makes the consumers to substitute relatively cheap imported commodities. Thus, incentives should be made to the firms in the industrial sector and restrictions should be imposed in terms of quota and tariffs on selected imports.
- ❖ The exchange rate shocks also induced the fixed investment to decline extremely unlike theoretical predictions. Thus, there is a need to mobilize domestic savings and channel it to investment. Moreover, foreign direct investment should be attracted through designing different incentive schemes in order to restrain the adverse effects of domestic absorption and real GDP.
- ❖ Devaluation in Ethiopia would succeed in increasing domestic prices of tradable goods and encourage producers to export. However, this affects the domestic consumers negatively because the increase in prices is unaccompanied by similar increases in the households' income. Therefore, devaluation would encourage producers of some sectors to increase their output and exports, while hindering welfare of the consumers, as the domestic prices increase fuelling domestic inflation. Thus, appropriate fiscal and monetary policy changes should accompany the realignment of exchange rate so as to restrain the welfare loss and inflationary impacts.

- ❖ Even though devaluation helps in improving the trade balance to some extent, it generally reduces the real GDP growth. Ethiopia as a developing country depends on exports of agricultural commodities and the export elasticity of these commodities are less sensitive to exchange rate changes. Moreover, devaluation increases the cost of imported commodities in domestic currency forcing the country to reduce its imports which negatively affects the real GDP of the country. To this end, import substitution mechanisms should be adopted in order to foster the economic growth.
- ❖ Based on the results, total government expenditure has been increased than its revenue as a result of devaluation. Consequently, the government budgetary situation worsens owing to the rise in fiscal deficit. Thus the final result is reducing the economic growth unless the government takes another policy action rather than intensive devaluation. Thus, appropriate fiscal policy measures like broadening the tax base should be adopted to fill the gap between government revenue and its spending.
- ❖ To sum up, there is no real benefit from devaluation due to its contractionary effects on the Ethiopian economy. Thus, the researcher suggests the monetary authority to stick to its managed floating policy stance and make changes in cautious and predictable manner. Moreover, there is an obvious need to combine monetary policy measures with fiscal policy in order to promote sustained economic development.

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## APPENDIX-I: ETHIOPIAN MACRO SAM 2009/10 (in Billion Birr)

										Commodities								Mrg
		Crp	Liv	Fs-Fr	Agpr	OMfg.	OInd	PrS	PuS	Crp	Liv	Fs-Fr	Agpr	OMfg.	OInd	PrS	PuS	
<b>Activities</b>	Crp									123.7								
	Liv										49.5							
	Fs-Fr											16.6						
	AgPr												31.9					
	OMfg													31.1				
	OInd														95.2			
	PrS															215.3		
	PuS																	34.9
<b>Commodities</b>	Crp	8.3			6.3	0.8	0.3	5.9										
	Liv				12	1.4		4.7										
	Fs-Fr				0.1	0.1	3.4	1.3	0.1									
	AgPr		0.6		2.2	0.1		13.1	1.1									
	OMfg	5.1	0.1		1.3	16.4	35.1	13.1	4.8									
	OInd				0.6	3.1	27.8	16.7	2.9									
	PrS	0.2	0	1.3	2.3	1.6	7.1	37.4	4									83.8
	PuS		0				0	0.1	0.5									
<b>Mrg</b>										11	1.1	2.7	11	27.6	30.3			
<b>Factors</b>	L-Sk				0.2	0.1	1.5	9.4	9.3									
	L-SS			3.4	3.6	4.2	5.1	38.4	2.4									
	L-US	69.6	15	3.3	0.6	0.3	1.8	5.4	0.4									
	Cap	0.8	2.9	8.7	2.7	3	12.9	69.7	9.5									
	Land	39.8	30.9															
<b>Housholds</b>	R-pr																	
	R-n-pr																	
	U-pr																	
	U-n-pr																	
<b>Gov.t</b>																		
<b>Taxes</b>	D-tax																	
	M-tax									0			0.5	9.1				
	S-tax									0.2	0.1	0	3.5	11	1.1	2.6	0.2	
<b>GCF</b>	$\Delta$ Stk																	
	Sav																	
<b>ROW</b>										8.8	0	0	4.9	79.6	1.9	31.2		
<b>Total</b>		123.7	49.5	16.6	31.9	31.1	95.2	215.3	34.9	143.7	50.8	19.4	51.9	158.5	128.5	249.1	35.1	83.8

