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The Effect of Improved Productivity of the Manufacturing Industries on the Ethiopian Economy: A Computable General Equilibrium (CGE) Analysis

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Abstract

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, 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 agro processing, 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 agro processing, 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. The study further extends its recommendation for Ethiopia to develop a strong industrial policy aimed towards promoting both agro and non-agro processing industries.

Key words: CGE, Productivity improvement in the manufacturing industry

JEL Classification: L60, C68

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1. Introduction

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. There is a strong correlation between the sophistication of the output produced by the manufacturing sector and economic growth; countries that have recently shown rapid growth are good examples (UNIDO, 2009). 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 while Underdeveloped countries are non industrialized countries that are still dependent on vulnerable and the erratic agricultural sector in the 21st century (Weiss, 2011).

The Manufacturing sector of underdeveloped economies is fragile with weak and unbalanced linkages and spillover effects producing unsophisticated basic consumer goods. Ethiopia is no different; the structure of the manufacturing sector can be summarized as being largely labor intensive producing basic consumer goods; with agro processing industries dictating in terms of growth, employment contribution and value added (Padma and Swamy, 2004). The Manufacturing sector accounted 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 in the same year. Moreover, MVA is narrow based functioning with the contribution of few sectors; food and beverage industry accounted more than 35% of MVA (CSA, 2011).

The 2003's Industrial Development Strategy is a step towards ratifying a policy that could stand on its own. The strategy identifies key sectors of the industry which include; textile and garment, meat, leather products and agro-processing industries (Tadele *et al.*, 2006).

In 2010, the government has set targets in improving the industrial sector in the newly introduced national development plan namely the Growth and Transformation Plan (MoFED, 2010). But the effect of these massive improvements in the manufacturing sector in other sectors has not been fully investigated.

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, as many of the studies conducted showed only a partial equilibrium analysis focusing on only the subsectors of the industry. Secondly, there is little research work that analyzed the impact of industrial performance on the economy of Ethiopia using General Equilibrium models, which is more powerful for policy evaluation. Hence, 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. More specifically it tries to assess the macroeconomic, factor income, household income and welfare effects of changes in the productivity growth of agro processing, non agro processing industries and overall manufacturing industries. The model is calibrated with the updated 2005/06 SAM of Ethiopia with three possible scenarios of TFP growth. All the three scenarios were compared to the business as usual, base simulation, assuming the economy continues with its past trend (with no policy shock) till 2015.

2. Literature Review

2.1 Theoretical Review

At the end of the Second World War, economists turned their work en route for devising methods to analyze the economies of developing countries such as Africa, Asia and Latin America and devise ways of achieving economic development in 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, advocated 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. A balanced growth model assumes a coordinated expansion of several sectors simultaneously, while supporters of the unbalanced growth believe that deliberate distortions and disequilibrium in the economy is the only way to sustain economic growth and development. The situation that some industries are more developed than others provides backward and forward linkages and also provides an inducement to grow.

Nicholas Kaldor (1966) 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. 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 the manufacturing sector, the faster will be the rate of growth of GDP. His' second law of economic growth also known as Verdoon's law states that the faster the rate of growth of manufacturing output, the faster will be the rate of growth of labor productivity in that sector (Thirlwall, 1983).

The third law is the association between the output of the manufacturing sector and labor transfer where, the faster the rate of growth of manufacturing output, the faster the rate of transfer of labor from non-manufacturing sectors to the manufacturing sector when there is either diminishing returns or where no relationship exists between employment growth and output growth (Chatterji and Wickens 1983).

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 the differences between developed and developing nations arise from endowment base, but a developing country can become developed by changing its industrial structure. With industrial restructuring comes infrastructural upgrading to suit the newly reformed structure, this in turn leads to industrialization, income growth and eventually poverty reduction (Lin, 2010).

2.2 Empirical Review

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 a causal relationship between output and labor productivity in the manufacturing sector.

Ghatax and Roberts (1997) analyzed the consequence of adopting two alternative scenarios of promoting a key sector and non key sector using a CGE model for Poland. The study revealed that promoting a key sector, which has the highest level of forward linkages and a large income multiplier, will result in a much higher efficiency gain in terms of GDP, employment, the volume of investment and exports. It also concluded that implementing an industrial policy based on unbalanced growth of promoting key sectors would exemplify a much better macroeconomic performance.

Robinson *et al.* (1999) explored the economy wide income and equity effects of three alternative industrialization strategies in a static CGE model for Indonesia. 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. In terms of manufacturing value added to GDP, light manufacturing based industrial growth showed the most significant ratio.

Cororaton and Orden (2008) examined the intersectoral linkages and poverty implications in the cotton and textile sector for Pakistan using CGE modelling of a set of alternative incentives to the sector. The study proposed that a 5% TFP improvement is welfare increasing for both rural and urban households and 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 study proved that in all the possible policy alternatives of corporate tax income reduction, increment of corporate subsidy and R&D investment subsidy 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.

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. Among the manufacturing sector large and medium agro processing activities like; food and beverages, textile and leather industries have better backward linkages compared to other industries. The study also found out that labor intensive manufacturing activities like; food and beverages, textiles, chemical and non-metallic minerals are pro poor.

Urgaia (2007) analyzed the contribution of Ethiopia's manufacturing industries to GDP using Johansen cointegration analysis. The study established that Ethiopia's manufacturing sector contribution to GDP is

about 6% which is approximately 1/11th and 1/6th of that of the agricultural sector and service sector respectively with negligible overall annual growth rate of about 0.24%. According to Urgaia, the manufacturing sector is labor intensive and is negatively influenced by total factors of production and the obsolete use of technology could be one reason for the sector's stagnant growth.

3. Data Source and Methodology

3.1 Data Source

The main database used to calibrate the 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). It is a general equilibrium (GE) data framework that records transactions taking place during an accounting period based on the underlying principle of double-entry accounting that requires the total incomes (row total) to equal total expenditures (column total) for each account. The benchmark 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 the year 2009/10 (Ermias *et al*., 2011)[2].

3.2 Model Specification

The use of the recursive dynamic Computable General Equilibrium in this study is motivated by the fact that first, it 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

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

among different policy packages and help to pass better-informed policy prescriptions (Robinson, 2002).

The static model assimilates the one period specification of the recursive dynamic CGE model. It is a detailed description of the economy at a particular time period but is restricted to one period and fails to provide explanations about subsequent periods (Thurlow, 2004). The recursive dynamic CGE model developed by International Food Policy Research Institute (IFPRI) which is an extension of the standard static model is based on the adaptive expectations behaviour of agents, where agents make decisions on the basis of their past experience. The dynamic or "between" CGE model allows us to model the course of transitional dynamics accounting for the second and subsequent period effects. [3]

4. Simulation Specification and Results

4.1 Simulation Specification

The policy variable chosen as a shock for this particular study is Total Factor productivity (TFP) growth of the manufacturing industry. According to 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 (Acemoglu, 2007).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 dynamic CGE model, comparative analysis is made with respect to the baseline scenario where the economy is assumed to grow in the absence of any shock. The baseline scenario in this study assumes that business continues as

[3] Refer to Lofgren *et al*., 2002 for detailed specification of the dynamic model.

usual with continuation of historical growth trends of 2005/06-2009/10 for additional five years, from 2010-2015 with no specific policy changes.

Simulations

The highest, lowest and the average annual growth rate of value added for each industry registered between 2005 and 2010 are used as a shock to proxy TFP in this simulation. This policy simulation is separately conducted on, agro processing, non-agro processing activities and overall manufacturing, in doing so the other activities are left to grow at a rate equivalent to the base simulation.

Table 1: Summary of simulation specification

	Total factor productivity growth % per year		
	SIM 1: High	**SIM 2: Medium**	**SIM 3: Low**
Agro processing	35%	25%	21%
Non-agro processing	58%	30%	13%
Manufacturing	46%	27%	20%

Source: CSA (2007 and 2011) and own computation

4.2 Analysis of the Simulation Results

4.2.1 Effects on Macroeconomic Indicators

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 while a 25% and 21% increase in growth rate of TFP, real GDP growth rate increased by 0.58% and 0.41% respectively. The average growth rates of exports and imports also showed positive changes in all the three simulations compared to the base although the percentage change from the base is high in exports relative to imports. This might be due to the fact that most manufactured exports stem from agro processing industries and as productivity of these industries increase manufactured exports also 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.

A 58%, 30% and 13% increase in productivities of non-agro processing industries will 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 the high case scenario due to the fact that non agro-processing industries take the smallest share in total manufacturing industry and the weak backward and forward linkages of the sector.

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 except a slight decline in the growth rate of investment which seems to diminish with the decline in TFP growth rate.

Table 2: Simulation result: effects of increased TFP growth on macroeconomic variables

Average annual growth rate 2010-2015 (% change from base)										
Macro variables		**Agro processing**			**Non agro processing**			**Manufacturing**		
	Initial	**Sim1**	**Sim2**	**Sim3**	**Sim1**	**Sim2**	**Sim3**	**Sim1**	**Sim2**	**Sim3**
Real GDP	355	0.84	0.58	0.41	0.47	0.34	0.2	0.65	0.48	0.3
Absorption	457.7	0.41	0.3	0.21	0.41	0.29	0.18	0.52	0.39	0.25
Private Consumption	338.6	0.47	0.35	0.23	0.59	0.42	0.25	0.73	0.54	0.35
Investment	85.5	0.31	0.2	0.15	-0.16	-0.11	-0.06	-0.12	-0.08	-0.05
Government	31.8	0	0	0	0	0	0	0	0	0
Exports	52.1	2.7	1.78	1.33	2.48	1.76	1.05	2.8	2.02	1.23
Imports	-127	1.61	1.06	0.78	1.48	1.05	0.62	1.67	1.2	0.73
Real Exchange Rate	90.85	-1.1	-0.7	-0.59	-1.38	-0.97	-0.57	-1.47	-1.05	-0.62

Source: CGE simulation result

4.2.2 Sectoral Effects

Productivity improvement of agro processing activities resulted in a slight decrease in the growth rate of the agricultural sector. The reason might be 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 (4.6%) followed by SIM2 (3.15%) and SIM3 (2.49%) compared to the base value.

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 all the three cases. The service sector's growth rate recorded 0.51%, 0.34% and 0.24% higher average rates in SIM1, SIM2 and SIM3 compared to the base, respectively.

Increasing growth rate of TFP of non agro processing activities resulted in a slight increase in growth rate of the agricultural sector, 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. The service sector also showed positive changes in all the policy simulations.

Industrial and service sectors showed positive growth trends in all the three cases of increased TFP of the overall manufactured sector, while agricultural growth rate stayed fairly the same in SIM1 and SIM2 relative to the base while it showed a slight decrease under the low case. This simulation tries to inculcate 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 3: Simulation results: Effects on sectoral output (% change)

Average annual growth rate 2010-2015 (% change from base)									
Sectors	**Agro processing**			**Non agro processing**			**Manufacturing**		
	Sim1	**Sim2**	**Sim3**	**Sim1**	**Sim2**	**Sim3**	**Sim1**	**Sim2**	**Sim3**
Agriculture	-0.03	-0	-0	0	0.01	0.01	0	0.01	-0.03
Industry	4.6	3.15	2.49	1.83	1.32	0.8	1.75	1.04	2.36
Service	0.51	0.34	0.24	0.61	0.44	0.25	0.51	0.32	0.69

Source: simulation results from CGE model

In all the three cases of increased TFP percentage share of agricultural sector declined while that of the industrial sector increased compared to the base scenario. 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 their particular values in the base by 0.61 and 0.05 percentage points respectively.

Table 4: Simulation results: effects on sectoral shares to GDP (%)

Share in GDP (%)									
Sectors	**Agro processing**			**Non agro processing**			**Manufacturing**		
	Sim1	**Sim2**	**Sim3**	**Sim1**	**Sim2**	**Sim3**	**Sim1**	**Sim2**	**Sim3**
Agriculture	-0.78	-0.5	-0.4	-0.45	-0.31	-0.18	-0.61	-0.43	-0.27
Industry	1.19	0.77	0.59	0.41	0.29	0.17	0.67	0.48	0.29
Service	-0.41	-0.3	-0.2	0.05	0.04	0.02	-0.05	-0.02	-0.01

Source: CGE simulation results

4.2.3 Factor Income

The 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. Since SIM1 induces a higher productivity shock, we would expect the returns to factors to be

greater in this simulation. Returns to labour increased by 0.41%, 0.30% and 0.22% from that of the base in SIM1, SIM2 and SIM3, respectively.

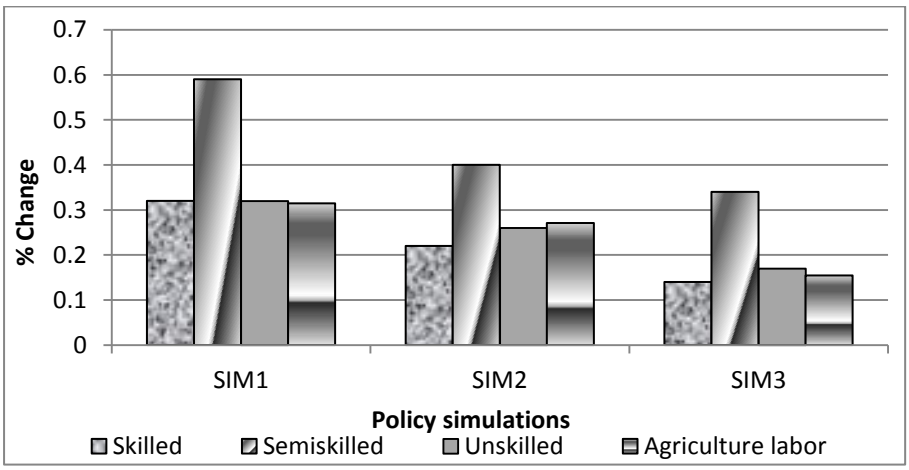
Table 5: Simulation results: effect of increased TFP of agro processing on factor income (% change from base)

Factors	Initial (billion birr)	Share	Sim1	Sim2	Sim3
Labor	174.02	49.03	0.41	0.30	0.22
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 1, reveals the simulation results on the income of the different categories of the labour force. Since the sector is largely labor intensive particularly with that of semi skilled labor, 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 1: Effects of increased TFP of agro processing on labour income (% change from base)



Source: CGE simulation results and own computation

Similarly, productivity improvement in 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 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. 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.

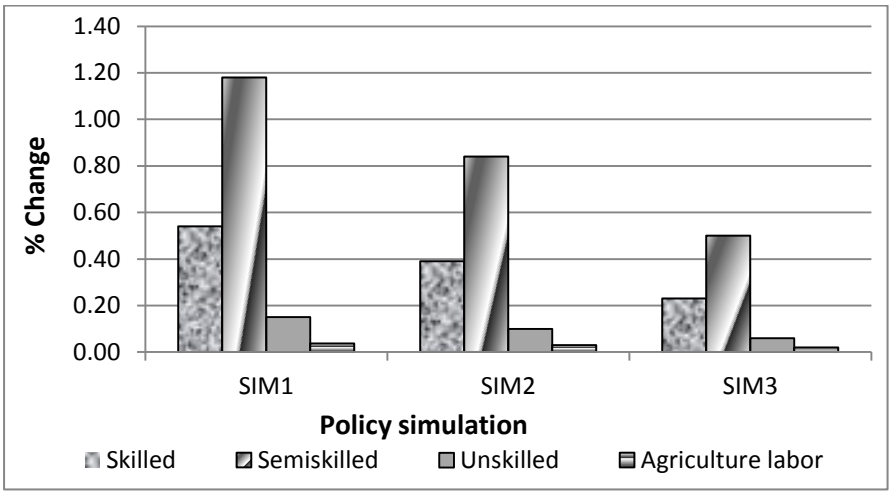
Table 6: Simulation results: effect of increased TFP of non-agro processing on factor income (% change from base)

Factors	Initial (in billion birr)	Share	Sim1	Sim2	Sim3
Labor	174.02	49.03	0.50	0.35	0.21
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

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 2: Effects of increased TFP of non-agro processing on labour income (% change from base



Source: CGE simulation results and own computation

The simulation which replicates the impact of overall policies results in improvement of the returns to all factors in all the three simulations. 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.

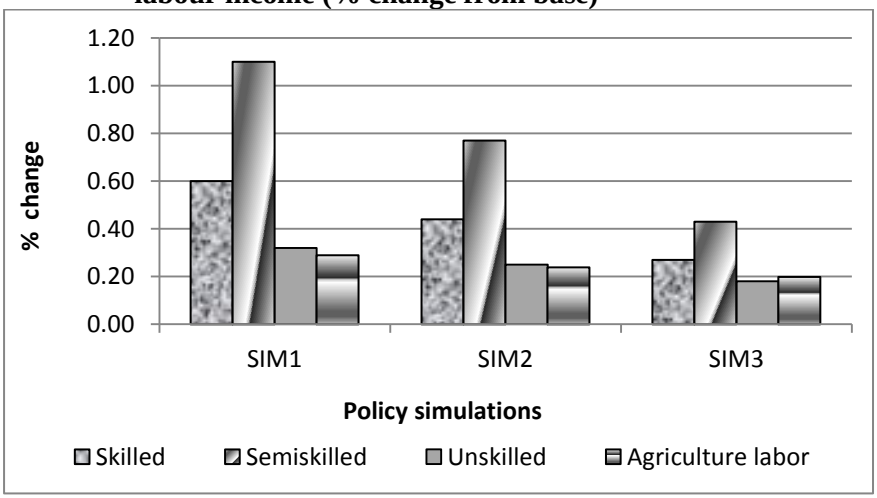
Table 7: Simulation results: effect of increased TFP of all manufacturing industries on factor income (% change from base)

Factors	Initial (in billion birr)	Share	Sim1	Sim2	Sim3
Labor	174.02	49.03	1.11	0.83	0.50
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 high case scenario resulted in the highest increase in all types of labour force while the smallest change was in the low case scenario. Semi skilled labour still remains to show the highest increase followed by skilled labour; this shows that the manufacturing sector largely employs semiskilled labour.

Figure 3: Effects of increased TFP of all manufacturing industries on labour income (% change from base)



Source: CGE simulation results

4.2.4 Household Income

The higher GDP growth under simulations on agro processing manufacturing industries resulted in substantial increase in real incomes of both poor and non poor households. Average growth of rural household income increased more than the urban counterpart in all the three scenarios. This is because as the productivities of agro processing industries 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.

Productivity increase in the non agro processing manufacturing industries benefits the urban households more than the rural counterpart since the sector are 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 increased more than that of the poor compared to the base in SIM2 (0.5%) and SIM3 (0.3%) while, in SIM1 both types of urban households showed the same change from the base. The income of the rural poor increased more than the poor in all the three simulations.

Increasing the productivity of overall manufacturing industries led to the urban households' income to increase more than that of the rural in SIM1 and SIM2 while the income of rural households increased more under the low case. 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 other reason is that urban households are relatively skilled and own more capital to that of the rural households and since returns to semi skilled labor and capital increased due to TFP improvement income of the urban households would increase at a higher rate than that of the rural.

The increase in income of non poor rural households is higher than the rural poor in all the simulations. 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 8: Simulation results: Effect of increased TFP on household income (% change from base scenario)

Households	Initial (billion birr)	Agro processing			Non agro processing			Manufacturing	
		Sim1	Sim2	Sim3	Sim1	Sim2	Sim3	Sim1	Sim2
Rural	325.8	0.38	0.29	0.18	0.44	0.32	0.21	0.61	0.43
Poor	74.6	0.39	0.33	0.19	0.23	0.19	0.08	0.46	0.32
Non- poor	251.2	0.38	0.28	0.18	0.5	0.36	0.24	0.66	0.46
Urban	34.6	0.3	0.2	0.1	0.6	0.49	0.29	0.69	0.49
Poor	3.7	0.3	0.2	0.1	0.6	0.4	0.2	0.6	0.4
Non-poor	30.9	0.3	0.2	0.1	0.6	0.5	0.3	0.7	0.5

Source: CGE simulation results

4.2.5 Welfare Effects

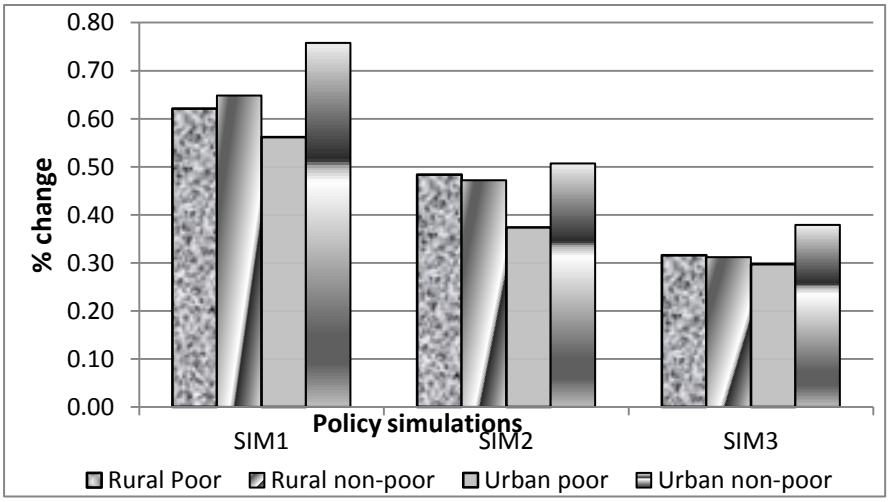
EV measures the change in utility due to the change in prices by using the current prices as the base price and asks what income change is needed at the current price that corresponds to the anticipated change in terms of its impact on utility (Varian, 1992). In other words, it measures the level of income that the consumer needs to forgo or payback before the shock so as to make him/her as well off after the price increase. Importantly, EV is extensively used as welfare indicator in the literature for CGE models as it measures the income change at current prices and keeps price fixed at status-quo for different policies, making 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.

The simulation of increased TFP of agro processing activities resulted in improved welfare for all the household groups in all the simulations.

The welfare of urban household improved by 0.76%, 0.51% and 0.38% (non poor) and 0.56%, 0.37% and 0.30% (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. This is due to the fact that a small TFP improvement in agroprocessing industries would avail similar gains to both the rural poor and nonpoor however, a higher TFP growth rate would be much beneficial for the non-poor as they enjoy higher consumer surplus and higher income.

Figure 4: Effects of increased TFP of agro processing on welfare (EV) of households (% change from base)

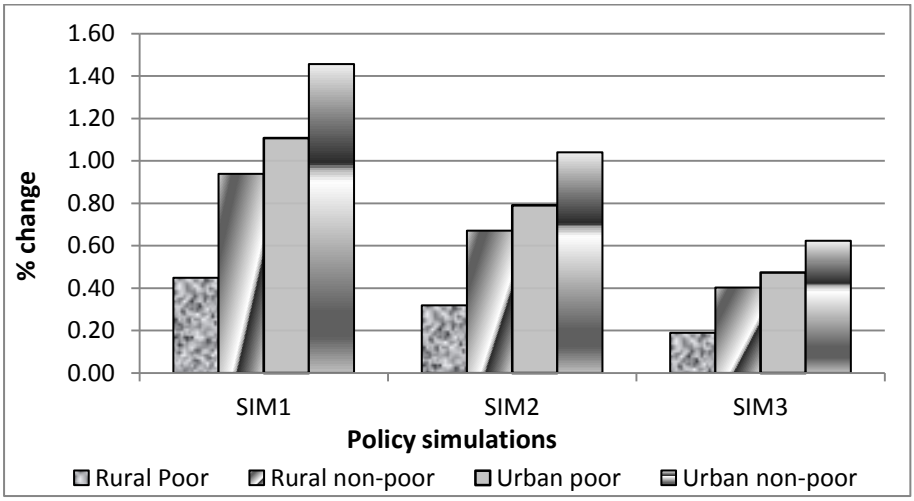


Source: CGE simulation results

Likewise, increased TFP growth rates of non agro processing industries, is welfare enhancing for all households in all the scenarios. (Comparatively the urban households are better-off from rural households with the non poor reaping the higher advantage in all simulations. Welfare of rural poor and non poor also showed positive changes from the base but the gain is small relative to the urban households. This may be due to the very nature of non agro processing industries being not dependent on agriculture, hence showing a small increase in the welfare of rural households. Furthermore,

urban households earn more from these activities relative to rural households hence as the productivity of the sector increase so does the gains to the factors and households.

