ST. MARY`S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

THE IMPACT OF ETHIO – CHINA BILATERAL TRADE ON THE ETHIOPIAN ECONOMY: A RECURSIVE DYNAMIC CGE APPROACH

BY

ESHETU LEMMA HAILE

JUNE, 2016

ADDIS ABABA, ETHIOPIA

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ID: SGS/0592/2007A

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DEDICATION

This thesis is dedicated to my beloved families of Betselot, Natanim, Eyosiyas and Yematawork.

Endorsement

This thesis is submitted to St. Mary`s University, School of Graduate Studies for Examination with my approval as a university advisor.

_____	_____
Advisor	Signature
St. Mary`s University, Addis Ababa	June, 2016

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Abbreviations and Acronyms

AGOA	African Growth and Opportunity Act
BTA	Bilateral Trade Agreement
CACOF	Central Advisory Committee of Food Safety
CES	Constant Elasticity of Substitution
CES	Constant elasticity of substitution
CGE	Computable general equilibrium
CM	Common Market
COMESA	Common Market for Eastern and Southern Africa
CPI	Consumer price index
CU	customs unions
CV	Compensating variation
EBA	Everything But Arms initiative
EDRI	Ethiopian development Research institute
EEC	European Economic Community
EEIZ	Ethiopian Eastern Industrial Zone
EPRDF	Ethiopian People's Revolutionary Democratic Front
ERCA	Ethiopian Revenue and Customs Authority
ETB	Ethiopia Birr
EU	Economic Unions
EV	Equivalent variation
FOCAC	Forum on China-Africa Cooperation
FTA	Free Trade Agreement
GAMS	General Alegebric Mathematics System
GATT	General Agreement on Trade and Tariffs
GDP	Gross Domestic Product
GE	General Equilibrium
GTP	Growth and Transformation Plan
IDS	Institute of Development Studies
IO	input-output

JECC	Joint Ethiopian- China commission
LDC	Least developing countries
LES	Linear Expenditure System
MFN	Most Favored Nation
MOT	Ministry of Trade
NAFTA	North American Free Trade Agreement
NIEO	New international Economics Order
OAU	Organization for Africa Union
PTA	preferential trading areas
PU	Political Union
RIAs	Regional Integration Arrangement
ROW	Rest of the world
SADC	Southern Africa Development Community
SAM	Social accounting matrix
S-I	Saving –Investment
SIM	Simulation
TFP	total factor productivity
UAE	United Arabic of Emirate
UMA	Union du Maghreb
UN	United Nation
US	United State
USD	united state Dollar
WTO	World Trade Organization
ZTE	Zhongxing Telecommunication Equipment

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Abstract

Bilateral and regional trade agreements have become an increasingly prominent feature of international trade over the last two decades. Bilateral and regional trade agreements are a feature of a global trading system alongside multilateral trade agreements. Bilateral and regional trade agreements are sometimes referred to as preferential trade agreements because they are only beneficial to the particular states or countries to which they relate.

The impact on Ethiopia's economy with bilateral trade between China and Ethiopia taking in to account the strategic sectors or otherwise, however, has not been studied. Thus this paper tried to see the impact of bilateral trade arrangement using a Dynamic Recursive CGE model.

Four simulation scenarios are examined involve tariff reeducation or create Free trade area (FTA) between Ethiopia and China at one time, in 2016, or through phases, a 25% tariff removal each year from 2016-2019. Another scenario involves excluding strategic sectors from the bilateral trade agreement and involving sensitive government sector in simulation. .

The impact of BTA has been found to be significant on traded commodities. Particularly, the price of machineries, vehicles and equipments will decrease. Government revenue also decreases as tariff revenue is an important source of revenue for the Ethiopian government. GDP and trade balance are, however, positively affected. The increase in GDP might be associated to the increase in disaggregated production and private consumption. The larger increase in exports as compared to the increase in imports leads to an improvement in trade balance. The private consumption is also increased that might be due to the availability of cheap consumption commodities from abroad as a result of tariff removal. On the other hand, the results show a decrease in investment which might be attributed to the inability of domestic producers to compete with foreign suppliers at a lower price. Household welfare is improving for simulation 1 and 2 where the the household enjoin the benefit of tariff reduction gradually and one time complete abolishment, however, this is not the case in simulation 3 where government strategic sectors are protected.

Furthermore the protection of strategic sectors benefits only producers in these sectors. Exclusion of strategic sectors from BTA helps producers face less competition as the price of imported commodities will include tariffs. Protection of strategic sectors will also increase government revenue. The impact of protecting strategic sectors on the overall economy, however, is negative. It results in a decrease in GDP as well as deterioration of trade balance. Overall household welfare will improve when there is tariff reduction.

Keywords: Preferential integration, Recursive dynamic CGE, Bilateral trade, Ethiopia Chin.

CHAPTER ONE: INTRODUCTION

1.1 Background

During the postcold war era, has captured the attention of many scholars, the new China–Africa relations (China and Ethiopia including) intensified with which the political and economic relations (Y.S Cheng and Huang Shi, 2009). However, their relations have evolved over a long period and could be traced back to centuries when Chinese officials were sent to distant lands in search of what Gao Jinyuan (1984,p.241-250) points out as for alliance formation in order to counter the powerful Huninvasion from the North of China. Chinese maritime traders had trade dealings with inhabitants of the coastal area along the Indian Ocean, and the Gulf of Aden and Persia and wherever merchants from different directions met (Filesi Teobaldo, 1972). The "ancientness" of China's political and economic relations with Africa and the dynamism with which it has proceeded in pace in the aftermath of the proclamation of People's Republic of China in October 1949.

Trade agreements, both bilateral and multilateral are seen as best instruments to facilitate trade between and/or among signatory countries and thus reap the benefit of trade (Asante, 1997). Both developed and developing countries use different types of trade agreements. Being one of these trade agreements, regional integration has prospered in the last three decades (Venables Anthony, 2000). Currently, cooperation in economic aspects is becoming the fashion of the day. One of the mechanisms of cooperation used is trade agreements. Countries in our world are becoming highly interdependent. The economy of a country is highly dependent on the economy of other countries.

Regional integration of Africa states began unifying against imperialism and colonialism. It was recognized as essential component of strategies of economic decolonization long before the attainment of political independence (Asante, 1997). African leaders adopted regionalism as a vehicle for overcoming the economic constraints imposed by the smallness and fragmentation of national markets. At the inaugural meeting of the OAU

in May 1963, regionalism was enshrined in the OAU charter (Lyakurwa, 1997). After independence, regional integration still remains to be the key strategy for African governments to accelerate the transformation of their fragmented small economies, expand their markets, widen the region‘s economic space, and reap the benefits of economies scale for production and trade, there by maximizing the welfare of their nations (ECA, 2010). Including the Union du Maghreb (UMA) in the North and Southern Africa Development Community (SADC) in the South, currently there are about 14 bilateral trade in Africa, in which eight of them are regional economic communities and the remaining six are inter-governmental organizations.

Several issues have been raised on enormous growth in bilateral trade between China and Ethiopia. China as the world's second largest economy with manufacturing industrial sector as its economic basis is far advanced than that of Ethiopia, whose economy is mostly concentrated on agricultural products. Even then, their bilateral trade has been on the upswing where China has been exporting low cost manufactured consumer products in return for access to Ethiopia’s relatively large market and resources within the Horn of African region. A significant quantity of manufactured goods and machineries and transport equipment’s are utilized by much of the Chinese firms in Ethiopia for the various infrastructural projects (Marcy-Francoise, 2011).

China is more attracted in Africa particularly Ethiopia due to Ethiopia is hub with several international organizations having headquarters in its capital, with a population of about 94 million and a potential access for other regional markets such as the Common Market for Eastern and Southern Africa (COMESA) (Yejoo 2013, p.183-184). With the introduction of liberalization policy in 1992 in Ethiopia, China got an opportunity to invest in various economic sectors. Notable among others are road construction, electric power generation and telecommunication. Side by side, trade between the two countries has grown steadily through time. Moreover, Chinese firms have taken over several public producer firms with the “intention of exploiting the preferential treatments of Ethiopia in the industrial countries such as the African Growth and Opportunity Act (AGOA) in the USA” (Geda, 2008). In all the above mentioned sectors, Chinese firms

have won big projects like Tekeze Hydro Project and telecom sector by the Chinese company ZTE besides major highway construction.

The growing and expanding scope of the relations with specific reference to trade is further reinvigorated through interactions between the two governments that have been intensified in recent times. Besides, a point worth noting is the Chinese industrial zone called Ethiopian Eastern Industrial Zone (EEIZ) some 37 km away from Addis Ababa in which more than 20 Chinese companies have invested in various projects such as textile and garment, shoe and leather products, food, electrical materials and steel manufacturing sectors (Geda 2009, p. 6).

1.2 Statement of the problem

Countries` level of export diversification, as general consensus in the empirical international trade literature, affected due to trade policy. Several recent papers have found that tariffs faced countries significantly contribute to shape their export extensive margins, i.e. their ability to export new products. Most of them take as benchmark the Ricardian model that precisely predicts that a reduction in trade barriers leads to an increased range of exported goods (Dornbusch et al., 1977; Venables A., 2003). Ruhl (2003) provides evidence that permanent tariff reductions raise the expected future gain from exporting impulsion more firms to enter the export markets and are therefore associated with increased extensive margins of trade.

Free trade promotes economic welfare, most industrial and developing countries in the world are becoming members of regional integration or bilateral agreement. Many countries are also considering bilateral trade agreement as one of the main policy issues (Wondale M., 2011). Both the developed and developing countries are joining bilateral agreement. With failure of bilateral agreement among developing countries, attention now has changed to those bilateral agreement among developed countries, and between developed and developing countries.

Negotiating free trade are a serious exercise as the outcome can have major implications for development policy and for social, economic and development outcomes (Khor, 2005). While it can result in some export gains, it can also: (a) result in increases in imports, with implications for the trade balance and the debt position; (b) facilitate import surges as tariffs decline or are eliminated, and this can adversely affect the local industries and farms; (c) reduce tariff revenue, with consequences for the government budget; (d) restrict and in some cases remove policy space, or the options and instruments available to a country to institute certain social, economic and development policies.

China's trade with Ethiopia 2013/14 at 1.3 billion USD annually is expected to rise to US$3 billion by 2015. This indicated that a bilateral trade with China is the highest and the closest level that Ethiopia has built up with China over the past decade since the new government under Ethiopian People's Revolutionary Democratic Front (EPRDF) took over power in 1991 (Venkataraman and Gofie Bandung, 2015).

China is a full member of WTO for over a decade Ethiopia on the other hand has been aspiring to become a member for some time now and hence one of the important aspect of Ethio-China trade relations is the heavy reliance on bilateral/international trade regimes (Venkataraman and Gofie Bandung, 2015).

Bilateral trade agreements are being undertaken between China and Ethiopia since 2010. The impact on Ethiopia's economy taking in to account the strategic sectors, however, has not been studied. This paper will try to fill this gap by using a Dynamic Recursive CGE model.

This study will forward the likelihood of trade balance in the next five years as estimated though CGE modeling. Although trade ties as one important channel of bilateral relations that China has embarked with the outside world and particularly with Africa is unequal and uneven. This is true of the Ethiopian context as well particularly when we

look at the economic capacity, balance of trade and at the two countries relations with international trade regimes.

The better way of expanding market is through trade agreements. Mainly PRA leads diversify and expansion of trade among trading partners. Ethiopia signed preferential bilateral trade agreement with China on June 25, 2010. Hence, the study tries to address, what will be the impact of Ethio-China in this bilateral preferential trade agreement? Besides, the analysis of the study will contribute for making policy decision as to whether continue to sign or not with other countries particular countries with WTO members.

Thus, a study investigating the impact of Ethio-china bilateral trade economic partnership agreements on the overall economy using dynamic recursive CGE model is important. Particularly, the 2009/10 Ethiopian SAM prepared by EDRI will be very important source of data for such analysis. This study is conducted with the intention of investigating economy wide impact of Ethio – China trade on Ethiopia using the 2009/10 Ethiopian SAM (EDRI 2010).

1.3 Hypothesis of the Study

Ho: is expected to increase GDP and private consumption, decrease in government revenue since joining of Ethio – China bilateral trade and does FTA make them better off than bilateral trade arrangement? , Yes.

Hl: the result could be different from general accepted economic theory and literature i.e. a decrease on GDP and private consumption, and government revenue increased since joining Ethio – China bilateral trade and does FTA make them better off than bilateral trade arrangement? , No.

1.4 Objectives of the study

1.4.1. General Objectives

- To describe qualitatively Ethio – China trade arrangements and estimates quantitatively the impact of Ethio – China bilateral trade on the Ethiopian economy.

1.4.2. Specific objectives:

- To describe the bilateral Ethio – China bilateral trade agreement
- To determine the effect of Ethiopian macro economy accounts such as GDP, Exports, Imports, Investment and Private Consumption
- To determine the likely gains (or losses) in government revenue as a result of the bilateral trade,
- To determine the trend of trade balance and welfare gain or loss within next four years.

1.5 Significance of the study

This study would provide qualitative and quantitative information on overall trade and the impact analysis of bilateral trade between Ethio and China. The results from this analysis can give valuable insight into the prospects of significantly expanding trade with other countries. It may help us on the policy implication either expand or refrain from such trade agreement and may also useful reference source for academic communities who like to do farther researches. It may up-to-date the current thought in two countries trade relationship to future high level.

1.6 Scope and limitation of the study

The study is limited to the economic analysis of joining Ethio – China preferential bilateral trade agreement for Ethiopia. Since the study use CGE model has its own limitations which are uncertainty over parameters, specification, and experimental design, miss Key features of critical sectors, involves comparative statics. Further, it lacks adequate dataset of export and import of service between two countries.

1.7 Organization of the Study

The paper is organized in five chapters. Chapter one is introduction part which includes background, statement of the problem, objectives, significance, hypothesis and scope of the study. Chapter two includes reviews both the theoretical and empirical literature. Chapter three presents detailed explanation of the methodology used in the study. Chapter four presents results and discussion. The last chapter, chapter five, has conclusion and policy recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.1. Theoretical Review

Modern trade theory is the product of an evolution of ideas in economic thought. In particular, the writings of the Mercantilists, Adam Smith, and David Ricardo have been instrumental in providing the framework of modern trade theory. A major task of modern trade theory is to answer the following questions: 1) What constitutes the basis for trade, that is, why do nations export and import certain products? 2) At what terms of trade (relative prices) are products exchanged in the world market? 3) What are the gains from international trade in terms of production and consumption? (Salvatore, D., 1995, p.38).

Integration represents the joining together of previously independent units for the purpose of creating a new entity or whole. There are three closely related concepts, namely, *economic integration*, *regional integration*, and *regional cooperation*. Economic integration aims at reducing or eliminating trade barriers, such as tariffs and quantitative restrictions, among the countries that are forming integration. The concept of regional integration is broader than economic integration and is geographically defined. Regional integration covers not only the coordination of economic policies, but also regional security, human rights, education, health, research and technology, and natural resource management. Regional cooperation is a collaborative venture, which is organized on an ad hoc and temporary basis through contractual arrangements. These arrangements are of special circumstances to address particular problems. Thus, regional cooperation is time-bound and reversible, and is much more limited in scope than regional integration (Sodersten, B. and G. Reed,1994).

A bilateral or regional trade agreement is an agreement entered into between two or more countries under which the participants agree to reduce tariffs, quotas and other restrictions on trade between them. Bilateral trade agreements are, as the name suggests, bilateral in character; whereas regional trade agreements are generally entered into between a number of countries in a particular region. The agreements

cover both trade in goods and trade in services and also deal with issues such as the protection of intellectual property. They also frequently contain provisions or whole chapters dealing with protection for foreign investments (Liz Brownsell Allen & Overy, 2012). Bilateral and regional trade agreements are sometimes referred to as preferential trade agreements because they are only beneficial to the particular states or countries to which they relate.

2.1.1 The Rationale for Integration Schemes

There are many convincing reasons for supposing that significant benefits may be derived from properly conceived integration schemes. The benefits classified into two major categories: economic and non – economic. The expected economic benefits include enlarged markets with economies of scale, improved resource allocation and availability of resources, and enhanced industrialization. Economies of scale are said to exist in the production process when large output volumes can be produced at a lower cost per unit than small output volumes. The argument for the lowering of unit costs of production is the specialization of labor and equipment that is made possible at a sufficiently large scale of production. The improvement in resource allocation and availability of resources is attributed to competition and new incentives for investment. Furthermore, by removing barriers to trade among members, economic integration provides the possibility of coordinated industrial planning (Langhammer and Hiemenz, 1990).

The non- economic benefits integration includes improved collective bargaining power and consensus building on political and security issues. In other words, regional integration arrangements enhance bargaining power and reduce the risk of conflict through regular political contact among members.

2.1.2 The Forms of Integration

There are several possible forms and degrees of integration. Three areas of economic integration identifies (Asante, 1997) three areas of economic integration: markets, factors of production, and economic policies. The main difference that lies among these three principal areas of integration is the degree of interdependence achieved by the member countries.

Market integration refers to the integration of goods and services. There are three forms of market integration, namely, *preferential trading areas (PTAs*), *free trade areas (FTAs*), and *customs unions (CUs*). *Preferential trade areas, example bilateral trade arrangement* are arrangements in which members apply lower tariffs to imports produced by other members than to imports produced by nonmembers. Members can determine tariffs on imports from nonmembers (Healey, N. M, 2002).

Free trade areas are arrangements in which members abolish tariffs on imports from other members. As in PTAs, members can determine tariffs on imports from nonmembers. A technical problem that can arise in a FTA is the so – called trade deflection. Trade deflection is the diversion of exports to a country within a FTA that has lower tariffs on a good. In other words, goods may enter the low – tariff members of the FTA and can then be transshipped to high – tariff members without paying taxes at the border**.** When the national tariffs of the FTA members are very different, exporters have a clear incentive to try to evade the higher tariffs. To overcome this problem, therefore, it is necessary to determine the origin of the goods. The purpose of rules of origin is to limit trade deflection. The problem can even be worse if some value – added occurs in the low – tariff member, and thus making it somewhat its “own” good. Therefore, some decisions and methods of measurement have to be applied concerning the degree of value – added Langhammer and Hiemenz, 1990).

A customs union is a free trade area in which members impose common external tariff (CET) on nonmembers. A common external tariff means that each country replaces its

own national tariff schedule with a common tariff schedule applicable to all member countries.

Table 1 The Dimensions of Economic Integration

Scheme	Free Trade Among Members	Common Commercial Policy	Free Factor Mobility	Common Monetary and Fiscal Policies	One Government
PTA	**No**	**No**	**No**	**No**	**No**
FTA	**Yes**	**No**	**No**	**No**	**No**
CU	**Yes**	**Yes**	**No**	**No**	**No**
CM	**Yes**	**Yes**	**Yes**	**No**	**No**
EU	**Yes**	**Yes**	**Yes**	**Yes**	**No**
PU	Yes	Yes	Yes	Yes	Yes

(Source: Healey, N. M. The Economics of the New Europe: From Community to Union, p.5. 1997).

Some RIAs could be shallow and others could be deep. Shallow integration involves the lowering or removal of barriers to the movement of goods and services across national borders with in the region. Deep integration, on the other hand, involves establishing or expanding the institutional environment in order to facilitate trade and location of production without regard to national borders (DeRosa,A.D., 1997, Healey, N. M., 2002).

Bilateral and regional trade agreements are a feature of a global trading system alongside multilateral trade agreements, the first of which was the General Agreement on Trade and Tariffs (known as GATT). The GATT created a multilateral trading system, which is now promoted by the World Trade Organisation (the WTO), and which has resulted in the removal of trade barriers around the world and the creation of a global marketplace (Lis Brownsell Allen, et al., 2012).

Bilateral and regional trade agreements have become an increasingly prominent feature of international trade over the last two decades. Statistics available on the WTO website show that 205 bilateral and regional trade agreements were in force in July 2007 and by 2010 it is estimated that this number will increase to approximately 400 (Liz Brownsell Allen & Overy 2012).

The proliferation of bilateral and regional trade agreements in recent years has resulted in significant debate as to the effect that "regionalism" will have on the multilateral trading system. There are valid arguments on both sides of the debate but there is also a school of thought that we should not be debating whether or not regionalism is a good or bad thing but instead should be looking at the way that bilateral and regional trade agreements operate and the new economic opportunities arising as a result (Lis Brownsell Allen, et al, 2012).

2.1.3 The development of bilateral and regional trade agreements

The increase in the number of bilateral and regional trade agreements in recent years has occurred despite the existence of the WTO and the multilateral trading system. One explanation for this is that the WTO has become increasingly slow and comparatively ineffective as a means of establishing a system of free trade between countries. As the trade rounds of the WTO have become more liberal and sought to address wider issues, they have also become more lengthy and difficult to conclude, with the last round (the "Uruguay" round) lasting for 8 years (Roberto V., 2006, Lis Brownsell Allen, et al., 2012).

It is perhaps not surprising that decisions required to be made unanimously on numerous issues relating to trade liberalisation often move slowly. It is also not surprising that the requirement for absolute consensus limits how far any trade reform agreements are able to go. There are also many external factors to consider, such as politics and economic growth, all of which have an impact on negotiations. The current difficulties in bringing the "Doha" round to a conclusion are a good illustration of the

slow nature of negotiations under the WTO trade rounds. It is possibly as a result of these limitations on the WTO that bilateral and regional trade agreements have become such a prominent feature in world trade in recent years (Lis Brownsell Allen, et al, 2012).

2.1.4 The impact of bilateral and regional trade agreements on global trade

As bilateral and regional trade agreements have become an increasingly prominent and important trade policy tool there has been a corresponding increase in the amount of literature discussing the impact that these agreements may have on global trade. There has been much discussion about the fact that bilateral and regional trade agreements could have a significantly detrimental impact on the progress of trade liberalisation and that, whilst certain benefits can be seen in the short term, unless care is taken, the long term result could be a complex system of preferential trade moving further away from the concept of multilateralism (Lis Brownsell Allen, et al, 2012).

[…] the promotion of free trade through preferential agreements can foster trade liberalisation and benefit the economic development by integrating developing countries into the world economy; yet the development of complex networks of non- Most Favored Nation (MFN) trade relations will increase discrimination and may well undermine transparency and predictability in international trade relations.

Of particular concern is the complex nature of interlacing bilateral and regional trade agreements and the impact that this structure may have on the developing world. In recent years, bilateral and regional trade agreements have become increasingly sophisticated and they now cover a far wider remit than the multilateral trading system: for example, most bilateral and regional trade agreements address issues relating to competition and intellectual property, which are contentious issues within multilateral trade negotiations. In addition, they are becoming geographically more far reaching; many regional trade agreements are now entered into between several countries from different regions with consistent trade policy aspirations. This suggests that regional

trade agreements are increasingly being used to strengthen political and economic partnerships rather than to simply enhance regional integration.

2.1.5. Trade policy

Developing countries are characterized by a relatively high concentration of exports in primary products, whose prices fluctuate in the world market. This has led to long – run forces that cause deterioration in their commodity terms of trade. However, there are economists (for example, G. Haberler, 1963) who argue that there are still many ways in which international trade can contribute to the development process (Thomas D.Willett. 1982).

Trade strategies can broadly be divided into two groups: outward – oriented and inward – oriented strategies. Some empirical evidence (for example, the study by the World Bank) suggests that outward – looking approach may enhance economic performance in comparison with the inward – looking approach. However, the outward – looking approach is not without difficulties. In general, economists think that the outward – looking approach may help the developing countries to realize positive static and dynamic development effects of trade (Krugman and Obstfeld, 2003).

It is recognized that today's most advanced economies used a range of industrial and trade policy tools during early stages of their development to support emerging industries. The new thinking stresses the complementary roles played by the state and the market. The East and South East Asian experience shows that trade policies cannot be pursued in isolation from broader development strategies. Furthermore, trade policies should be carefully selected, phased, and sequenced to gain the benefits of reform as quickly as possible while minimizing transitional costs and political resistance.

The current most serious problems that confront developing countries are poverty, unsustainable foreign debt, and trade protectionism of developed countries. To overcome these problems, developing countries demanded a New international

Economics Order (NIEO). But, because of the changing circumstances in the world economy, these demands could not be materialized.

In general, many developing countries including Ethiopia are signing up to bilateral and regional trade agreements because the benefits of the reciprocal arrangements are attractive and offer a much faster solution to trade liberalisation than the "Doha" round is currently able to offer. However, the result of the proliferation of bilateral and regional trade agreements is a complex system of overlapping arrangements, which many people fear will have a negative impact on the developing world because it is not equipped to deal with such a high degree of complexity.

Bilateral and regional trade agreements are, by their very nature, discriminatory and there is a concern that many developing countries are signing up to arrangements that may erode over time. The worry, therefore, is that developing countries and small corporations, which are unable to handle this chaotic structure, will lose out in the long run.