**ETHIOPIAN MACRO SAM 2009/10 Continued .....**

		Factors					Households				Gov. t	Taxes			GCF		ROW	Total
		L-Sk	L-SS	L-US	Cap	Land	R-pr	R-n-pr	U-pr	U-n-pr		D-tax	M-tax	S-tax	ΔStk.	Inv		
Activ ities	Crp																	123.7
	Liv																	49.5
	Fs-Fr																	16.6
	Agpr																	31.9
	OMf g																	31.1
	OInd																	95.2
	PrS																	215.3
	PuS																	34.9
Com modi ties	Crp						30.3	74.7	0.9	3.1						0.3	12.6	143.7
	Liv						7.5	18.9	0.5	2.8				1.8			1.1	50.8
	Fs-Fr						2.4	11.5	0	0.4							0.2	19.4
	Agpr						7.1	21.2	0.7	2.8							3.1	51.9
	OMf g						8.7	39.3	0.5	7.9					17.1		9.1	158.5
	OInd						0.4	6.8	0	2					68.1			128.5
	PrS						13.3	64.1	0.6	7.4							26.1	249.1
	PuS						0.5	1.5	0.1	0.6	31.8							35.1
<b>Mrg</b>																		83.8
Fact ors	L-Sk																	20.5
	L-SS																	57
	L-US																	96.5
	Cap																	110.3
	Land																	70.6
Hous ehol ds	R-pr	0.4	9.1	28.7	6.3	25.1					0.5						4	73.9
	R-n-pr	10.7	43.8	63.5	87.7	45.6											9.9	261.1
	U-pr	0.3	0.7	0.9	1.6						0						0.3	3.8
	U-n-pr	9.1	3.5	3.4	14.9												4.6	35.5
<b>Gov.t</b>												5.6	9.6	18.8			33.8	67.8
Tax es	D-tax							3.1		2.5								5.6
	M-tax																	9.6
	S-tax																	18.8
GC F	Sav														1.8			1.8
	ΔStk						3.8	20	0.4	6	35.5						21.7	87.3
<b>ROW</b>					-0.1													126.4
<b>Total</b>		20.5	57	96.5	110.3	70.6	73.9	261.1	3.8	35.5	67.8	5.6	9.6	18.8	1.8	87.3	126.4	

Where, *Crp* = Crops, *Liv* = Livestock, *Fs-Fr* = Fishing and Forestry, *Agpr* = Agro Processing, *OMfg* = Other Manufacturing, *OInd* = Other Industry, *PrS* = Private Service, *PuS* = Public Service, *Mrg* = Margins, *L-Sk* = Labor Skilled, *L-SS* = Labor Semi-Skilled, *L-US* = Labor Unskilled, *Cap* = Capital, *Land* = Land including Livestock, *R-pr* = Rural poor, *R-n-pr* = Rural non poor, *U-pr* = Urban poor, *U-n-pr* = Urban non poor, *Gov.t* = Government, *D-tax* = Direct tax, *M-tax* = Import tax, *S-tax* = Sales tax, *GCF* = Gross Capital Formation, *Sav* = Savings, *Inv* = Investment,  $\Delta Stk$  = Stock change, and *ROW* = Rest of the World

