

**ADDIS ABABA UNIVERSITY**

**School of Graduate Studies**

**ECONOMY WIDE IMPACT OF UNILATERAL  
AGRICULTURAL TRADE LIBERALIZATION. A**

*RECURSIVE DYNAMIC CGE MODEL FOR*

*ETHIOPIA: THE CASE OF EPA*

By

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### ***Dedication***

*All my achievements in this research paper are dedicated to my beloved parents. My dream comes true because of you. You were with me all the way long. I know your love, thoughtfulness and care for me is extraordinary. I have no words to thank you. Just God bless you!!! I love you!!!*

**Long live Papa!!! Long live Mama!!!**

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## **Abstract**

*This paper sets out to explore the economy wide effects of Ethiopia's measure to liberalize its agricultural trade according to the rules of EPA (Economic Partnership Agreement). This objective is undertaken by highlighting on sectoral and macroeconomic indicators. To this end, the dynamic recursive CGE modeling approach in the context of the Ethiopian economy is used.*

*The findings show that there is no significant change in the economy by liberalizing the agriculture sector only. Productivity in the agricultural sector decreases together with the real GDP. Total investment in the economy declines while unemployment gets deeper and deeper consecutively. Returns to factors of production decrease except a slight increase in the real wage rate. As a result, owners of factors of production are discouraged in every sector.*

*Domestic producers in the agriculture sector are negatively affected by the trade liberalization measure. The opposite is true for producers in the non agriculture sector. On the other hand, Domestic consumers are better off because of the availability of cheap agricultural commodities. However, the aggregate supply of every composite commodity decreases together with private consumption.*

*On the other hand, government fiscal revenue falls, its consumption rises however. Moreover trade liberalization is likely to increase volume of export in the non agriculture sector.*

*Therefore, the findings of this paper imply that domestic policies should be encouraging for domestic producers and export oriented for the non agricultural sectors.*

**Keywords:** trade liberalization, recursive dynamic, CGE, EPA, Ethiopia

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## 1-BACKGROUND

Inspired by the gains from free trade, countries of the world are gradually abolishing their protectionist trade policies and switching to free trade regimes. Ethiopia is also gradually opening up its door wider and wider for foreign trade and investment. There are a number of policy reforms undertaken by the government to enable the country penetrate deeper into the globalizing world economy in order to speed up the country's economic growth. As part of the economic liberalization program, the Ethiopian government has embarked on a comprehensive trade reform program. Dismantling quantitative restrictions and gradual reduction of the level and dispersion of tariff rates have been the major manifestations of the liberalization program. These reforms could make domestic producers to some extent exposed to and familiar with the fierce competition from foreign products. Moreover, the reforms are paving a way for the country to be a member in different economic integrations. In fact, Ethiopia is acceding for the WTO (World Trade Organization), negotiating for the EPA among ACP-EU (African Caribbean and Pacific-European Union) countries and already a member of COMESA (Common Market for East and Southern Africa) and negotiating for its Free Trade Area (FTA). All these economic integrations in general and EPA in particular have a number of principles and obligations that any member is obliged to accept. Especially those of EPA are very tight. To comply with these principles, most of the national trade and trade related policies of Ethiopia are going to be changed or somewhat amended. One and the most decisive of these policy changes is making trade freer in line with the standards of the integrations. Especially in the case of EPA import tariff elimination is mandatory. The issue is, therefore, what these trade policy changes are going to imply on the economy. This paper concentrates on analyzing Ethiopia's economic integration with the ACP-EU countries in the EPA framework.

### ***The problem***

The entire economy of Ethiopia is just a replica of the agriculture sector. This overwhelming importance makes policies in the sector have a strong implication on the

national economy. Therefore, measures to liberalize agricultural trade can have impacts on the other sectors in particular and the macro economy in general.

The Ethiopian agriculture sector is dominated by poor farmers with low productivity. Thus, joining EPA will leave them unprotected for the cut-throat competition from the highly productive European farmers. Moreover, from the Common Agriculture Program (CAP) European agricultural exports are highly subsidized which exacerbates the problem of poor competitiveness of Ethiopian agricultural products in international markets. Imported agricultural items take the price advantage over the domestically produced ones. Therefore, domestic producers will die out along with the largest share of households. Afterwards, this can make the forward and backward effects of agriculture stated in the ADLI policy quite unlikely.

World rules for abolishing of trade distortions are not evenly implemented for both developed and developing countries. There is absolute unfairness in favor of the developed countries, which makes international trade a profit versus life game. The unfair market domination by the highly profit oriented producers of developed countries has put poor farmers' survival into question.

Contrary to that, domestic consumers can possibly benefit from the availability of low priced and high quality products from ACP-EU countries following EPA. This will reduce cost of living in urban centers, which can in turn pressure the wage rate down in the other sectors of the economy. This will help producers in these sectors to be highly profitable. Moreover, agricultural trade liberalization in the EPA framework can decrease prices of agriculture inputs imported from ACP-EU countries. Cheaper imported inputs can raise productivity via learning, variety and quality effects (Yu and Frandsen, 2005). This can make agricultural production and products cheaper in domestic markets. This in turn, will help producers of the sector develop better capacity to compete in global markets. Furthermore, the agriculture sector will be able to provide the other sectors with cheaper and high quality products to be used as an input and increase the productivity and profitability of these sectors.

As it can be clearly seen, agricultural trade liberalization in the EPA framework has two opposing effects on the Ethiopian economy generally and the agriculture sector particularly. Therefore, with the expected benefits and challenges that the country can face when heading into the EPA, the central aim of this study is to investigate the sum-total economy wide effect of Ethiopia's own unilateral agricultural trade liberalization following the signing of EPA. The most likely changes on macroeconomic and sectoral indicators will be studied.

This study hypothesizes that elimination of tariff on agricultural imports has positive effect on amount of agricultural imports and negative effect on the sector's output which causes agricultural exports to fall. The real GDP and government revenue face negative effect.

So far, the case of EPA was treated with a static CGE model which can examine its impact for a yearlong only<sup>1</sup>. There have been little attempts to investigate the long-run effects. So, this paper is an attempt to fill this gap by analyzing the issue using a dynamic CGE model. Besides, the research tries to urge policy makers or negotiators, implementers and non-governmental and other agencies give emphasis for agricultural trade liberalization and its impacts. The paper could also indicate areas of future research and could contribute to the wealth of information existing on the subject in the country.

This study is organized as follows. Section two is devoted to a brief review of related theoretical and empirical literatures. Section three presents a general overview of the Ethiopian economy and the trade liberalization measures already taken by the Ethiopian government. In the fourth section EPA is discussed. The methodology employed is outlined in section five. Section six discusses the empirical results. Conclusions and policy implications section is provided at the end.

## 2- LITRATURE REVIEW

### **2.1 Theoretical literature**

In short, trade liberalization is a reduction or complete elimination of barriers on trade. Kottis (1989) put its definition as follows: “Trade liberalization implies any change, which leads a country’s trade system toward neutrality in the sense of bringing its economy closer to the situation, which would prevail if there were no governmental interference in the trade system”. There are two major indicators of a move in the direction of trade liberalization: 1) a reduction or elimination of tariff or non-tariff barriers; and 2) a change in the form of intervention: substituting more distorting for less distorting form of intervention, just like Tariffication<sup>2</sup>. To be able to justify whether agricultural trade liberalization is healthy or not for a country with respect to its prevailing circumstances, we have to be clear about the likely benefits and costs of trade liberalization in general and that of agriculture in particular.

The reduction or elimination of barriers to trade among countries encourages countries to produce and trade goods and services in which they have comparative advantage. The specialization accordingly will scale-up production efficiency in the economy. In addition, increased competition from abroad and enhanced access to better technology made possible by trade liberalization induce technological innovation and higher productivity (Oyejide, 1997). These lead to greater exploitation of economies of scale. Market expansion following trade liberalization can also create favorable condition for economies of scale. This is extremely important for the very poorest developing nations whose domestic markets are small and very inadequate for production expansion based solely on local demand (De Vylder, 2007).

The other significant benefit of trade liberalization is allocation efficiency that could be especially important for a poor country. In trade models that presume perfect competition, trade liberalization in highly distorted economies generally improves the existing allocation of factors across sectors and thereby induces a rise in the value of domestic production (Taybout, 1992). The directly unproductive rent-seeking activities that were encouraged by distortionary protective policies waste real resources, including

entrepreneurial talents, which are particularly scarce in developing countries. In a dynamic sense, liberalization allows allocation of investment in more profitable activities. This improves the efficiency of investment. Thus, it has often been observed that, controlling for other factors, more open economies, in the sense of less distortions in their foreign trade regime have both higher GDP growth rates, and higher growth rates of total factor productivity<sup>3</sup> (TFP) (de Melo & Summana, 1992).

However, the general empirical literature on the relationship between openness and growth is mixed. Kruger (1978) argued that openness positively affected growth through two channels. First, the direct effect - via higher capacity utilization and more efficient investment projects and the second is the indirect effect that works through exports: more liberalized economies have faster growth of exports and this, in turn, result in more rapidly growing GNP. Thirlwall (2000) shared this idea by arguing that trade liberalization has a positive impact on economic growth mainly through improving efficiency and stimulating export performance which have powerful effects on both supply and demand with in an economy.

To strengthen the literature on the positive correlation between openness and growth, Edwards (1992), using nine indicators of trade orientation constructed by Leamer (1988) and taking a sample of 30 developing countries over the period 1970 – 1982, concluded that open economies tend to grow faster. According to Edwards, the only channel through which trade liberalization enhances growth is through the absorption of foreign technology. Moreover, Kneller et al. (2008) using a sample of 48 liberalizing developing countries, argued that there is no clear cut effect of trade liberalization on economic growth for all countries. It can be negative, zero or positive depending on the country's particular situations. A wide dispersion of growth rates, ranging from – 1.4% per annum in Guinea-Bissau to + 12.4% per annum in Nicaragua is resulted. Ethiopia is found in between: a growth rate that is ranging from 1.67 to 4.73 can be recorded as a result of trade liberalization.