Figure 5: Effects of increased TFP of non-agro processing on welfare (EV) of households (% change from base)

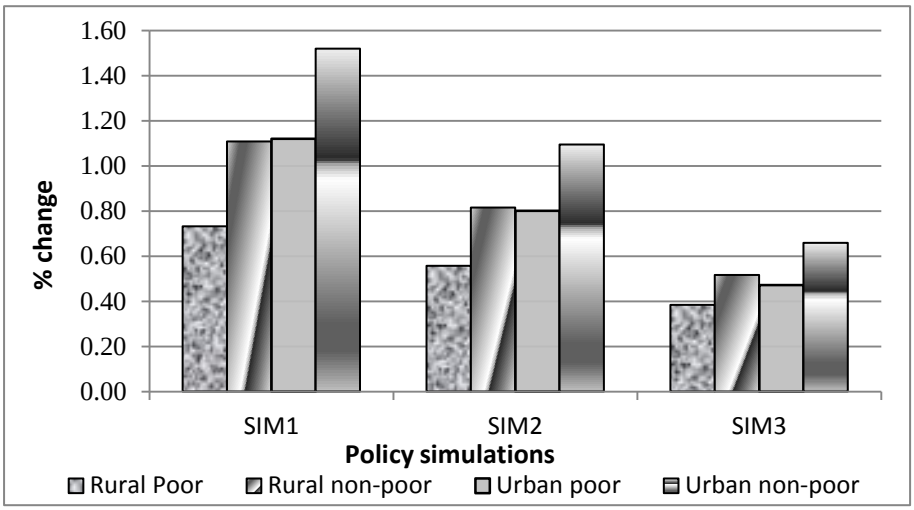


Source: CGE simulation results

Increased productivity of all manufacturing activities is translated into improved wellbeing of all household groups where the urban enjoys most of it in all the 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. The result suggests 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 be benefited 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 6: Effects of increased TFP of all manufacturing activities on welfare (EV) of households (% change from base)



Source: CGE simulation results

5. Conclusions

This study, tries to examine the dynamic economy-wide impacts of productivity improvement in the manufacturing industry on the macro and sectoral variables, factor and household incomes and welfare of the society utilizing a recursive dynamic CGE model.

Using the 2005/06 SAM for Ethiopia the scenarios of increasing activity specific TFP showed that, macro variables such as real GDP, private consumption, imports and exports all showed increasing trend in the high, medium and low scenario. The income of factor and households also showed improvements in all the scenarios. In general, increasing TFP growth of agro processing, non-agro processing and overall manufacturing industries is welfare increasing to all household groups.

Based on the empirical analysis, it is observed that the manufacturing sector has a positive impact on the Ethiopian economy and this impact was observed from TFP improvement hence efforts should be made to increase TFP through research and development and technological innovation and infusion. This calls for the development of a strong industrial policy that aims at ensuring the long-run productivity of the sector. Furthermore, results from this study advocates 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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The Impact of Fiscal Policy on Poverty in Ethiopia: A Computable General Equilibrium Microsimulation Analysis[1]

Daniel Abraham Mengistu[2]

Abstract

Ethiopia has implemented various fiscal policy reforms in the past decade. Most of these reforms center on indirect taxes and pro-poor expenditure patterns. This study investigates the economy-wide impacts of these fiscal policy changes on poverty. To this effect, the study used a static computable general equilibrium (CGE) model linked to a microsimulation (MS) model. The CGE model used the 2005/06 social accounting matrix (SAM) and the MS model used the 2004/05 Household Income, Consumption and Expenditure (HICE) survey to investigate household poverty by way of the consumption expenditure changes from the CGE model. The fiscal policies simulated are domestic indirect taxes, government consumption expenditures, and government transfers to households. The findings of the study suggest that the increase in revenue from indirect taxes has worsened the poverty state of households. The results from the CGE model have all shown decline in real GDP, sectoral output, employment and welfare. In contrast, the study found improvements in the poverty state of households as a result of the introduction of various short-run expenditure measures. However, examination of the net effect revealed worsening poverty at the national level in general and for rural households in particular. On the other hand, poverty tended to decline among urban households. The major conclusion is that the tax policy has dominant adverse effect on poverty in the short-run. Thus, policy makers need to take into account these adverse effects and come up with pro-poor spending policies that would protect households from the negative strains while the financing policies go along.

Keywords: Fiscal policy, poverty, indirect taxes, government consumption expenditure, government transfers, social accounting matrix, computable general equilibrium, household income, consumption and expenditure survey, microsimulation

JEL Classification: H30, H53, I32

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1. Introduction

The state of poverty in Ethiopia is among the worst in the world measured by most socio-economic and human development indicators. Over the period 2005-2010, the Human Development Report (HDR) ranked the country as 157th, out of 169 countries, in human development index (HDI) and second highest in multidimensional poverty index (MPI)[3] next only to Niger (UNDP, 2010). Though the country is reported to have improved its HDI rank in the report, there is little doubt that a long and rough way awaits as poverty dominates the center stage in the endeavor of change in the country.

Poverty reduction is one of the principal development challenges facing low income countries. The challenges and impediments to reduce poverty are difficult in countries like Ethiopia where poverty is persistent and widespread, vulnerability to shocks is high, and income is extremely low (Abebe, 2005). Hence, addressing the problems of poverty has become the priority of development policy and Ethiopia considers poverty reduction as its primary development goal (MoFED, 2010).

Like most African countries, Ethiopia has implemented the policy directions of the World Bank and the International Monetary Fund in the 1990s and 2000s. The 1990s saw orientation of the earlier development approaches in the form of the Structural Adjustment Programs (SAPs). According to Alemayehu and Alem (2006), these policies mainly opted to the welfare improvements through the liberalization and conservative macro-policies. A series of economic reforms took place to take the country from a command to a market economy which opted to bring macroeconomic stability and workable business climate. The country also adopted the Agricultural Development Led Industrialization (ADLI) strategy which was considered as

[3] The UNDP (2010) introduced MPI for the first time to complement money-based measures by considering multiple deprivations and their overlap. The MPI is 0.582 for Ethiopia and 0.64 for Niger.

a necessary step towards economic growth, poverty reduction, and industrial development.

In the new millennium, as a way to join the Highly Indebted Poor Countries (HIPC) initiative of the World Bank, Ethiopia embarked on new policy directions by developing an Interim Poverty Reduction Strategy Paper (I-PRSP) in the year 2000 (AFRODAD, 2005). In 2002, the country launched the full-PRSP known as Ethiopia's Sustainable Development and Poverty Reduction Program (SDPRP). As the Millennium Development Goals (MDG) initiative started in 2000, the SDPRP targeted economic growth averaging 7% per annum in order to reduce poverty by half in 2015. A second phase of the PRSP process, a Plan for Accelerated and Sustained Development to End Poverty (PASDEP) was launched in 2005 as a guiding framework for the period 2005-2010. Most of its strategic directions were continuations of the SDPRP in relation to human development, rural development, food security, and capacity building, but it added new directions like intensifying agricultural commercialization, private sector participation, and scaling up the efforts to achieve the MDGs (MoFED, 2010).

Though poverty reduction is a forefront agenda, as Agenor, 2004 argued, the policies to be pursued to its attainment are complex and openly contested. Understanding the direct and indirect impacts of macroeconomic policy on poverty still remains a key policy challenge (Aziz, 2008; Mallick, 2009). IMF (2001), for instance, stated that there is a large literature on issues of poverty and poverty reduction while there is a lack of detailed understanding of the relationships between macro- policies and poverty. In Ethiopia, likewise, despite the abundant discourse on poverty, the rigorous economy-wide studies to address its link with fiscal policies are scarce. Mentions can be made of two studies. Munoz and Cho (2003) focused on the poverty impacts of the 2003 E.C. tax reform using incidence analysis and didn't find major adverse effects on the poor. Kasahun (2003), on the other hand, focused on the reductions in government consumption and import tariff, and nominal exchange rate devaluation using a CGE – MS analysis and found

out poverty reducing results. The literature, however, could be extended further by examining the economy-wide impact of fiscal policies on poverty using a recent and comprehensive data.

Fiscal policy is one of the few and most important instruments available to governments of poor nations in fighting poverty (Johannes et al., 2006; Kiringai et al., 2006). The interest of this study on fiscal policy, among the macroeconomic policies, emanates mainly from the fact that it can play a role in poverty reduction as an indirect intervention besides being one of the influential direct interventions targeting specific groups or pro-poor sectors which are vulnerable to economic or natural shocks (Damuri and Perdana, 2003).

However, fiscal policies that were designed as pro-poor might in fact have no impact on poverty or sometimes even worsen the poverty situation if the direct and indirect effects of the link are not well articulated. Ethiopia has implemented fiscal policy reforms in the past decade mainly in relation to indirect taxes and pro-poor expenditures. These policies have short-run and long-run implications on the poverty state of households. Thus, the central research question of the study is: what are the short-run impacts of fiscal policies on poverty of households in Ethiopia?

Among the variety of policy analysis tools, CGE models are widely used because of their ability to illustrate the feedback effect between different markets, and produce disaggregated results at the sectoral or microeconomic level within a consistent macroeconomic framework (Wang et al., 2010). As Cury et al. (2010) argue, formal assessments on the poverty effects of economic policies using CGE models took shape in the 1970s and 1980s. As a result, a bulk of empirical studies was conducted to examine poverty mainly by linking CGE with MS models in many developing countries (Cury et al., 2010; Wang et al., 2010).

In this line, the objective of the study is to analyze the short-run impact of fiscal policy on poverty in Ethiopia. To this effect, scenarios of changes in

domestic indirect taxes, government consumption expenditure, and government transfer expenditures were used. Policy combinations that represent the net effects are evaluated for scenarios with respect to total government recurrent expenditure (government consumption plus transfers) and combined impact of the financing (revenue) and spending schemes applied together. The remaining part of the paper is organized as follows. Section 2 reviews the literature briefly. Section 3 focuses on overview of fiscal policy in Ethiopia. Section 4 introduces the data base (SAM) and specifies the theoretical framework for the CGE and MS models. Section 5 discusses the results from the CGE and MS models. The final section concludes and provides implications for policy and future research.

2. Literature Review

The common understanding in policy making was to evaluate macro policies based on their macroeconomic objectives. But this notion was gradually replaced, mainly in developing countries, in the sense that the policies are also to be judged based on their impact on poverty and income distribution (Agenor, 2004). Much progress has been achieved in recent years in understanding the various transmission mechanisms despite the difficulties due to the multidimensionality of poverty.

The 1980s and 1990s were periods where macro adjustment policies were implemented with the intention of achieving a wide range of macroeconomic objectives. But most literature criticized the adverse impacts of adjustment policies on poverty and income distribution. Agenor (2004) identified direct and indirect channels through which macro policies could adversely impact poverty in times of such macroeconomic adjustment. The major indirect effects identified operate through aggregate demand, the rate of economic growth, distributional effects, employment and the like. Contractionary policies affect aggregate demand and employment (and thus poverty) through reductions in transfers and subsidies, and expenditure cuts (mainly capital spending). Moreover, reductions in public spending have divergent

negative effects on private spending. Rates of growth are affected as well when the poor are constrained of their public transfers which deplete economic savings. In addition, due to the complementary effects of private and public spending, decreases in public spending may lead to the same on private spending that have negative impact on the rate of growth. In relation to income distribution, the argument was that initial levels matter to the extent and nature of subsequent growth and redistribution (Agenor, 2004).

In most developing countries, the beginning years of the new millennium saw shift in policy away from structural adjustment programs. The recent approach, as Lipton and Ravallion (1993) attest, has evolved in the sense that the government could intervene to determine the pattern of growth. In other words, emphasis is evolving away from the link between economic growth and poverty reduction to explore what policies, beyond growth itself, contribute to poverty reduction and income distribution. With respect to fiscal policy, this refers to expansionary policies that target most of the expenditure to basic social services like education and health (or more elaborately) on primary education, preventive health, safety net programs (transfers to households) and the like. This approach attempts to cut overall expenditures without affecting the main entry points of such pro-poor expenditures. The expenditure reallocation came up with distinctions between levels of expenditure and composition (nature) of expenditure.

Figure 1 depicts the short run transmission mechanisms of fiscal policy on poverty. The framework in this study focuses on the transmission mechanisms of the impacts on poverty of government consumption and transfers to households on the spending side and (domestic) indirect taxes on the revenue side (Damuri and Perdana, 2003). When we look into government expenditure financed by increased indirect taxation (increase in VAT, excise or service taxes), this brings issues of who bears the tax burden since indirect taxes are mostly imposed on consumable commodities. As Gunter (2005) states, there is a broad agreement on the beneficial effects on the poor of increase in the budget share of priority sectors and better

targeting of public expenditures. But the more we come to indirect (mostly price related) effects, the more it gets blurred on how fiscal policy could lead to positive impacts on poverty. Most studies agree that the labor market constitutes the most central mechanism through which macro policies are transmitted to poverty (Islam, 2001; Mulat et al., 2003; Agenor, 2004; Heintz et al., 2008).

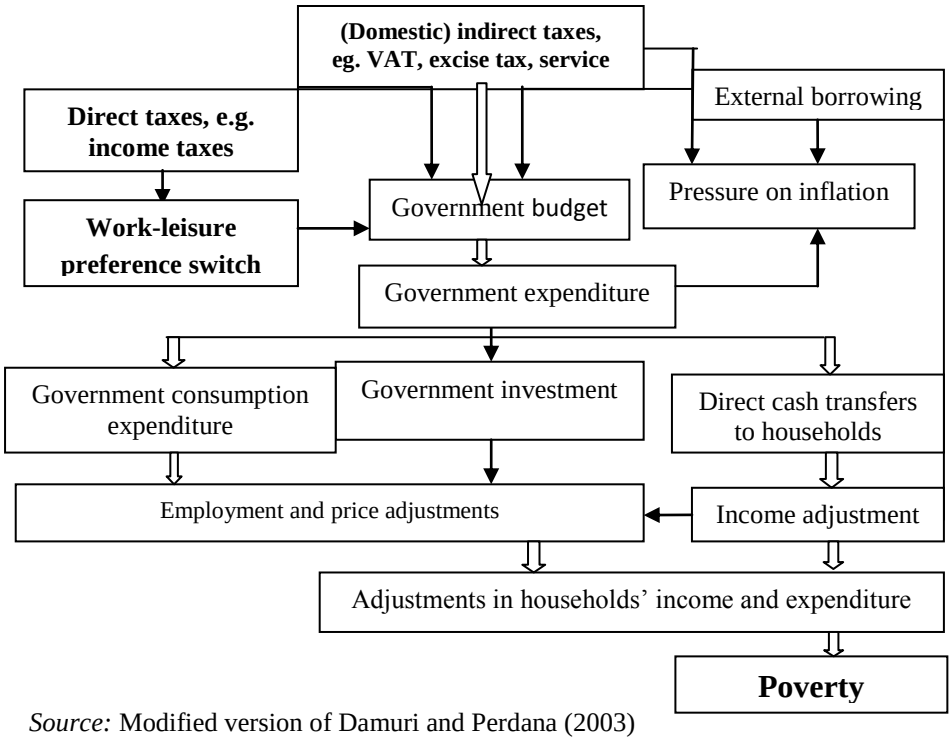
As depicted in the figure, the principal transmission mechanism envisaged in the study is pointed by the "block arrows". It starts from the indirect taxes that are the source of revenue to government budget which is spent on consumption and transfer expenditure schemes. These revenue and expenditure changes bring about employment, price, income and expenditure adjustments by households that lead to changes in poverty. The study didn't extend the analysis to government investment expenditure, effects of direct taxes, external borrowing and inflation. Damuri and Perdana, 2003 arrived at similar results with this study for Indonesia though it differs in its incorporation of government investment into the analysis.

To this effect, the study used a CGE – MS model. We can site numerous advantages of CGE modeling to analyze indirect effects. In CGE models, general equilibrium effects can be accounted for, interactions of different measures can be investigated, complex micro-macro relationships can be performed better, and constraints of linearity can be reduced to the minimum (Iqbal and Sidiqqui, 2001). Besides, such models have ability of examining variety of incidence assumptions and socioeconomic divisions including various welfare measures and behavioral responses (Gemmel and Morrisey, 2002). These models are also consistent with generally accepted microeconomic theory, have significant structural detail, and their general equilibrium nature - changes in one area of economic activity affecting the rest of the economy- elevates their influence for economic analysis (Bibi et al., 2010).

Although CGE models are among the most influential tools in applied economics and have provided unique insight into the policy-poverty debate,

they have also raised the sophistication of prediction in the policy debate (Iqbal and Sidiqqui, 2001). The literature raises various limitations of CGE models in relation to quality and intensity of data requirement, choice of parameters, choice of functional forms, calibration of the model, unrealistic assumptions of neoclassical theory, lack of sensitivity analysis, validity of predictions for policy etc. One fact that most researchers agree on is that the analysis is still evolving, incorporating new dimensions and methods in which we can see development of software packages like GAMS (General Algebraic Modeling System) in simplifying the complex model simulations. Apart from this, we find that other modeling approaches are confronted with critical limitations as well. For instance, some consider the criticisms against CGE models as part of the wide debate concerning the issue of contributions of empirical economics in general (Iqbal and Sidiqqui, 2001).

Figure 1: Transmission mechanisms of fiscal policy impacts on poverty



Source: Modified version of Damuri and Perdana (2003)

Some argue that CGE models are more appropriate than traditional partial equilibrium models as the latter do not account for the economy-wide multiplier effects (don't allow knowledge of who gained and who lost) and as they overestimate sectoral benefits ignoring the negative repercussions evident in a general equilibrium framework (Ahmed and Donoghue, 2004). The underlying cause of this is that, partial equilibrium models implicitly assume fixed-prices where as CGE models give due consideration to relative price changes in commodity and factor markets (Wobst, 2001). Advances in computer technology and numerical simulation soft-ware exercise have allowed the transformation from such partial equilibrium approach to a general equilibrium approach which can very modestly incorporate many more sectors and complex behaviors (RTI, 2008). After the 1970s, the general equilibrium approach became advanced enough to incorporate imperfect information, increasing returns, price rigidities, and many extensions addressing various markets and institutions (Sinha and Latigo, 2003).

3. Characterizing Fiscal Policy in Ethiopia (1999/00 – 2009/10)

For the decade from 1999/00 to 2009/10, MoFED and NBE reports from EEA (2009) data base show that the real GDP has grown by 129% in constant 1999/00 prices. As the reports disclose, it has shown sluggish real growth around the down of the new millennium (with a negative growth in 2002/03) but started to consistently record double digit figures after 2003/04 except 2008/09 in which a relatively lower 8.8% real growth was recorded.

Though the reports show that government revenue and expenditure have shown major increases, the fiscal balance as a proportion of GDP continued to record negative figures. In this period, fiscal policy was aimed at maintaining the deficit at a sustainable level besides increasing pro-poor expenditures. The financing aspect of these huge expenditures has been of great concern since the budget couldn't be covered from domestic revenue collection alone. To improve on this, reforms took place with the aim of

strengthening domestic borrowing, domestic revenue collection capacity, and mobilizing external aid and borrowing.

Comparing 1999/00 and 2009/10 periods, government reports claim that capital expenditure, including external assistance, has shown significant increases in comparison to the current expenditure. It has shown increases up to five times its 1999/00 levels. Capital expenditure as a ratio of GDP has risen from 3.8% to 10.3% and total expenditure as a ratio of GDP has risen from 20% to 55.3%. Capital expenditure on social development in education, health, social welfare and the like has also increased covering 2.6% of GDP in 2009/10. Current expenditure, on the contrary, has decreased as a share of GDP and total expenditure from 20.6% and 80% to 8.4% and 44.7% in the ten year period. However, in real terms, current expenditure has grown by 10% in 2009/10 from 2005/06 values whereas its basic component, final government consumption expenditure, has risen by a mere 4%. Notably, the share of social services like education and health has shown increases in 2009/10 like the growths in social development for the same sectors. Capital expenditure showed constant increases in the new millennium replacing current expenditure as the largest component of total expenditure (Annex 1).

We can resort to the 2005/06 Ethiopia SAM for data on government transfers to households as a component of general government recurrent expenditure which also includes government consumption expenditure on goods and services and government savings. Government consumption takes the lions share in this account (68.5%) where as government transfers plus external interest payments cover about (8.5%) and the remaining is government saving. Of the government transfers, transfers to households take about 6.6%.

When we come to the revenue side, tax and non-tax revenues have increased in the ten year period with larger shares recorded by the tax component compared to the non-tax component. Tax revenue as a share of total revenue and grants has increased from 54.6% to 65.4% from 1999/00 to 2009/10

where as non-tax revenue declined. In the same period, direct taxes have increased from 19.9% to 22.5% whereas indirect taxes have increased by a larger amount from 34.7% to 42.9% (Annex 2). As a ratio of total revenue and grants, the size of government revenue has recorded constant increases in which most of the changes are results of the tax reform introduced. In 2009/10, domestic indirect taxes have increased by 34% as proportions of total revenue and grants compared to the 1999/00 period.

The Ethiopian government has set out to achieve a large sum of revenue collection in aggregate during the course of a five-year Growth and Transformation Plan (GTP) from 2010/11 to 2014/15 thereby raising the country's annual domestic revenue to GDP from 14% to 17.1% and annual tax revenue to GDP from 11.3% to 15% (MoFED, 2010). On the expenditure side, resource allocation is planned towards growth enhancing (mainly agriculture and infrastructure) and social sectors (mainly education and health). In the five year GTP; increases as percentages of GDP are anticipated for total expenditure (18.6% to 23.7%), capital expenditure (10.3% to 14.4%), recurrent expenditure (8.4% to 9.3%), and total poverty oriented expenditure (12.3% to 17.3%). Expenditures in the social sectors show great increases in the plan which reveals tendency to continue from the PASDEP. Also, the GTP targets to reduce total poverty head count from 29.2% to 22.2%.[4]

When we consider poverty-oriented spending as a share of total expenditure, the trend doesn't show significant changes in the five year period from 2005/06. In fact, the trend is one of decrease in the cases of agriculture, education and social welfare, whereas it fluctuated in the case of health expenditures. Road construction is the only spending, in this case, to have constantly increasing share of the total expenditures with most of the funds allotted to construction of rural roads or roads for poor areas in general. A point to note here is that education expenditures are the largest, about a

[4] The base period for all these forecasts of the GTP is 2009/10.

quarter, whereas health and social welfare spending constitutes the smallest among the poor-related expenditures (Annex 3).

Domestic indirect taxes have been the center of focus in the past decade. Since its introduction in 2003 with the objectives of reducing distortions by other indirect taxes, VAT has been one of the principal sources of revenue for the government and yet there is a large unexploited potential in the use of this tax. The share of local and import VAT as a share of total indirect taxes and GDP has been at around 50% and 4% respectively over the five year period examined. Domestic indirect tax revenue has increased by 80% in 2009/105 from the 2005/06 values though the share to real GDP showed minor increase from 2.6% to 2.8%. Excise taxes, both domestic and foreign, have also steadily increased in the period. The share of most of the taxes has fluctuated over the period though most showed minor increases from the 2005/06 period. Total indirect tax revenue to the government, which is the sum of domestic indirect tax revenue and foreign trade tax revenue, has shown an overall 48% increase in real terms in 2009/10 compared to the 2005/06 period though share to real GDP stagnated (Annex 4).