## APPENDIX-II: CGE MODEL EQUATIONS

### A. Sets

Sets	Explanation
AC	Global set for model accounts
A(AC)	activities
ACES(A)	activities with CES fn at top of technology nest
ALEO(A)	activities with Leontief fn at top of technology nest
C(AC)	commodities
CD(C)	commodities with domestic sales of output
CDN(C)	commodities without domestic sales of output
CE(C)	exported commodities
CEN(C)	non-exported commodities
CM(C)	imported commodities
CMN(C)	non-imported commodities
CX(C)	commodities with output
F(AC)	factors
INS(AC)	institutions
INSD(INS)	domestic institutions
INSDNG(INSD)	domestic non-government institutions
H(INSDNG)	households

### B. Parameters

Symbol	Explanation
$\alpha_a^a$	Efficiency parameter in the CES activity function
$\alpha_a^{va}$	Efficiency parameter in the CES value-added function
$\alpha_c^{ac}$	Shift parameter for domestic commodity aggregation function
$\alpha_c^q$	Armington function shift parameter c
$\alpha_c^t$	CET function shift parameter
$\beta^a$	Capital sectoral mobility factor
$\beta_{ch}^m$	Marginal share of consumption spending on marketed commodity c for household h
$\delta_a^a$	CES activity function share parameter
$\delta_{ac}^{ac}$	Share parameter for domestic commodity aggregation function
$\delta_{cr}^q$	Armington function share parameter
$v_f$	Capital depreciation rate
$\delta_r^t$	CET function share parameter
$\delta_{fa}^{va}$	CES value-added function share parameter for factor f in activity a

$\gamma_{ch}^m$	Subsistence consumption of marketed commodity c for household h
$\theta_{ac}$	Yield of output c per unit of activity a
$\rho_a^a$	CES production function exponent
$\rho_a^{va}$	CES value-added function exponent
$\rho_c^{ac}$	Domestic commodity aggregation function exponent
$\rho_c^q$	Armington function exponent
$\rho_c^t$	CET function exponent
$\eta_{fat}^a$	Sector share of new capital
$QF_{fa}$	Quantity demanded of factor
$cwts_c$	Weight of commodity c in the CPI
$dwts_c$	Weight of commodity c in the producer price index
$ica_{ca}$	Quantity of c as intermediate input per unit of activity a
$icd_{cc'}$	Quantity of commodity c as trade input per unit of c' produced and sold domestically
$ice_{cc'}$	Quantity of commodity c as trade input per exported unit of c'
$icm_{cc'}$	Quantity of commodity c as trade input per imported unit of c'
$inta_a$	Quantity of aggregate intermediate input per activity unit
$iva_a$	Quantity of aggregate intermediate input per activity unit
$\overline{mps}_i$	Base savings rate for domestic institution i
$mps01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
$pwe_c$	Export price (foreign currency)
$pwm_c$	Import price (foreign currency)
$qdst_c$	Quantity of stock change
$\overline{qg}_c$	Base-year quantity of government demand
$\overline{qinv}_c$	Base-year quantity of private investment demand
$shif_{if}$	Share for domestic institution i in income of factor f
$shii_{ii'}$	Share of net income of i' to i (i' $\in$ INSDNG'; i $\in$ INSDNG)
$ta_a$	Tax rate for activity a
$\overline{tins}_i$	Exogenous direct tax rate for domestic institution i
$tins01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
$tm_c$	Import tariff rate
$tq_c$	Rate of sales tax
$trnsfr_{if}$	Transfer from factor f to institution i

### C. Exogenous Variables

Variable	Explanation
$\overline{CPI}$	Consumer price index
$\overline{DTINS}$	Change in domestic institution tax share (= 0 for base; exogenous variable)
$\overline{FSAV}$	Foreign savings (FCU)
$\overline{GADJ}$	Government consumption adjustment
$\overline{IADJ}$	Investment adjustment factor
$\overline{MPSADJ}$	Savings rate scaling factor (= 0 for $f$ base)
$\overline{QFS_f}$	Quantity supplied of factor
$\overline{TINSADJ}$	Direct tax scaling factor (= 0 for base; exogenous variable)
$\overline{WFDIST_{fa}}$	Wage distortion factor for factor $f$ in activity $a$