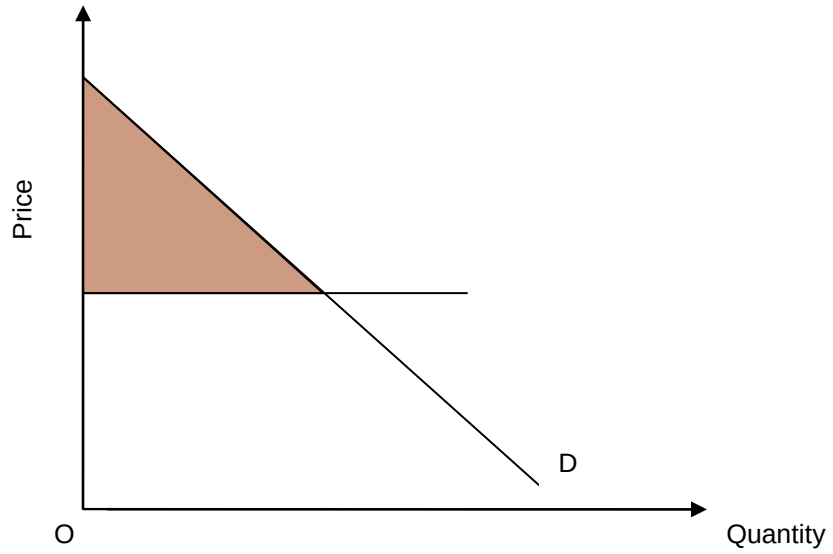
2.1.6. The Effects of a Tariff

It is important to realize that the imposition of a tariff on commodities imported from abroad will affect not only the economy of the country imposing the tariff but will also affect the country's trading partners. Furthermore, one needs to separate the effects of a tariff on consumers from those on producers. In order to analyze the effects of a tariff on consumers and producers, a separate welfare measure is needed for consumers and producers. These separate measures are called consumer and producer surpluses (Dennis R & Alfred.J., 1995).

Consumer surplus is the difference between the price a consumer would be willing to pay for the good and the market price. As market price rises, consumer surplus falls; and as market price falls, consumer surplus increases. Graphically, consumer surplus is

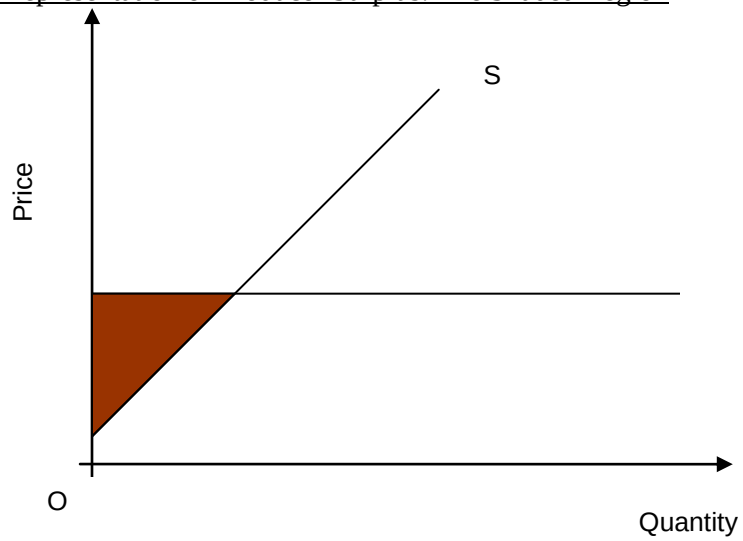
the area bounded by the demand curve from above and the market price from below. On the other hand, producer surplus is the difference between the price at which a good is sold and the minimum price which the seller would be willing to accept for the good. As market price rises, producer surplus increases; and as market price falls, producer surplus decreases. Graphically, producer surplus is the area bounded by the market price from above and the supply curve from below (Dennis R & Alfred.J., 1995).

Figure 1Graphical Representation of Consumer Surplus: The Shaded Region



(Source: Appleyard, Dennis R. and Field, Alfred J. International Economics, 1995, p. 269).

Figure 2 Graphical Representation of Producer Surplus: The Shaded Region



(Source: Appleyard, Dennis R. and Field, Alfred J. International Economics, 1995, p. 269).

2.1.7 Partial Equilibrium Analysis of a Tariff

The effects of an import tariff can be examined by using what is refereed to as partial equilibrium analysis. A partial equilibrium analysis is the situation where the analysis of a policy effect is confined to only one market in isolation of subsequent or secondary effects. This approach is most appropriate when a small (or a price – taker) nation imposes a tariff on imports that compete with the output of a small domestic industry. When the country is small, a tariff that it imposes cannot lower the foreign price of the good it imports. However, the domestic price of the importable commodity will rise by the full amount of the tariff (Dennis R & Alfred.J., 1995).

2.1.8 Theories on Protection and the Role of Lobbying

Who Gets Protected?

As a practical matter, which industries actually get protected from import competition? In recent years, economists have developed several theories regarding which groups and industries get protected. Some of these theories have been empirically confirmed.

There are at least three theories in this regard. In industrial countries, protection is more likely to be provided to labor-intensive industries employing unskilled and low-wage workers who would have great difficulty in finding alternative employment if they lost their present jobs. Some empirical support has also been found for the pressure-group or interest-group theory, which postulates that industries that are highly organized receive more trade protection than less organized industries. An industry is more likely to be organized if it is composed of only a few firms (Dennis R & Alfred.J., 1995).

The second theory argues that more protection seems to go to geographically decentralized industries that employ a large number of workers than to industries that operate in only some regions and employ relatively few workers. The large number of workers has a strong voting power to elect government officials who support protection for the industry. In other words, decentralization ensures that elected officials from many regions support the trade protection. Finally, protection seems to be more easily obtained by those industries that compete with products from developing countries. The argument is that developing countries have less economic and political power than industrial countries to successfully resist trade restrictions against their exports. For example, the most highly protected industries in the United States today are the textile and apparel, the auto industry, and the steel industry (Dennis R & Alfred.J., 1995).

2.1.9 Costs and Benefits of Regional Integration

Starting from the works of Adam Smith and David Ricardo, economic theory tells us that international trade is welfare improving. According to Adam Smith, countries could specialize in the production of commodities which they have absolute advantage than others. Different countries having absolute advantage in the production of different commodities could enter in to exchange and maximize their welfare rather than producing commodities which they lack absolute advantage in production. This theory, however, states that a country should have absolute advantage in the production of at least one commodity to trade with others. It was David Ricardo who corrected this flaw with his comparative advantage theory.

Accordingly, a country does not need to be a least cost producer of a commodity. A lower opportunity cost will help the country to specialize in the production of the commodity and hence can exchange it with others. Regional integration, being part of international trade, was originally supported with this theoretical background. That is, regional integration is believed to be a move towards free trade (Geda A., and Haile K., 2007).

2.2. Empirical Review

2.1.2 Historical Origins of Regional Integration

Cooperation between countries for the mutual benefit of their people dates back to ancient times. The cooperation might be between two countries, also known as bilateral or among many countries, mostly with geographical proximity, which is also known as regional agreement. It might also involve agreements to be applied all over the world. This type of agreement is known as multilateral agreement. Bilateral and regional agreements are discriminatory while multilateralism involves the application of non-discriminatory policies (DeRosa, 1997).

In modern times, regionalism and bilateralism have a longer history than multilateralism. A major agreement taken to be the beginning of regionalism is the Anglo-French commercial treaty of 1860. Accordingly, France abolished all prohibitions and imposed specific duties not exceeding 30 percent of ad valorem while Britain cut the number of dutiable goods from 419 to 48 and reduced the wine tariff (Irwin A.D., 1993). Multilateralism, on the other hand, is a recent phenomenon associated with the formation of General Agreement on Tariffs and Trade (GATT) in 1948 (Solomon L., 2007). GATT‘s main idea is expanding free trade for all countries in the world.

The world has witnessed the flourishing of regional agreements over the past decades (Asante, 1997) while GATT is in trouble regionalism spread worldwide after the formation of the European Economic Community (EEC) in 1957. In this so called first wave of regionalism, many free trade areas and customs union were formed all over the world. In the first wave of regionalism, all regional integration schemes among developing countries were not successful (Lyakurwa et al, 1997). The European Community and FTA was the only successful regional integration scheme.

Many writers attributed the failure of regionalism among developing countries in this period to the policies pursued by the member countries such as import substituting strategy, restriction on factor mobility, and issues related to implementation such as failure to implement reduction in trade barriers, macroeconomic instability, and lack of strong and sustained political commitment.

Despite the absence of economic development that regionalism was expected to bring in developing countries in the first round, regional integration schemes were again revived in the mid 1980s. Many writers believe that this revival amid the disappointing performance is due to the slow progress made in multilateral agreements of GATT negotiations. Regionalism substituted multilateralism (Krugman, 1993). This resurrection of regional integration schemes is called the second wave of regionalism (Asante, 1997).

De Melo et al (1993) argued that the second wave of regionalism differs from the first in two important aspects. First the second wave of regionalism is taking place in an environment of outward oriented policies. As we said above, the first wave of regionalism represented an extension of the import substitution industrialization strategy, which was inward looking. Second, in the first round, developing countries formed regional integration only with other developing countries.

There was no regional integration formed between developing and developed countries. But in the second round of integration, developing countries are forming regional

integration with developed countries. A typical example is the membership of Mexico in North American Free Trade Agreement (NAFTA). Ethio – china economic partnership agreements are also another example or regional integration formed between developed (Asian) and developing (African) countries.

2.2.2 WTO Accession and Preferential Trade Agreements

Ethiopia's accession to the WTO would bring about few changes, at least in the short run, for the Ethiopian private sector, except possibly in some services subsectors. Why, then, should the organized private sector push for WTO accession? Aren't PTA negotiations and regional trade agreements more important?

It is true that preferential trade agreements or the regional agreements have a more important impact on the Ethiopian economy in the short run, because they are likely to require an actual liberalization of Ethiopia's foreign trade regime. However, the impact of WTO accession in the medium and long run should not be underestimated. WTO accession will change the rules of doing business in Ethiopia by strengthening the forces of the market. Competition will gradually increase, which will create both opportunities and risks for the Ethiopian private sector. However, according to analyses the benefits of stronger competition in Ethiopia outweigh the risks, precisely because competition currently is hampered by many factors and the Ethiopian economy does not provide a level playing field for the private sector. This is especially true for Ethiopia's international trade: According to the World Bank's Doing Business indicators, which are based on surveys among private enterprises, Ethiopia is doing particularly badly in the area "Trade across Borders".

Ethiopia's WTO accession will be a catalyst for change and will strengthen the role of the private sector in the economy. This will be the main benefit – not improved market access for Ethiopian goods or cheaper import of inputs.
Finally: does the fact that these changes will be brought about only in the medium and long term justify that the private sector sits back and watches?

The answer is a clear “no”: The conditions of accession are defined now. Therefore, private sector must define its position, and advocate it vis-à-vis Government now. Measures to enhance competitiveness require years to bear fruit.

Therefore, they must be taken now. Regardless of whether WTO accession will take place in five years, in ten years or even later – the negotiation process itself provides a clear signal to the private sector to organise itself and shape its own future. Enhanced competitiveness is vital, and WTO accession may be one of the keys.

Nevertheless, WTO accession negotiations cannot be contemplated without also considering the other negotiation forums. This is because the outcome of WTO accession negotiations will set the floor for all preferential trade agreements. The latter make sense only if liberalisation goes further than commitments vis-à-vis the WTO (i.e. tariff rates are lower, more sectors are opened, etc.).

Therefore, from a defensive point of view it will make sense for Ethiopia not to make too many commitments in its WTO accession package. In this context, the timing of the negotiations becomes important. If FTA negotiations are concluded first, it can be expected that WTO members which are not parties to the signed FTA will push for similar market access conditions. It follows that WTO accession should be prioritized in terms of timing, and FTAs should be concluded thereafter.

Developing countries’ including Ethiopia has suffered from large trade deficit, as imports have grown much faster than exports. Exports of a country are considered as a main pillar of the economy, a source of earnings, and foreign exchange, employment opportunities and ability to achieve strong and sustainable growth for a country. Rising domestic demand due to strong economic growth increased the level of investment which ultimately increased the country’s demand for capital goods and machinery imports. The import bill still remains much larger than exports revenue and Ethiopia experiences an enormous trade deficit. Trade deficits remain a burden on the economy,

despite trade liberalization, primarily removal of barriers, rationalization of tariff structure and reduction in protectionist policies. As the measures were mostly on liberalizing imports rather than promoting exports there may have been a limited stimulus to export performance, hence persistent deficits.

There is a large literature on the possible determinants of export performance distinguishing external and internal factors. The internal factors are associated with supply side conditions. The external factors consist of market access conditions, demand conditions, proximity of international markets, and trade barriers in foreign markets. Relating these factors are transportation cost, location of origin and market destination country and the physical infrastructure of internal and external markets (Venables A., 2000).

Changes in countries' international market access arise due to changes in aggregate import demand from partner countries, especially those that are close. This can be encouraged through regional trade and integration agreements. There are many studies on the effects of preferential trade agreements (i.e., regional and free trade agreements) on export performance and emphasizing the role of PTAs (Preferential trade agreements). However, the results are inconclusive. According to Grossman and Helpman (1995), the establishment of PTA requires the consent of two countries' governments to improve comparative stability in trade between the partner countries.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1. Research Design

A descriptive and causal research design conducted on the bilateral trade agreement between Ethiopia and China. Since Ethio –China bilateral trade is started in 2010; the study is used ERCA dataset of 2010 import and export account and incorporated into recent SAM of 2009/2010.

3.2. Data sources for the model

The main dataset used was 2009/2010 social accounting matrix (SAM) which is developed by the Economic Development Research Institute (EDRI). This SAM includes five agro-ecological zones and a detailed regional disaggregation of household groups.

3.3. The Basic Concept of Social Accounting Matrix (SAM)

Social Accounting Matrix (SAM) is a comprehensive, economy-wide set of accounts that quantify economic flows (incomes and expenditures) in an economy, typically representing the economy of a nation for a given period of time, usually one year (Lofgren et al, 2002). A SAM is a square matrix where the columns represent expenditure and the rows represent receipts.

Each cell shows the payment from the account of its column to the account of its row. The major principle in SAM is double entry accounting which equalizes row total (total revenue) with column total (total expenditure). This reflects the intuition that GDP (the aggregate of the components of expenditure) is equal to value added (the aggregate of the components of income). The fact that these properties are the expression of Walrasian general equilibrium makes the SAM an ideal data base from which to construct a CGE model.

SAM is an important modeling device particularly in studies involving CGE. For this reason, countries are constructing their own SAM. Ethiopia has also been constructing its first comprehensive and own SAM in 2005/2006. The recent of these developed in 2009/2010 by Ethiopian Development Research Institute (EDRI) and Institute of Development Studies (IDS), Sussex. It contains 256 separate accounts.

The major importance of SAM is enabling researchers to conduct economy-wide analysis that trace the impacts of policy changes and shocks emanating from the world economy on the macro economy; the sectoral structure of production, employment, and trade; and on household income and poverty (EDRI, 2009).

SAM is an extension of the input-output (IO) table. The IO table shows the interdependence among various sectors of the economy. Agricultural sector might purchase inputs from the industrial and service sectors while industrial could purchase inputs from service and agricultural sectors. This whole interdependence is captured by the IO table. The IO table also traces the flow of goods and services from one sector of the economy to all other sectors (inter- sectoral flows) and to itself (intra-sectoral flows). In short, the IO table summarizes the income and expenditure flows of industries.

The SAM is an extension of the IO table because it also adds elements which do not exist in the IO table, such as, government, investment and savings, and the rest of the world. These institutions do not exist in the IO table. The SAM is also more disaggregated than the IO table. For example the SAM disaggregates households in to various groups such as poor or rich and urban or rural.

Most SAMs have four major types of accounts: activities, commodities, factors of production, and institutions (households, government and the rest of the world), including an aggregate savings-investment account (EDRI, 2009/2010). The activity account shows the value of commodities (goods and services) produced by each activity and the cost of inputs in to each production activity consisting of intermediate input purchases along with payments to primary factors of production.

Commodity accounts show the components of total supply in value terms (domestic production, imports, indirect taxes and marketing margins) and total demand (intermediate input use, final consumption, investment demand, government consumption and exports). Factor accounts describe the sources of factor income (value added in each production activity) and how these factor payments are further distributed to the various institutions in the economy (households of different types, government and the Rest of World).

Accounts for institutions record all income and expenditures of institutions, including transfers between institutions. Savings of the different institutions and investment expenditures by commodities are given in the savings-investment account.

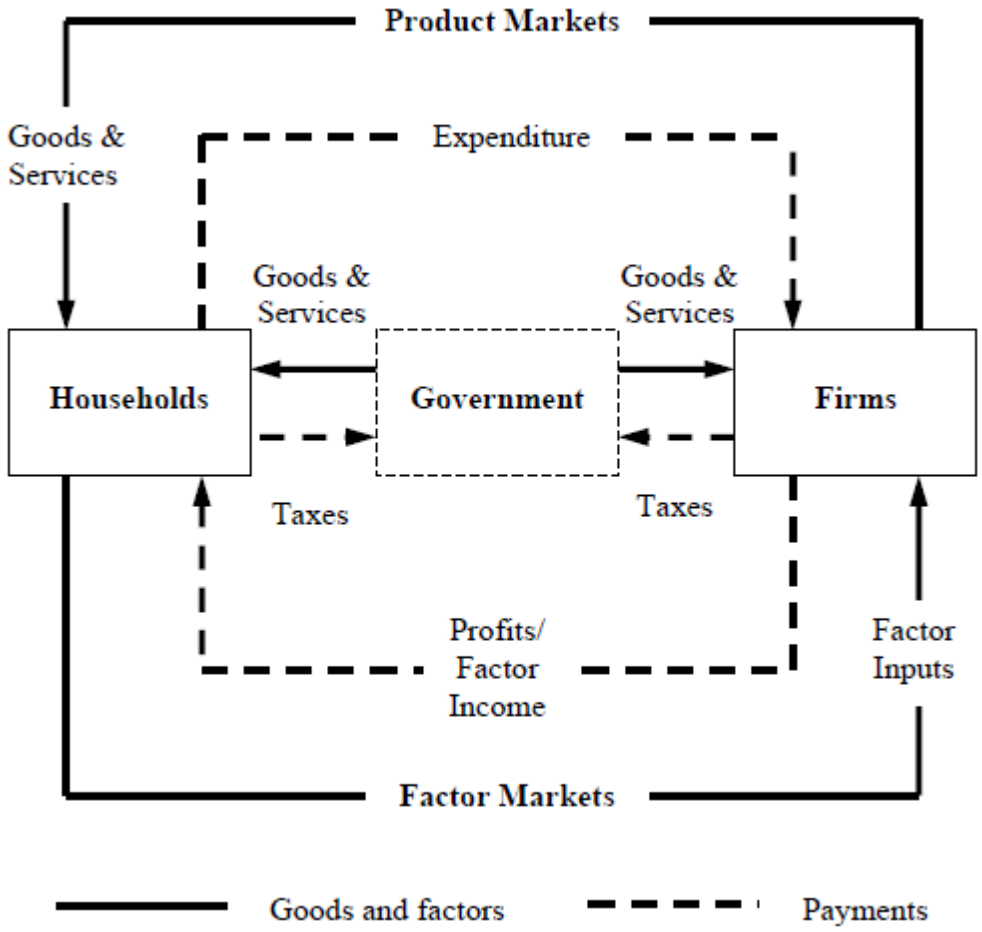
The SAM incorporates the three macro balances: government deficit, trade deficit, and savings-investment balance. The macro balances are expressed as flows - the SAM does not include asset account - and any macro relationship in this framework will be in flow terms. In particular, the savings-investment (S-I) account should be seen as representing the loanable funds market. This account collects savings from various sources (government, private, and foreign) and spends the accumulated savings on capital goods (I). The SAM provides no information about who —owns the capital goods or in which sectors they are installed. Investment demand in the SAM is by sector of origin, not sector of destination, so the SAM cannot provide information about changes in sectoral capital stocks, or their valuation.

3.4. Model selection: Computable General Equilibrium (CGE) Model

Foundations: The Circular Flow and Walrasian Equilibrium:

As the Wing Ian Sue (2004) explained, the fundamental conceptual starting point for a CGE model is the circular flow of commodities in a closed economy, shown in Figure 3. The main actors in the diagram are households, who own the factors of production and are the final consumers of produced commodities, and firms, who rent the factors of production from the households for the purpose of producing goods and services that the households then consume.

Figure 3The Circular flow of commodities



Many CGE models also explicitly represent the government, but its role in the circular flow is often passive: to collect taxes and disburse these revenues to firms and

households as subsidies and lump-sum transfers, subject to rules of budgetary balance that are specified by the analyst. In tracing the circular flow one can start with the supply of factor inputs (e.g. labor and capital services) to the firms and continue to the supply of goods and services from the firms to the households, who in turn control the supply of factor services. One may also begin with payments, which households receive for the services of labor and capital provided to firms by their primary factor endowment, and which are then used as income to pay producing sectors for the goods and services that the households consume.

Equilibrium in the economic flows in above Figure -- results in the conservation of both product and value. Conservation of product, which holds even when the economy is not in equilibrium, reflects the physical principle of material balance that the quantity of a factor with which households are endowed, or of a commodity that is produced by firms, must be completely absorbed by the firms or households (respectively) in the rest of the economy. Conservation of value reflects the accounting principle of budgetary balance that for each activity in the economy the value of expenditures on inputs (i.e., price × quantity) must be balanced by the value of the income that it earns, and that each unit of expenditure has to purchase some amount of some type of commodity. The implication is that neither product nor value can appear out of nowhere: each activity's production or endowment must be matched by others' uses, and each activity's income must be balanced by others' expenditures. Nor can product or value disappear: a transfer of purchasing power can only be effected through an opposing transfer of some positive amount of some produced good or primary factor service, and vice versa (Wing Ian Sue, 2004).

These accounting rules are the cornerstones of Walrasian general equilibrium. Conservation of product, by ensuring that the flows of goods and factors must be absorbed by the production and consumption activities in the economy, is an expression of the principle of no free disposability. It implies that firms' outputs are fully consumed by households, and that households' endowment of primary factors is in turn fully employed by firms. Thus, for a given commodity the quantity produced must equal the

sum of the quantities of that are demanded by the other firms and households in the economy. Analogously, for a given factor the quantities demanded by firms must completely exhaust the aggregate supply endowed to the households. This is the familiar condition of market clearance.

Conservation of value implies that the sum total of revenue from the production of goods must be allocated either to households as receipts for primary factors rentals, to other industries as payments for intermediate inputs, or to the government as taxes. The value of a unit of each commodity in the economy must then equal the sum of the values of all the inputs used to produce it: the cost of the inputs of intermediate materials as well as the payments to the primary factors employed in its production. The principle of conservation of value thus simultaneously reflects constancy of returns to scale in production and perfectly competitive markets for produced commodities. These conditions imply that in equilibrium producers make zero profit (Wing Ian Sue, 2004).

CGE models employ the market clearance, zero profit and income balance conditions to solve simultaneously for the set of prices and the allocation of goods and factors that support general equilibrium. Walrasian equilibrium is defined not by the transaction processes through which this allocation comes about, but by the allocation itself, which is made up of the components of the circular flow shown by solid lines in above Figure 3.

General equilibrium is therefore customarily modeled in terms of barter trade in commodities and factors, without the need to explicitly keep track of (or even represent) the compensating financial transfers. Consequently, it is rare for CGE models to explicitly include money as a commodity. Nevertheless, the relative values of the different commodities and factors still need to be made denominated using some common unit of account. This is accomplished by expressing the simulated flows in terms of the value of one commodity (the so-called numeraire good) whose price is fixed. For this reason, CGE models only solve for relative prices (Wing Ian Sue, 2004).

To study the impact of bilateral trade between Ethiopia and China , the most commonly used approaches in the literature are a set of trade indices, gravity models and Computable general equilibrium (CGE) models.

According to Mikic and Gilbert (2007) Computable general equilibrium (CGE) models are numerical models based on general equilibrium (GE) theory which turn abstract models of general equilibrium theory into a practical tool for policy analysis. A number of features distinguish GE models. They are multi-sectoral, and in many cases multi-regional, and the behavior of economic agents is modeled explicitly through utility and profit maximizing assumptions. In addition, economy-wide constraints are rigorously enforced. In other words, the markets in a CGE model are all linked together.

Distortions in an economic system will often have outcomes far beyond the sector in which they occur. By linking markets, CGE techniques are effective at capturing the relevant feedback and flow-through effects. CGE models have been widely adopted in the bilateral trade policy literature - Scollay and Gilbert (2000), Gilbert and Wahl (2002), Robinson and Thierfelder (2002), Lloyd and MacLaren (2004) and Hertel and Winters (2005). Limitations are uncertainty over parameters, specification, and experimental design, Miss Key features of critical sectors, involves comparative statics.

Analysis of Ethio – China Bilateral preferential agreements involves taking in to account the economy wide effects. The introduction of a single shock will have impact on different activities of the economy. The methodology used to analyze, thus, should be able to take this in to consideration. Computable general equilibrium (CGE) models are used for this purpose.

The standard CGE model explains all of the payments recorded in the SAM (Lofgren et al., 2002, p.11). The disaggregation in the CGE is similar with the disaggregation in SAM. The CGE model is a set of mainly non-linear simultaneous equations. For the overall model, there is no objective function. The non-linear equations define the behavior of different economic agents, such as, maximization of profit for producers and

maximization of utility for consumers. The equations also include a set of constraints that have to be satisfied by the system as a whole but are not necessarily considered by any individual actor. These constraints cover markets (for factors and commodities) and macroeconomic aggregates (balances for Savings- Investment, the government, and the current account of the rest of the world).

CGE models are broadly divided in to two: static and dynamic. Static CGE models show one time effects of policy changes. Despite their simplicity advantage, static CGE models are unable to account for growth or second round effects (Annabi et al., 2004, and Thurlow, 2004). For example, the impact of changes in current investment on future capital is not taken in to consideration in static CGE models (Thurlow, 2004).