The new five year GTP is already underway. But the huge task ahead is how to maximize overall domestic tax and non-tax revenue using tax reforms like the VAT without constraining the lives of consumers. Pro-poor spending schemes have been constrained by this issue of financing as they are dubbed to lack the financial requirements and possible (investment) sources.

4. Methodology

4.1 The Social Accounting Matrix

The benchmark data used for calibration in CGE modeling is the Social Accounting Matrix (SAM) (Thurlow, 2004). A SAM is a comprehensive and consistent, economy wide data framework or set of accounts that has detailed

[5] There was around 50% increase in domestic indirect tax revenue collected in 2009/10 compared to 2008/09.

quantification for economic flows of incomes and expenditures in an economy, usually a nation, for a given period of time, mostly a year (Decaluwe et al., 1999; Lofgren et al., 2002).

In this study, we used the 47×47 aggregated SAM prepared by EDRI (2009). In this 15 sector SAM,[6] productions and incomes of the various agro-ecological zones were aggregated into one account before further aggregations were made. The matrix has 14 activities,[7] 15 commodities, 4 factors of production (labor, land, livestock and capital), 7 institutions (an enterprise, a government, 4 households, and a rest of world or ROW), 3 tax accounts (direct tax, sales tax and import tax), transaction costs (total margins), stock changes,[8] and S – I account.

The four household categories distinguished are rural-poor, rural non-poor, urban-poor and urban non-poor. The sales tax account incorporates local VAT, domestic excise tax and service taxes whereas the import tax account incorporates import duty, sur tax, import excise tax, import VAT, and withholding tax.

[6] The production activities are for teff, maize and wheat, non-traded agriculture, exportable cash crops, livestock, food processing, chemicals, machinery, other manufacturing, construction, utility, domestic trading, private services; and government services. These activities are basically aggregations and disaggregations from the agriculture, industry and service sectors. The agricultural sector includes five production activities: teff, maize and wheat, non-traded agriculture, exportable cash crops, and livestock. The industrial sector includes five production activities: construction, food processing, other manufacturing, chemicals and machinery. And, the service sector includes four production activities: utilities, domestic trading, private services and government services. There are three activities that produce more than one commodity. 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.

[7] The commodity account for fuel (cfuel) does not have activities account as Ethiopia is non-oil producing nation. Thus, the 14 activities produce 14 commodities with some combinations, as mentioned above, but commodity fuel doesn't have domestic production activity.

[8] A stock change represents inventory investment by sector of origin (Lofgren *et al.*, 2002).

4.2 The Computable General Equilibrium Model

The static CGE model used is based on a comparative static standard neoclassical-structuralist model developed in IFPRI by Lofgren et al. (2002). It follows the neoclassical – structuralist modeling tradition with additional features included like treatment of transaction costs, household consumption of non-marketed (home) commodities, and separation between production and commodities (Lofgren et al., 2002; Thurlow and Seventer, 2002). The model incorporates both paradigms to better represent the real world features that are found in developing countries.

The standard CGE model is a system of simultaneous linear and non-linear equations. The equations of the model include non-linear first order optimality conditions for production and consumption decisions which are driven by maximizations of profit and utility respectively. The CGE model also includes equations for closures. The term 'closure' implies the way adjustment is made in the economy to ensure equilibrium or an indicator on how the model gets solved (Tadele, 2010). The choice of closures, hence, provides the macroeconomic settings to conduct the policy simulations (Damuri and Perdana, 2003). The structure of the CGE model is divided into four major blocks: price, production and trade, institutions and system constraint blocks.

The production in the economy takes place in each activity to yield the commodities produced domestically. The producer is assumed to maximize profit (subject to a production technology) which is the surplus after payments are made to (primary) factors and intermediate inputs. The production technology connotes a multi-level production function. It chooses between a constant elasticity of substitution (CES) and Leontief technology at the top level of the technology nest. In this study, the technology at the top level is a Leontief function of the quantities of value-added and intermediate inputs that yield commodity outputs in the production process. The value-added part is a CES function of primary factors. This CES specification for

value-added makes producers respond to dynamics in factor returns by substituting among available factors (Thurlow, 2004). The aggregate intermediate input part is a Leontief function of composite commodities partly domestic and partly imported (Lofgren et al., 2002).

The notion of closure rule implies equality of equations and endogenous variables which requires fixation of some variables for the model to have a solution. The choices on closures do not have impact on solutions of the base simulation but affect other simulations, and in addition, the choice per closure doesn't constrain the choice for the other closures (Damuri and Perdana, 2003). This study selected the model closures that are applicable to the Ethiopian economy.

The standard CGE model has closures for factor markets and the macroeconomic system. In this study, the factory closures are that labor is unemployed and mobile across sectors; land is fully employed and mobile across sectors, and capital is fully employed and activity specific. In our model, labor is not disaggregated into skilled, semi skilled and unskilled. A cumulative of these subdivisions is made to follow the labor market characteristics of the large proportion of the labor force in Ethiopia, unskilled labor. Land and capital are fully employed and hence have fixed supply whereas labor is unemployed and its employment is flexible. On the other hand, labor and land are mobile across sectors implying that they can be employed in different activities. But capital is activity specific as its use is usually immobile across sectors in Ethiopia.

The macroeconomic closures (balances) are based on the government balance, the external (current account) balance and the saving-investment (S-I) balance. In this study, we follow the government closure in which direct tax rates are exogenous and it is the changes in government savings that equilibrate the economy. For the external (ROW) balance, foreign saving is fixed, and thus it is real exchange rate that plays the equilibrating role. In the S-I balance; we follow a saving-driven investment closure in which we have

flexible capital formation but fixed propensities to save for all non-government domestic institutions. We follow this closure in this model in which investment adjusts to ensure equilibrium.

In our model, the DPI is the numeraire and hence is fixed whereas the CPI is made flexible. The CPI is made flexible in order to adjust the expenditures we used in the microsimulation model. Since price is normalized to one in the CGE model, the changes in CPI indicate consumer prices changes that bring about equilibrium within the model.

4.3 The Microsimulation Model

Though the frequently used measure of the extent of poverty has been the head count index, the FGT measures are considered to be the standard as they combine the head count index with the poverty gap index and the squared poverty gap index (Yesuf, 2007; MoFED, 2008).

Foster, Greer and Thorbecke (1984) lumped these measures into one formula that incorporates the three consistent and additively decomposable (by income class or region) poverty indices.

The formula for the FGT index is given as:

$$P_\alpha = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z - y_i}{z}\right)^\alpha$$

; $\alpha \geq 0$, $y < z$, $i=1, 2,\ldots, q$; [$y1 < y2 <\ldots< yq < z < yq+1 <\ldots\leq yn$]

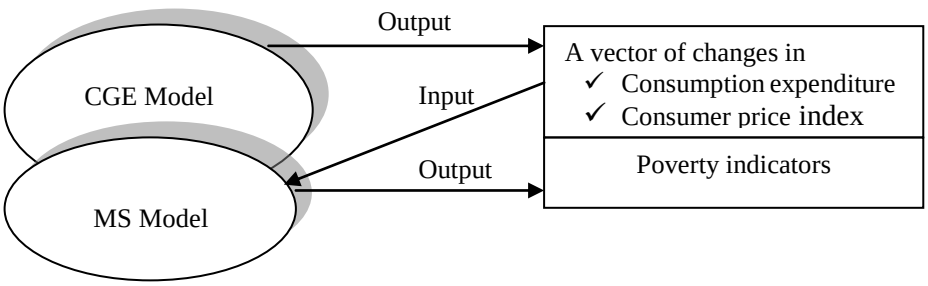
Where z is the poverty line, i is the sub-group of individuals with income below the poverty line, yi is the value of poverty indicator chosen (consumption expenditure below the poverty line in increasing order)[9], n is the total population size, q is the total number of poor people in the

[9] If $g_i = Z - Y_i$, then g_i represents income (consumption) short fall of the ith individual (household) and this is assumed to be zero for those above the poverty line (Abebe, 2005).

population, and α is the poverty aversion parameter. By setting the value of α to zero, one, two respectively,[10] the FGT poverty formula delivers a set of poverty indices. Setting α equal to zero, P0, reduces to the head count index (q/n) measuring the incidence (prevalence) of poverty. Setting α equal to one, P1, becomes the poverty gap measuring the depth or intensity of poverty. Setting α equal to two, P2, will be the squared poverty gap measuring the severity of poverty (the weighted sum of the poverty gaps themselves)[11] (Yesuf, 2007).

In this study, we link the CGE and the MS models in a top-down (sequential) manner as can be seen from Figure 2. In this top-down approach, the CGE model is linked with 21,594 households in the 2004/05 HICE survey of CSA (CSA, 2008). The changes in the fiscal policies introduced in the CGE model bring about economy-wide changes in the consumer price index and consumption expenditures of households once we solve the CGE model using GAMS software. These simulation results for the before and after shock period are later fed into the MS model using distribution analysis[12] (DAD) software that yields the FGT poverty indices.

Figure 2: The Top-down (sequential) approach



Source: Modified version of Colombo (2008) and Dejene et al. (2007)

[10] Some refer to the three measures: incidence, intensity, and inequality as the "**T**hree "**I**"s of **P**overty" (Gemmel and Morissey, 2002).

[11] "α" denotes the weight given to the poorest of the poor and so the higher the value of α, the more is the concern for the poorest (Abebe, 2005).

[12] The DAD (distribution analysis) software is "designed to facilitate the analysis and the comparisons of social welfare, inequality, poverty and equity across distributions of living standards." (Duclos *et.al.*, 2010)

As per EDRI, 2009, the households in the SAM were categorized into four as rural-poor, rural non-poor, urban-poor and urban non-poor. The bottom 40% of the households are taken as poor after the households are arranged in descending expenditure levels. In other words, the bottom two quintiles (4th and 5th) were considered as poor. Based on this treatment of the HICE survey in the 2005/06 SAM, this study used the consumption expenditure level at the demarcation of the top 60% and bottom 40% of the total households to be the poverty line in estimating the FGT indices (EDRI, 2009).

5. Simulations and Results

5.1 Description of Simulations

Baseline simulation

This scenario is used as a reference point where the economy is evaluated at times of no policy change or at times where the present policy environment is maintained.

Simulation 1: Increasing sales tax rate by 80%[13]

The 15 sector SAM used has a sales tax aggregate account which includes the domestic indirect taxes of local VAT, local excise taxes and service taxes. Local VAT contributes the largest to the account followed by service and excise taxes. The 2005/06 SAM represents the early years of intensification of the indirect tax reform that come of age after January, 2003 which marked the period in which VAT was introduced. To deal with the 80% huge increases in sales tax revenue in 2009/10 compared to 2005/06, we opted to a proxy increase in the sales tax rate that would represent the revenue increase. The underlying fact of the matter is that revenue increased due mainly to changes in the tax base (not the rate). It is rather difficult to capture the (price related) impacts on the poor of this expansions of the tax

[13] This percentage is based on calculations using EEA (2009) data base as discussed in section 3 above.

base or tax collection and thus we proxied this by changes in the sales tax rate (tq_c) in the CGE model.

Simulation 2: Increasing government consumption expenditure by 4%

This simulation is in relation to government consumption expenditure policies. As discussed in section 3, the MoFED data retrieved from EEA (2009) data base shows that final government consumption expenditure has increased by close to 4% in 2009/10 compared to 2005/06 in real terms which runs in opposite direction to Kasahun, 2003 that decreased government consumption by 20% as a result of structural adjustment. In line with this, we used this 4% value to introduce the shock, with no financing changes. Government consumption expenditure is explicitly accounted for in the CGE model as QG_c and thus we look into the impacts of a 4% increase in government consumption. In the SAM, government consumption spending is reported for public administration, education and health.

Simulation 3: Increasing government transfers to households by 20%

Another fiscal policy variable of our interest is the transfers from the government to households. This simulation implies government expenditure on transfers with no financing changes. The EDRI (2009) report states that it used the 2004/05 HICE survey for the government transfers to households. An important point to note here is that we have introduced this policy change to all poor and non-poor households in the SAM as anti-poverty policies are designed to hinder households from slipping into extreme poverty and to minimize the length of the poverty spell once they fall into it (Bigsten and Abebe, 2007). Thus, based on the 2004/05 HICE survey and the static nature of our CGE analysis, we have included the non-poor into the transfer scheme as well. In the HICE survey, for example, the 3rd quintile which is just in the consumption category above the bottom two poor quintiles (4th and 5th) has households with a mere 500 birr difference in consumption expenditures with the national poverty line. Thus, we introduced the shock to each household category assuming transfer of equal percentage.

It is useful to know the transfer schemes of the government to introduce a shock to the model but these values are difficult to get and are not consistent with those in the model. Thus, we introduced an increase in these transfers to look into their importance in reducing poverty if government gives more focus on to these mechanisms. We assume a 20% DPI indexed increase in government transfers, $trnsfr_{hgov}$, to all households in the 2005/06 SAM.

Simulation 4: Sim 2 + Sim 3

This simulation is a combination of consumption expenditure (sim 2) and government transfer (sim 3) policies of the government. In the EDRI (2009) report, these two cover the largest part of government recurrent expenditure with the remaining part allotted to government savings. Thus we examine the combined impacts of increases in government consumption expenditure and government transfers by 4% and 20%, respectively.

Simulation 5: Sim 1 + Sim 2 + Sim 3

This simulation is the one that helps us to evaluate the combined impact or the net effect of the fiscal policy options employed together. Domestic indirect tax is contributing one of the largest to government revenue, but likewise, it may adversely contribute to price related impacts on the consumer. On the expenditure side, we have stated that the government has invested heavily on the poor sectors using domestic and foreign finance. As the realistic economy usually pursues simultaneous fiscal measures, the intent in this simulation is to investigate the combined (net) impacts on the revenue side of an 80% increase in the sales tax rate that proxied the revenue increase (sim 1) vis-a-vis 4% and 20% respective increases in government consumption (sim 2) and transfer expenditures (sim 3).

Analysis of Results

In this section, we analyze the results of the simulations. We give central focus to the poverty impact of the fiscal policies with three related effects:

macroeconomic, sectoral and welfare. The analysis is based on the changes brought about by the five policy simulations.[14]

Effects on Macroeconomic Indicators

In Table 1, we report the simulation results of selected macro indicators. In simulation 1, the macroeconomy has recorded negative changes in most cases. An 80% increase in government indirect tax revenue brought about a 0.67% decrease in real GDP at factor cost. Absorption has shown a 0.58% increase due mainly to the strong increases in investment (4.13%) that offsets the negative changes in private consumption by 1.75%. This decrease in private consumption could also be affirmed by the decreases in consumption expenditure of households. Also government recurrent expenditure has increased by 0.64% contributing to increases in absorption. Due to the increase in taxes, government income has increased by a huge margin of 14.03%. This explains most of the changes in investment as government investment is larger. The CPI has risen by 0.67% indicating the general increases in prices when government imposes taxes on consumers.

In simulation 2, the results are mostly opposite compared to the first simulation. Real GDP has shown a 0.18% growth at factor cost. Absorption has grown by 0.15%, like the first simulation, but in this case, the causes are 11.89% increase in government recurrent expenditure and 0.4% increase in private consumption that offset the 3.26% negative changes in investment. The major reason for the decrease in investment is the decline in government income by 0.44%. CPI has changed negatively by 0.11% which explains why private consumption has increased.

Simulation 3 results in an increase in real GDP by 0.05% at factor cost. Like the second simulation, the increase in absorption by 0.03% could be explained by the increases in government recurrent expenditure (2.58%) and private consumption (0.19%) though investment has declined by 0.58% due mainly to decreases in government income by 0.08%. The increase in private

[14] This percentage changes calculate the changes from the base year, 2005/06.

consumption of households could directly be associated with increases in purchasing power of the households as a result of the transfers. Hence, most of the increment in the GDP is related to increases in domestic absorption. In this case, CPI has increased by a small 0.07% which could be linked to the direct impact of the transfers on purchasing power of households.

In simulation 4, real GDP has grown by 0.22% at factor cost. Absorption has increased by 0.19% due mainly to increases in government expenditure and private consumption which have grown by 14.48% and 0.59%, respectively to offset the 3.88% decline in investment that is caused by decrease in government income. Since the simulation principally is a shock to recurrent expenditure in general, consumption expenditure has dominated the transfer changes in explaining the 0.05% decrease in the CPI.

Table 1: Summary of results of macroeconomic effects of simulations (% changes)

Macro Indicators	Base value (billions birr)	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5
Real GDP (factor cost)	122.22	-0.67	0.18	0.05	0.22	-0.43
Absorption	162.48	0.58	0.15	0.03	0.19	0.77
Investment	28.18	4.13	-3.26	-0.58	-3.88	0.6
Private Consumption	114.75	-1.75	0.4	0.19	0.59	-1.21
Government Income	17.45	14.03	-0.44	0.08	-0.37	13.75
Government Expenditure	12.09	0.64	11.89	2.58	14.48	15.19
Consumer Price Index	1.13	0.67	-0.11	0.07	-0.05	0.65

Source: Simulation results from the CGE model

In the last simulation, we find interesting results that resemble the results of the first simulation. We find that the real GDP has decreased by 0.43% at factor cost. Domestic absorption has increased by 0.77%. Parts of domestic absorption, investment and government recurrent expenditure, have increased by 0.6% and 15.19%, respectively, though private consumption

has declined by 1.21%. The small increase in investment, unlike the first case, could be explained by the fact that government now channels most of its increased income (13.75%) to recurrent expenditure. The CPI has now increased by 0.65% which follows mainly from the increases in indirect taxes.

Sectoral Effects

For reporting purposes, we classified activities into two; agriculture and non-agriculture. Table 2 and 3 present the simulation results based on the mean growths of the agricultural and non-agricultural activities. Table 2 presents the results for sectoral growth of output.

In simulation 1, sectoral output has shown negative growth both in the agricultural and non-agricultural sectors. Domestic output in the agricultural sector has declined by 1.2% whereas non-agricultural output declined by 0.5%. The underlying reason for these changes could emanate from the price related effects when indirect taxes are imposed. For instance, factor returns have decreased in all cases and that the output purchasing power of consumers decreases as the CPI increases. A peculiar change we can appreciate in non-agriculture is the 3.6% output increase in construction services which could be associated with the increases in fixed investment as a result of increase in government income.

In simulation 2, sectoral output has increased by 0.05% and 0.003% for agriculture and non-agriculture in that order. When government consumption for goods and services increases, it could bring in producers who want to gain profits from the increase in exogenous government demand for goods and services. The very small change in level of output in non-agriculture emanated from the large decline in construction services by 2.79%.

In simulation 3, output level in agriculture has increased by 0.14% whereas output level in non-agriculture has declined by 0.04%. The transfers are

provided to both rural and urban households. Most of the rural households are expected to engage in agriculture. This exogenous increase in household income helps such households to purchase more (increasing their consumption demand) and could allow them buy more raw material for further production. But in the non-agricultural sector; production activities of machinery, construction services and other-manufacturing have shown major decreases that offset the increases in the remaining non-agricultural activities. This is probably because government has shifted the expenditure away from such industrial and service activities.

In simulation 4, similar changes have resulted whereby agricultural output has increased by 0.19% and non-agricultural output has declined by 0.05%. As this is a combined simulation to represent recurrent expenditures, it has a demand and supply side effect on output production following from the changes in government consumptions and transfers.

The last simulation has replicated the first simulation as we have seen in the behaviors of macro indicators. Production in both sectors has shown declines. Agricultural production has declined by a relatively stronger margin of 1.1%. In the non-agricultural sector, similar results of 0.5% decrease have resulted.

Table 2: Effects of simulations on sectoral output (% changes)

Sectors	Base	Sim 1	Sim 2	Sim 3	Sim 4	Sim5
Agriculture	12.9	-1.2	0.05	0.14	0.19	-1.1
Non - Agriculture	13.6	-0.51	0.003	-0.04	-0.05	-0.5

Source: Simulation results from the CGE model

The other way to approach the changes in the production activities is by evaluating the changes in the demand and supply of factors (labor). Table 3 presents the results. The simulations have only produced results for the employment (supply) of labor input combining the changes in the

agricultural and non-agricultural sectors. Labor employment has declined, especially in the first and last simulations by 1.6% and 1.3%, respectively. This might be due to decreases in returns to labor, as output production shrinks, which decreases labor supply. But when we come to the other simulations, labor employment has increased for the second (0.4%), third (0.1%), and fourth (0.49%) simulations. As we discussed in table 6, the increase in output for these simulations could be associated with the increase in labor inputs for production as a result of increases in returns.

For the demand for factors, we can examine labor as the only flexible input of production. In the first simulation, demand for labor has declined for both agriculture and non-agriculture by 1.6% and 1.09%, respectively. The decline in labor demand is mainly related to the contraction in output production as a result of the tax increases.

In the second simulation, the demand for labor has increased by 0.05% in the agricultural sector. However, demand for non-agricultural labor has declined by 0.32%. We could associate these declines to the negligible change in output production in the aggregates for agriculture and non-agriculture. In the third simulation, the increases in transfers have brought about increased demand for labor by 0.18%. In contrast, the demand for labor has decreased by 0.15% in the non-agricultural sector. The intuition is related to the use of the cash transfer in rural areas. The benefited households (most of which are farmers) could aspire to produce more which requires inputs. In agriculture, labor is a principal input of production which validates the increase. In non-agriculture, output production has declined on average which is related with shift in use of government resources. This could lead to reduction in surplus inputs. In the fourth simulation, similar patterns of change have been observed. Demand for agricultural labor has increased by 0.22%, while non-agricultural labor has decreased by 0.46%. This decline could also follow from the decreases in production of output in the non-agricultural sector.

In the fifth simulation, we also find similar results like the first simulation. Demand for agricultural labor has decreased by 1.34%. Like the case of agricultural labor, demand for non-agricultural labor has declined by 1.6% in this last simulation. The increase in tax seems to have strained the use of labor in both agriculture and non-agriculture.

Table 3: Effects of simulations on labor employment and demand by sector (% changes)

Sectoral Indicators	Base	Sim 1	Sim 2	Sim 3	Sim 4	Sim5
Changes in labor employment (both agriculture and non-agriculture)						
Labor employment	60.29	-1.33	0.4	0.1	0.49	-0.83
Changes in demand for labor by activity						
Agricultural labor	8.86	-1.6	0.05	0.18	0.22	-1.34
Non-agricultural labor	1.78	-1.09	-0.32	-0.15	-0.46	-1.6

Source: Simulation results from the CGE model

Welfare Effects

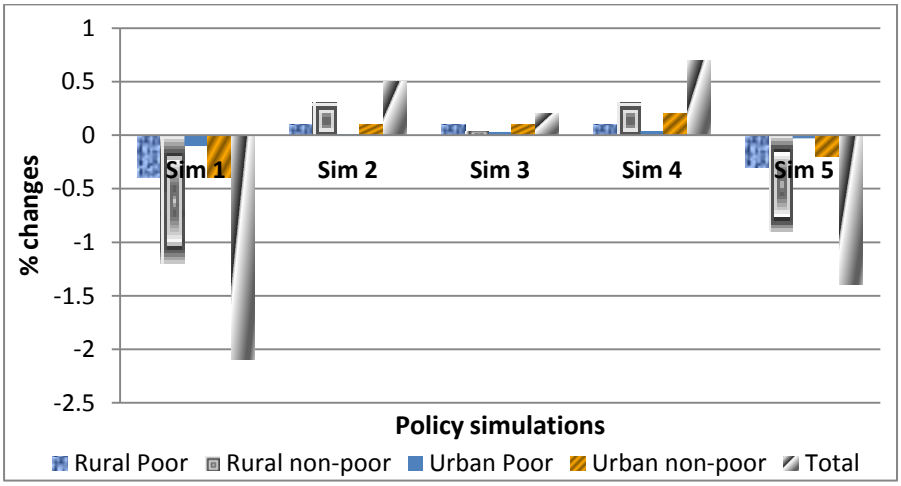
The most important welfare indicator used in the literature for CGE models is the equivalent variation (EV). Since policy shocks are usually followed by major price adjustments, the EV measures the level of income (in money terms) that the consumer needs to (presumably) pay before the shock to leave him as well off at the equivalent level of utility loss after the price increase. Since the consumer is harmed prior to the policy change by paying the price equivalent in income, negative EV changes represent welfare (utility) loss as a result of the policy shock. Figure 3 presents the welfare effects of the policy shocks.