### D. Endogenous Variables

Variable	Explanation
$AWF_t^f$	Average capital rental rate in time period $t$
$DMPS$	Change in domestic institution savings rates (= 0 for base; exogenous variable)
$DPI$	Producer price index for domestically marketed output
$EG$	Government expenditures
$EH_h$	Consumption spending for household
$EXR$	Exchange rate (LCU per unit of FCU)
$GSAV$	Government savings
$QG_c$	Government consumption demand for commodity
$QH_{ch}$	Quantity consumed of commodity $c$ by household $h$
$QHA_{ach}$	Quantity of household home consumption of commodity $c$ from activity $a$ for $h$
$QINTA_a$	Quantity of aggregate intermediate input
$QINT_{ca}$	Quantity of commodity $c$ as intermediate input to activity $a$
$QINV_c$	Quantity of investment demand for commodity
$QM_{cr}$	Quantity of imports of commodity $c$
$MPS_i$	Marginal propensity to save for domestic non-government institution
$PA_a$	Activity price (unit gross revenue)

$PDD_c$	Demand price for commodity produced and sold domestically
$PDS_c$	Supply price for commodity produced and sold domestically
$PE_{cr}$	Export price (domestic currency)
$PINTA_a$	Aggregate intermediate input price for activity a
$PK_{ft}$	Unit price of capital in time period t
$PM_{cr}$	Import price (domestic currency)
$PQ_c$	Composite commodity price
$PVA_a$	Value-added price (factor income per unit of activity)
$PX_c$	Aggregate producer price for commodity
$PXAC_{ac}$	Producer price of commodity c for activity a
$QA_a$	Quantity (level) of activity
$QD_c$	Quantity sold domestically of domestic output
$QE_{cr}$	Quantity of exports
$QQ_c$	Quantity of goods supplied to domestic market (composite supply)
$QT_c$	Quantity of commodity demanded as trade input
$QVA_a$	Quantity of (aggregate) value-added
$QX_c$	Aggregated quantity of domestic output of commodity
$QXAC_{ac}$	Quantity of output of commodity c from activity a
$RWF_f$	Real average factor price
$TABS$	Total nominal absorption
$TINS_i$	Direct tax rate for institution i ( $i \in INSDNG$ )
$TRII_{ii'}$	Transfers from institution i' to i (both in the set INSDNG)
$WF_f$	Average price of factor
$YF_f$	Income of factor f
$YG$	Government revenue
$YI_i$	Income of domestic non- government institution
$YIF_{if}$	Income to domestic institution i from factor f
$\Delta K_{fat}^a$	Quantity of new capital by activity a for time period t

## E. Model Equations

### Prices Block

**Import Price:** The import price expressed in local currency units is the price paid by domestic users for imported commodities (exclusive of the sales tax). Thus,

$$PM_c = PWM_c (1 + tm_c) EXR + \sum PQ_{c'} \cdot icm_{c'c} \quad c \in CM \text{ ----- (1)}$$

**Export Price:** The export price in local currency units (LCU) is the price received by domestic producers when they sell their output in export markets.

$$PE_c = PWE_c (1 - te_c) EXR - \sum PQ_{c'} \cdot ice_{c'c} \quad c \in CE \text{ ----- (2)}$$

**Demand Price of Domestic Non traded Goods:** is the sum of domestic supply price and the cost of trade inputs per unit of domestic sales of the commodity

$$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c'c} \text{ ----- (3)}$$

**Absorption:** Absorption is expressed as the sum of spending on domestic output and imports at the demand prices, PDD and PM.

$$PQ_c QQ_c = PD_c QD_c + PM_c QM_c \quad c \in C \text{ ----- (4)}$$

**Marketed Output Value:** For each domestically produced commodity, the marketed output value at producer prices is stated as the sum of the values of domestic sales and exports. PXc

$$QX_c = PDS_c QD_c + PE_c QE_c \quad c \in C \text{ ----- (5)}$$

**Activity Price:** The gross revenue per activity unit, the activity price, is the return from selling the output or outputs of the activity, defined as yields per activity unit multiplied by activity-specific commodity prices, summed over all commodities. This allows for the fact that activities may produce multiple commodities.