Dynamic CGE models are developed to solve this problem. Dynamic CGE models are again divided in to two: truly dynamic (intertemporal) and sequential dynamic (recursive) models (Annabi N., 2004). The basic difference between the two is the assumption on economic agents: truly dynamic models assume economic agents have perfect foresight about the future, which means they know all about the future and react to future changes in prices, while recursive dynamic CGE model assumes adaptive expectations, where economic agents are assumed to be myopic.

A recursive dynamic CGE model is a series of static CGE models that are linked between periods by an exogenous and endogenous variable updating procedure. (Ibid) capital stock is updated endogenously depending on previous outcomes while population growth and technological changes are exogenously updated. Since the recursive dynamic CGE model is a series of static CGE models, we can have both the within period (one period static) component, and the between periods (dynamic) component.

3.5. Model Specification: The Within period Specification

As Lofgren Hans and Carolina Diaz-Bonilla (2006) explained detail of CGE with equations, the Within-period module defines a one-period, static CGE model. It is divided into blocks covering prices, production and trade, domestic institutions, investments, and system constraints and macro variables. The price system of the model is extensive, especially for commodities.

Price Block

In the CGE model, we have many prices, primarily because of the assumed quality differences among commodities of different origins and destinations (exports, imports, and domestic outputs used domestically). The price block (Annex: Equations 1 -11) defines prices that can be expressed as functions of other endogenous variables. Among these prices, it is worth noting that transaction costs (the cost of moving the commodity between the border and the demanders or suppliers or between domestic demanders and suppliers) are accounted for in the definitions of demander (domestic – currency) import prices, supplier (domestic – currency) export prices and demander prices for domestic output sold domestically (Annex: Equations 1, 2, and 4).

Production and Trade Block

The production and trade block (Annex: Equations 12 -29) includes the first-order conditions for profit-maximizing production and transformation decisions as well as cost-minimizing domestic demand decisions. Given available technology and marker prices, producers maximize profits.

Producers are assumed to maximize profit subject to the production technology. Accordingly, five factors of production are specified: unskilled labor, skilled labor, semiskilled labor, capital and land. Producers in the model maximize profit subject to constant returns to scale, with the choice between factors being governed by a constant elasticity of substitution (CES) function. CES allows smooth substitution between

available factors so as to derive a final value added composite. Profit maximization implies that the factors receive income where marginal revenue equals marginal cost based on endogenous relative prices. Once determined, these factors are combined with fixed-share intermediates using a Leontief specification. 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. The final price of an activity‘s output is derived from the price of value-added and intermediates, together with any producer taxes or subsidies that may be imposed by the government per unit of output (Lofgren H and Carolina D.B., 2006).

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. Fixed-shares govern the disaggregation of activity output into commodities since it is assumed that technology largely determines the production of secondary products. These commodities are supplied to the market.

Institutional Block

The domestic institution block (Annex: Equations 30 – 45) accounts for the receipts and expenditures of all domestic institutions, both government and non-government (households) as well as selected payment flows to and from the rest of the worlds. The equations are structured to accommodate databases with any number of households, one government, and one entity representing the rest of the world.

The model has households and the government as domestic institutions. The households are divided in to rural and urban as well as poor and rich. The main sources of income for households are factor returns generated through production. Capital and skilled labor are assumed to be activity specific and fully employed. This implies that

these factors are immobile and will earn sector specific returns. Semiskilled labor and land are fully employed but mobile across sectors. This implies their returns are not sector specific. Full employment assumption leaves the amount of the factors to be fixed. Unskilled labor, on the other hand, is mobile but unemployed. Its amount will not be fixed.

The investment block

The investment block (Annex: Equations 46-55) defines the transformation of savings into different types of investments, including adjustment for financial transaction (some of which involve the rest of the world) and foreign direct investment. The prices of new capital stock depend on their composition and market prices (Equation 46). Government fixed investment spending is defined on the basis of these prices and real government fixed investment demand (Equation 47)

System Constraint Block and Macro block

The system constraint and macro block (Annex: Equations 56 - 62) explicitly captures the over-all resource constraints under which the economy operates as well as the determinants of TFP (total factor productivity) in the different production activities. For each market factor (all factors except government capital stocks), the supply is defined as the sum of institutional endowments (Equation 56).

System constraint deals with the mechanisms where equilibrium is attained both in goods market and factor market. Equilibrium in the goods market is achieved by the equality of demand for goods and supply of goods. Demand is the sum of private consumption, investment spending, government consumption, exports as well as transaction demand. Supply, on the other hand, is the sum of domestic production and imported commodities.

Equilibrium is attained through the endogenous interaction of domestic and foreign prices, and the effect that shifts in relative prices have on sectoral production and employment, and hence institutional incomes and demand.

Factor market equilibrium is brought by the equality of factor demand and factor supply. The equilibrium is highly dependent on how the relationship between factor supply and wages is defined. We assumed capital and skilled labor to be fully employed and sector-specific, implying that sector-specific wages adjust to ensure that demand for capital and skilled labor equals total supply. Unemployment amongst unskilled labour is assumed to be sufficiently large such that wages are fixed in real terms and supply passively adjusts to match demand.

Macro closure

The model includes has three macroeconomic accounts: the current account, the government balance, and the savings and investment account. The following assumptions, commonly called macroclosure rules in CGE, are necessary to bring equilibrium in different macro accounts.

For the current account, flexible exchange rate adjusts in order to maintain a fixed level of foreign borrowing. This is found to be appropriate as Ethiopia follows a flexible exchange rate system.

In the government account the level of direct and indirect tax rates, as well as real government consumption, are held constant. As such the balance on the government budget is assumed to adjust to ensure that public expenditures equal receipts. This closure is chosen since it is assumed that changes in direct and indirect tax rates are politically motivated and thus are adopted in isolation of changes in other policies or the economic environment.

For the savings-investment account, closure rule used by Dorosh and Thurlow (2009) is used. This means, real investment adjusts to changes in savings. Thus, we have saving driven investment, where saving is assumed to be fixed.

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

Between-period Specification

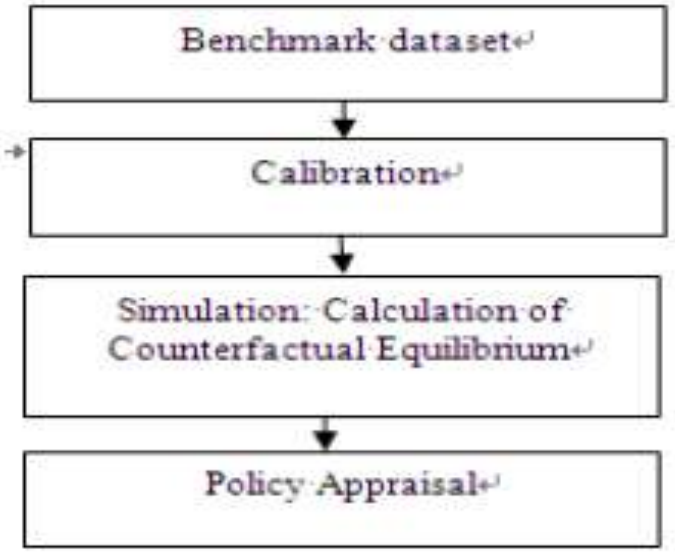
The equations in the between-period module update household populations and institutional stocks of assets and liabilities and TFP for selected activities. The equations in this module do no apply to the first year, for which the values of the variables defined in this module are fixed (Lofgren H. and Carolina D.B., 2006).

The between period specification represents the dynamics of the model (Annex: Equations 63-76). Some variables are adjusted endogenously while others exogenously. The process of capital accumulation is modeled endogenously, with the previous-period investment generating new capital stock for the subsequent period. The model also takes exogenous population growth in to account.

3.6. How Does a CGE Model Work?

In studying the possible impacts of a certain change in trade policy on the economy, once can use a static CGE model. The counterfactual experiment widely used in the CGE simulation, according to Kehoe P and T Kehoe (1994), is the empirical analogy of the comparative-static analysis used in theoretical work. This is shown in figure 4 which summarizes the main steps involved in constructing and using CGE models.

Figure 4 Flowchart of CGE Modeling



Source: Based on Shoven and Whalley (1984, p.1019).

The procedure as explained by Petersen (1997, p.4) is as follows: Begin the experiment with an assumption that the economy under study is in equilibrium in the presence of an existing policy regime and for the dataset in a chosen year. This dataset is considered the benchmark dataset. Using that data, parameter values are chosen so that the model will replicate this benchmark equilibrium through a model solution (called calibration). This "benchmark" or "observed" equilibrium dataset serves as the point of comparison for counterfactual-equilibrium analysis of any hypothetical policy change.

The second step is to then simulate the policy change by altering the relevant policy parameters and calculating the new counterfactual equilibrium. This approach allows the researcher to predict what would have happened if the policy change had actually been made.

Choosing Functional Forms

Shoven and Whalley (1984, pp.1017-1018) argue that the selection of appropriate demand and production functions in CGE models requires that they be consistent with theory and at the same time be analytically tractable. The first constraint involves choosing functions that satisfy restrictions such as the Walras' Law for demand functions. The second requires that the demand and supply responses of the economy be reasonably easy to evaluate. This largely explains why most research done in this area often uses functional forms like Cobb- Douglas, Constant Elasticity of Substitution (CES), Linear Expenditure System (LES) among others.

The choice of a specific functional form, according to Shoven and Whalley (1984, p.1018) typically depends on how the researcher will use elasticities in the model. This point is best illustrated by considering the demand side of these models. For example, demands derived from Cobb- Douglas utility functions ($x_i = \alpha_i m/p_i$) are easy to work with, but have the restrictions of unitary income elasticity ($\eta_m = 1$), unitary uncompensated own-price elasticities ($\eta_i = 1$), and zero cross-price elasticities. These restrictions are generally implausible, given empirical estimates of such elasticities estimated in the literature. That's why CGE models usually make use of more general functional forms like CES functions. Obviously, the normal approach is to select the functional form that best allows key parameter values like income and price elasticities to be accurately incorporated while allowing for tractability.

Choosing Behavioral Elasticities

After all information about the expenditures and revenues and the interactions of all agents have been included into a SAM, the modeler needs to provide the value of the exogenous parameters (called behavioral parameters) that characterize the behavior of producers and consumers. According to Piermartini and Teh (2005, p.19), there are at least three types of behavioral parameters which are needed.

First are the elasticities of substitution in value added which govern the substitutability of the primary factors of production. Second, are the Armington elasticities which determine the substitutability of the domestic vs. the imported products. Third, are the demand and income elasticities of the households.

Calibration

Calibration, as mentioned earlier, is the process of selecting the parameter values. As presented in figure (4), the economy is assumed to be in equilibrium, the so-called "benchmark" equilibrium. The next step is to choose the parameters of the model such that the model can reproduce this data set as an equilibrium solution. According to Shoven and Whalley (1984, p.1018), if CES or LES functions are to be used in the model, then exogenously specified elasticity values, which are usually based on previous literature estimates, are required in this procedure because the benchmark data only give price and quantity observations associated with a single equilibrium. On the demand side, for instance, only the slope of the budget constraints at the equilibrium consumption quantities is given by the benchmark data. The parameter values thus generated can then be used to solve for the alternative equilibrium associated with any changed policy regime. These are usually termed counterfactual equilibria.

Bohringer, Rutherford, and Wiegard (2003, p.5) argue that the researcher should conduct a consistency check that must necessarily hold before proceeding with policy analysis and that is the replication of the initial benchmark. In other words, the calibrated model must be capable of generating the base-year (benchmark) equilibrium.

Counterfactual Equilibrium

As presented in figure 4, once the calibration procedure is completed, a fully specified numerical model will be available and can now be used for studying the impacts of different policy changes. Therefore, one can start doing counterfactual experiments. This is basically asking the question what would happen to the equilibrium if...?, and

thus the name counterfactual experiments. As indicated in Figure 3, following a policy change, a counterfactual equilibrium is computed for the new policy regime, and policy appraisal can be made by comparing the counterfactual to the benchmark equilibrium.

In the case of trade effects, one could ask the questions what would happen if the country at hand changes its trade policy. For example, what would happen if the country engages in unilateral trade liberalization, enters a new customs union, or reduces tariffs under a multilateral tariff reduction scheme.

3.7. Measuring Welfare in CGE Models

After calculating the counterfactual equilibrium, one can use comparative statics to compare welfare both before and after a trade policy change to arrive at policy conclusions. Different welfare measures have been proposed, but the most commonly used according to Shoven and Whalley (1984, p.1021) are Equivalent variation (EV) and Compensating variation (CV).

Equivalent Variation uses current prices as the base, and asks what income change at the current prices would be equivalent to the proposed change in terms of its impact on utility. In other words, EV shows how much additional money is needed at the original prices to make the consumer as well off as he would be facing the new prices. In terms of a tariff removal, Piermartini and Teh (2005, p.14) explain EV as the amount of income, measured in current prices, that consumers would be willing to forego and still have the same level of well-being as before the tariff was removed.

Compensating Variation, on the other hand, uses new prices as the base, and asks what income change would be necessary to compensate the consumer for the price change. In other words, CV shows how much money should be given to the consumer to leave him as well off as he was facing the old prices. Another possible measure of interest to policy makers is distributional effects of a policy change. One can look at

differences between benchmark and counterfactual equilibria to evaluate income distribution effects; whether labor gains against property owners. Shoven and Whalley (1984,p.1022) argue that distributional effects from CGE models can be examined using the Lorenz curve, or the Gini coefficient. They further argue that one can examine changes in relative prices, changes in the use of factors of production across industries. Also, specifically for international trade models, one can examine changes in the country's terms of trade.

3.8. Scenarios Approaches

Data from Ethiopian Revenue and custom author (ERCA) of 2010 were used for SAM dataset. The process of selecting appropriate dataset where as follow:

1) Import and export data set of 2010 were retrieved from ERCA database.
2) Using HS Code and HS Description, goods were classified into 53 sectors.
3) Total value of import (C.I.F) and export (F.O.B) goods where collected.
5) China`s import and export value was separated.
6) ROW`s import and export value was also separated.
7) The share of import and export were calculated for china and ROW.
7) An absolute share value were entered into Social Accounting Matrix (SAM) 2009/2010 based on 53 sectors.
8) Checked SAM equilibrium (row and column) total value that equate SAM total value with sum of china and ROW share value.
9) Design CGE model specification and develop its own syntax.
10) Calibration procedure was done and system check up was done.

Simulation types:

Simulation 0: This assumes that the status quo continues. That is, no Bilateral trade for any product at all. In CGE terminology, this is known as the baseline simulation and used 2010 SAM as baseline.

Simulation 1: "What if" when gradual removal of tariff, liberalization, for all products. Since the simulation runs for 4 years between 2016 and 2019, a yearly 25% tariff removal on all products is considered i.e. 25% in 2016, 50% in 2017, 75% in 2018, 100% in 2019. This simulation is considered because it might be difficult to eliminate all tariffs at one time. The government might be afraid of the revenue loss and other impacts which the tariff removal will bring. Under this circumstance, it might resort to gradual removal of tariff.

Simulation 2: "What if" when one time complete abolishment of tariff in the year 2016 for all products. Even if this seems unlikely in the real world, it will help for comparison to other simulations. Particularly, it will help us see the impact that protecting the above sectors will have on the economy.

Simulation 3: "What if "when a complete abolishment of tariff in the year 2016 for all products except textile, cloth and leather which are considered by the government as strategic sectors. This type of simulation considers the case where the country decides to join the free trade or regional integration at one time but discriminating products. Countries usually have sectors which they believe are pillars of the economy. That is, they plan to give emphasis for some sectors. The form of the emphasis given might vary but usually it involves protecting those industries from external competition. To make these sectors competitive, import tariff will be levied on same commodities which these sectors could produce but are imported from outside. In the Ethiopian case, it is clearly explained in the Growth and Transformation Plan (GTP II) that the above sectors will receive special support similar with GTP I. Textile and apparel products, clothes, and leather and leather products are included in the list. So, we avoided these sectors from the simulation.

3.9. Limitations of the Model

Thurlow (2004) identifies the following as the major limitations of the CGE model. First, CGE models depend on Walrasian equilibrium which assumes market clearance. However, certain institutional and structural factors might bring rigidities resulting imbalance between supply and demand. Of course, in this paper we tried to incorporate rigidities in the model. Capital and skilled labor are assumed to be activity specific, which implies they are immobile. We also assume unskilled labor to be unemployed.

Second, the use of recursive dynamic CGE model is also a deviation from the truly dynamic CGE model which assumes perfect foresight rather than adaptive expectations assumption. Despite its deviation, the model however applies for countries like Ethiopia where economic agents lack perfect foresight.

Third, the model assumes that there is no interaction between monetary and real sectors. The use of a numeraire and the lack of an explicitly modeled monetary sector imply that the model is essentially one of a barter economy in which money is neutral.

CHAPTER FOUR: RESULT AND DISCUSSION

4.1. Descriptive Review of Ethio – China Bilateral Trade

The volume of trade between China and Ethiopia

In 2010, study baseline, Ethiopia was imported commodities from globe where petroleum is registered as the highest imported good (16%), and the rest electricity (12%), electronic equipment (11.24%), and chemicals (9.58%). Similarly, the major commodity imported from China includes electricity (34.5%), electrical equipment (17.4%), metal and products (15.5%), textile (9.2%), other manufacturing (8.2%), vehicle and transport equipment (5.0%), chemical (3.0%) and clothes (2.8%). Ethiopia exported to china in 2010, baseline simulation, oilseeds (81%) was registered highest of all commodities followed by leather product (6.0%0 and other mining (5.01%) and chat (2.7%).Ethiopia`s trade share of import and export during the same year is 23.5% and 11.3% respectively (see Annex 1).

Ethiopia`s exports to China have been observed to have steadily increased over time although not diversified with amount (Figure 7 and Table 2). This is because of Ethiopia has been benefiting from the tariff and quota free preferential market access granted by China (Wudeneh Z., 2010, p.2). The result further reminded us China Africa partnership whereby china's grant of preferential treatment through duty and quota free preferential market access has progressively grown (Eight Steps to Boost China -Africa Partnership, 2007) by way of increasing 190 to 440 the number of export items China has been receiving. China has also taken initiatives during the 3rd CACOF Forum that allows Ethiopia to export over 95 % of its products into Chinese market free of duty and quota limitations (Xinhua News Agency 2007).

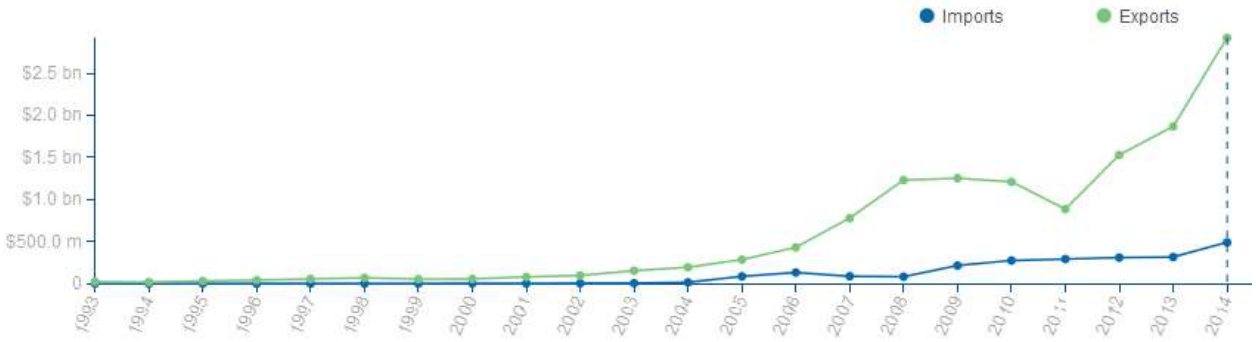
Table 2Bilateral trade between Ethiopia and China

Year	Country	Export	Import	Trade balance	Bilateral trade
2014	Ethiopia	$533.2 m	$5.8 bn	-$5.3 bn	$6.3 bn
	China	$2.9 bn	$489.9 m	$2.4 bn	$3.4 bn
2013	Ethiopia	$329.1 m	$3.2 bn	-$2.9 bn	$3.6 bn
	China	$1.9 bn	$315.7m	$1.6bn	$2.2 bn
2012	Ethiopia	$320.9 m	$2.6 bn	-$2.3bn	$2.9 bn
	China	$1.5 bn	$309.4 m	$1.2 bn	$1.8 bn
2011	Ethiopia	$283.4m	$1.7 bn	-$1.4bn	$2.0 bn
	China	$885.4 m	$292.1 m	$593.3 m	$1.2 bn
2010	Ethiopia	$241.8 m	$2.1bn	-$1.8bn	$2.3bn
	China	$1.2 bn	$274.0 m	$935.6 bn	$1.5 bn

(Source: UN Comtrade, 2010 – 2014).

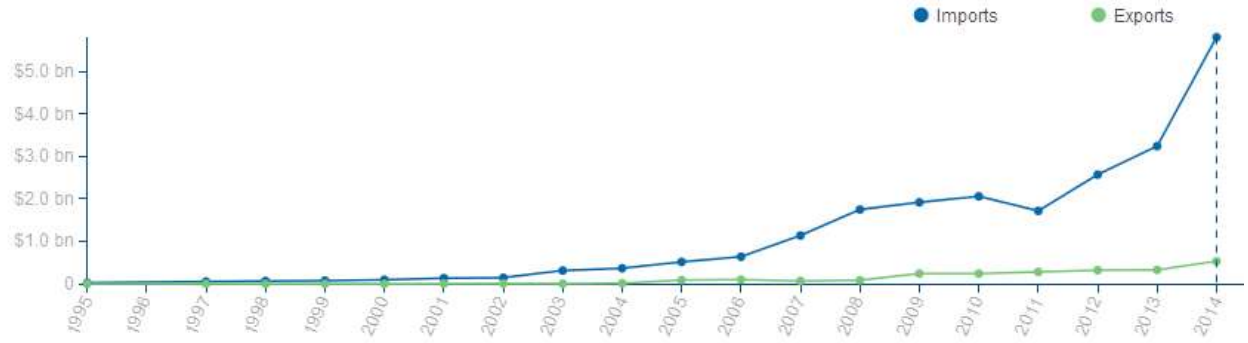
As depicted above table 2, the bilateral trade has been increasing year to year of $2.3 to $6.3bn of 2010 and 2014 respectively. This finding has also supported by Figure 5 and 6 below.

Figure 5 China **trade in goods with** Ethiopia **in** 2014 since 1993



(Source: UN Comtrade, 1993 – 2014).

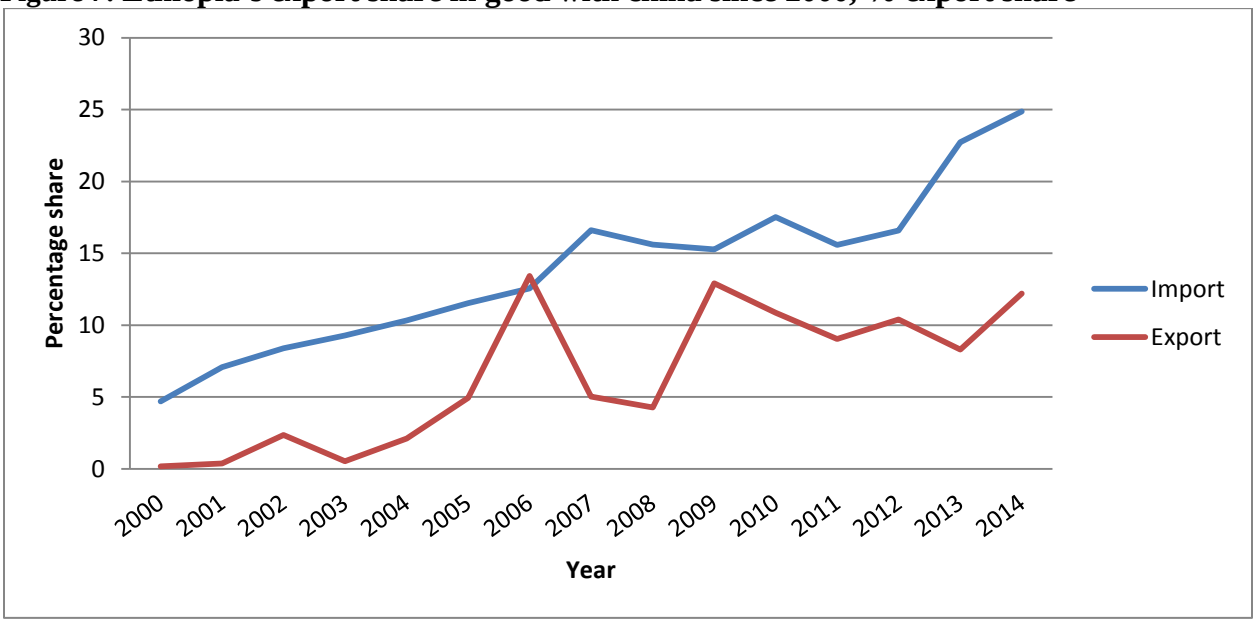
Figure 6 Ethiopia **trade in goods with** China **in** 2014 since 1995,



(Source: UN Comtrade, 1995 – 2014).

On average since 2000 to 2014 Ethiopia`s export increased 6.4% annually and the highest export registered was 2014 of 12.2%. Similarly, the import from china is increased by 13.9% annually and the highest, 24.8%, is recorded in 2014 (figure 7).