Increased competition because of free trade is often required in protected home markets in order to raise productivity and exert pressure on monopoly prices (De Vylder, 2007). As domestic producers get more into competitive markets, they will tend to adjust their behavior in a way that reduces the likelihood that they will demand protection in the future. Thus, domestic markets will tend to look like perfectly competitive markets as a result of trade liberalization.

As we consider the costs of openness, it is widely argued that it is poor countries that suffer more. Openness will expose domestic producers to cut throat competition from imported high quality and low priced products. Consequently, the propensity to import may increase than export following trade liberalization which leads to the worsening of the trade balance. Net demand for domestically produced goods and services will reduce. This in turn, leads to lower income for domestic producers and generally lower GDP (Pawell and Thirlwall, 1993). In the long run, domestic producers will end up in bankruptcy which can be accompanied by increasing unemployment. Therefore, Befekadu (1997) put deindustrialization as the first and most important impact of an open economic framework for developing countries. Moreover, these economies will be left without endogenous technology and capital in the course of time. A widening of the gap between foreign exchange demand and the supply can happen following higher import propensity than export and this will tackle the developing countries' development struggle in the long run.

The integration of a country into the global economy brings benefits and challenges not only to consumers and producers but also to the public sector. In the poorest developing countries fall of government revenue is considered as the major cost of openness. This is because many of them remain heavily dependent on import tariffs as a source of government revenue. Edwards (1998) stated that before the commencement of the new millennium tariff revenue exceeded 30% of the governments total tax revenue in more than 25 developing countries. Ethiopia is not an exceptional country for this reality; above 40% of government revenue between 1996/97 – 1999/2000 was contributed by tariff revenue (Fantahun, 2002; Abebe, 2004). In fact, complete elimination of import

tariff reduces tariff revenue. However, the effect of a partial tariff reduction depends on responsiveness of imports to price changes.

With regard to agricultural trade liberalization, it is currently being hotly discussed in many developed and developing countries. Since agriculture is the pillar of their economy, developing countries especially show considerable interest on issues relevant to it in the WTO or any other regional integration negotiations. This is because liberalizing agricultural trade has its own costs and benefits.

A reduction in support for agricultural producers will improve economic efficiency, as the inefficient resources in the agriculture sector are reallocated to the other sectors where they are more efficient. The improvement in economic efficiency in turn will tend to raise real income, (Tokarick, 2008).

The largest effect of agricultural trade liberalization has been a major rise in the volume of cheap imports. The fall in prices of imported products accompanied by a rise in domestic production cost following abolishing of subsidies on agriculture inputs will leave small holder farmers no longer compete on local markets. The reduced profitability for these small holder farmers is devastating to food security (De Vylder, 2007). With the agriculture sector dominated by small holder farmers such losses have very significant negative effect on the non agriculture sector in particular and the entire economy in general.

The exact opposite of this is also potentially true. The reduction of agriculture trade barriers will make imported agricultural inputs like fertilizer, pesticides, agriculture capitals like farm machineries etc available domestically at cheaper prices. This can obviously reduce cost of production and foster production efficiency. However, in developing countries like Ethiopia where the agriculture sector is not subsidized currently, the decrease in production cost will be insignificant. These productivity and production cost gains may make domestic producers somewhat profitable but this

depends on the extent of market competition that domestic farmers are expected to face from imported agricultural final products.

## **2.2 Empirical evidence on agricultural trade liberalization**

A research on the economy wide effect of tariff elimination on agricultural imports for Pakistan was conducted by Rizwana Siddiqui in 2007. Using a dynamic CGE analysis Siddiqui came up with imports declining in the non-agriculture sector and increasing in the agriculture sector in the long run (assumed ten years). Tariff elimination affected both output and export positively for all the sectors. These effects were stronger on the manufacturing sectors. When we focus on the total economy wide effect, output, export and import, increased by 0.21%, 0.53% and 0.05% respectively. On the other hand, households were generally adversely affected in terms of real income and consumption (with 0.47% and 0.60% decline respectively). However, as income effects are concerned urban households were relatively in better position. In turn, rural households were relatively better off as consumption decline less for rural households than urban households.

In the Ethiopian case there are few studies conducted to assess the economy wide impact of agricultural trade liberalization. Solomon (2007) has tried to assess the short-run impacts of WTO accession on the Ethiopian economy. Elimination of tariff rates on agricultural imports resulted in positive changes in all GDP, private consumption, investment, imports and exports with the exception of government revenue which recorded an adverse effect. When we look into sector specific results; quantity of domestic output declined for the non-agriculture sector while it increased for the agriculture sector. Factor returns increased for almost all of the sectors with a decline of capital returns only for the non-agriculture sector.

## **3- OVERVIEW OF THE ETHIOPIAN ECONOMY**

### **3.1-Ethiopian economy and the agriculture sector, its role and performance**

Despite its bad history, Ethiopian economy has been recording high growth rate in a row for the last three years (12.6% in 2004/05, 11.6% in 2005/06 and 11.4% in

2006/07). Although all sectors contributed for this success, agriculture stands first growing by 13.5% in 2004/05, 10.9% in 2005/06 and 9.4% in 2006/07. The non-agriculture sector was also growing. The industry sector was showing successive growth (9.4% in 2004/05, 10.2% in 2005/06, and 11.0% in 2006/07). However, this sector is characterized by low productivity and the domination of the manufacturing sub sector which has been engaged in production of labor intensive and low value added consumer goods. Likewise, the service sector has been fastly growing with growth rate of 12.8%, 13.4% and 13.5% for the same period respectively (NBE, 2006/07).

Ethiopian agriculture is characterized by low productive small-holder subsistence farmers. Generally, overall economic performance in Ethiopia has been heavily associated with the performance of the agriculture sector. However, the sector's contribution to the GDP is significantly decreasing (50.4% in 2004/05, 44.0% in 2005/06 and 38.0% in 2006/07). It is the service sector that completely substitutes the agriculture sector in its contribution to the GDP. On the other hand, the agriculture sector still brings the largest share of Ethiopia's export earning (83% in 2004/05) (NBE, 2006/07). In terms of employment, about 88% of the active population lives in rural areas. This can witness that the majority of the country's work force is engaged in this sector. It in fact shows the low productivity of the sector.

TABLE 1 Ethiopian agricultural import (in million birr)

Commodities	2004		2005		2006		Tariff rate
	value	%	value	%	value	%	%
Fertilizer	1120.67	4.5	850.34	2.4	1148.27	2.5	0
Agricultural capital goods	117.33	0.5	294.71	0.83	309.92	0.67	-
Cereals	1657.4	6.7	2009.1	5.7	938.4	2	5
Live animals & animal products	53.0	0.2	54.13	0.15	110.54	0.24	5-30
Vegetables	302.14	1.2	428.32	1.2	1670.3	3.6	5-30
Tobacco	12.43	0.05	30.68	0.09	30.62	0.07	20
Total agricultural imports	3273.1	13.2	3675.1	10.4	4243.2	9.2	-
Total import	24830.57	100	35366	100	46141.9	100	-

Source: CSA

From table 1 share of agricultural import has been decreasing though it was increasing in value terms. Fertilizer import, though it is exempted from tariff, has been decreasing. Therefore, trade liberalization can have no effect on domestic price of fertilizer and its volume of import. However, agricultural capital goods has shown successive rise in value terms. This can be further intensified by the trade liberalization. As a result, domestic farmers will gain higher productivity and efficiency. Almost all of agricultural final products that are used as inputs for domestic industries have been increasing in terms of both import share and value of import. This trend will drastically intensify when the large tariff rates on them are reduced or eliminated. Keeping its low tariff rate in mind, we can forecast that trade liberalization can have weaker effect on cereal import.

Let us look at agriculture's forward and backward linkages with the rest of the sectors of the economy. "When general equilibrium effects are taken into consideration, agriculture is found to be superior, through income and consumption linkages, in terms of stimulating economic growth in the country.... With regard to the direct or transfer effect, rural households have greater transfer effect than urban households." (Tadele, 2001: 223). Accordingly, CSA data for 1999/2000 shows that the rural households spent almost half of their income on industrial products but only 29% on agriculture products. Milled cereals and clothing and footwear are the two industrial products that they spent more at (almost 30% of the total expenditure). Adding the expenditure on services and that on the industry we can conclude that around 3/5 of the total expenditure of rural households is made on products from the non-agriculture sector.

Regarding the input – output linkage, Tadele (2001) found that agriculture has got the highest backward linkage followed by the industry. As we consider backward linkages of the agriculture sector with the other individual sectors, it has the lowest linkage with the industry sector. The same is true for the industry; it has got the lowest of its input requirements from the agriculture sector. Thus, both the sectors rely more on imports for their input requirement. Moreover, each of the agriculture and the industry sectors are highly interlinked within themselves. Therefore, in the Ethiopian economy the intra-

sectoral linkage is stronger than the inter-sectoral one. Because of this, the effects of agricultural trade liberalization on the agriculture sector will be less likely to be transmitted to the non-agriculture sector. Therefore, the highest effect on the non-agriculture sector will be either directly from the trade liberalization or from the intra-sectoral linkage.

### **3.2- A Brief Account on Trade Liberalization Measures of Ethiopia**

Since the 1991 government change, Ethiopia has undertaken significant trade liberalization measures including the SAP. These measures include devaluation of the 'Birr' against Dollar, introduction of inter-bank auction to determine foreign exchange rate, removal of subsidies, reduction or elimination of limits on access to foreign exchange for specific items of imports, simplification of the system of granting import licenses and permits deregulation of prices and restructuring and privatization of public enterprises. With respect to import trade liberalization, substantial measures have been introduced. The level and dispersion of effective rates of protection and average nominal tariff rates have been reduced, a number of import duties have been exempted and non tariff barriers as well as specific tariff rates removed. The maximum tariff rate reduced from 230% to 35%. The current tariff rate ranges from 0 to 35% with only 6 tariff bands which was reduced from 23. The average simple tariff rate reduced from 79.1% during the pre-reform period to 20% in 2007 while the weighted average tariff rate reduced from 41.6% to 17.5% over the same period. This makes Ethiopia's weighted average tariff rate lower than other developing countries which is around 20%. Moreover, effective rate of protection on agriculture is 13.4% and on manufacturing sector is 13.5%.