$$PA_a = \sum_{c \in C} PX_{ac} \theta_{ac} \quad a \in A \text{ ----- (6)}$$

**Aggregate Intermediate Input Price:** The activity-specific aggregate intermediate input price shows the cost of disaggregated intermediate inputs per unit of aggregate intermediate input.

$$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca} \text{ ----- (7)}$$

**Activity Revenue and Costs:** For each activity, total revenue net of taxes is fully exhausted by payments for value-added and intermediate inputs. Given the definitions of PA and PINTA, equation (8) implicitly defines the value-added price, PVA.

$$PA_a \cdot (1 - ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a \text{ ----- (8)}$$

**Consumer Price Index (CPI):** is the sum of prices and weights of a commodity.

$$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwtsc \text{ ----- (9)}$$

**Producer Price Index for Non-traded Market Output:** defines the producer price index for domestically marketed output.

$$DPI = \sum_{c \in C} PDS_c \cdot dwts_c \text{-----} \quad (10)$$

### PRODUCTION AND COMMODITY BLOCK

**Demand for Aggregate Value added (Leontief Technology):** Demand for value added is a function of activity level.

$$QVA_a = iva_a \cdot QA_a \text{-----} \quad (11)$$

**Demand for aggregate intermediate input (Leontief Technology):** Demand for aggregate intermediate input is a function of activity level.

$$QINTA_a = inta_a + QA_a \text{-----} \quad (12)$$

**Quantity of Value-Added:** is the CES function of the factor inputs.

$$QVA_a = a_a^{va} \cdot \left( \sum_{f \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-1/\rho_a^{va}} \text{-----} \quad (13)$$

**Factor Demand:** According to equation (14), activities demand factors at the point where the marginal cost of each factor is equal to the marginal revenue product (net of intermediate input costs) of the factor.

$$WF_f \cdot \overline{WFDIST}_{fa} = PVA_a (1 - tva_a) \cdot QVA_a \cdot \left( \sum_{f \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va} - 1} \text{-----} \quad (14)$$

**Disaggregated Intermediate Input Demand:** For each activity, the demand for disaggregated intermediate inputs is determined via a standard Leontief formulation as the level of aggregate intermediate input use times a fixed intermediate input coefficient.

$$QINT_{ca} = ica_{ca} \cdot QINTA_a \text{-----} \quad (15)$$

**Commodity Production and Allocation:** Marketed quantity of commodity c from activity a plus household home consumption of commodity c from activity a equals production of commodity c from activity a.

$$QXAC_{ca} + \sum_{h \in H} QHA_{ach} = \theta_{ac} \cdot QA_a \text{-----} \quad (16)$$

**Output Aggregation Function:** Aggregated production of any commodity is defined as a CES aggregate of the different activities producing the commodity. The function exponent specifies the degree of  $\rho$  substitutability between different products.

$$QX_c = a_c^{ac} \cdot \left( \sum_{a \in A} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-1/\rho_c^{ac} - 1} \text{-----} \quad (17)$$

**First-Order Condition for Output Aggregation Function:** Marginal cost of commodity c from activity a = Marginal revenue product of commodity c from activity a

$$PXAC_{ac} = PX_c \cdot QX_c \cdot \left( \sum_{a \in A'} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-1} \cdot \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}-1} \text{-----} (18)$$

**Output Transformation (CET) Function:** Domestic production is allocated to two destinations, namely domestic sales and exports. The CET function is determined by both exports and domestic sales. The CET function is identical to a CES function except for negative elasticities of substitution. The exponent is a transformation of the elasticity of substitution between exports and domestic sales. This reflects the assumption of imperfect substitution between the two destinations.