Figure 7: Ethiopia`s export share in good with china since 2000, % export share

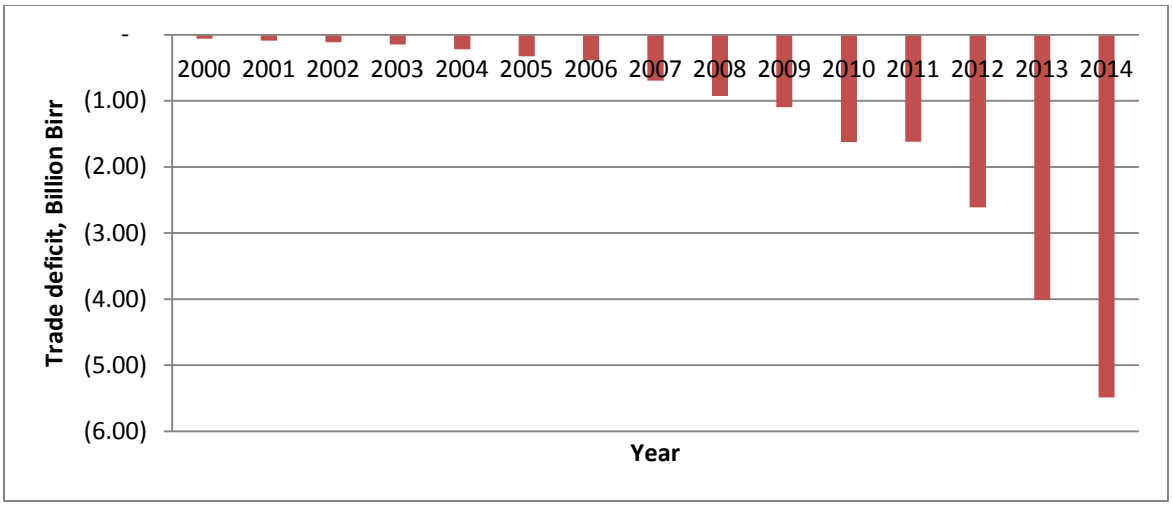


(source: Ethiopian Customs Authority , NBE, 2000 – 2014).

Balance of trade

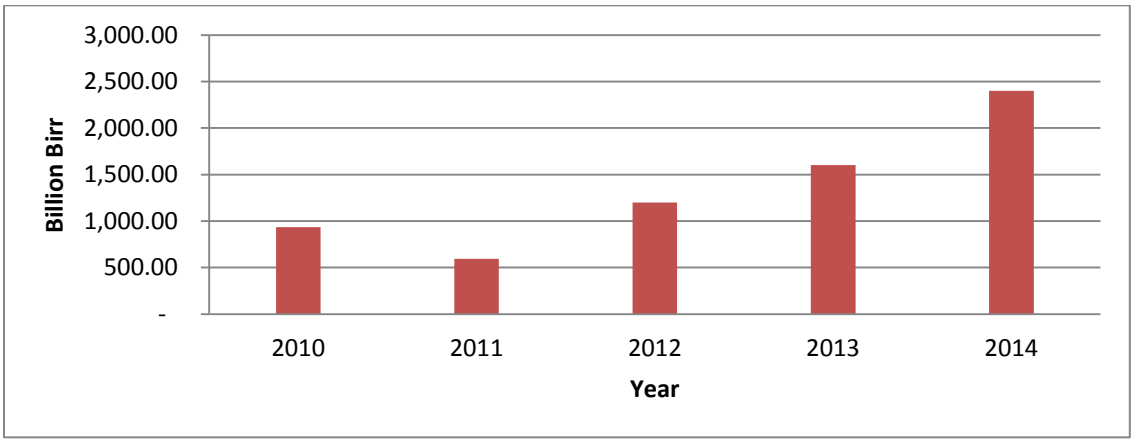
The central point of concern is whether the countries enjoy positive trade balance or not. Ethiopia was reported to have recorded a trade deficit of 54. 8 Million Birr of 2014, figure 8. Ethiopia's balance of trade has been in deficits due to its limited export largely owing to the limited nature of products exported to China. Moreover Ethiopia is a net importer of fuel and machineries. The figure 8 below clearly indicate the balance of trade of both countries, showing that Ethiopia's trade balance is in the negatives while that of China is overwhelmingly on the positives side.

Figure 8 Ethiopia trade balance with China



(Source: NBE, 2000- 2014)

Figure 9 China trade Balance with Ethiopia



(Source: NBE, 2010- 2014)

4.2. Model Simulation result

Data from Ethiopian Revenue and custom authority (ERCA) of 2010 were used for SAM dataset and set as baseline simulation. The study was conducted and simulations were done by considering only tariff barriers, four simulations are considered.

Simulation 0: This assumes that the status quo continues. That is, no Bilateral trade for any product at all. In CGE terminology, this is known as the baseline simulation and used 2010 SAM as baseline.

Simulation 1: "What if" when gradual removal of tariff, liberalization, for all products. Since the simulation runs for 4 years between 2016 and 2019, a yearly 25% tariff removal on all products is considered i.e. 25% in 2016, 50% in 2017, 75% in 2018, 100% in 2019. This simulation is considered because it might be difficult to eliminate all tariffs at one time. The government might be afraid of the revenue loss and other impacts which the tariff removal will bring. Under this circumstance, it might resort to gradual removal of tariff.

Simulation 2: "What if" when one time complete abolishment of tariff in the year 2016 for all products. Even if this seems unlikely in the real world, it will help for comparison to other simulations. Particularly, it will help us see the impact that protecting the above sectors will have on the economy.

Simulation 3: "What if "when a complete abolishment of tariff in the year 2016 for all products except textile, cloth and leather which are considered by the government as strategic sectors. Countries usually have sectors which they believe are pillars of the economy. That is, they plan to give emphasis for some sectors. The form of the emphasis given might vary but usually it involves protecting those industries from external competition. This type of simulation considers the case where the country decides to join the free trade or regional integration at one time but discriminating products. To make these sectors competitive, import tariff will be levied on same

commodities which these sectors could produce but are imported from outside. In the Ethiopian case, it is clearly explained in the Growth and Transformation Plan (GTP II) that the above sectors will receive special support similar with GTP I. Textile and apparel products, clothes, and leather and leather products are included in the list. So, we avoided these sectors from the simulation.

The global Picture: Macro analysis

Removal of all tariffs at gradual level and abolish at one time the GDP is increased for all simulations compared to baseline. It has two variables: GDP at factor cost (GDPFC2) and GDP at market prices (GDPM2). PRVCON is private consumption, ABSORP is absorption, FIXINV is fixed investment, and GOVCON is government consumption.

Table 3 Impact on Selected Macro Variables (% change of real values)

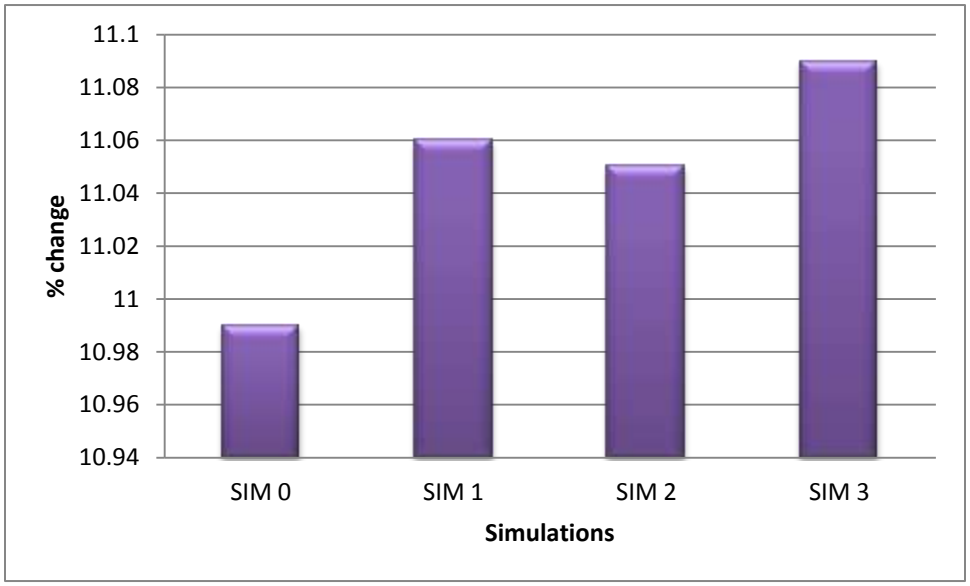
Macro variables	INITIAL	SIM 0	SIM 1	SIM 2	SIM 3
ABSORP	457.74	8.5	8.57	8.57	8.54
PRVCON	338.61	7.47	7.68	7.72	7.58
FIXINV	85.49	10.37	10.03	9.91	10.2
GOVCON	31.82	12.99	12.99	12.99	12.99
EXPORTS	52.14	18.47	19.21	19.37	18.89
IMPORTS	-126.51	12.11	12.61	12.72	12.39
GDPMP2	383.36	9.17	9.25	9.26	9.22
GDPFC2	354.95	9.96	10.12	10.15	10.02

(Source: CGE Simulation result and own analysis)

As shown in table 3 the growth path of both GDPFC2 and GDPMP2 have increased in all the simulations compared from baseline. The highest growths for both are registered, however, under simulation 2 i.e. the growth path is the highest when Ethiopia removes the tariff rate for all products at one time. The growth in GDP might be explained by the increase in private consumption and disaggregated activity production levels (QATABPY). The trend in total disaggregated activity production level is shown below,

figure 10. The growth of both GDP and disaggregated activity production levels increase in all simulations compared with baseline.

Figure 10 Disaggregated Activity Production Levels (QATABPY)



(Source: CGE Simulation result and own analysis)

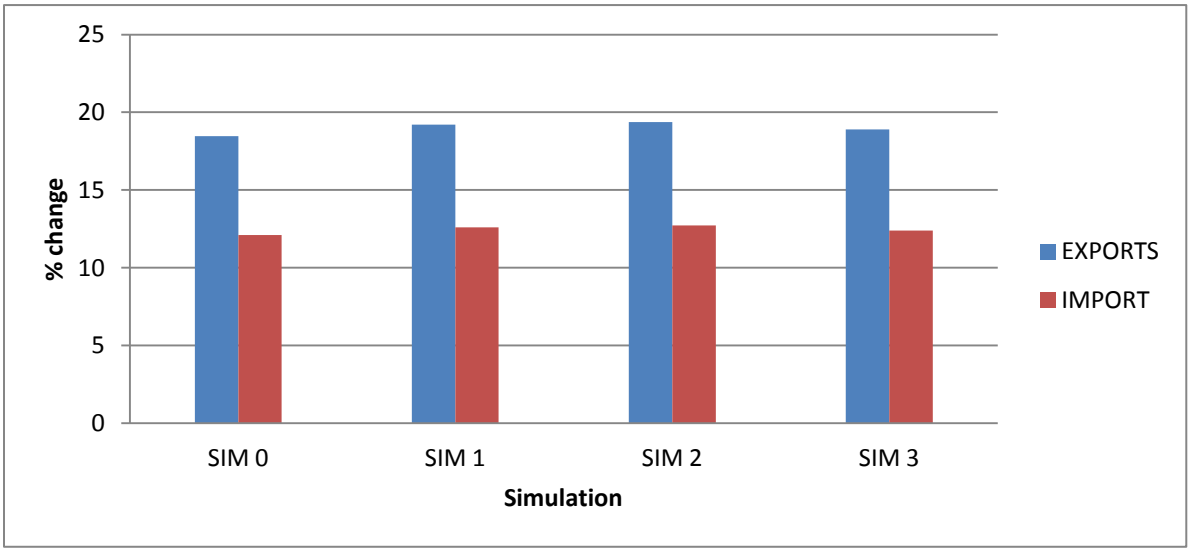
Private consumption is the largest component of aggregate demand. According to Keynesian analysis, where demand derives supply, increase in expenditure will lead to an increase in GDP. The increase in GDP could not be because of the increase in investment because our results show that investment itself decreases from baseline.

Direction of Trade

On figure11, as economic theory explained importing capital goods leads to increase export though domestic industry get imported goods at lower tariff or zero tariff. Trade surplus is the results of outweighed export grow faster than import in the long run. Tariff removal reduces the price of imports, and as a result, there is a higher demand for imports. The increase in exports might be because of the increase in GDP and import of capital goods. This will increase the production capacity of the country, leading to an increase in exports.

The increase in exports, however, is greater than the increase in imports. This leads to an improvement in trade balance

Figure 11 Direction of trade



(Source: CGE Simulation result and own analysis)

In all the three simulations, the increase in exports is greater than the increase in imports. The impact of bilateral trade across commodities depends on whether the commodity is traded or not. Particularly, the regional preferential trade agreement decreases the prices of commodities imported while the price of commodities that are not imported will increase.

The main exports and imports of the country as of 2009/2010 are given in the Annex 1 & 2. The main imports goods from world to Ethiopia are Electricity, electrical equipments, petroleum, chemical, metal and products and vehicles and transport.
Similarly Ethiopia import from trading partner i.e. China are electricity, metal & product, electrical equipments, other manufacturing and textiles.

The main exports of Ethiopia to world, on the other hand, are primary agricultural products such as coffee, oilseeds, chat, flowers, metals and products and leather products. Our major imports are very essential products for production. Similarly

Ethiopia exports to China are oilseeds, leather product, other mining, chat, cotton, and other foods processing.

Table 4 Price of import (% change)

	SIM 0	SIM 1	SIM 2	SIM 3
sectors				
Agriculture	-4.41024	-4.56517	-4.62949	-4.54608
Industry	-4.43943	-4.91714	-5.01999	-4.70862
Service	-3.66084	-3.74654	-3.76754	-3.63839

(Source: CGE Simulation result and own analysis)

As can be seen from the table 4 above, the price of imports from China decreases. This will make imports from China cheaper. Quantity of imports coming from China will increase in all simulations as compared from baseline (Annex 3, Table5). For example, in simulation 1, imports of agriculture from china increased from 11.55 % to 11.75 % (SIM 3). Imports from china, on the other hand, increased from 11.55 to 11.82 (SIM 2). The impact of bilateral trade on quantity of imports is also different among sectors.

The price reduction effect on china imports is significant in the industrial sector. Besides the reduction in the price of industrial products from china is higher in simulations 2 and 1, where there is no protection for strategic sectors. The significance of the impact on industrial sector is because of the tradable nature of the commodities. Most of Ethiopia‘s imports are industrial products.

Table 5 Quantity of import (% change)

	INITIAL	SIM 0	SIM 1	SIM 2	SIM 3
sectors					
Agriculture	6.902222	11.55556	11.78778	11.82722	11.75056
Industry	4.208	11.37	12.4112	12.592	11.8224
Service	5.198333	11.42	11.72	11.78167	11.56333

(Source: CGE Simulation result and own analysis)

The price of textile, cloth and leather depends on our simulation: whether we included them in the bilateral no tariff. If they are included in the BTA, their price will decrease (-6.61 and -7.11) respectively. See the table on price of imports (PMXPY) in the annex 4 for simulations 2 and 3. But if they are excluded from the BTA, their price will not decrease (-4.372 and 4.377) respectively. See the table on price of imports (PMXPY) for simulations 1 and 2 (Annex 4). This implies that the government could protect its strategic sectors by imposing tariff on imports of the same commodity.

Government Revenue

Tariff revenue is an element of tax. Tax is an important part of government revenue. If the two countries agreed to remove of tariff, it leads to the decrease in government revenue. Our simulation results also show this. In the table and figure below, we compare simulations 1 to 3 to the baseline simulation (Simulation 0). Up to 2016, government revenue is the same for all as the simulation are not imposed. In 2016, the value of government revenue is different for all the simulation.

In the baseline, the government revenue is the highest as compared to other simulation results. This simply implies the different simulation which involve tariff removal have led to decrease in government revenue. We can use both the table and the figure to see which of the simulations have led to the highest decrease in government revenue.

Accordingly, up to 2019, simulation 1 has led to the lowest decrease in government revenue compared with SIM 0. The highest decrease in government revenue is brought by simulation 2 which is one time complete abolishment of tariff in the year 2016 for all products and SIM 3 removal of tariff except sensitive sectors. That means for the coming four years, including 2016, there will be no tariff revenue.

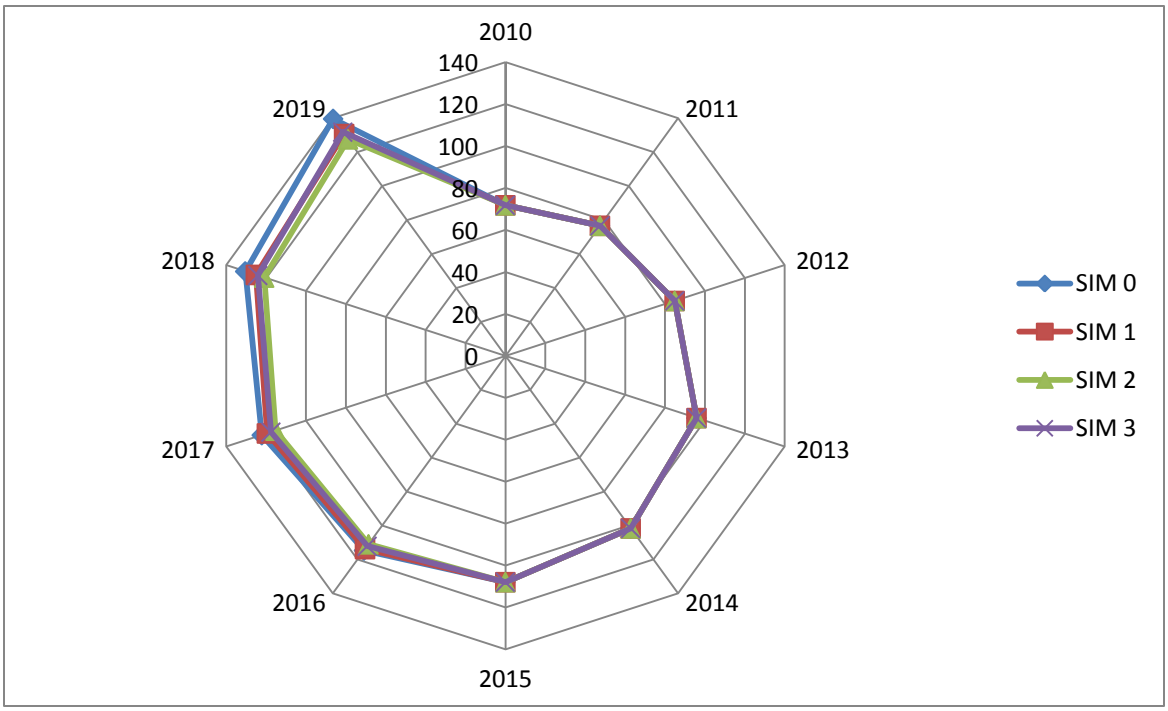
Simulation 1 is a gradual removal of tariff and the study appreciated that the level of government revenue is decease relatively small as compare to other simulation 2 and 3. This means the government can still collect tariff from this sectors. Simulation 3 not only leaves these same sectors out of BTA but also permits the government to collect a portion of the previous tariff on other commodities too as the tariff removal is in phases. Simulation 2, on the other hand, does not leave textile and leather out of BTA but still it permits the government to collect a portion of previous tariff.

Table 6 Government revenue (Billion Birr)

Simulation	2010	2016	2017	2018	2019
SIM 0	71.83	114.63	122.11	130.40	139.71
SIM 1	71.83	113.83	119.52	125.05	130.75
SIM 2	71.83	110.98	115.24	120.90	127.65
SIM 3	71.83	112.14	117.56	124.10	131.88

(Source: CGE Simulation result and own analysis)

Figure 12 Government revenue (Billion Birr, Year, 2010 – 2019).

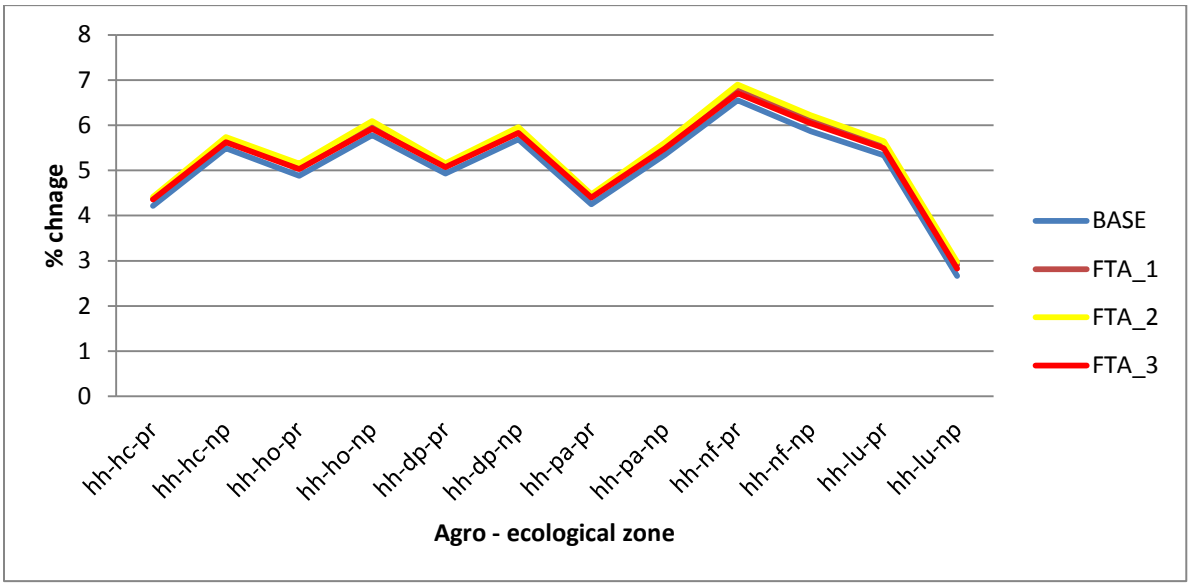


(Source: Simulation result)

Impact on Households (EHXPY)

Household consumption has increased for both the poor and the non poor even if the increase for the poor is greater than the increase for the non-poor. Household consumption expenditure is the product of household consumption and average output price. This is indicated in our study, figure 15 , household consumption expenditure, of poor are less consumed as compare to non-poor household i.e. household living in all agro – ecological zone (humid cereals, humid enset, drought prone) except nf and lu the poor are consumed more. Contrary to above, non-poor households living in pastoralist and lu consumed more as compare to poor.

Figure 13 Household consumption expenditure (EHXPY- % change)



(Source: CGE Simulation result and own analysis)

A decrease in household consumption expenditure for the non poor implies that the price goods they consumed have decreased by larger amount than the price the poor consumed. We have found that the decreases the price of industrial products more than it decreases the price of agricultural commodities and services. Thus, the decrease in household expenditure for the non poor might be because of their higher consumption of industrial products compared to the poor. In the table 7 below, the effect of the tariff shock on household consumption depicted and classified.

Table 7: Household consumption expenditure (% change)

HH in Agro – ecological zone	SIM 0	SIM 1	SIM 2	SIM 3
hh-hc-pr	4.218472	4.370713	4.415234	4.354532
hh-hc-np	5.492995	5.692084	5.737675	5.625431
hh-ho-pr	4.881461	5.090726	5.150414	5.031713
hh-ho-np	5.78163	6.032533	6.092625	5.92453
hh-dp-pr	4.931491	5.109392	5.157199	5.073097
hh-dp-np	5.689786	5.909103	5.959382	5.82921
hh-pa-pr	4.248013	4.425045	4.469709	4.40227
hh-pa-np	5.339755	5.562016	5.611706	5.48475
hh-nf-pr	6.554828	6.834923	6.898241	6.710204
hh-nf-np	5.866054	6.148508	6.216084	6.038869
hh-lu-pr	5.335593	5.589348	5.646141	5.487838
hh-lu-np	2.662788	2.913654	2.973219	2.826336

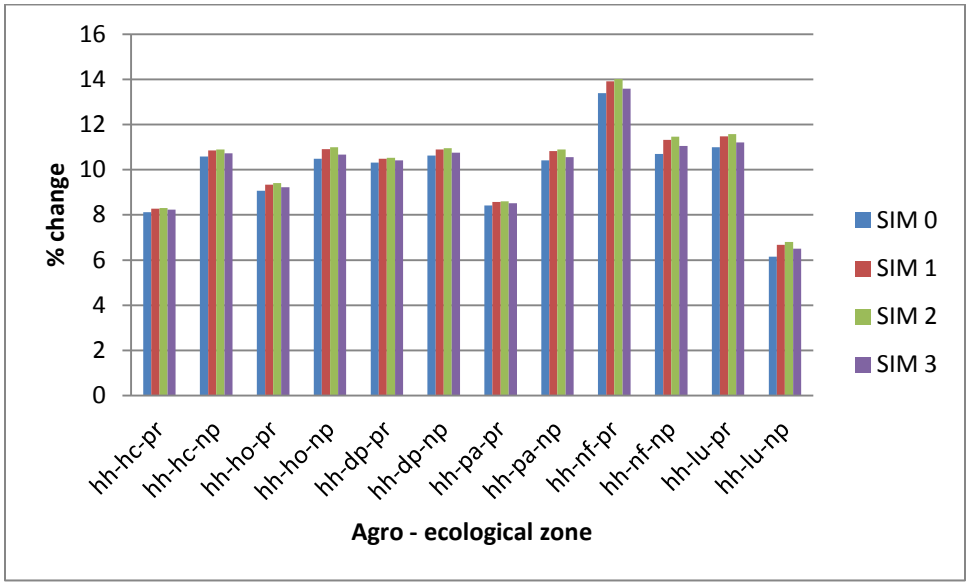
(Source: CGE Simulation result and own analysis)

Welfare Effects

To measure the welfare impact, Equivalent Variation (EV) is used as an important tool which measures the level of income of consumer need to pay before a shock to leave them better off at equivalent level of utility loss after the shock.

