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Addis Ababa University

School of Graduate Studies

The Effect of Improved Productivity of the Manufacturing Industry on the Ethiopian Economy: A Computable General Equilibrium Analysis

By

Bethelhem Berhane Kidane

A Thesis Submitted to the Department of Economics Presented in Partial Fulfilment of the Requirements for the Degree of Masters of Science in Economics (International Economics)

Addis Ababa, Ethiopia

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This is to certify that the thesis prepared by Bethelhem Berhane, entitled: *The Effect of Improved Productivity of The Manufacturing Industry Ethiopian Economy* and submitted in partial fulfilment of the requirements for the degree of Master of Science (International Economics) complies with the regulations of the University and meets the accpted standards with respect to originality and quality.

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Examiner Bamlak Alamirew Signature ________ Date 27/06/2012

Advisor Tadele Ferede Signature ________ Date 13/06/12

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ABSTRACT

The Effect of Improved Productivity of the Manufacturing Industry on the Ethiopian Economy: A Computable General Equilibrium Analysis

Bethelhem Berhane

Ethiopia's manufacturing industry is at the onset of development though there are recent upsurges in the number of firms. This study examines the effect of productivity improvement of the manufacturing sector on the macro economy, sectoral output, factor and household income and welfare of households. In order to investigate this impact, the study utilized the recursive dynamic computable general equilibrium (CGE) model. The recently updated 2005/06 Ethiopian SAM was used to calibrate the CGE framework. Three policy simulations of high, medium and low TFP growth rates were simulated on textile, leather, agro processing, and non-agro processing and overall manufacturing activities.

The study demonstrated that the manufacturing sector is a key driver of economic growth in particular; the findings suggest that productivity increase in textile, agro processing, and non-agro processing and overall manufacturing sector largely increases real GDP and sectoral outputs. Moreover, both rural and urban households are well-off in all the policy simulations. However, increasing the TFP of the leather sector alone showed no significant change on the macro variables like; real GDP, absorption, private consumption and investment. It also resulted in welfare loss to all households except rural poor. The study further extends its recommendation for Ethiopia to develop a strong industrial policy aimed towards promoting both agro and non-agro processing industries.

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I dedicate this thesis to my Mother W/ro Mulu Kifle and hope she is proud of her little girl. To my father Ato Berhane Kidane, you have pushed me to achieve my dreams. My sister, my brother, my friends, Doyo and Taiki I thank you for believing in me and being my support system. To Elias thank you for being with me through thick and thin.

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List of Acronyms and Abbreviations

ADLI	–	Agricultural Development Led Industrialization
AEZ	–	Agro-Ecological Zone
CES	–	Constant Elasticity of Substitution
CET	–	Constant Elasticity of Transformation
CGE	–	Computable General Equilibrium
CPI	–	Consumer Price Index
CSA	–	Central Statistical Agency
DESA	–	Department of Economic and Social Affairs
EDRI	–	Ethiopian Development Research Institute
EEA	–	Ethiopian Economic Association
EPRDF	–	Ethiopian People's Revolutionary Democratic Front
ESSP	–	Ethiopia Strategy Support Program
EV	–	Equivalent Variation
GAMS	–	General Algebraic Modeling Systems
GDP	–	Gross Domestic Product
GE	–	General Equilibrium
GTP	–	Growth and Transformation Plan
GVO	–	Gross Value of Output
IDS	–	Industrial Development Strategy
IFPRI	–	International Food Policy Research Institute
IMF	–	International Monetary Fund

MDG	–	Millennium Development Goals
MoFED	–	Ministry of Finance and Development Economics
MoTI	–	Ministry of Trade and Industry
MSE	–	Medium and Small scale Enterprises
MVA	–	Manufacturing Value Added
NBE	–	National bank of Ethiopia
PASEDEP	–	Plan for Accelerated and Sustained Development to End Poverty
ROW	–	Rest of World
SAM	–	Social Accounting Matrix
S-I	–	Saving-Investment
UNCTAD	–	United Nations Conference on Trade and Development
UNIDO	–	United Nations Industrial Development Organization
VAT	–	Value Added Tax
WTO	–	World Trade Organization

Chapter One: Introduction

1.1 Background of the Study

Industrialization is the progression of social and economic change that alters the system of an economy from agrarian into an industrial system. It is a part of a wider modernization process, where social changes and economic developments are closely related with technological innovation engaging in the process of building up a country's capacity to convert raw materials into new products (UNIDO&UNCTAD, 2011). The process of industrialization is accompanied by an increase in output and involves mounting complexity of production that demands greater reliance on other sectors. In the mid 18^{th} and 19^{th} centuries the idea of industrial revolution flourished in Europe and North America later overwhelming the whole world.

According to UNCTAD and UNIDO (2011), Industrial sector is composed of manufacturing, mining and construction where the manufacturing sector dominates. Manufacturing is defined as the transformation of materials and substances into new products. The transformation could be physical or chemical but either ways; the process involves value adding to raw materials that are derived from agriculture, forestry, and mining and from the manufacturing sectors itself. Manufacturing industry is the "engine of growth", since it raises productivity through dynamic increasing returns and in generating high levels of growth and productivity (Weiss, 2011). It plays the role of aiding in technological innovation and diffusions to the other sectors.

This can also be explained by the high forward and backward linkages and spill over effects the sector has in contrast to the service and agriculture sector. The sector has advantages over the agricultural sector in terms of raising productivity since a raise in the share of manufacturing in total output raises the average productivity of the economy as a whole and in expanding export market, this is due to the fact that the share of agriculture in total household expenditure falls as per capita income rises while the share of manufactures increases. Another role that the manufacturing sector plays, is aiding in technological innovation and diffusions to the other sectors. The manufacturing sector is most important for African countries since it is considered as the means for sustained economic growth and employment opportunities and a way out of poverty compared to the other types of industries (UNCTAD and UNIDO 2011).

Ethiopia has a long history of imperial rule up until 1974, followed by a military dictatorship (1974-1991) and from 1991 till present EPRDF took control. Under the last king of the imperial regime, economic progress was sluggish with poor performance from all the sectors including agricultural and industry. To improve the situation emperor Haileselassie passed several laws and legislations and presented different incentives like tax exemptions imposition of banns and tariffs so as to protect and encourage investors. In the 1950's and 1970's the emperor initiated a series of five year development plans with a private-led import substitution policy (Tsegaye, 2011). Throughout this plan there were increased manufacturing activities and emphasis was given to agro processing industrial activities and small scale industries were left out from the picture as the incentives only benefited medium and large scale industries (MEDaC, 1999). In general, imperial Ethiopia's industrial policies failed to have a substantial impact on the economy.

When Emperor Haileselassie was deposed in 1974 by the military dictatorship, it was an occasion for a reform. The Derg introduced the socialist economy and it was the rule of the day. In 1975, Derg turned the economy to being dependent on publicly owned industries and started nationalizing private properties while in the process severely harming the economy. Besides from being granted with market monopoly, foreign exchange, labor and credit were strictly allocated to state owned manufacturing industries. The "Ten Year Perspective Plan" of 1984/85-1993/94, adopted the same industrialization policies with that of the imperial regime but under the control of the state i.e. state-led import substitution industrialization. The policies followed by Derg only resulted in misallocation of resources to unproductive subsectors (Public enterprises) with no significant improvement in the structure and development of the industrial sector. It didn't take too long for socialism to fail with its policies, in 1974 the communist military junta seized power and EPRDF took the seat.

The new government launched reforms for reconstruction of the country and announced a market-based economy. From lessons learned from the previous governments the EPRDF recognised the role of the private sector and hence privatized many state-owned firms, encouraged competition, and reduced government intervention in trade and factor markets (Tilmann, 2010). The government do away with the preferential access to credit, labour and foreign exchange for public enterprises and lifted the restrictions on private sector investment capital (MEDaC, 1999). Along with Agricultural Development Led Industrialization (ADLI), which was launched in 1994, the government followed export-oriented industrialization policies with the expansion of labour intensive industries.

1.2 Statement of the Problem

Industrialized economies are characterized by having a strong manufacturing sector with linkages between and within sectors each being equally strong and dependent on the other. Their manufacturing sector is wide based and fragmented which enabled the labour abundant, low-wage economies to be integrated into global production either as a contract supplier or own manufacturers (Thoburn, 2000). According to UNIDO (2009), there is strong correlation between the sophistication of the output produced by the manufacturing sector and economic growth; countries that have recently shown rapid growth like East Asian are good examples. Having manufacturing sector at their core, the most industrialized countries have a well thought-out industrial policy that is designed to target industries with high productivity growth and technological transfers and support industries at their take-off stage (Weiss, 2011).

Under developed countries are non industrialized countries that are still dependent on vulnerable and erratic agricultural sector in the 21st century. Their manufacturing sector is fragile with weak and unbalanced linkages and spill over effects producing unsophisticated basic consumer goods (UNIDO, 2009). Ethiopia is no different; the economy is dependent on agriculture as a source of growth, employment and foreign currency. It contributes almost half of real growth in GDP, and employs 85% of the total population. It is the major source of foreign currency through exports of agricultural products with coffee accounting for 40% of total exports (African Development Bank Group, 2010).

The structure of Ethiopian manufacturing sector can be summarized as being largely labour intensive dominated by the large and medium consumer goods manufacturing of which agro processing industries dictate in terms of growth, employment contribution and value added (Padma and Swamy, 2004). It accounts for about 13% of GDP and 5% of total employment in 2010. The sector is the least contributor to total value added; the total manufacturing value added (MVA) was no more than 5% of GDP. Moreover, MVA is narrow based functioning with the contribution of few sectors; food and beverages industry accounted more than 35% of MVA (CSA, 2011). The sector is mainly engaged in the production of basic consumer goods to cater for the local market. However, it even fails to fully capture the local demands thus, is faced with the most import competition; 34.7% of total demand for manufactured goods is supplied by imports (EDRI, 2009). There is high dependency on agriculture and itself for intermediate input (manufactured inputs account for 35.4% of the sector's gross output) which contributes to it being vulnerable to the problems that the agricultural sector faces that is evident for its volatility.

There is no industrial policy for Ethiopia that aims at promoting industrial development; the 2003's Industrial Development Strategy is the only step towards ratifying an industrial policy that could stand on its own. The strategy was so designed to give the government the role of filling the market gap by creating favourable conditions for the private sector and involving in the activities where the private sector is unable to participate. The strategy identifies key sectors of manufacturing industry which include; textile and garment, meat, leather products and agro-processing industries (Tadele *et al.*, 2006).

Besides having no industrial policy, the policies so far implemented by the government are pro agriculture; in that priority is given to the agricultural sector and the other sectors are considered to be second in line. Even ADLI bases itself on agriculture and lets the other sectors to be an out effect of it. These kinds of policies and strategies had made it impossible for the manufacturing sector to develop and fulfil its role of being the driver of economic growth. In 2010, the government has also set targets in improving the industrial sector in the newly introduced national development plan namely the Growth and Transformation Plan (GTP) that aims at attaining social issues, good governance and creation of a solid source of growth (MOFED, 2010). But the effect of these massive improvements in the manufacturing sector on other sectors has not been fully investigated.

Bulk of empirical studies were conducted to examine the role of manufacturing industry on economic development for both developed and developing countries such as; Robinson *et al.* (1999), Ghatax and Roberts (1997), Libanio (2006), Kim and Cho (2006) and Cororaton and Orden (2008). Studies like; Urgaia (2007) and Tadele *et al.* (2006) also tried to see the manufacturing sector of Ethiopia and its link with the economy.

The first inspiration for this study comes from the research gaps identified from the previous studies conducted regarding the manufacturing industry and industrial policy and strategies and its repercussion on the economy. Secondly, there is little research work that analyzed the impact of industrial performance on the economy of Ethiopia using dynamic Computable General Equilibrium (CGE) model, which is more powerful for policy evaluation.

1.3 Objectives of the Study

The central objective of the study is to analyze the long run effect of improved productivity of the manufacturing industry on the economy of Ethiopia by using a dynamic computable general equilibrium modeling.

The specific objectives of this thesis are to assess the macroeconomic, factor income, household income and welfare effects of:

- changes in the productivity growth of the textile industry;
- changes in the productivity growth of the leather industry;
- changes in the productivity growth of agro-processing industries;
- changes in the productivity growth of non-agro processing industries and;
- changes in combinations of the above industrial policies.

1.4 Methodology of the Study

In this thesis, we used a dynamic Computable General Equilibrium model in an attempt to attain the objectives set, since it provides an economy wide evaluation of policies. The dynamic CGE is calibrated with the 2005/06 SAM of Ethiopia which is updated in 2009. The study employs three scenarios of productivity increase in the manufacturing activities so as to observe the impact on macroeconomic variables, income and welfare which are High case scenario (SIM1), Medium case Scenario (SIM2) and Low case scenario (SIM3).

All the three scenarios were compared to the business as usual, base simulation assuming the economy continues with it past trends with no policy shock. Scenarios are conducted five times each time on priority sectors; textile, leather, agro processing, non-agro processing and on the overall manufacturing sector. Data collected from the Central Statistical Agency (CSA) of Ethiopia were used to see the trend and performance of the manufacturing sector.

1.5 Scope of the Study

This study is basically limited to analyzing the effects of improved productivity of the manufacturing industry on the Ethiopian economy. Furthermore, it focuses on economic growth, factor and household income and welfare among many micro and macro variables. The study is based on the recent and updated 2005/06 SAM for Ethiopia formulated by IFPRI. The simulation period covered in this study is only for five years (2010-2015).

1.6 Limitations of the Study

In conducting this study, we simulated policy shocks only to the manufacturing industry, which may not be the same had policies of agricultural and services were incorporated. Furthermore, growth of TFP was not estimated in conducting this simulation however, growth rate of manufacturing value added were used to implicitly proxy TFP shocks.

1.7 Significance of the study

Most of the studies conducted regarding the manufacturing industry and economic growth and on industrial policy and strategies have only applied partial equilibrium analysis. This study would contribute in developing policies as the analysis employs General Equilibrium which enables to see the economy wide effect. Moreover, the implications from the simulation analysis would help in dictating the formulation of Ethiopia's industrial strategy and policy.

1.8 Organization of the Paper

The organization of the paper is as follows: chapter one presents the overall purpose of the study. The second chapter reviews theoretical and empirical literatures on manufacturing industry and economic growth. The third chapter gives an overview on the manufacturing sector of Ethiopia. The fourth chapter introduces the data base (SAM) and specifies the theoretical framework for the Dynamic CGE model used in this study. The fifth chapter discusses the results and findings of the dynamic CGE models. The final chapter, chapter six, concludes and provides implications for policy and future research agenda.

Chapter Two: Literature Review

In this section, we begin by briefly reviewing the theories behind manufacturing industry and economic growth, and then a discussion on the empirical literatures will be given.

2.1 Theoretical Review

For a lay man industrialization could be defined crudely as the transformation from manual labour based system into a system of machines and manufactured goods. But the term incorporates very wide issues. Industrialization is a historical phase where there is an overall transformation of a society's progression from farm production to manufacturing production while depending on technology to solve problems rather than nature. It is part of a wider modernization process, where social changes and economic developments are closely related with technological innovation. It is accompanied by an increase in output and involves increasing complexity of production and demands greater reliance on other sectors. It is not a simple accumulation of capital but involves a dynamic process involving time and space (UNIDO, 2009).

Since the 18th century many economists had a mission to publicize theories of economic growth and to establish the drivers of economic growth. Through this quest, numerous theoretical literatures about the link between industrial development and economic growth have surfaced.

Economist like, Hecksher and Ohilin and Nicholas Kaldor have presented formal models and theories as part of their respective interpretations of economic growth and industry as a driver.

One of the neo-classical trade theories, the Hecksher-Ohilin trade theory draws a link between a country's endowments with the sector of specialization (Feenstra, 2002). Even though, there are different versions of this theorem the basic postulate is that a country should choose what to produce and export on the basis of relative scarcity and abundance of resources i.e. labour, land and capital. The relative scarcity of factors determines the comparative advantage of the country and automatically answers the question of specialization on production and exports (Flam and Flanders, 2000). In that sense, a country should specialize in the production of a commodity which intensively uses its abundant resource. The H-O model predicts the pattern of trade in goods between countries based on their differences in factor endowments and the consequence of trade on the functional distribution of income (Jones, 2008). In brief, the H-O theorem states that a country exports those commodities which require for their production relatively intensive use of those productive factors found locally in relative abundance.

At the end of the Second World War, economists turned their work en route for devising methods to analyse the economies of developing countries such as Africa, Asia and Latin America and formulating ways of achieving economic development for these countries. In the process, a new school of thought with the slogan manufacturing as the engine of growth emerged.

The new school had two wings; where economists like Roseinstein-Rodan and Nurkse, advocating the 'Balanced growth' while Hirschman and Streeten sided with the 'Unbalanced growth theories'. Both schools agreed on industrialization as being the driver of economic growth, but had different views on the strategies towards industrialization. Balanced growth model assumes a coordinated expansion of several sectors simultaneously. It advocates learning by doing through encouraging surplus labour to be captured by the manufacturing sector and protecting infant industries (Weiss, 2011).

Unlike balanced growth theory, the other wing, the Unbalanced Growth theory refers to the expansion of only one economic sector at a time. Supporters of the unbalanced growth, like Hirschman, believe that deliberate distortions and disequilibrium in the economy is the only way to sustain economic growth and development. The theory claims that unequal development of various sectors often generates conditions for rapid development as it creates complementarities, a situation where increased production of one good builds up the pressure for increasing the supply of another good which complements the first one (Holz, 2011). The situation that some industries are more developed than others provides backward and forward linkages and also provides an inducement to grow. Ghatax and Roberts, (1997) citing Hirschman (1958), argued that industries are usually connected with each other in manners that can be assessed in formulating an appropriate development policy. Such linkages could be backward and forward linkages together they have the effects for setting up new industries by creating new profit opportunities.

Acemoglu and Guerrieri (2008) have also advocated the theory of Unbalanced Growth path. They set to find out how a mixture of factor proportion differences across sectors and capital deepening leads to an unbalanced pattern of economic growth but still being consistent with Kaldor's stylized facts[1].

A formal presentation of the theory of manufacturing as the 'engine of growth' came from the works of Nicholas Kaldor in 1966. He came up with his famous law of economic growth and further developed three major laws after his work on the stylized facts of economic growth in 1961. According to Kaldor's first law, "Manufacturing industry is the engine of economic growth", in essence it states that the faster the rate of growth of manufacturing sector, the faster will be the rate of growth of GDP. The association is not merely based on the fact that manufacturing is a large component of total output but for fundamental economic reasons connected with induced productivity growth of the manufacturing sector relative to agricultural (Thirlwall, 1983). Kaldor's second law of economic growth also known as verdoon's law states that there is a positive association between productivity growth and the rate of growth of employment (Thirlwall, 1983).The faster the rate of growth of manufacturing output, the faster will be the rate of growth of labour productivity in that sector.

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[1] Kaldor, 1961 pointed out six facts that were general true about economic growth in the long-run. These stylized facts are: 1) Output per worker grows at a roughly constant rate that does not diminish over time.2) Capital per worker grows over time.3) the capital/output ratio is roughly constant. 4) The rate of return to capital is constant.5) the share of capital and labor in net income are nearly constant.6) Real wage grows over time.

The third law that he introduced is the association between output of the manufacturing sector and labour transfer (Chatterji and Wickens 1983). The faster the rate of growth of manufacturing output, the faster the rate of transfer of labour from nonmanufacturing sectors of the economy to the manufacturing sector when there are either diminishing returns or where no relationship exists between employment growth and output growth (Thirlwall, 1983).

Recent growth literatures; Sokoloff *et al.* (1994), Lin *et al.*(2009), and Lin (2010) suggest that economic development requires structural change from low to high productivity activities and that the industrial sector is key in the development process. Lin *et al.*, (2009) developed a general equilibrium model based on endowment structure in an attempt to develop a formal model to describe the industrial dynamics along the path of economic growth particularly in developing countries. The theory captures a continuous inverse V shaped industrial dynamics driven by capital accumulation. Lin *et al.,* (2009) also suggested that as capital endowment reaches a certain level a new industry evolves, prospers and dies out, this cycle continues indefinitely. Hence, industrial evolution and economic growth is based on endowment structure of an economy. According to Lin *et al.,* (2009) persistent economic development and transformation from low income to high income is characterised by technological innovation and structural changes in the industrial sector. Initially being engaged in the production of labour intensive manufactured products will then shift to the production of more capital-intensive goods as the endowment grows and changes in composition.

Lin *et al.* (2009) also argued that the difference between a developed economy and that of a developing is in the relative abundance of factor endowment especially capital and in essence, it justified why least developed countries are labour abundant relative to capital. They concluded that the continuous inverse V shaped pattern of industrial growth is the result of capital deepening and that a country should direct its industrial policy along with the capital-labour ratio. In these regard, if a country's capital-labour ratio is relatively small, then an industrial policy leaning towards the production of labour intensive goods is primal to maintain rapid economic growth. On the contrary, if countries capital-labour ratio is relatively growing then an industrial policy towards capital intensive manufacturing is needed.

After the recent global economic recession, there was an urgency to rethink economic development by international organizations like the IMF and World Bank, as the policies developed so far failed to avoid and further resolve the crisis. Works of the vice president of the World Bank (Lin, 2010) and (Lin and Monga, 2010) emphasized the role of New Structural Economics on industrial policy for economic development. The new structural economics states that industrial structure is endogenous to endowment structure, and further assumes differences between developed and developing nations arise from their endowment base, but a developing country can become developed by changing its industrial and economic structure through endowment structure (Lin, 2010). According to Lin (2010), initial endowments of an economy determine the economy's total resources and relative factor prices at any given point in time. This leads to identifying the sector where the economy enjoys comparative advantage and hence reform its optimal industrial structure.

With industrial restructuring comes infrastructural upgrading to suite the newly reformed structure, this in turn leads to industrialization, income growth and eventually poverty reduction.

2.2. Empirical Review

Several researchers have conducted empirical studies on the link between manufacturing industry and economic growth. These studies have applied different methodologies to capture the effect of a wide range of industrial policies and strategies and have arrived at different conclusions.