$$QX_c = a_c^t \cdot \left( \delta_c^t \cdot QE_c^{\rho_c^t} + (1 - \delta_c^t) \cdot QD_c^{\rho_c^t} \right)^{1/\rho_c^t} \quad c \in (CE \cap CD) \text{-----} (19)$$

**Export-Domestic Supply Ratio:** This equation is determined by maximizing producer revenues subject to the CET function and a fixed quantity of output. This equation then defines the optimal mix of exports and domestic sales. The exports-domestic price ratio will determine the export domestic demand ratio.

$$\frac{QE_c}{QD_c} = \left( \frac{PE_c}{PDS_c} \cdot \frac{1 - \delta_c^t}{\delta_c^t} \right)^{1/\delta_c^t - 1} \quad c \in (CE \cap CD) \text{-----} (20)$$

**Composite Supply (Armington) Function:** This function is called the Armington function and is a CES function. It specifies the composite supply as a function of imports and domestic supply. Imperfect substitutability between imports and domestic supply is assumed. The elasticity of substitution is specified by  $\rho$ .

$$QQ_c = \alpha_c^q \cdot \left( \delta_c^q \cdot QM_c^{-\rho_c^q} + (1 - \delta_c^q) \cdot QD_c^{-\rho_c^q} \right)^{1/\rho_c^q} \quad c \in (CM \cap CD) \text{-----} (21)$$

**Import-Domestic Demand Ratio:** This equation is obtained by minimizing cost subject to the CES function and a fixed quantity of composite supply. This is the optimal mix between imports and domestic supply. The domestic-import price ratio determines the import-domestic demand ratio. The elasticity of substitution is specified by  $\rho$ .

$$\frac{QM_c}{QD_c} = \left( \frac{PDD_c}{PDC_c} \cdot \frac{\delta_c^q}{1 - \delta_c^q} \right)^{1/1 + \rho_c^q} \quad c \in (CM \cap CD) \text{-----} (22)$$

**Demand for Transactions Services:** Total demand for trade inputs is the sum of the demands for these inputs that are generated by imports (from moving commodities from the border to domestic demanders), exports (from moving commodities from domestic producers to the border), and domestic market sales (from moving commodities from domestic producers to domestic demanders).

$$QT_c = \sum_{c' \in C'} (icm_{cc'} \cdot QM_{c'} + ice_{cc'} \cdot QE_{c'} + icd_{cc'} \cdot QD_{c'}) \text{-----} (23)$$

## INSTITUTION BLOCK

**Factor Income:** This equation defines the total income of each factor and is equal to the sum of activity payments. Activity payments, in turn, are equal to activity-specific wages multiplied with employment levels.

$$YF_f = \sum_{a \in A} WF_f \cdot \overline{WFDIST}_{fa} \cdot QF_{fa} \quad f \in F \text{ ----- (24)}$$

**Institutional Factor Incomes:** Here the total income of each factor is split among domestic institutions in fixed shares after payment of direct factor taxes and transfers to the rest of the world. The latter are fixed in foreign currency and transformed into domestic currency by multiplying by the exchange rate.

$$YIF_{if} = Shift_{if} [(1 - t_{ff}) \cdot YF_f - transfr_{row\ f} \cdot EXR] \text{----- (25)}$$

**Income of domestic, Nongovernment Institutions:** Domestic nongovernment institutions form a subset of the set of domestic institutions. The total income of any domestic nongovernment institution is the sum of factor incomes, transfers from other domestic nongovernment institutions, transfers from the government (indexed to the CPI), and transfers from the rest of the world.

$$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{i\ gov} \cdot CPI + trnsfr_{row} \cdot EXR \text{----- (26)}$$

**Intra-Institutional Transfers:** Transfers between domestic nongovernment institutions are paid as fixed shares of the total institutional incomes net of direct taxes and savings.

$$TRII_{ii'} = shii_{ii'} \cdot (1 - MPS_{i'}) \cdot (1 - TINS_{i'}) \cdot YI_i \text{----- (27)}$$