As indicated below figure 15, relatively the welfare of household is improving when trade linearization with removal of tariff 25% per annum reduction. Similarly there is registered welfare gain after complete removal of tariff and significantly improvement documented as compared to baseline simulation. However, this is not in case of simulation 3 because the government strategic sectors are protected and then the welfare loss happened may be due to increase the price of imported goods.

Figure 14 Disaggregated Equivalent Variation of household group (EV- % change)



4.3. General discussion on Ethio –China Bilateral trade

China is a member of World Trade Organization (WTO) and it passed more than a decade after being a member of the international body, it appears that it has come to terms with the rules of WTO. In other side of world, Ethiopia is not a member of the WTO while it has shown an interest to join. This means that Ethio-China Trade is essentially based on bilateral trade agreements, and the fact that Ethiopia is not member would raise a number of issues.

The growing trade relations between the two countries take place within the larger framework of Chinese development assistance to Ethiopia. However, what has been questioned is its institutional capacity in the form of adjusting domestic laws and enacting, appropriate economic reforms in order to become an active member of the world organization.

Therefore given Ethiopia's non-accession status, international trade regimes have implications for China-Ethiopia trade. China being one of the dominant trading partner of the WTO and Ethiopia an aspiring least developing countries (LDC) it largely depends

on bilateral agreements, sometimes enjoys quota- and duty free access to a number of major export markets.

In the short term such preferential trade relations may be working, but in the long term this is subject to change. Ethiopia is believed to be enjoying access to markets which appears favorable than operating under WTO rules. It has been argued that the preferences which Ethiopia enjoys, with China, AGOA, EBA and others schemes can be withdrawn at will. However there is an argument that withdrawal from such schemes could damage the reputation of the withdrawing country. Therefore, becoming a member of WTO by countries such as Ethiopia could provide scope for the predictability of trade strategies of the country and also have strong implications for its transparency in its trade with China.

If Ethiopia remained outside of the WTO it would be barred from entering into these negotiations and representing its own interests – while at the same time being affected by the negotiation outcomes". Moreover, the issue of transparency is important not just for the WTO and the adherence to its rules by member countries but also for the private sectors and trading communities of both countries. It is expected that WTO would bring benefits for the Ethiopian private sector. It is argued that WTO accession or subscription to more transparent trade regimes beyond preferential treatment will change the rules of doing business in Ethiopia by strengthening the forces of the market. The argument is that competition will gradually increase, creating opportunities for the private sectors (Bienen, 2010).

CHAPTER FIVE: CONCLUSIONS AND POLICY IMPLICATION

5.1. Conclusions

Following an agreement between Ethiopia and China of Bilateral trade affects the overall economy. Our study showed us GDP is increased in all the three scenarios (SIM 1, SIM 2 & SIM3). Both GDP at market price and GDP at factor cost increased. The highest increase in GDP was registered when the tariff rate is removed for all products.

There is a registered positive effect on the Ethiopian economy such as both imports and exports are increased proportionally. Another positive impact is an increase in disaggregated activity production levels and private consumption. The increase in imports is because of the decrease in import price when tariff is removed. The increase in exports, on the other hand, might be due to different reasons. First, an increase in GDP will help increase the potential for our export quantity. Second, when imports are cheap, we have seen an increase in imports of capital goods which could be used in the production process.

In other hand, not all the effects are positive. Government revenue has decreased due to the elimination of tariff. This is because tariff revenue is a very important source of government revenue. Its removal implies there is no more government income from tariff. The highest decrease in government revenue is brought by the complete abolishment of tariff in 2016 for all products. This is logical since, it leaves no possibility for the government to collect tariff. Other scenarios, on the other hand, give the government the chance to collect tariff revenue partially.

Impact on household found that disaggregated household consumption increased for both the poor and the non-poor even if the increase for the poor is greater than the increase for the poor. The household consumption expenditure decreases for the non poor and increases for the poor. Our results also show that price of industrial products decrease by a higher percentage than price of agricultural products and services. Thus, decrease in household consumption expenditure for the non-poor while their quantity of

consumption is increasing might be because of their higher consumption of industrial products as compared to the poor.

Excluding strategic sectors of textile, cloth and leather from tariff removal will make these industries competitive as their price will not decrease. This can be simply observed by comparing simulations 2 and 3. The economy growths relatively become slowdown because of decease GDP, export and import at the end of simulation year that is in 2019. This is because exports increase by a higher amount in simulation 1 and 2 where there is no discrimination for the strategic sectors. GDP also increases by a higher amount in simulations 1 and 2. Therefore, the study does not support the so called protection of infant industries.

5.2. Policy Implications – Specific

Based on our simulation report, the following implication could be taken:

- In depth policy study may require with regards to protecting strategic sectors before excluding them from the BTA or FTA because such kind of trade arrangement may benefit only those sectors while the overall economy is affected negatively. Our study clearly indicated that GDP increases by a higher percentage when these sectors are not protected.

- In developing countries tax is major source of government revenue including Ethiopia, where tariff revenue is the significant contributor to government income, policy should be put in place to compensate this loss in government revenue. One of the negative impacts of free trade area is loss of government revenue. The policy option could include broadening the domestic tax base, increasing the collection rate etc.

- Primary the most important aim of bilateral or free trade arrangement is benefiting consumers. Consumers will be beneficial at the cost of producers. The study indicated that an increase in private consumption while investment

decreases which is related with decease of government saving. The decrease in investment might be because of fear for the competition with foreign producers. So, policy makers have to compensate producers by making the investment environment attractive, such as avoiding bureaucracy.

- This study provides a highlight to analyze the welfare effects of trade policy changes. In conclusion to this study considering the welfare and distributional effects of different Ethio-China trade liberalization scenarios using the CGE model, one can notice that trade liberalization scenarios agree that there is some potential for welfare gains.

- With this particular study able to conclude, welfare gains are always expected to be higher when the trade policy change is accompanied by improvements in other complementary policies and procedures.

- Regarding welfare of households consumer it has been observed that the consumer is better off when gradual or complete removal of tariff in case of SIM 1 & 2 compared with baseline

5.3. Policy Implications – General

- In general, many developing countries including Ethiopia are signing up to bilateral and regional trade agreements because the benefits of the reciprocal arrangements are attractive and offer a much faster solution to trade liberalization than the "Doha" round is currently able to offer. However, the result of the proliferation of bilateral and regional trade agreements is a complex system of overlapping arrangements, which many people fear will have a negative impact on the developing world because it is not equipped to deal with such a high degree of complexity.

- Bilateral and regional trade agreements are, by their very nature, discriminatory and there is a concern that many developing countries are signing up to arrangements that may erode over time. The worry, therefore, is that developing countries and small corporations, which are unable to handle this chaotic structure, will lose out in the long run.

- Trade liberalization in the face of distortionary taxes, is liable to produce markedly smaller welfare gains than is available from joint policy reform that includes trade liberalization as well as tax policy reform.

- Deep integration between is more likely to produce welfare gains than shallow integration.

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Annex: 1 Imported goods value from China and ROW, 2010, SAM, ETB.

Description	WORLD_CIF_in birr	China_CIF_ in birr	China_Share_AV	ROW_Share_AV
Animal products	1,427,164.14	112,237.27	0.078643561	0.921356439
Barley	1,053,368.34	0.00	0	1
Beverages	148,058,485.38	880,600.76	0.005947655	0.994052345
Cattle	9,260,281.54	0.00	0	1
Chat	0.00	0.00	0	0
Chemicals	12,074,556,424.34	878,731,546.25	0.072775472	0.927224528
Clothing	1,322,631,511.81	817,458,376.48	0.618054514	0.381945486
Coal	24,785,283.56	0.00	0	1
Coffee	6,003,349.94	45,971.30	0.007657608	0.992342392
Construction	0	0.00	0	0
Cotton	26,797,071.10	3,389,833.49	0.126500149	0.873499851
Dairy	17,579,565.87	56,206.80	0.00319728	0.99680272
Electronic equipment	14,224,802,859.63	5,136,513,277.74	0.361095569	0.638904431
Electricity	15,880,522,993.16	10,167,021,961.51	0.640219593	0.359780407
Fertilizer	3,518,857,970.05	23,969,455.74	0.006811714	0.993188286
Fisheries	5,511,063.13	240,596.73	0.043657045	0.956342955
Flowers	844,532.22	0.00	0	1
Other foods processing	826,311,625.93	55,950,446.53	0.067711073	0.932288927
Forestry	0	0.00	0	0
Fruits	711,822.39	0.00	0	1
Grain milling	0	0.00	0	0
Leather products	117,386,278.84	87,996,633.07	0.74963304	0.25036696
Machinery	642,301,508.57	162,743,325.81	0.253375282	0.746624718

Description	WORLD_CIF_in birr	China_CIF_ in birr	China_Share_AV	ROW_Share_AV
Maize	44,197,605.76	2,521.36	5.70474E-05	0.999942953
Meat	685,491.15	1,813.18	0.002645082	0.997354918
Metals and products	12,122,425,285.31	4,570,979,378.55	0.377068059	0.622931941
Milk	230,119,964.03	39,334.09	0.000170929	0.999829071
Milling services	0	0.00	0	0
Natural gas	0	0.00	0	0
Non-metallic minerals	370,981,266.98	129,988,975.40	0.350392289	0.649607711
Other crops	69,502,436.17	35,763.47	0.000514564	0.999485436
Oilseeds	88,792,646.88	1,931,189.88	0.021749435	0.978250565
Other manufacting	8,869,825,581.00	2,555,288,074.50	0.288087748	0.711912252
Other mining	3,738,057,464.94	178,694,548.53	0.04780412	0.95219588
Paper and publishing	1,809,066,714.52	186,685,361.28	0.103194293	0.896805707
Poultry	973,131.34	4,407.42	0.004529111	0.995470889
Sugar refining	113,522,709.04	31,210,160.12	0.274924378	0.725075622
Tea processing	1,156,503.88	264,693.89	0.228874191	0.771125809
Tobacco processing	61,892,018.81	15,106,263.05	0.244074492	0.755925508
Petroleum	20,351,896,719.69	0.00	0	1
Pulses	470,397,689.17	122,137.87	0.000259648	0.999740352
Sorghum	583,542,362.09	0.00	0	1
Sugarcane	1,543,602,577.07	52,384.69	3.39366E-05	0.999966063
Tea	1,176,234.57	168,768.67	0.143482154	0.856517846

Description	WORLD_CIF_in birr	China_CIF_ in birr	China_Share_AV	ROW_Share_AV
Cteff	0	0.00	0	0
Textiles	4,606,846,531.50	2,718,462,367.44	0.590091801	0.409908199
Tobacco	173,781,102.13	4,242.22	2.44113E-05	0.999975589
Vegetables	38,895,898.09	704,867.19	0.01812189	0.98187811
Vehicles and transport equipment	11,288,123,381.30	1,469,899,954.75	0.130216503	0.869783497
Vegetable products	4,675,233,213.00	18,327,116.41	0.003920043	0.996079957
Water	6,125,612.56	11,713.57	0.001912228	0.998087772
Wheat	4,355,904,977.23	0.00	0	1
Wood products	593,134,125.47	266,137,278.95	0.448696623	0.551303377

Annex: 2 Export to World and China in 2010, ERCA

Description	WORLD_FOB_in birr	China_FOB_ in birr	China_Share_AV	ROW_Share_AV
Animal products	689,535,232.29	0.00	0	1
Barley	750,480.83	0.00	0	1
Beverages	25,039,003.12	0.00	0	1
Cattle	1,867,272,970.69	0.00	0	1
Chat	3,486,142,248.15	68,812,435.77	0.019738849	0.980261151
Chemicals	70,493,167.80	1,936,174.55	0.027466131	0.972533869
Clothing	0.00	0.00	0	0
Coal	40.00	0.00	0	1
Coffee	9,854,961,875.55	14,137,103.34	0.001434516	0.998565484
Construction	-	0.00	0	0
Cotton	334,058,806.86	20,824,379.90	0.062337467	0.937662533
Dairy	42,133,710.54	0.00	0	1
Electronic equipment	5,266,018.50	16,996.76	0.00322763	0.99677237
Electricity	0.00	0.00	0	0
Fertilizer	0.00	0.00	0	0
Fisheries	6,481,826.54	0.00	0	1
Flowers	2,024,896,988.76	0.00	0	1
Other foods processing	64,044,843.59	50,116,840.30	0.782527328	0.217472672
Forestry	0.00	0.00	0	0
Fruits	65,469,136.97	0.00	0	1
Grain milling	8,373,299.06	0.00	0	1
Leather products	952,794,883.47	221,181,911.85	0.232140113	0.767859887
Machinery	22,118,098.49	6,699.79	0.00030291	0.99969709
Maize	142,881,799.09	0.00	0	1
Meat	25,706,510.83	0.00	0	1

Description	WORLD_FOB_in birr	China_FOB_ in birr	China_Share_AV	ROW_Share_AV
Metals and products	2,702,598,062.25	507,128.46	0.000187645	0.999812355
Milk	0.00	0.00	0	0
Milling services	0.00	0.00	0	0
Natural gas	0.00	0.00	0	0
Non-metallic minerals	1,814,378.03	0.00	0	1
Other crops	0.00	0.00	0	0
Oilseeds	4,868,486,519.24	2,724,234,301.91	0.559564927	0.440435073
Other manufacting	4,232,644.12	0.00	0	1
Other mining	239,616,825.68	166,509,213.11	0.694897834	0.305102166
Paper and publishing	1,036,660.71	0.00	0	1
Poultry	0.00	0.00	0	0
Sugar refining	8,675.52	0.00	0	1
Tea processing	12,225,057.81	0.00	0	1
Tobacco processing	4,364,985.01	0.00	0	1
Petroleum	0.00	0.00	0	0
Pulses	0.00	0.00	0	0
Sorghum	104,893,852.04	2,730,207.48	0.026028289	0.973971711
Sugarcane	99,967.93	0.00	0	1
Tea	53,251.17	0.00	0	1
Cteff	35,733,175.97	0.00	0	1
Textiles	366,953,048.89	0.00	0	1
Tobacco processing	4,364,985.01	0.00	0	1
Vegetables	349,188,148.73	0.00	0	1
Vehicles and transport equipment	21,187.02	0.00	0	1
Vegetable products	944,467,822.74	52,052,435.10	0.055112979	0.944887021
Water	2,173,683.86	0.00	0	1

Description	WORLD_FOB_in birr	China_FOB_ in birr	China_Share_AV	ROW_Share_AV
Wheat	3,427.85	0.00	0	1
Wood products	20,769,006.92	0.00	0	1

Annex: 3 Quantity of Import (% change)

	INITIAL	SIM 0	SIM 1	SIM 2	SIM 3
cwhea	92.41	10.58	11.5	11.72	10.98
cpuls	10.09	11.85	12.55	12.71	12.16
cteal	0.02	13.06	13.42	13.02	12.29
ctoba	0.73	15.08	13.49	13.11	14.64
cocrp	13.38	12.25	13.02	13.2	12.6
cpoul	0.02	16.25	16.69	16.81	16.47
cfish	0.01	12.84	13.23	13.33	13.01
ccoal	0.02	6.5	5.28	4.76	6.7
cngas	0.07	8.02	8.31	8.37	8.16
comin	1.86	18.3	17.6	17.36	17.93
cdair	0.44	35.17	36.18	36.47	35.69
cvprd	1.9	8.17	8.31	8.34	8.26
cgmll	0.28	10.48	11.2	11.41	10.73
cpsgr	0.8	7.05	6.08	6.04	6.86
cptea	0	5.65	6.11	6.17	5.74
cfood	1.43	6.86	7.84	8.23	7.9
cbeve	0.56	5.19	5.46	5.52	5.3
cptob	0.22	4.7	5.91	6.32	6.09
ctext	4.38	13.31	22.63	24.56	12.96
cclth	3.07	1.54	4.11	4.42	1.81
cleat	0.5	22.11	31.79	33.15	22.12
cwood	0.97	7.48	8.1	8.16	8.04
cpapr	2.27	23.15	21.93	21.32	24.91
cptrl	20.92	11.8	11.45	11.3	11.82
cfert	4.74	8.49	8.47	8.45	8.48
cchem	12.42	15.72	15.08	14.76	16.41
cnmet	5.27	13.92	14.14	14.17	14.32
cmetl	13.08	9.79	9.56	9.44	9.66
cmach	8.88	10.35	10.02	9.9	10.18
cvehe	8.78	10.29	10.29	10.29	10.32
ceequ	10.68	8.59	8.97	9.06	9.02
coman	1.66	11.62	15.46	16.83	16.15
ctrad	0.2	11.85	12.32	12.45	11.89
chotl	1.28	7.8	7.92	7.94	7.86
ctran	22.42	11.27	11.51	11.58	11.32
ccomm	0.97	10.06	10.4	10.49	10.18
cfsrv	1.23	11.46	11.6	11.6	11.64
cbsrv	5.09	16.08	16.57	16.63	16.49

Annex: 4 Price of import (% change)

		INITIAL	BASE	SIM 1	SIM 2	SIM 3
cwhea	row	0.076348	-4.39331	-4.46366	-4.48022	-4.36225
cpuls	row	0.120922	-4.39076	-4.46571	-4.48351	-4.36053
cteal	row	0.25338	-4.41213	-5.2541	-5.65298	-5.58196
ctoba	row	0.230766	-4.44619	-4.4213	-4.41244	-4.39785
cocrp	row	0.076181	-4.42344	-4.43948	-4.4415	-4.38255
cpoul	row	1.028658	-4.38517	-4.47022	-4.49073	-4.35676
cfish	row	1.021545	-4.42066	-4.44171	-4.44507	-4.38067
ccoal	row	1	-4.41757	-4.44418	-4.44903	-4.37859
cngas	row	1	-4.41342	-4.44751	-4.45435	-4.3758
comin	row	7.83521	-4.61974	-4.2849	-4.19528	-4.5143
cmeat	row	1				
cdair	row	1.037739	-4.3875	-4.46834	-4.48772	-4.35833
cvprd	row	1.374192	-4.45253	-4.41625	-4.40437	-4.40212
cgmll	row	1.124001	-4.40998	-4.45026	-4.45876	-4.37348
cpsgr	row	1.553657	-4.51121	-4.36973	-4.33015	-4.44155
cptea	row	1.284803	-4.44271	-4.4481	-4.45006	-4.42914
cfood	row	1.141065	-4.41162	-4.78734	-4.97909	-4.90123
cbeve	row	1.707775	-4.49925	-4.3906	-4.36331	-4.45208
cptob	row	1.570465	-4.49724	-5.17308	-5.44403	-5.55608
ctext	row	1.124705	-4.40892	-6.34808	-6.6194	-4.37276
cclth	row	1.327177	-4.44845	-6.51027	-6.75318	-4.39938
cleat	row	1.144011	-4.41612	-6.96145	-7.11801	-4.37761
cwood	row	1.101903	-4.40297	-4.96075	-5.08258	-4.98752
cpapr	row	1.114887	-4.40654	-4.66847	-4.78736	-4.69762
cptrl	row	1	-4.44815	-4.41974	-4.40995	-4.39917
cfert	row	1	-4.43941	-4.42672	-4.4211	-4.3933
cchem	row	1.208291	-4.42711	-4.61009	-4.70256	-4.65365
cnmet	row	1.404374	-4.45685	-5.31958	-5.57427	-5.60072
cmetl	row	1.221799	-4.45048	-4.83028	-4.92936	-4.93122
cmach	row	1.145531	-4.41244	-4.69539	-4.79346	-4.71575
cvehe	row	1.103715	-4.40681	-4.73877	-4.8864	-4.79793

ceequ	row	1.047549	-4.40937	-5.0537	-5.23429	-5.15379
coman	row	1.044742	-4.38927	-5.70499	-6.1716	-6.05236
ctrad	row	1	-4.37751	-4.4764	-4.50062	-4.3516
chotl	row	1	-4.37751	-4.4764	-4.50062	-4.3516
ctran	row	1	-4.37751	-4.4764	-4.50062	-4.3516
ccomm	row	1	-4.37751	-4.4764	-4.50062	-4.3516
cfsrv	row	1	-4.37751	-4.4764	-4.50062	-4.3516
cbsrv	row	1	-4.37751	-4.4764	-4.50062	-4.3516

Annex: 5 Average output price (% change)

	INITIAL	SIM 0	SIM 1	SIM 2	SIM 3
cteff	0.065296	-4.0573	-3.91688	-3.88218	-3.92514
cbarl	0.067166	-3.77104	-3.62888	-3.59332	-3.63755
cwhea	0.071957	-4.61416	-4.48541	-4.45406	-4.4897
cmaiz	0.040834	-3.08759	-2.93942	-2.90363	-2.9503
csorg	0.030919	-4.07149	-3.91779	-3.8809	-3.93165
cpuls	0.115097	-2.59063	-2.44084	-2.40404	-2.45105
coils	0.065218	-3.78862	-3.96915	-4.01827	-3.77614
cvege	0.055426	-2.92508	-2.77203	-2.73497	-2.78401
cfrui	0.02335	-3.48964	-3.33865	-3.30191	-3.3496
cnset	0.285771	-4.5503	-4.23877	-4.16935	-4.36523
ccott	0.19297	8.36684	8.732385	8.923939	8.298349
csugr	0.007492	1.079034	-1.32159	-1.42051	0.599347
cteal	0.221481	3.308809	2.990791	1.741814	0.455745
cchat	0.674965	-1.33788	-1.15424	-1.12064	-1.18122
ctoba	0.17322	-0.36273	-0.9463	-1.08701	-0.47066
ccoff	0.804076	-3.89918	-3.99065	-4.01719	-3.85641
cflow	0.361128	-4.29924	-4.40021	-4.42617	-4.26485
cocrp	0.063641	-2.8472	-2.69949	-2.66446	-2.71335
ccatt	1	3.688701	3.835073	3.887486	3.852216
cmilk	1	3.630803	3.771794	3.822792	3.790919
cpoul	1	3.715882	3.862158	3.914752	3.879475
caprd	1	3.610915	3.731714	3.790552	3.771066
cfish	1	-1.71431	-1.64203	-1.62052	-1.62306
cfore	1	9.753004	10.02027	10.0736	9.875431
comin	1	33.73548	33.10013	32.82666	33.31332
cdair	1	3.493855	3.636268	3.687523	3.653381
cvprd	1	-5.54827	-5.5551	-5.58959	-5.575
cgmll	1	-3.64708	-3.52023	-3.47018	-3.54618
cmsrv	1	-2.2323	-1.89114	-1.80077	-2.06678
cpsgr	1	-4.69049	-5.75692	-5.80794	-4.91345
cptea	1	-5.52509	-5.53247	-5.56456	-5.54474
cfood	1	-5.5234	-5.53419	-5.57086	-5.55299
cbeve	1	-9.52246	-9.45887	-9.43205	-9.50107
cptob	1	-10.4124	-10.451	-10.4566	-10.3808
ctext	1	-4.03059	-4.06677	-3.99095	-4.06373
cclth	1	-8.47244	-9.10789	-9.22098	-8.45466
cleat	1	-0.20071	-0.17225	-0.14139	-0.10646
cwood	1	-6.13586	-6.02832	-6.01101	-6.11945
cpapr	1	-7.8573	-8.01066	-8.04792	-7.87824

cchem	1	-2.05273	-2.14537	-2.20163	-2.18314
cnmet	1	3.591108	3.534632	3.483484	3.484003
cmetl	1	-3.8947	-4.22928	-4.30448	-4.17551
cmach	1	-4.02029	-4.27765	-4.36015	-4.38117
cvehe	1	-5.32154	-5.60607	-5.71648	-5.67551
ceequ	1	-3.93096	-4.06383	-4.09555	-4.00897
coman	1	-3.39334	-3.66115	-3.73427	-3.80684
celec	1	-10.8336	-11.0335	-11.1271	-10.9451
cwatr	1	-3.63538	-3.33871	-3.26751	-3.52849
ccons	1	-0.2462	-0.34146	-0.38805	-0.42104
ctrad	1	-4.71314	-4.32021	-4.21576	-4.59688
chotl	1	-2.65859	-2.4354	-2.37166	-2.53609
ctran	1	-4.77003	-4.73263	-4.70238	-4.71127
ccomm	1	-5.25478	-5.01139	-4.93453	-5.13018
cfsrv	1	-4.03411	-3.81659	-3.76549	-3.88474
cbsrv	1	-4.37751	-4.4764	-4.50062	-4.3516
creal	1	-4.48946	-4.24022	-4.18194	-4.40915
cosrv	1	-0.97594	-0.64974	-0.55565	-0.77953
cpadm	1	-0.39294	-0.11779	-0.02895	-0.24348
ceduc	1	1.0841	1.407276	1.512905	1.301419
cheal	1	0.411149	0.727619	0.825722	0.603713