Libanio (2006) tried to prove the Kaldorian perspective towards economic growth in the study of the relationship between manufacturing output growth and economic performance of a sample of seven Latin American economies. The study confirms the hypothesis that manufacturing is the engine of growth and that there is a positive and casual relationship between output and labour productivity in the manufacturing sector which is derived from static (internal to the firm) and dynamic (learning by doing) increasing returns to scale.

Studies done by Ghatax and Roberts (1997), aimed at analysising the consequence of adopting two alternative scenarios of promoting a key sector and non key sector using CGE model for Poland. The study revealed that promoting a key sector, which has the highest level of forward and a large income multiplier, will result in a much higher efficiency gain.

The efficiency gain is expressed in terms of GDP, employment, volume of investment and volume of exports relative to promoting the non key sector. Factor incomes are also much higher in the case of key sector experiment. The study also concluded that implementing an industrial policy based on unbalanced growth of promoting key sectors would exemplify a much better macroeconomic performance.

In a study done for Indonesia, Robinson *et al.* (1999) explored the economy wide income and equity effects of three alternative industrialization strategies in a static CGE model. The study found out that the strategy of ADLI exhibited the highest GDP growth relative to the food-processing and light manufacturing based industrial growth paths. The ADLI scenario even displayed a greater GDP growth under the assumption of full tradability of food and non-food crops. However, the study didn't come up with a clear cut result on the impact on equity; the ADLI alternative revealed the lowest real incomes of farm households relative to the other two alternatives but generates a favourable income effect on all farm households under the assumption of full tradability. Without the assumption, food processing based industrial growth path improves farm households relative to rural non-farm and urban households' income better than both ADLI and light manufacturing industrialization. In terms of manufacturing value added to GDP, light manufacturing based industrial growth showed the most significant ratio while ADL industrialization exhibits the least. The study concluded that ADL industrialization would generate large GDP increase nevertheless, it would be crucial to avert the agricultural terms of trade from deteriorating by improving exports of farm products to protect the income gains and improve equity of farm households.

Another study by Cororaton and Orden (2008), examined the intersectoral linkages and poverty implications in the cotton and textile sector for Pakistan using CGE modelling of 1) an increase in the foreign savings inflows 2) an increase in the world price of cotton yarn and textile 3) an increase in government subsidy to one of the cotton related sectors and 4) an improvement in total factor productivity in one or more sectors. The study proposed that a 5% TFP improvement is welfare increasing for both rural and urban households in the long run where the highest overall increase in income accrues when TFP improvement occurs simultaneously in all stages of production i.e. TFP improvement in raw cotton, cotton lint, yarn and textile. Furthermore, TFP improvements also resulted in expansion of production, exports and reduction of poverty.

Kim and Cho (2006) used dynamic CGE model to examine the effect of various industrial policies on the Korean economy in terms of efficiency and equity criteria from 2007 up to 2030. The simulations of industrial policies of corporate tax income reduction, increment of corporate subsidy and R&D investment subsidy were so intended to investigate the different effects of these policies on the parts and materials industry versus the finished goods industry. The study proved that in all the three policy alternatives supporting the parts and materials industry relative to the final goods industry would be efficient in terms of resource allocation as it performed better in almost all macro variables. The parts and materials industry had the highest GDP and factor supply of both labour and capital relative to the finished goods industry. For instance, output effect on parts and materials increased at an average of 0.20% from that of finished goods industry in all the three alternative policies.

Their findings indicated that R&D investment was the best policy in terms of increased output effect, increased factor supply and increased demand for consumption, investment and government expenditure. The only drawback of the R&D investment subsidy, according to the study, was its smaller effect in the improvement of net trade balance since the positive output effect leads to increased imports. In terms of equity criteria the corporate income tax reduction and increased corporate subsidy worsened the income distribution accounting for a higher Gini coefficient as compared with the bench mark equilibrium of 2007.

Urgaia (2007) analyzed the contribution of Ethiopia's manufacturing industries to GDP using Johansen cointegration analysis of time series model. The study established that Ethiopia's manufacturing sector contribution to GDP is about 6% which is approximately $1/11^{th}$ and $1/6^{th}$ of that of the agricultural sector and service sector respectively with negligible overall annual growth rate of about 0.24%. This calls for immediate restructuring to improve the sector's contribution to the overall economy. According to Urgaia, the manufacturing sector is labour intensive and is negatively influenced by total factors of production. The study further established that the obsolete use of technology could be one reason for the sector's stagnant growth.

A SAM based analysis conducted by Tadele *et al.* (2006), revealed that the manufacturing sector of Ethiopia is weakly integrated with the rest of the economy portrayed in the low backward and forward linkage effects. The study showed that this low level of backward linkages indicates that the sector is highly dependent on imports.

Among the manufacturing sector large and medium agro processing manufacturing activities like; food and beverages, textile and leather industries have better backward linkages compared to the other industries. According to Tadele *et al.* (2006), manufacturing of agro processing industries had the highest forward linkages among other industries though it is still weak compared to the agricultural sector. The study also found out that employment creation through increase in productivity depends on the growth of the activity itself. Where productivity increase in a shrinking sector would only lead to a reduction in employment; for instance, expanding food and beverages industry reflected in a higher employment creation whereas, in the textile activity which is a slow growing activity increase in productivity only resulted in reduction of employment. The study also found out that labour intensive manufacturing activities like; food and beverages, textiles, chemical and non-metallic minerals are pro poor.

To summarize, the empirical studies so far conducted to analyse the link between manufacturing sector and growth failed to capture the economy wide effect. The use of partial equilibrium analyses only gives a rudimentary view of what is actually happening in the economy. Moreover crudely observing the impact of manufacturing sector on economic growth without specifically considering the effects of each major industry would only give indefinite results. So, this study aims to fill the gaps identified as it uses a GE model and observes the impact of manufacturing sector on the economy through several manufacturing industries.

Chapter Three: Overview of the Ethiopian Economy with a Focus on the Manufacturing Industry

3.1 Performance of Ethiopian Economy

Ethiopia, with a population of more than 80 million, is the third most populous country in Africa. It is one of the least developed countries with GDP (PPP) per capita of $1,004 USD in 2010. 39% of the population lives under the international poverty line of $1.25 USD and 77.6% of the population lives below the $2 USD demarcation. It is one of the world's least developed countries that are largely dependent on Agriculture.

As can be observed from figure 3.1, over the last 8 years Ethiopia has consistently displayed a strong economic growth of almost double digits of growth percentages, with an average growth of 11.4% (MoFED, 2010). This growth in GDP is a big leap from both the Imperial and the Derg regime with an average growth rate of 4% (per capita growth being 1.5%) and 2.3% (-0.4% of per capita growth) from 1960-1974 and 1975-1990, respectively (Alemayehu and Befekadu, 2005 and Alemayehu, 2011). This substantial economic growth is the result of different circumstances of which good weather, favourable government policies and increased expansion of public investment on infrastructure being the major reasons (African Development Bank Group, 2010).

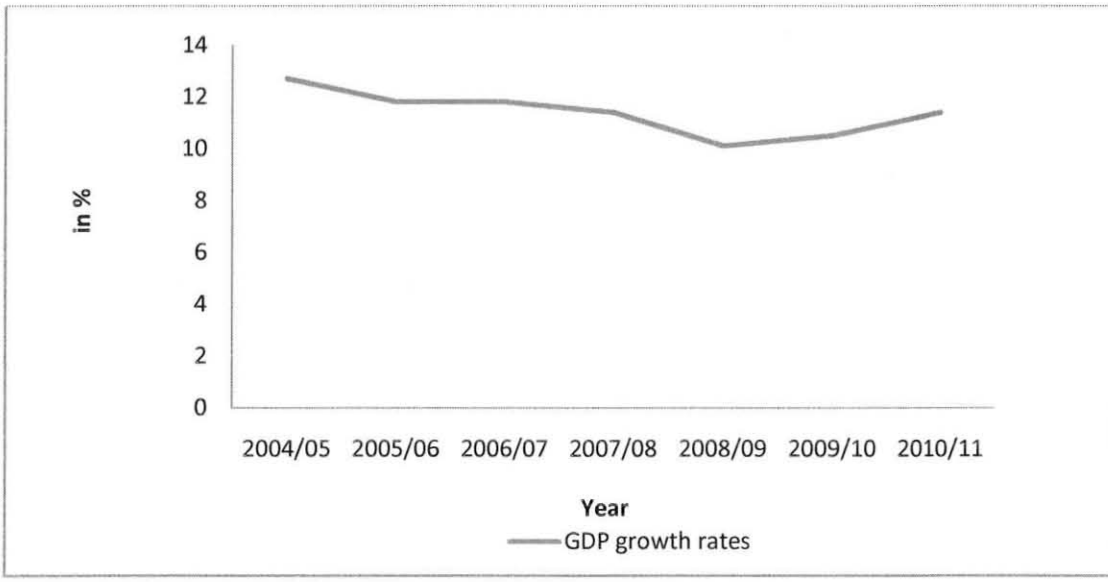

Figure 3.1: Real GDP growth, 2001/02-2010/11

Source: MoFED (Various Years)

It is evident from figure 3.2 that not only is the growth rate of Ethiopia during the last 8 years a remarkable outcome in respect to the past regimes, but it is also an outstanding performance compared to other African countries. For instances, for the year 2008/09 Ethiopia's GDP growth was four times higher to that of the continent wide average for Africa and it was twice the average growth rates of Sub-Saharan countries in 2010/2011.

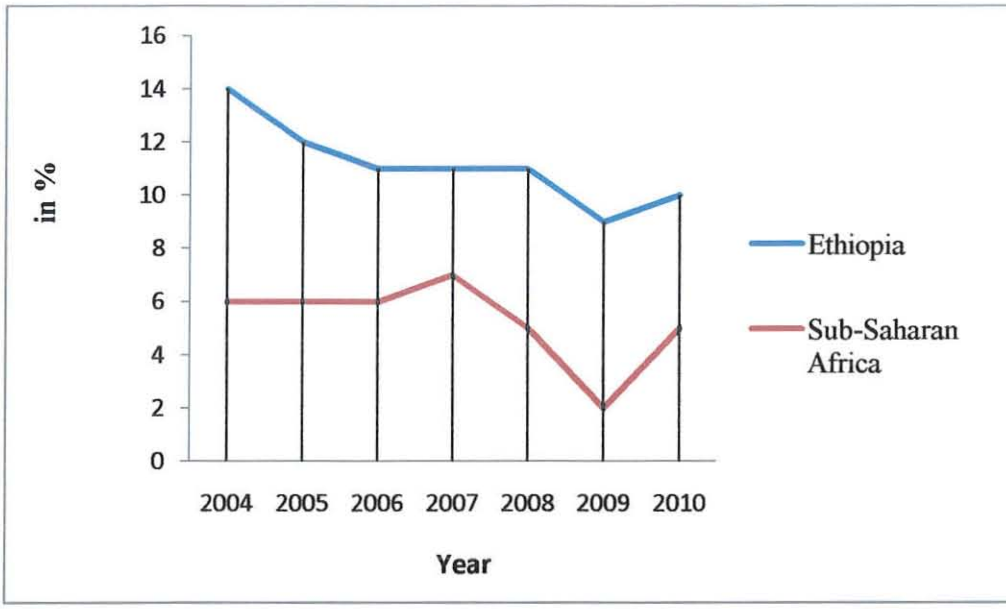

Figure 3.2: Comparison of Ethiopia's growth rate with Sub Saharan Africa

Source: World Bank

3.2 Structure of the Manufacturing Industry in Ethiopia

The industrial sector is, in general, composed of manufacturing, mining and construction, where the manufacturing sector is part of industry that presents superior power of creating sustained growth, employment and poverty reduction for underdeveloped countries (UNIDO & UNCTAD, 2011). According to DESA (2008), manufacturing involves the physical or chemical alteration of resources or components into new products, whether the work is performed by power-driven machines or by hand. From this definition, manufacturing is not a onetime incidence but a continuous process of alterations of raw materials into new value adding products.

The raw materials that are transformed eminent from agriculture, forestry, fishing, mining or quarrying or from other manufacturing activities. Substantial alteration, renovation or reconstruction of goods and assembly of the components parts of manufactured products are generally considered to be manufacturing (UNIDO & UNCTAD, 2011). Hence, manufacturing outputs can be finished goods, intermediate, semi finished goods including assembly of components (DESA, 2008).

Manufacturing industry takes different forms under different types of economic and political systems. In a command economy, manufacturing is often directed by the state to supply a centrally planned economy where the private sector is excluded from engaging in any activity. While in a free market economy, it is largely controlled by the private sector and directed towards the mass production of goods for sale to consumers at a profit with minimum degree of government intervention.

The manufacturing industry can be broadly divided into three groups: namely Resource-Based Manufacturing, Low Technology Manufacturing and Medium/High Technology Manufacturing (UNIDO & UNCTAD, 2011). Resource based manufacturing is the manufacturing of goods from the resources with little processing. Manufacturing industries that are categorized under resource based include manufacturing of food and beverages, wood, paper, rubber, glass, non-metals and basic Metals. The Low Technology Manufacturing uses minimum technology in the manufacturing process and includes manufacturing of textiles, apparel, leather and leather products, fabricated metals, furniture and printing and publishing.

Medium/High Technology Manufacturing industries are capital intensive industries that use high-tech machineries; it includes manufacturing of Chemicals, Machinery, equipment and motor vehicles. Although the policies towards the manufacturing sector and hence the structures of the sector change with the political economy, Ethiopia's manufacturing industries can be broadly classified under the subsequently mentioned subgroups.

- Food and beverages industry: which includes production, processing and preserving dairy products, meat, fruits and vegetables, manufacturing of sugar, grain mills, manufacturing of edible oils, soft drinks and alcohol beverages.
- Textile and Clothing industry: includes spinning, weaving, finishing textiles, manufacturing of cords, rope, twine, netting and knitting mills
- Leather and Foot Wear industry: Tanning and dressing of leather apparel, luggage, handbags and manufacturing of foot wear.
- Manufacturing of Wood and wood products: manufacturing of wood products and furniture.
- Paper and paper products industry: manufacturing of paper products, publishing and printing
- Chemical industry: manufacturing of basic chemicals, pharmaceuticals, paints, varnishes, soaps and detergents.
- Manufacturing of Rubber and plastic industry
- Manufacturing of Non-metals: Manufacturing of non- metallic minerals, glass, cement, lime and plasters.

- Manufacturing of Metals:- manufacturing of basic Iron and Steel, fabricated metal, machineries, equipments, vehicles and trailers

3.3 History of Industrial Policy in Ethiopia

It was during the reign of emperor Haileselassie that the direction towards setting policies and strategies for industrial development were introduced. Policies and legislations implemented during the 1960's regarding foreign investment like, tax exemption, protection of enterprises trough tariff barriers and import bans gave a glimpse view of the future of the industrial sector. The strategy of Agricultural Development Led Industrialization (ADLI), which basically emphasizes on raising the productivity of agriculture and increasing the importance of labour intensive industrialization, was the building block of the policies during that period (Alemayehu, 2011).

A series of "Five Year Plan" were put forth to enact a framework of the economic objectives of the country. To this effect in the 1950's and 1960's the emperor initiated a series of five year development plans (1958-1962, 1963-67 and 1969-74) with a private-led import substitution policy. It was an inward looking policy in a free market system where the private sector plays a key role and aims at supporting domestic industries (Tsegaye, 2011). High tariff rates, non tariff barriers, overvaluing exchange rates and foreign exchange controls were the major tools identified to encourage domestic industrial firms during the first five year plan (Amin, 2002). In 1963, the second five year plan was formulated to consolidate investment policies, extend benefits to Ethiopian investors and to create a conducive investment climate.

Throughout this plan, there were increased manufacturing activities and emphasis were given to light consumer goods manufacturing industries while small scale industries like cottage and handcrafting were left out of the picture (MEDaC, 1999). Prior to the cease of power by the Derg, Ethiopia's industrialization policies included a range of fiscal incentives, direct government investment, and equal participation of private enterprises. The newly set policies attracted considerable foreign investment to the industrial sector; many foreign enterprises operated as private limited companies, usually as a branch or subsidiary of multinational corporations. Even though a series of favourable policy packages to trigger industrialization were introduced, there were no explicitly drawn or specified industrial policy or strategy, import substitution was what was considered to be a strategy for industrial development during the downfall of the imperial era (Tadele *et al.,* 2006).

As the military dictatorship (Derg) came to power in 1974, it destroyed what had been a glimpse of hope for the industrialization of Ethiopia. The Derg under the socialist ideology nationalized almost all industries and subsequently reorganized them into state-owned corporations and identified three manufacturing areas for state involvement. Those were basic industries that produced goods that are used by other industries and that had the capacity to create linkages in the economy; industries that produced essential goods for the general population; and industries that made drugs, medicine, tobacco, and beverages. Nationalization of major industries left nationals and foreigners discouraged to make investments in any of the sectors, especially the industrial sector in the country.

The policy also grouped areas of the public and private sectors into activities reserved for the state, activities where state and private sector could operate jointly, and activities left to the private sector. Another means that Derg used to restrict participation of the private sector in the economy was through imposition of capital ceilings and by being biased towards public companies (at the time, US$ 250,000 ceiling was imposed on private investment). In the later years, the regime introduced a decree which allowed less than 49% share of private sector in many sectors except in those sectors related to public utilities, banking and finance, trade, transportation, and communications. All in all, Derg followed the industrial development strategy like that of the imperial regime, i.e. import substitution. With the same token, the manufacturing industries continued to be dominated by light consumer goods (Tadele *et al.*, 2006).

Though too late, the Derg acknowledged that socialism had failed as an ideology and policy base and consequently implemented mixed economy in 1990. Under the new system, the private sector would be able to participate in all parts of the economy with no limit on capital, developers would be allowed to build houses and office buildings for rent or sale and commercial enterprises would be permitted to develop industries, hotels, and a range of other enterprises on government-owned land to be leased. Additionally, farmers would receive legal ownership of land and would have the right to sell their produce in a free market. However, the newly proposed policies didn't have a chance to materialize as the Derg was overthrown in 1991.

The year 1991 was a turning point in Ethiopia's economic and political history as it marked the departure from the 'Socialist' system to adopting a market-oriented economy.

In fact, much of the policies adopted by the new government had been set off by Derg nearly at the end of its reign. During the post 1991, most of the domestic policy restrictions were lifted and many state owned firms were privatized with incentives to encourage domestic producers. But it was not till 2004 that the design of comprehensive strategy for industrial development was declared with structural transformation in mind. The Industrial Development Strategy (IDS) of Ethiopia is part of the second poverty reduction strategy paper "Plan for Accelerated and Sustained Development to End Poverty (PASDEP)' which was developed for the period between 2005/06-2009/10 (Tilmann, 2010). The strategy, which was approved in 2002, is the first-ever comprehensive industrial development strategy developed for Ethiopia which identified the need for institutional reforms.

The industrial policy directions have their roots in the Agricultural Development Led Industrialization (ADLI), Export led development and expansion of labour intensive industries which are the fundamental principles of the strategy. The quintessence of the strategy, as envisaged in the document, is acknowledging the role of the private sector as an engine of economic growth. The plan implemented substantial changes in strengthening and establishing capacity building and technology institutes and identified four priority sectors i.e. textile and garment, meat, leather products and agro-processing industries (Tadele *et al.*, 2006).

The objectives of the IDS include: recognizing the private sector as the key for industrial development and in effect removing obstacles that are in the way of private sector.

It is also aimed at ensuring backward and forward linkages between agriculture and industry through rapid industrial development that produces inputs and consumption goods that are suitable for the agricultural sector based on ADLI. Furthermore, the development strategy focuses on labour intensive industries and export oriented sectors that are believed to solve the problem of limited size of local markets and lack of foreign exchange. Cottage and small scale manufacturing enterprises have been given special attention in the industrial development strategy as it accounts the highest share of non-farm employment in Ethiopia (Tilmann, 2010).

During the PASDEP period most of the pre set targets for the industrial sectors were achieved however, only a 10% growth rate in the sector could be achieved which were 1% and 8% below the base and high case scenarios of the plan (MOFED,2010). Targets of job creation for the micro and small scale enterprises were more or less achieved though the respective targets for the large and medium manufacturing industry were not fully met. One of the major aims of the PASDEP was generation of export earnings from the textile and leather sector but facts revealed that the sectors only achieved on average 4% and 34% of the target set, respectively (MOFED, 2010). The five year plan also failed to achieve the goals set for the non agro-processing industries including Metal and Metal engineering, chemicals and cement manufacturing both in the volume of output and expansion of factories.

In 2010, the government of Ethiopia launched a national development plan for the next five years: "Growth and Transformation Plan (GTP)" that aims at attaining social issues, good governance and creation of a solid source of growth.

GTP is based on Ethiopia's past policies and ideas like the ADLI, PASDEP, MDG's and Industrial Development strategy (MoFED, 2010). The core idea of the plan is to link each policy with the 8 goals of the MDGs. The basic policies are, 1) to create a stable and democratic developmental state. 2) to sustain projected GDP growth of 11-15% per year till 2015 while attaining the MDGs. 3) to expand the agricultural sector and craft vast investment opportunities primarily in the industrial sectors. 4) to complete Ethiopia's accession to the World Trade Organization, WTO (MoFED, 2010).

Under the targets set for industrial sector, the GTP plans to ensure faster and sustained development of the sector through giving emphasis in the micro and small scale enterprises and large and medium industry development. Furthermore, it plans to increase the growth rate of the sector from 10.6% in 2009/10 to an average growth of 20% and 21.3% throughout the medium and high cases scenarios, respectively. The plan projects the share of industry in the total GDP to increase up to 18.8% and 16.9 % at the end of the plan period (2014/15) for the medium and high case scenarios respectively. Like the PASDEP and the Industrial Development Strategy, ADLI is the fundamental building block for the GTP industrial plan. With this point in mind, the target is set on industries that are labour intensive, have broad linkages with the rest of the sectors, use agricultural products as inputs, and are export oriented and import substituting not excluding contributing to rapid technological transfers (MoFED, 2010). As one of the key sectors, the MSE are given emphasis since it is important in enhancing sustainable rural-urban and urban to urban functional and economic connections. Creation of large scale job opportunities and expansion of competent private sector are the objectives set for the MSE.