**Household Consumption Expenditures:** The total value of household consumption spending is defined as the income that remains after direct taxes, savings, and transfers to other domestic non-government institutions.

$$EH_h = (1 - \sum_{i \in INSDNG} shii_{ih}) \cdot (1 - MPS_h) \cdot (1 - TINS_h) \cdot YI_h \text{----- (28)}$$

**Investment Demand:** Fixed investment demand is defined as the base-year quantity multiplied by an adjustment factor. Here the adjustment factor is exogenous, in effect also making the investment quantity exogenous.

$$QINV_C = \overline{IADJ} + qinv_C \text{----- (29)}$$

**Government Consumption Demand:** Similarly, government consumption demand, in which the main component tends to be the services provided by the government labour force, is also defined as the base-year quantity multiplied by an adjustment factor. This factor is also exogenous and, hence, the quantity of government consumption is fixed.

$$QG_C = \overline{GADJ} + qg_C \text{----- (30)}$$

**Government Revenue:** Total government revenue (YG) is the sum of revenues from taxes,

factors, and transfers from the rest of the world. Thus, Government revenue is composed of direct taxes from institutions, direct taxes from factors; value added tax, activity tax, import tariffs, export taxes, sales tax, factor income and transfers from ROW.

$$YG = \sum_{i \in INSDNG} TINS_i \cdot YI_i + \sum_{f \in F} tf_f \cdot YF_f + \sum_{a \in A} tva_a \cdot PVA_a \cdot QVA_a + \sum_{a \in A} ta_a \cdot PA_a \cdot QA_a + \sum_{c \in CM} tm_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum_{c \in CE} te_c \cdot pwe_c \cdot QE_c \cdot EXR + \sum_{c \in C} tq_c \cdot PQ_c \cdot QQ_c + \sum_{f \in F} YIF_{gov\ f} + trnsfr_{gov\ row} \cdot EXR \text{-----} (31)$$

**Government Expenditure:** Total government spending (EG) is the sum of government spending on consumption and transfers.

$$EG = \sum_{c \in C} PQ_c \cdot QG_c + \sum_{i \in INSDNG} trnsfr_{i\ gov} \cdot \overline{CPI} \text{-----} (32)$$

### SYSTEM CONSTRAINTS AND MARKET CLOSURES BLOK

**Commodity Constraint:** Equilibrium in the goods market requires that demand for commodities equal supply. The composite supply of a commodity consists of its domestic supply and imported commodities. Aggregate demand for each commodity comprises household and government consumption spending, investment spending, and export and transaction services demand.

$$QQ_c = \sum_{a \in A} QINT_{c\ a} + \sum_{h \in H} QH_{c\ h} + QG_c + QINV_c + qdst_c + QT_c \text{-----} (33)$$

**Factor Markets closure:** The factor market closure requires the equality between factor demand and factor supply. This equality is based on how the relationship between factor supply and wages is defined.

$$\sum_{a \in A} QF_{f\ a} = QFS_f \text{-----} (34)$$

**Current-Account Balance for the Rest of the World, in Foreign Currency:** The current-account balance, which is expressed in foreign currency, imposes equality between the country's spending and its earning of foreign exchange.

$$\sum_{c \in CM} pwm_c \cdot QM_c + \sum_{f \in F} trnsfr_{row\ f} = \sum_{c \in CE} pwe_c \cdot QE_c + \sum_{i \in INSD} trnsfr_{i\ row} + FSAV \text{---} (35)$$

**Government Balance:** The government balance imposes equality between current government revenue and the sum of current government expenditures (not including government investment) and savings. Savings may be negative.