Annex: 6 Annex: GDP for the next four years

		2015	2016	2017	2018	2019
ABSORP	BASE	734.9637	797.9724	867.9311	946.1941	1034.782
ABSORP	SIM 1	734.9637	798.5796	870.2543	951.2475	1041.669
ABSORP	SIM 2	734.9637	800.436	872.9642	953.4468	1042.042
ABSORP	SIM 3	734.9637	798.4903	869.0218	948.1608	1038.474
PRVCON	BASE	514.4065	553.6319	596.3706	643.3543	695.8074
PRVCON	SIM 1	514.4065	554.8462	600.716	652.6337	709.5845
PRVCON	SIM 2	514.4065	559.0227	606.9093	658.1423	712.4635
PRVCON	SIM 3	514.4065	555.0831	599.2603	647.9681	703.0139
FIXINV	BASE	152.8092	167.9557	185.4072	205.6384	229.2777
FIXINV	SIM 1	152.8092	167.3485	183.385	201.4125	222.3874
FIXINV	SIM 2	152.8092	165.0285	179.9015	198.1031	219.8821
FIXINV	SIM 3	152.8092	167.0223	183.6082	202.9914	225.7639
DSTOCK	BASE	1.816911	1.816911	1.816911	1.816911	1.816911
DSTOCK	SIM 1	1.816911	1.816911	1.816911	1.816911	1.816911
DSTOCK	SIM 2	1.816911	1.816911	1.816911	1.816911	1.816911
DSTOCK	SIM 3	1.816911	1.816911	1.816911	1.816911	1.816911
GOVCON	BASE	65.93101	74.56797	84.33637	95.38444	107.8798
GOVCON	SIM 1	65.93101	74.56797	84.33637	95.38444	107.8798
GOVCON	SIM 2	65.93101	74.56797	84.33637	95.38444	107.8798
GOVCON	SIM 3	65.93101	74.56797	84.33637	95.38444	107.8798
EXPORTS	BASE	131.6513	155.8977	186.9159	227.7798	283.8927
EXPORTS	SIM 1	131.6513	157.1013	192.0934	240.2853	302.294
EXPORTS	SIM 2	131.6513	161.5251	200.191	248.6551	306.2708
EXPORTS	SIM 3	131.6513	156.9613	189.3701	232.676	294.0787
IMPORTS	BASE	-226.573	-254.926	-290.274	-335.703	-396.631
IMPORTS	SIM 1	-226.573	-256.129	-295.451	-348.209	-415.033
IMPORTS	SIM 2	-226.573	-260.553	-303.549	-356.579	-419.009
IMPORTS	SIM 3	-226.573	-255.989	-292.728	-340.6	-406.817
GDPMP	BASE	640.0418	698.9444	764.5733	838.2704	922.0432
GDPMP	SIM 1	640.0418	699.5516	766.8965	843.3238	928.9302
GDPMP	SIM 2	640.0418	701.4081	769.6064	845.5231	929.3037
GDPMP	SIM 3	640.0418	699.4624	765.664	840.2372	925.7359
GDPMP2	BASE	640.0418	698.9444	764.5733	838.2704	922.0432
GDPMP2	SIM 1	640.0418	699.5516	766.8965	843.3238	928.9302
GDPMP2	SIM 2	640.0418	701.4081	769.6064	845.5231	929.3037
GDPMP2	SIM 3	640.0418	699.4624	765.664	840.2372	925.7359
NETITAX	BASE	35.4374	33.13766	28.32356	19.6869	4.681936
NETITAX	SIM 1	35.4374	33.07142	27.22766	15.63204	-2.07791
NETITAX	SIM 2	35.4374	32.38522	24.54275	11.85481	-4.13628

NETITAX	SIM 3	35.4374	33.4032	28.71666	19.9037	3.78735
GDPFC2	BASE	604.6044	665.8068	736.2497	818.5836	917.3613
GDPFC2	SIM 1	604.6044	666.4802	739.6689	827.6918	931.0081
GDPFC2	SIM 2	604.6044	669.0228	745.0636	833.6683	933.44
GDPFC2	SIM 3	604.6044	666.0592	736.9473	820.3335	921.9485

Annex: 7 CGE Model Equations

Price Block

(1)	$PM_{c,t} = pwm_{c,t} \cdot (1 + tm_{c,t}) \cdot EXR_t + \sum_{c' \in C} (PQ_{c',t} \cdot icm_{c',c,t})$ $\left[\begin{matrix}\text{import price}\\(LCU)\end{matrix}\right] = \left[\begin{matrix}\text{import price}\\(FCU)\end{matrix}\right] \cdot \left[\begin{matrix}\text{tariff}\\\text{adjustment}\end{matrix}\right] \cdot \left[\begin{matrix}\text{exchange rate}\\(LCU \text{ per } FCU)\end{matrix}\right] + \left[\begin{matrix}\text{transaction}\\\text{costs}\end{matrix}\right]$	$c \in CM$ $t \in T$	Import price
(2)	$PE_{c,t} = pwe_{c,t} \cdot (1 - te_{c,t}) \cdot EXR_t - \sum_{c' \in C} (PQ_{c',t} \cdot ice_{c',c,t})$ $\left[\begin{matrix}\text{export price}\\(LCU)\end{matrix}\right] = \left[\begin{matrix}\text{export price}\\(FCU)\end{matrix}\right] \cdot \left[\begin{matrix}\text{tariff}\\\text{adjustment}\end{matrix}\right] \cdot \left[\begin{matrix}\text{exchange rate}\\(LCU \text{ per } FCU)\end{matrix}\right] - \left[\begin{matrix}\text{transaction}\\\text{costs}\end{matrix}\right]$	$c \in CE$ $t \in T$	Export price
(3)	$PDS_{c,t} \geq PE_{c,t}$ $\left[\begin{matrix}\text{domestic supply}\\\text{price}\end{matrix}\right] \geq \left[\begin{matrix}\text{export price}\\(LCU)\end{matrix}\right]$	$c \in (CD \cap CECETN)$ $t \in T$	Domestic floor price (= export price) for non-CET exportables

(4)	$PDD_{c,t} = PDS_{c,t} + \sum_{c' \in C} (PQ_{c',t} \cdot icd_{c',c,t})$ $\left[\begin{matrix}\text{domestic demander}\\\text{price}\end{matrix}\right] = \left[\begin{matrix}\text{domestic supplier}\\\text{price}\end{matrix}\right] + \left[\begin{matrix}\text{transaction}\\\text{costs}\end{matrix}\right]$	$c \in CD$ $t \in T$	Domestic demander price for domestic commodity
(5)	$PQ_{c,t} \cdot (1 - tq_{c,t}) \cdot QQ_{c,t} = PDD_{c,t} \cdot QD_{c,t} + PM_{c,t} \cdot QM_{c,t}$ $\left[\begin{matrix}\text{absorption}\\(\text{at demand prices}\\\text{net of sales tax})\end{matrix}\right] = \left[\begin{matrix}\text{domestic demander}\\\text{price times}\\\text{domestic sales quantity}\end{matrix}\right] + \left[\begin{matrix}\text{import price}\\\text{times}\\\text{import quantity}\end{matrix}\right]$	$c \in (CD \cup CM)$ $t \in T$	Absorption
(6)	$PX_{c,t} \cdot QX_{c,t} = PDS_{c,t} \cdot QD_{c,t} + PE_{c,t} \cdot QE_{c,t}$ $\left[\begin{matrix}\text{producer price}\\\text{times marketed}\\\text{output quantity}\end{matrix}\right] = \left[\begin{matrix}\text{domestic supplier}\\\text{price times}\\\text{domestic sales quantity}\end{matrix}\right] + \left[\begin{matrix}\text{export price}\\\text{times}\\\text{export quantity}\end{matrix}\right]$	$c \in (CD \cup CE)$ $t \in T$	Marketed output value
(7)	$PA_{a,t} = \sum_{c \in C} PXAC_{a,c,t} \cdot \theta_{a,c}$ $\left[\begin{matrix}\text{activity}\\\text{price}\end{matrix}\right] = \left[\begin{matrix}\text{producer prices}\\\text{times yields}\end{matrix}\right]$	$a \in A$ $t \in T$	Activity price
(8)	$PINTA_{a,t} = \sum_{c \in C} PQ_{c,t} \cdot ica_{c,a}$ $\left[\begin{matrix}\text{aggregate}\\\text{intermediate}\\\text{input price}\end{matrix}\right] = \left[\begin{matrix}\text{intermediate input cost}\\\text{per unit of aggregate}\\\text{intermediate input}\end{matrix}\right]$	$a \in A$ $t \in T$	Aggregate intermediate input price

(9)	$PA_{a,t} \cdot (1 - ta_{a,t}) \cdot QA_{a,t} = PVA_{a,t} \cdot QVA_{a,t} + PINTA_{a,t} \cdot QINTA_{a,t}$ $\left[\begin{array}{c}\text{activity price (net of taxes) times activity level}\end{array}\right] = \left[\begin{array}{c}\text{value-added price times quantity}\end{array}\right] + \left[\begin{array}{c}\text{aggregate intermediate input price times quantity}\end{array}\right]$	$a \in A$ $t \in T$	Activity revenue and costs
(10)	$\overline{CPI}_t = \sum_{c \in C} PQ_{c,t} \cdot cwts_c$ $\left[CPI\right] = \left[\begin{array}{c}\text{prices times weights}\end{array}\right]$	$t \in T$	Consumer price index
(11)	$DPI_t = \sum_{c \in CD} PDS_{c,t} \cdot dwts_c$ $\left[\begin{array}{c}\text{price index for non-tradables}\end{array}\right] = \left[\begin{array}{c}\text{supplier price for output marketed domestically times weights}\end{array}\right]$	$t \in T$	Price index for non-tradables

Production and trade block

(12)	$QA_{a,t} = \alpha a_a \cdot \left(\delta a_a \cdot QVA_{a,t}^{-\rho a_a} + (1 - \delta a_a) \cdot QINTA_{a,t}^{-\rho a_a}\right)^{-\frac{1}{\rho a_a}}$ $\left[\begin{array}{c}\text{quantity of aggregate activity}\end{array}\right] = CES\left[\begin{array}{c}\text{demand for value - added and demand for aggregate intermediate input}\end{array}\right]$	$a \in ACES$ $t \in T$	CES technology: Aggregate activity production function
(13)	$\frac{QVA_{a,t}}{QINTA_{a,t}} = \left(\frac{PINTA_{a,t}}{PVA_{a,t}} \cdot \frac{\delta a_a}{1 - \delta a_a}\right)^{\frac{1}{1+\rho a_a}}$ $\left[\begin{array}{c}\text{value-added - intermediate input quantity ratio}\end{array}\right] = f\left[\begin{array}{c}\text{intermediate input - value-added price ratio}\end{array}\right]$	$a \in ACES$ $t \in T$	CES technology: Aggregate value added - intermediate input ratio
(14)	$QVA_{a,t} = iva_a \cdot QA_{a,t}$ $\left[\begin{array}{c}\text{demand for value-added}\end{array}\right] = f\left[\begin{array}{c}\text{activity level}\end{array}\right]$	$a \in ALEO$ $t \in T$	Leontief technology: Demand for aggregate value-added
(15)	$QINTA_{a,t} = inta_a \cdot QA_{a,t}$ $\left[\begin{array}{c}\text{demand for aggregate intermediate input}\end{array}\right] = f\left[\begin{array}{c}\text{activity level}\end{array}\right]$	$a \in ALEO$ $t \in T$	Leontief technology: Demand for aggregate intermediate input
(16)	$QVA_{a,t} = \alpha va_{a,t} \cdot \left(\sum_{f \in F} \delta va_{f,a} \cdot \left(fprd_{f,a,t} \cdot QF_{f,a,t}\right)^{-\rho va_a}\right)^{-\frac{1}{\rho va_a}}$ $\left[\begin{array}{c}\text{quantity of aggregate value-added}\end{array}\right] = CES\left[\begin{array}{c}\text{factor inputs}\end{array}\right]$	$a \in A$ $t \in T$	Value-added

(17)	$WF_{f,t} \cdot \overline{WFDIST}_{f,a,t} = PVA_{a,t} \cdot (1 - tva_{a,t}) \cdot QVA_{a,t} \cdot \left(\sum_{f' \in F} \delta va_{f',a} \cdot \left(fprd_{f',a,t} \cdot QF_{f',a,t} \right)^{-\rho va_a} \right)^{-1} \cdot \delta va_{f,a} \cdot fprd_{f,a,t}^{-\rho va_a} \cdot QF_{f,a,t}^{-\rho va_a - 1}$ $\left[\begin{matrix} \text{marginal cost of} \\ \text{factor } f \text{ in activity } a \end{matrix} \right] = \left[\begin{matrix} \text{marginal revenue product} \\ \text{of factor } f \text{ in activity } a \end{matrix} \right]$	$a \in A$ $f \in F$ $t \in T$	Factor demand
(18)	$QINT_{c,a,t} = ica_{c,a} \cdot QINTA_{a,t}$ $\left[\begin{matrix} \text{intermediate demand} \\ \text{for commodity } c \\ \text{from activity } a \end{matrix} \right] = f \left[\begin{matrix} \text{aggregate intermediate} \\ \text{input quantity} \\ \text{for activity } a \end{matrix} \right]$	$c \in C$ $a \in A$ $t \in T$	Disaggregated intermediate input demand
(19)	$QXAC_{a,c,t} + \sum_{h \in H} QHA_{a,c,h,t} = \theta_{a,c} \cdot QA_{a,t}$ $\left[\begin{matrix} \text{quantity of output} \\ \text{of commodity } c \\ \text{from activity } a \end{matrix} \right] + \left[\begin{matrix} \text{quantity consumed of} \\ \text{home commodity } c \\ \text{from activity } a \text{ in} \\ \text{all households} \end{matrix} \right] = \left[\begin{matrix} \text{activity-specific} \\ \text{marketed} \\ \text{production of} \\ \text{commodity } c \end{matrix} \right]$	$a \in A$ $c \in C$ $t \in T$	Commodity production and allocation between market and home
(20)	$QX_{c,t} = \alpha ac_c \cdot \left(\sum_{a \in A} \delta ac_{a,c} \cdot QXAC_{a,c,t}^{-\rho ac_c} \right)^{-\frac{1}{\rho ac_c}}$ $\left[\begin{matrix} \text{aggregate marketed} \\ \text{production of} \\ \text{commodity } c \end{matrix} \right] = CES \left[\begin{matrix} \text{output of commodity } c \\ \text{from activity } a \end{matrix} \right]$	$c \in (CE \cup CD)$ $t \in T$	Output aggregation function
(21)	$\frac{PXAC_{a,c,t}}{PX_{c,t}} = QX_{c,t} \cdot \sum_{a' \in A} \left(\delta ac_{a',c} \cdot QXAC_{a',c,t}^{-\rho ac_c} \right)^{-1} \cdot \delta ac_{a,c} \cdot QXAC_{a,c,t}^{-\rho ac_c - 1}$ $\left[\begin{matrix} \text{ratio of price of commodity } c \\ \text{from acitivty } a \text{ to} \\ \text{average output price} \end{matrix} \right] = f \left[\begin{matrix} \text{aggregate marketed commodity} \\ \text{output and output of commodity } c \\ \text{from activity } a \end{matrix} \right]$	$a \in A$ $c \in C$ $t \in T$	Ratio of prices for output aggregation function
(22)	$QX_{c,t} = \alpha t_c \cdot \left(\delta t_c \cdot QE_{c,t}^{\rho t_c} + (1 - \delta t_c) \cdot QD_{c,t}^{\rho t_c} \right)^{\frac{1}{\rho t_c}}$ $\left[\begin{matrix} \text{aggregate marketed} \\ \text{domestic output} \end{matrix} \right] = CET \left[\begin{matrix} \text{export quantity, domestic} \\ \text{sales of domestic output} \end{matrix} \right]$	$c \in (CD \cap CECET)$ $t \in T$	Output transformation (CET) function
(23)	$\frac{QE_{c,t}}{QD_{c,t}} = \left(\frac{PE_{c,t}}{PDS_{c,t}} \cdot \frac{1 - \delta t_c}{\delta t_c} \right)^{\frac{1}{\rho t_c - 1}}$ $\left[\begin{matrix} \text{export-domestic} \\ \text{supply ratio} \end{matrix} \right] = f \left[\begin{matrix} \text{export-domestic} \\ \text{price ratio} \end{matrix} \right]$	$c \in (CD \cap CECET)$ $t \in T$	Export-domestic supply ratio

(24)	$QX_{c,t} = QD_{c,t} + QE_{c,t}$ $\left[\begin{array}{c}\text{aggregate}\\ \text{marketed}\\ \text{domestic output}\end{array}\right] = \left[\begin{array}{c}\text{domestic market}\\ \text{sales of domestic}\\ \text{output [for}\\ c \in (CD \cap CEN)]\end{array}\right] + \left[\begin{array}{c}\text{exports [for}\\ c \in (CE \cap CDN)]\end{array}\right]$	$c \in (CD \cap CEN) \cup (CE \cap CDN) \cup (CD \cap CECETN),$ $t \in T$	Output transformation for outputs without exports, exports without domestic sales, and non-CET exports with domestic sales
(25)	$QE_{c,t} = \overline{qe}_{c,t} \cdot \left(\frac{PWE_{c,t}}{pwse_{c,t}}\right)^{\rho e_c}$ $\left[\begin{array}{c}\text{export}\\ \text{demand}\end{array}\right] = f\left[\begin{array}{c}\text{trend export quantity, world price}\\ \text{for exports relative to world}\\ \text{price for export substitutes}\end{array}\right]$	$c \in CED$ $t \in T$	Export demand with constant-elasticity demand function
(26)	$QQ_{c,t} = \alpha q_c \cdot \left(\delta q_c \cdot QM_{c,t}^{-\rho q_c} + (1 - \delta q_c) \cdot QD_{c,t}^{-\rho q_c}\right)^{-\frac{1}{\rho q_c}}$ $\left[\begin{array}{c}\text{composite}\\ \text{supply}\end{array}\right] = f\left[\begin{array}{c}\text{import quantity, domestic}\\ \text{use of domestic output}\end{array}\right]$	$c \in (CM \cap CD)$ $t \in T$	Composite supply (Armington) function
(27)	$\frac{QM_{c,t}}{QD_{c,t}} = \left(\frac{PDD_{c,t}}{PM_{c,t}} \cdot \frac{\delta q_c}{1 - \delta q_c}\right)^{\frac{1}{1+\rho q_c}}$ $\left[\begin{array}{c}\text{import-domestic}\\ \text{demand ratio}\end{array}\right] = f\left[\begin{array}{c}\text{domestic-import}\\ \text{price ratio}\end{array}\right]$	$c \in (CM \cap CD)$ $t \in T$	Import-domestic demand ratio
(28)	$QQ_{c,t} = QD_{c,t} + QM_{c,t}$ $\left[\begin{array}{c}\text{composite}\\ \text{supply}\end{array}\right] = \left[\begin{array}{c}\text{domestic use of}\\ \text{marketed domestic}\\ \text{output [for}\\ c \in (CD \cap CMN)]\end{array}\right] + \left[\begin{array}{c}\text{imports [for}\\ c \in (CM \cap CDN)]\end{array}\right]$	$c \in (CD \cap CMN) \cup (CM \cap CDN),$ $t \in T$	Composite supply for non-imported outputs and non-produced imports
(29)	$QT_{c,t} = \sum_{c' \in C'} \left(icm_{c,c',t} \cdot QM_{c',t} + ice_{c,c',t} \cdot QE_{c',t} + icd_{c,c',t} \cdot QD_{c',t}\right)$ $\left[\begin{array}{c}\text{trade and transport}\\ \text{demand for commodity } c\end{array}\right] = \left[\text{from imports}\right] + \left[\text{from exports}\right] + \left[\begin{array}{c}\text{from marketed}\\ \text{domestic output}\end{array}\right]$	$c \in CT$ $t \in T$	Demand for transaction services

Domestic institution block

(30)	$YF_{f,t} = \sum_{a \in A} WF_{f,t} \cdot \overline{WFDIST}_{f,a,t} \cdot QF_{f,a,t} + trnsfr_{f\_row,t} \cdot EXR_t$ $\left[\begin{array}{c}\text{income of}\\ \text{factor } f\end{array}\right] = \left[\begin{array}{c}\text{sum of activity payments}\\ \text{(activity-specific wages}\\ \text{times employment levels)}\end{array}\right] + \left[\begin{array}{c}\text{income to factor } f\\ \text{from Rest of World}\end{array}\right]$	$f \in F$ $t \in T$	Factor income

(31)	$SHIF_{i,f,t} = \frac{QFACINS_{i,f,t}}{\sum_{i' \in INS} QFACINS_{i',f,t}}$ $\left[\begin{array}{c}\text{share of institution } i \text{ in}\\ \text{the income of factor } f\end{array}\right] = \left[\begin{array}{c}\text{endowment of institution } i \text{ of factor } f\\ \text{divided by total endowment of factor } f\end{array}\right]$	$i \in INS$ $f \in F$ $t \in T$	Institutional shares in factor incomes
(32)	$YIF_{i,f,t} = SHIF_{i,f,t} \cdot \left[\left(1 - tf_{f,t}\right) \cdot YF_{f,t}\right]$ $\left[\begin{array}{c}\text{income of}\\ \text{institution } i\\ \text{from factor } f\end{array}\right] = \left[\begin{array}{c}\text{share of income}\\ \text{of factor } f \text{ to}\\ \text{institution } i\end{array}\right] \cdot \left[\begin{array}{c}\text{income of factor } f\\ \text{(net of tax)}\end{array}\right]$	$i \in INS$ $f \in F$ $t \in T$	Institutional factor incomes
(33)	$YIINT_{i,t} = gintrat_{i,t} \cdot GBOND_{i,t} - fintrat_{i,t} \cdot FDEBT_{i,t} \cdot EXR_t$ $\left[\begin{array}{c}\text{net interest}\\ \text{income of}\\ \text{institution } i\end{array}\right] = \left[\begin{array}{c}\text{interest earnings}\\ \text{on government}\\ \text{bonds}\end{array}\right] - \left[\begin{array}{c}\text{interest}\\ \text{payments}\\ \text{on foreign debt}\end{array}\right]$	$i \in INSDNG$ $t \in T$	Institutional net interest income
(34)	$TRII_{i,i',t} = shii_{i,i'} \cdot (1 - MPS_{i',t}) \cdot (1 - TINS_{i',t}) \cdot YI_{i',t}$ $\left[\begin{array}{c}\text{transfer from}\\ \text{institution } i' \text{ to } i\end{array}\right] = \left[\begin{array}{c}\text{share of net income}\\ \text{of institution } i'\\ \text{transfered to } i\end{array}\right] \cdot \left[\begin{array}{c}\text{income of institution}\\ i', \text{ net of savings and}\\ \text{direct taxes}\end{array}\right]$	$i \in INS$ $i' \in INSDNG$ $t \in T$	Intra-institutional transfers
(35)	$YI_{i,t} = \sum_{f \in F} YIF_{i,f,t} + \sum_{i' \in INSDNG'} TRII_{i,i',t} + YIINT_{i,t}$ $\left[\begin{array}{c}\text{income of}\\ \text{institution } i\end{array}\right] = \left[\begin{array}{c}\text{factor}\\ \text{income}\end{array}\right] + \left[\begin{array}{c}\text{transfers from other}\\ \text{domestic non-government}\\ \text{institutions}\end{array}\right] + \left[\begin{array}{c}\text{net}\\ \text{interest}\\ \text{income}\end{array}\right]$ $+ trnsfr_{i,gov,t} \cdot \overline{CPI_t} + trnsfrpc_{i,gov,t} \cdot POP_{i,t} \cdot \overline{CPI_t}$ $+ \left[\begin{array}{c}\text{transfers from government}\\ \text{to non-household institutions}\end{array}\right] + \left[\begin{array}{c}\text{transfers from}\\ \text{government to households}\end{array}\right]$ $+ trnsfr_{i,row,t} \cdot EXR_t + trnsfrpc_{i,row,t} \cdot POP_{i,t} \cdot EXR_t$ $+ \left[\begin{array}{c}\text{transfers from Rest of World}\\ \text{to non-household institutions}\end{array}\right] + \left[\begin{array}{c}\text{transfers from}\\ \text{Rest of World to households}\end{array}\right]$	$i \in INSDNG$ $t \in T$	Income of domestic, non-government institutions
(36)	$TINS_{i,t} = \overline{tins_{i,t}} \cdot \left(1 + \overline{TINSADJ_t} \cdot tins01_i\right) + \overline{DTINS_t} \cdot tins01_i$ $\left[\begin{array}{c}\text{direct tax}\\ \text{rate for}\\ \text{institution } i\end{array}\right] = \left[\begin{array}{c}\text{base rate adjusted}\\ \text{for scaling for}\\ \text{selected institutions}\end{array}\right] + \left[\begin{array}{c}\text{point change}\\ \text{for selected}\\ \text{institutions}\end{array}\right]$	$i \in INSDNG$ $t \in T$	Direct tax rates for domestic non-government institutions