Bearing in mind, aside from MSE development, concrete and well built large and medium scale industries are identified to be one of the motives for sustained economic growth for the coming five years. Enclosed in the objectives set for the large and medium scale manufacturing subsectors like textiles and garment, leather, sugar, cement, metal and engineering, chemicals, pharmaceuticals and agro processing industries are priority given sectors (MoFED, 2010).

3.4 Characteristics and Performance of the Manufacturing Sector of Ethiopia

3.4.1 Characteristics of the Manufacturing Sector

Manufacturing sector is considered as one of the industries that would result in sustained economic growth. It is characterized as an activity that would raise income, meet the demands for other sectors like agricultural and service sectors and absorbs surplus labour (Urgaia, 2007). Manufacturing sector has high forward and backward linkages and spill over effects compared to the other sectors. For example, the agricultural sector and service rendering sectors like banks, insurances, transport and communications largely supply their products to the manufacturing industry as it is the sector with the highest demand (UNIDO & UNCTAD, 2011). Furthermore, the sector is a key driver of growth in trade as it promotes export from its intrinsic nature of having positive relationship with income.

This is due to the reason that as the share of manufacturing to the total households' expenditure increases with the increase of per capita income. Manufacturing sector also has higher potential for employment creation compared to the agricultural sector. The fact that there are diminishing returns to scale with fixed land in the agricultural sector restricts the amount of labour the sector can absorb. But, in the manufacturing sector the increase in population growth would increase the demand for manufactured products there by allowing more and more industries to flourish which will in the process absorb the additional labour force (UNIDO & UNCTAD, 2011).

(a) Concentration of Firms

The total number of large and medium scale manufacturing industries has shown an increasing trend over the last 10 years. In 2009/10, the number of establishments were 2172 which are more than double the figure for 2002/03 (CSA, 2011). This trend of increasing establishments was also noticeably observed in most of industries except the manufacturing of paper and paper products, manufacturing of textiles and manufacturing of fabricated metals which showed a slight decline over the last five years. As can be seen from table 3.1, manufacturing of food products and beverages, manufacturing of non-metallic minerals and manufacturing of furniture are the top three industries contributing to the increased number of establishments over the last five years. Out of the total large and medium scale manufacturing industries in 2009/10, more than 40% were located in Addis Ababa followed by Oromiya with almost 21% and S.N.N.P with 13% of the industries. More than 26% of the manufacturing industries fell in the category of food products and beverages followed by non-metallic mineral products with more than 22% and the furniture industry with almost 13% (CSA, 2011).

Table 3.1: Share of sub industries in total manufacturing industry, 2005-2010 (%)

Manufacturing industry	2005/06	2006/07	2007/08	2008/09	2009/10
Food Products and Beverages	30.01	26.42	25.18	25.57	26.34
Tobacco Products	0.08	0.07	0.05	0.05	0.05
Textiles	3.38	2.84	1.14	1.96	1.84
Wearing Apparel, Except Fur	2.49	2.22	2.02	1.87	2.35
Leather and Footwear	5.07	4.99	4.31	4.05	5.25
Wood and Products of wood, Cork except Furniture	2.33	2.84	3.63	2.18	2.49
Paper, Paper Products and Printing	7.00	8.11	7.42	5.78	5.66
Chemicals and Chemical products	4.26	4.44	4.15	3.41	4.42
Rubber and Plastic products	5.07	4.44	4.26	3.96	6.40
Non- Metallic Mineral products	12.23	19.69	25.34	27.66	22.19
Basic Iron and Steel	1.45	0.90	0.78	0.82	1.80
Fabricated Metals	8.53	3.95	5.24	5.46	7.09
Machinery and Equipment	0.97	0.28	0.16	0.18	0.69
Motor Vehicles	0.88	2.91	0.78	0.55	0.51
Furniture	16.25	15.88	15.52	16.52	12.94
Total	100	100	100	100	100

Source: CSA (various years)

(b) Employment in the Sector

It has been a fact that the agricultural sector absorbs the highest share of total employment followed by the service sector and industrial sector. There has been a steady growth in the number of persons engaged in the manufacturing industries from 2001/02-2009/10 where the highest number was recorded in 2009/10 with over 186,700 workers engaged in the large and medium scale manufacturing industries. More than 32% of the persons engaged in the manufacturing industries were reported to be in the manufacture of food products and beverages, more than 11% in the textile industry, and almost 11% in the manufacture of non-metallic mineral products in 2009/10 (CSA, 2011).

(c) Raw Material Intensity

Manufacturing activities have relatively low backward linkages indicating their high dependency on imported sources and less on domestic materials. The manufacturing sector of Ethiopia uses imported raw materials intensively comprising almost 50% of the overall raw materials used in the production process. As observed in figure 3.3, in the period between 2004/05-2009/10 out of the total cost of raw materials consumed by the manufacturing sector 52% was the cost of imported raw materials where, the highest ratio of import to total cost of raw materials consumed was a whapping 58% that was recorded in the year 2006/07. There has not been major shifts in raw materials in several of the manufacturing industries; the textile industry showed a decline in import intensity from 40% to 37% while the manufacturing of non-metallic minerals revealed a massive shift to imported raw materials from 9% to 58% for the period between 2004/05 -2009/10 (CSA, 2011).

In 2009/10, out of the total cost of raw materials consumed 51% was due to imported raw materials and among the major industrial groups manufacturing of motor vehicles and trailers, manufacturing of rubber and plastics and manufacturing of fabricated metal and iron contributed the highest shares of imported raw materials (CSA, 2011). The food and beverages and wood and wood products manufacturing industries are relatively less import intensive compared to the other manufacturing industries as they are labour intensive and employ simple technology.

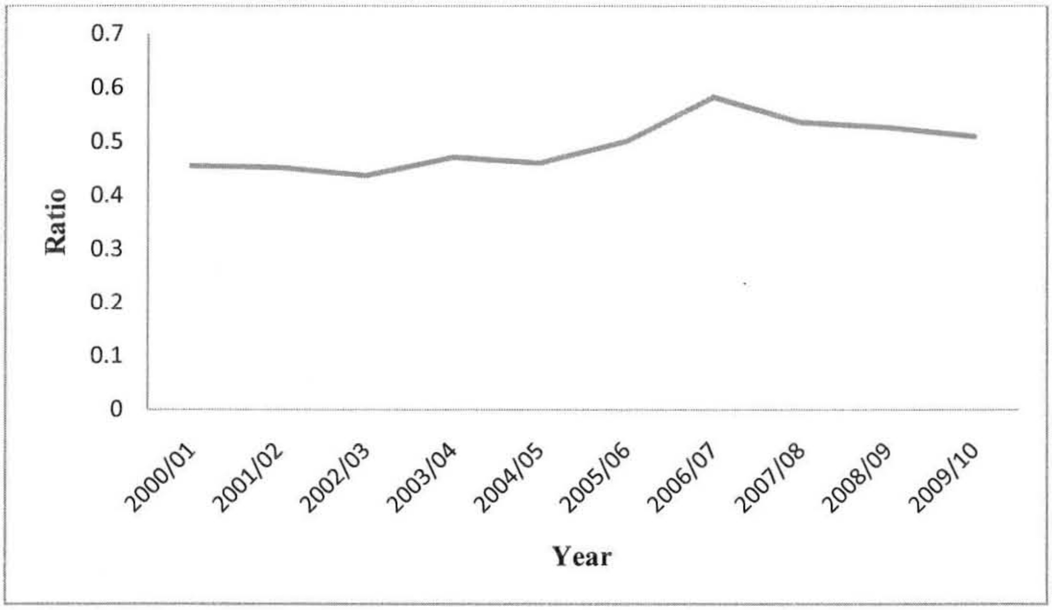

Figure 3.3: Ratio of imported to total raw materials

Source: CSA, various years

3.4.2 Performance of the Manufacturing Sector

Ethiopia's industrial sector is comprised of agro processing industries like food processing, beverages, textile and leather industries and non-agro processing industries like chemical, metallurgy and cement industry. The government of Ethiopia has identified the textile and leather industry as priority given areas based on exportability, employment creation, gross value of production and overall contribution to the economy. It is in these sectors that Ethiopia has comparative advantages since the industry is highly labour intensive and requires simple technology.

(a) Contribution of Manufacturing to GDP

The industrial sector of Ethiopia is in its early stage of development with weak operation resulting in unsatisfactory performance. This problem has its roots in the overall weakness of the country's economy. There are shortages of skilled personnel, lack of market, inadequate finance, obsolescence of machinery and equipment and low level of local technological development (Alemayehu, 2011). Though there is recent upsurge of the manufacturing sector, its role in the overall economic growth is small relative to the agriculture and service sectors. The manufacturing industry contribution to GDP has never exceeded 15% in all the regimes. The share of Ethiopian manufacturing in GDP rose from a low of 11.57% in 1960-64 to 15% in 1970-74 (Alemayehu and Befekadu, 2005). This good performance in the manufacturing industry during the Haileselassie regime was due to the policies regarding investment in infrastructure.

The 3 five year development plans and the promotion of ultra modernism at the expense of conservatism were at the core of the policies that helped enhance the sector.

During the Derg regime reasons like nationalization, control of resources and the command economy itself led to the decline in the share of industry to GDP and to be stagnant at about 12% for the period 1974-1991.

The post reform period, marked the departure from the command 'Socialists' system to a market oriented economy. The economy was reviving from the continuous plummeting of economic growth during the last 2 decades. During this period even though GDP growth was ever greater than the last two regimes the contribution of industry didn't show a significant change. As can be seen from table 3.2, the share of industry to overall GDP hasn't shown a remarkable change from 1990-2010, averaging at about 13% over the period in question. For the year 2010/11 out of the total GDP growth the sector contributed only 13.4% making it the least contributor.

Table 3.2: Share of industry to GDP during the three regimes (%)

Haileselassie Regime	% share	**Derg**	% share	**Present**	% share
1960-64	11.57	1975-79	14.42	1990-94	9.13
1965-69	14.29	1980-84	12.55	2000-04	13.48
1970-74	15.19	1985-89	12.8	2005-10	13.4

Source: own computation using World Bank data and Alemayehu (2011)

In terms of gross value of production, the sector has shown an increasing trend over the last ten years[2]. In 2009/10, the sectors gross value of production was more than 42 billion out of which the Food and Beverages, Non – metallic mineral, and Chemical industries have contributed more than 38%, 10%, and 8% respectively (CSA, 2011).

(b) Manufacturing Value Added (MVA)

The manufacturing sector of Ethiopia is largely dependent on agricultural sector for its raw materials. Agricultural product processing (Agro-processing) manufacturing industries account the highest share of the total MVA. There has been a slight shift in the share of value added from agricultural to non agricultural product processing industries during the last 5 years. As can be observed from figure 3.4, in 2005/06 out of the total MVA of agro processing industries accounted for 61% and the remaining 39% was explained by the non-agro processing. While in 2009/2010 share of agro processing declined to 54% and that of the non-agro processing increased to 46%.

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[2] the gross value of production includes sales value of all products of the establishment, the net change of stocks between the beginning and end of the reference period in the value of finished goods and the value of semi finished goods, the value of industrial services rendered to others, the value of goods bought and resold without any transformation or processing, and other receipts.

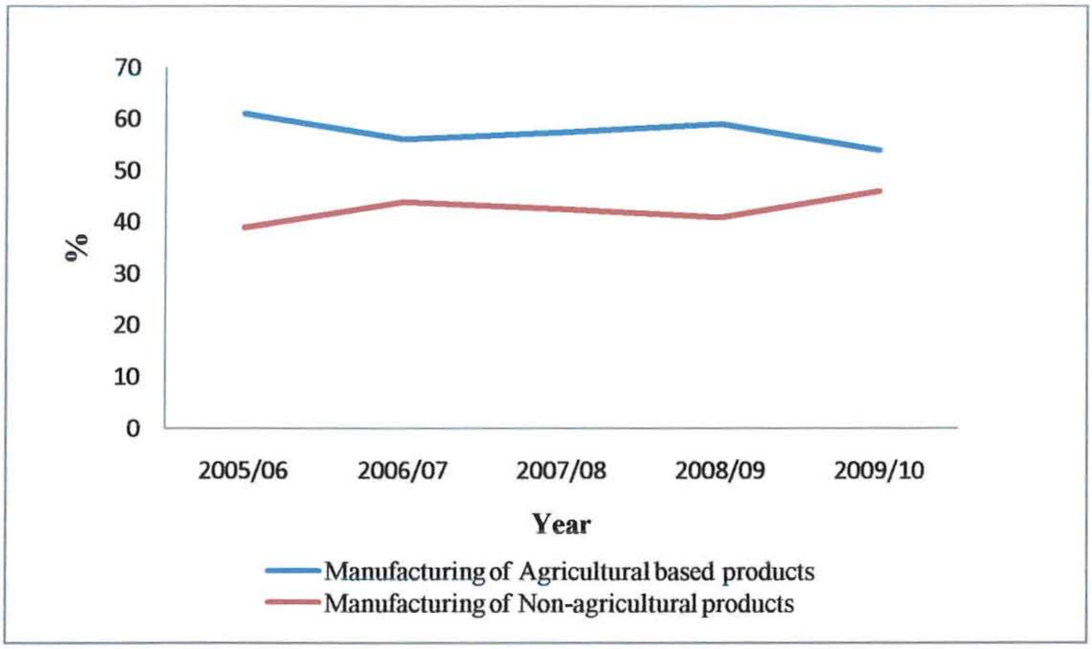

Figure 3.4: Percentage distributions of manufacturing value added
Source: CSA (2011)

The total value added by all industries as a ratio of gross value of production has remained very low over the last decade and there wasn't much difference on the ratios among each industry (CSA, 2011). The food and beverages manufacturing industry has remained the top contender till date, followed by the non- metallic minerals industry in the share of value added. In 2009/10 food and beverages industry accounted for 35% and non metallic industry 19% of the overall manufacturing value added. One confirmation to the fact that the industry is in its infant stage, is that the contribution of fabricated metals, basic iron and steel and manufacturing of equipments are the least value adding industries in the sector.

As can be seen from table 3.3, the ratio of manufacturing value added per employee has remained fairly stagnant during the period 2000/01-2004/05 averaging at about 26,000. Since 2005/06, it has shown a remarkable leap, in 2009/10 the sector accounted more than 61,000 which is more than double the value for 2004/05 (CSA, 2011).

(c) Labour Productivity

According to CSA, the ratio of cost of labor to gross value of production can be a proxy for labor productivity. It is evident from table 3.3 that the total ratio for all manufacturing industries is very low and didn't show a significant change during the last 10 years from 2000/01-2010/11.The ratio varies across major industrial groups for the year 2009/10, manufacturing of wood and wood products and manufacturing of basic iron and steel exhibited the highest and the lowest ratios.

Table 3.3: Performance of manufacturing sector in Ethiopia, 2000/01- 2009/10

Year	Value added per employee	Ratio of Cost of labor to GVP*	Ratio of Industrial cost per GVP	Ratio of MVA at factor cost to GVP	Ratio of imported to total raw material consumption
2000/01	25270	0.078	0.53	0.281	0.455
2001/02	22557	0.92	0.512	0.274	0.452
2002/03	25478	0.089	0.504	0.287	0.437
2003/04	27027	0.08	0.513	0.262	0.471
2004/05	27766	0.076	0.514	0.246	0.46
2005/06	31036	0.073	0.542	0.244	0.501
2006/07	36480	0.071	0.506	0.265	0.583
2007/08	45005	0.073	0.513	0.258	0.536
2008/09	52269	0.069	0.507	0.27	0.527
2009/10	61588	0.059	0.517	0.271	0.51
Maximum	61588	0.92	0.542	0.287	0.583
Minimum	22557	0.059	0.504	0.244	0.437
Average	35447.6	0.1588	0.5158	0.2658	0.4932

*GVP: - Gross Value of Production as defined by CSA

Source: CSA (various years) and own computation

3.5 Problems of the Manufacturing Sector

According to Delmar and Dante (1977), resource endowments, lack of education and skilled labour force and infrastructure are the major factors that could influences a countries road towards industrialization.

Ethiopian manufacturing sector is also faced with these factors from the onset of establishment to the operation process. The manufacturing process requires huge investments so as to equip it with the necessary fixed capital and thus, many establishments are challenged with the problem of getting finance in terms of foreign exchange. Infrastructure development is vital to the functioning of manufacturing industries; where the country lack adequate infrastructure in terms of roads, electricity, water and communications. Apart from the aforementioned lack of supply of raw materials, absence of market demand and shortage of electricity and water supply are major reasons that hinder the sector from not being fully operational and operating at less than full capacity.

In 2009/10, more than 34% of the manufacturing industries reported shortage of supply of raw materials as a first problem for not being fully operational followed by shortage of electricity and absence of water at 23% and 10% respectively. The non metallic mineral manufacturing industry is the sub sector which is highly affected due to the above mentioned factors, with 50%, 22% & 34%, respectively (CSA, 2011). Overall more than 41% of the manufacturing industries reported shortage of supply of raw materials as a first problem for not working at full capacity out of which more than 28% were from the non-metallic mineral industry groups. More than 14% of all the manufacturing industries reported absence of demand for products as a first major reason for not working at full capacity and the food and beverages manufacturing industry is the top candidate with more than 37% (CSA, 2011).

Chapter Four: Methodology and Data Source

To address the previous mentioned objectives different methods and modelling can be used. Since CGE modelling provides both an economy-wide assessment of policies and a framework in which the workings of policies can be more easily understood, it is the objective of this paper to present the effect of productivity improvement in the manufacturing industry on economic growth using the recursive dynamic Computable General Equilibrium.

The use of this framework is motivated by the fact that it is a coherent framework to analyze policy changes and impacts on the whole economy as the name "General" implies. First, the model allows multi-sectoral modelling which makes it well suited for this study. Second, it can be used to model changes for which there is no past experience; in that sense it can be used to analyze new shocks to the economy where there is no previous data about that particular shock. Finally, CGE models compared to other econometric models provide a consistent framework to assess the linkages and tradeoffs among different policy packages and help to pass better-informed policy prescriptions (Robinson, 2002).

In this study, we make use of the recursive dynamic CGE model developed by International Food Policy Research (IFPRI) Institute (see Lofgren *et al.*, 2002). A recursive dynamic CGE model is based on the assumption that the behaviour of agents is based on adaptive expectations, where agents make decisions on the basis of their past experience of the economy.

The recursive nature of this model implies that the model is solved one period at a time which allows to separate the within period component or the static part from the between or dynamic component of the model. The model is calibrated with the Social Accounting Matrix, which provides initial values for variables and parameters in the model. A social accounting matrix (SAM) is a comprehensive, economy-wide set of accounts that quantify economic flows (incomes and expenditures) in an economy for a given period of time usually one year (EDRI, 2009). The recently updated 2005/06 SAM developed by EDRI and institute of Development studies of the University of Sussex with support from IFPRI will be used in this research. In so doing, the researcher will first introduce the notion about the SAM, which is the data source for calibration of the model. Then a detailed specification of the standard CGE model will be provided followed by specifications of the dynamic CGE model.

4.1 Data Source

4.1.1 Social Accounting Matrix

The main database used to calibrate a CGE model is a social accounting matrix (SAM), which provides a complete representation of the economy for a particular year. "SAM is a comprehensive economy wide data framework, typically representing the economy of a nation" (Lofgren *et al.*, 2002). The Social Accounting Matrix (SAM) is based on the 'Input- Output' table but is more complex in that it provides insights into sectoral and institutional structure of the economy (Thurlow, 2004).

As a development from the input- output matrix, the SAM is a square matrix which is consistent with economic wide data that has detailed quantification for economic flows of incomes and expenditures in an economy for a given period of time (Lofgren *et al.*, 2002). It is a general equilibrium (GE) data framework that records transactions taking place during an accounting period. In effect it links factors, production activities, markets and institutions and rest of the world within circular flow of any economic system. According to Round (2003), SAM has three distinct features. First, it is a matrix based data which shows interconnections between agents by showing explicitly transactions in the cells (incomes and expenditures are shown in rows and columns). Second, it shows all economic activities like consumption, production, accumulation and distribution comprehensively and consistently. Thirdly, the SAM is quiet powerful in letting some degree of flexibility, since it allows for disaggregation from the basic framework.

The SAM is based on the underlying principle of double-entry accounting which requires that total incomes (row total) must equal total expenditures (column total) for each account. Hence, the incomes of an account appear along its row and its expenditures along its column (Lofgren *et al.*, 2002). The standard SAM essentially has four major accounts; these are the activities (production) account, the commodities account, factors account, and the institutions (households, firms, government and the Rest of the world (ROW)) account (see EDRI, 2009). In addition to these four basic accounts, SAMs can have additional accounts for saving-investment (S-I), taxes, total margins etc. The SAM distinguishes between the entities that carry out production (activities) and the commodities produced.

This distinction is crucial in cases where one commodity is produced by more than one activity and when an activity produces several commodities (Lofgren *et al.*, 2002). Valuation in the SAM is also different for activities and commodities. The incomes in the activities account are valued at producer prices, whereas in the commodities account, costs of indirect taxes and transactions are added so it is valued at market prices.

Activities Account

The activities account shows the production in the domestic economy. It summarizes the value of goods and services produced (supplied) by each activity and the costs of inputs into each production activity (EDRI, 2009). The rows in this account represent the value of goods produced by each activity while the columns correspond to the costs (expenditures) of each activity which includes costs to purchase intermediate inputs and payment to factors of production.

Commodities Account

The commodities account summarizes the demand for commodities on the row and the supply of commodities on the column. The demand (row) includes household demands, government demand, demand for inputs for production, investment demand and export demand whereas, the supply (column) implies domestic production supply, marketing margins, indirect taxes and imports (EDRI, 2009).

Factors Account

The factor account reveals the payments from different sources and payments to different accounts.

The incomes received from various activities in domestic economy and the rest of the world is recorded in the rows of the factors account whereas the column side indicates distribution of factor incomes to various institutions[3].