Thus, the government balance closure is formulated as:

$$YG = EG + GSAV \text{-----} (36)$$

**Institutional Savings Rates:** Equation (37) defines the savings rates of domestic nongovernment institutions.

$$MPS_i = \overline{mps}_i \cdot (1 + \overline{MPSADJ} \cdot mps01_i) + DMPS \cdot mps01_i \text{-----} (37)$$

**Savings–Investment Balance:** This closure states that total savings and total investment have to be equal. Total savings is the sum of savings from domestic nongovernment institutions, the government, and the rest of the world, with the last item converted into domestic currency. Total investment is the sum of the values of fixed investment (gross fixed capital formation) and stock changes.

$$\sum_{i \in INSDNG} MPS_i + (1 - TINS_i) \cdot YI_i + GSAV + EXR \cdot FSAV = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \text{-----} (38)$$

**Total Absorption:** Total nominal absorption is measured as the total value of domestic final demands, which equals GDP at market prices plus imports minus exports. Total absorption is the summation of household consumption (both market and home consumption), government consumption, fixed investment and stock change.

$$TABS = \sum_{h \in H} \sum_{c \in C} PQ_c \cdot QH_{ch} + \sum_{a \in A} \sum_{c \in C} \sum_{h \in H} PXAC_{ac} \cdot QHA_{ach} + \sum_{c \in C} PQ_c \cdot QG_c + \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \text{-----} (39)$$

**Ratio of Investment to Absorption:** Ratio of investment to absorption is equal to the summation of fixed investment and stock change

$$INVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \text{-----} (40)$$

**Ratio of Government Consumption to Absorption:** This equation states that government consumption share of total absorption equals sum of government spending on consumption.

$$GOVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QG_c \text{-----} (41)$$

### CAPITAL ACCUMULATION AND ALLOCATION EQUATIONS

**Average capital rental rate:** This is equal to the sum of the rental rates of each sector Weighted by the sector's share of total capital factor demand.

$$AWF_{ft}^a = \sum_a \left[ \left( \frac{QF_{fat}}{\sum_a QF_{fa't}} \right) \cdot WF_{ft} \cdot WFDIST_{fat} \right] \text{-----} (42)$$

**Share of new capital:** The share of existing capital stock is multiplied by the capital rental rate ratio to obtain the share of new capital stock.

$$\eta_{fat}^a = \left( \frac{QF_{fat}}{\sum_a QF_{fa't}} \right) \cdot \left( \beta^a \left( \frac{WF_{ft} \cdot WFDIST_{fat}}{AWF_{ft}^a} - 1 \right) + 1 \right) \text{-----} (43)$$

**Quantity of new capital by sector:** The share of the new capital is then multiplied by total quantity of new capital to arrive at a sectoral distribution for new capital.

$$\Delta K_{fat}^a = \eta_{fat}^a \left( \frac{\sum_a PQ_{ct} \cdot QINV_{ct}}{PK_{ft}} \right) \text{-----} (44)$$

**Unit price of capital:** Unit price of capital is a weighted market price of investment commodities.

$$PK_{ft} = \sum_c PQ_{ct} \frac{QINV_{ct}}{\sum_c QINV_{c't}} \text{-----} (45)$$

**Average Price of capital:** Here, the new aggregate quantity of capital ( $QFS_{f,t+1}$ ) and the sectoral quantities of capital ( $QF_{fat+1}$ ) are adjusted from their previous levels to include new additions to the capital stock. Over and above these changes there is also a loss of capital to account for depreciation ( $v_f$ ).

$$QFS_{f,t+1} = QFS_{ft} \cdot \left( 1 + \frac{\sum_a \Delta K_{fat}}{QFS_{ft}} - v_f \right) \text{-----} (46)$$

$$QF_{fat+1} = QF_{fat} \cdot \left( 1 + \frac{\Delta K_{fat}^a}{QF_{fat}} - v_f \right) \text{-----} (47)$$

**Average real wage per factor unit:** It is a ratio of average wage per factor supplied and CPI ratio.

$$RWF_{ft} = \frac{YF_{ft}}{QFS_{ft}} / \frac{CPI_t}{CPI_{t-1}} \text{-----} (48)$$

## DECLARATION

I, the undersigned, declare that this thesis 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 thesis have been duly acknowledged.

Signature \_\_\_\_\_

Date: 27/06/2018 G.C

Aklilu Abebe Aleto