TABLE 2 Tariff reform measures

Description	Pre-reform period	Post-reform period						
		Aug'93	Jan'96	Dec'96	Jan'98	Dec'98	Jan'03	Nov'07
Maximum tariff rate (in %)	230	80	60	60	50	40	35	35
Lowest tariff rate (in %)	5	5	5	5	5	5	5	5
Number of tariff bands	23	9	8	7	7	7	6	6
Number of tariff exemptions	327	138	169	170	168	167	179	241
Tariff dispersion (in %)	225	75	55	45	45	35	30	30
Prohibited items	2	2	2	2	2	2	2	5
Simple average tariff rate (in %)	79.1	35	28.8	24.3	24.3	20	20	20
Weighted average tariff rate (in %)	41.6	29.6	24.6	23.6	21.5	19.5	17.5	17.5
Number of items With specific tariffs	157	4	4	4	4	3	0	0
Average collected tariff revenue(in million birr)	231.3	577	1067	1021.7	1083	1258.8	2630.3	ND
Growth rate (in %)	-	149.5	84.9	-4.2	6.0	18.7	104.6	ND
Total number of items	1821	5332	5294	5295	5486	5426	5608	5426

Source: MOFED

ND – no data is available

Table 2 indicates that a partial reduction in tariff is accompanied by a significant increase in government revenue. This shows that Ethiopian imports are highly tariff elastic. In trade liberalization negotiations like in the WTO, which requires partial tariff reduction only, Ethiopia may enjoy a rise in tariff revenue. This may also be true in EPA and COMESA cases at least during the transition period when Ethiopia is going to reduce tariff step by step.

#### 4-THE ECONOMIC PARTNERSHIP AGREEMENT (EPA)

European and ACP member countries had started institutional relationship since the Yaoundé Convention – Yaoundé I, as of July 20 1963. Following this convention European countries were extending economic development fund to the poor ACP countries. It was only after the signing of the Lome treaty in 1975 that the relation between EU and ACP countries went beyond economic cooperation to include trade partnership agreements. But these trade agreements were not reciprocal. Between the Yaoundé I and the Lome I-IV conventions which ended in 2000, the EU offered preferential market access to the ACP countries' exports, without requiring the group to reciprocate those preferences to the EU.

However, in June 2000, the EU (15 member countries at that time) and the 77 African, Caribbean and Pacific (ACP) countries under the Cotonou Partnership Agreements (CPA), a successor of Lome IV, commenced negotiations of a new arrangement titled Economic Partnership Agreement (EPA). The introduction of WTO in 1995 as the new world trade system was the major reason for the signing of a new reciprocal trade agreement between EU and ACP countries. The ACP-EU cooperation undertook a radical change. Starting from January 1<sup>st</sup> 2008, the new EPA was expected to come into force with a new reciprocal but asymmetric trade regime phasing out the non-reciprocal preferential trade regime. This is to make the EPA WTO compatible. According to the new EPA, EU will offer duty free entry into its markets, except for sugar and rice which are subject to quantity restriction for a short transition period and more liberal rules of origin for clothing exports. To reciprocate this, ACP countries are required to gradually eliminate tariffs on at least 80% of their imports from the EU over the next 15 years, (World Bank, 2008).

So far 106 countries of the world are involved in the ACP-EU partnership agreement. The ACP-EU grouping currently has members of 48 countries from SSA, 16 from the Caribbean, 15 from the Pacific and the 27 EU member states.

Ethiopia is one of the members of ACP-EU since the time of Lome-I Convention. It is currently negotiating for the new EPA. So far, it has been enjoying the preferential market access EBA (Everything But Arms), which has been offered by the EU. Focusing on Ethiopia's trade with the members of ACP-EU, EU is its first major trade partner for both imports and exports, with a share of 27.1% of the total Ethiopian foreign trade. However, its trade with Africa is very small and that with the Caribbean and Pacific countries is almost non-existent.

## 5- THE METHODOLOGY

### 5.1-The model

Computable general equilibrium (CGE) models are simulations that combine the abstract Walrasian general equilibrium model with realistic economic data to solve numerically for the levels of supply, demand and price that support equilibrium across a specified set of markets (Shoven and Whalley, 1984). A CGE model captures the detailed accounts of the circular flows of receipts and outlays in an economy. In addition, it satisfies the equilibrium conditions for all markets simultaneously and is thus useful in analyzing associations between various agents of the economy (Bazlul et al, 2006). The Walrasian general equilibrium theory states that in an economy where consumers are endowed with factors and demand produced goods, and firms demand factors and produce goods with a constant returns to scale production function, both output and factor markets clear, whilst perfect competition assures that producer prices equal the costs of production for every operating activity.

Though the CGE body of literature has advanced considerably over the last decade to include non-Walrasian elements (e.g. imperfect competition, increasing returns to scale, dynamics, macroeconomic relationships), at its core, it still remains Walrasian in spirit. In short, the CGE theoretical framework draws on a combination of general equilibrium theory, neo-classical microeconomic optimization behavior of rational economic agents, and some macroeconomic elements (Kirkpatrick and Serban, 2007).

Dynamic general equilibrium models can be classified as inter-temporal or sequential (recursive). Inter-temporal dynamic models can be explained by agents that have rational expectations and make inter-temporally optimal decisions — everybody knows everything about the future, and they use that information in making decisions (Lofgren et al, 2004). In reality, particularly in developing countries, it is hard to assume that agents have perfect foresight. For this reason and because it is certainly plausible for simulation analysis in such circumstances, it is much more appropriate to develop a recursive dynamic CGE model. In recursive models, the behavior of all economic agents (private and public) is characterized by adaptive expectations - make their decisions on the basis of past and current conditions, with no role for forward-looking expectations about the future (Thurlow, 2008).

The model developed for this particular study belongs to the recursive dynamic strand of the dynamic CGE model. It is solved recursively - one period at a time; a recursive model is a series of static CGE models that are linked between periods by behavioral equations for endogenous variables and by updating procedures for exogenous variables (Annabi et al, 2007). The equations in this model are separated into a within-period module, which defines the decisions in each time period, and a between-period module, which governs the dynamics of the model. The equation set and the full list of symbols are shown in ANNEX III.

#### ***Within period specification***

The within-period component (the static module) describes a one-period static CGE model. In this description, all blocks of equations that are included in the model, except the dynamic block, are covered.

The model assumes that producers maximize profits subject to production functions. In this model a multi-stage production technology is adopted. At the top level, value added and intermediate inputs are combined via a Constant Elasticity of Substitution (CES) production technology to produce gross output. Value added in non agriculture sector (industry and service) is in turn represented by a CES function of labour and capital,

while that of agriculture sector is given as a CES function of land and composite factors. The composite factors are also represented by a CES function of labour and agricultural capital. In addition, producers in a sector are assumed identical. The model assumes no similarity between products of sectors: Each sector produces its own distinctive product. The multi-level technology underlying production is depicted for a representative producer in Figure 1 in ANNEX II.

Total domestic output: produced by the technology explained above is either domestically used or exported. Profit maximization motive drives producers to sell their products in domestic and foreign markets based on the returns they can achieve (Thurlow, 2008). This allocation is held using sectoral constant elasticity of transformation (CET) function. Commodities that are exported are further disaggregated according to their region of destination under a CES specification. Changes in relative prices across regions lead to a shift in the geographic composition of exports. Small countries like Ethiopia are assumed to face a perfectly elastic world demand at a fixed world price. On the other hand, the model incorporates imperfect substitutability between domestically produced (which are not exported) and imported goods (i.e. Armington assumption). This allocates domestic demand across a composite commodity that is made up of imports and domestic output on the basis of constant elasticity of substitution (CES) function. Imports are further disaggregated according to their region of origin using a CES function. This specification allows for regionally specific tariffs, and for substitution between regions following changes in relative import prices. Again under the small country assumption, Ethiopia is assumed to face infinitely elastic world supply at fixed world prices. All consumers of a commodity are assumed in this model to have the same import – intensity of consumption. Figure 2 in ANNEX II describes this clearly.

Domestic demand is the sum total of final consumption demands by households and government, and investment demand, intermediate consumption demands by activities and transaction services demand. Households consumption demand is given by a linear expenditure system (LES), derived from a Cobb-Douglas utility function. The model

assumes households maximize utility subject to budget constraints. Households finance consumption demand from their income. This income is collected from labour wage, dividends, intra-household transfers, government transfers and remittances. They allocate their income for consumption and saving after paying personal income tax to the government. The saving and direct income tax rates are assumed to be fixed. This matter is discussed more on the macro-closure part.

The return from capital is the main source of income for enterprises (or firms) along with the return on land. This income is transferred as dividends to domestic households and saved (at a fixed rate) after having paid corporate income taxes to the government (based on fixed tax rates). The government on the other hand, earns its income from direct and indirect tax revenues, and foreign transfers and spends it on consumption and transfers. Government consumption is fixed in real (quantity) terms whereas government transfer to households is CPI-indexed.

The common assumption here is that the economy observed is in general equilibrium in its base year: the year to which the SAM applies. General equilibrium is defined by the equality (in each period) between supply and demand of goods and factors, and between investment and saving (Annabi et al, 2007). Equilibrium in the goods market is attained through the endogenous interaction of domestic and foreign prices. Flexible prices equilibrate demands for and supplies of domestically marketed outputs. In factor market, capital is fully employed and sector-specific, implying that sector-specific returns adjust to ensure that demand for capital equals total supply. Labour unemployment is assumed and wage is fixed in real terms and supply passively adjusts to match demand. Savings by households and enterprises are collected to form total domestic saving (or loanable funds) from which investment is financed. Capital inflows from the rest of the world and government saving augment it. The savings rates of domestic institutions are fixed, and investment passively adjusts to match savings in equilibrium.

The model includes three macroeconomic balances: the current account balance, the government balance, and the savings and investment balance. To introduce new flow equilibrium condition of the three macro balances and impose a macro feature as well into CGE models a macro closure rule needs to be specified, (Robinson et al, 2005). The neoclassical closure which is the most frequently used seems extreme when studying countries historical experiences of analyzing the impacts of exogenous shocks or policy changes. Thus, a closure that resembles the real world most is preferred most (Lofgren et al, 2002). Modelers had to abandon some of the strict neoclassical assumptions and incorporate structural rigidities that capture non neoclassical behaviour, macroeconomic imbalances, and institutional rigidities typical of developing economies, (Taylor 1990; Robinson 1989, 1991; Carri 2008).