Institutions Account

Accounts for institutions reports all incomes and expenditures of the institutions, there are three separate accounts for each institution. Government has one separate account where as the private sector have two accounts (Households and Enterprises). The rows of the households account defines the incomes to households from factor ownership and transfers from other households, the government and the ROW while the column of this account denotes the payment to activities (household consumption), payment to commodity accounts (marketed consumption)[4], transfers to other households, savings and direct taxes (payment to government). The enterprise account's row illustrates the incomes of enterprises from operating surplus, transfers from other enterprises and ROW.

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[3] Factor incomes are value added in each production activity and factor payments are the payments to households of different types, government and the Rest of World (EDRI, 2009).

[4] The SAM identifies two types of consumption namely home consumption (activity-based) and marketed consumption (commodity- based). Home consumption appears as household payments to activities and is valued at producer price (without marketing margins and the sales taxes) while household consumption of marketed commodities appears as payments from household accounts to commodity accounts, values of which include marketing margins and commodity taxes (Lofgren *et al.*, 2002).

The expenditures of enterprises which include distributed profit to households, direct taxes and savings are shown in the column of the account.

The government income from direct and indirect taxes and transfers from ROW are shown in the rows and the expenditures on government consumption, transfers to other institutions and government savings are recorded in the column of the governments account. The ROW account shows the inflow and outflow of foreign exchange. The incomes (outflows) come from sale of imports and factors in the rows of the ROW account while, payments for exports, factors, transfers to households and the government, including foreign savings (inflows) are represented in the columns.

As pointed out, apart from the basic four accounts, the SAM also has additional accounts. The Saving- Investment (S-I) account is a separate account that traces the savings of institutions in the rows and the investment expenditures for commodities in the columns. Savings come from households, enterprises, government and ROW and these savings are what is eventually spent (invested) on capital goods (column)[5]. In the SAM the government is separated into two accounts, to avoid ambiguous interpretations of some payments; one as an institution and into tax (direct/ Indirect tax) account (Lofgren *et al.*, 2002). An account for marketing margins captures transaction costs due to trade flows and transportation in relation to domestic, import and export marketing.

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5 Investment in the SAM only shows the source of investment (sector of origin) and not sector of destination and further it does not give information about who "owns" the capital goods or in which sectors they are installed (EDRI,2009)

4.1.2 The updated 2005/06 Bench Mark SAM for Ethiopia

The bench mark data used in this study is the 2005/06 SAM developed by EDRI but updated for 2009/10 by IFPRI in order to adjust the data so as to match it with the economic performance during 2009/10 (Ermias *et al.*, 2011). The SAM disaggregates agricultural activities, land and rural households geographically by agro-ecological zone (AEZ). The five AEZs distinguished in the SAM (which differ in terms of climate, moisture regime and land use) are: Zone 1 Humid Lowlands Moisture Reliable, Zone 2 Moisture Sufficient Highlands that is cereal based, Zone 3 Moisture Sufficient- enset based, Zone 4 Drought- prone Highlands and Zone 5 Pastoralists (Arid low land plains)[6].

The micro (regional) SAM is a matrix of 225x 225 implying that it has 225 separate accounts. It is comprised of 98 activities, 93 commodities and 26 factors. The institutions accounts has 17 accounts, among which 14 for households and 1 separate account for enterprise, government and ROW each. There are 9 direct and 8 indirect taxes, trade and transport margins, stock changes, saving-investment accounts and finally we have an account for total values.

The SAM is also aggregated into different levels; the 47x47 SAM where productions and incomes of the various agro-ecological zones were aggregated into one account before further aggregations were made is the macro SAM.

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[6] For detailed explanation about the SAM and various accounts, see EDRI (2009)

This SAM consists of 14 activities, 14 commodities, 4 factors of production, 7 institutions, 3 tax accounts transaction costs, stock changes and S-I account[7]. The 4 factors of production are labor, land, livestock and capital and the institutions account encompasses 4 households (rural poor, rural non-poor, urban poor and urban non-poor), an enterprise, government and an account for ROW. The production activities in the SAM are mere disaggregation of the 3 basic sectors in an economy; agricultural sector, industrial sector and services.

The SAM covers five production activities in the agricultural sector namely; Teff, Maize and Wheat, Non-traded agriculture, Exportable cash crops and Livestock. The industrial sector also has five production activities; chemicals, machinery, food processing, construction and other manufacturing. Unlike the agricultural and industrial sectors, in the service sector there are only four production activities which are utilities, domestic trading, private services and government services. The sales tax account incorporates local value added taxes, domestic excise tax and service taxes whereas the import tax account incorporates import duty, sur tax, import excise tax, import VAT, and withholding tax. As noted above, one merit of the SAM is to distinguish between activities and commodities; the insight behind this is seen in the three activities accounts which produce more than one commodity.

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[7] Since Ethiopia is non-oil producing nation, the corresponding activities account for the commodity account of fuel (cfuel) is missing. Hence, the 14 activities produce 14 commodities, although the domestic production activities for commodity fuel are unavailable.

These are cash crop production activity which produces cash crops for export and non-traded agricultural commodities, livestock activity which produces food products and raw materials for further production, and activities for utility which produces utilities and machinery.

4.2. Model Specification

In this section, we will closely examine the recursive dynamic Computable General Equilibrium model. Since the recursive dynamic is an extension of the standard static model, a detailed discussion about the static model or the within model will be given in addition to the between and dynamism of the model. The within or static period specification accounts for detailed description of the economy at a particular time period but is restricted to one period and fails to provide explanation about subsequent periods (Thurlow, 2004). The between period fills the gap of the static model by accounting for second and subsequent period considerations. The dynamics is captured by assuming that investments in the current period are used to build on the new capital stock for the next period. With this thought in mind, endogenously or exogenously updating of variables is needed to extend the one period model into second period considerations. Capital stock could be updated endogenously with capital accumulation equation and population could be updated exogenously between periods.

The recursive model helps to separate the within-period component from the between-period component as it is based on the on adaptive expectations rather than on the forward looking expectations that underline the inter-temporal optimisation models.

Since recursive model is solved one period at a time the statics and dynamics of the model can be separately analysed. Although a detailed mathematical description can be found in the appendix and in Lofgren *et al.* (2002), this section presents a more discursive overview of the model's structure.

4.2.1 Basic Structure of the Computable General Equilibrium

The standard CGE model explains all of the payments recorded in the SAM tracking the disaggregation followed by the SAM of factors, activities, commodities, and institutions. It is written as a set of simultaneous equations, both linear and nonlinear. Unlike dynamic CGE model, there is no objective function in standard CGE model.

The simultaneous equations define the behaviour of each actor. Production and consumption decisions are driven by nonlinear first order optimality condition (maximization) of profits and utility respectively. The equations also include a set of constraints (markets for both factors and commodities and Macroeconomic aggregates of saving-investment, government and current account balance of the rest of the world) that have to be fulfilled by the system. Activities, representing producers, are assumed to maximize profits which are the difference between revenue earned and the cost of factors and intermediate inputs as intermediate inputs and value added outputs are used to produce final outputs. Profits are subject to a production technology.

At the top level, the technology is specified by a Leontief function of the quantities of value added and aggregate intermediate inputs. Value added in turn is Constant Elasticity of Substitution (CES) function of primary input factors while for intermediate inputs; it is a Leontief functions.

Each activity produces one or more commodities according to fixed coefficients and a commodity may be produced by more than one activity. The supply of a particular commodity from each producer is combined to derive aggregate commodity output. This aggregation is presided over a CES function which permits demanders to substitute between the different producers supplying a particular commodity, in order to maximise consumption subject to relative supply prices (Thurlow, 2004). Activities (producers) have the potential to substitute between producing for the domestic (local) market and for foreign (international) markets. The constant elasticity of transformation (CET) function, which distinguishes between exported and domestic goods, allows for this substitution and in the course reflects quality differences between the two products. The CET function also allows producers to optimize profits either by selling locally or to foreign markets, which are constrained by returns based on domestic and export prices (Thurlow, 2004)[8].

There is imperfect substitution between domestically produced and foreign (imported) goods which characterizes the international trade flows. This substitution is governed by CES Armington Specification[9]. Akin to the profit maximization of suppliers (producers), demanders minimize costs based on the relative prices of imports and domestic goods.

[8] Export prices are determined in the model by the world price times the exchange rate adjusted for any taxes or subsidies.

[9] Substitution between domestic and imported goods can take place both in final and intermediates usage. The Armington elasticises vary across sectors, with lower elasticises reflecting greater differences between domestic and imported goods (Thurlow, 2004).

According to Thurlow (2004), imports are further disaggregated according to their region of origin using a CES Function. This specification allows for regionally specific tariffs, and for substitution between regions following changes in relative import prices. Total sectoral absorption is also an Armington specification of domestic and imported goods. It is differentiated among four uses: private consumption, government consumption, intermediate input and investment. The domestic country is assumed to be a price-taker in the international markets, that is world prices of imports and exports are exogenously determined.

The CGE model also includes system constraints and closures. Market clearing (equilibrium) in the goods markets follows the rule that demand for commodities (composite of households and government consumption, investment spending and exports) equal supply of commodities (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 (Thurlow, 2004). Factor markets are equilibrated based on the relationship between factor supply and wages. In the model capital is fully employed and sector specific which entails that sector-specific wages adjust to ensure that demand for capital equals total supply.

For labour (unskilled, semi-skilled and skilled) which is assumed to be unemployed, wages are fixed in real terms and supply adjusts to match demand. The model includes three broad macroeconomic accounts: the current account, the government balance, and the savings and investment account and alternative ways of adjustment to ensure equilibrium.

These adjustments are called 'macroclosure' rules providing mechanisms in which the system is solved (Thurlow, 2004). For this particular study, the closure rule taken for saving investment is; investment is savings driven which implies that capital formation is flexible with fixed marginal propensity to save for all non government institutions. The government closure defined for this study is letting government savings to vary while fixing the direct tax rates. The closure rule pursued for the ROW is fixed foreign savings with flexible real exchange rates.

4.2.2 The "Within" Period Specification

The "within" model assimilates the static or the one period specification of the recursive dynamic CGE model. As discussed above, the CGE model is represented as a system of simultaneous, nonlinear equations where the number of equation must equal the number of variables i.e. the model must be square. The structure of the CGE model is divided into four major blocks: price, production and trade, institutions and system constraint blocks.

Price Block

The price system of the model consists of equations in which endogenous model prices are linked with other exogenous or endogenous prices and to non price variables. The price system block is outstanding in capturing the quality differences among commodities based on origins and destinations. The following section will present different type of prices.

Import Price

The import price of a commodity in local currency units (LCU) is simply the price paid by domestic users for commodities which are imported excluding sales taxes.

It is the summation of the transformed world price of imports (by considering both the exchange rate and import tariffs) and transaction costs associated with the cost needed to move the commodity from the border to the demander per unit of the import. Equation 4.1 shows the import price mathematically.

$$PM_c = pwm_c.(1+tm_c).EXR + \sum_{c'\in CT} PQ_{c'}.icm_{c'c} \qquad c \in CM \qquad (4.1)$$

Where, C is a set of commodities, CM is a set of imported commodities, PM_C is import price in LCU including transaction costs, Pwm_C is CIF (Cost, Insurance and Freight) import price in FCU (foreign-currency units), tm_C is import tariff rate, PQ_C is composite commodity price (inclusive of sales tax and transaction costs), and $icm_{C'C}$ is quantity of commodity c' as trade input per imported unit of c and the last term in the equation shows the cost of trade. In this model both exchange rate (EXR) and the domestic import price are flexible, whereas the tariff rate and the world price are kept fixed.[10]

Export price

This represents the price received by domestic producers when they sell their output in export markets. Mathematically,

$$PE_c = pwe_c.(1-te_c).EXR - \sum_{c'\in CT} PQ_{c'}.ice_{c'c} \qquad c \in CE \qquad (4.2)$$

[10] In this model the country is assumed to be " small open economy " hence is a world price taker implying that share in world trade is so small for its imports, so the modeled country faces an infinitely elastic supply curve at the prevailing world price(Lofgren *et al.*, 2002)

Where, CE a set of exported commodities, PE_c is export price (LCU), pwe_c is F.O.B (Free on Board) export price (FCU), and $ice_{c'c}$ is quantity of commodity c' as trade input per exported unit of c. For the country modelled in this study (Ethiopia) there is no imposition of tax on export. Thus, te_c (export tax rate) is removed from export price equation i.e., te_c is zero for the case of Ethiopia and the export price equation for this study can be given by:

$$PE_c = pwe_c.EXR - \sum_{c' \in CT} PQ_{c'}.ice_{c'c} \qquad c \in \text{CM} \qquad (4.3)$$

Demand Price of Domestic Non-traded Goods

The price of domestic demanded goods is the aggregation of domestic supply price and cost of trade inputs per unit of domestic sales. This pricing model makes a distinction between the price paid by demanders and those by suppliers which is crucial whenever there is transaction costs involved. Consequently, the demand price for domestically produced non-traded goods (commodities that are neither imported nor exported) can be represented as follows:

$$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'}.icd_{c'c} \qquad c \in \text{CM} \qquad (4.4)$$

Where, CD is a set of commodities with domestic sales of domestic output, PDD_c is demand price for commodity produced and sold domestically, PDS_c is supply price for commodity produced and sold domestically, and $icd_{c'c}$ is quantity of commodity c' as trade input per unit of c produced and sold domestically.

Absorption

Absorption is the total domestic spending on a commodity (imported and domestically produced excluding commodities entirely exported) at domestic demander's prices. Which is expressed as the sum of spending on domestic output and imports at demand prices (PDD and PM) where these prices include the cost of trade inputs but exclude the commodity sales taxes.

$$PQ_c.(1-tq_c).QQ_c = PDD_c.QD_c + PM_c.QM_c \qquad c \in (CD \cup CM) \qquad (4.5)$$

Where, QQ_c is quantity of goods supplied to domestic market (i.e., composite supply), QD_c is quantity sold domestically of domestic output, QM_c is quantity of imports of commodity, and tq_c is rate of sales tax

Activity prices

Activity prices are represented as multiplication of yields per activity unit by activity-specific commodity prices which are summed over all commodities.

$$PA_a = \sum_{c \in C} PXAC_{ac}.\ \theta_{ac} \qquad a \in A \qquad (4.7)$$

Where, a is a set of activities, PA_a is activity price or gross revenue per activity unit, $PXAC_{ac}$ is the producer price of commodity c for activity a and θ_{ac} is the yield of output c per unit of activity a.

Aggregate intermediate input prices

Aggregate intermediate input price is activity specific price which shows the cost of disaggregated intermediate inputs per unit of aggregate intermediate input.

$$PINTA_a = \sum_{c \in C} PQ_c \, . \, ica_{ca} \qquad a \in A \qquad (4.8)$$

Where $PINTA_a$ is aggregate intermediate input price for activity a and ica_a is the quantity of c per unit of aggregate intermediate input a.

Consumer Price Index

$$\overline{CPI} = \sum_{c \in C} PQ_c . cwts_c \qquad (4.9)$$

Where, $cwts_c$ is weight of commodity c in consumer price index and $\overline{CPI}$ is an exogenous variable for consumer price index.

Producer Price Index for Non-traded Market Output

$$DPI = \sum_{c \in C} PDS_c . dwts_c \qquad (4.10)$$

Where, $dwts_c$ is the weight of commodity c in the producer price index and DPI is producer price index for domestically marketed output. In the basic model version the *CPI* is a fixed variable which functions as the numeraire but we can alternatively fix *DPI*. Either the CPI or *DPI* should be a numeraire since the model is homogenous of degree zero in prices. Consequently, a doubling of the value of the numeraire would double all prices but leave all real quantities unchanged. As a remark, all simulated price and income changes should be interpreted as changes in relation to the numeraire price index (Lofgren *et al.*, 2002).

In addition to the above different price equation, the price block also gives specifications for marketed output value for each domestically produced commodities (at producer prices) which is the value of domestic sales and exports and activity revenue and costs which states that for each activity, total revenue net of taxes is fully captured by payments for value-added and intermediate inputs.

Production and Trade Block

The production and trade block is comprised of four categories: domestic production and input use; the allocation of domestic output to home consumption and markets (both for domestic market and exports); the aggregation of supply to the domestic market (from imports and domestic output sold domestically); And finally the definition of the demand for trade inputs that is generated by the distribution process (Lofgren *et al.*, 2002).

As briefly discussed above each activity, which is involved in the production process is assumed to maximize their profit subject to their technology, taking prices of intermediate inputs, factors and outputs to be exogenous. There are two acceptable alternative specifications at the top level of the technology nest: the activity level is either a CES value-added or a Leontief function of the quantities for aggregate intermediate input use. In this study, Leontief technology is assumed at the top level of the technology, a function of quantities of valued added and aggregate intermediate inputs to yield commodities in the production process. Mathematically,

$$QVA_a = iva_a.QA_a \qquad a \in ALEO \qquad (4.11)$$

$$QINTA_a = \text{int}\, a_a.QA_a \qquad a \in ALEO \qquad (4.12)$$

Where, a represent a set of activities in the Leontief activity function, iva_a represents quantity of value-added per activity unit, and $\text{int}\,a_a$ represents quantity of aggregate intermediate input per activity unit and QVa represents demand for value added and $QINTA$ shows the aggregate intermediate input. As we can see from the above equations, both demand for value-added (QVA_a) and aggregate intermediate inputs ($QINTA$) are expressed as a fixed share of the level of activity (QA_a). As noted by Thurlow (2004), expressing these values as a fixed share would give technology ultimate command to determine the necessary combination or ratio of value-added and intermediate inputs per unit of output rather than the producers' decision making power.

Commodities produced by activities are either sold in market (for domestic market or for ROW) or consumed at home. For marketed output, a CES function with activity specific price (market clearing price) is used as the aggregation function to aggregate domestic output from different activities of a given commodity. But the commodities are imperfect substitutes to each other as there are differences in timing, quality, and distance between the locations of activities (Lofgren *et al.*, 2002).

Producers of a commodity have the choice between exporting or domestic sales while striving to maximize profits (sales revenue) at an aggregate level. The optimization of profits by the suppliers is subject to imperfect transformability between exports and domestic sales which is represented by a constant elasticity of transformation (CET) function. Accordingly, the CET function verifies the relationship between the quantity of goods produced for domestic and foreign export market.

Allocations of the marketed domestic output, QX_c, to domestic sales, QD_c, and exports, QE_c, are formulated in the output transformation (CET) function (Lofgren *et al.*, 2002). Mathematically, it is formulated as:

$$QX_c = \alpha^t_c.(\delta^t_c.QE_c^{\rho^t_c} + (1-\delta^t_c).QD_c^{\rho^t_c})^{\frac{1}{\rho^t_c}} \qquad c \in (CE \cap CD) \qquad (4.13)$$

Where, a^t_c represents a shift parameter measuring the supply shift in the destination of domestic products based on profitability, δ^t_c represents a share parameter indicating the proportion of exports or domestic sale from domestically produced output and ρ^t_c represent an elasticity exponent of transformation between two destinations (export or domestic sales) in the CET function.

The design of imperfect transformability also helps to determine the optimal mix between exports and domestic sales or export-domestic supply ratio. According to Lofgren *et al,* (2004), an increase in the export-domestic price ratio brings about an increase in the export supply relative to domestic supply hence ratio of export-domestic supply increases resulting in a shift towards the export supply (destination that offers the higher return). The export-domestic supply ratio is given by:

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c}.\frac{1-\delta^t_c}{\delta^t_c}\right)^{\frac{1}{\rho^t_c - 1}} \qquad c \in (CE \cap CD) \qquad (4.14)$$

As specified in the previous section, there is an imperfect substitutability between domestic outputs and imports from ROW.

This imperfect substitutability is captured by a CES aggregation function where the composite commodity supplied uses domestic and imported inputs. For commodities that are both imported from the ROW and produced domestically the CES function is called an Armington function (Lofgren *et al.*, 2002). The mathematical formulation is given as:

$$QQ_c = \alpha^{q}_{c}.(\delta^{q}_{c}.QM_c^{-\rho^{q}} + (1-\delta^{q}_{c}).QD_c^{-\rho^{q}})^{-\frac{1}{\rho^{q}}} \qquad c \in (CE \cap CD) \qquad (4.15)$$

Where, QQ_c denotes quantity of goods domestically supplied (Composite supply), QM_c indicates the quantity of imports of commodity c, α^{q}_{c}, δ^{q}_{c} and ρ^{q} denotes the Armington function, shift parameter, share parameter, and exponent respectively. The shift parameter measures the shift in demand based on the expensiveness of the quantity supplied to the domestic economy. The share parameter signifies the domestic market share of imports or domestically produced output. The Armington exponent shows the elasticity of substitution between the two types of commodities. The import-domestic demand ratio, which is a function of domestic import price ratio, describes the optimal mix between imports and domestic output. Unlike the export-domestic supply ratio, increase in the domestic-import price ratio generates an increase in the import-domestic demand ratio implying a shift away from the source that becomes more expensive (Lofgren *et al.*, 2002. Expressed as:

$$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c}.\frac{\delta^{q}_{c}}{1-\delta^{q}_{c}}\right)^{\frac{1}{1+\rho^{q}}} \qquad c \in (CM \cap CD) \qquad (4.16)$$

Institutional Block

As portrayed prior to this section, the CGE model specification follows the SAM's framework and disaggregation, as a case in point the institutions block models the income and expenditure of the four institutions (Households, Enterprises, Government and Rest of the World) specified in the SAM.

Households

Households source of income are income received from the sale of factors of production and transfers from other institutions[11] which is expressed in equation 4.17 and 4.18. The income received by households is then used to pay for consumption spending, saving, payment of direct taxes and to make transfers to other institutions. In the basic model version, direct taxes and transfers to other domestic institutions are defined as fixed shares of household income whereas the savings share is flexible for selected households. In dealing with direct tax and savings shares the choice between flexing and fixing is fully dependent up on the choice of closure rule for the government and savings - investment balances. So, based on the closure rule defined for this particular study, direct tax rates and marginal propensity to save are fixed.