In the first simulation, the instant increases in domestic indirect tax collected by government seems to have negatively affected both the urban and rural households as the negative values for EVs would suggest. The EVs have declined by 0.4%, 1.2%, 0.1% and 0.4% for rural-poor, rural- non-poor, urban-poor and urban-non-poor, respectively. Comparatively, the EVs

indicate that the non-poor receive much of the welfare strain in both rural and urban areas. This may be indicative of the fact that tax impositions have adversely affected these well off household groups, dragging their livelihoods downwards. Probably, the major culprit behind this is the price increasing effect of taxes which is mainly evident in urban areas in relation to VAT imposition. Comparing urban and rural households, however, we find that rural households face larger welfare loses.

In the second simulation, we see positive EVs for the increases in government consumption indicating welfare improvements. The EVs showed increases for all household groups by 0.1% (rural-poor), 0.3% (rural-non-poor), 0.01% (urban-poor) and 0.1% (urban-non-poor). The welfare of rural households improved larger than that of the urban counterparts with non-poor households reaping the relative advantage in both areas. This could mainly be because, in the SAM, recurrent government expenditure is spent on public administration, education, and health most of which constitute wage and non-wage payments that the non-poor are characterized with.

Figure 3: Effects of simulations on welfare (EV) of household groups (% changes)



Source: Simulation results from the CGE model

In the third simulation, the results show that welfare increased by 0.1%, 0.03%, 0.03% and 0.1% for rural-poor, rural-non-poor, urban-poor, and urban-non-poor, respectively. The outcomes seem to favor the rural-poor and urban-non-poor. This seems to suggest that the rural-poor will need to be targeted in such programs whereas the urban-poor may not get the benefits expected from such transfer programs. Since welfare has improved for all households, though by small amounts, transfers could be one of the policy instruments of government to improve welfare.

In the fourth simulation, we have combined sim 2 and sim 3 to have an overall impact of government recurrent expenditure on welfare. The results are improvements in welfare by 0.1%, 0.3%, 0.04% and 0.2% for rural-poor, rural-non-poor, urban-poor and urban-non-poor, respectively. The improvement in welfare is found to be larger for non-poor households in urban and rural areas. Since this simulation is a combination, the influence of government consumption looks larger as the non-poor seem more benefited from the policy shock. The welfare effects on the poor, however, are positive but small.

The last simulation shows that the effect of combined policy shocks are almost similar with the first simulation. The rural-poor, rural-non-poor, urban-poor and urban-non-poor have all recorded negative welfare changes by 0.3%, 0.9%, 0.03% and 0.2%, respectively. Household welfare seems to be strained for both urban and rural households but the non-poor seem to receive the bigger blow. These results suggest that heavy tax collection schemes of the government have brought about a net negative impact on welfare of all the household groups. Interestingly, the urban-poor are found to have the lowest decrease in welfare. The CGE results depicted in figure 3 also show total welfare changes for households in each simulation. We see that the welfare loss in the last simulation is lower than the first simulation due to the offsetting effects of the spending schemes.

Impacts on Poverty

To analyze poverty, we used the percentage changes in consumption expenditure of household groups that are taken from the CGE model. It is these economy-wide changes in consumption that we used as the source of link with the MS model in conducting the poverty analysis using the three poverty indicators. Figure 4 presents the CGE results for changes in consumption.

In the first simulation, consumption shrank for all the household groups by 1.3%, 1.2%, 1% and 0.8% for rural-poor, rural-non-poor, urban-poor and urban-non-poor, respectively. The likely explanation is that the increases in price of consumption commodities forced households to adjust their use of income. For instance, when VAT is imposed on commodities, it is imposed on the price paid by the consumer which increases the "menu price". Hence, consumption expenditure has to fall assuming fixed incomes.

For the three spending simulations, consumption expenditure increases. In the second simulation, consumption has increased by 0.3% for rural households whereas it has increased by 0.2% for urban households. The reason could be the effect of increases in wage and non-wage payments that give households more income to expend. In the third simulation, the rural-poor and non-poor experienced consumption expenditure increases by 0.3% and 0.1%, respectively. But the urban- poor and non-poor experienced higher increases by 0.8% and 0.5%, respectively. As can be seen from the figure, both rural and urban-poor have larger increases in their income compared to the non-poor mainly because the transfer covers a larger proportion of their total income. In the fourth simulation, the consumption expenditure increased for all household groups by a larger amount compared to the previous two individual simulations of government spending schemes. Consumption increased in all cases for rural-poor (0.6%), rural-non-poor (0.5%), urban-poor (1%), and urban-non-poor (0.7%). The explanations we

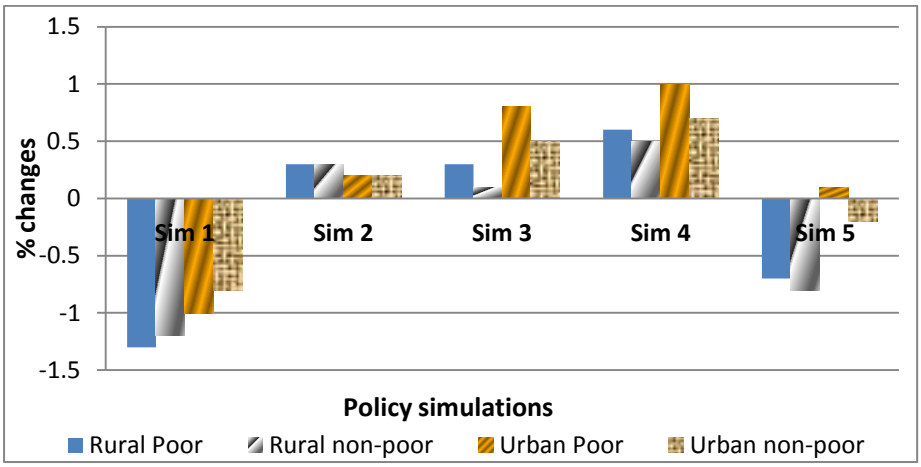
give to the previous two simulations apply in the combination when recurrent expenditure increases.

In the last simulation, consumption expenditures of rural households have decreased by 0.7% (poor) and 0.8% (non-poor). Likewise, the urban-non-poor have recorded negative consumption growths by 0.2%. In contrary, urban poor seem to have a slight increase in their consumptions (0.1%) which emerge as an interesting net impact of the fiscal policy combinations. In the welfare results from the CGE model, we also noticed that welfare losses are smallest for the urban-poor in this fifth simulation. The possible explanation could be that urban poor in the survey are less affected by the tax increases or that the government consumption and transfer expenditures have a stronger positive impact as can be seen from the results in the third and fourth simulations. The government transfers seem to have largely benefited the urban-poor. A study by Obi, 2007 for Nigeria found out different results in which transfers and subsidies to firms were found to be more productive than transfers to households.

To investigate the impacts of this consumption changes on poverty, the FGT poverty estimates are generated for households at national, rural and urban levels. Among the 21,594 households at national level; we found that 9,493 were rural and 12,101 were urban.[15] Since the SAM has delineated poor and non-poor households based on levels of consumption expenditure with the bottom 40% as poor, we needed to separate the poor and non-poor in rural and urban areas in the same manner. Rural and urban households were each divided into two categories taking the bottom 40% as poor and the top 60% as non-poor. As shown in figure 5, since consumption expenditures separately change for these four household categories, we made necessary adjustments on the consumption expenditures in the 2004/05 HICE survey using the CGE results for each policy simulation.

[15] Though the number of rural households is smaller in the survey, one point of note is that the number of people each sample rural household represents (weights) is very large compared to urban households.

Figure 4: Effects of simulations on consumption expenditure growth of household groups



Source: Simulation results from the CGE model

To elaborate more, based on additional information on adult equivalent household size for the 2004/05 survey from CSA, we changed the consumption expenditures in the survey to consumption expenditure per adult equivalent. After this, we took approximate levels of consumption expenditure at the demarcation of the bottom 40% (two quintiles) to represent cut points for national, rural and urban-poor and non-poor households. So among rural households, we got 3,861 as poor and 5,632 as non-poor whereas among urban households, we got 4,751 as poor and 7,350 as non-poor. We then introduced the consumption changes on the base values of the four households after simulations from the CGE model (Savard, 2003). The new values we calculated are the ones we used in DAD to compute the FGT indices.

An important point here is the disparity that may be created in the poverty results when we compare it with the official levels of the poverty measures gathered from the 2004/05 HICE of CSA. The main reason is that the CSA used 1075.03 poverty line that is CPI indexed to compute the FGT indices. But in this study, we are guided by the mechanism followed in the 2005/06

SAM that is to arrange the households based on expenditure in descending order and take the bottom 40% as poor. The consumption expenditure level at the demarcation of total households in the survey, 1782.98, is taken as the poverty line. This national poverty line is adjusted for the CPI in each simulation based on CPI values generated from the CGE model. After this basic ground work, we came up with the results for the poverty measures.

Table 4 presents the results for the head count index. At the base run, the proportion of the poor from total population is 40.9% at the national level. But at rural and urban levels, the index becomes 42.8% and 30.8%. In the first simulation, we see that poverty incidence has increased by 1.5%, 1.4% and 1% at national, rural and urban levels implying worsening of the poverty situation in the short-run. Since this simulation is related to tax imposition, the indication is that when government squeezes money out of the pockets of households for various purposes, it has a short-run adverse impact on their well being. Similar results were found by Wong et al., 2008 for the case of Ecuador.

In the second, third and fourth simulations, the head count poverty has shown slight decreases. In the second simulation, the national, rural and urban head counts declined by 3.2%, 3.3% and 1.6%. The explanation could be that government consumption has increased on sectors that benefit the poor. If consumption of government increases on public administration, education and health, then this may result in short-run decreases in head count poverty. In the third simulation, the results are similar with the second that are decreases in poverty incidence by 2.5% (national), 2.6% (rural) and 1.9% (urban). The likely implication is that government transfer schemes to households can be used as a policy in reducing poverty in the short-run. Also, in the fourth simulation, the proportion of poor has shown decreases by 3.4% (national), 3.5% (rural) and 2.3% (urban). These figures are relatively larger compared to the separate spending simulations. Most of these decreases in the poverty head count are related to the increases in income and real consumption that come with the government recurrent expenditures.

In the last simulation, we find that at national and rural levels, the poverty incidence increased by 0.5% and 0.7%, respectively. But for urban households, poverty incidence decreased by a slight 0.3%. From these results, we see the dominant straining effects from the first simulation which has increased the poverty head count only for total households and rural households. In case of urban households, a peculiar decrease in head count poverty is found. The explanation for this could be the increase in consumption expenditure of urban-poor that we have examined in figure 4. When we compare these values with the results from the first simulation, we find that they are moderate indicating that the welfare loss from the increases in tax collection could be overturned by government spending schemes that bring benefits to households.

Table 4: Effects of simulations on poverty head count index (P_0) (% changes)

	Base	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5
National	0.409	1.5	-3.2	-2.5	-3.4	0.5
Rural	0.428	1.4	-3.3	-2.6	-3.5	0.7
Urban	0.308	1	-1.6	-1.9	-2.3	-0.3

Source: Microsimulation results

Table 5 presents the results for the poverty gap index. The results imply similar changes like the head count index in the sense that the index increases in the first simulation for all the three categories from the base. Poverty depth has increased by around 2.5%, 1.7% and 1% at national, rural and urban levels, respectively. Rural poverty gap has increased by a relatively larger margin compared to urban poverty gap. The implication is that when the increases in domestic indirect taxes press the consumption power of households downwards, the mean level of consumable goods that the households need to get out of poverty increases worsening their poverty state or pushing them down to chronic poverty.

In the second, third and fourth simulations; the poverty gap has declined by relatively higher percentages. In the second simulation, poverty gap has

declined by 3.5%, 4.3% and 3.2% for national, rural and urban households, respectively. The indication is that increase in government consumption reduces the income shortfall of poor households from the poverty line. In the third simulation, poverty gap has declined by 3.5%, 3.4% and 4.2% for national, rural and urban households, respectively. Compared to the effect of changes in government consumption, changes in transfers to households seem to have larger impact on urban households compared to rural households. In the fourth simulation, a stronger decrease in poverty depth has resulted for all the households. At national, rural and urban levels, the poverty depth declined by 4.4%, 5.1% and 5.3%. The evident explanation could be that the poverty gap decreases are a cumulative effect of the second and third simulations.

In the last simulation, we observe that the poverty gap index has shown negligible changes. Poverty gap has slightly increased by a mere 1% at national and urban levels. However, we find that poverty gap has not changed for rural households. The possible explanation is that the net impact of the fiscal policies employed together did offset each other for the poverty depth of rural households leaving the poor households unaffected.

Table 5: Effects of simulations on poverty gap index (P_1) (% changes)

	Base	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5
National	0.113	2.5	-3.5	-3.5	-4.4	1
Rural	0.117	1.7	-4.3	-3.4	-5.1	0
Urban	0.095	1	-3.2	-4.2	-5.3	1

Source: Microsimulation results

Table 6 presents the results for the poverty severity (squared poverty gap) index. In the first simulation, we see a 4.8%, 2.3% and 2.7% increase in poverty severity at national, rural and urban levels, respectively. The implication of this is that the inequality among the poor has risen due to the imposition of the domestic indirect taxes. Poverty severity has increased by higher margins for urban households compared to rural households.

In the second, third and fourth simulations; poverty severity has declined. In the second simulation, poverty severity has been reduced by 4%, 6.8% and 5.4% at national, rural and urban levels, respectively. We can see from the result that increases in government consumption expenditure reduce the inequality among the poor. This is more pronounced for rural households compared to urban households. Likewise, for the third simulation, poverty severity has declined in all cases by 3.8%, 4.5% and 5.4% for national, rural and urban households. In this simulation, poverty severity in urban areas has declined by larger amounts compared to rural areas. Similarly, in the fourth simulation, we see stronger declines in the inequality among the poor. Poverty severity has declined by 5.2%, 6.8% and 8.1% at national, rural and urban levels, respectively. What we can infer from the results of the three FGT indices is that the combined effects of the government expenditure measures have stronger impacts on reducing poverty compared to the separate policy options.

Table 6: Effects of simulations on poverty severity index (P_2) (% changes)

	Base	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5
National	0.042	4.8	-4	-3.8	-5.2	2.4
Rural	0.044	2.3	-6.8	-4.5	-6.8	0
Urban	0.037	2.7	-5.4	-5.4	-8.1	-2.7

Source: Microsimulation results

In the fifth simulation, we find mixed results. At the national level, poverty severity has shown a 2.4% increase. But it has shown no change for rural households which follows from similar results for rural poverty gap. However, urban poverty severity has declined by 2.7%. This result seems to follow from the results that we reported for changes in welfare and consumption expenditure for this simulation.

6. Conclusions and Implications

6.1 Conclusions

In this study, we set out to investigate the economy-wide impacts of fiscal policy on poverty. We looked into the impacts of government tax measures and expenditure schemes. The crux of the matter is that the Ethiopian government is intensifying domestic revenue collection usable for various spending plans.

The results of increasing domestic indirect taxes indicate negative changes in the macro economy represented by the declines in real GDP. The sectoral effects also show reductions in output production and labor employment. The results generally indicate welfare loss, decline in household consumption expenditures and worsening of poverty in the short-run when domestic indirect tax increases are imposed on commodities.

When we come to the short-run expenditure policies, we see opposite results. In these cases, real GDP has grown positively though its various components exhibited various changes across the simulations. The sectors showed increments in labor employment and output production. The expenditure schemes also revealed welfare gains to households. Moreover, household consumption expenditure has increased in all cases. Though these increases were different in magnitude, the impacts of these changes were also visible on poverty. The poverty measures revealed improvements in the poverty status of all households in the short-run.

In the last simulation, we found out that the combined tax and expenditure interventions lead to declines in real GDP. Sectoral output and labor employment were also reduced as a result of the policy combinations. The results show net welfare loss and worsening of the poverty in the case of majority of households. In this simulation, consumption expenditure has decreased for all households except the urban-poor. Due to this, the poverty state of urban households has revealed improvements though small in

magnitude. Overall, this scenario resulted in many indicators that had similar changes like the first simulation implying dominant adverse effects of changes in domestic indirect tax policies over the changes in government consumption and transfer expenditure policies.

6.2 Implications

This study has some useful implications for policy and future research in relation to the link between fiscal policy and poverty in Ethiopia. Firstly, the Ethiopian government has been expanding the tax base through improved tax collection principally from domestic sources. This trend seems to even be widened further as we can see from the Growth and Transformation plan (GTP) for the period 2010/11 to 2014/15. The results in this study, however, indicate that government policy towards domestic sources has repercussions on poverty in the specific case of domestic indirect taxes, with all other anticipated changes retained at the base level.

Secondly, the government consumption spending schemes are poverty reducing. The study results revealed that the government policy of increasing consumption expenditure does not worsen the poverty situation in the short-run though inflation in the economy was not examined.

Thirdly, government transfers to households are poverty reducing. The results from the study indicate that increasing transfers to households improves the poverty status of both poor and non-poor households. Hence, the government can use these policies as an alternative in addressing the poverty problem in the short-run. However, this argument shouldn't be taken at face value. Practically, transfer schemes require preliminary justifications. For example, given the dynamic nature of poverty, transfers can take various forms based on the type of poverty state.

Fourthly, in relation to the fiscal policy combinations, we found out that the tax policies have a dominant short-run negative impact on poverty. This

implies that in the financing plans that government formulates that use domestic indirect taxes, households could be negatively affected. So, to protect households from such unintended strains of the fiscal plans, the government has to also prepare short-run spending policies like safety nets schemes. As stated, the spending policies we examined are poverty reducing, hence policy makers need to exploit such policies that would improve the status of households while the financing policies go along.

Finally, we could raise two agenda worth investigating in future research. First, since we only focused on ex-post analysis based on the 2005/06 data, it is difficult to extrapolate to the future. Further studies in this area could extend this study by using ex-ante analysis using recent SAM to predict the poverty impacts of financing plans like the GTP. Second, it would be difficult to have a full picture of the net impact of the fiscal policy changes without in depth analysis on long term capital expenditure schemes. Poverty reduction is a principal long term development objective and the Ethiopian government has designed a number of poverty reduction strategies in which pro-poor expenditure policies are at the center. Since the study is a static analysis, it remains for future research to examine the impacts of government financing and spending policies in the long-run. Future researchers will however be faced with the implicit nature of government capital investment in the Ethiopian SAM and the IFPRI CGE model. In this regard, a suggestion is that the Ethiopian SAM should be prepared in a manner that could allow a separate analysis of private and government investment. This will be helpful in investigating the long – run effects of government and/or private investments using dynamic CGE models. Dynamic CGE analysis that examines the anticipated returns from government capital investment could add a lot to the literature in the country.

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Annexes

Annex 1: Current and Capital Expenditure as % of Total Expenditure in 1999/00 constant prices

Ethiopian fiscal year ending July 7	1999/00	2001/02	2003/04	2005/06	2007/08	2009/10
Current Expenditure	80	63.2	58.5	52.3	48.4	44.7
Economic services	4.7	6.3	6.8	6.8	6.7	5.6
Social services	12.2	16.8	16.3	17	18.5	17.4
General services	48.4	27.8	25.3	22.2	19.5	17.9
Other	14.6	12.4	9.6	6.3	3.7	4.7
Capital Expenditure	20	36.7	41.5	47.7	51.6	55.3
Economic development	12	20	24.8	35.5	37.9	38.3
Social development	3.6	6	10.4	10.5	11.6	13.8
General development	2	4.2	6.4	1.8	2.1	3.2
External assistance	2.4	6.7	5.3	7.5	8.6	7
Total Expenditure (,000 birr)	17,181	18,535	18,794	22,630	23,383	28,462

Source: Own computations based on MoFED data retrieved from EEA (2009) data base

Annex 2: Tax and Non-tax Revenue as % of Total Revenue & Grants in constant 1999/00 prices

Ethiopian fiscal year ending July 7	1999/00	2001/02	2003/04	2005/06	2007/08	2009/10
Tax Revenue	54.6	61.4	61.2	60.8	59.9	65.4
Direct Taxes	19.9	34.2	18.2	19.1	17.7	22.5
Indirect taxes	34.7	37.3	43	41.8	42.3	42.9
Domestic Indirect Taxes	12.1	11.6	12.3	13.4	12.8	16.2
Foreign Indirect Taxes	22.5	25.6	30.7	28.4	29.5	26.7
Non Tax Revenue	30.9	19.8	15.5	23.1	15.1	15.9
Total Revenue(exc. grants)	85.5	81.2	76.7	83.9	75.1	81.3
External Grants	14.5	18.8	23.3	16.1	25	18.7
Total Revenue & Grants (,000 birr)	11,872	14,337	16,214	17,865	19,853	26,495

Source: Own computations based on MoFED data retrieved from EEA (2009) data base.

Annex 3: Share of public expenditure on poverty-oriented sectors at constant 1999/00 prices

Sectors	2005/06			2007/08			2009/10		
	Current	Capital	Total	Current	Capital	Total	Current	Capital	Total
Agriculture	10.2	23.9	16.7	10.3	16.1	13.3	6.9	12.1	9.8
Education	25.4	17.7	21.7	29.2	14.1	21.4	30.3	18.4	23.7
Health	5.3	3.7	4.6	6.6	7.7	7.3	6.6	6.2	6.4
Social Welfare	0.9	0.4	0.7	0.6	0.04	0.3	0.4	0.03	0.2
Roads	1.3	24.5	12.4	1.2	33.6	17.9	1.3	36.5	20.8
Total poverty targeted spending	43.1	70.2	56.1	47.9	71.7	60.2	45.6	73.2	60.8

Source: Own computations based on MoFED data retrieved from EEA (2009) data base

Annex 4: Indirect tax revenue by component at constant 1999/00 prices (% of GDP)

Ethiopian fiscal year ending July 7	2005/06	2006/07	2007/08	2008/09	2009/10
Domestic indirect taxes	2.6	2.6	2.1	2.2	2.8
VAT and TOT on local goods	1.4	1.4	1.1	1.0	1.2
VAT and TOT on services	0.5	0.6	0.6	0.8	1.2
Excise tax	0.5	0.4	0.3	0.3	0.3
Stamp duty	0.2	0.2	0.1	0.1	0.1
Foreign trade taxes on imports	5.0	4.6	4.7	3.5	4.6
Customs duty	2.3	2	1.6	1.2	1.5
Import VAT	2.3	2.1	1.6	1.2	1.7
Excise tax	0.5	0.5	0.4	0.4	0.5
Sur tax	--	--	1.1	0.7	0.9
Total Indirect tax revenue	7.6	7.1	6.8	5.6	7.5

Source: Own aggregations and computations based on regional and federal data from MoFED.