Deviations from neoclassical theory as a result of certain institutional and structural rigidities within the Ethiopian economy are considered in this model. For example, in the factor market capital is assumed to be immobile across sectors, and labour supply is unemployed and mobile at a fixed real wage. Furthermore, capital return is assumed to vary across sectors. Whereas, in product market, the model considers perfect competition which is quite neoclassical. The macro closure specified for this model is, therefore, a relaxed neoclassical one which is discussed below.

For current account balance the simplest solution, widely practiced, is to assume the current account balance as exogenous and the resulting imbalance is filled by the flow of funds from the savings-investment account, (Robinson and Lofgren, 2005). In this model current account balance is held by assuming flexible exchange rate at a fixed level of foreign saving (fixed in foreign currency). There is an implicit functional relationship between the real exchange rate and the trade balance (or foreign saving). Changes in the exchange rate work only through affecting export supply and import demand. If there exists a trade deficit then real exchange rate depreciates increasing exports while decreasing imports which finally leads to balanced trade with a fixed foreign saving (Lofgren et al, 2002). This closure is appropriate for countries following a flexible exchange rate system like Ethiopia.

In the government account, the level of government expenditure: consumption and transfers, is fixed in real terms while government revenue is determined by fixed direct and indirect tax rates. Government savings (the current surplus of the government) is determined residually as the gap between revenue and expenditure. This closure is chosen since it is assumed that changes in direct and indirect tax rates are exogenously determined based on political objectives.

The macro closure applied for the saving-investment balance is the savings-driven neoclassical closure in which volume of investment is determined by volume of savings. Fixed savings rates for non-governmental institutions and scale investment demand are specified so that all savings find outlet in investment.

It should be noted that the model designed in this paper can only solve for the relative prices and the real variables of the economy. To achieve this and anchor the absolute price level a normalization rule has been fed into the model, a completely exogenous practice. In addition, a no-inflation benchmark is employed in the model by setting the price index exogenous. The consumer price index (CPI) is chosen as the numéraire, so all changes in nominal prices and incomes in simulations are relative to the weighted unit price of households' initial consumption bundle (i.e a fixed CPI). The model is also homogenous of degree zero in prices, implying that doubling of all prices will not result in any changes in simulated real, price deflated, quantities in production, consumption or trade. In macro terminology, the model displays neutrality of money.

### ***Between-period Specification***

In this part the dynamics of the model is described. The updating equations define the changes in the stocks of labour and capital. In every period the capital stock ( $KD$ ) is updated with the total amount of depreciation and the new investment ( $Ind$ ). The investment demand function<sup>4</sup> included in the model, presents how new investment is distributed among sectors based on the return to capital and the user cost in each sector. Total labour supply, on the other hand is assumed as endogenous variable, which

simply increases at the exogenous population growth rate. i.e. as population grows, the total labour supply increases at the same rate.

### **5.2-The Ethiopian SAM**

The SAM used in this study is originally developed in IFPRI in 2001. Later on Tadele et al (2007) modified this SAM for their study on the impacts of COMESA and EPA trade liberalization on workers of textile and leather industries in Ethiopia. This SAM is 37x37 matrix. In order to meet the desired objectives in this study, the researcher further modify the modified IFPRI-2001 SAM in to an 18x18 matrix which contains three production activities, three commodities, three factors of production, three institutions, three trade partners, two tax accounts, and a saving investment account. See Table 1 in ANNEX I. Furthermore, the resent version of GAMS software, GAMS.ide 22.5 is used in this study.

### **5.3-Definition of the Scenario**

The scenario used in this study is related to assessing the impacts of custom tariff elimination on economic variables. This scenario imposes a 100% reduction on the tariff rate on agricultural imports from EPA member countries. This choice is based on the policy of EPA that obliges acceding countries to eliminate their tariff rates on at least 80% of their imports from EPA member countries. It is assumed that Ethiopian agricultural imports from EPA member countries are included in these 80%. In this study EPA is taken as the aggregate of EU and COMESA.

## **6-DISCUSSION OF RESULTS**

### ***Sectoral impacts***

The trade liberalization measure affects different commodity prices differently. The tariff elimination primarily affects import prices which lead to affect other prices through their effect on commodities demand and supply.

Domestic price of agricultural imports decreases by 0.6%, 0.7% and 0.6% for consecutive years. No change is recorded in the domestic price of industrial imports for

all the years while the service sector shows a slight increase throughout the period. Moreover, domestic price of agricultural imports from EPA decreases by 1.9% and from ROW increases by around 0.3% for all the years. There is no change in the domestic price of industrial imports from all regions while the service sector shows a slight increase which ranges from 0.1% to 0.3% for all regions throughout the period. On the other hand, price of exported commodity shows no change for all the sectors throughout the period. This is also true for all the trade partners. The rationale behind this is that Ethiopia is a price taker small economy in the world market. Therefore, the major determinant of the export prices is the price set at world market rather than domestic policy change.

Domestic supply and domestic demand prices increase by 0.3% in the agriculture sector and decrease by around 0.1% in the non agriculture sector for all the period. The rise in domestic demand price can be partly explained by the supply shortage following the production loss in the agriculture sector after the trade liberalization measure. In line with this, the decline in the domestic demand price in the industry sector can be explained as a result of excess supply following the production rise as a result of the decline in industrial imports. However, composite commodity price decreases by 0.1% in the agriculture sector leaving the other sectors more or less unchanged for all the years. Therefore, we can conclude that as a result of the trade liberalization measure domestic consumers enjoy cheaper agricultural commodities.

Table 2 Annex I shows that factor returns face negative impact as a result of trade liberalization. Rate of return to capital and agricultural land in the agriculture sector decrease by 0.6%, 0.5% and 0.4% and 0.6%, 0.1% and 0.5% for 2010, 2011 and 2012 respectively. This could be probably due to a decrease in demand for capital and agricultural land following a decrease in agricultural production. Similarly, rate of return to capital declines in the non agriculture sector by around 0.1% in the entire period. However, real wage rate increases by 0.2%, 0.1% and 0.2% for 2010, 2011 and 2012 respectively. This can be explained by an increase in nominal wage rate and a decrease in price of agricultural composite commodity. Therefore, domestic households

enjoy a slightly higher purchasing power. The combination of all the changes in factor returns shows us that the trade liberalization has a negative impact on the prices of factors of production except real wage. Moreover, agricultural trade liberalization leaves capital owners worse off. Relatively, the negative effect gets stronger in the agriculture sector.

The decrease in domestic price of agricultural imports from EPA primarily leads to a rise in the amount of agricultural imports from this trade partner by 2.4%, 1.6% and 1.5% for 2010, 2011, and 2012 respectively. However, agricultural imports from the rest of the world (ROW) decrease by 0.7% for 2010 and show no change for the remaining years. This is due to the substitution effect in favor of EPA for the agricultural imports from EPA are now relatively cheaper than that from ROW. On the other hand, industrial imports from EPA decrease by 1.3%, 1.1% and 1.3% for the consecutive years respectively while that from ROW exhibits no change. The decrease in domestic price of agricultural imports from EPA makes domestic consumers demand more agricultural imports with less industrial imports from EPA. This is the reason for the decrease in industrial imports from EPA. Moreover, service sector import from EPA increases by 0.2% and 0.1% for 2010 and 2012 respectively while it decreases by 0.1% for 2011. Service sector import from ROW shows no change.

The increase in aggregate agricultural imports leads to a production lose in the agriculture sector for 2010 and 2012 by 0.3% and 0.2% respectively. And the sector's output for 2011 shows no change. Thus, trade liberalization causes switch of consumption in favor of cheap imports which in turn can lead the sector to face downward pressure on sales and profits. This may result in a slowdown in the growth of investment and employment in the sector which is the source of livelihood for the majority of Ethiopians. However, industrial output increases slightly by 0.02% for 2010 and 2012. The fall in aggregate industrial import can be the reason for this. Output in the service sector shows no change, however. Therefore, producers in the agriculture sector are negatively affected by the trade liberalization measure while producers in the

industry sector are affected positively. Producers in the service sector are neither better off nor worse off.

The production fall in the agriculture sector leads to a reduction in volume of agricultural export. It decreases by 0.7%, 0.5% and 0.6% for the consecutive years respectively. The volume of industrial export increases by 0.3%, 0.2% and 0.3% for 2010, 2011 and 2012 respectively partly because of the rise in industrial production. In line with this, export from the service sector increases by 0.2%, 0.5% and 0.3% for 2010, 2011 and 2012 respectively. The increase in export from the non agriculture sector shows us that the trade liberalization measure stimulates domestic producers supply more to the international market which consequently enhances productivity of the sectors. Therefore, market expansion is one of the advantages of trade liberalization.

When we look at exports to different trade partners, agricultural export to EPA increases by 1.3%, 1% and 1.2% that to ROW decreases by 0.8%, 0.6% and 0.8% for 2010, 2011 and 2012 respectively. Exports from industry and service sectors to EPA decline by 0.7%, 0.5% and 0.7%, and 0.5%, 1% and 0.7% for the consecutive years respectively. However, industry and service exports to ROW rise by 0.4%, 0.3% and 0.4%, and 0.3%, 0.6% and 0.4% for 2010, 2011 and 2012 respectively. Here the net export from industry and service sectors to all the regions increases.

From Table 3 Annex I we can take a look at the decline in agricultural marketed outputs. It decreases by 0.3% and 0.2% for 2010 and 2012. This could be partly due to the decrease in agricultural output. Agricultural home consumption increases by 0.4%, 0.7% and 0.6% consecutively. This can partly explain the decline in agricultural marketed outputs. On the other hand, industrial marketed outputs rise by 0.02% for 2010 and 2012, and remain unchanged in 2011. While marketed outputs of the service sector show no change in the entire period. Furthermore, quantity of composite commodity decreases for all the sectors for all the time except a slight rise in the service sector for 2010. Quantities of agricultural and industrial composite commodities decline

by 0.5%, 0.2% and 0.4%, and 0.1% for 2010, 2011, and 2012 respectively. This is partly because the fall in agricultural production goes beyond the rise in volume of agricultural import while the fall in industrial import remains uncompensated by the rise in industrial output. In addition, quantity of composite commodity in service sector declines very slightly by 0.04% and 0.01% in 2011 and 2012. This is partly due to the rise in volume of export in the sector with no change in production output for all the years. This reason also holds for the decrease in quantity of industrial composite commodity. As a result of trade liberalization, the domestic market shrinks: aggregate supply of every commodity to the domestic market decreases. This can partly explain the decrease in private consumption.