[11] Transfers from the rest of the world to households are fixed in foreign currency this is not restricted to transfers to households but all transfers between the rest of the world and domestic institutions and factors are fixed in foreign currency (Lofgren *et al.*, 2002).

Enterprises

Enterprises income are transfers from other institutions, the income received are allocated to direct taxes, savings, and transfers to other institutions. Enterprises do not consume. Apart from this, the payments to and from enterprises are modelled in the same way as the payments to and from households.

Government

The income sources for the government are taxes collected and transfers received from other institutions. These incomes are expended on consumption (which is fixed in real terms), saving, and transfers to non-government domestic institutions. Government consumption is fixed in real (quantity) terms whereas government transfers to households and enterprises are CPI-indexed. Government savings is a residual defined as the difference between government income and spending.

ROW

Incomes for this institution are transfers between the rest of the world and domestic institutions and factors which are all fixed in foreign currency. Foreign savings or the current account deficit is the difference between foreign currency spending and receipts.

Factor incomes are the total income of each factor, derived as;

$$YF_f = \sum_{a \in A} WF_f . \overline{WFDIST}_{fa} . QF_{fa} \qquad f \in F \qquad (4.17)$$

Where, YF_f denotes factor incomes, WF_f denotes the average factor price, $\overline{WFDIST}_{fa}$ denotes the wage distortion factor, and QF_{fa} denotes the quantity demanded of factor f from activity a. The mathematical expression above articulates income as the sum over all activities of the product of the average factor price, the wage distortion factor and the quantity demanded of factor f from activity a. The wage distortion term measures the deviation from the average wage. In the model, for each factor the deviation from the average wage is the same, subsequently the wage distortion term is fixed.

In the basic model, factor income is split among domestic institutions with fixed shares after settling payments for direct taxes and transfers to the ROW. This equation makes reference to the set of domestic institutions (households, enterprises, and the government), a subset of the set of institutions, which also includes the rest of world.

$$YIF_{if} = shif_{if}.\left[(1-tff).YF_f - trnsfr_{rowf}.EXR\right] \qquad i \in INSD \qquad (4.18)$$

Where, i stands for institutions is an element of INDS (it represents a set of domestic institutions), YIF_{if} represents institutional factor income, $shif_{if}$ represents the share of domestic institution i in income of factor f, tf_f represents direct tax rate of factor f and $trnsfr_{rowf}$ represents transfer from factor f to institution i.

In this study and for the country in question, Ethiopia does not impose direct tax rate for factor (tf_f) and hence, the above equation most be modified as tf_f is taken as zero.

$$YIF_{if} = shif_{if}.\left[YF_f - trnsfr_{rowf}.EXR\right] \qquad i \in INSD \qquad (4.19)$$

The total income of any domestic non-government (households and enterprises) institution is the sum of factor incomes, transfers from other non-government institutions, transfers from the government and transfers from the rest of the world, expressed as:

$$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{gov}.\overline{CPI} + trnsfr_{irow}.EXR \qquad i \in INSDNG \quad (4.20)$$

Where, $INSDNG$ stands for domestic non-government institutions, YI_i denotes income of institution i and $TRII_{ii'}$ denotes transfers from institution i' to i.

Households are the only domestic nongovernment institutions that demand commodities. Household consumption expenditure is divided among spending on marketed commodities and home commodities.

$$EH_h = (1 - \sum_{i \in INSDNG} shii_{ih}).(1\text{-}MPS_h).(1\text{-}TINS_h).YI_h \qquad h \in H \qquad (4.21)$$

Where EH_h is household consumption, h is an element of a set of households H, $shii_{ih}$ is share of net income of household h to institution i, MPS_h is the marginal propensity to save for household h, $TINS_h$ is direct tax rate for h; and YI_h is income of household h. Thus, this equation indicates that consumption spending is a residual after payments to direct taxes, savings and transfers.

The model specifies the investment demand expressed as the base-year quantity multiplied by an adjustment factor which is exogenous in the basic model version implying that investment quantity is also exogenous in the process. Then, it is framed as:

$$QINV_c = \overline{IADJ}.\overline{qinv_c} \qquad c \in C \qquad (4.22)$$

Where, $QINV_c$ denotes quantity of fixed investment demand for commodity, $\overline{IADJ}$ denotes investment adjustment factor, and $\overline{qinv_c}$ denotes the base-year quantity of fixed investment demand.

With the same token, government consumption demand is fixed like the investment demand as it is defined as the base-year quantity multiplied by an adjustment factor which is exogenous. The main component of government consumption demand is services provided by the government labour force, it is mathematically given as:

$$QG_c = \overline{GADJ}.\overline{qg_c} \qquad c \in C \qquad (4.23)$$

Where, QG_c represents government consumption demand for commodity, $\overline{GADJ}$ represents government consumption adjustment factor, and $\overline{qg_c}$ represents the base-year quantity of government demand.

Government revenue is mainly driven from direct taxes from institutions, import tariff, sales taxes, factor incomes and transfers from ROW[12].

$$YG = \sum_{i \in INSDNG} TINS_i.YI_i + \sum_{c \in CM} tm_c.pwm_c.QM_c.EXR + \sum_{c \in C} tq_c.PQ_c.QQ_c + \sum_{f \in F} YIF_{govf} + trnsfr_{govrow}.EXR \qquad (4.24)$$

[12]The basic model includes direct taxes from factors, value added taxes, activity taxes and export taxes in the specification for government revenue but this taxes are excluded from the equation in this study and for the country in question, since they are inexistent in Ethiopia. For detailed description of the basic mathematical equation for government revenue (see the appendix).

Where, YG is government revenue, $TINS_i$ is direct tax rate for institution i, YI_i is income of institution i, tm_c is import tariffs, pwm_c is world price of import, QM_c quantity of import, tq_c is indirect sales tax, PQ_c is composite commodity price, QQ_c is composite supply, YIF_{govf} is transfer from institution to the government, $trnsfr_{govrow}$ is transfer from the rest of the world to the government, and EXR is exchange rate.

This revenue collected from different sources by the government is spent on consumption of commodities and transfers to other institutions. Government consumption is fixed in real terms while transfers to domestic institutions are CPI indexed. Mathematically;

$$EG = \sum_{c \in C} PQ_c . QG_c + \sum_{i \in INSDNG} trnsfr_{i\ gov} . \overline{CPI} \qquad (4.25)$$

Where, EG represents government expenditure, PQ_c is composite price, QG_c is government consumption demand for commodity, $trnsfr_{igov}$ is transfers from the rest of the world (ROW) to the government, and CPI stands for consumer price index.

In the institutions block aside from the above specified equations, the model gives equations specifying separately for households consumption of home commodities and consumption of marketed commodities. A specification is also given to infra-institutional transfer that is transfers between domestic non-government institutions, where the payment is made as fixed shares of total institutional incomes net of direct taxes and savings (Lofgren *et al.*, 2002).

System Constraint Block

The system constraint block defines closure rules for the system. These closures and macroeconomic closures (government closures, saving-investment closures and current account balance) involve equalizing the number of equations and endogenous variables which requires fixation of some variables for the model to have a solution. The choice made on different closures will not have any effect on the solution to the base simulation but has an impact on the results of other simulations (Lofgren *et al.,* 2002). This study selected the model closures that are applicable to the Ethiopian economy.

Factor market closures

The closure for factor markets, which enforce equality between quantities demanded and quantity supplied for each factor f. Mathematically shown as:

$$\sum_{a \in A} QF_{fa} = QFS_f \qquad f \in F \qquad (4.26)$$

QFS_f denotes quantities supplied of factor f and QF_{fa} are factor demanded by activity a where the equation imposes equality between demands of factor by all activities and supply of factor. Conditional on the type of the closure rule, QFS_f can be fixed or flexible. But in the basic model all demand variables are flexible, while supply is fixed. Consequently, the average prices for each factor (the economy-wide wage); WF play the role of market clearing in the case of perfect factor mobility across activities. Apart from the above factor market closures two alternative closures have been specified to impose unemployment and segmented factor market.

The alternative closure to specify unemployment at a given wage rate for a factor is given by allowing flexibility of supply variable for the factor while the economy-wide wage is fixed (WF_f). The second alterative is the case of a fully segmented factor market with fixed factor demands and supply and wage distortions are flexible (Lofgren *et al.*, 2002).

In this particular study, the factor market closure is that labour is unemployed and mobile across sectors; land is fully employed (fixed in quantity) and mobile across sectors, and capital is fully employed (fixed in quantity) and activity specific. Labour is the only factor that is unemployed, and labour and land can be mobile across sectors but capital is activity specific and immobile. Notice that although closure for the labour market can be relaxed depending on the type of labour, there is no disaggregation of labour into skilled, semi-skilled and unskilled. Given that unskilled labour constitutes the large portion of the labour force, the assumption of unemployed and mobile across sectors can be a realistic characterization of the Ethiopian labour market.

Government closure

The default government balance, is flexing government saving, *GSAV* and fixing direct tax rates while the fact that the government saving is flexible plays the role of balancing the government account. There are two other alternative closures, these alternative allow the direct tax rates of domestic institutions to be adjusted endogenously to generate a fixed level of government savings either by inflicting uniform tax rates or scaling direct tax rates for selected institutions. This closure enforces the equality of government revenue and the sum of government expenditure and savings.

The general formulation of government balance is given as:

$$YG = EG + GSAV \tag{4.27}$$

In this study, we will follow the first closure where the direct tax rates are held fixed and government saving is flexible.

Current account balance

The closure rule for the ROW imposes the equality between the country's spending and its earning of foreign exchange. There are two alternative closure rules indicated in the model where the default closure is fixed foreign savings and flexible exchange rate which plays the role of an equilibrating variable to the current account balance. As an alternative closure exchange rate may be fixed and foreign savings flexed. The mathematical formulation of the current account balance expressed in foreign currency given as:

$$\sum_{c \in CM} pwm_c . QM_c + \sum_{f \in F} trnsfr_{rowf} = \sum_{c \in CE} pwe_c . QE_c + \sum_{i \in INSD} trnsfr_{irow} + \overline{FSAV} \tag{4.28}$$

Where, $\overline{FSAV}$ denotes foreign saving (in foreign currency unit). According to the above equation, import spending plus factor transfers to the ROW must equal the sum of export earning, institutional transfers from the rest of the ROW and foreign savings. Specifically, in this study the first closure where foreign saving is held fixed will be employed. Therefore, real exchange rate plays the role of equilibrating the current account balance.

Saving-Investment closures

The saving-investment balance (S-I) obliges the equality of total savings and total investment. In the S-I balance; we have about five alternative closures. As a default closure, the saving-driven closure where marginal propensity to save for all non-government domestic institutions is held fixed, while capital formation is made flexible. The other alternative closure is also saving-driven except for the saving rate which is not uniform (the saving rates are scaled). The remaining closures are the variants of investment-driven closures, but the adjustment of government consumption is required. Therefore, the remaining two alternatives impose fixed investment and government consumption absorption shares but have inconsistencies regarding MPS being uniform or scaled respectively (Lofgren *et al.*, 2002). Generally the S-I closure rule is stated as:

$$\sum_{i \in INSDNG} MPS_i.(1 - TINS_i).YI_i + GSAV + EXR.\overline{FSAV} = \sum_{c \in C} PQ_c.QINV_c + \sum_{c \in C} PQ_c.qdst_c \quad (4.29)$$

Where, $qdst_c$ represents the quantity of stock changes. Accordingly, the sum of savings from the government, domestic non-government institutions and the ROW are equated with the sum of fixed investment and stock change.

To accommodate with the imbalance, the S-I balance also has an optional add-on in 'WALRAS 'which is valued at zero if the model is in equilibrium (balanced).[13]

4.2.3 The "Between" Specification

While the static model described above is detailed in its representation of the Ethiopian economy within a particular time-period, its lack of ability to account for second-period considerations restricts its appraisal of the full effect of policy and non-policy changes. A standard static CGE model inspects a one point in time sectoral reallocation of resources. However, a dynamic CGE model allows us to model the course of transitional dynamics. For instance; it is the dynamic model that accounts for the second-period effect of the changes in current investment on the subsequent availability of capital. The elemental difference of dynamic CGE model from a static one is the inclusion of intertemporal structure of consumption and investment decision in the dynamic model.

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[13] At this point, the model is not square implying that number of equations exceeds the number of variables by one. However, the model satisfies" Walras Law" where one equation is functionally dependent on the others and can be dropped. Briefly stated the "walras law" states that in a pure neoclassical setting, producers and consumers react passively to prices in order to determine their demand and supply schedules hence, interaction of relative prices is a mechanism to clear the market (Thurlow,2004).The model provides two alternative ways to make the model square either to drop one equation (The Savings-Investment balance or the current account balance is commonly eliminated) or add one variable to the macro balance whose solution is zero. The GAMS version of the model follows the alternative to add a variable, a variable called *WALRAS* is added to the Savings-Investment balance and no equation is dropped.

So to cater for the limitations of the static model, the recursive dynamic model is used in this study. The recursive dynamic model as stated before selects parameters to be updated either endogenously or exogenously to reveal demographic and technological changes supported upon the previous periods and the intertemporal (adaptive expectations) behaviour. Capital and labour growth rate are the variables which are adjusted in the dynamic model[14].

Capital Accumulation Equation

In the dynamic model capital accumulation is modelled endogenously; last periods investment determines the subsequent period's capital stock (investment is added to the capital stock) (Thurlow, 2004).

$$KD_{i,t+1} = (1-\delta)KD_{i,t} + IND_{i,t} \qquad (4.30)$$

The mathematical expression declares that, in each period, capital stock (KD) used in each sector (i) varies with sectoral rate of investment (IND_i) and the rate of depreciation of capital stock (δ).

Labour Force Growth Equation

Labour growth is adjusted exogenously with the rate of population growth.

$$LS_{t+1} = (1+ng).LS_{h,t} \qquad (4.31)$$

[14] Refer to the appendix for detailed specification of the dynamic model.

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

4.2.4 Limitations of the Model

CGE modelling is an important tool for policy-analysis given that it is able to isolate the effects of individual policies, while explicitly specifying the causal mechanisms through which policies influence the economy. Nonetheless, while economy-wide models have certain advantages over other methods of analysis, these models have their own demons to deal with. According to Thurlow (2004), the static model is closely intertwined to the Walrasian idea of equilibrium. Even if in a pure neoclassical setting markets are assumed to clear through the interaction of relative prices, such that equilibrium is achieved in both goods and factor markets. The model accommodates prices in relative terms and therefore cannot adequately address matters related to inflation. Furthermore, this model does not include the banking sector; the model assumes there is no interaction between monetary and real economies and use of a numéraire and the lack of an explicitly modelled monetary sector imply that the model is essentially one of a barter economy in which money is neutral. Aside from the above mentioned problems, there is a massive inconsistency regarding reflection on welfare effects as the model fall short to distinguish between households that are net-buyers or net-sellers of various food crops (Thurlow, 2004).

Chapter Five: Simulation Specification and Results

5.1 Simulation Specification

In this section, we specify a series of different scenarios, each representing exogenous change in economic conditions, which are used to analyse the effect of productivity improvement in the manufacturing industry on the Ethiopian economy. In addition to the baseline scenario, we have three policy simulations that would allow us to measure the impact of policy shocks regarding the manufacturing industry. Running scenarios allows us to conduct a sort of controlled experiment of various types of shocks. The simulations are designed so as to scrutinize the outcome on selected macroeconomic, sectoral and welfare indicators.

The policy variable that is chosen as a shock for this particular study is Total Factor productivity (TFP) growth of particularly the manufacturing industry. According to growth accounting, there are 3 elements that contribute to the production of goods and services i.e. labour capital and TFP or technology (Acemoglu, 2007). Based on the growth accounting there are two sources of growth; 1) input driven, which is adding up more and more resources into the production and 2) technology driven, what is not input driven is considered as technology or TFP growth or otherwise known as, 'Solow residual' is the growth in real value added after deducting the contributions made by the growth of labour, land and capital.

Since the former is subject to the law of diminishing returns output growth can't be sustained indefinitely so that's why TFP growth is considered as a policy variable for this study.

BASE

In static CGE model, comparative analysis is made with respect to the base run which is the initial SAM. However, in dynamic models since the economy can grow even without a policy shock, analysis should be made with respect to the growth path in the absence of any shock (business as usual) or baseline scenario. The baseline scenario in this study assumes that business continues as usual with continuation of historical growth trends of 2005/06-2009/10 for additional five years, from 2010-2015 with no specific changes made to policies. We calibrate the model under the baseline for the simulation period to generate about 10.7% for real GDP growth which was the average for the period 2005-2010. All other simulations are evaluated by taking the baseline scenario as a reference point.

SIM1: high case scenario

The highest annual growth rate of value added for each industry registered between 2005 and 2010; textile, leather, agro processing, non agro processing and manufacturing industries is used as a shock in this simulation. This policy simulation is separately conducted on textile, leather, agro processing and non-agro processing activities, in doing so the other activities are left to grow at a rate equivalent to the base simulation. Hence, each simulation is compared with the respective value under the baseline scenario.

SIM2: Medium case scenario

In simulation 2, the average annual growth rate of value added for textile, leather, agro processing and non-agro processing between 2005 and 2010 is taken as a shock. Like in SIM1, the simulation is separately conducted for textile, leather, agro processing and non-agro processing activities and on overall manufacturing activities with their respective growth of value added.

SIM 3: Low case scenario

In the same way, the lowest annual growth rates of value added observed between 2005 and 2010 for each manufacturing sector is taken as a shock in the same manner as that of SIM1 and SIM2.

It should be noted that the three scenarios are implemented in the form of changing manufacturing activity-specific TFP. Implicit in this exercise is the assumption that TFP is growing by the same magnitude as the scenarios identified above.

Table 5.1: Summary of simulation specification

	Total factor productivity growth % per year		
	SIM 1: High	SIM 2: Medium	SIM 3: Low
Textile	90%	40%	20%
Leather	60%	14%	4%
Agro processing	35%	25%	21%
Non-agro processing	58%	30%	13%
Manufacturing	46%	27%	20%

Source: CSA (various years) and own computation

5.2 Analysis of the Simulation Results

This section provides the results of the three simulations discussed above and the implications of the results on macroeconomic, sectoral and welfare indicators of the economy. The analysis covers the period from 2010 to 2015.

5.2.1 Effects on Macroeconomic indicators

Tables 5.2a to 5.2e present the effects of the three simulations on the macro economic variables such as, real GDP, absorption, private consumption, investment, government expenditure, real exports, imports and exchange rate as average annual percentage change for the period 2010-2015.

(a) Textile expansion

In table 5.2a, the macro economy has recorded positive changes in all the three simulations compared to the base simulation. As expected, the highest percentage change of all macro variables was recorded under SIM1 or the high case scenario. For instance, real GDP grew by 12.04%, 11.56% and 11.05% which are 1.37, 0.89, and 0.38 percentage points higher than the base in SIM1, SIM2, and SIM3, respectively. Absorption increased from 9.98% to 10.58% due to a 90% increase in total factor productivity of the textile and clothing sector in SIM1. This is due to the strong increase in investment and private consumption which were 0.62 percentage points higher compared to the respective value in base simulation.

In the same manner, a 40% and 20% increase in TFP of the sectors resulted in growth rate of absorption to increase to 10.39% and 10.17%, respectively.

Furthermore, the TFP shock in the textile and clothing industries brought about a significantly higher growth rate in exports under SIM1 (26.21 %,), SIM2 (24.55%) and SIM3 (22.78%) compared to the base simulations. Real exchange appreciated in all the three simulation, where the highest appreciation was under SIM1 or the high case scenario with 1.89 percentage points higher than the respective value under the base simulation. The medium (SIM1) and low case (SIM2) real exchange rate appreciated with 1.71% and 0.99%. Even if increasing TFP of the textile and clothing sector results in an appreciation of the domestic currency which in theory would result in a diminished exports, the possible decrease in exports is offset by a significantly higher increase in the exports like; clothing. The clothing average annual real export growth rate was more than double the value of the base simulation in all the three scenarios.

Table 5.2a: Simulation results: effects of increased TFP growth of textile on macroeconomic variables

Average annual growth rate 2010-2015 (% change from base)				
		Textile		
	Initial	Sim1	Sim2	Sim3
Real GDP (at factor cost)	355	1.37	0.89	0.38
Absorption	457.7	0.6	0.41	0.19
Private Consumption	338.6	0.63	0.44	0.21
Investment	85.5	0.62	0.37	0.14
Government	31.8	0	0	0
Exports	52.1	4.66	3	1.23
Imports	-126.5	2.81	1.79	0.73
Real Exchange Rate	90.85	-1.89	-1.27	-0.55

Source: CGE simulation results

(b) Leather expansion

Here, we increased the TFP of the leather sector with the high, medium and low productivity growth rates. As can be observed from table 5.2b, the macro economy showed no significant change in all the indicators compared to the base simulation under SIM1, SIM2 and SIM3. No significant change in real GDP growth rate in all the three cases, this might be due to the fact that increasing the productivity of the leather sector is counterproductive in relation to the agricultural sector. Ethiopia's agricultural sector uses backward technology (uses cattle ploughing) and as the productivity of the leather sector increase more livestock will be demanded by the manufacturing sector at the expense of the agricultural sector. Which will offset the possible increase due to productivity improvement of the leather sector there by having no significant impact on the real GDP.

The three simulations also showed negligible effects on exports this justifies the fact that the sector is not competitive. According to Berhanu and Kibre (2004), the leather sector is characterised as having low productivity and poor processing techniques which makes it hard for the sector to compete internationally. So even with a high TFP growths as high as 60% total export will not increase.

Table 5.2b: Simulation results: effects of increased TFP growth of leather on macroeconomic variables

Average annual growth rate 2010-2015 (% change from base)				
		Leather		
	Initial	Sim1	Sim2	Sim3
Real GDP (at factor cost)	355	-0.01	0	0
Absorption	457.7	0	0	0
Private Consumption	338.6	0	0	0
Investment	85.5	-0.01	-0.01	-0.01
Government	31.8	0	0	0
Exports	52.1	-0.03	-0.01	0
Imports	-126.5	-0.01	0	0
Real Exchange Rate	90.85	-0.01	0	0

Source: CGE simulation results

(c) Expansion of agro-processing

The impact of increased productivity of agro processing industries is presented in table 5.2c. The economy showed positive changes in all the three simulations; a 35% increase in the annual growth rate of TFP of agro processing activities brought about a 0.84% increase in real GDP from the base. With a 25% and 21% increase in growth rate of TFP, real GDP growth rate increased by 11.25% and 11.08%, respectively. Similarly, the impact on private consumption, investment and hence absorption is satisfying.