Climate Change and Variability: Implications for Household Food Security in Agro-pastoral Areas of Jigjiga District, Eastern Ethiopia

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Abstract

Ethiopia is one of the most vulnerable countries of the world to the impacts of climate change and variability. The impact is even stronger in pastoral areas of the country. However, studies on the actual climate change dynamics and its effect on food security at local and household levels are limited. The present study took Jigjiga district as a case and analyzed changes in local climate; status of household food security; the relative significance of climate related causes of food insecurity; and household level determinants of food security. The study used rainfall and temperature data from the period 1952 to 2010 and primary data gathered from 140 sample households and focus group discussions. Using Mann-Kendall trend test, the study revealed the existence of statistically significant declining trend in rainfall in the rainy season and increasing trend in temperature at annual and seasonal time scale. Moreover, respondents confirmed the presence of climate change, with increasing temperature, decreasing rainfall amount and increasing seasonality of rainfall in the past two decades. The Rash model estimation result based on the Food Security Core Module showed high prevalence of food insecurity in the district with 81 per cent of food insecure households consisting of 27 per cent food insecure without hunger, 29 per cent food insecure with moderate hunger, and 25 per cent food insecure with severe hunger. Respondents ranked climate factors as their top most important causes of food insecurity. These are drought, low annual rainfall, high temperature, and water shortage. The econometric model estimation result revealed the important factors determining household food security. These are household perception of climate change, use of soil and water

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conservation practices, use of livestock feed management techniques, loss of livestock due to drought and/or disease, literacy level of household head, and dependency ratio. Among other things, the study suggested improving climate change awareness and strengthening the existing adaptation measures that have positive impacts on food security.

Keywords: climate change, climate variability, adaptation measures, food security, agro-pastoralism.

1. Introduction

There is clear scientific evidence that the earth's climate is changing (IPCC, 2007; Spore, 2008). Some facts about this global change include: increasing temperature (temperature has increased by 0.74°C over the20th century), melting polar icecaps, uncontrolled forest fires and annual average increase in sea level of 3.1 mm (Spore, 2008). The changes occur mainly because of increasing concentration of greenhouse gases emitted from various activities of human beings. Such changes have already had some impacts on the natural equilibrium at the risk of the survival of human beings. The problem is recognized as one of the most serious global challenges of the 21st century with multiple effects on basic human support systems such as agriculture, forest, water resources, and the ecosystem (Aklilu and Alebachew, 2008).

Climate variability and change are a major threat to food security in Africa and many regions of the developing world, which are largely dependent on rain-fed and labor-intensive agricultural production (Parry et al., 2004; IPCC, 2007). Within the African region, the Horn countries are among the most vulnerable but least prepared for adverse global environmental change in the word. Among the horn countries, Ethiopia is one of the most poverty stricken, ecologically fragile countries whose growing population and feeble economy are heavily impacted by climatic events (Aklilu and Alebachew, 2008).

In Ethiopia, there is a general trend of increasing temperature, decreasing precipitation and increasing frequency of droughts and floods (World Bank, 2003; NMA, 2007). According to the National Adaptation Program of Action (NAPA) report of National Meteorological Agency (NMA, 2007), the average annual minimum and maximum temperature have increased by about 0.250C and 0.10C respectively every ten years. The report further showed that there was a very high variability of rainfall over the past 50 years. This has already led to a decline in agricultural production, and cereal production is expected to decline still further under moderate global warming (Ringer, 2008). Moreover, it has led to shortage of food, a decline in biodiversity, and increases in human and livestock health problems, rural-urban migration and dependency on external support.

Pastoral and agro-pastoral livelihood systems in the lowlands of the country are among the most vulnerable to the impacts of climate change and variability (NMA, 2007). Over the past several decades, pastoral livelihood systems were affected by repeated droughts, famine and epidemics that relate to the changing climatic condition. As a result, the losses of productive assets and increasing household food insecurity have become defining features of lowland poverty in Ethiopia (Sandford and Yohannes, 2000; Beruk, 2003; Pantuliano and Wekesa, 2008).

There exists a dearth of empirical evidences regarding the relationship between global climate change and food security at local and household levels in Ethiopia. Moreover, the existing studies focused on household adaptation strategies and climate change impact on agriculture while they are not comprehensive particularly in terms of household level assessment (Temesgen et al., 2008; Zenebe, et al., 2011; Virtanen, et al., 2011). For example, Temesgen et al. (2008) have conducted an integrated quantitative vulnerability assessment for seven Regional States of Ethiopia using biophysical and social vulnerability indices of Ricardian approach. The study has found that decline in precipitation and increase in temperature are both damaging to Ethiopian agriculture. The result of the study has further

pointed out that Somali National Regional State (SNRS), where this study is conducted, is one the two highly vulnerable regions to climate change impacts in the country. As their study is aggregated, the authors have acknowledged the need for further study at local and district levels.

Therefore understanding the implication of climate change for household food security at local level is critical to looking for options to adaptation as well as mitigation of climate change impacts. This study therefore assesses the role of climate change on food security of agro-pastoral households in Jigjiga district, in Eastern Ethiopia. Specifically, the following objectives would be pursued in investigating this research problem:

- To analyse the presence of significant changes in local climatic variables such as temperature and rainfall,
- To assess the perception of households on climate change;
- To assess the perception of households on the significance of climate related causes of food insecurity;
- To quantify the status of household food security; and to
- To identify determinants of food security at household level.

2. Climate change and food security linkages

Climate change has an impact on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows. Agriculture-based livelihood systems that are already vulnerable to food insecurity face immediate risk of increased crop failure, new patterns of pests and diseases, lack of appropriate seeds and planting material, and loss of livestock (FAO, 2008). Some of the direct and indirect impacts of climate change on livestock and livestock systems are:

Water: Increasing water scarcity is an accelerating condition affecting 1-2 billion people worldwide, resulting in problems with food production (MA, 2005). Climate change impacts will have a substantial effect on global water availability in the future. This will not only influence livestock drinking

water sources, but it also affect livestock feed production systems and pasture yield (Thornton, et al., 2008).

Feed quality and quantity: climate change can be expected to have several impacts on feed and grazing including; changes in herbage growth, changes in the composition of pastures and changes in herbage quality (Hopkins and Del Prado, 2007). As climate becomes more variable, species niches change (i.e. plant and crop substitution) which brings about changes in land use system, species composition and quality of plant material. This may modify animal diets and compromise the ability of smallholders to manage feed deficits (Thornton et al., 2008).

Biodiversity: climate change may accelerate the loss of genetic diversity in crops as well as domestic animals. A 2.50C increase in global temperature will see major losses: 20-30 percent of all plant and animal species assessed could be at high risk of extinction (IPCC, 2007). Local and rare breeds are at risk of being lost through the impact of climate change and disease epidemics. The recent FAO report on animal genetic resources indicates that 20 percent of reported breeds are now classified as at risk, and that almost one breed per month is becoming extinct (CGRFA, 2007).

Livestock diseases and disease vectors: climate change may bring about substantial shifts in disease distribution. Higher temperatures may increase the rate of development of pathogens or parasites that spend some of their life cycle outside their animal host, which may lead to larger populations (Harvell et al., 2002). Changes to winds could affect the spread of certain pathogens and vectors. Expansion of vector populations into cooler areas (in higher altitude areas: malaria and livestock tick-borne diseases) or into more temperate zones (such as bluetongue disease in northern Europe). Changes in rainfall pattern may also influence expansion of vectors during wetter years, leading to large outbreaks of disease (Rift Valley Fever virus in East Africa) (Thornton et al., 2008).

3. Methodology

3.1 The study site

The study site is located in the Somali region (Eastern Ethiopia). Somali is the second largest region of Ethiopia with an area of 327,000km2. According to the 2007 Census of Central Statistics Agency (CSA), Somali Region population was numerated at 4.4 million in 2007, of whom 2.5 million were male and 1.9 million were female(CSA, 2007).The region is overwhelmingly rural and the level of urbanisation is low, at 14.3 per cent (Devereux, 2006). There are approximately 665,397 households in Somali Region with household size averaging 6.6, with a range from 6.3 in urban to 6.7 in rural areas (CSA, 2007).

The study site, Jigjiga district, has a total population of 276,818 of whom 148,862(53.78 percent) were men and 127,954 (46.22 percent) were women; 151,232 (54.63 per cent) are rural and 125,584 (45.47 percent) are urban dwellers (CSA, 2007). The district has two major seasons Gu (long rainy season) and Jilaal (dry season). Unlike other parts of the region, the rainy season (Gu) in the district has three sub seasons: Dira (April - May), Hagaa (June - July), and Karan (August -September) all of which are equally important for cultivation of crops; availability of water and pasture for livestock. Furthermore, the dry season, Jilaal (October - March) is divided in to two sub seasons: Deyr (October - November) and Kalil (December-March) (Devereux, 2006; SC UK, 2007).

The district has two major livelihood systems; sedentary farming and agro-pastoral systems. Sedentary farmers depend on rain-fed crop production (sorghum, wheat, barley and maize) and livestock (mainly shoats and cattle) while agro-pastoralists highly depend on animal rearing (shoats, camel and cattle) besides some opportunistic farming (mainly sorghum). Agro-pastoralists and farmers highly depend on rain-fed agriculture and pasture which makes them particularly vulnerable to drought, livestock disease and crop pests (SC UK, 2007).

3.2 Data collection

The study used both quantitative and qualitative data, to capture information on the changing climate and its multiple effects on household food security. Hence, relevant data were derived from both primary and secondary data sources. Primary data were collected from sample agro-pastoral households and community groups in Jigjiga district. Time series rainfall and temperature data for Jigjiga district were collected from the NMA Jigjiga branch office. The data cover the period from 1952 to 2010 (59 years). The lack of metrological station that provides long-term climatic data in other pastoral areas of the Region and the time available for field research has led to conduct the study in one administrative area.

A two stage sampling technique was applied to select sample households. In the first stage, 5 villages were randomly selected out of the total 20 agro-pastoral villages in the district. In the second stage, a total of 140 households were randomly selected using probability proportional to sample size sampling and simple random sampling technique from the list of households enumerated in each of sampled villages. Household surveys were carried out to obtain information regarding the effect of climate change and other factors on household food security. A range of vulnerability factors were identified and included in the questionnaire for sampled households to indicate the extent of these factors to have effect on their food security.

USDA's Food Security Core Module (FSCM) was included in the household questionnaire for the assessment of household food security status. FSCM is a structured survey questionnaire having a set of 10 questions for households with no children and 18 questions for households with children. The food security status of each household was assessed by responses to the questions about food-related behaviors, experiences, and conditions that are known to characterize households having difficulty meeting their food needs. In order to triangulate household data and gain a better understanding of the link between climate change and food security, ten focus group discussions (2 per

sampled PAs) were made using participatory methods such as semi-structured group interview and ranking.

3.3 Data Analysis

This study mainly employed the Mann-Kendall non-parametric trend test, to detect significant trend among climatic variables (rainfall and temperature), Likert-scale, to summarize household perception of the changing environment and its effect on their food security; Rasch model, to analyse the status of household food security; and logistic regression model, to identify factors influencing household food security.

3.3.1 Mann-Kendall Trend Test

The basic principle of Mann-Kendall (Mann, 1945; Kendall, 1975) test for trend involves the examination of the sign of all pair-wise differences of observed values. The Mann-Kendall test is based on the statistic S. Each pair of observed values xj, xk (k> j) of the random variable is inspected to find out whether xk>xj or xk<xj. The test statistic for the Mann-Kendall test is given as:

$$S = \sum_{k-1}^{n-1} \sum_{j=k+1}^{n} \mathrm{sign}(x_i - x_k) \quad \textbf{(1)}$$

Where xj and xk are the sequential data values and j <k, n is the length of the data set and

$$\mathrm{sign}(x_j - x_k) = \begin{cases} 1 & \mathrm{if} x_j - x_k > 0 \\ 0 & \mathrm{if} x_j - x_k = 0 \\ -1 & \mathrm{if} x_j - x_k < 0 \end{cases} \quad \textbf{(2)}$$

The Mann-Kendall test has two parameters that are important for trend detection. These parameters are the significance level that indicates the test strength and the slope magnitude estimates that indicates the direction as well as the magnitude of the trend. Given the null hypothesis that xj are

independent and randomly ordered, the statistic S is approximately normally distributed when $n \geq 8$, with zero mean and variance (Capodici et al., 2008).

The Mann-Kendall test allows inquiring on the presence of tendency of long period without having to make an assumption about the distributional properties. Moreover, the non-parametric methods are less influenced by the presence of outliers in the data compared with other methods (Capodici et al., 2008).

3.3.2 Likert Scale

In Likert scale method, a sample household indicates his or her degree of agreement or disagreement for a variety of statements related to the perceived changes of a given variable over time. Total score can then be calculated by summing up the values for all statements to see the significance of each variable. An important assumption of this scaling method is that each of the statement measures some aspect of a single variable so as to legitimately apply summation. In addition, the relative importance of sub categories of statements can be measured, by relating its score with the household's total score (Bunce et al., 2009). For this study a 5 point Likert scale method was used.

3.3.3 Rasch model

It has already been mentioned that this study employed the FSCM to assess household food security status. An essential characteristic of the FSCM is that the items/questions comprising it vary across a wide range of severity of food insecurity. The precise severity level of each item is estimated empirically using Rasch model (named after the Danish Mathematician, Georg Rasch) (Mesfin and Zelalem, 2008).

In determining the household food security status, first; responses of 'yes', 'often true', or 'sometimes true', and 'two or more months' for the frequency of occurrence follow up questions were coded as affirmative responses.

Then, the responses were combined into a food security scale using Rasch measurement model. Finally, households were classified into four food security categories based on USDA's classification standard (Bickel et al., 2000). These include:

- Food secure: households that show no or minimal evidence of food insecurity. The group's value ranges from 0-2.32 on the food security scale
- Food insecure without hunger: with a food security scale values that ranges from 2.33-4.56, households in this group concern about adequacy of food and show adjustments to household food management, including reduced quality of food and increased unusual coping patterns.
- Food insecure with moderate hunger: food intake for adults in the household has been reduced to an extent that implies that adults have repeatedly experienced the physical sensation of hunger. Such reductions are rarely observed among children in households that have food insecurity in this range of severity. The group's value on the food security scale ranges from4.57-6.53.
- Food insecure with severe hunger households: at this level, all households with children have reduced the children's food intake to an extent indicating that the children have experienced hunger. For some other households with children, this already has occurred at an earlier stage of severity. Adults in households with and without children have repeated experience of more extensive reductions in food intake. The group's value ranges from 6.54-10.0.

3.3.4 Logistic regression model

This study used household food security status as a dependent variable for the identification of factors influencing food security at household level. As has been indicated in the preceding section, sample households were classified into four food security categories based on their food security scale. This gives the dependent variable to have an ordinal characteristic i.e. the prevalence of food insecurity varies among different food security

categories. In such variables, the difference among adjacent categories cannot be treated as the same and cannot be easily modelled with classical regression models (Gujarati, 2003).In this case, either ordered logit or probit models are used as a framework for analyzing such responses (Green, 2004). For practical applicability, the study used ordered logit model to assess the determinants of household food security. The functional form of logistic regression model is specified as follows (Green, 2004)

$$y^* = \alpha + \sum_{k=1}^{k} \beta_k X_k + \varepsilon \qquad \textbf{(6)}$$

where y* is the exact but unobserved dependent variable; X is the vector of independent variables, β is the vector of regression coefficients and ε is the unobservable factor which is assumed to follow a certain symmetric distribution with zero mean such as normal or logistic distribution.

Instead of y*, what we can only observe is the categories of response:

$$y = \begin{cases} 1 \text{ if } y* \leq \mu_1 \\ 2 \text{ if } y* \leq \mu_2 \\ 3 \text{ if } y* \leq \mu_3 \\ \vdots \\ j \text{ if } y* \leq \mu_{j-1} \end{cases} \qquad (\mathbf{7})$$

Where y is observed in j number of ordered categories, μs are unknown threshold parameters separating the adjacent categories to be estimated with βs.

The general form for the probability that the observed y falls into category j and the μs and the βs are to be estimated with an ordinal logit model is:

$$\text{Prob}(y = j) = 1 - L\left(\mu_{j-1} - \sum_{k=1-1}^{k} \beta_k X_k\right) \qquad (\mathbf{8})$$

Where L (·) represents cumulative logistic distribution.

Marginal effects on the probabilities of each food security category were calculated by:

$$\frac{\partial \text{Prob (Y=j)}}{\partial X_k} = \left[f\left(\mu_{j-1} - \sum_{k=1}^{k} \beta_k X_k\right) - f\left(\mu_j - \sum_{k=1}^{k} \beta_k X_k\right)\right] \qquad (\mathbf{9})$$

Where f (·) represents the probability density function.

The table below summarizes the definitions and expected signs of explanatory variables hypothesized to affect household food security status (the dependent variable) in the ordered logit model.

Table 1: Summary of explanatory variables included in the logistic regression model

Variable type and code	Variable definition	Expected sign
Continuous (Mean and SD)		
AGE	Age of household head	+ve
DPR	Dependency ratio	-ve
LND	Land holding (ha)	+ve
LSIN	Total livestock income in ETB	+ve
DSMKT	Distance from market centre in km	-ve
CCP	Climate change perception (mean 5 point Likert – scale)	+ve
DRGT	Total livestock died due to drought and/disease TLU	-ve
Dummy (Number and percent)		
SEX	Sex of HHH; 1, if male; 0, otherwise	+ve
LTRCY	Literacy level of HHH; 1, if literate; 0, otherwise	+ve
RIDG	Moisture conservation practice; 1, if used ridge; 0, otherwise	+ve
CHRD	Change in herd composition; 1, if changed herd composition; 0, otherwise	+ve
FMP	Livestock feed management practice; number of feed management practices used	+ve

4. Results and discussions

4.1 Socioeconomic characteristics of respondents

Demographic features: The mean age of sample household heads was 45.32 years. Dependency ratio, the proportion of dependent household members (household members aged less than 15 years and those older than 64 years) to that of the active age group (15-64), was close to one (0.98). The proportion of male headed households was about 83 per cent, while the remaining 17 per cent were female headed households. Out of the total sample household heads (N=140), 26 people (18.6 percent) were able to read and write at the time of the survey, while 114 (81.4 percent) could not. A livelihood study conducted among selected pastoral and agro-pastoral areas of SNRS found similar result with regard to dependency ratio but less literacy rate of only 13.7 percent (Devereux, 2006).

Land holding: Land is the most important natural capital held by agro-pastoral households in the study area. Regardless of the size, all the respondents have reported that they own land. The average land holding was 2.82ha out of which 1.33ha was pastureland and 1.5ha was cultivated land during the study period. A household food security study in agro-pastoral district of SNRS reported similar result for average cultivated land (Guled, 2006).

Livestock production: In pastoral communities, livestock serve as the main financial asset. The herd composition of sample households shows that cattle comprise significantly large proportion (about 73 percent) followed by sheep (13 percent), goats (7 percent) and camels (3 percent). Finally, average livestock holding calculated using tropical livestock units (TLUs) reveals that mean livestock ownership for the total sample equals 8.67.

Cash income: the average yearly income of sample households was just over 7200. Income from livestock and livestock product appears to constitute nearly all amount of the total household income (90 percent or 6510 ETB). On the other hand, income from sell of crop and non/off farm sources were less significant (452 ETB and 240 ETB respectively).

4.2 Household food security status

Based on the transformed Rash model estimation result using USDA's classification standards described earlier, there is high prevalence of food insecurity in the study area. Out of the total 140 surveyed households, 113 (81 percent) were food insecure. The remaining 27 (19 percent) were food secure. The food insecure households comprised of; 35 (25 percent) food insecure without hunger, 41 (29 percent) food insecure with moderate hunger, and 37 (27 percent) food insecure with severe hunger.

4.3 Identification of trends in local climate

This section investigates the existence of significant changes in temperature and rainfall chronologies of Jigjiga district. Moreover, agro-pastoralists' perception of climate change was contrasted with the historical trend.

4.3.1 Climate observations

4.3.1.1 Rainfall

Analysis of total annual rainfall data for the period 1952-2010 reveals a consistent decline since 1976, when a maximum amount of 1825mm was recorded. Before 1976, the total annual rainfall was for most of the time in excess of the long term average (about 681 mm). However, since 1976 the total rainfall has never exceeded the long term average more than five times. However, the Mann-Kendall trend analysis revealed no statistically significant trend in the amount of annual rainfall in the period. On the other hand, dividing the whole period into two halves (1952-81 and 1982-2010), it is interesting to note that the average rainfall of the later period is significantly lower than the previous period. The mean difference between the two periods is about 170mm (Table 2)

At seasonal scale, the trend analysis shows a significant negative trend at ten per cent probability level for the Gu (long rainy season starting from March to September). On the other hand, rainfall trend in the Jilaal (dry season) is positive with no statistical evidence. A closer look at the rainfall data for the

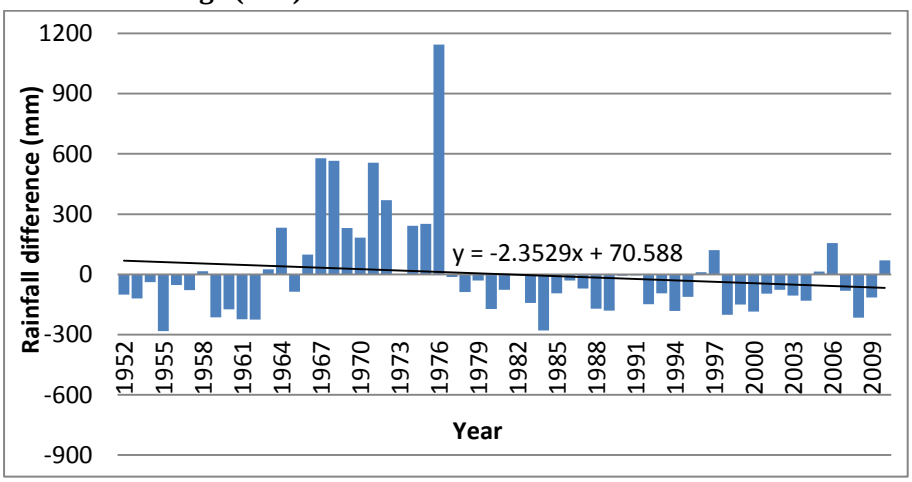
rainy season reveals a stronger declining and statistically significant trend at five per cent probability level for Karan (the third rainy season which coincide with Keremt season in the highland of Ethiopia).

Table 2: Mann-Kendall and t-statistic results of annual and seasonal rainfall

Time scale	1952-1981		1982-2010		t	1952-2010		Change/ decade
	Mean	MK***	Mean	MK		Mean	MK	
Annual	764.7	0.251*	594.4	0.079	-2.84*	681	-0.09	23.53
Gu-wet season	584.2	0.228*	422.6	-0.03	-3.42*	504.8	-0.17*	28.18
Dira (Ap, M)	160	0.143	116.2	0.163	-2.12**	138.5	-0.07	6.11
Haga (J, Jl)	165.1	0.329**	112.4	0.039	-3.60*	139.2	-0.15*	8.24
Karan (Ag, S)	227.9	0.108	147.9	-0.05	-3.83*	188.6	-0.23**	16.93
Jilaal-dry season	180.4	0.168	171.9	0.172	-0.35	176.2	0.072	4.65
Deyer (O, N)	31.88	-0.02	26.06	0.168	-1.13	29.02	0.013	3.22
Kalil (D-Mar)	116.7	0.195	126.5	0.118	0.42	121.5	0.113	7.87

*, and **; Significant at 10% and 5% probability levels, respectively; ***Mann Kendal
Source: Computed based on data obtained from NMSA, Jigjiga Branch Office

Figure 2: Year to year annual rainfall difference compared to 1952-2010 average (mm)



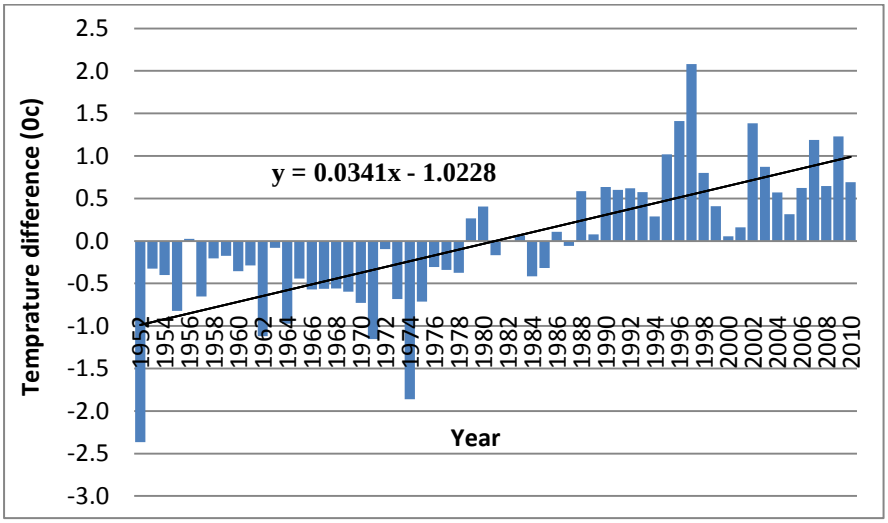
Source: Computed based on data obtained from NMSA, Jigjiga Branch Office

4.3.1.2 Temperature

The year to year variation of mean annual temperature expressed in terms of temperature differences from the long term average (1952-2010) is shown in Figure 3. As it can be seen from the figure, the years until early 1980s were cooler than later years. Specifically, temperature has never exceeded the long term average until 1981 while the reverse was true for nearly all of the subsequent years.