When we look at the inter-sectoral (i.e forward-backward) linkage in the economy, intermediate input demand from the agriculture sector to the other sectors declines by 0.2% and 0.1% for 2010 and 2012. This implies that agriculture sector's forward linkage with the other sectors gets weaker. This is because of the decline in production in the agriculture sector. Therefore, as a result of trade liberalization, the non agriculture sector switches to the cheaper imported agricultural commodities for their intermediate input demand.

### ***Macroeconomic impacts***

Let us look into the fiscal impact of the trade liberalization. Tariff revenue takes almost 27.2% of total government revenue and 3.4% of total GDP. Tariff elimination on agricultural imports from EPA results in a 0.33% decline in government tariff revenue. This can partly explain the decrease in government revenue by 0.2%, 0.1% and 0.2% consecutively. Despite the decrease in revenue, government consumption rise by 0.5%, 0.1% and 0.4% for 2010, 2011 and 2012 respectively. This rise in 2010 stimulates the economy get back in 2011 to its performance before the trade liberalization.

The trade liberalization measure decreases total labor demand by 0.2% for both 2010 and 2012. This effect could be due to a production slow down in the economy. However, labor supply keeps increasing by 2.8% and 3% for 2011 and 2012



respectively. This shows that unemployment is getting deeper as time passes. As a result of this, households' income falls by 0.1%, 0.03% and 0.1% for 2010, 2011 and 2012 respectively which leads to a decline in private consumption by 0.3% across the period. The decline in private consumption can also be explained by the decrease in supply of composite commodity in the domestic market.

The results of the model simulation show that real GDP declines by 0.1% in 2010. However, the economy gets some stimulant like the rise in government consumption to get back to its base year performance. Thus, in 2011 the real GDP comes equal with the base year value - no change in real GDP for 2011. Once more, the economy slows down slightly in 2012. This leads to a 0.07% decrease in real GDP. In line with this, total investment decreases by 0.2%, 0.1% and 0.2% for 2010, 2011 and 2012 respectively.

## 7-CONCLUSIONS AND POLICY IMPLICATIONS

In this paper, attempts were made to look at the dynamic impact of joining EPA using a recursive dynamic CGE model. The import tariff elimination calculated by the model has far reaching sectoral and macroeconomic consequences. The following are the main conclusions and policy implications.

Tariff elimination on agricultural imports from ACP-EU countries reduces prices on agricultural imports from EPA and raises prices on agricultural imports from ROW. As a result, volume of agricultural imports from EPA increases while that from ROW decreases. In the non-agriculture sector, industrial import price exhibits no change at all whereas service import price shows a small rise for the entire period. As a result, the volume of non-agricultural imports from ROW remains unchanged while industrial import from EPA falls slightly. Consequently, agricultural production falls and industrial output rises where as that of the service sector remains unchanged. This makes the real GDP fall. This in turn results in a consecutive rise in unemployment rate across the period. Households' income and private consumption both fall as a result.

On the other hand, volume of agricultural export to EPA increases while that to ROW declines throughout the period. In addition, non-agricultural export to EPA decreases where as that to ROW increases. On the other hand, aggregate supply of every commodity in the domestic market decreases which makes the domestic market shrink.

Government fiscal revenue decreases throughout the period partly because of the decline in tariff revenue. However, government consumption rises which stimulates the economic activities that is slowed down a little bit by the trade liberalization measure.

Finally, to summarize with, tariff elimination on agricultural imports from EPA makes cheaper agricultural commodities available in domestic market. Moreover, real wage rate increases across the period while real GDP and total investment decreases. In line with this, domestic producers in agriculture sector are discouraged because of the production lose in the sector but those in the non-agriculture sector are better off. However, capital owners in every sector are worse off throughout the period. Unemployment increases from time to time. Government revenue decreases as a result of a decline in import tariff revenue. However, government consumption rises. Moreover the trade liberalization measure makes the inter-sectoral linkage weaker.

Therefore, policies directed towards enhancing production efficiency would generate substantial capacity for all the sectors to withstand the fierce competition from imported products and increase volume of export. Thus, domestic policies should be encouraging for domestic producers. In the non agriculture sector especially, policies should be export oriented.

Expansionary fiscal policy is found to be good policy measure that stimulates activities in the economy. Thus, this study implies that well managed expansionary fiscal policy can be part of the solution for economic slowdown following trade liberalization measures.

In order to be able to decrease the number of unemployed, government should provide additional sources of employment and income. In the agriculture sector especially rural households should be encouraged to be more involved in non-farm activities besides the agricultural activities.

#### NOTES

<sup>1</sup> See Tadele *et al.* (2007)

<sup>2</sup> changing non tariff barriers (NTBs) like quota into tariff form

<sup>3</sup> TFP is defined as the difference between output growth and a factor share weighted growth of inputs (this difference is also known as the “residual” – a measure of the unexplained source of output growth)

<sup>4</sup> See Bourguignon *et al.* (1989), and Jung and Thorbecke (2003)

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Table 1 The structure of Ethiopia macro-SAM

Exp \ Receipt	LAB	CAP	LAND	HH	FIRM	GOV	ITAX	DTAX	AAGR	AIND	ASER	CAGR	CIND	CSER
LAB									19241	1575	15889			
CAP									813	5029	13241			
LAND									4424					
HH	36705			945	13693	833								
FIRM		18570	4424											
GOV							4871	5749						
ITAX										1083	492	27	3269	
DTAX				1573	4176									
AAGR				16340								14929		
AIND													22216	
ASER														44815
CAGR				8922					6162	3071	569			
CIND				10695					629	9453	5699			
CSER				12656		11274				2005	8925	6275	2617	19431
S-I				3369	5125									
COMESA		77											398	367
EU		154										590	3508	1285
ROW		282										856	9976	2019
TOTAL	36705	19083	4424	54500	22994	12107	4871	5749	31269	22216	44815	22677	41984	67917

ANNEX I

Exp Receipt	S-I	COMESA	EU	ROW	TOTAL
LAB					36705
CAP					19083
LAND					4424
HH			772	1552	54500
FIRM					22994
GOV	703	15	216	553	12107
ITAX					4871
DTAX					5749
AAGR					31269
AIND					22216
ASER					44815
CAGR	1218	272	783	1680	22677
CIND	12691	220	905	1692	41984
CSER	929	335	1170	2300	67917
S-I			1691	5356	15541
COMESA					842
EU					5537
ROW					13133
TOTAL	15541	842	5537	13133	

Factors

LAB- labor

CAP- capital

LAND –land

Institutions

HH-households

FIRM - firm

GOV-government

Tax

ITAX – indirect tax

DTAX – direct tax

Activity

AAGR – agriculture

AIND – industry

ASER – service

Commodity

CAGR – agriculture

CIND – industry

CSER - service

Trade partners

COMESA – common market

for east and southern Africa

EU – European union

ROW – rest of the world

S-I – saving-investment

Table 2 Impacts of tariff elimination on prices

Indicators	Symbol	Base value	Change in indicators value					
			2010	%	2011	%	2012	%
Domestic price of imported commodity	PM <sub>C</sub>	1						
Agriculture			0.994	-0.6	0.993	-0.7	0.994	-0.6
Industry			1.000	0	1.000	0	1.000	0
Service			1.001	0.1	1.002	0.2	1.002	0.2
Regional import price	PM <sub>R,C,TP</sub>	1						
EU								
Agriculture			0.981	-1.9	0.981	-1.9	0.981	-1.9
Industry			1.000	0	1.000	0	1.000	0
Service			1.001	0.1	1.002	0.2	1.001	0.1
COMESA								
Agriculture			1.000	0	1.000	0	1.000	0
Industry			1.000	0	1.000	0	1.000	0
Service			1.001	0.1	1.001	0.1	1.001	0.1
ROW								
Agriculture			1.003	0.3	1.002	0.2	1.003	0.3
Industry			1.000	0	1.000	0	1.000	0
Service	1.001	0.1	1.003	0.3	1.002	0.2		
Domestic price of exported commodity	PE <sub>C</sub>	1						
Agriculture			1.000	0	1.000	0	1.000	0
Industry			1.000	0	1.000	0	1.000	0
Service			1.000	0	1.000	0	1.000	0

*Economy wide impact of unilateral agricultural trade liberalization*

Table 2 continuation

Region specific export price								
EU			1.000	0	1.000	0	1.000	0
Agriculture			1.000	0	1.000	0	1.000	0
Industry			1.000	0	1.000	0	1.000	0
Service								
COMESA	PER <sub>C,TP</sub>	1	1.000	0	1.000	0	1.000	0
Agriculture			1.000	0	1.000	0	1.000	0
Industry			1.000	0	1.000	0	1.000	0
Service								
ROW			1.000	0	1.000	0	1.000	0
Agriculture			1.000	0	1.000	0	1.000	0
Industry			1.000	0	1.000	0	1.000	0
Service								
Activity price								
Agriculture			0.999	-0.1	0.999	-0.1	0.999	-0.1
Industry	PA <sub>A</sub>	1	1.000	0	1.000	0	1.000	0
Service			1.000	0	0.999	-0.1	1.000	0
Price of value added								
Agriculture			0.999	-0.1	0.999	-0.1	0.999	-0.1
Industry	PVA <sub>A</sub>	1	1.000	0	1.000	0	1.000	0
Service			1.000	0	0.999	-0.1	1.000	0
Aggregate producer price								
Agriculture			1.002	0.2	1.003	0.3	1.002	0.2
Agriculture	PP <sub>C</sub>	1	0.999	-0.1	0.999	-0.1	0.999	-0.1
Industry			0.999	-0.1	0.998	-0.2	0.999	-0.1
Service								
Domestic supply price								
Agriculture			1.003	0.3	1.003	0.3	1.003	0.3
Industry	P <sub>C</sub>	1	0.999	-0.1	0.999	-0.1	0.999	-0.1
Service			0.999	-0.1	0.998	-0.2	0.999	-0.1