The average growth rates of exports and imports also showed positive changes in all the three simulations compared to the base simulation although the percentage change from the base is high in exports relative to imports. The reason behind this might be due to the fact that most manufactured exports stem from agro processing industries and as we increase the productivities of these sectors manufactured exports increase. Moreover, the increased productivity of agro-processing industries would also be able to meet the demands of the local market otherwise fulfilled by imports. Among the commodities imported chemicals showed the highest increase since the chemical industry in Ethiopia largely supplies the local textile and leather industries and as their productivity increases their outputs would increase demanding more chemicals as raw materials.

Table 5.2c: Simulation result: effects of increased TFP growth of agro processing on macroeconomic variables

Average annual growth rate 2010-2015 (% change from base)				
		Agro processing		
	Initial	Sim1	Sim2	Sim3
Real GDP (at factor cost)	355	0.84	0.58	0.41
Absorption	457.7	0.41	0.3	0.21
Private Consumption	338.6	0.47	0.35	0.23
Investment	85.5	0.31	0.2	0.15
Government	31.8	0	0	0
Exports	52.1	2.7	1.78	1.33
Imports	-126.5	1.61	1.06	0.78
Real Exchange Rate	90.85	-1.11	-0.74	-0.59

Source: CGE simulation results

(d) Expansion of non agro-processing industries

Table 5.2d also shows the effect of increased productivities of non-agro processing industries. As can be seen, a 58%, 30% and 13% increase in productivities of non-agro processing industries would increase growth rates of real GDP to 0.47%, 0.34% and 0.2% percentage points higher than the base respectively. But the percentage change from the base is small even in SIM1 (high case scenario) due to the fact that non agro-processing industries take the smallest share in total manufacturing industry and due to the weak backward and forward linkages the sector has.

Table 5.2d: Simulation result: effects of increased TFP growth of non-agro processing on macroeconomic variables

Average annual growth rate 2010-2015 (% change from base)				
		Non-agro processing		
	Initial	Sim1	Sim2	Sim3
Real GDP (at factor cost)	355	0.47	0.34	0.2
Absorption	457.7	0.41	0.29	0.18
Private Consumption	338.6	0.59	0.42	0.25
Investment	85.5	-0.16	-0.11	-0.06
Government	31.8	0	0	0
Exports	52.1	2.48	1.76	1.05
Imports	-126.5	1.48	1.05	0.62
Real Exchange Rate	90.85	-1.38	-0.97	-0.57

Source: CGE simulation results

(e) Expansion of manufacturing industries

Increasing TFP's of all activities that are engaged in the manufacturing process reveals a positive change from the base simulation in all macro variables.

Table 5.2e: Simulation results: effects of increased TFP growth of all manufacturing industries on macroeconomic variables

Average annual growth rate 2010-2015 (% change from base)				
		Manufacturing		
	Initial	Sim1	Sim2	Sim3
Real GDP (at factor cost)	355	0.65	0.48	0.3
Absorption	457.7	0.52	0.39	0.25
Private Consumption	338.6	0.73	0.54	0.35
Investment	85.5	-0.12	-0.08	-0.05
Government	31.8	0	0	0
Exports	52.1	2.8	2.02	1.23
Imports	-126.5	1.67	1.2	0.73
Real Exchange Rate	90.85	-1.47	-1.05	-0.62

Source: CGE simulation result

5.2.2 Sectoral Effects

For the purpose of reporting, we have aggregated activities into three: agricultural, industrial and service sectors. Table 5.3a to e presents the results for mean sectoral growth rates of output in each sector and the percentage change from the baseline simulation respectively[15] while table 5.4 shows the sectoral share in total output. In all the simulations, of increased TFP of each activity in the manufacturing industry, sectoral output has shown positive growth in the industrial and service sectors while the agricultural sector showed slight ambiguous results.

[15] Average percentage change in sectoral output is calculated by aggregating output of activities into total outputs of agricultural, industrial and service sector for each year from 2009 to 2015. Then the mean growth rates is calculated from the annual growth rates of each sector

(a) Textile expansion

First, we start with increased TFP of textile. The simulation has resulted in improved industrial output, i.e. industrial output increased by about 25.64 %, 23.3% and 20.41% under SIM1, SIM2 and SIM3, respectively. This change in growth rates is major compared to what was in the business as usual scenario; all the simulations resulted in a more than 2 percentage points higher growth rates from that of the base. The underlying reason for these changes could be due to the fact that increasing TFP of the textile and clothing activities would lead to higher outputs in the textile and clothing activities.

Service sector also showed positive growth although the rate of increase is quiet small compared to the industrial sector. For instance, in SIM1 and SIM3, the sector grew by 13.20% and 12.55% which was 0.88 and 0.22 percentage points higher than the growth rate under the base simulation. However, the effect on agriculture is quite opposite to that of industry and services, it showed a slight decline in SIM1 (-0.06%) and SIM2 (-0.02) where the highest growth rate was recorded but remained to grow at its base value in SIM3. The decline in agricultural sector might be because as textile industries productivity improves it puts pressure on the stagnant agricultural sector and hence output will also be affected.

Table 5.3a: Simulation results: effects on sectoral output of increased TFP of textile (% change)

	Average annual growth rate 2010-2015 (% change from base) Textile		
	Sim1	Sim2	Sim3
Agriculture	-0.06	-0.02	0.00
Industry	7.55	5.21	2.32
Service	0.87	0.55	0.22

Source: CGE simulation result

(b) Leather expansion

As can be seen from table 5.3b, the effect of increasing the TFP of the leather sector by 60%, 14% and 4% in SIM1, SIM2 and SIM3, would have either a negative change or no change in all the three sectors compared to the base simulation. The output of the industrial sector (-0.7) recorded the highest decline in growth rate followed by the agriculture (-0.2) under the high case scenario compared with the respective value in the base. The leather activity itself only showed a slight increase in all the simulations while most of the manufacturing activities were not affected due to the policy shocks. The agricultural sector also revealed approximately a 0.02% decline in growth rate in SIM1 compared to the base simulation. Among agricultural activities outputs of activity cattle and milk showed the highest decline (-0.1%), this may be as a result of more cattle being slaughtered for the leather production which would affect the agricultural sector, especially the cereal production since it involves the uses of backward technology.

With the same token, the increase in TFP of the leather activity would have a negative impact on livestock activity as the cattle which would have been part of the livestock activity would now be inputs to the manufacturing of leather.

Table 5.3b: Simulation results: effects on sectoral output of increased TFP of leather (% change)

	Average annual growth rate 2010-2015 (% change from base)		
		Leather	
	Sim1	Sim2	Sim3
Agriculture	-0.02	0.00	0.00
Industry	-0.07	-0.02	0.00
Service	0.00	0.00	0.00

Source: CGE simulation result

(c) Expansion of agro-processing industries

Increasing the TFP of activities, that are engaged in the manufacturing and processing of agricultural products have resulted in the increase of growth rates of industrial and service outputs and slightly decrease that of agricultural sector (table 5.3c). The highest decline in growth of agricultural output was recorded in SIM1, relative to the other simulations. Though it was the highest among the other simulations, the decline is very small (-0.03), one factor that might contribute to this decline is that as the agro processing manufacturing industries develop, their demand for agriculture outputs largely increase and if the sector can't cope up, the agricultural activities that are highly demanded by the industries like, crops and cereals will be hard hit.

The industrial sector recorded the highest growth rate, under SIM1 (22.69 %) followed by SIM2 (21.24%) and SIM3 (20.58%) which were 4.6%, 3.15% and 2.49% higher compared to the base value, respectively. Since the simulation was to increase the TFP of agro-processing manufacturing industries, a wide range of activities were benefited like: beverages, food processing, leather, textile and clothing industries which recorded higher growth rates among the other activities in the all the three cases. The service sector is next in line with a 0.51%, 0.34% and 0.24% higher average growth rate in Sim1, Sim2 and Sim3compared to the base, respectively, where wholesale and retail trade had the highest growth rates.

Table 5.3c: Simulation results: effects on sectoral output of increased TFP of agro processing industries (% change)

	Average annual growth rate 2010-2015 (% change from base)		
	Agro processing		
	Sim1	Sim2	Sim3
Agriculture	-0.03	-0.01	-0.01
Industry	4.60	3.15	2.49
Service	0.51	0.34	0.24

Source: CGE simulation result

(d) Expansion of non agro-processing industries

Next, the growth of TFP of manufacturing activities that are engaged in processing non agricultural products is increased by 58% (SIM1), 30% (SIM2) and 13% (SIM3). This resulted in a more or less similar sectoral growth trends. The agricultural sector showed a slight increase, especially in the medium (SIM2) and low (SIM3) case scenarios.

On the contrary, the highest increase in the overall growth of the industrial sector was under the high case scenario (19.92%) followed by SIM2 (19.41%). However activities which were based on agriculture such as raw materials and processed agricultural products showed negative growth trends. For instance, in SIM1, growth rate of manufacturing of beverages and leather declined by -0.4 and -6.3 percentage points from that of business as usual scenario. Which is resulted from the shift of production to non-agro processing.

Table 5.3d: Simulation results: effects on sectoral output of increased TFP of non-agro processing industries (% change)

	Average annual growth rate 2010-2015 (% change from base)		
	Non-agro processing		
	Sim1	Sim2	Sim3
Agriculture	0.00	0.01	0.01
Industry	1.83	1.32	0.80
Service	0.61	0.44	0.25

Source: CGE simulation result

(e) Expansion of manufacturing industries

In summary, the simulations conducted on all manufacturing activities either agro or non-agro processing had the same patterns like that of the simulations conducted on all manufacturing industries. Industrial and services sectors had shown positive growth trends in all the three cases while agricultural growth rate stayed fairly the same in SIM1 and SIM2 relative to the base while it has shown a slight decrease under the low case (SIM3).

This simulation tries to inculcate to the net effect of the policies, in which case it ascertains that productivity increase in the manufacturing sector increases the sectoral output of the industrial and service sectors while having no impact or only a negligible decline in agricultural output growth.

Table 5.3e: Simulation results: effects on sectoral output of increased TFP of all manufacturing industries (% change)

	Average annual growth rate 2010-2015 (% change from base)		
		Manufacturing	
	Sim1	Sim2	Sim3
Agriculture	0.00	0.01	-0.03
Industry	1.75	1.04	2.36
Service	0.51	0.32	0.69

Source: simulation results from CGE model

Table 5.4 shows the percentage share of the sectors to the overall output (real GDP). In the high case scenario SIM1, industrial percentage share to output increases under all the activities (textile, agro processing, non-agro processing and manufacturing sector as a whole) except where the leather sectors TFP is increased.

A 90% increase in the productivity growth of textile reduces the share of agriculture and service at the same time as significantly raising the share of industrial sector from 12.5 to 15.18. The high case scenario for agro processing, non-agro processing and the overall manufacturing activities also replicated more or less the same sectoral shares as that of the textile.

Whereas, like the effect on real GDP, the leather scenario of a SIM1, SIM2 and SIM3 resulted in only minor changes in the shares. From all the simulations conducted on the different manufacturing activities it is the leather sector that showed an increase in the share of agriculture due to policy shock although the change is small relative to the percentage share in the base simulation. This increase in the share of agriculture is equally offset by a decline in the service sector for high, medium and low productivity shocks.

The net impact of industrial policies is captured in the simulation, where the growth of TFP's of all the manufacturing activity is shocked with the high, medium and low productivity growths. For instance, a 46% increase in TFP of all the manufacturing activities (SIM1) reduced the share of agriculture and service from the particular values in the base by 0.61 and 0.05 percentage points respectively

Table 5.4: Simulation results: effects on sectoral shares to GDP (%)

	Share in GDP (%)		
		Textile	
	Sim1	Sim2	Sim3
Agriculture	-1.81	-0.88	-0.34
Industry	2.68	1.36	0.54
Service	-0.88	-0.48	-0.21
		Leather	
Agriculture	0.03	0.01	0.00
Industry	0.01	0.01	0.00
Service	-0.03	-0.01	0.00
		Agro processing	
Agriculture	-0.78	-0.50	-0.35
Industry	1.19	0.77	0.59
Service	-0.41	-0.27	-0.23
		Non- agro processing	
Agriculture	-0.45	-0.31	-0.18
Industry	0.41	0.29	0.17
Service	0.05	0.04	0.02
		Manufacturing	
Agriculture	-0.61	-0.43	-0.27
Industry	0.67	0.48	0.29
Service	-0.05	-0.02	-0.01

Source: CGE simulation results

5.2.3 Factor Income

In relation to returns to factors of production, the results from the CGE model are presented in table 5.4. Incomes of all labour groups are improved in all simulations.

(a) Textile expansion

Increasing the productivity of the textile sector will improve the returns to all factors in all the three cases; SIM1, SIM2 and SIM3. But the high case scenario resulted in higher growth while SIM3 resulted in the least growth of factor incomes.

Accounting the highest share in total factors, returns to labour have shown higher improvements compared to the other factors with semiskilled labour showing the most increase in all the three simulations. This is because the textile sector is highly labour intensive. Returns to capital, land and livestock also showed similar growth trends with that of the return to the labour force where the highest change from the base was recorded in SIM1; 0.46%, 0.43% and 0.68%, respectively.

Table 5.5a: Simulation results: effect of increased TFP of textile on factor income (% change from base)

Factors	Initial (in billion birr)	Share	Sim1	Sim2	Sim3
Labor	174.02	49.03	0.73	0.53	0.28
Skilled	20.48	5.77	0.50	0.33	0.15
Semiskilled	57.05	16.07	0.94	0.73	0.35
Unskilled	39.40	11.10	0.37	0.27	0.16
Agriculture labor	57.09	16.08	0.23	0.19	0.13
Capital	110.32	31.08	0.46	0.28	0.11
Land	39.76	11.20	0.43	0.35	0.24
Livestock	30.85	8.69	0.68	0.49	0.26

Source: CGE simulation results

Among the different categories of labour, income of semi skilled showed the highest increase in all the three scenarios followed by skilled labour (figure 5.1a)

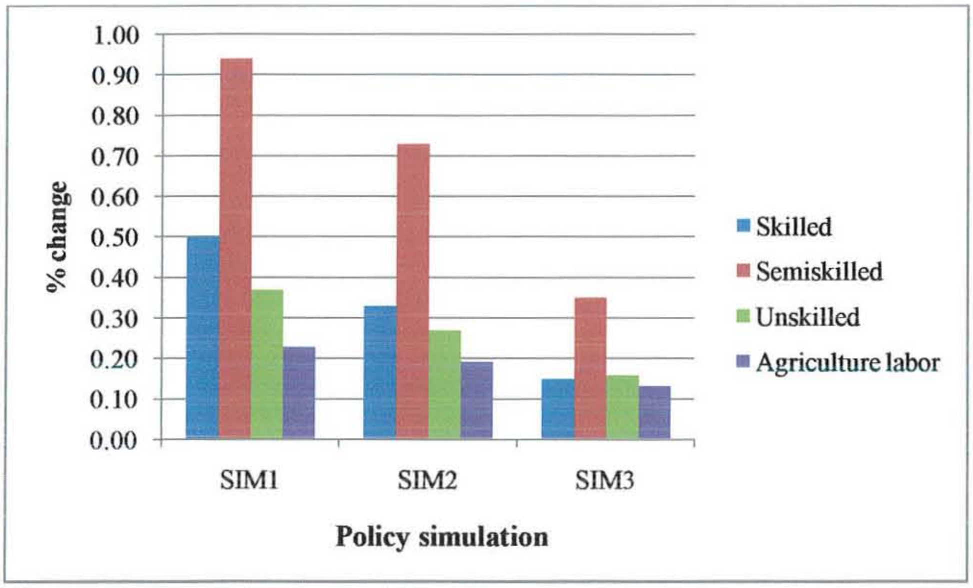

Figure 5.1a: Effects of increased TFP of textile on labour income (% change from base)
Source: CGE simulation results and own computation

(b) Leather Expansion

The effect of increased TFP of leather on factor income is no different than the macroeconomic and sectoral effects. SIM1 and SIM2 both showed a decline in factor incomes of labour (both skilled and semiskilled) and capital while the low case scenario (SIM3) does not show any changes from the business as usual scenario. The reason behind the sluggish growth of factor incomes might be due to the lack of overall and sectoral growth of output in all the three simulation.

As has been pointed out by Tadele *et al.* (2006), a productivity increase in a slow growing "shrinking sector" would lead to a decline in employment and hence income of factors. So in this study, we have established that the leather sector is a shrinking sector.

Income of livestock has increased in all the 3 simulations due to the fact that the major input for the leather manufacturing is hides and skins which will be automatically benefited from productivity improvement of the sector.

Table 5.5b: Simulation results: effect of increased TFP of leather on factor income (% change from base)

Factors	Initial (in billion birr)	Share	Sim1	Sim2	Sim3
Labor	174.02	49.03	-0.01	0.00	0.00
Skilled	20.48	5.77	-0.01	-0.01	0.00
Semiskilled	57.05	16.07	-0.02	-0.01	0.00
Unskilled	39.40	11.10	0.00	0.00	0.00
Agriculture labor	57.09	16.08	0.00	0.00	0.00
Capital	110.32	31.08	-0.02	-0.01	-0.01
Land	39.76	11.20	0.00	0.00	0.00
Livestock	30.85	8.69	0.03	0.02	0.01

Source: CGE simulation results

(c) Expansion of agro-processing industries

The same simulations conducted on the agro processing manufacturing sectors revealed that all factor returns (labour, land, capital and livestock) exhibited positive growth from that of the base simulation.

Returns to labour increased by 0.41%, 0.30% and 0.22% from that of the base in SIM1, SIM2 and SIM3, respectively. Since SIM1 induces a higher productivity shock, we would expect the returns to factors to be greater in this simulation.

Table 5.5c: Simulation results: effect of increased TFP of agro processing on factor income (% change from base)

Factors	Initial (in billion birr)	Share	Sim1	Sim2	Sim3
Labor	174.02	49.03	0.41	0.30	0.22
Skilled	20.48	5.77	0.32	0.22	0.14
Semiskilled	57.05	16.07	0.59	0.40	0.34
Unskilled	39.40	11.10	0.32	0.26	0.17
Agriculture labor	57.09	16.08	0.31	0.27	0.15
Capital	110.32	31.08	0.28	0.19	0.10
Land	39.76	11.20	0.53	0.45	0.28
Livestock	30.85	8.69	0.62	0.48	0.32

Source: CGE simulation results

Figure 5.1b, presents the simulation results of a high, medium and low TFP growth rates on the income of the different categories of the labour force. Undoubtedly, semiskilled labour is most benefited due to development in manufacturing industries that are engaged in the processing of agricultural products over all other categories of the labour force.

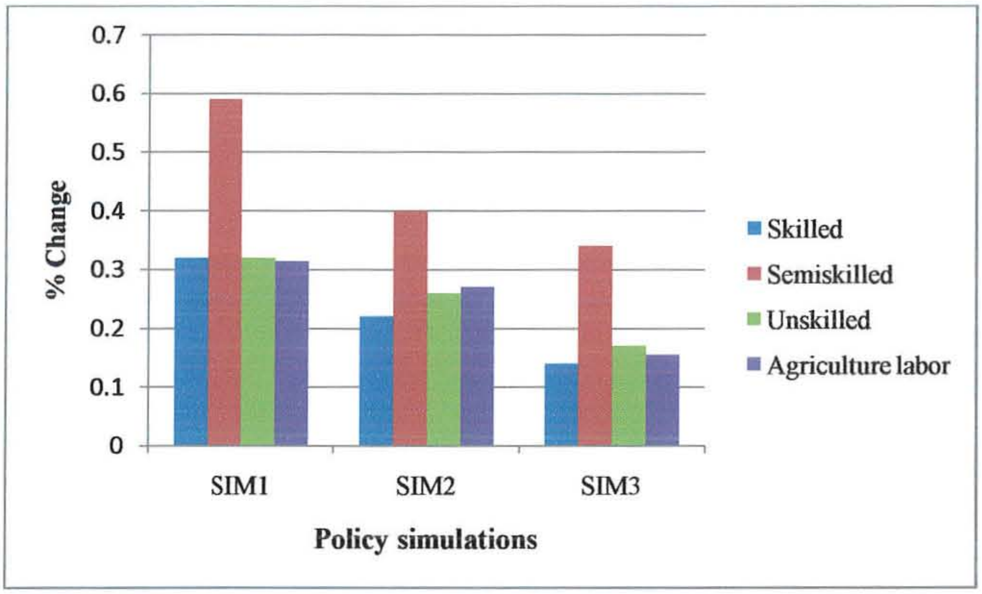

Figure 5.1b: Effects of increased TFP of agro processing on labour income (% change from base)

Source: CGE simulation results and own computation

(d) Expansion of non agro-processing industries

Similarly, the three simulations conducted on the non-agro processing manufacturing industries revealed a positive change in all the factors except in the returns to land. Returns to land showed a 0.03, 0.02 and 0.02 percentage point decline in SIM1, SIM2 and SIM3 respectively compared to the base scenario. This is because of the shift from agro processing to non-agro processing would result in a decline of demand of agricultural raw materials for these industries and as land is one input its return would decline with decline in demand.

Returns to capital and livestock both showed improvements due to all the policy shocks with only a small percentage difference among the three simulations; returns to capital increased by 0.73%, 0.54% and 0.33% while income to livestock grew by 0.37%, 0.28% and 0.17% from the base value in SIM1, SIM2 and SIM3. Returns to capital showed the highest change among all factors from the base simulation in all the three scenarios followed by labour implying that the sector is capital intensive.