Figure 3 clearly reveals the warming trend in the mean annual temperature over the past 59 years. The regression line shows that it has been increasing by about 0.340c every ten years (Figure 3).

Figure 3: Year to year Temperature difference (^{0}c) compared to 1952-2010 average



Source: Computed based on data obtained from NMSA, Jigjiga Branch Office

Table 3 shows the results of Mann-Kendall trend test and the mean difference test between the periods 1952-81 and 1982-2010 at annual and seasonal time scale. For the whole period, the Mann-Kendall trend test indicates a positive and significant trend at one per cent probability level for all time scale

levels (at annual and all seasons). More strikingly, these changes are mainly attributed to the alarming rate of temperature increase in recent years. During the second period (1982-2010), statistical trends have been found at all time scale levels, while it was only Hagaa season that has statistical trend during the first period (1952-1981). The t test further revealed a significant difference in the mean temperature between the two periods at both annual and seasonal time scale (Table 3).

Table 3: Mann-Kendall and t-statistic results of annual and seasonal temperature

Time scale	1952-1981		1982-2010		t	1952-2010		Change/ decade
	Mean	MK	Mean	MK		Mean	MK	
Annual	19.04	0.09	20.14	0.43***	7.57***	19.58	0.59***	0.34
Gu-wet season	20.4	0.12	21.43	0.44***	6.49***	20.91	0.57***	0.34
Dira(Ap, M)	20.66	-0.05	21.41	0.27**	4.55***	21.03	0.36***	0.22
Haga(J, Jl)	20.41	0.25*	21.57	0.40***	5.24***	20.98	0.57***	0.41
Karan (Ag, S)	20.14	0.1	21.32	0.36***	5.94***	20.72	0.51***	0.39
Jilaal-dry seas.	17.37	0.05	18.52	0.29**	5.79***	17.93	0.47***	0.34
Deyer(O, N)	17.75	0.07	19.07	0.28**	4.95***	18.4	0.44***	0.39
Kalil (D-Mar)	17.66	0.08	18.74	0.22*	5.89***	18.19	0.45***	0.32

*, **, ***; Significant at 10%, 5% and 1% probability levels, respectively

Source: Computed based on data obtained from NMSA, Jigjiga Branch Office

The preceding results of increasing trends in temperature and declining rainfall for the rainy season have clearly negative impacts for the livelihoods of agro-pastoral households in the study area as their livelihood depend on the availability pasture and water which in turn depend on the amount of rainfall and temperature.

4.3.2 Perception of climate and other changes

Sample households were asked to indicate their general perceptions of the changes in climate, climate induced hazards and other variables such as population, market prices and land use changes in the last one or two decades. Table 4 shows the direction and magnitude of changes using a five point Likert scale, with; -2 showing the highest decrease, -1 decrease, 0 no change, +1 increase, and +2 the highest increase. The right side column (Mean) shows the perception index of households calculated by averaging the absolute values of Likert scale results.

In line with the climatic data presented earlier, respondents indicated overwhelmingly highest perceptions (-2 or +2) of trends in climatic variables. The survey data show that a large share of households perceive temperature has been increasing overtime (83 per cent), that rainfall has been decreasing (84 per cent) and that irregularity of rainfall has been increasing (86 per cent). The mean value of Likert score indicate that temperature is the most important to have had changed over the past one or two decades followed by annual rainfall and altered rainy seasons (including early secession and late start). A few households reported that temperature has been declining (6 per cent) and that rainfall has been increasing while about 11, 12 and 14 percent of the respondents perceive no changes in temperature, seasonality and annual rainfall respectively (Table 4). Though it is not large, this intra household variation in the perception of climate change could be attributed to a range of factors that determine the level of household perception including the characteristics of households, asset ownership and access to institutions (Dosset al., 2006; Temesgen, 2010).

Table 4: Perceived changes in climate, climate induced hazards and other variables

Variables	Rank	Changes (Number and Percent)					Mean
		-2	-1	0	+1	+2	
Climate variables							**1.20**
Temperature	1	2(1.4)	6(4.3)	16(11.4)	27(19.3)	89(63.6)	1.39
Annual rainfall	2	47(33.6)	72(51.4)	17(12.1)	1(.7)	3(2.1)	-1.14
Altered rainy seasons	3	0(0.0)	0(0.0)	20(14.3)	89(63.6)	31(22.1)	1.08
Climate change induced hazards							**1.22**
Parthinium and other species encroachment	1	0(.0)	2(1.4)	0(.0)	15(10.7)	123(87.9)	1.85
Frequency of drought	2	0(0)	1(.7)	2(1.4)	17(12.1)	120(85.7)	1.83
Water shortage	3	1(.7)	12(8.6)	3(2.1)	54(38.6)	70(50.0)	1.29
Crop pest infestation	4	0(.0)	0(.0)	9(6.4)	85(60.7)	46(32.9)	1.26
Land degradation	5	13(9.3)	1(.7)	15(10.7)	38(27.1)	73(52.1)	1.12
Livestock disease outbreak	6	1(.7)	1(.7)	16(11.4)	93(66.4)	29(20.7)	1.06
Frost hazard	7	6(4.3)	3(2.1)	44(31.4)	21(15.0)	66(47.1)	0.99
Pasture shortage	8	3(2.1)	24(17.1)	5(3.6)	67(47.9)	41(29.3)	0.85
Human health problems	9	2(1.4)	11(7.9)	31(22.1)	75(53.6)	21(15.0)	0.73
Other Changes							**0.98**
Cereal prices	1	0(0.0)	6(4.3)	9(6.4)	59(42.1)	66(47.1)	1.32
Livestock holding	2	36(25.7)	97(69.3)	7(5.0)	0(0.0)	0(0.0)	-1.21
Crop land	3	8(5.7)	5(3.6)	11(7.9)	79(56.4)	37(26.4)	0.94
Livestock prices	4	2(1.4)	21(15.0)	12(8.6)	66(47.1)	39(27.9)	0.85
Human population	5	8(5.7)	0(0.0)	31(22.1)	57(40.7)	44(31.4)	0.92
Settlement on grazing area	6	0(0.0)	3(2.1)	47(33.6)	54(38.6)	36(25.7)	0.88

Note: Numbers in parenthesis represent percent; Values -2, -1, 0, +1, +2 indicate; highly decreased, decreased, no change, increased, and highly increased, respectively
Source: Survey data

Sample households were also reported nine most important hazards to have had increased over the past years. These are; invasion of parthinium and other unwanted plant species (99 per cent), frequency of drought (98 per cent), water shortages (89 per cent), crop pest infestations (81 per cent), land

degradation (79 per cent), livestock disease outbreak (87 per cent), frost hazard (62 per cent), pasture shortage (77 per cent), and human health problems (69 per cent). Similarly, the perception of households to other changes such as market prices, land use and human population was indicated (Table 4). In here, the most important changes reported were an increase in cereal price, a decline in livestock holding, and expansion of area under crop. The implication of such changes on the livelihoods and food security of agro-pastoral household is mostly negative. For example, as agro-pastoralists are more reliant on market for food/cereal, the increase in price could exacerbate food insecurity in the area unless it is backed by increase in the livestock prices which leads to a better terms of trade. However, the reality is that though respondents confirmed that there is improvement in livestock price in recent years, the magnitude of price increase is less than that of the increase in cereal prices.

4.4 Climate change and the underlying causes of food insecurity

In Ethiopia, food security of pastoral livelihood systems has been highly threatened by climate change and its variability (NMA, 2007). This section describes the relative importance of climate related variables amongst myriad of other variables threatening household food security in the study area. Using 5 point Likert scale, households were requested to indicate the extent (5, a very great extent; 4, great extent; 3, medium extent; 2, slight extent; and 1, no extent at all) that they considered each variable has effect on their food security. Then, the relative significance of each variable was calculated by dividing the total score values given by all households in the sample for each variables to the total sample size (N=140).

The rated vulnerability factors by food security status of households are shown in (Table 5). The variables include climate and climate change induced hazards, market and service problems and human factors[4]. The relative importance of major factors is indicated in the right side of (Table 5). The result reveals that climate and climate change induced hazards were rated first. This was followed by market and service problems, and by human factors, in that order.

[4] Adapted from Nnamchi and Ozor (2009) and Bunce *et al.*, (2009)

4.4.1 Climate and climate change induced hazards

Climate and climate related factors are of great concern to the agro-pastoralists in the study area. These include aspects of rainfall and rainfall variability such as low rainfall in a year and early cessation and late start of rainy season; high temperature; and the effect of these factors like drought, invasion of unwanted plant species, water shortage, crop pest infestation, pasture shortage and livestock disease outbreaks. Surprisingly, only climate and climate change related factors were rated in the top ten most important causes of food insecurity except the high cereal price which was rated seventh. According to their order of importance; drought, invasion of unwanted plant species (parthinium), low annual rainfall, high temperature, and water shortage are the five most important causes of food insecurity (Table 5).

Respondents in focus groups expressed similar views with that of survey respondents and discussed a broad range of climate change impacts and relationships. They reported that, most of the natural, financial, human and social capitals up on which they depend for food and livelihood security are already significantly affected by climate-related hazards. Communities described that drought and high temperature have significant effects on natural resources such as pasture, water sources and crop land. These in turn increase pasture and water shortages which impact the livestock and crop resources that serve as main sources of food and cash income. Other factors like Parthinium largely reduce pasture availability and quality which translates into a reduction in milk availability and quality. In addition, the problem has effect on human health (skin irritation, exposure to respiratory disease-asthma when they try to uproot the stem and serve as breeding ground for mosquito and other biting flies during wet season). Moreover, according to the groups, livestock holdings are at critical stage due to expansion of drought induced livestock diseases (like anthrax, black leg and pasteurellosis) and pasture shortage. Shortage of water source is a very series problem due prolonged drought and none functionality of most birkas that used to serve as a main source of water for communities.

Table 5: Mean Likert-scale results of sample households response to the underlying causes of food insecurity

Food insecurity causes	Rank	Mean
Climate and Climate change induced hazards		4.19
Drought	1	4.91
Parthinium and other species encroachment	2	4.81
Too low rainfall in a year	3	4.42
High temperature	4	4.4
Water shortage	5	4.3
Crop pest infestation	6	4.26
Pasture shortage	8	3.95
Livestock disease outbreak	9	3.94
Early cessation of rainy season	10	3.91
Late start of rainy season	12	3.86
Human health problems	16	3.76
Frost	18	3.73
Market and service problems		3.69
Cereal price increase	7	4.16
Lack of farm inputs	11	3.87
Poor market price for livestock	13	3.79
Lack of veterinary services	14	3.78
Poor extension services	19	3.69
Lack of credit-services	20	3.68
Lack of improved crop varieties	22	3.45
Lack of improved animal varieties	23	3.44
Poor transport facilities	24	3.33
Human factors		3.23
Land degradation	15	3.77
Human population pressure	17	3.74
Settlements on grazing areas	21	3.57
Pasture land enclosure	25	3.04
Mobility restriction	26	2.64
Lack of farmland	27	2.64

Source: Survey data

Focus groups also shared their experience of how climatic factors inter-related to each other. For instance, drought is linked to occurrence of livestock disease (through reduced disease resistance, transmission of diseases when livestock concentrated at few water points, death of livestock when rain finally comes), and crop pests (occur mostly when rain comes after prolonged droughts). In addition, drought exacerbates human health problem such as child malnutrition (because of lack of milk).

4.4.2 Market and service problems

These include market problems like high cereal price and poor price for livestock; service problems such as lack of veterinary, credit and extension services; and other problems like lack of farm inputs, improved varieties and poor transport facilities. Out of all factors under this category, cereal price increase was ranked first. Households mainly depend on market for cereal/food consumption and their main source of income is from livestock sale which was at the same time reported to be unfavorable.

Focus group discussions reveal that the availability of farm inputs (especially fertilizer), credit and extension services are almost none-existent in the area and these largely hinder improvement in farm productivity and food security. Groups also cited sky rocketing rental price of tractors and lack of farming skills like the use of oxen for traction purpose as important constraints of crop production and food security in the area. Moreover, villages visited were in a poor state, with non-functional water points and little infrastructure such as schools, human and animal health clinics.

4.4.3 Human factors

This category contains population growth and land use change related factors. These include; land degradation, expansion of settlement on grazing areas, pastureland enclosure, and mobility restriction. In general, sample respondents downplayed the impact of these factors on their food security.

As shown in Table 5, most of the factors under this category were ranked last and did not appear among the top ten causes of food insecurity.

4.5 Adaptation measures

In response to the changing climatic situation of the area, agro-pastoral households have developed various adaptation and coping strategies to minimize the risks posed by climate change and extreme events. As an agro-pastoralist, households in the study area implemented a combination of techniques that minimize crop failure and shortage of pasture due to drought and/or any other climate related hazards (Table 6).

Table 6: Number and percentage of sample households using adaptation and cooping measures

Adaptation measures	Number	Percent
Adaptation	**96**	**68.6**
Herd mobility	66	47.1
Use of moisture conservation (ridge)	31	22.1
Changing herd composition	31	22.1
Preparing hay and using cut and carry	29	20.7
Use of short season verities	4	2.9
Coping	**113**	**80.7**
Livestock sell	47	33.6
Use of crop residue	37	26.4
Purchase feed and hay	28	20.0
Renting pastureland	19	13.6
Convert failed crop to feed	27	19.3
Grass uprooting	24	17.1
Sought off farm opportunities	15	10.7

Source: Survey data

Herd mobility and livestock sale are the major adaptation and coping strategies, respectively whereas use of short season varieties was the least adaptation practice used by sample households in response to crop failure.

More use of livestock sale practice could be associated with the liquidity nature of the asset and easy access by agro-pastoralists; and limited use of short season verities could be attributed to lack of access to improved technologies and extension service in the area. These adaptation and coping measures are similar to the findings of the adaptation study in pastoral and agro-pastoral areas of Ethiopia (Richéet al., 2009).

4.6 Determinants of household food security

Logistic regression model was fitted to analyze the factors influencing household food security status. Before the estimation of the ordered logit model parameters, the problem of multicollinearity and heteroscedasticity were checked using the variance inflation factor (VIF) and Contingency coefficient (CC) test for continuous and discrete variables, respectively. Accordingly, there was no serious problem of multicollinearity among the explanatory variables. Moreover, the problem of heteroscedasticity was checked using Breusch-Pagan/Cook-Weisberg test for heteroskedasticity. The result reveals that p value of 0.97 which is acceptable level of significance for accepting homoscedasticity.

The estimated result of ordered logit model and its marginal effects are shown in Table 6. Positive coefficients imply improvements in the household food security status as the value of explanatory variables increase, whereas the reverse is true for variables having negative coefficients. In addition, the calculated marginal effects show the expected changes in the probability of household food security status with respect to a unit change in the independent variable, ceteris paribus. These are shown in right side of Table 6 for each categories/outcomes of the dependent variable (Y=4, …,Y=1; representing improvements in the food security status from the worst level of food insecurity to food secure category).The explanatory variables included in the model are jointly significant at P< 0.000 and the Pseudo R2 is 0.143. Hence, the hypothesis that all coefficients except the

intercept are equal to zero was rejected. Therefore, it is possible to interpret the results meaningfully.

Out of the total twelve independent variables, six significantly influenced household food security at one and five percent probability levels. These are; Dependency ratio, Income from livestock and livestock products, use of water conservation technique (ridge), climate change perception, TLU of livestock lost due to drought/disease, and use of livestock feed management practices.

Table 6: Results of ordered logit model

Variables	Coefficients	P>|z|	Marginal effects			
			Y=4	Y=3	Y=2	Y=1
AGE	-0.00754	0.581	-0.00082	-0.00101	0.00062	0.00121
DPR	-1.28130***	0.000	-0.13865***	-0.17148***	0.10460**	0.20553***
SEX	0.24116	0.602	0.02459	0.03281	-0.01689	-0.04052
LTRCY	0.86421*	0.054	0.11448	0.09787**	-0.09518	-0.11717*
LND	0.00739	0.914	0.00080	0.00099	-0.00060	-0.00119
LSIN	0.00008***	0.000	0.00001***	0.00001***	-0.00001**	-0.00001***
DSMKT	-0.00247	0.842	-0.00027	-0.00033	0.00020	0.00040
CCP	1.48936***	0.003	0.16117***	0.19932**	-0.12159**	-0.23890***
DRGT	-0.08209**	0.018	-0.00888**	-0.01099**	0.00670	0.01317**
RIDG	0.94982**	0.022	0.12539*	0.10719**	-0.10306*	-0.12952***
CHRD	-0.39244	0.329	-0.03916	-0.05347	0.02557	0.06706
FMP	1.18234***	0.001	0.11580***	0.15427***	-0.06295*	-0.20711***
Number of obs. = 140		Prob.>chi2=0.0000			Pseudo R2 =0.1643	
LR chi2(12) = 63.28		Log likelihood = -160.90352				

***, **, * significant at 1%, 5% and 10% probability level, respectively;
Source: Survey data

Dependency ratio was negatively related to household food security status, implying that households with large dependency ratio were more likely to be food insecure than those with less dependency ratio. This result is in agreement with the findings of Hillina (2005) for pastoral areas of Somali

Region. According to Sandford and Ashle (2008), high dependency ratio is one of the characteristics of poor pastoral households (Sandford and Ashle, 2008). Moreover, a livelihood study documented the existence of high dependency ratio in the study area and raised questions about the nature and sustainability of future livelihood opportunities and the adverse synergies between more frequent and severe droughts, and environmental degradation in the area (Devereux, 2006).

As expected, income from sale of livestock and livestock products (LSIN) was found to be positively correlated to household food security status (at one per cent significant level). The fact that increasing livestock income increases the likelihood of households being classified as food secure is associated with the use of livestock as a main source of income by agro-pastoralists to buy grains from the market and become food secure (Sandford and Ashle, 2008; Amwata, 2009).

Climate change perception (CCP) was positively related to household food security, implying that households with highest perception of climate change were more likely to be food secure and less likely to be food insecure. The probable explanation is that households that perceive change in climatic conditions have higher chances of being food secure through taking adaptive measures in response to observable changes. Different studies of determinants of climate change adaptation have shown that perception significantly affects adaptation strategies (Maddison, 2006; Hassan and Nhemachena, 2008; Temesgen, 2010). It is, therefore, important to raise awareness of the climate changes among households in the study area.

Loss of livestock due to drought or disease (DRGT), the number of livestock (measured in TLU) that died due to drought and/or livestock diseases, was found to be negatively associated with household food security status. The result shows that prevalence of drought and/or disease has a significant impact in determining agro-pastoral households' food security status. The negative correlation indicates that higher mortality of livestock increase

household vulnerability to food insecurity. The probable reason is that an increase in livestock morbidity and mortality would result in a lower number of animals. This implies reduced income and a declining in home food production, eminently contributing to increased vulnerability to food insecurity (Lai, 2007).On the other hand, households who took preventive measures to minimize loss of livestock could have greater probability of being foods secure than those households who could not through reduction in the number of died animals. Studies points out that those pastoralists who undertake measures like herd mobilization during climatic disasters have considerably fewer livestock losses than those who do not (Little et al., 2001; Kaimba et al., 2011).

The model result confirmed that undertaking moisture conservation technique (RIDG) like ridging positively and significantly affects household food security status. The marginal effects shows that the use of ridge at farm on farming fields increases the probability of being food secure and food insecure without hunger by about 13 and 10 per cent, respectively. While the same reduces the probability of either being food insecure with moderate hunger or food insecure with severe hunger by 11 and 10 per cent, respectively. The fact that taking soil and water conservation measures reduces household vulnerability to food insecurity is in line with the argument that the measures help mitigate soil erosion and conserve the little rain which both increases crop production that directly contribute to a better food security status (Li et al., 2001; Mmbaga and Lyamachai, 2001; McHugh et al., 2007; Tesfaye, et al., 2010).

Livestock feed management practices (FMP) is another category of adaptive measure which households took in response to pasture shortage problem. The variable was found positively related to household food security status. The result shows that as a household start implementing a new type of feed management techniques such as hay preparation, using crop residue, and cut and carry system, his/her probability of being food secure increases. The probable explanation is that declining pasture availability in the study area

has caused agro-pastoralists to adopt new feed management techniques that reduce the risk of food insecurity because of loss of livestock. Households who did not start alternative measures face food insecurity that arises from loss of livestock due to pasture shortage.

5. Conclusion and recommendations

Ethiopia is one of the most vulnerable countries of the world to the impacts of climate change and variability. The impact is even stronger in the pastoral areas of the country, where small changes in rainfall and temperature could cause serious impact on the livelihood and food security of these communities (NMA, 2007; Aklilu and Alebachew, 2008). However, studies on the effects of local climate change and variability on food security is limited. The main objective of this study was to assess the role of climate change on food security of agro-pastoral households in Jigjiga district, in Eastern Ethiopia. In relation to this, the study attempted to analyze trends in local climate; quantify the status of household food security; assess the perception of households on the significance of climate related causes of food insecurity; and identify determinants of food security at household level.

Rainfall and temperature data for the period from early 1950s were used to test the presence of significant changes using Mann-Kendal test for trend. The result showed statistically significant changes for both rainfall (for the rainy season) and mean temperature (annual and seasonal).Furthermore, the time series climate data were contrasted with agro-pastoralists perception of the changes in climate, climate variability and other factors undergoing in the area. The result reveals that a very large proportion of respondents perceive changes in climate; with increasing temperature, decreasing amount of rainfall, and increasing seasonality of rainfall. Moreover, a significant majority perceive the consequences of these changes like invasion of parthinium and other unwanted plant species, increased frequency of drought, water shortages, crop pest infestations, livestock disease outbreak, frost hazard, and pasture shortage.

The food security status result from Rasch model estimation indicated a very high prevalence of food insecurity in the district. Out of the total 140 surveyed households, 81 per cent were food insecure; consisting of 25 per cent food insecure without hunger, 29 per cent food insecure with moderate hunger and 27 per cent food insecure with sever hunger.

Likert-scale was used to assess the relative importance of climatic factors in affecting household food security. The result showed the high importance attached by sample agro-pastoral households and communities in Jigjiga district to climate change and variability causes of food insecurity. These factors constitute the five most important causes of food insecurity in the area. These are drought, invasion of unwanted plant species (parthinium), low annual rainfall, high temperature, and water shortage.

In response to the above problems, respondents have adopted various strategies including sale of animals, soil and water conservation practices, use of crop residue, changing herd composition, hay making and the use of cut and carry system.

Finally, ordered logit model was used to closely analyze factors influencing the status of household food security. The result confirmed that variables hypothesized in relation to climate change were important in determining household food security. Among these, household perception of climate change, use of conservation technique (ridge), and use of livestock feed management techniques influenced household food security status positively and significantly; whereas loss of livestock due to drought and/or disease was found negatively and significantly related to household food security. Moreover, income from livestock and livestock products were found to be positively related to food security status, while the reverse was found to be true for large dependency ratio.