Table 2 continuation

Domestic demand price								
Agriculture	PD <sub>C</sub>	1	1.003	0.3	1.003	0.3	1.003	0.3
Industry			0.999	-0.1	0.999	-0.1	0.999	-0.1
Service			0.999	-0.1	0.998	-0.2	0.999	-0.1
Consumer price of composite commodity								
Agriculture	PC <sub>C</sub>	1	0.999	-0.1	0.999	-0.1	0.999	-0.1
Industry			1.000	0	1.000	0	1.000	0
Service			1.000	0	0.999	-0.1	1.000	0
Rate of return to capital								
Agriculture	R <sub>a</sub>	1	0.994	-0.6	0.995	-0.5	0.996	-0.4
Industry			0.999	-0.1	1.000	0	0.999	-0.1
Service			0.998	-0.2	0.999	-0.1	0.998	-0.2
Rate of return to composite factor	RC	1	1.001	0.1	0.999	-0.1	1.000	0
Rate of return to agricultural land	RL	1	0.994	-0.6	0.999	-0.1	0.995	-0.5
Wage rate	W	1	1.001	0.1	1.000	0	1.001	0.1
Nominal exchange rate	E	1	1.000	0	1.000	0	1.000	0
Consumers' price index	CPI	1	1.000	0	0.999	0.1	1.000	0

Table 3 Impact of tariff elimination on sectoral indicators

Indicators	Symbol	Base value	Changes in indicators' volume or value					
			2010	%	2011	%	2012	%
Quantity of imported commodity								
Agriculture	M <sub>C</sub>	7748	7681	-0.9	7705	-0.6	7687	-0.8
Industry		19768	19725	-0.2	19731	-0.2	19723	-0.2
Service		23102	23120	.08	23092	-.04	23110	-.04
Regional imported quantity								
EU								
Agriculture		3150	3112	-1.2	3102	-1.5	3082.3	-2.2
Industry		4169	4116.2	-1.3	4123.7	-1.1	4113.6	-1.3
Service		8087	8106	0.2	8075.4	-0.1	8095.1	0.1
COMESA								
Agriculture	QMR <sub>C,TP</sub>	-	113.86	-	98.032	-	113.67	-
Industry		473	473	0	473.03	0	473.03	0
Service		2310	2310	0	2309.6	0	2309.6	0
ROW								
Agriculture		4571	4540.7	-0.7	4570.7	0	4570.7	0
Industry		11857	11857	0	11857	0	11857	0
Service		12706	12706	0	12706	0	12706	0
Quantity of exported commodity								
Agriculture	EX <sub>C</sub>	2735	2716.4	-0.7	2721.3	-0.5	2717.5	-0.6
Industry		2817	2826.1	0.3	2823.5	0.2	2826.1	0.3
Service		3805	3812.3	0.2	3822.5	0.5	3817.5	0.3

Table 3 continuation

Regional exported quantity								
EU								
Agriculture		783	783	0	783	0	783	0
Industry		905	905	0	905	0	905	0
Service		1170	1170	0	1170	0	1170	0
COMESA								
Agriculture	QER <sub>C,TP</sub>	272	285.19	4.9	281.7	3.6	284.36	4.5
Industry		220	212.04	-3.6	214.28	-2.6	212.04	-3.6
Service		335	328.04	-2.1	320.67	-4.3	324.15	-3.2
ROW								
Agriculture		1680	1666	-0.8	1669.6	-0.6	1666.7	-0.8
Industry		1692	1699	0.4	1697	0.3	1699	0.4
Service		2300	2305.7	0.3	2313.4	0.6	2309.6	0.4
Output of activity								
Agriculture		31269	31180	-0.3	31269	0	31200	-0.2
Industry	XS <sub>A</sub>	22216	22220	.02	22216	0	22219	0.02
Service		44815	44815	0	44815	0	44815	0
Quantity of marketed output								
Agriculture		14929	14887	-0.3	14929	0	14896	-0.2
Industry	QX <sub>C</sub>	22216	22220	.02	22216	0	22219	0.02
Service		44815	44815	0	44815	0	44815	0
Quantity of composite commodity								
Agriculture		19942	19851	-0.5	19912	-0.2	19865	-0.4
Industry	CC <sub>C</sub>	39167	39119	-0.1	39123	-0.1	39116	-0.1
Service		64112	64122	.02	64084	-.04	64107	-.01
Quantity of domestic consumption								
Agriculture		12194	12170	-0.2	12208	0.1	12178	-0.1
Industry	DC <sub>C</sub>	19399	19394	-.03	19393	-.03	19393	-.03
Service		41010	41003	-.02	40993	-.04	40998	-.03
Households' consumption demand								
Agriculture		8922	8900.2	-0.3	8895	-0.3	8895	-0.3
Industry	HCD <sub>C</sub>	10695	10667	-0.3	10661	-0.3	10662	-0.3

*Economy wide impact of unilateral agricultural trade liberalization*

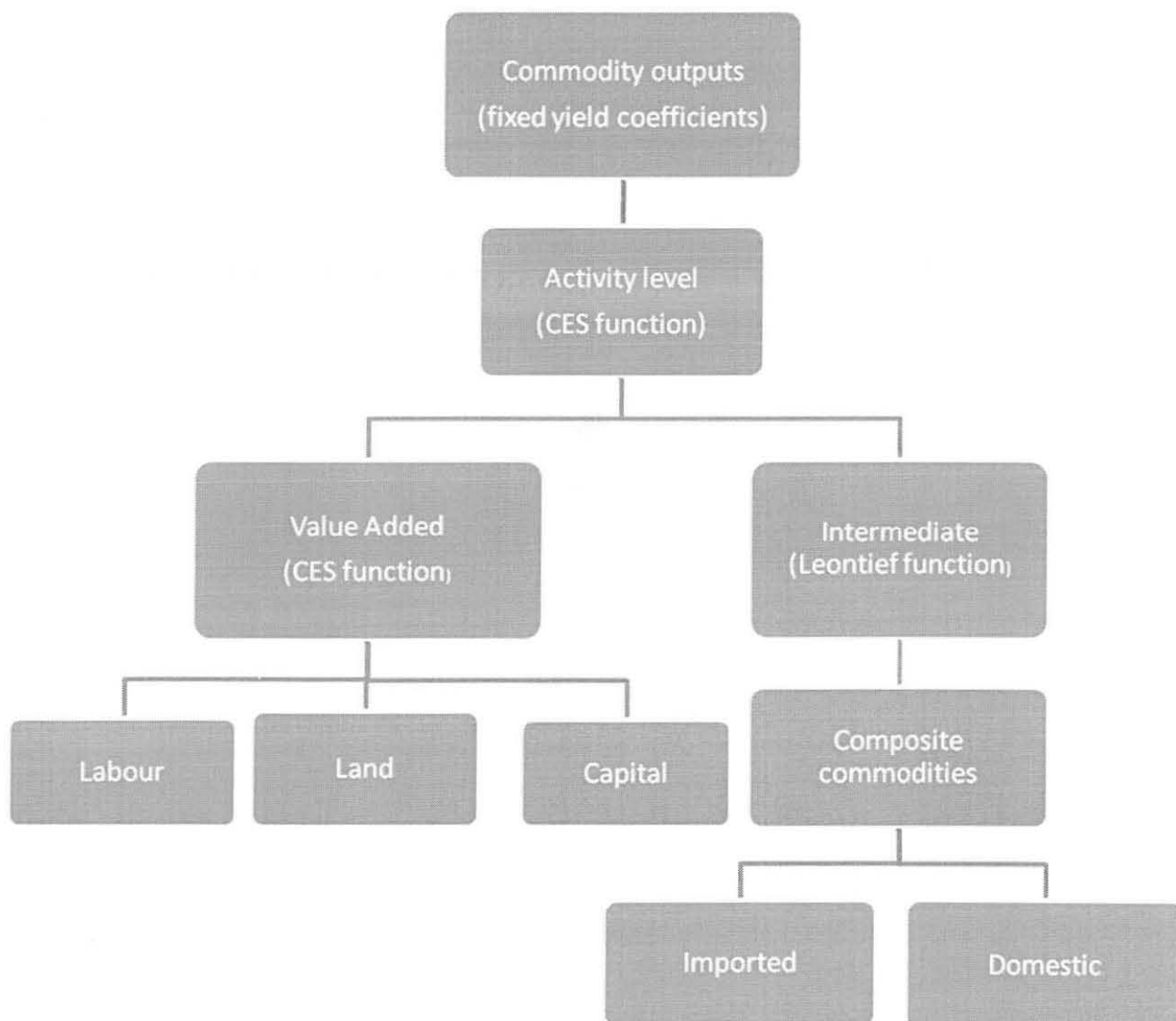
Service		12656	12617	-0.3	12619	-0.3	12614	-0.3
Government consumption								
Agriculture	CGQ <sub>C</sub>	-	-		-		-	
Industry		-	-		-		-	
Service		11274	11325	0.5	11284	0.1	11313	0.4
Household's home consumption								
Agriculture	HC <sub>A</sub>	16340	16409	0.4	16449	0.7	16430	0.6
Industry		-	-		-		-	
Service		-	-		-		-	
Investment demand								
Agriculture	Ind <sub>a</sub>	371	366.59	-1.1	368.25	-0.7	367.9	-0.8
Industry		2294	2292.8	-0.4	2293.4	-0.2	2293	-0.4
Service		6040	6030	-0.2	6035.6	-0.1	6030	-0.2
Intermediate input demand								
Agriculture	QDINT <sub>C</sub>	9802	9785	-0.2	9802	0	9789	-0.1
Industry		15781	15781	0	15781	0	15781	0
Service		10930	10930	0	10930	0	10930	0
Institutions' income								
Households	Y <sub>I</sub>	54500	54454	-0.1	54484	-0.03	54459	-0.1
Firms		22994	22947	-0.2	22979	-0.07	22953	-0.2