(37)	$$MPS_{i,t} = \overline{MPS}_{i,t} \cdot \left(\frac{(1 - TINS_{i,t}) \cdot YI_{i,t}}{POP_{i,t}} \right)^{\rho mps_i - 1} \cdot \left(1 + \overline{MPSADJ}_t \cdot mps01_i\right)$$ $$\begin{bmatrix} marginal \\ propensity \\ to\ save \end{bmatrix} = \begin{bmatrix} exogenous \\ term \end{bmatrix} \times \begin{bmatrix} adjustment\ for \\ per-capita \\ post-tax\ income \end{bmatrix} \times \begin{bmatrix} scaling\ adjustment \\ for\ selected \\ institutions \end{bmatrix} + \overline{DMPS}_t \cdot mps01_i + \begin{bmatrix} point-change \\ adjustment\ for \\ selected\ institutions \end{bmatrix}$$	$i \in INSDNG$ $t \in T$	Savings rates for domestic non-government institutions
(38)	$$INSSAV_{i,t} = MPS_{i,t} \cdot (1 - TINS_{i,t}) \cdot YI_{i,t}$$ $$\begin{bmatrix} savings\ for \\ institution\ i \end{bmatrix} = \begin{bmatrix} savings \\ rate\ for \\ institution\ i \end{bmatrix} \cdot \begin{bmatrix} income\ of \\ institution\ i \\ (net\ of\ direct\ taxes) \end{bmatrix}$$	$i \in INSDNG$	Savings for domestic non-government institutions
(39)	$$EH_{h,t} = \left(1 - \sum_{i \in INSDNG} shii_{i,h}\right) \cdot (1 - MPS_{h,t}) \cdot (1 - TINS_{h,t}) \cdot YI_{h,t}$$ $$\begin{bmatrix} household\ income \\ disposable\ for \\ consumption \end{bmatrix} = \begin{bmatrix} household\ income,\ net\ of\ direct \\ taxes,\ savings,\ and\ transfers\ to \\ other\ non-government\ institutions \end{bmatrix}$$	$h \in H$ $t \in T$	Household consumption expenditure
(40)	$$QH_{c,h,t} = POP_{h,t} \cdot \left(\gamma m_{c,h} + \frac{\beta m_{c,h} \cdot \left(\left[\frac{EH_{h,t}}{POP_{h,t}} \right] - \sum_{c' \in C} PQ_{c',t} \cdot \gamma m_{c',h} - \sum_{a \in A} \sum_{c' \in C} PXAC_{a,c',t} \cdot \gamma h_{a,c',h} \right)}{PQ_{c,t}} \right)$$ $$\begin{bmatrix} quantity\ of \\ household\ demand \\ for\ commodity\ c \end{bmatrix} = f \begin{bmatrix} household \\ consumption \\ spending,\ prices \end{bmatrix}$$	$c \in C$ $h \in H$ $t \in T$	Household consumption demand for commodities from market
(41)	$$QHA_{a,c,h,t} = POP_{h,t} \cdot \left(\gamma h_{a,c,h} + \frac{\beta h_{a,c,h} \cdot \left(\left[\frac{EH_{h,t}}{POP_{h,t}} \right] - \sum_{c' \in C} PQ_{c',t} \cdot \gamma m_{c',h} - \sum_{a' \in A} \sum_{c' \in C} PXAC_{a',c',t} \cdot \gamma h_{a',c',h} \right)}{PXAC_{a,c,t}} \right)$$ $$\begin{bmatrix} quantity\ of\ household\ demand \\ for\ commodity\ c\ from\ activity\ a \end{bmatrix} = f \begin{bmatrix} household\ consumption \\ spending,\ prices \end{bmatrix}$$	$a \in A$ $c \in C$ $h \in H$ $t \in T$	Household consumption demand for own production

(42)	$YG_t = \sum_{i \in INSDNG} TINS_{i,t} \cdot YI_{i,t} + \sum_{f \in F} tf_{f,t} \cdot YF_{f,t} + \sum_{a \in A} ta_{a,t} \cdot PA_{at} \cdot QA_{a,t}$ $\left[\begin{matrix}\text{government}\\\text{revenue}\end{matrix}\right] = \left[\begin{matrix}\text{direct taxes}\\\text{from institutions}\end{matrix}\right] + \left[\begin{matrix}\text{direct taxes}\\\text{from factors}\end{matrix}\right] + [\text{activity tax}]$ $+ \sum_{a \in A} tva_{a,t} \cdot PVA_{a,t} \cdot QVA_{a,t} + \sum_{c \in CM} tm_{c,t} \cdot pwm_{c,t} \cdot QM_{c,t} \cdot EXR_t$ $+ [\text{value-added tax}] + [\text{import tariffs}]$ $+ \sum_{c \in CE} te_{c,t} \cdot pwe_{c,t} \cdot QE_{c,t} \cdot EXR_t + \sum_{c \in C} tq_{c,t} \cdot PQ_{c,t} \cdot QQ_{c,t}$ $+ [\text{export taxes}] + [\text{sales tax}]$ $+ \sum_{f \in F} YIF_{gov,f,t} + \sum_{i \in INSDNG} TRII_{gov,i,t} + trnsfr_{gov,row,t} \cdot EXR_t$ $- [\text{factor income}] + \left[\begin{matrix}\text{transfers from}\\\text{domestic institutions}\end{matrix}\right] - [\text{transfers from RoW}]$	$t \in T$	Government recurrent revenue
(43)	$EG_t = \sum_{c \in C} PQ_{c,t} \cdot QG_{c,t} + \sum_{i \in INSDNH} trnsfr_{i,gov,t} \cdot \overline{CPI}_t$ $\left[\begin{matrix}\text{government}\\\text{spending}\end{matrix}\right] = \left[\begin{matrix}\text{government}\\\text{consumption}\end{matrix}\right] + \left[\begin{matrix}\text{transfers to domestic}\\\text{non-household institutions}\end{matrix}\right]$ $+ \sum_{h \in H} trnsfrpc_{h,gov,t} \cdot POP_{h,t} \cdot \overline{CPI}_t + trnsfr_{row,gov,t} \cdot EXR_t$ $+ \left[\begin{matrix}\text{transfers to domestic}\\\text{households}\end{matrix}\right] + \left[\begin{matrix}\text{transfers to}\\\text{Rest of World}\end{matrix}\right]$ $+ \sum_{i \in INS} gintrat_{i,t} \cdot GBOND_{i,t} + fintrat_{gov,t} \cdot FDEBT_{gov,t} \cdot EXR_t$ $+ \left[\begin{matrix}\text{interest payment}\\\text{on domestic debt}\end{matrix}\right] + \left[\begin{matrix}\text{interest payment}\\\text{on foreign debt}\end{matrix}\right]$	$t \in T$	Government recurrent expenditures
(44)	$QG_{c,t} = QG_{c,t-1} \cdot \left(1 + \overline{RQGT}_t + \sum_{c' \in C''} rqgadj_{c,c',t} \cdot \overline{RQGCT}_{c',t}\right)$ $\left[\begin{matrix}\text{real government}\\\text{consumption}\\\text{of } c \text{ in } t\end{matrix}\right] = \left[\begin{matrix}\text{real government}\\\text{consumption}\\\text{of } c \text{ in } t-1\end{matrix}\right] \cdot \left[1 + \left[\begin{matrix}\text{growth}\\\text{rate}\end{matrix}\right]\right]$	$c \in C$ $t \in T$ $t > 1$	Real government consumption
(45)	$GSAV_t = YG_t - EG_t$ $\left[\begin{matrix}\text{government}\\\text{savings}\end{matrix}\right] = \left[\begin{matrix}\text{government}\\\text{recurrent revenue}\end{matrix}\right] - \left[\begin{matrix}\text{government}\\\text{recurrent expenditures}\end{matrix}\right]$	$t \in T$	Government savings

Investment block

(46)	$PK_{f,t} = \sum_{c \in C} capcomp_{c,f} \cdot PQ_{c,t}$ $\left[\begin{matrix}\text{price of new}\\\text{capital stock}\end{matrix}\right] = \left[\begin{matrix}\text{total value of commodities } c\\\text{per unit of new capital}\end{matrix}\right]$	$f \in FCAP$ $t \in T$	Price of new capital stock

(47)	$INVVAL_{gov,t} = \sum_{f \in FCAPGOV} PK_{f,t} \cdot DKINS_{gov,f,t}$ $\left[\begin{matrix}\text{government fixed}\\ \text{investment value}\end{matrix}\right] = \left[\begin{matrix}\text{government spending}\\ \text{on capital goods}\end{matrix}\right]$	$t \in T$	Government fixed investment value
(48)	$INVVAL_{gov,t} = GSAV_t - \sum_{c \in C} PQ_{c,t} \cdot qdst_{c,gov,t} + DGBONDTOT_t$ $\left[\begin{matrix}\text{government fixed}\\ \text{investment value}\end{matrix}\right] = \left[\begin{matrix}\text{government}\\ \text{savings}\end{matrix}\right] - \left[\begin{matrix}\text{spending on}\\ \text{stock changes}\end{matrix}\right] + \left[\begin{matrix}\text{total change in holdings}\\ \text{of government bonds}\end{matrix}\right]$ $+ CBBORTOT_t + \left(\overline{FBOR}_{gov,t} + \overline{FGRANT}_{gov,t}\right) \cdot EXR_t$ $+ \left[\begin{matrix}\text{Government Central Bank}\\ \text{borrowing (deficit monetization)}\end{matrix}\right] + \left[\begin{matrix}\text{foreign borrowing and}\\ \text{foreign grants (in LCU)}\end{matrix}\right]$	$t \in T$	Government investment financing
(49)	$DGBOND_{i,t} = \frac{gbdist_i \cdot INSSAV_{i,t}}{\sum_{i' \in INSDNG'} gbdist_{i'} \cdot INSSAV_{i',t}} \cdot DGBONDTOT_t$ $\left[\begin{matrix}\text{change in holdings of}\\ \text{government bonds}\\ \text{by institution } i\end{matrix}\right] = \frac{\left[\begin{matrix}\text{savings by}\\ \text{by institution } i\end{matrix}\right]}{\left[\begin{matrix}\text{total institution}\\ \text{savings value}\end{matrix}\right]} \cdot \left[\begin{matrix}\text{(scaled) total change}\\ \text{in holdings of}\\ \text{government bonds}\end{matrix}\right]$	$i \in INSDNG$ $t \in T$	Allocation of government bond borrowing across domestic non-government institutions
(50)	$CBBOR_{i,t} = \frac{gbdist_i \cdot INSSAV_{i,t}}{\sum_{i' \in INSDNG'} gbdist_{i'} \cdot INSSAV_{i',t}} \cdot CBBORTOT_t$ $\left[\begin{matrix}\text{Government Central Bank}\\ \text{borrowing by institution } i\end{matrix}\right] = \frac{\left[\begin{matrix}\text{savings by}\\ \text{by institution } i\end{matrix}\right]}{\left[\begin{matrix}\text{total institution}\\ \text{savings value}\end{matrix}\right]} \cdot \left[\begin{matrix}\text{(scaled) total Government}\\ \text{Central Bank borrowing}\end{matrix}\right]$	$i \in INSDNG$ $t \in T$	Allocation of the burden of Central Bank borrowing across domestic non-government institutions
(51)	$INVVAL_{i,t} = INSSAV_{i,t} - \sum_{c \in C} PQ_{c,t} \cdot qdst_{c,i,t} - DGBOND_{i,t}$ $\left[\begin{matrix}\text{non-government fixed}\\ \text{investment value}\end{matrix}\right] = \left[\text{savings}\right] - \left[\begin{matrix}\text{stock}\\ \text{changes}\end{matrix}\right] - \left[\begin{matrix}\text{change in holdings of}\\ \text{government bonds}\end{matrix}\right]$ $- CBBOR_{i,t} + \left(\overline{FBOR}_{i,t} + \overline{FGRANT}_{i,t} + fdi_{i,t}\right) \cdot EXR_t$ $- \left[\begin{matrix}\text{Government Central}\\ \text{Bank borrowing}\end{matrix}\right] + \left[\begin{matrix}\text{foreign borrowing, grants,}\\ \text{and direct investment (in LCU)}\end{matrix}\right]$	$i \in INSNG$ $t \in T$	Investment financing for non-government institutions
(52)	$PK_{f,t} \cdot DKINS_{i,f,t} = gfcfshr_{f,i,t} \cdot INVVAL_{i,t}$ $\left[\begin{matrix}\text{non-government spending}\\ \text{on capital stock } f\end{matrix}\right] = \left[\begin{matrix}\text{total fixed investment value}\\ \text{times share for capital stock } f\end{matrix}\right]$	$i \in INSNG$ $f \in FCAP$ $t \in T$	Non-government investment by capital stock
(53)	$DKGOV_{f,t} \geq \sum_{\substack{a \in A \\ (f,a) \in MFA}} \left(ifa_{f,a} \cdot QA_{a,t} \cdot \frac{QA_{a,t}}{QA_{a,t-1}} \right) - QFACINS_{gov,f,t} \cdot (1 - depr_f)$ $\left[\begin{matrix}\text{gross government}\\ \text{investment demand}\\ \text{for capital}\end{matrix}\right] = \left[\begin{matrix}\text{anticipated demand for capital}\\ \text{next year (based on current}\\ \text{production and its growth)}\end{matrix}\right] - \left[\begin{matrix}\text{remaining capital stock}\\ \text{(after depreciation) next}\\ \text{year if no investment}\end{matrix}\right]$	$f \in FCAPGOV$ $t \in T$ $t > 1$	Real government demand for investment in capital stock f

(54)	$DKINS_{gov,f,t} = DKGOV_{f,t}$ $\begin{bmatrix}\text{gross investment in } f \text{ of}\\ \text{institution ins (here "ins" = gov)}\end{bmatrix} = \begin{bmatrix}\text{gross government investment}\\ \text{demand for capital}\end{bmatrix}$	$f \in FCAPGOV$ $t \in T$ $t > 1$	Real government investment in capital stock f
(55)	$QINV_{c,t} = \sum_{f \in FCAP}\left(capcomp_{c,f} \cdot \sum_{i \in INS} DKINS_{i,f,t}\right)$ $\begin{bmatrix}\text{real investment demand}\\ \text{for commodity } c\end{bmatrix} = \begin{bmatrix}\text{demand for c for each type of capital,}\\ \text{summed over all institutions and capital types}\end{bmatrix}$	$c \in C$ $t \in T$	Total real investment demand by commodity

System constraint and macro block

(56)	$QFS_{f,t} = \sum_{i \in INS} QFACINS_{i,f,t}$ $\begin{bmatrix}\text{supply of}\\ \text{factor } f\end{bmatrix} = \begin{bmatrix}\text{sum of all}\\ \text{institutional endowments}\end{bmatrix}$	$f \in F$ $t \in T$	Factor supplies
(57)	$\sum_{a \in A} QF_{f,a,t} = QFS_{f,t}$ $\begin{bmatrix}\text{demand for}\\ \text{market factor } f\end{bmatrix} = \begin{bmatrix}\text{supply of}\\ \text{market factor } f\end{bmatrix}$	$f \in F$ $t \in T$	Factor markets
(58)	$QQ_{c,t} = \sum_{a \in A} QINT_{c,a,t} + \sum_{h \in H} QH_{c,h,t} + QG_{c,t}$ $\begin{bmatrix}\text{composite}\\ \text{supply}\end{bmatrix} = \begin{bmatrix}\text{intermediate}\\ \text{use}\end{bmatrix} + \begin{bmatrix}\text{household}\\ \text{consumption}\end{bmatrix} + \begin{bmatrix}\text{government}\\ \text{consumption}\end{bmatrix}$ $+QINV_{c,t} + \sum_{i \in INS} qdst_{c,i,t} + QT_{c,t}$ $+\begin{bmatrix}\text{fixed}\\ \text{investment}\end{bmatrix} + \begin{bmatrix}\text{stock}\\ \text{change}\end{bmatrix} + \begin{bmatrix}\text{trade and}\\ \text{transport}\end{bmatrix}$	$c \in C$ $t \in T$	Composite commodity markets equilibrium
(59)	$\sum_{c \in CM} pwm_{c,t} \cdot QM_{c,t} + \frac{\sum_{f \in F} YIF_{row,f,t}}{EXR_t} + \frac{\sum_{i \in INSDNG} TRII_{row,i,t}}{EXR_t}$ $\begin{bmatrix}\text{import}\\ \text{spending}\end{bmatrix} + \begin{bmatrix}\text{factor income}\\ \text{to Rest of World}\end{bmatrix} + \begin{bmatrix}\text{transfers from domestic}\\ \text{non-gov institutions to RoW}\end{bmatrix}$ $+trnsfr_{row,gov,t} + \sum_{i \in INSD} fintrat_{i,t} \cdot FDEBT_{i,t}$ $+\begin{bmatrix}\text{transfers from}\\ \text{government to RoW}\end{bmatrix} + \begin{bmatrix}\text{interest payment}\\ \text{on foreign debt}\end{bmatrix}$ $= \sum_{c \in CE} pwe_{c,t} \cdot QE_{c,t} + \sum_{i \in INSDNH} trnsfr_{i,row,t} + \sum_{h \in H} trnsfrpc_{h,row,t} \cdot POP_{h,t}$ $= \begin{bmatrix}\text{export}\\ \text{revenue}\end{bmatrix} + \begin{bmatrix}\text{transfers from RoW to domestic}\\ \text{non-household institutions}\end{bmatrix} + \begin{bmatrix}\text{transfers from RoW to}\\ \text{domestic households}\end{bmatrix}$ $+\sum_{f \in F} trnsfr_{f,row,t} + \sum_{i \in INSD}\left(\overline{FBOR}_{i,t} + \overline{FGRANT}_{i,t}\right) + fdi_{row,t}$ $+\begin{bmatrix}\text{factor income}\\ \text{from RoW}\end{bmatrix} + \begin{bmatrix}\text{borrowing}\\ \text{from RoW}\end{bmatrix} + \begin{bmatrix}\text{grants}\\ \text{from RoW}\end{bmatrix} + \begin{bmatrix}\text{foreign direct}\\ \text{investment}\end{bmatrix}$	$t \in T$	Balance of payments (in foreign currency)

(60)	$$GDPREAL_t = \sum_{c \in C}\sum_{h \in H} PQ_c^0 \cdot QH_{c,h,t} + \sum_{a \in A}\sum_{c \in C}\sum_{h \in H} PXAC_{a,c}^0 \cdot QHA_{a,c,h,t}$$ $$\left[\text{real GDP}\right] = \left[\begin{matrix}\text{household market}\\ \text{consumption}\end{matrix}\right] + \left[\begin{matrix}\text{household own}\\ \text{production consumption}\end{matrix}\right]$$ $$+\sum_{c \in C} PQ_c^0 \cdot QG_{c,t} + \sum_{c \in C} PQ_c^0 \cdot QINV_{c,t} + \sum_{c \in C}\sum_{t \in DNS} PQ_c^0 \cdot qdst_{c,t,t}$$ $$+\left[\begin{matrix}\text{government}\\ \text{consumption}\end{matrix}\right] + \left[\begin{matrix}\text{fixed}\\ \text{investment}\end{matrix}\right] + \left[\begin{matrix}\text{stock}\\ \text{change}\end{matrix}\right]$$ $$+\sum_{c \in CE} EXR^0 \cdot pwe_c^0 \cdot QE_{c,t} - \sum_{c \in CM} EXR^0 \cdot pwm_c^0 \cdot QM_{c,t}$$ $$+\left[\text{exports}\right] - \left[\text{imports}\right]$$	$t \in T$	Real GDP at market prices
(61)	$$TRDGDP_t = \frac{\sum_{c \in CE} EXR^0 \cdot pwe_c^0 \cdot QE_{c,t} + \sum_{c \in CM} EXR^0 \cdot pwm_c^0 \cdot QM_{c,t}}{GDPREAL_t}$$ $$\left[\begin{matrix}\text{ratio of}\\ \text{trade to GDP}\end{matrix}\right] = \frac{\left[\text{real trade}\right]}{\left[\text{real GDP}\right]}$$	$t \in T$	Real Trade-GDP ratio
(62)	$$GDPREALFC_t = \sum_{a \in A} pva_a^0 \cdot \left(1 - tva_{a,t}^0\right) \cdot QVA_{a,t}$$ $$\left[\begin{matrix}\text{real GDP}\\ \text{at factor cost}\end{matrix}\right] = \left[\begin{matrix}\text{value-added}\\ \text{net of taxes}\end{matrix}\right]$$	$t \in T$	Real GDP at factor cost

CORE CGE MODEL: BETWEEN-PERIOD MODULE

Asset stock updating block

(63)	$$POP_{h,t} = POPSCAL_t \cdot POP_{h,t-1} \cdot \frac{\sum_{f \in FLAB} QFACINS_{h,f,t}}{\sum_{f \in FLAB} QFACINS_{h,f,t-1}}$$ $$\left[\begin{matrix}\text{population of}\\ \text{household } h\\ \text{in year } t\end{matrix}\right] = \left[\begin{matrix}\text{population}\\ \text{scaling}\\ \text{factor for } t\end{matrix}\right] \cdot \left[\begin{matrix}\text{population of}\\ \text{household } h\\ \text{in year } t\text{-}1\end{matrix}\right] \cdot \left[\begin{matrix}\text{factor for labor}\\ \text{force growth}\\ \text{for household } h\end{matrix}\right]$$	$h \in H$ $t \in T$ $t > 1$	Population by household
(64)	$$poptot_t = \sum_{h \in H} POP_{h,t}$$ $$\left[\begin{matrix}\text{total population}\\ \text{(exogenous)}\end{matrix}\right] = \left[\begin{matrix}\text{sum of population}\\ \text{for households } h\end{matrix}\right]$$	$t \in T$ $t > 1$	Population by household
(65)	$$QFACINS_{h,f,t} = QFSCAL_{f,t} \cdot POP_{h,t} \cdot qfpc_{h,f,t}$$ $$\left[\begin{matrix}\text{stock of non-labor}\\ \text{factor } f \text{ by household}\end{matrix}\right] = \left[\begin{matrix}\text{scaling}\\ \text{factor}\end{matrix}\right] \cdot \left[\begin{matrix}\text{population for}\\ \text{household } h\end{matrix}\right] \cdot \left[\begin{matrix}\text{per-capita stock}\\ \text{for household } h\end{matrix}\right]$$	$h \in H$ $f \in (FEXOG \cap FLABN)$ $t \in T,\ t > 1$	Non-labor factors with exogenous total stocks
(66)	$$qfachhtot_{f,t} = \sum_{h \in H} QFACINS_{h,f,t}$$ $$\left[\begin{matrix}\text{total household stock of}\\ \text{exogenous, non-labor factors}\end{matrix}\right] = \left[\begin{matrix}\text{sum of disaggregated}\\ \text{household stocks}\end{matrix}\right]$$	$f \in (FEXOG \cap FLABN)$ $t \in T$	Constraint of total household stocks of exogenous, non-labor factors

(67)	$QFACINS_{i,f,t} = QFCAPRED_{i,f,t-1} + DKINS_{i,f,t-1} + qfacinsadj_{i,f,t-1}$ $\begin{bmatrix}\text{stock of capital}\\ \text{type } f \text{ held}\\ \text{by institution } i\end{bmatrix} = \begin{bmatrix}\text{redistributed old}\\ \text{capital stock}\end{bmatrix} + \begin{bmatrix}\text{gross stock}\\ \text{change in t-1}\end{bmatrix} + \begin{bmatrix}\text{exogenous adjustment}\\ \text{in capital stock}\end{bmatrix}$	$i \in INS$ $f \in FCAP$ $t \in T,\ t>1$	Capital stocks by institution
(68)	$QFCAPRED_{i,f,t} = (1-depr_f)\cdot QFACINS_{i,f,t} \quad if\ i \notin H$ $= (1-depr_f)\cdot QFACINS_{i,f,t}\cdot\left(QFSCAL_{f,t}\cdot\frac{POP_{i,t}}{POP_{i,t-1}}\right) \quad if\ i \in H$ $\begin{bmatrix}\text{redistributed old capital}\\ \text{stock by institution } i\end{bmatrix} = \begin{bmatrix}\text{depreciated}\\ \text{capital stock}\end{bmatrix}\cdot\begin{bmatrix}\text{(if institution } i \text{ is a household, then the depreciated}\\ \text{capital stock is scaled for population changes)}\end{bmatrix}$	$i \in INS$ $f \in FCAP$ $t \in T,\ t>1$	Redistribution of old capital stocks
(69)	$\sum_{h\in H} QFCAPRED_{h,f,t} = (1-depr_f)\cdot\sum_{h\in H} QFACINS_{h,f,t}$ $\begin{bmatrix}\text{total redistributed (and}\\ \text{depreciated) household stock}\end{bmatrix} = \begin{bmatrix}\text{sum of disaggregated (and depreciated)}\\ \text{household stocks before redistribution}\end{bmatrix}$	$f \in FCAP$ $t \in T,\ t>1$	Constraint on total household capital stocks after redistribution
(70)	$FDEBT_{i,t} = FDEBTRED_{i,t-1} + FBOR_{i,t-1}$ $+\left(fintratdue_{i,t-1} - fintrat_{i,t-1}\right)\cdot FDEBT_{i,t-1} - fdebtrelief_{i,t-1}$ $\begin{bmatrix}\text{foreign}\\ \text{debt in } t\end{bmatrix} = \begin{bmatrix}\text{redistributed}\\ \text{foreign debt in t-1}\end{bmatrix} + \begin{bmatrix}\text{foreign bor-}\\ \text{rowing in t-1}\end{bmatrix} + \begin{bmatrix}\text{unpaid interest on}\\ \text{foreign debt in t-1}\end{bmatrix} - \begin{bmatrix}\text{foreign debt}\\ \text{relief in t-1}\end{bmatrix}$	$i \in INSD$ $t \in T$ $t>1$	Foreign debt of domestic institutions
(71)	$FDEBTRED_{i,t} = FDEBT_{i,t} \quad if\ i \notin H$ $= FDEBT_{i,t}\cdot\left(FDEBTSCAL_t\cdot\frac{POP_{i,t}}{POP_{i,t-1}}\right) \quad if\ i \in H$ $\begin{bmatrix}\text{redistributed old foreign}\\ \text{debt by institution } i\end{bmatrix} = \begin{bmatrix}\text{original}\\ \text{debt}\end{bmatrix}\cdot\begin{bmatrix}\text{(if institution } i \text{ is a household, then the foreign}\\ \text{debt is scaled for population changes)}\end{bmatrix}$	$i \in INSD$ $t \in T$ $t>1$	Redistribution of old foreign debt
(72)	$\sum_{h\in H} FDEBTRED_{h,t} = \sum_{h\in H} FDEBT_{h,t}$ $\begin{bmatrix}\text{total redistributed}\\ \text{household debt}\end{bmatrix} = \begin{bmatrix}\text{sum of household debts}\\ \text{before redistribution}\end{bmatrix}$	$t \in T$ $t>1$	Constraint on total household foreign debt after redistribution
(73)	$GBOND_{i,t} = GBONDRED_{i,t-1} + DGBOND_{i,t-1}$ $\begin{bmatrix}\text{stock of government}\\ \text{bond held by}\\ \text{institution } i\end{bmatrix} = \begin{bmatrix}\text{redistributed holdings of}\\ \text{stock of government bond}\\ \text{held by institution } i \text{ in t-1}\end{bmatrix} + \begin{bmatrix}\text{government}\\ \text{borrowing}\\ \text{from } i \text{ in t-1}\end{bmatrix}$	$i \in INSDNG$ $t \in T$ $t>1$	Government bond holdings of domestic institutions
(74)	$GBONDRED_{i,t} = GBOND_{i,t} \quad if\ i \notin H$ $= GBOND_{i,t}\cdot\left(GBONDSCAL_t\cdot\frac{POP_{i,t}}{POP_{i,t-1}}\right) \quad if\ i \in H$ $\begin{bmatrix}\text{redistributed old bond}\\ \text{holdings by institution } i\end{bmatrix} = \begin{bmatrix}\text{original}\\ \text{bond holdings}\end{bmatrix}\cdot\begin{bmatrix}\text{(if institution } i \text{ is a household, then the bond}\\ \text{holdings is scaled for population changes)}\end{bmatrix}$	$i \in INSDNG$ $t \in T$ $t>1$	Redistribution of holdings of old government bonds
(75)	$\sum_{h\in H} GBONDRED_{h,t} = \sum_{h\in H} GBOND_{h,t}$ $\begin{bmatrix}\text{total redistributed}\\ \text{household bond holding}\end{bmatrix} = \begin{bmatrix}\text{sum of household bond holdings}\\ \text{before redistribution}\end{bmatrix}$	$t \in T$ $t>1$	Constraint on total household holdings of government bonds after redistribution