Given the negative trends in local climate and high prevalence of food insecurity, there is a need for urgent action aimed at addressing the causes of food insecurity mentioned in this study. These may include:

Promoting climate change awareness among the local people. This may require strengthening early warning and disaster risk reduction institutions starting from community level, so that both government and local communities could be informed of the changing climate and accordingly take appropriate actions.

Strengthening the existing adaptation strategies having positive role on the food security of agro-pastoral households. In addition, government policies should support adoption of new technologies that have the potential to reduce risk of crop failure and livestock losses; such as the use of drought tolerant crop and livestock varieties, water harvesting, and pasture conservation and management practices. In line with this, the realization of access to services such as extension, micro-finance and credit facilities could increase local resilience to climate change and food insecurity (Hassan and Nhemachena, 2008).

The Livestock resource of agro-pastoral households could play an important role in reducing the prevalence of food insecurity and vulnerability to climate change. Improving livestock income through promoting livestock marketing and diversification activities such as providing easy access to market information, increasing milk collection centres, adding value to livestock products such as milk and ghee could contribute to increased incomes and food security.

Increasing investments on key infrastructure and services that reduce the vulnerability of agro-pastoralists. For example, construction of animal health clinics, their appropriate staffing and supply of veterinary medicine could reduce livestock mortality from preventable diseases, and reduce vulnerability during drought events. Increasing family planning service reduce dependency ratio.

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Households Willingness to Pay for Improved Urban Solid Waste Management: The Case of Mekelle City, Ethiopia

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Abstract

Cities in developing countries experiencing rapid urbanization and population growth too often lack the financial resources and institutional capacity to provide needed municipal infrastructure for adequate solid waste management, despite citizens' demand for it. This paper uses a cross-sectional survey of 226 randomly selected households in Mekelle city, Ethiopia, to assess the current municipal sanitary fees and the willingness to pay (WTP) of residents for improved urban waste management, and suggest mechanisms for cost recovery. We used Tobit and probit models in the empirical analysis to determine the factors that influence households' WTP for improved solid waste management. Results reveal that residents' WTP for improved solid waste management is significantly related to income and awareness of environmental quality, among other factors. The results suggest that the current city fee for sanitation is far below the WTP of the residents. The mean WTP we found can be a guide for municipal officials in setting a more appropriate fee that can finance improvements in city solid waste management, where all households receive collection services, waste is disposed of properly, and recycling features are added.

Keywords: Urban waste management, willingness to pay, cost recovery, Ethiopia, cities
JEL Classification: D13, Q51, Q53

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1. Introduction

Due to lack of appropriate planning, inadequate governance, resource constraint, and ineffective management, solid waste—especially insufficient collection and improper disposal—is a major concern for many rapidly growing cities in developing countries (Chuen-Khee and Othman 2010; Medina 2010). According to the United Nations Environment Programme (UNEP 2004), solid waste generation is an increasing global environmental and public health problem. The swift expansion of urban agricultural and industrial activities, stimulated by population growth, has produced vast amounts of solid and liquid wastes that pollute the environment and destroy resources. Changing economic trends and rapid urbanization also complicate solid waste management (SWM) in developing countries. Consequently, solid waste is not only rising in quantity but also changing in composition (from less organic matter to more paper, packing materials, plastics, glass, metal, and other substances), and is exacerbated by low collection rates (Bartone and Bernstein 1993; Medina 2002).

Establishing effective municipal solid waste management should be a priority for emerging cities, given its crucial role in protecting public health and the environment. However, in the past, most attempts by cities to improve solid waste management have focused on the different technical means of collection and disposal (World Bank 1992; Alaf and Deshazo 1996; Medina 2002). More recently, cities have begun paying more attention to enhancing municipal systems and sustainable solid waste service delivery, with special emphasis on involving the private sector.

Ethiopia has experienced rapid urbanization and increasing urban population in the last few years due to more rural-urban migration and rising per capita incomes (FDRE PCC 2008). Presumably, increased demand for infrastructure and public services (Chakrabarti and Sarkhel 2003) accompanies this growth, but this has not been the case. Many towns in Ethiopia lack the financial resources and institutional capacity to provide the

most basic municipal infrastructures and services, including solid waste management.

Commercial clients and especially households—which are the primary producers of solid waste and suffer the effects of uncollected solid waste more directly—should be able to participate in municipal discussions on improving SWM and structuring effective public-private partnerships to deliver such services. The service provider (whether city or private vendor) needs to better understand households' demands and motivation. Therefore, the key question here is how much are citizens willing to pay for efficient and cost-effective delivery of solid waste services to residential areas?

Solid waste management in cities has typically been gauged and evaluated by the performance of the service provider (the supply side), while the demand side has been given limited attention. With the increasing volume of solid waste, the Mekelle City administration has not been able to collect and dispose of the waste satisfactorily. Moreover, cost recovery poses a critical problem. Solid waste collection services cover only about 50 percent of households most of the time (Mekelle Municipality 2008). According to Promise Consulting (2005), the city's annual solid waste generation is over 28 million kilograms of solid waste; however, overall collection coverage is only about 34 percent which exposes city residents to serious public health problems and diseases, including often fatal water-borne diseases, such as cholera and dysentery (Venkateshwaran 1994; McMichael 2000). In addition, the city improperly disposes its municipal solid waste on open land near farms and cultivated fields (Gebremichael 2002). Plastic bags and other debris from the waste disposal site are carried away by the wind, which trashes surrounding farms and homesteads. These problems will only become more pronounced as urbanization continues to expand.

The aim of this paper is to assess the current sanitary service fees and the willingness to pay (WTP) of residents for improved urban waste management, and to suggest mechanisms for cost recovery applying

contingent valuation method (CVM). The paper uses a cross-sectional survey of 226 randomly selected households in Mekelle City, Ethiopia. The remainder of the paper is organized as follows. Section 2 presents a brief review of studies on households' demand for improved environmental quality. In section 3, we provide the analytical framework for municipal solid waste management. Section 4 provides the empirical strategy of the study. Section 5 describes the study area, survey, and data description. Section 6 discusses the results and section 7 concludes with some policy implications.

2. Households' Demand for Improved Environmental Quality: A Brief Review

The method of contingent valuation has been applied both in developed and developing countries (Carson et al. 1998; Carson 2002; Carson et al. 2001; Tait et al. 2005) for valuation of a number of environmental and natural resources. Rigorous economic studies on solid waste management in Ethiopia especially those involving contingent valuation method are extremely scanty. Therefore, in this section, we review the broader literature, i.e., studies in other developing countries that look at the demand for improved environmental quality or services using contingent valuation technique. In this regard Altaf and Deshazo (1996), Whittington et al (2005), Chuen-Khee and Othman (2010), and Wang et al. (2011) appear to be the most important ones. Related studies in Africa that apply CVM also include Fonta et al. (2008), Weldesilassie et al. (2009), Niringiye and Omortor (2010), Banga et al. (2011), and Joel et al. (2012).

Altaf and Deshazo (1996) investigate existing solid waste disposal system, willingness to pay for improvements, and the priority households attach to improvements in solid waste management relative to improvements in water supply and sanitation. They used a stratified random sample of about 1000 households in Gujranwala city, in the Punjab, Pakistan. They emphasize exploring the demand-side information and using such demand-side

information for improved solid waste management in developing countries. More specifically, they intend to test the beliefs that integrating demand-side information can improve the planning for provision of municipal services. Besides collecting both demand-side and supply-side information, their study involves analysis of the municipal budget, field observations and interviews with municipal officials for soliciting information on the supply of solid waste services. In general, their study calls for a different approach that is based on integrating demand-side information into the planning process. They also challenge the conventional presumptions that households accord low priority to solid waste management compared to other urban services and are unwilling to pay for it. They contend that despite the fact that solid waste management in most cities of the developing world is unsatisfactory and yet in some cases consuming a relatively high proportion of their municipal budgets, most attempts at improving performance have focused on supply-side issues as collection and disposal capacity but with little success. They argue that simple and inexpensive household surveys can provide valuable inputs into the planning process.

Whittington et al (2005) investigate households' demand for improved water services. Specifically they look into coping costs and willingness to pay (WTP) and assess how coping costs and WTP vary across types of water users and income. They use data from a survey of 1500 randomly sampled households in Kathmandu, Nepal. They find that households in Kathmandu Valley engage in various types of behaviors for coping with unreliable water supply and that these activities impose average coping costs of 3 U.S. dollars per month per household or about 1% of their current incomes, representing hidden but real costs of poor infrastructure service. Their finding shows that these coping costs are almost twice as much as the current monthly bills paid to water utility though significantly lower than estimates of WTP for improved services. They also argue that coping costs are statistically correlated with WTP and several characteristics of households.

In light of the fact that use of wastewater for irrigation, which is common in many developing countries, can cause considerable harm to public health and the environment some of the related works have focused on use of wastewater. For example, Weldesilassie et al (2009) estimate the economic value of safe use of wastewater for crop production on farms within and around Addis Ababa, Ethiopia using contingent valuation technique. They find a surprisingly large welfare gain from policies for safe use of wastewater for irrigation. They note the potentials but also possible pitfalls of using nonmarket valuation techniques as an input into public decision making in situations where traditional resource use interacts with public health and environmental concerns in complex ways.

Chuen-Khee and Othman (2010) estimate the economic values of household preference for enhanced solid waste disposal services in Malaysia employing the contingent valuation method (CVM). They estimate and compare the mean WTP for two alternative disposal methods, representing improved options with better levels of service characteristics, alongside the current disposal method, both in the generic and labeled format. They also assess the factors influencing the probability of their WTP. The generic options constitute 'Existing facility' vis-à-vis 'Proposed alternatives' and the labeled options are 'Control tipping'[5] vis-à-vis 'Sanitary landfill' and 'Incineration'. In this case the WTP is interpreted as the additional or incremental monthly solid waste management (SWM) payment that the public pays for improved services quality. They find an average estimate of additional monthly WTP in solid waste management charges of €0.77 to 0.80 for the improved waste disposal services quality. They find a slightly higher WTP from the generic CV question as compared to that of the label-specific one. Their study also further reveals a higher WTP, i.e., €0.90, for sanitary landfill as compared to €0.63 for incineration, suggesting that sanitary landfill is a more preferred

[5] Controlled tipping is method of controlled disposal of municipal solid waste (refuse) on land. Britannica Online Encyclopedia (http://www.britannica.com/EBchecked/topic/522463/sanitary-landfill). Accessed March 2012.

alternative. They also show that household's concern of where their rubbish is disposed, age, ownership of house, household income, and format of CV question are important factors that significantly influence their WTP.

Wang et al (2011) conduct economic analysis of municipal solid waste management in Eryuan, a poor county located in Yunnan Province of China. They estimate willingness to pay of residents for an improved solid waste collection and treatment service and compared it with the project cost. Their study finds that the mean willingness to pay is about 1 percent of household income and the total willingness to pay can basically cover the total cost of the project. Their analysis also shows that the poorest households in Eryuan, in general, are not only willing to pay more than the rich households, in percentage of income terms, but also are willing to pay not less than the rich, in absolute terms, particularly where no solid waste services are available. They argue that the poorest households have stronger demand for public solid waste management services while the rich have the capability to take private measures when public services are not available. They underscore that municipal solid waste management still continues to be a major challenge for local governments in both urban and rural areas across the developing world, and that one of the key issues is their financial constraints.

The following issues turn out quite apparent from the foregoing review. Firstly, the contingent valuation method has been applied both in developed and developing countries (Carson et al. 1998; Carson 2002; Carson et al. 2001; Tait et al. 2005) for valuation of a number of environmental and natural resources. However, despite the fact that solid waste management in most cities of the developing world is unsatisfactory and yet in some cases consuming a relatively high proportion of their municipal budgets, applications to solid waste management in developing countries, and particularly in Africa are very limited. Secondly, simple and inexpensive household surveys involving CVM can provide valuable inputs into the planning process and inform policy makers on how to improve SWM service delivery (Altaf and Deshazo 1996; Fonta et al. 2008). Thirdly, and perhaps

most importantly, cost recovery is a serious impediment to efficient and effective solid waste management in these cities (Wang et al. 2011) and eliciting mechanisms for cost recovery is important. Fourthly, applications of valuation technique to SWM in Ethiopia are rare. In addition, to our knowledge either they have focused on the capital city, Addis Ababa (Terfasa 2007; Fantu 2007) or other aspects of improvement in environmental quality (Weldesilassie et al. 2009). We do not know of any such study for Mekelle City and it would be of interest undertaking this study.

3. Analytical Framework of Municipal Solid Waste Management

A considerable part of empirical environmental economics concerns the economic benefit of changes in the level of environmental quality. Such benefits are typically not marketed and are usually measured using such concepts as individuals' willingness to pay. A typical measure of such benefits is referred to as Hicksian compensating surplus (see, e.g., Freeman 2003).

Suppose, as in our case, Mekelle City is considering an improvement in SWM (environmental quality) and desires a measure of WTP—in other words, a Hicksian compensated surplus, where a participant is asked to respond by giving the difference of two expenditure functions:

$$e(p, q_0, U_0, Q, T) - e(p, q_i, U_0, Q, T) \quad \textbf{(1)}$$

where p is vector of prices for the marketed goods; q_i is the level of environmental quality being changed (with q_0 representing the initial level); U_0 is the initial level or status quo of the utility to which the respondent is assumed to be entitled; Q is the vector of other public goods that are assumed not to change; and T is a vector of the participant's taste parameters.

Suppose that Y_0 is the value of the first expenditure function (i.e., the participant's current income); and Y_i is the level of income that solves for U_0, given p, q_i, Q, and T, the value of the second expenditure function. Now, we can define WTP as the difference between Y_0 and Y_i. The Willig condition states that equation (1) can equivalently be expressed as an income compensation function. If WTP is the desired benefit measure, then the WTP function is given by:

$$WTP(q_i) = f(p,\ q_0, Q, Y_0, T) \qquad \textbf{(2)}$$

where q_o is now the baseline level of the public good of interest. This equation forms the basis for estimating a valuation function that depicts the monetary value of a change in economic welfare that occurs for any change in q_i (Freeman 2003).

In this study, we use contingent valuation, which is a widely used valuation technique to estimate benefits such as improved solid waste management. Compared with other valuation techniques (e.g., the travel-cost method), it is more flexible and better adapted to valuation tasks, such as improvement in waste management. In addition, its results are relatively easy to understand and interpret, which makes it valuable to policymakers.

4. Empirical Strategy

The main purposes of this study are to assess the residents' willingness to pay for improved urban waste management, analyze the determinants of WTP and suggest mechanisms for cost recovery. In this regard, the main objectives of the WTP survey are to calculate mean WTP and estimate a parametric model that includes respondents' socioeconomic factors in the WTP function.

Using the single bounded dichotomous choice value elicitation format, we asked yes or no question. Because we do not know the random preferences

and can only make probability statements about the yes and no responses, we used a probit model to estimate the probability of WTP. Moreover, for the results of the open ended question format, because the dependent variable, or WTP, is not fully observed (it is censored at zero), we used a Tobit model in the analysis of determinants of WTP. Both models are detailed below.

4.1 The Probit Model

The probit model specifies an indirect utility function for each respondent. Assume that the representative household gains utility from improvement in SWM and the two possible levels of environmental quality involved are the status quo q^0 and a specific level of improvement, q^1. Hence, each household's utility function at status quo (no improvement) is:

$$u_{oi} = u(y_i, z_i, q^0, \varepsilon_0) , \quad \textbf{(3)}$$

and each household's utility function with improvement is:

$$u_{1i} = u(y_i, z_i, q^1, \varepsilon_1). \quad \textbf{(4)}$$

We can rewrite equations (3) and (4) into one equation as:

$$u_{ji} = u_j(y_i, z_i, q^j, \varepsilon_j) , \quad \textbf{(5)}$$

where $j = 0, 1$ refers to the two different states of the environment; $i = 1,2,\ldots, n$ refers to household i;U_{0i} and U_{1i} represent, respectively, indirect utilities at the status quo and the hypothetical improved scenario; y_i is the ith utility maximizer's (individual household i) discretionary income; z_i represents a vector of household socioeconomic, demographic, environmental, and design variables (initial fee levels, etc.); q^j refers to the quality of the good being valued (improved solid waste management); and ε_j represents other

variables known to the utility maximizer, but not observed by the researcher (the error term).

Note that when the quality of environmental good q changes from q^0 to q^1 (as the result of a change in policy), the household's utility also changes from $u(y_i, z_i, q^0, \varepsilon_{0i})$ to $u(y_i, z_i, q^1, \varepsilon_{1i})$. Therefore, the condition that utility maximizer i answers yes to the offered price (bid) b_i is given by:

$$u_1(y_i - b_i, z_i,, q^1, \varepsilon_{1i}) > u_0(y_i, z_i, q^0, \varepsilon_{0i}) \quad \textbf{(6)}$$

Equation (6) states that household i will answer yes to the question about the offered price (bid) b_i if the household's utility at the improved level, net of the required payment, exceeds its utility at the status quo. However, because we typically do not know the random preferences and can only make probability statements about yes or no responses, the probability of a utility maximizer answering yes to the valuation question is consequent upon $U_1 > U_0$ (i.e., the utility maximizer is better at q^1 even with the required payment b_i). Hence, the probability of saying yes for utility maximizer i is given by:

$$Pr(yes) = pr[u_1(y_i - b_i, z_i, q^1, \varepsilon_{1i}) > u_0(y_i, z_i, q^0, \varepsilon_{0i})] \quad \textbf{(7)}$$

For parametric estimation of the above model, we need to choose a functional form for $U(y_i, z_i, q^1, \varepsilon_{1i})$ and specify the distribution of the error term ε_{ji}. Generally, most applied empirical research, whether it employs a random willingness-to-pay model (Cameron and James 1987) or a utility differential model (Hanemann 1984), begins specification by assuming a utility function that is additively separable in systematic and stochastic components of preferences:

$$u_j(y_i, z_i, \varepsilon_{ji}) = v_j(y_i, z_i,) + \varepsilon_{ji} \quad \textbf{(8)}$$

Given the specification in equation (8), the probability of utility maximizer i giving a positive response to the valuation question becomes:

$$Pr(yes) = pr[v_1(y_i - b_i, z_i, q^1) + \varepsilon_{1i} > v_0(y_i, z_i, q^0) + \varepsilon_{0i}] \quad \textbf{(9)}$$
$$= pr[v_1(y_1 - b_i, z_i\, q^1) - v_0(y_i, z_i, q^0) > \varepsilon_{0i} - \varepsilon_{1i}]$$

Note that the probability of the utility maximizer *i* giving a negative response (i.e., rejects the improvement) is given by:

$$Pr(no) = 1 - pr(yes) \quad \textbf{(10)}$$

This equation is still too general for parametric estimation. However, when the systematic component of the preference function is assumed to be linear in income and other covariates, the model can be simplified as:

$$v_{ij}(y_i) = \alpha z_i + \beta(y_i), \quad \textbf{(11)}$$

where y_i represents the individual consumer's (utility maximizer *i*) discretionary income; z_i represents an *m*-vector of household socioeconomic, demographic, environmental, and design variables; and α_i is an *m*-dimensional vector of parameters; and $v_{ij}(.)$ is the utility of consumer *i* from choice *j* associated with systematic components of the individual's preferences. For the new scenario, in which the dichotomous choice question will require a yes or no response to some offered price b_i, the probability that respondent *i* will answer yes to the valuation question is given by:

$$pr(yes) = pr[\alpha z_i + \beta b_i + \varepsilon_i > 0] \quad \textbf{(12)}$$

To estimate equation (12), we assume that the error term is normally, independently, and identically distributed with mean zero and variance 1.
If we assume that $\eta = \varepsilon_{0i} - \varepsilon_{1i}$ and that $F_\eta(\ )$ is the cumulative distribution function of η, then the probability that the household is willing to pay for the improvement is:

$$pr(yes) = F_\eta(\Delta V) \quad \textbf{(13)}$$
$$pr(no) = 1 - F_\eta(\Delta V),$$

where $\Delta V = V_1(y_i - b_i, z_i, q^1) - V_0(y_i, z_i, q^0)$.

Note the main purpose of the analysis is to estimate WTP and derive a WTP function from the assumed utility function. Assuming that p_i is the household's unobservable actual WTP for improved SWM service, then:

$$p_i = \alpha z_i + \beta(y_i)$$
$$\alpha_0 z_i + \beta y_i + \varepsilon_{0i} = \alpha_1 z_i + \beta(y_i - b_i,) + \varepsilon_{1i} \quad \textbf{(14)}$$
$$= \alpha_1 z_i + \beta(y_i - WTP_i,) + \eta_i$$

where p_i is the unobservable individual household's actual WTP for improved SWM service. By solving equation (14), household i's WTP can be expressed as:

$$WTP_i = (\alpha z_i + \eta_i)/\beta \quad \textbf{(15)}$$

In the probit model, F_η (…) is the normal cumulative distribution function. As we define it above, the unobservable individual household's actual WTP for improved SWM service is p_i, with linear relation to the initial bid b_i and the covariates, and the actual WTP for an individual can be presented as:

$$WTP_i = 1 \text{ if } p_i \geq b_i \quad \textbf{(16)}$$
$$WTP_i = 0 \text{ if } p_i < b_i$$

With dichotomous choice contingent valuation, the ith household (utility maximizer) is asked if it would be willing to pay the initial bid (b_i) to get a given improvement in solid waste management (both quality and quantity). This is a random variable. The probability of yes or no response can be presented as:

$$pr(\text{“yes” to } b_i) = pr(p_i \geq b_i) \quad \textbf{(17)}$$
$$pr(\text{“no” to } b_i) = pr(p_i < b_i)$$

4.2 The Tobit Model

It is important to note that for the open ended value elicitation question the dependent variable, or the WTP, is not fully observed and the dependent variable assumes zero values for a substantial part of the sample. When a substantial part of the sample is censored OLS (ordinary least squares) estimates will be biased. Hence, because an OLS estimator cannot be applied, we use a Tobit model for the observed maximum willingness to pay (MWTP):

$$MWTP_i^* = \alpha + \beta_X{}'_i + \varepsilon_i$$
$$MWTP_i = MWTP_i^* \text{ if } MWTP_i^* > 0 \qquad \textbf{(18)}$$
$$= 0 \text{ if } MWTP_i^* \leq 0 \ ,$$

where $MWTP_i^*$ is a household's unobserved maximum willingness to pay for improved solid waste management; $MWTP_i$ is a household's actual maximum willingness to pay for improved solid waste management; $_X{}'$ is vector of independent variables; β is vector of coefficients; α is the intercept; and ε_i is disturbance term, which is assumed to be normally and independently distributed. In other words, NID (0, σ^2) and independent of x_i. Assuming that censoring point is zero, then:

$$MWTP = \alpha + \beta_1 ASWG + \beta_2 Income + \beta_3 Bid + \beta_4 SER + \beta_5 AGR + \beta_6 EDLR + \beta_7 EAR + \beta_8 Fam\_Sz + \beta_9 Marriage + \beta_{10} PERCEPT + \beta_{11} House + \beta_{12} TSWSD + \varepsilon_i \text{ if } MWTP_i^* > 0 \qquad \textbf{(19)}$$
$$= 0 \text{ otherwise } (\text{if } MWTP_i^* \leq 0)$$

where MWTP stands for monthly maximum WTP, ASWG is household's weekly generation of solid waste, Income is monthly income of the head of the household, Bid is bid price, SER is sex of respondent, AGR is age of respondent, EDLR is educational level of respondent, EAR is environmental awareness of the respondent, Fam_Sz is family size, Marriage stands for marital status of respondent, PERCEPT stands for perception of the

respondent on current solid waste management, House stands for house ownership, TSWSD stands for type of solid waste service demanded by the household, and ε is error term.