Table 4 Impacts of tariff elimination on macroeconomic variables

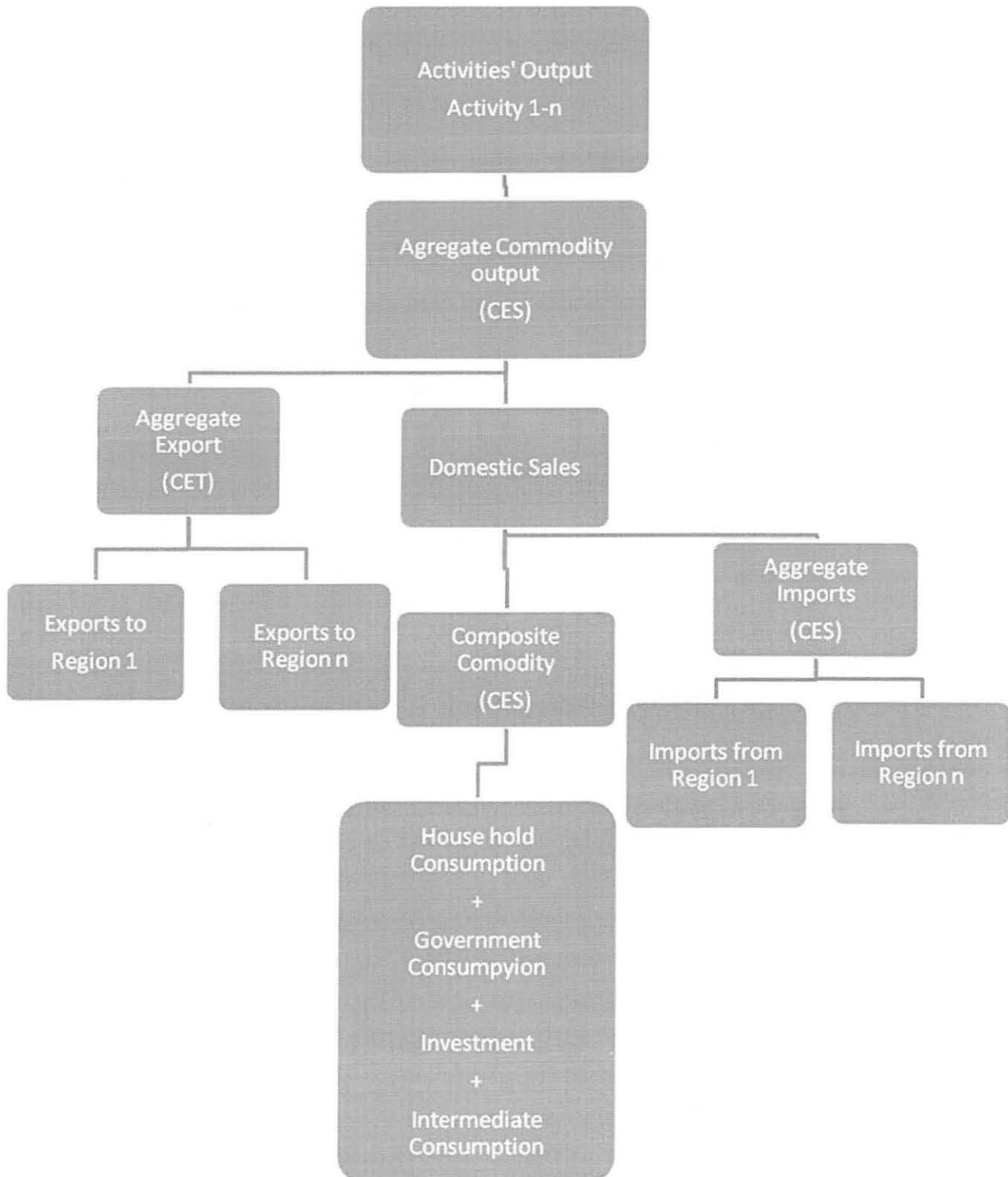
Indicators	Symbol	Base value	Changes in indicators' volume or value					
			2010	%	2011	%	2012	%
Real GDP	-	98300	98215	-0.1	98300	0	98234	-0.07
Government revenue	Y <sub>GOV</sub>	12107	12086	-0.2	12092	-0.1	12087	-0.2
Total investment	TI	15541	15509	-0.2	15523	-0.1	15512	-0.2
Private consumption	-	32273	32184	-0.3	32175	-0.3	32170	-0.3

## ANNEX II

Figure 1 The production technology in the Ethiopian CGE model



Source: Lofgren et al, 2002 with adjustment



ANNEX III

Mathematical Equations for Ethiopian CGE Model

Production equations

$$XS_{A,T} = A_A^A \left[ \alpha_A^A \left( QVA_{A,T} (1 + ta_a) \right)^{-\rho_a^A} + (1 - \alpha_A^A) QINT_{A,T}^{-\rho_a^A} \right]^{-1/\rho_a^A}$$

$$QVA_{A,T} / QINT_{A,T} = \left[ (\alpha_a^A PINT_{A,T}) / ((1 - \alpha_a^A) PVA_{A,T}) \right]^{\kappa_a^A}$$

$$QVA_{NAG,T} = A_{NAG}^{KL} \left[ \alpha_{NAG}^{KL} LD_{NAG,T}^{-\rho_{NAG}^{KL}} + (1 - \alpha_{NAG}^{KL}) KD_{NAG,T}^{-\rho_{NAG}^{KL}} \right]^{-1/\rho_{NAG}^{KL}}$$

$$QVA_{AAGR,T} = A_{AAGR}^{CL} \left[ \alpha_{AAGR}^{CL} CF_T^{-\rho^{CL}} + (1 - \alpha_{AAGR}^{CL}) LANDS_T^{-\rho^{CL}} \right]^{-1/\rho^{CL}}$$

$$CF_T = A_{AAGR}^{KL} \left[ \alpha_{AAGR}^{KL} LD_{AAGR,T}^{-\rho_{AAGR}^{KL}} + (1 - \alpha_{AAGR}^{KL}) KD_{AAGR,T}^{-\rho_{AAGR}^{KL}} \right]^{-1/\rho_{AAGR}^{KL}}$$

$$QINT_{A,T} = \sum_c (io_{c,a} XS_{A,T})$$

$$LANDS_T = \left[ (1 - \alpha^{CL}) rc_t / (\alpha^{CL} rl_t) \right]^{\kappa^{CL}} CF_T$$

$$LD_{A,T} = (\alpha_A^{KL} / (1 - \alpha_A^{KL}))^{\kappa_A^{KL}} (r_{a,t} / w_t)^{\kappa_A^{KL}} KD_{A,T}$$

$$TKD_T = \sum_a (r_{a,t} KD_{a,t})$$

Income and saving equations

$$Y_{HH,T} = w_t \sum_A LD_{A,T} + CPI_T TG_{HH,T} + DIV_{HH,T} + REM_T e_t + TII_{HH,T}$$

$$Y_{firm,t} = \lambda^f \sum_A (r_{a,t} KD_{A,T}) + rl_t LANDS_T$$

$$MREV_{C,T} = \sum_{tp}^a tm_{c,tp} TC_C$$

$$Y_{GOV,T} = [(tyf Y_{firm,t}) + (tyh Y_{HH,T}) + \sum_C MREV_{C,T} \\ + \sum_C \sum_{TP} tx_c PER_{CTP,T} QER_{CTP,T} e_t \\ + \sum_A PVA_{A,T} QVA_{A,T} ta_a + TRANSFR_{GOV,T} e_t + pinv_t II_{GOV,T}]$$

$$S_{firm,t} = Y_{firm,t} (1 - tyf) mps_{firm}$$

$$DINV_{c,t} = \frac{mu_c TI_t}{PC_{c,t}}$$

$$ICE_{HH,T} = Y_{HH,T} (1 - tyh) (1 - mps_{hh}) - TII_{HH,T}$$

$$HCD_{c,t} = \gamma_c [ICE_{HH,T} - \sum_A (PA_{AT} HC_{AT})] / PC_{c,t}$$

$$ICE_{GOV,T} = \sum (PC_{c,t} CGQ_{c,t}) + TG_{hh,t} CPI_T$$

$$QDINT_{c,t} = \sum_a (i_{c,a} XS_{a,t})$$

$$QX_{c,t} = \sum_a (XI_{a,c} XS_{a,t})$$

Price equations

$$r_{nag,t} = (PVA_{NAG,T} QVA_{NAG,T} - W_t LD_{NAG,T}) / KD_{NAG,T}$$

$$r_{aagr,t} = (rc_t CF_T - W_t LD_{AAGR,T}) / KD_{AAGR,T}$$

$$rc_t = (PVA_{AAGR,T} QVA_{AAGR,T} - rl_t LANDS_T) / CF_t$$

$$PD_{c,t} = P_{c,t} (1 + ts_c)$$

$$PM_{c,t} = \left[ \sum_{ty} (b_{c,ty} PMR_{c,ty,t}^{(1-\eta^m)}) \right]^{1/(1-\eta^m)}$$

$$PMR_{c,ty,t} = [pwm_{c,ty,t} (1 + ts_c) (1 + tm_{c,ty}) e_t] - PC_{c,t} lcd_c$$

$$PER_{c,ty,t} = pwe_{c,ty,t} e_t / (1 + tx_c)$$

$$PC_{c,t} = (PD_{c,t} DC_{c,t} + PM_{c,t} M_{c,t}) / CC_{c,t}$$

$$PP_{c,t} = (P_{c,t} DC_{c,t} + PE_{c,t} EX_{c,t}) / QX_{c,t}$$

$$PA_{a,t} = \left[ (PVA_{a,t} QVA_{a,t} (1 + ta_a)) + PINT_{a,t} QINT_{a,t} \right] / XS_{a,t}$$

$$PINT_{a,t} = \frac{\sum_c PC_{c,t} \iota_{c,a}}{\sum_c \iota_{c,a}}$$

$$pinv_t = \prod_c [(PC_{c,t}/m\iota_c)^{m\iota_c}]$$

$$CPI_T = \sum_c \omega_c PC_{c,t}$$

International trade equations

$$QX_{C,T} = \theta_c [\beta_c EX_{C,T}^{\sigma^e} + (1 - \beta_c) DC_{c,t}^{\sigma^e}]^{\frac{1}{\sigma^e}}$$