Table 5.5d: Simulation results: effect of increased TFP of non-agro processing on factor income (% change from base)

Factors	Initial (in billion birr)	Share	Sim1	Sim2	Sim3
Labor	174.02	49.03	0.50	0.35	0.21
Skilled	20.48	5.77	0.54	0.39	0.23
Semiskilled	57.05	16.07	1.18	0.84	0.50
Unskilled	39.40	11.10	0.15	0.10	0.06
Agriculture labor	57.09	16.08	0.04	0.03	0.02
Capital	110.32	31.08	0.73	0.54	0.33
Land	39.76	11.20	-0.03	-0.02	-0.02
Livestock	30.85	8.69	0.37	0.28	0.17

Source: CGE simulation results

When we come to the returns to the different categories of labour, returns to semi skilled labour showed the highest change in all the three simulations compared to the other categories. For instance, in the high case scenario SIM1, it was 1.18 percentage points higher than the respective value under the base while the figure was small for skilled (0.54%), unskilled (0.15%) and agricultural labour (0.04%).

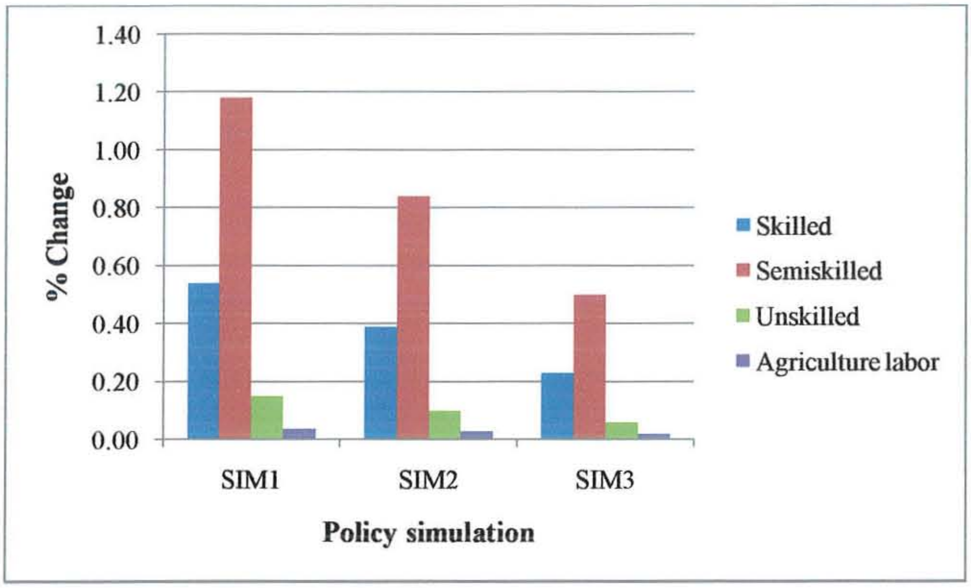

Figure 5.1c: Effects of increased TFP of non-agro processing on labour income (% change from base)

Source: CGE simulation results and own computation

(e) Expansion of manufacturing industries

In the simulation which replicates the impact of overall policies i.e. the overall manufacturing sector improves the returns to all factors in all the three simulations (SIM1, SIM2 and SIM3) where the highest change from the base is in the high case scenario of a 46% increase in the TFP's of the manufacturing activities. The rationale might be owing to the higher rise in the output of goods, due to productivity increase which will increase the returns of labour, land, and capital more in these sectors within the simulations conducted on the manufacturing activities and since the combined effect captures both agro and non-agro processing all factors will be benefited.

Table 5.5e: Simulation results: effect of increased TFP of all manufacturing industries on factor income (% change from base)

Factors	Initial (in billion birr)	Share	Sim1	Sim2	Sim3
Labor	174.02	49.03	1.11	0.83	0.50
Skilled	20.48	5.77	0.60	0.44	0.27
Semiskilled	57.05	16.07	1.10	0.77	0.43
Unskilled	39.40	11.10	0.32	0.25	0.18
Agriculture labor	57.09	16.08	0.29	0.24	0.20
Capital	110.32	31.08	0.79	0.58	0.37
Land	39.76	11.20	0.40	0.33	0.28
Livestock	30.85	8.69	0.62	0.48	0.34

Source: CGE simulation results

The impact on the different categories of the labour force replicated those of the simulations where we increased the TFP's of agro and non-agro processing; returns to all types of labour were raised. The high case scenario (SIM1) resulted in the highest increase in all types while the smallest change was in the low case scenario (SIM3). Semi skilled labour still remains to show the highest increase followed by skilled labour (figure 5.2c); this shows that the manufacturing sector largely employs semiskilled labour. In SIM1, increasing the TFP growth rate of manufacturing sector by 46%, resulted in the income of semi skilled labour to grow by 11.12%, which is 1.1 percentage points higher than the base value, in SIM2 and SIM3 it grew by 10.79% and 10.45% respectively. Skilled labour is next in line, growing with 0.6, 0.44 and 0.27 percentage points higher than the base value in SIM1, SIM2 and SIM3.

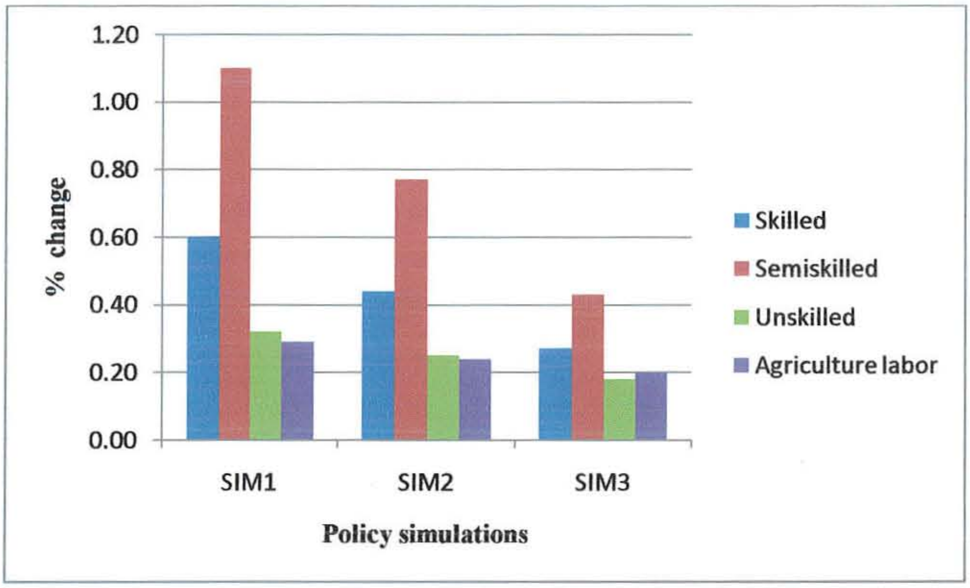

Figure 5.1d: Effects of increased TFP of all manufacturing industries on labour income (% change from base)

Source: CGE simulation results

5.2.4 Household Income

(a) Textile expansion

Productivity increase in textile industry substantially improves the real incomes of all households (both rural and urban households). As can be seen from table 5.6a, rural and urban households showed more or less the same changes from the base simulation. Income of rural household showed a 0.48% (SIM1), 0.33% (SIM2) and 0.18% (SIM3) percentage points higher growth rates than the base scenario while urban households' income was 0.49% (SIM1), 0.3% (SIM2) and 0.1% (SIM3) percentage points higher than the growth rate of the household income during the base simulation.

This implies that productivity increase of the textile industry would benefit the rural and urban households in the same manner whilst the least TFP growth (SIM3), is pro-rural households compared to the urban households as the rate of change is higher in rural households. A 90% increase in the TFP of textile (SIM1), resulted in the growth rate of rural household income to increase with a 0.48 percentage points relative to the base (10.64%), this percentage change is the highest among all the simulations. Amid the different types of households, the income of non-poor illustrated the highest growth, growing at a rate 0.5 percentage points higher than the base. The same trend is observed for the rural incomes in SIM2 and SIM3, though the rate of change is small relative to SIM1.

The result from the simulation illustrated that the urban non-poor household earnings would increase at a higher rate in SIM1 compared to the poor while in SIM2 and SIM3 rate of increase is the same for the poor and non poor. This implies that as the rate of TFP growth of textile increases, the non-poor urban households would be benefited more than the poor urban households. This is because the urban non-poor is the segment of the population that owns either skilled or semi skilled labour and we have seen that the semi skilled labour is the factor that is largely benefited from activity specific TFP growth.

Table 5.6a: Simulation results: effect of increased TFP of textile on household income (% change from base)

	Initial (in billion birr)	Sim1	Sim2	Sim3
Rural	325.80	0.48	0.33	0.18
Poor	74.60	0.41	0.31	0.19
Non- poor	251.20	0.50	0.34	0.18
Urban	34.60	0.49	0.30	0.10
Poor	3.70	0.40	0.30	0.10
Non-poor	30.90	0.50	0.30	0.10

Source: CGE simulation results

(b) Leather expansion

Increasing the productivity of the leather sector by 60% (SIM1), 14% (SIM2) and 4% (SIM3) showed no significant change in the incomes of both the poor and non poor urban households. The income of the rural households showed a slight decline in the high and medium case scenarios particularly the rural non-poor. This is due to the decline in the output of the agricultural sector where most rural households are engaged in.

Table 5.6b: Simulation results: effect of increased TFP of leather on household income (% change from base)

	Initial (in billion birr)	Sim1	Sim2	Sim3
Rural	325.80	-0.01	-0.01	0.00
Poor	74.60	0.00	0.00	0.00
Non- poor	251.20	-0.02	-0.02	0.00
Urban	34.60	0.00	0.00	0.00
Poor	3.70	0.00	0.00	0.00
Non-poor	30.90	0.00	0.00	0.00

Source: CGE simulation results

(c) Expansion of agro-processing industries

Table 5.6c shows that, the faster GDP growth under simulations on agro processing manufacturing industries resulted in substantial increase in real incomes of both poor and non-poor households. Continuation of productivity growth patterns as under the base would increase average real incomes of rural and urban households by 10.64% and 9.4% per year, respectively. Average growth of rural household incomes increased more than the urban counterpart in all the three scenarios. This is because as the productivities of agro processing increase demand for agricultural products would increase hence the rural households who are mostly engaged in agricultural activities get paid more. The highest rural income growth rate was recorded under SIM1 with the non poor benefiting the most. Urban household income also showed improvements from the base value; 0.3, 0.2 and 0.1 percentage points higher in SIM1, SIM2 and SIM3, respectively.

There is no distinction on the changes in growth rates between the urban poor and non poor in each simulation.

Table 5.6c: Simulation results: effect of increased TFP of agro processing on household income (% change from base scenario)

	Initial (in billion birr)	Sim1	Sim2	Sim3
Rural	325.80	0.38	0.29	0.18
Poor	74.60	0.39	0.33	0.19
Non- poor	251.20	0.38	0.28	0.18
Urban	34.60	0.30	0.20	0.10
Poor	3.70	0.30	0.20	0.10
Non-poor	30.90	0.30	0.20	0.10

Source: CGE simulation results

(d) Expansion of non agro-processing industries

As can be seen from table 5.6d, productivity increase in the non agro processing manufacturing industries benefits the urban households more than the rural counterpart since the sectors' who's TFP has been increased are non agriculture urban based manufacturing industries which will increase the income for capital owners and as urban households are more capital owners compared to rural households their income would also increase. Among the urban households, the income of non poor increases more than that of the poor compared to the base in SIM2 (0.5%) and SIM (0.3%) while, in SIM1 both types of urban households show the same change from the base.

The income of the rural poor increased more than the poor in all the three simulations; for instance, in SIM1 the change from the base for rural non poor was 0.5% while it was only 0.23% for the poor.

Table 5.6d: Simulation results: effect of increased TFP of non-agro processing on household income (% change from base scenario)

	Initial (in billion birr)	Sim1	Sim2	Sim3
Rural	325.80	0.44	0.32	0.21
Poor	74.60	0.23	0.19	0.08
Non- poor	251.20	0.50	0.36	0.24
Urban	34.60	0.60	0.49	0.29
Poor	3.70	0.60	0.40	0.20
Non-poor	30.90	0.60	0.50	0.30

Source: CGE simulation results

(e) Expansion of manufacturing industries

Table 5.6e illustrates the effect of a 46%, 27% and 20% increase in the productivity of all activities engaged in the manufacturing industry on the income of households. The urban households' income increases more than the rural in SIM1 and SIM2 while the income of rural households increases more under the low case (SIM3). The underlying reason is that as productivity of the manufacturing industry increases resources will be shifted to the industrial sector from the agricultural sector thus showing a moderate effect on the rural households. The increase in income of non poor rural households is higher than the rural poor in all the simulations; 0.66 (SIM1), 0.46% (SIM2) and 0.32% (SIM3). The same trend has been observed for urban households; the income of the non- poor urban households improved more than that of the poor.

Table 5.6e: Simulation results: effect of increased TFP of all manufacturing industries on household income (% change from base scenario)

	Initial (in billion birr)	Sim1	Sim2	Sim3
Rural	325.80	0.61	0.43	0.31
Poor	74.60	0.46	0.32	0.28
Non- poor	251.20	0.66	0.46	0.32
Urban	34.60	0.69	0.49	0.30
Poor	3.70	0.60	0.40	0.30
Non-poor	30.90	0.70	0.50	0.30

Source: CGE simulation results

5.2.5 Welfare Effects

Equivalent variation (EV) is one of the widely used measures of welfare from some policy change in monetary terms. EV measures the change in utility due to the change in prices by using the current prices as the base price and asks what income change is needed at the current price that corresponds to the anticipated change in terms of its impact on utility (Varian, 1992). In other words, it measures the level of income that the consumer needs to forgo or payback before the shock so as to make him/her as well of as the equivalent level of utility after the price increase.

Importantly, EV is extensively used as welfare indicator in the literature for CGE models. The fundamental reason behind this is that EV measures the income change at current prices and keeps price fixed at status-quo for different policies, this makes it suitable to compare more than one proposed policy change. Negative EV would imply that there is welfare (utility) loss due to the policy shock while positive EV implies a welfare gain.

(a) Textile expansion

In all the three scenarios, we see positive EVs for the increase in TFP of textile industry indicating welfare improvements. The EVs showed the highest increase for all household groups during the high case scenario (SIM1) by 0.71% (rural poor), 0.89% (rural non-poor), 0.98% (urban poor) and 1.29% (urban non-poor). The welfare of urban households improved larger than that of the rural counterparts with non-poor households being relatively well-off in both areas.

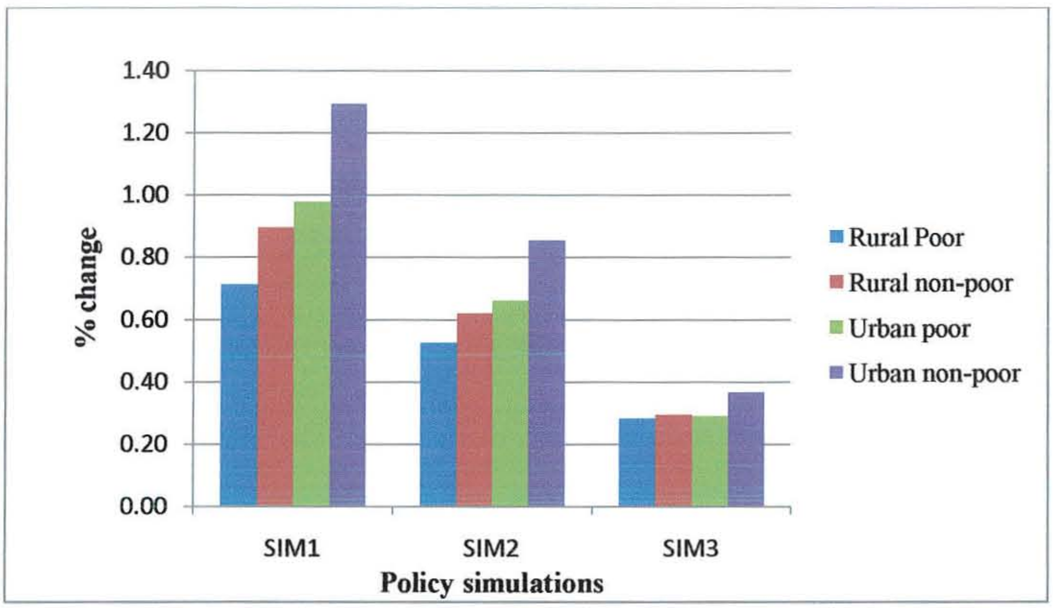

Figure 5.2a: Effects of increased TFP of textile on welfare (EV) of households (% change from base)
Source: CGE simulation results and own computation

(b) Leather expansion

The CGE results depicted in figure 5.2b, shows that the high TFP growths, (SIM1) of the leather industry seems to have negatively affected both the urban and rural households as the negative values for EVs would suggest. The EVs have declined by 0.01%, 0.02%, and 0.02% for rural non-poor, urban poor and urban non-poor, respectively from the base simulation while EV for rural poor showed a slight welfare gain. The EV result implies that relatively the non-poor receive much of the welfare strain in both rural and urban areas. Comparatively, we find that urban households face larger welfare loses which may be due to the counterproductive effect of the productivity increase of the leather dragging their livelihoods downwards as has been illustrated in the previous sections.

We can see that as the TFP growth declines (SIM2 and SIM3) the impact on both rural and urban households diminishes. In SIM2, we find that the policy shock only affected the urban households with a decline of -0.01% in both the poor and non poor relative to the business as usual. SIM3 resulted in no significant change on the welfare of both the urban and rural households. This indicates that productivity increase in only the leather sector is welfare shrinking.

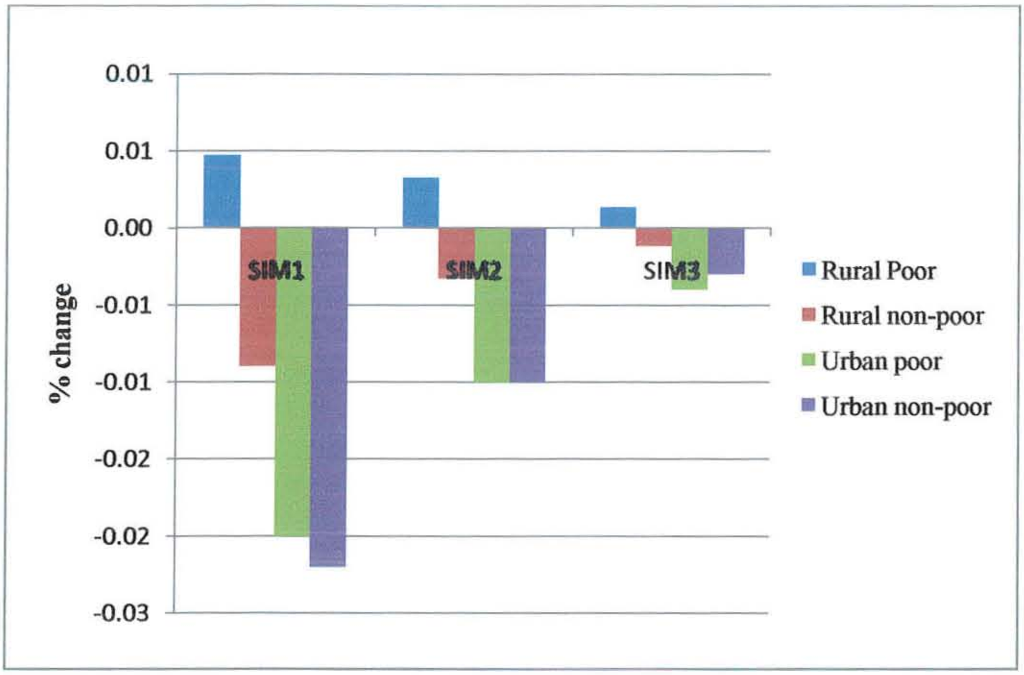

Figure 5.2b: Effects of increased TFP of leather on welfare (EV) of households (% change from base)
Source: CGE simulation results and own computation

(c) Expansion of agro-processing industries

In the case of all agro processing manufacturing activities including textile and leather, results from the CGE model suggest that all the three simulations are welfare improving for all the household groups. The welfare of urban household improved by 0.76%, 0.51% and 0.38% (urban non-poor) and 0.56%, 0.37% and 0.30% (urban poor) in SIM1, SIM2 and SIM3, respectively. The rate of welfare improvements in the rural households seemed to be diverse in each simulation; in SIM1 rural non poor seemed to be somewhat better-off relative to the poor with 0.65% for the non poor and 0.62% for the poor.

In SIM2 and SIM3, the welfare increase slightly shifts to the rural poor; 0.48% and 0.32% for rural poor while 0.47% and 0.48% change for rural non poor in SIM2 and SIM3, respectively.

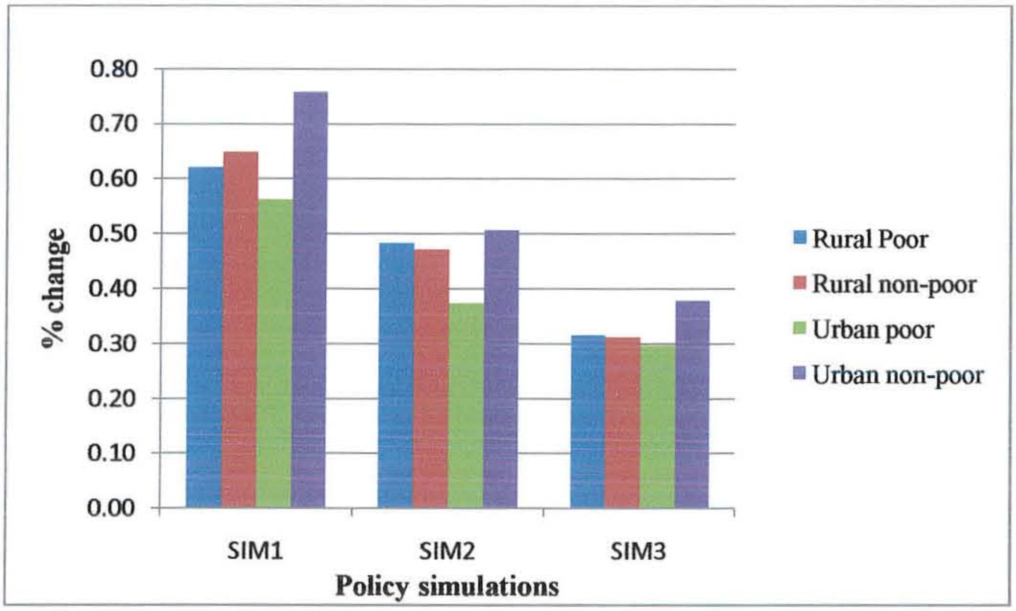

Figure 5.2c: Effects of increased TFP of agro processing on welfare (EV) of households (% change from base)

Source: CGE simulation results

(d) Expansion of non agro-processing industries

Like the agro processing, increased TFP growth rates of non agro processing manufacturing industries is welfare increasing for all households in all the scenarios (figure 5.2d). Comparatively the urban households are better-off from rural households with the non poor reaping the higher advantage in all simulations. Welfare of the urban non poor increased by 1.46 (SIM1), 1.04(SIM2) and 0.62 (SIM3) percentage points higher than the base scenario while the poor only increased by 1.11% (SIM1), 0.79% (SIM2) and 0.47% (SIM3).