(76)	$$\alpha_{va_{a,t}} = \alpha_{va2_{a,t}} \cdot \prod_{f \in FCAP} \left[\frac{\sum_{i \in INS} QFACINS_{i,f,t}}{\sum_{i \in INS} QFACINS^{0}_{i,f}} \right]^{tfpelasvag_{a,f,t}} \cdot \left(\frac{\sum_{t' \in T} tfptrdwt_{t,t'} \cdot TRDGDP_{t'}}{TRDGDP^{o}} \right)^{tfpelastrd_{a}}$$ $$\begin{bmatrix} efficiency \\ term\ for \\ activity\ a \end{bmatrix} = \begin{bmatrix} endogenous \\ trend \\ term\ for \\ activity\ a \end{bmatrix} \cdot \begin{bmatrix} product\ of: ratio\ of\ all \\ current\ real\ capital \\ endowment\ f\ to\ inital \\ value,\ raised \\ to\ the\ relevant\ elasticity \end{bmatrix} \cdot \begin{bmatrix} weighted\ avg.\ (over\ time) \\ of\ ratios\ of\ openness \\ to\ initial\ value,\ raised \\ to\ the\ relevant\ elasticity \end{bmatrix}$$	$a \in A$ $t \in T$	Efficiency (TFP) by activity
(77)	$$\alpha_{va2_{a,t}} = \alpha_{va2_{a,t-1}} \cdot \left(1 + \overline{CALTFPGT}_{t} \cdot tfp01_{a,t} + \overline{\alpha_{vag}}_{a,t}\right)$$ $$\begin{bmatrix} endogenous \\ trend\ term\ for \\ activity\ a \end{bmatrix} = \begin{bmatrix} endogenous \\ trend\ term\ for \\ activity\ a\ in\ t-1 \end{bmatrix} \cdot \begin{bmatrix} growth \\ adjustment \\ factor \end{bmatrix}$$	$a \in A$ $t \in T$ $t > 1$	TFP trend term by activity

Annex: 8 Activity Account

Sector	Code	Description	ISIC
		Industry	
15	**amining**	Mining and quarrying	1010-1429
16	**aofood**	Production, processing and preserving of meat and meat products	1511
		Production and preserving of fish and fish products	1512
		Processing and preserving of fruit and vegetables	1513
		Manufacture of vegetables and animal oils and fats	1514
		Manufacture of prepared animal feeds	1533
		Manufacture of bakery products	1541
		Manufacture of macaroni, noodles, couscous and similar farinaceous products	1544
		Manufacture of other food products n.e.c.	1549
17	**adairy**	Manufacture of dairy products	1520
18	**agmill**	Manufacture of grain mill products	1531
19	**agmillserv**	Manufacture of grain mill services	1532
20	**asug**	Manufacture of sugar	1542
		Manufacture of cocoa, chocolate and sugar confectionery	1543
21	**abev**	Distilling, rectifying and blending of spirits; ethyl talc production from fermented materials	1551
		Manufacture of wines	1552
		Manufacture of malt liquors and malt	1553
		Manufacture of soft drinks; production of mineral waters	1554
22	**amtob**	Manufacture of tobacco products	1600
23	**atext**	Preparation and spinning of textile fibers; weaving of textiles	1711
		Finishing of textiles	1712
		Manufacture of made-up textile articles, except apparel	1721
		Manufacture of carpets and rugs	1722
		Manufacture of cordage, rope, twine and netting	1723
		Manufacture of other textiles n.e.c.	1729
		Manufacture of knitted and crocheted fabrics and articles	1730
24	**aapar**	Manufacture of wearing apparel except fur apparel	1810
25	**aleath**	Tanning and dressing of leather	1911
		Manufacture of luggage handbags and the like, saddler and harness	1912
		Manufacture of footwear	1920
26	**awood**	Wood and wood products	20
27	**apaperp**	Manufacture of paper and paper products; publishing; printing	21,22
28	**achem**	Manufacture of chemicals, rubber and plastic products	24, 25
29	**aminprod**	Manufacture of mineral products	26
30	**abmetalp**	Manufacture of basic iron and steel	2710
		Manufacture of metal products	28
31	**amach**	Manufacture of ovens, furnaces and furnace burners	2914
		Manufacture of machinery for food, beverage and tobacco processing	2925
32	**aelecq**	Manufacture of office, accounting and computing machinery	3000
		Manufacture of accumulators, primary cells and primary batteries	3140
33	**aveh**	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	3420
		Manufacture of parts and accessories for motor vehicles and their engines	3430
34	**aomanu**	Manufacture of furniture	3610
		Manufacture of jewelry and related articles	3691

Continued

Sector	Code	Description	ISIC
		Agriculture	
1	**atef 1-5**	Growing of Teff	in 011
2	**abar 1-5**	Growing of Barley	in 011
3	**awhea 1-5**	Growing of Wheat	in 011
4	**amaiz 1-5**	Growing of Maize	in 011
5	**asorg 1-5**	Growing of Sorghum	in 011
6	**apul 1-5**	Growing of Pulses	in 011
7	**avegfr 1-5**	Growing of Vegetables and Fruits nec	in 011
8	**aoils 1-5**	Growing of Oil seeds	in 011
9	**acash 1-5**	Growing of Cash crops nec: Sugar cane and beet, tea, chat, plant-based fibers, cotton	in 011
10	**aenset 1-5**	Growing of Enset	in 011
11	**acrop 1-5**	Growing of crops nec	in 011
12	**acoff 1-5**	Growing of Coffee	in 011
13	**alivst 1-5**	Livestock farming, dairy farming, production of animal products	0121,0122
14	**afisfor**	Forestry and fishing	
		Services	
35	**aelect**	Electricity, gas, steam and hot-water supply	40
36	**afwater**	Activity of collecting(fetching) free water-(own consumption by HH)	41
37	**awater**	Collection purification and distribution of Water	41
38	**acons**	Construction	45
39	**atrad**	Wholesale and retail trade; repair of Motor vehicles, motorcycles and personal and household goods.	50,51,52
40	**ahotel**	Hotels and Restaurants	55
41	**atrncom**	Transport, Storage and communications	60-64
42	**afserv**	Financial intermediation	65,66,67
43	**arest**	Real Estate, Renting and Business Activities	70,71
44	**apadmin**	Public administration	75
45	**aeduc**	Education	80
46	**aheal**	Health and Social Work	85
47	**aoserv**	Business Activities	72,73,74
		Other Community, Social and Personal Service activities	90-93
		Private Households with Employed Persons	95

Annex: 9 Commodity account

No.	Code	Description
		Agricultural Marketed Commodities
1	ctef	Teff
2	cbar	Barley
3	cwhea	Wheat
4	cmaiz	Maize
5	Csorg	Sorghum
6	cpul	Pulses
7	cveg	Vegetables nec
8	coils	Oil seeds
9	ccotts	Cotton Seed
10	ccane	Sugar cane sugar beet
11	cfruit	Fruit Crops
12	ctea	Tea
13	cchat	Chat
14	ccoff	Coffee
15	Censet	Enset
16	ccrop	Cereal grains and other crops nec
17	cfibre	Plant-based fibers
18	ccatt	Cattle
19	cpoul	Poultry; Other small livestock
20	cmilk	Raw milk
21	ccott	Raw cotton, Wool, silk-worm cocoons
22	caprod	Animal products nec
23	cfors	Forestry products
24	cflower	Flowers
25	cfish	Fish
		Marketed Services
56	celect	Electricity
57	cwater	Water
58	ccons	Construction
59	ctrad	Trade and repair services
60	chotel	Hotels and restaurants
61	ctrans	Transport services
62	ccomm	Communication
63	cfserv	Financial services
64	cbserv	Business services nec
65	cpadmin	Public administration and defense
66	ceduc	Education
67	cheal	Health
68	coserv	Recreation and other services
69	crest	Real estate and renting services

Continued

No.	Code	Description
		Marketed Industrial Commodities
26	**ccoal**	Coal
27	**cngas**	Gas
28	**cmin**	Minerals nec
29	**cmeat**	Meat products
30	**cvprod**	Vegetable products; animal oils and fats
31	**cdairy**	Dairy products
32	**csug**	Sugar and sugar confectionary
33	**cgmill**	Grain mill products
34	**cgmillserv**	Grain mill services
35	**cfood**	Food products nec; animal feeds
36	**cbev**	Beverages
37	**ctob**	Tobacco Products
38	**cmtea**	Manufacturing of tea
39	**cmtob**	Manufacturing of tobacco
40	**clcott**	Lintel Cotton
41	**ctext**	Textiles
42	**capar**	Wearing apparel
43	**cleath**	Leather products
44	**cwood**	Wood products
45	**cpaper**	Paper products publishing
46	**coilptrl**	Petroleum coal products
47	**cfert**	Fertilizers
48	**cchem**	Chemicals, rubber and plastic products
49	**cminprod**	Mineral products nec
50	**cmetal**	Metals nec
51	**cmprod**	Metal products
52	**cveh**	Motor vehicles and parts; other transport equipment
53	**celecq**	Electronic equipment
54	**cmach**	Machinery and equipment nec
55	**comanu**	Manufactures nec

Continued

No.	Code	Description
		Own-Consumed Agricultural Commodities
70	**ctefo**	Teff
71	**cbaro**	Barley
72	**cwheao**	Wheat
73	**cmaizo**	Maize
74	**cpulo**	Pulses
75	**cvego**	Vegetables nec
76	**coilso**	Oil seeds
77	**ccaneo**	Sugar cane sugar beet
78	**cfruito**	Fruit Crops
79	**cchato**	Chat
80	**ccoffo**	Coffee
81	**ccropo**	Cereal grains and other crops nec
82	**cpoulo**	Poultry; Other small livestock
83	**cmilko**	Raw milk
84	**ccotto**	Raw cotton, Wool, silk-worm cocoons
		Own-Consumed Processed Commodities
85	**caprodo**	Animal products nec
86	**cforso**	Forestry products
87	**cfisho**	Fish
88	**cmeato**	Meat products
89	**cdairyo**	Dairy products
		Own-Consumed Services
90	**cfwatero**	Water collection
91	**cresto**	Housing

Annex: 10 Basic structure of SAM

	Expenditures								
Receipts	Activities	Commodities	Factors	Households	Enterprises	Government	Savings-Investment	Rest of the World (ROW)	Total
Activities		Marketed outputs		Home-consumed outputs					Activity income (gross output)
Commodities	Intermediate inputs	Transaction costs		Private consumption		Government consumption	Investment	Exports	Demand
Factors	Value-added							Factor income from ROW	Factor income
Households			Factor income to households	Interhousehold transfers	Surplus to households	Transfers to households		Transfers to households from ROW	Household income
Enterprises			Factor income to enterprises			Transfers to enterprises		Transfers to enterprises from ROW	Enterprise income
Government	Producer taxes, value-added tax	Sales taxes, tariffs, export taxes	Factor income to government, factor taxes	Transfers to government, direct	Surplus to Government, direct enterprise taxes			Transfer to Government from ROW	Government income
Savings-Investment				Household savings	Enterprise savings	Government savings		Foreign savings	Savings
Rest of the World (ROW)		Imports	Factor income to ROW		Surplus to ROW	Government transfers to ROW			Foreign exchange outflow
Total	Activity	Supply expenditures	Factor expenditures	Household expenditures	Enterprise expenditures	Government expenditures	Investment	Foreign exchange inflow	

Annex: 11 Mathematical model

SETS

$\alpha \in A$	activities
$\alpha \in ACES (\subset A)$	activities with a CES function at the top of the technology nest
$\alpha \in ALEO (\subset A)$	activities with a Leontief function at the top of the technology nest
$c \in C$	commodities
$c \in CD (\subset C)$	commodities with domestic sales of domestic output
$c \in CDN (\subset C)$	commodities not in CD
$c \in CE (\subset C)$	exported commodities
$c \in CEN (\subset C)$	commodities not in CE
$c \in CM (\subset C)$	imported commodities
$c \in CMN (\subset C)$	commodities not in CM
$c \in CT (\subset C)$	transactions service commodities
$c \in CX (\subset C)$	commodities with domestic production
$f \in F$	factors
$i \in INS$	institutions (domestic and rest of the world)
$i \in INSD (\subset INS)$	domestic institutions
$i \in INSDNG$ $(\subset INSD)$	domestic nongovernment institutions
$h \in H (\subset INSDNG)$	households

PARAMETERS

Latin Letters

$cwts_c$	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

Continued

	iva_a	quantity of value-added per activity unit
	$\overline{mps_i}$	base savings rate for domestic institution i
	$mps01_c$	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
	te_c	export tax rate
	tf_f	direct tax rate for factor f
	$\overline{tins_i}$	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
	tva_a	rate of value-added tax for activity a
Greek Letters	α_a^a	efficiency parameter in the CES activity function
	α_a^{va}	efficiency parameter in the CES value-added function
	α_a^{ac}	shift parameter for domestic commodity aggregation function
	α_c^q	Armington function shift parameter
	α_c^t	CET function shift parameter
	β_{ach}^h	marginal share of consumption spending on home commodity c from activity a for household h
	β_{ch}^m	marginal share of consumption spending on marketed commodity c for household h
	δ_a^a	CES activity function share parameter
	δ_{ac}^{ac}	share parameter for domestic commodity aggregation function
	δ_c^q	Armington function share parameter
	δ_c^t	CET function share parameter
	δ_{fa}^{va}	CES value-added function share parameter for factor f in activity a
	γ_{ch}^m	subsistence consumption of marketed commodity c for household h
	γ_{ach}^h	subsistence consumption of home commodity c from activity a for household h

Continued

	θ_{ac}	yield of output c per unit of activity a
	ρ_a^a	CES production function exponent
	ρ_a^{va}	CES value-added function exponent
	ρ_c^{ac}	domestic commodity aggregation function exponent
	ρ_c^q	Armington function exponent
	ρ_c^t	CET function exponent
EXOGENOUS VARIABLES	$\overline{CPI}$	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 factor
	$\overline{IADJ}$	investment adjustment factor
	$\overline{MPSADJ}$	savings rate scaling factor (= 0 for 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
ENDOGENOUS VARIABLES	$DMPS$	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*)
	$GOVSHR$	government consumption share in nominal absorption
	$GSAV$	government savings
	$INVSHR$	investment share in nominal absorption
	MPS_i	marginal propensity to save for domestic non-government institution (exogenous variable)
	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_c	export price (domestic currency)
	$PINTA_a$	aggregate intermediate input price for activity a
	PM_c	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

Continued

QE_c	quantity of exports
QF_{fa}	quantity demanded of factor f from activity a
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 household 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_c	quantity of imports of commodity
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 marketed quantity of domestic output of commodity
$QXAC_{ac}$	quantity of marketed output of commodity c from activity a
$TABS$	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 f
YF_f	income of factor f
YG	government revenue
YI_i	income of domestic nongovernment institution
YIF_{if}	income to domestic institution i from factor f

Annex: 12 Core GAMS codes for standard CGE Model

```
*SETS ========================================================

AC              global set for model accounts-aggregated microsam 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


*PARAMETERS ==================================================

 Parameters     other than tax rates
 alphaa(A)      shift parameter for top level CES function
 alphaac(C)     shift parameter for domestic commodity aggregation fn
 alphaq(C)      shift parameter for Armington function
 alphat(C)      shift parameter for CET function
 alphava(A)     shift parameter for CES activity production function
 betah(A,C,H)   marg shr of hhd cons on home com c from act a
 betam(C,H)     marg share of hhd cons on marketed commodity c
 cwts(C)        consumer price index weights
 deltaa(A)      share parameter for top level CES function
 deltaac(A,C)   share parameter for domestic commodity aggregation fn
 deltaq(C)      share parameter for Armington function
 deltat(C)      share parameter for CET function
 deltava(F,A)   share parameter for CES activity production function
 dwts(C)        domestic sales price weights
 gammah(A,C,H)  per-cap subsist cons for hhd h on home com c fr act a
 gammam(C,H)    per-cap subsist cons of market com c for hhd h
 ica(C,A)       intermediate input c per unit of aggregate intermediate
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Continued…

```
 inta(A)          aggregate intermediate input coefficient
 iva(A)           aggregate value added coefficient
 icd(C,CP)        trade input of c per unit of com cp produced & sold dom'ly
 ice(C,CP)        trade input of c per unit of com cp exported
 icm(C,CP)        trade input of c per unit of com cp imported
 mps01(INS)       0-1 par for potential flexing of savings rates
 mpsbar(INS)      marg prop to save for dom non-gov inst ins (exog part)
 qdst(C)          inventory investment by sector of origin
 qbarg(C)         exogenous (unscaled) government demand
 qbarinv(C)       exogenous (unscaled) investment demand
 rhoa(A)          CES top level function exponent
 rhoac(C)         domestic commodity aggregation function exponent
 rhoq(C)          Armington function exponent
 rhot(C)          CET function exponent
 rhova(A)         CES activity production function exponent
 shif(INS,F)      share of dom. inst i in income of factor f
 shii(INS,INSP)   share of inst i in post-tax post-sav income of inst ip
 supernum(H)      LES supernumerary income
 theta(A,C)       yield of commodity c per unit of activity a
 tins01(INS)      0-1 par for potential flexing of dir tax rates
 trnsfr(INS,AC)   transfers fr inst. or factor ac to institution ins
*Tax rates
 ta(A)            rate of tax on producer gross output value
 te(C)            rate of tax on exports
 tf(F)            rate of direct tax on factors (soc sec tax)
 tinsbar(INS)     rate of (exog part of) direct tax on dom inst ins
 tm(C)            rate of import tariff
 tq(C)            rate of sales tax
 tva(A)           rate of value-added tax

*VARIABLES ============================================================

CPI               consumer price index (PQ-based)
DPI               index for domestic producer prices (PDS-based)
DMPS              change in marginal propensity to save for selected inst
DTINS             change in domestic institution tax share
EG                total current government expenditure
EH(H)             household consumption expenditure
EXR               exchange rate
FSAV              foreign savings
GADJ              government demand scaling factor
GOVSHR            govt consumption share of absorption
GSAV              government savings
IADJ              investment scaling factor (for fixed capital formation)
INVSHR            investment share of absorption
MPS(INS)          marginal propensity to save for dom non-gov inst ins
MPSADJ            savings rate scaling factor
PA(A)             output price of activity a
```

Continued

```
PDD(C)            demand price for com c produced & sold domestically
PDS(C)            supply price for com c produced & sold domestically
PE(C)             price of exports
PINTA(A)          price of intermediate aggregate
PM(C)             price of imports
PQ(C)             price of composite good c
PVA(A)            value added price
PWE(C)            world price of exports
PWM(C)            world price of imports
PX(C)             average output price
PXAC(A,C)         price of commodity c from activity a
QA(A)             level of domestic activity
QD(C)             quantity of domestic sales
QE(C)             quantity of exports
QF(F,A)           quantity demanded of factor f from activity a
QFS(F)            quantity of factor supply
QG(C)             quantity of government consumption
QH(C,H)           quantity consumed of marketed commodity c by household h
QHA(A,C,H)        quantity consumed of home commodity c fr act a by hhd h
QINT(C,A)         quantity of intermediate demand for c from activity a
QINTA(A)          quantity of aggregate intermediate input
QINV(C)           quantity of fixed investment demand
QM(C)             quantity of imports
QQ(C)             quantity of composite goods supply
QT(C)             quantity of trade and transport demand for commodity c
QVA(A)            quantity of aggregate value added
QX(C)             quantity of aggregate marketed commodity output
QXAC(A,C)         quantity of ouput of commodity c from activity a
TABS              total absorption
TINS(INS)         rate of direct tax on domestic institutions ins
TINSADJ           direct tax scaling factor
TRII(INS,INSP)    transfers to dom inst insdng from insdngp
WALRAS            Savings-Investment imbalance (should be zero)
WF(F)             economy-wide wage (rent) for factor f
WFDIST(F,A)       factor wage distortion variable
YF(F)             factor income
YG                total current government income
YIF(INS,F)        income of institution ins from factor f
YI(INS)           income of (domestic non-governmental) institution ins

*EQUATIONS ==========================================================

*Price block  ========================================================
 PMDEF(C)         domestic import price
 PEDEF(C)         domestic export price
 PDDDEF(C)        demand price for com c produced and sold domestically
 PQDEF(C)         value of sales in domestic market
 PXDEF(C)         value of marketed domestic output
```

Continued

```
 PADEF(A)          output price for activity a
 PINTADEF(A)       price of aggregate intermediate input
 PVADEF(A)         value-added price
 CPIDEF            consumer price index
 DPIDEF            domestic producer price index

*Production and trade block ==========================================
 CESAGGPRD(A)      CES aggregate prod fn (if CES top nest)
 CESAGGFOC(A)      CES aggregate first-order condition (if CES top nest)
 LEOAGGINT(A)      Leontief aggreg intermed demand (if Leontief top nest)
 LEOAGGVA(A)       Leontief aggreg value-added demand (if Leontief top nest)
 CESVAPRD(A)       CES value-added production function
 CESVAFOC(F,A)     CES value-added first-order condition
 INTDEM(C,A)       intermediate demand for commodity c from activity a
 COMPRDFN(A,C)     production function for commodity c and activity a
 OUTAGGFN(C)       output aggregation function
 OUTAGGFOC(A,C)    first-order condition for output aggregation function
 CET(C)            CET function
 CET2(C)           domestic sales and exports for outputs without both
 ESUPPLY(C)        export supply
 ARMINGTON(C)      composite commodity aggregation function
 COSTMIN(C)        first-order condition for composite commodity cost min
 ARMINGTON2(C)     comp supply for com without both dom sales and imports
 QTDEM(C)          demand for transactions (trade and transport) services

*Institution block ===================================================
 YFDEF(F)          factor incomes
 YIFDEF(INS,F)     factor incomes to domestic institutions
 YIDEF(INS)        total incomes of domest non-gov't institutions
 EHDEF(H)          household consumption expenditures
 TRIIDEF(INS,INSP) transfers to inst ins from inst insp
 HMDEM(C,H)        LES cons demand by hhd h for marketed commodity c
 HADEM(A,C,H)      LES cons demand by hhd h for home commodity c fr act a
 INVDEM(C)         fixed investment demand
 GOVDEM(C)         government consumption demand
 EGDEF             total government expenditures
 YGDEF             total government income

*System constraint block  ============================================
 COMEQUIL(C)       composite commodity market equilibrium
 FACEQUIL(F)       factor market equilibrium
 CURACCBAL         current-account balance (of RoW)
 GOVBAL            government balance
 TINSDEF(INS)      direct tax rate for inst ins
 MPSDEF(INS)       marg prop to save for inst ins
 SAVINVBAL         Savings-Investment balance
 TABSEQ            total absorption
 INVABEQ           investment share in absorption
 GDABEQ            government consumption share in absorption
```

DECLARATION

I, the undersigned, declare that this thesis is my original research work, prepared under the guidance of Girma Estiphanos (PhD) and Ermias Engida. All sources of materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted either in part or in full to any other higher learning institution for the purpose of earning any degree.

Eshetu Lemma Haile

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Name	Signature & date