$$EX_{C,T} = [(\beta_c (1 - \beta_c)) / (PC_{c,t} \beta_c)]^{\sigma^e} DC_{c,t}$$

$$EX_{C,T} = \theta_c^{TP} [\sum_{TP} d_{c,TP} QER_{c,TP,t}^{\sigma^e}]^{\frac{1}{\sigma^e}}$$

$$CC_{C,T} = \psi_c [\varphi_c M_{c,t}^{-\sigma^m} + (1 - \varphi_c) DC_{c,t}^{-\sigma^m}]^{\frac{-1}{\sigma^m}}$$

$$M_{C,T} = [\varphi_c PD_{c,t} / (1 - \varphi_c) PM_{c,t}]^{\sigma^m} DC_{c,t}$$

$$M_{C,T} = \psi_c^{TP} \left[ \sum_{TP} b_{c,TP} QMR_{c,TP,t}^{-\sigma^m} \right]^{\frac{-1}{\sigma^m}}$$

$$TVM_{C,T} = \sum_{TP} (PMR_{C,TP,t} QMR_{C,TP,t})$$

$$TVE_{C,T} = \sum_{TP} (PER_{C,TP,t} QER_{C,TP,t})$$

Equilibrium equations

$$CC_{C,T} = QDINT_{C,T} + HCD_{C,T} + DINV_{C,T} + CGQ_{C,T} + DTS_{C,T}$$

$$KS_T = \sum_a KD_{a,t}$$

$$LS_T = \sum_a LD_{a,t}$$

$$TI_T = Y_{hh,t} (1 - tyh) mps_{hh} + S_{firm,t} + (Y_{gov,t} - ICE_{gov,t}) + FSAV_t e_t + WALRAS_t$$

$$\begin{aligned} \sum_c TVM_{c,t} - \sum_c DTS_{c,t} + \sum_{\forall} (\lambda_{\forall} TKD_{\forall}) / e_t \\ = \sum_c TVE_{c,t} + \text{transfr}_{govt} + REM_t + FSAV_t \end{aligned}$$

Dynamic equations

$$KD_{a,t+1} = (1 - \delta) KD_{a,t} + Ind_{a,t}$$

$$LS_{t+1} = (1 + ng) LS_t$$

$$Ind_{a,t} = SIADJ_t \zeta_a KD_{a,t} \left( r_{a,t} / U_t \right)^2$$

$$U_t = \text{pinv}_t (ir + \delta)$$

$$TI_T = \text{Pinv}_t \sum_a Ind_{a,t} + II_{govt}$$

### Endogenous variables

$XS_a$	Output of activity a (volume)
$QINT_a$	Aggregate intermediate input absorption of activity a (volume)
$QVA_{agr}$	Aggregate value added for agriculture (volume)
$QVA_{nagr}$	Aggregate value added for non-agriculture activities (volume)
$KD_a$	Demand for capital in activity a (volume)
$KS$	Total capital supply
$TKD$	Total capital Demand (value)
$LD_a$	Activity a labour demand (volume)
$LS$	Total labour supply (volume)
$CF$	Composite agricultural capital-labour factor (volume)
$DC_c$	Domestic consumption (volume)
$QX_c$	marketed output (volume)
$CC_c$	composite commodity Demand (volume)
$CGQ_c$	government consumption of composite commodity c (volume)
$HC_a$	household's home consumption (volume)
$HCD_c$	households' consumption demand of good c (volume)

$ICE_{hh}$	Household's consumption expenditure
$DINV_c$	Investment demand for good c (volume)
TI	Total investment
$Ind_a$	investment demand in activity a (volume)
$QDINT_c$	intermediate input demand from composite commodity c (volume)
$DTS_c$	transaction services Demand
$M_c$	Imports in good (volume)
$QMR_{c,TP}$	Regional imported quantity
$EX_c$	Exports in good c (volume)
$QER_{c,TP}$	Export quantity, region specific
$TVM_c$	Total value of commodity C import
$TVE_c$	Total value of commodity C export
$Y_I$	Institution's income
$MREV_c$	Import tariff revenue
$S_I$	Institutions' saving
$PVA_a$	activity a Price of value added
$PA_a$	activity price
$PINT_a$	activity's intermediate input cost
$PP_c$	Aggregate producer price of commodity
$PC_c$	Consumer price of composite commodity
$PD_c$	Domestic demand price of commodity c
$P_c$	Domestic supply price of commodity c
$PM_c$	Domestic price of imported commodity
$PE_c$	Domestic price of exported commodity c
$PMR_{c,TP}$	Regional import price
$PER_{c,TP}$	Region specific export price
$PINV$	Price index of investment
$R_a$	Rate of return to capital in activity a
RC	Rate of return to composite factor

RL	Rate of return to agricultural land
e	Nominal exchange rate
W	Wage rate
U	Capital user cost

**Exogenous variables**

TG <sub>I</sub>	Government transfers to Institutions
TII <sub>I</sub>	intra Institution transfer
DIV <sub>I</sub>	Dividends paid to institutions
TRNSFR <sub>I</sub>	transfer from ROW to institutions
II <sub>I</sub>	Institutions' investment expenditure
CPI	Consumers' price index (GDP deflator)
REM	remittance income from ROW to households
FSAV	foreign savings (Foreign Currency Unit)
LANDS	Agricultural land (volume)
PWM <sub>C,TP</sub>	World price of import
PWE <sub>C,TP</sub>	World price of export
ICE <sub>GOV</sub>	Government's consumption expenditure
SIADJ	investemnt-saving Adjustment
WALRAS	Dummy variable (zero at equilibrium)

**Parameters**

**Production functions**

$A_a^c$	Scale parameter (CES between value added and intermediate input)
$\alpha_a^c$	Share parameter (CES between value added and intermediate input)
io <sub>c,a</sub>	Input output coefficient
$\zeta_a$	Scale parameter in the investment demand function

**CES function between capital and labour**

$A_a^{k,l}$	Scale parameter (CES between labor and capital)
$\alpha_a^{k,l}$	Share parameter (CES between labor and capital) in a

$\rho_a^{ki}$  Substitution parameter (CES capital and labor) in a

$\kappa_a^{ki}$  Substitution elasticity (CES capital and labor)

**CES function between composite factor and land**

$A_{ag}^{ci}$  Scale parameter (CES between composite factor and land)

$\kappa^{ci}$  Substitution elasticity (CES composite factor and land)

$\alpha^{ci}$  Share parameter (CES between composite factor and land)

$\rho^{ci}$  Substitution parameter (CES composite factor and land)

$\kappa_a^c$  Substitution elasticity (CES value added and intermediate)

$\rho_a^c$  Substitution parameter (CES value added and intermediate input)

**CES function between imports and domestic production**

$\psi_c$  Scale coefficient

$\psi_c^{tp}$  Scale coefficient (regional composite import)

$\varphi_c$  Share parameter

$b_{c,tp}$  Share parameter between regional imports

$\sigma^m$  Substitution (Armington) parameter

$\eta^m$  Substitution elasticity

**CET function between domestic production and exports**

$\theta_c$  Scale coefficient

$\theta_c^{tp}$  Scale coefficient (regional composite export)

$\beta_c$  Share parameter

$d_{c,tp}$  Share parameter between exports to regions

$\sigma^e$  Transformation parameter

$\eta^e$  Transformation elasticity

**Tax rates**

$tx_c$  Tax on exports

$tm_{c,tp}$  Regional import duties

$ta_a$  value added tax rate

$ts_c$  Sales tax rate on commodity c

$ty_h$  Direct tax rate on households' income

tyf      Direct tax rate on firms' income

**Price block parameters**

icd<sub>c</sub>    Quantity of trade input per unit of c imported

ω<sub>c</sub>      weight of commodity c in CPI

μ<sub>c</sub>      Share of the value of good c in total investment

ξ<sub>a,c</sub>     Marketed commodity c per unit of activity output (volume)

δ         Capital depreciation rate

ir        Real interest rate

**Income and saving block parameters**

mpsi<sub>i</sub>    institutions' Propensity to save

γ<sub>c</sub>      Marginal household consumption share of good c

λ<sup>f</sup>      Share of capital income received by firms

λ<sub>tp</sub>     Share of capital income received by trade partner TP

**Others**

ng        Population growth rate

π<sub>a</sub>      The share of investment directed to activity A

χ<sub>a</sub>      The elasticity of investment to differences in capital returns

**Sets**

{aagr, nag} ∈ a

a ∈ A = { AAGR, AIND, ASER}    All activities (AAGR: agriculture, AIND: industry, ASER: services)

c ∈ C = {CAGR, CIND, CSER}    All goods or commodities (CAGR: agriculture, CIND: industry, CSER: services)

nag ∈ NAG = {AIND, ASER}    Non agricultural activities (AIND: industry, ASER: services)

f ∈ F = {LAB, CAP, LAND}    Factors (LAB: labour, CAP: capital, LAND: land resource)

i ∈ I = {HH, FIRM, GOV}    Institutions (HH: household, FIRM: firm, GOV: government)

TAX = {DTAX, ITAX}    Taxes (DTAX: direct tax, ITAX: indirect tax)

$tp \in TP = \{EU, COMESA, ROW\}$  All trade partners ( EU: European union,  
COMESA: common market for east and southern  
Africa, ROW: rest of the world)

$EPA \subset TP = \{EU, COMESA\}$  Economic Partnership Agreement (EU: European  
union, COMESA: common market for east  
southern Africa)

$t \in T = \{2010, 2011, 2012\}$  Periods

## Declaration

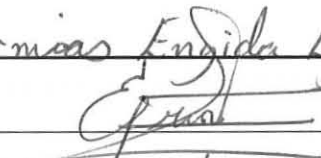
I, the undersigned, declare that this project is my original work and has not been presented for a degree in any other university, and that all source of materials used for the project have been duly acknowledged.

Declared by:

Name:

Ermiyas Engida Legesse.

Signature:



Date:

25/06/2009.

Confirmed by Advisor:

Name:

Wassie Berhan

Signature:



Date:

26/06/09

Place and date of submission: Addis Ababa University 25/06/2009.