Welfare of rural poor and non poor also showed positive changes from the business as usual scenario with a 0.45 (SIM1), 0.32 (SIM2) and 0.19 (SIM3) and 0.94 (SIM1), 0.62 (SIM2) and 0.40 (SIM3) percentage points higher than the base, respectively. This may be due to the fact the very nature of non agro processing manufacturing industries being not dependent on agriculture, hence showing a small increase in the welfare of rural households. Furthermore, urban households earn more from non agricultural processing industries relative to rural households hence as the productivity of the sector increase so does the gains to the factors and households.

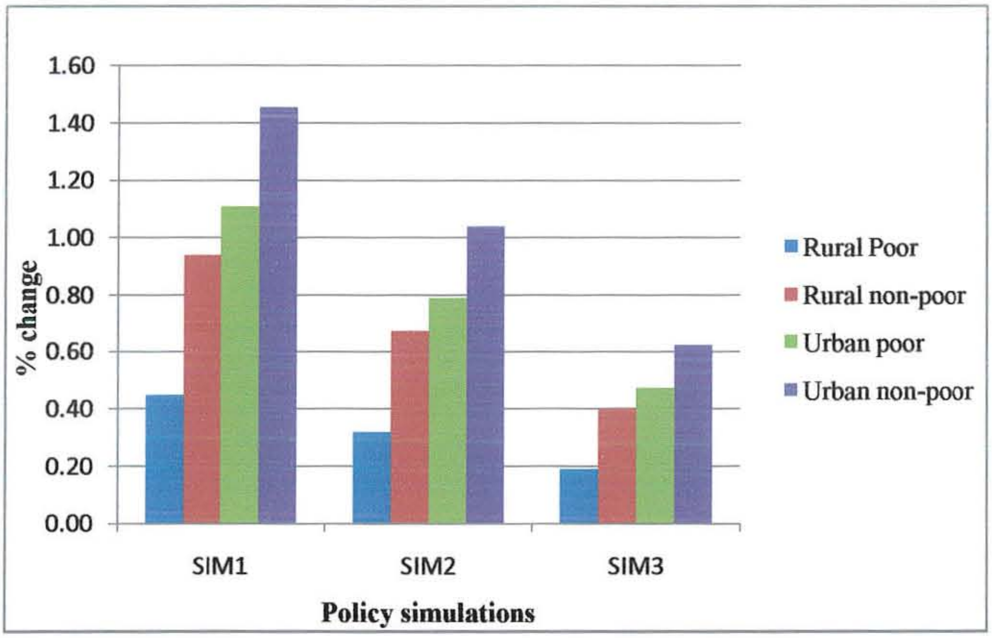

Figure 5.2d: Effects of increased TFP of non-agro processing on welfare (EV) of households (% change from base)

Source: CGE simulation results

(e) Expansion of manufacturing industries

The increased productivity of all manufacturing activities including both agro and non agro processing is translated into improved wellbeing of all household groups where the urban enjoys most of it in all the three scenarios. Moreover, The EV result implies that relatively the non-poor receive much of the welfare gain in both rural and urban areas. The urban poor and non poor were 1.12 (SIM1), 0.8 (SIM2) and 0.47 (SIM3) and 1.52 (SIM1), 1.1 (SIM2) and 0.66 (SIM3) percentage points well off from the base simulation respectively. These results suggest that rural households will also be better-off with more or less the same rate with that of the urban households though the latter seems to benefit a little bit more in all the three scenarios. Welfare of the rural poor and non poor increased by 0.73 (SIM1), 0.56 (SIM2) and 0.38 (SIM3) and 1.11 (SIM1), 0.82 (SIM2) and 0.52 (SIM3), respectively.

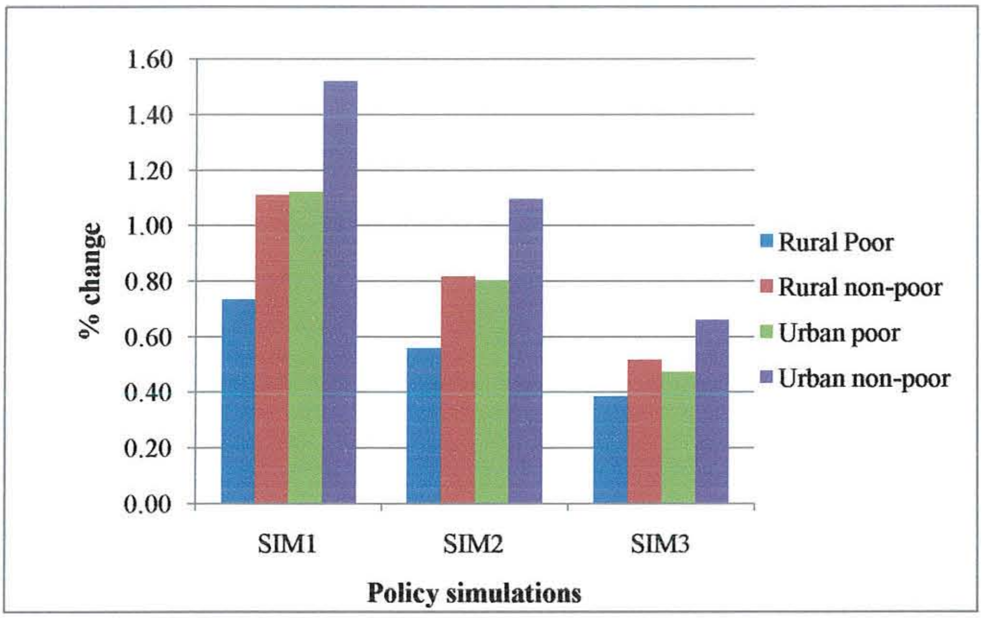

Figure 5.2e: Effects of increased TFP of all manufacturing activities on welfare (EV) of households (% change from base)
Source: CGE simulation results

Chapter Six: Conclusions and Policy Implications

6.1 Conclusions

In this study, we tried to examine the long-run economy-wide impacts of productivity improvement in the manufacturing industry on the Ethiopian economy. We utilized a dynamic CGE model to study the interrelationships and also model the effects of the productivity improvement of priority sectors of the manufacturing industry on macro and sectoral variables, factor and household incomes and welfare of the society. The model used for this study was the standard IFPRI model calibrated with the 2005/06 adjusted SAM for Ethiopia.

The descriptive analysis pointed out that the manufacturing sector is in its infant stage, contributing a small amount to GDP and employment though the number of firms has shown an increasing trend over the last decade. Agro-processing industries are leading in terms of share in total manufacturing, employment and labour productivity. Among the agro processing industries, food and beverages manufacturing industry accounted the highest share in overall manufacturing and employment contribution. The highest share of manufacturing value added was from manufacturing of wood and wood products and basic iron.

The scenarios of increasing the TFP's of textile, leather, agro processing and non-agro processing and all activities engaged in the manufacturing process showed mixed results.

Macro variables such as real GDP, private consumption, investment, imports and exports all showed increasing trend in the high, medium and low scenario as a result of improved TFP of textile, agro processing, and non agro processing and overall manufacturing activities. The income of factor and households also showed improvements in all the scenarios. In general, increasing TFP growth of textile, agro processing, non-agro processing and overall manufacturing industries are welfare increasing to all household groups. Increasing the TFP of the leather activities has not resulted in significant effect on the macro economy. Increasing TFP of the leather sector, results in welfare loss to rural non-poor, urban poor and non-poor households in all the three scenarios. Rural poor households are the only households that gained from productivity increase though the gain is small.

6.2 Implications

Based on the empirical analysis, it is observed that the manufacturing sector has a positive impact on the Ethiopian economy. Although the sector is at its early stage of development, productivity increase would substantially affect the entire economy. This calls for the development of a strong industrial policy that aims at ensuring the long-run productivity of the sector.

The study also found out that productivity increase in the leather sector alone doesn't have any significant impact on the economy; it even results in welfare loss to most of the households.

So, the study recommends that policies and strategies regarding the leather sector should be carefully analyzed and supply side interventions should be introduced. Furthermore, results from this study advocate policy interventions towards both the agro and non-agro processing industries but recommends to give emphasis to agro-processing industries.

Finally, the study recommends for further researches to use estimated TFP growth as a policy shock since this might lead to different conclusions.

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$i \in INS$ - institutions (domestic and rest of the world)

$i \in INSD(\subset INS)$ - domestic institutions

$i \in INSDNG(\subset INS)$ - domestic non government 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'

$\text{int}\, a_a$ - quantity of aggregate intermediate input per activity unit

iva_a - quantity of value-added per activity unit

$\overline{mps_i}$ - base saving rate for domestic institution i

$mps01_c$ - 0-1 parameter with 1 for institutions with potentially flexed direct tax rate pwe_c - export price(foreign currency)

α^{t}_{c} - CET function shift parameter

β^{h}_{ach} - marginal share of consumption spending on home commodity c from activity a for household h

β^{m}_{ch} - marginal share of consumption spending on marketed commodity c for household h

δ^{ac}_{ac} - share parameter for domestic commodity aggregation function

δ^{q}_{c} - Armington function share parameter

δ^{t}_{c} - CET function share parameter

δ^{va}_{fa} - CES value –added function share parameter for factor f in activity a

γ^{m}_{ch} - subsistence consumption of marketed commodity c for household h

γ^{h}_{ach} - subsistence consumption of home commodity c from activity a for household h

θ_{ac} - yield of output c per unit of activity a

ρ^{va}_{a} - CES value – added function exponent

ρ^{ac}_{a} - domestic commodity aggregation function exponent

ρ^{q}_{c} - Armington function exponent

ρ'_c - 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 Variable

$DMPS$ -change in domestic institution saving rates (= 0 for base; exogenous variable)

DPI - producer price index for domestically marketed output

EG - government expenditure

EH_h - consumption spending for household

QA_a - quantity (level) of activity

QD_c - quantity sold domestically of domestic output

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 import 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 ($i \in INSDNG$)

$TRII_{ii'}$ - transfer from institution i' to i (both in the rest $INSDNG$)

WF_f - average price of factor f

YF_f - income of factor f

YG - government revenue

YI_i - income of domestic non-government institution

YIF_{if} - income to domestic institution i from factor f

Appendix A2: Model Equation

Price Block

[1] Import price

$$PM_c = pwm_c.(1+tm_c).EXR + \sum_{c' \in CT} PQ_{c'}.icm_{c'c} \qquad c \in CM$$

[2] Export price

$$PE_c = pwe_c.EXR - \sum_{c' \in CT} PQ_{c'}.ice_{c'c} \qquad c \in CE$$

[3] Demand price of domestic non-traded goods

$$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'}.icd_{c'c} \qquad c \in CD$$

[4] Absorption

$$PQ_c.(1-tq_c).QQ_c = PDD_c.QD_c + PM_c.QM_c \qquad c \in (CD \cup CM)$$

[5] Marketed output value

$$PX_c.QX_c = PDS_c.QD_c + PE_c.QE_c \qquad c \in CX$$

[6] Activity price

$$PA_a = \sum_{c \in C} PXAC_{ac}.\theta_{ac} \qquad a \in A$$

[7] Aggregate intermediate input price

$$PINTA_a = \sum_{c \in C} PQ_c .ica_{ca} \qquad a \in A$$

[8] Activity revenue and costs

$$PA_a .QA_a = PVA_a .QVA_a + PINTA_a .QINTA_a \qquad a \in A$$

[9] Consumer price index

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

[10] Producer price index for non-traded market output

$$DPI = \sum_{c \in C} PDS_c .dwts_c$$

Production and Trade Block

[11] Leontief technology: Demand for aggregate value-added

$$QVA_a = iva_a .QA_a \qquad a \in ALEO$$

[12] Leontief technology: Demand for aggregate intermediate input

$$QINTA_a = \text{int}\, a_a .QA_a \qquad a \in ALEO$$

[13] Value-added and factor demand

$$QVA_a = \alpha^{va}{}_a \left(\sum_{f \in F} \delta^{va}{}_{fa} .QF_{fa}{}^{-\rho^{va}{}_a} \right)^{-\frac{1}{\rho^{va}{}_a}} \qquad a \in A$$

[14] Factor Demand

$$WF_f.\overline{WFDIST}_{fa} = PVA_a.QVA_a\left(\sum_{f\in F'} \delta^{va}{}_{fa}.QF_{fa}{}^{-\rho^{va}{}_a}\right)^{-1}.\delta^{va}{}_{fa}.QF_{fa}{}^{-\rho^{va}{}_a-1} \qquad a\in A; f\in F$$

[15] Disaggregated intermediate input demand

$$QINT_{ca} = ica_{ca}.QINTA_a \qquad a\in A;\ c\in C$$

[16] Commodity production and allocation

$$QXAC_{ac} + \sum_{h\in H} QHA_{ach} = \theta_{ac}.QA_a \qquad a\in A;\ a\in CX$$

[17] Output aggregation function

$$QX_c = \alpha^{ac}{}_c.\left(\sum_{a\in A}\delta^{ac}{}_{ac}.QXAC_{ac}{}^{-\rho^{ac}{}_c}\right)^{-\frac{1}{\rho^{ac}{}_c-1}} \qquad c\in CX$$

[18] First-order condition for output aggregation function

$$PXAC_{ac} = PX_c.QX_c\left(\sum_{a\in A'}\delta^{ac}{}_{ac}.QXAC_{ac}{}^{-\rho^{ac}{}_c}\right)^{-1}.\delta^{ac}{}_{ac}.QXAC_{ac}{}^{-\rho^{ac}{}_c-1} \qquad a\in A\ ;\ c\in CX$$

[19] Output transformation (CET) function

$$QX_c = \alpha'_c.(\delta'_c.QE_c^{\rho'_c} + (1-\delta'_c).QD_c^{\rho'_c})^{\frac{1}{\rho'_c}} \qquad c\in (CE\cap CD)$$

[20] Export-domestic supply ratio

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c}.\frac{1-\delta'_c}{\delta'_c}\right)^{\frac{1}{\rho'_c-1}} \qquad c\in (CE\cap CD)$$

[21] Output transformation for non-exported commodities

$$QX_c = QD_c + QE_c \qquad c \in (CD \cap CEN) \cup (CE \cup CDN)$$

[22] Composite supply (Armington) function

$$QQ_c = \alpha^{\Box}{}_c.(\delta^{\Box}{}_c.QM_c{}^{-\rho^{\Box}} + (1-\delta^{\Box}{}_c).QD_c{}^{-\rho^{\Box}})^{-\frac{1}{\rho^{\Box}}} \qquad c \in (CM \cap CD)$$

[23] Import-domestic demand ratio

$$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c} . \frac{\delta^{\Box}{}_c}{1-\delta^{\Box}{}_c} \right)^{\frac{1}{1+\rho^{\Box}}} \qquad c \in (CM \cap CD)$$

[24] Composite supply for non-imported outputs and non-produced imports

$$QQ_c = QD_c + QM_c \qquad c \in (CD \cap CMN) \cup (CM \cup CDN)$$

[25] Demand for transaction services

$$QT_c = \sum_{c' \in C'} (icm_{cc'}.QM_{c'} + ice_{cc'}.QE_{c'} + icd_{cc'}.QD_{c'}) \qquad c \in CT$$

Institutional Block

[26] Factor income

$$YF_f = \sum_{a \in A} WF_f.\overline{WFDIST}_{fa}.QF_{fa} \qquad f \in F$$

[27] Institutional factor income

$$YIF_{if} = shif_{if}.\left[YF_f - trnsfr_{rowf}.EXR \right] \qquad i \in INSD;\ f \in F$$

[28] Income of domestic, non-government institutions

$$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{gov}.\overline{CPI} + trnsfr_{irow}.EXR \qquad i \in INSDNG$$

[29] Intra-institutional transfer

$$TRII_{ii'} = shii_{ii'}.(1 - MPS_{i'}).(1 - TINS_{i'}).YI_{i'} \qquad i \in INSDNG;\ i' \in INSDNG'$$

[30] Household consumption expenditure

$$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih}\right).(1 - MPS_h).(1 - TINS_h).YI_h \qquad h \in H$$

[31] Household consumption demand for marketed commodities

$$PQ_c.QH_{ch} = PQ_c.\gamma^m{}_{ch} + \beta^m{}_{ch}.\left(EH_h - \sum_{c' \in C} PQ_{c'}.\gamma^m{}_{c'h} - \sum_{a \in A} \sum_{c' \in C} PXAC_{ac'}.\gamma^h{}_{ac'h} \right) \quad c \in C; h \in H$$

[32] Household consumption demand for home commodities

$$PXAC_{ac}.QHA_{ach} = PXAC_{ac}.\gamma^h{}_{ach} + \beta^h{}_{ach}.\left(EH_h - \sum_{c' \in C} PQ_{c'}.\gamma^m{}_{c'h} - \sum_{a \in A} \sum_{c' \in C} PXAC_{ac'}.\gamma^h{}_{ac'h} \right) \quad a \in A$$

$;c \in C;\ h \in H$

[33] Investment demand

$$QINV_c = \overline{IADJ}.\overline{qinv_c} \qquad c \in CINV$$

[34] Government consumption demand

$$QG_c = \overline{GADJ}.\overline{qg_c} \qquad c \in C$$

[35] Government revenue

$$YG = \sum_{i \in INSDNG} TINS_i.YI_i + \sum_{c \in CM} tm_c.pwm_c.QM_c.EXR + \sum_{c \in C} tq_c.PQ_c.QQ_c$$

$$+ \sum_{f \in F} YIF_{govf} + trnsfr_{govrow}.EXR$$

[36] Government expenditure

$$EG = \sum_{c \in C} PQ_c.QG_c + \sum_{i \in INSDNG} trnsfr_{i\ gov}.\overline{CPI}$$

System Constraint Block

[37] Factor market

$$\sum_{a \in A} QF_{fa} = \overline{QFS_f} \qquad f \in F$$

[38] Composite commodity market

$$QQ_c = \sum_{a \in A} QINT_{ca} + \sum_{h \in H} QH_{ch} + QG_c + QINV_c + qdst_c + QT_c \qquad c \in C$$

[39] Current account balance for the rest of the world (in foreign currency)

$$\sum_{c \in CM} pwm_c.QM_c + \sum_{f \in F} trnsfr_{rowf} = \sum_{c \in CE} pwe_c.QE_c + \sum_{i \in INSD} trnsfr_{irow} + \overline{FSAV}$$

[40] Government balance

$$YG = EG + GSAV$$

[41] Direct institutional tax rates

$$TINS_i = \overline{tins_i}.(1 + \overline{TINSADJ}.tins01_i) + \overline{DTINS}.tins01_i \qquad i \in INSDNG$$

[42] Institutional savings rates

$$MPS_i = \overline{mps_i}.(1 + \overline{MPSADJ}.mps01_i) + DMPS.mps01_i \qquad i \in INSDNG$$

[43] Saving-investment balance

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

[44] Total absorption

$$TABS = \sum_{h \in H}\sum_{c \in C} PQ_c.QH_{ch} + \sum_{a \in A}\sum_{c \in C}\sum_{h \in H} PXAC_{ac}.QHA_{ach} + \sum_{c \in C} PQ_c.QG_c$$

$$+ \sum_{c \in C} PQ_c.QINV_c + \sum_{c \in C} PQ_c.qdst_c$$

[45] Ratio of investment to absorption

$$INVSHR.TABS = \sum_{c \in C} PQ_c.QINV_c + \sum_{c \in C} PQ_c.qdst_c$$

[46] Ratio of government consumption to absorption

$$GOVSHR.TABS = \sum_{c \in C} PQ_c.QG_c$$

Appendix B: The "Between" Model

[49] Average capital rental rate

$$AWF_{ft}^{a} = \sum_{a}\left[\left(\frac{QF_{fat}}{\sum_{a'} QF_{fa't}}\right).WF_{ft}.WFDIST_{fat}\right]$$

[50] Share of new capital

$$\eta^{a}{}_{fat} = \left(\frac{QF_{fat}}{\sum_{a'} QF_{fa't}}\right).\left(\beta^{a}.\left(\frac{WF_{ft}.WFDIST_{fat}}{AWF_{ft}^{a}} - 1\right) + 1\right)$$

[51] Quantity of new capital by sector

$$\Delta K^{a}{}_{fat} = \eta^{a}{}_{fat}.\left(\frac{\sum_{a} PQ_{ct}.QINV_{ct}}{PK_{ft}}\right)$$

[52] Unit price of capital

$$PK_{ft} = \sum_{c} PQ_{ct} \frac{QINV_{ct}}{\sum_{c'} QINV_{c't}}$$

[53] Average Price of capital

$$QF_{fat+1} = QF_{fat}.\left(1 + \frac{\Delta K^{a}{}_{fat}}{QF_{fat}} - v_{f}\right)$$

Declaration

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

The examiners' comments have been duly incorporated

Declared by

Name: Bethelhem Berhane Kidane

Signature: ____________________

Date: 27/06/2012

Confirmed by (Advisor)

Name: Tadele Ferede (Dr.)

Signature: ____________________

Date: 27/06/12

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