5. Study Area, Survey and Data Description

The study assesses current sanitary service fees and the WTP of residents for improved urban waste management, using contingent valuation method. It uses a cross-sectional survey data of randomly drawn households in Mekelle City, Ethiopia. In what follows we describe the study area, survey design and elicitation format employed and data collected.

5.1 Study Area

Mekelle City is the capital of Tigrai National Regional State, with a population of about 257, 290 which grows at an annual rate of 5.4 percent, and an average family size of 5 people (FDRE PCC 2008). The city generates about 0.3 kilograms of solid waste per capita per day (Tesfay 2004). This is low compared to other developing countries, such as Nepal, Bangladesh, and Cambodia, which generate 0.5–1.0 kilograms/capita per day (Zurbrügg 2002). The city is the main collector of solid waste, employing 14 waste collection cooperatives[6] (mainly micro and small enterprises). Of these, 11 cooperatives handle house-to-house collection, 2 are street sweepers (only asphalt streets), and 1 gathers waste dumped in open spaces and near the communal containers. All waste collection cooperatives bring

[6] Private firms may be subcontracted by the waste collection cooperatives, which are collectively owned and operated by members. (For example, the waste collection cooperatives may hire privately-owned and -driven horse-carts.) There is a difference in size and scale between the two, and they both collect the same type of waste. The city encourages cooperatives because it sees them as employment generation. The municipality pays the cooperatives and the cooperatives pay the private firms. There are also instances where households and neighborhoods contract the cooperatives directly.

waste to the city communal containers. Mekelle City pays the cooperatives ETB 33.30[7] per cubic meter of waste collected.

Solid waste is primarily collected with hand carts (cooperatives and private firms), horse carts (private firms), and wheel barrows (street sweepers and adult laborers).[8] There are 64 communal containers located throughout Mekelle City, one container per 54 hectares on average. The city transports the collected solid waste from the communal containers to the landfill site, using three skip loaders, each with an 8 cubic meter capacity (Tesfay 2004; MCA 2007a).

Mekelle City has a number of problems with collection and disposal of solid waste (Gebremichael 2002; MCA 2003). First, collection coverage is hugely inadequate: less than 50 percent of solid waste is collected. Second, lack of cost recovery and the unsustainable fee structure for current waste collection and disposal are serious issues. For example, during the first half of fiscal year 2007/2008, waste collection fees only brought in ETB 90, 283 (US$ 9,222), while expenditure for the same six-month period was ETB 953,422 (US$ 97,387) (MCA 2007b). Basically, revenue from solid waste collection and disposal covers only 9.5 percent of the cost and the remaining 90.5 percent has to come from other sources. As a result, there are insufficient numbers of waste containers and the long distances between these containers increases the likelihood that citizens will dump waste in open spaces and along the roadsides (Tadesse et al. 2008).

Mekelle City needs to find a sustainable source of funding to improve solid waste management and broaden collection. One solution is to involve the community in determining how to finance this service, hence the need to estimate the households' willingness to pay as a starting point.

[7] ETB = Ethiopian birr. US$ 1 = ETB 9.7898 at the time of the study.
[8] The adult laborers are largely self-employed. Because waste collection coverage is not sufficient, the municipality also hires adult laborers for street sweeping.

5.2 Sampling and Design of Survey Questionnaire

Sample households for the study were drawn from a list of household heads residing in six local administrations[9] in Mekelle City, who had been in residence for one year or longer. With proportionate random sampling, 240 households were selected and 226 questionnaires completed.

The design of the survey followed recommendations from the NOAA Panel (Arrow et al. 1993) and Mitchell and Carson (1989), and consisted of four sections. Questions in the survey's first section asked about respondents' awareness of the current situation with solid waste in Mekelle City. Section 2 of the survey covered general environmental problems and the proposed SWM improvement scheme. The third section of the survey asked respondents about their willingness to pay, and the fourth section asked about socioeconomic conditions of the households. The improved SWM scenarios detailed the services to be provided, reliability of services, the current waste management problems in the city, the hypothetical improved condition, and how each consumer would pay for the improvement (payment vehicle).

The survey was given to 226 randomly selected households in Mekelle City. Data covered socioeconomic and demographic characteristics of the household, including gender and age of household head, marital status, family size, income, and house ownership; environmental attributes, such as level of environmental awareness, amount of solid waste generated by the household, etc.; and design variables, such as initial fee size and maximum WTP for environmental improvement and better SWM. Table 1 describes the variables. Table 2 presents the four initial fee points used in the study, which were based on responses in the pilot survey and assessment of the sanitation fees that existed in Mekelle City at the time of the survey. Only 24 individuals (10.6 percent of all respondents) said no to the initial fee size.

[9] Kedamay Woyane, Adi Haki, Hadnet, Hawelti, Semen, and Ayder are the local administrations.

The frequency of the no response for WTP increased as the amount of the initial fee rose.

Table 1: Description of Variables

Variable	Description	Mean	Std. dev.
WTP*	1 = yes to the starting bid; 0 otherwise	0.920354	0.271345
Maximum WTP	Monthly maximum WTP of respondent in ETB (open ended format)**	7.878319	5.21255
Initial fee (bi)	Initial monthly fees offered to the respondents: ETB 2.50, ETB 5, ETB 10, ETB 15	7.47549	4.161797
Age (AGR)	Age of respondent in years	39.5354	10.8538
Sex (SER)	Gender of respondent (1 = female; 0 otherwise)	0.5132743	0.5009332
Perception (PERCEPT)	Perception of the respondent on the current solid waste management (1 = respondent perceives current solid waste management as fair; and 0 otherwise)	0.4867257	0.500933
Household waste (ASWG)	Household's weekly generation of solid waste measured in sacks	0.436946	0.25420
Educational level (EDLR)	Educational level of respondents (0 = illiterate or informal education; 1 =for elementary school; 2 = secondary school; 3 = university)	1.743363	1.02223
Family size (Fam_Sz)	Number of members of household	4.756637	1.94777
Marriage	Marital status of respondent (1 = married; 0 otherwise)	0.7212389	0.449385
Income	Monthly income of the head of the household in ETB	1495.854	1325.04
Awareness (EAR)	Environmental awareness of the respondent (0 = not aware; 1 = fairly aware; 2 = much aware)	1.287611	0.680866
House ownership	Respondent owns house (1= owns; 0 otherwise)	0.5353982	0.499852
Type of solid waste service (TSWSD)	Type of solid waste service demanded by the household (1 = collection, recycling, and disposal; 0 otherwise)	1.41592	0.493975

Our contingent valuation employed a single-bounded dichotomous choice format, followed by open-ended questions in the WTP section. The survey was conducted during March–May 2008 and the questionnaire was translated into Tigrigna, the local language, to make it easier for the interviewers and to ensure that respondents would understand the questions. Six data collectors (one from each local administration) with college diplomas or more, were given one day's training to ensure they understood each question and learned how best to approach and interview respondents to get valid information. In the training session, we emphasized that they had to obtain the consent of each respondent. We also conducted a trial survey of 12 household heads to determine the initial fee value and work out any problems.

Table 2: Willingness-to-Pay Responses for Starting Prices

Response	Initial fee points (in ETB)			
	2.50	***5.00***	***10.00***	***15.00***
No. of "yes" responses	16	99	64	23
No. of "no" responses	24	40	139	203
Percentage of "no" responses	10.62%	17.70%	61.50%	89.82%

5.3 Data Description

Table 3 provides WTP responses in relation to the socioeconomic characteristic of the sample households. About 92 percent had positive WTP values for the improvement in SWM. Considering the entire sample, 51.33 percent of respondents are women,[10] and a higher proportion of female respondents, (95.69 percent) had a positive WTP for improved SWM, compared to male respondents (88.18 percent). This may be due to the fact that women traditionally are more responsible for solid waste management in

[10] Not all of the female respondents were heads of households. Some were wives and others were elders interviewed when the head of the household was not available for the interview.

the household. The average monthly income of the sample households was ETB 1,495.85, with a minimum monthly income of ETB 200 and a maximum of ETB 12,776. As the level of income and education increased, so did the percentage of yes responses for the improved SWM system. The average age of respondents was 39.5 years and average family size 4.76. In addition, 53.54 percent of respondents currently own their home, and the others rent in houses, either from public or private owners.

Regarding environmental attributes, 53.33 percent of sample households considered the current SWM to be inadequate, and 48.67 percent perceived the current SWM system as fair. Furthermore, 58.4 percent demanded only collection and disposal services of solid waste, while 41.6 percent demanded recycling in addition to collection and disposal. On average, sample households generated 0.44 sacks[11] of solid waste per week, with the minimum and maximum being 0.25 and 2 sacks per week, respectively.

About 40 percent of respondents reported that they disposed of their solid waste in nearby community containers, 12 percent dumped it in an open space, and 2.6 percent on the river banks near their home. Only 45.6 percent of respondents had their waste collected from home by the waste collection cooperatives contracted by the municipality. Almost all respondents reported that they did not separate their solid waste (organic, plastic, or glass) before disposing of it. In addition, 90.26 percent agreed that women were responsible for dealing with household waste, 5.6 percent said children were responsible, and the remaining 4 percent responded that both were responsible.

Respondents were also asked who was responsible for SWM at the city level. Around 44 percent said the city should take care of it, about 28.3

[11] As is common in such studies in developing countries, we used sacks as a measurement unit, which is the most common unit in this case. It should be noted, however, that it is not an accurate measure since sack sizes differ. However, in this particular study, we weighed sacks randomly and in most cases they ranged between 15 and 20 kilograms.

percent thought the community should deal with it, and 27.8 percent wanted government, community, and polluters to share responsibility. On the question of who should provide the improved services for SWM, 34 percent preferred that the municipal government take charge, 24 percent said private contractors should manage it, and 42 percent wanted it organized by the community.

6. Results and Discussion

In this section, we present and discuss the results of the multivariate empirical analysis to help determine which factors are significant for the likelihood of WTP for improved solid waste management service, as well as the amount respondents are willing to pay.

Of the 226 completed interviews, 24 respondents (10.6 percent) had invalid responses[12] to the valuation question. We also checked whether excluding invalid responses would insert a sample selection bias by comparing the means of household covariates of the two groups (i.e., valid and invalid responses). Simple s of household covariates between the two groups (i.e., valid and invalid responses) were performed. For some of the variables the mean comparison showed that these are not significantly different. However, for other variables, such as gender, income, perception of existing SWM system, educational level, and household generation of wastes, the differences between the two groups (i.e., valid and invalid responses) was quite significant. If these variables influence the respondent's WTP value for the scheme, then the final estimates obtained from the sub-sample of valid responses may be affected by selectivity bias. Thus, we included all the respondents in the analysis.

[12] By invalid, we mean WTP responses that were excluded from the censored regression, actual (6) and protest (12) zeros, as well as outliers (4). We identified actual or protest zeros to the valuation question by asking respondents to give reasons for not wanting to pay for SWM. In this respect, 6 had insufficient income, 2 had no faith in the scheme, and 10 preferred to wait until the city government acted. Outliers were those whose maximum willingness-to-pay bids are more than 5% of their estimated income and those who wanted the improvement at a significantly lower amount than the initial stated fee.

On the whole, we found that multicollinearity was not a serious problem in our dataset. Testing for heteroskedasticity also revealed no problem.

Table 3: Probit Results for Likelihood of Willingness to Pay

Variable	Coefficient	z-statistic
Age of head	-0.064**	-2.39
Sex of head	0.428	0.96
Education	0.108	0.29
Awareness	1.581***	2.54
Family size	-0.026	-0.21
Income	0.004***	6.98
Marriage	0.556	1.07
Perception	0.457	0.82
House ownership	0.618	1.12
Household waste	0.039	0.03
Type of solid waste service	0.025	0.04
Starting price	-1.972	-1.30
Pseudo R^2	0.6398	
McFadden	0.608461	

** represents significance at 5% level and *** represents significance at 1% level.

Table 3 presents the probit results. While household income and awareness of environmental quality are positively associated with the likelihood of willingness to pay, age of head is negatively associated with WTP. These results make intuitive sense. A consumer with higher income has a greater demand for waste management and is more likely to be willing to pay for it. Households with greater awareness of environmental quality are also expected to be more likely to be willing to pay. On the other hand, the sign of the coefficient for age of household head is negative suggesting that older people who have freely disposed their solid waste for many years are less willing to pay for improved solid waste management.

In Table 4, we present the Tobit results and 8 of the 12 explanatory variables are statistically significant. These eight variables are: educational level, environmental awareness, household income, marital status, perception of the current SWM system, house ownership, amount of solid waste generated

by the household per week, and type of solid waste service demanded by the households. Except for the perception variable, the rest of the eight variables have a positive effect on the amount of WTP, as expected.

Thus, we find that households that generated more solid waste have a higher demand for improved SWM. The type of SWM service demanded by the households positively correlates with the amount of WTP and is significant at 5 percent. As this variable captures whether or not respondents choose collection, recycling, and separation of waste as a bundle, the results suggest that households that chose these services have a higher WTP for improved SWM. As generally expected, educational level and environmental awareness of respondents are positively associated with for amount of WTP and are significant at 1 percent.

Table 4: Tobit Results for Amount of Willingness to Pay

Variable	Coefficient	t-statistic
Age of head	-0.035	-1.32
Sex of head	-0.168	-0.38
Education	1.120***	3.96
Awareness	2.287***	5.02
Family size	-0.106	-0.83
Income	0.001***	3.21
Marriage	0.905*	1.74
Perception	-1.239***	-2.47
House ownership	1.310***	2.82
Household waste	4.795***	5.18
Type of solid waste service	1.217**	2.38
Starting price	-0.751	-0.48

*, ** and *** represent significance at 10%, 5% and 1% levels respectively. .

Income of respondents is also positively associated with the amount of WTP (significant at 1 percent), indicating that improved solid waste management is a normal good since its demand increases with income. Respondents' perception of current SWM is negatively associated with WTP for improved solid waste management (and significant at 5 percent), indicating that

households who perceive the current SWM system as good are willing to pay less than those who perceive it as bad. Marital status is positively associated with WTP (and significant at 10 percent) suggesting that married households are willing to pay more.

Table 5: Probit Results for Starting Price

Variable	Coefficient	Z
Starting price	-0.056**	-2.08
Constant	-0.666***	-3.51

** and *** represent significance at 5% and1% levels respectively.

In order to assess the implications for cost recovery and sustainability of the service, we use the probit model for the single-bounded dichotomous format and calculate the mean WTP (μ) as $\mu = -\alpha/\beta$, where α is the intercept and β is coefficient of the bid price or starting price. We find that the mean WTP for improved solid waste management per household per month is ETB 11.89 (Table 6). We also computed the mean WTP using the open-ended format. Thus, based on Table 6, the mean WTP is ETB 7.88 per household per month, which is less than but closer to the WTP obtained using the close-ended format. Therefore, households' mean WTP for improved solid waste management may be considered to be in the range of ETB 7.80–ETB 11.89 per month. Hence, we can calculate the monthly WTP for the city by multiplying these mean values by the total number of households in the city. Given the current population of Mekelle of 257,290, with an average family size of 4.76 (in the sample), the number of households is about 54,090.

The total monthly WTP of the city, using the mid WTP, is estimated at ETB 430,566 (Table 6).[13] Using the responses to the dichotomous single-bounded

[13] Note that the total monthly WTP of the city can be calculated using the open-ended elicitation format, i.e., the maximum WTP of the respondents as follows using one of the aggregation methods of WTP. First, i.e., prior to the aggregation of benefits class boundaries for the results of the open-ended questions are set. Then, mid WTP or class mark is determined. That is, mid WTP or class mark is the average of the WTP interval or class boundaries. Total WTP for the class is derived

question, the monthly WTP is estimated at ETB 532,536.05. The actual WTP of the households in Mekelle city may fall between these two figures.

Table 6: Total Monthly Willingness-to-Pay Estimates for Improved Solid Waste Management

WTP* interval (in ETB**/month)	Frequency of sample distribution		Mid WTP	Total no. of households	Total WTP (in ETB)
	Number	*Percent*			
0–3	36	15.93	2	8616.106195	17,232.21
4–6	83	36.73	5	19864.9115	99,324.56
7–9	19	8.41	8	4547.389381	36,379.12
10–12	59	26.11	11	14120.84071	155,329.2
13–15	12	5.31	14	2872.035398	40,208.5
16–18	2	0.88	17	478.6725664	8,137.434
19–21	14	6.19	20	3350.707965	67,014.16
22–24	0	0	23	0	0
25–27	0	0	26	0	0
28–30	1	0.44	29	239.3362832	6,940.752
Total	*226*	*100*		*54,090*	*430,566.0*

* Willingness to pay.
** ETB = Ethiopian birr.
Source: Authors' calculations.

7. Conclusions and Policy Implications

In rapidly growing cities in developing countries, solid waste is a major source of concern due to lack of appropriate planning, inadequate governance, resource constraint, and ineffective solid waste management. According to UNEP (2004), the generation of solid waste has become an increasing environmental and public health problem everywhere in the world, particularly in developing countries' cities. The aim of this paper is to assess the current sanitary fees in Mekelle City, Ethiopia, and the willingness

multiplying mid WTP or class mark by the total number of households in the class. Then this is aggregated across all classes.

to pay (WTP) of residents for improved urban waste management, and suggest mechanisms for cost recovery.

We used contingent valuation with a single-bounded format followed by open-ended follow-up questions. We administered our survey via in-person interviews. We randomly selected a sample of 226 household heads, and used twelve explanatory variables in the regression models based on the degree of theoretical importance and their impact on WTP. Probit and Tobit models were used to identify the determinants of households' WTP for improved solid waste management system and to analyze the mean WTP of households.

In Mekelle City, solid waste management is mainly provided by the municipality. Traditionally, SWM has been measured and evaluated based on the performance of the service supplier, while the demand of the residents has not been paid attention to. Resident households, who are the primary producers and generators of uncollected solid waste and perhaps the main victims of its deleterious effects, should be allowed to determine their SWM providers and participate in deciding effective solutions for SWM. Among other benefits, this would help providers understand households' willingness to participate and pay.

Solid waste collection in Mekelle is poor partly because its SWM system is not modern, and there is no organized recycling. Solid waste is primarily dumped haphazardly by the citizens in open spaces and the too-few community waste containers are dumped in landfill located in an area not appropriate for the purpose. More importantly, cost recovery of SWM is a serious problem for the city. The revenue generated covers only 9.5 percent of the costs and the remaining 90.5 percent has to be covered from other sources. Because waste management has no adequate source of revenue, it cannot even sustain the present level of service let alone to improve it.

The empirical analysis using the probit model suggest that household income and respondents' awareness of environmental quality increase the likelihood of respondents' willingness to pay. Older respondents are less likely to pay. In the Tobit regression, on the other hand, eight explanatory variables are statistically significant for households' WTP for improved solid waste management system. The level of solid waste generated by the household per week, education of household head, environmental awareness, and house ownership are positively associated with WTP. Type of solid waste service demanded by the households, income of households, and marital status of household head are also positively associated with WTP, while household perception of current SWM is negatively associated with WTP.

The mean WTP for improved solid waste management per month per household from the probit analysis (using the dichotomous single bounded value elicitation format) is ETB 11.89, while corresponding figure from the open-ended format is ETB 7.88 per month per household. The total monthly aggregated WTP of the city is estimated at ETB 532,536 and ETB 430,566 using the dichotomous single-bounded and the open ended question format respectively. Compared to the current sanitary fees, this WTP is much higher. The citizens appear to be eager for improved SWM, so there is plenty of room to increase the fee and acquire sufficient funds to substantially improve and modernize SWM in Mekelle City. Comparing the mean WTP to what a private solid waste collector currently charges a household for its service (ETB 10 per month) offers a starting point for municipal officials in determining a more appropriate sanitation fee.

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The Impact of Financial Access on Firm Growth: Evidence from Ethiopian Grain Traders and Millers

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Abstract

Although both formal and informal financial institutions exist in developing economies, firms are often constrained by lack of access to financial services. Grain traders and millers in Ethiopia need a lot of finance to pay their suppliers (e.g. farmers) but it is not clear whether or not which sources of credit matter most for their growth and expansion. Using firm survey data collected for the purpose, we assessed access to and the impact of different sources of finance on growth of traders and millers in Ethiopia. Descriptive and econometric methods (e.g. ordered probit) were employed to address the issue. The results indicate that both formal and informal sources of credits are accessed by a small number of firms on a sporadic basis. With credit from commercial banks is mainly channeled to large businesses while microfinance institutions (MFIs) are designed to assist small and micro enterprises as part of a poverty alleviation strategy, medium firms such as most grain traders and millers have limited access to finance. Bank or MFI credit was found to have no impact on growth and expansion in the econometric analysis. Access to informal credit is also limited and largely used to meet short-term emergency cash requirements. Without improved and regular access to finance, grain traders and millers cannot make the necessary investment to provide effective marketing services for the transformation of agriculture.

Key words: finance, financial access, Growth, Grain, Grain traders and millers, Ethiopia

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1. Introduction

The grain market liberalization policy in Ethiopia was introduced in March 1990 during the Derg regime, aimed at achieving a mixed economy based on wide private sector participation and greater use of the market mechanism to guide economic decisions. However, the Derg (Military government) was overthrown in May 1991 before it could implement its own reforms. The market liberalization actually removed the major bottlenecks in food grain markets and eliminated quotas, fixing prices and the legal monopoly of the Ethiopian Grain Trading Enterprise (EGTE) (previously the Agricultural Marketing Corporation) and reduced the number of *Kellas* (checkpoints). In November 1991, the economic policy of the Transitional Government of Ethiopia (TGE), (led by the Ethiopian People's Revolutionary Democratic Front, EPRDF), signaled a significant move away from the centrally planned economy towards a market-oriented one and introduced a federal political and economic system. The market liberalization process of the TGE reduced the role of the EGTE to a minor role in grain marketing and, created a large number of private traders, processors, transporters, etc. Moreover, many marketing cooperatives were established in both rural and urban areas. The reform ensured the dominance of market-driven policies in resource allocation decisions that depend on supply, demand and price signals.

The immediate results of the grain market liberalization were vivid. A study by Negassa and Jayne (1997) revealed that the price of cereals in surplus-producing regions increased by 12 to 48 percent, while prices in deficit regions declined by 6 to 36 percent, leading to a decline in cereal price spread. The volatility of wholesale cereal prices also declined immediately after the introduction of the reform process. However, grain prices have become increasingly volatile and unpredictable in recent years. Despite officially withdrawing from market intervention, the Ethiopian government had to intervene at least three times over the last 10 years: in 2002–03 when cereal prices collapsed, in 2007/08 when prices sky-rocketed, and in 2011 when prices soared again. Grain traders and miller have not been able to

cope with supply shortfalls or deficits (Rashid and Negassa, 2011). It appears that the private grain marketing remains weak and unreliable 20 years after the liberalization measures were introduced.

Although the policy reforms had positive impact on grain production, marketing and processing, there have been a number of challenges which constrained the growth and performance in grain traders and millers in Ethiopia. These include: lack of market infrastructure, inadequate market information, lack of training, storage problems, limited access to finance, weak regulatory and legal framework (property rights and contract enforcement), inadequate market facilities (marketing premises, parking places, storage facilities, etc), weak vertical and horizontal integration, low quality products, etc (Wolday Amha and Eleni Gebremadhin 2003).

Grain traders and millers have limited financial access to construct storage facilities, purchase equipment such as cleaning and machines, and obtain working capital to expand their business. The study of Amha and Gebremedhin (2003) indicated that limited access to institutional finance for traders to construct storage facilities, purchase equipment such as cleaning machines, and to obtain working capital to finance grain purchases were among the key problems in expanding grain marketing in Ethiopia. According to Dessalegn *et.al*. (1997), limited access to finance was identified as one of the major constraints of grain marketing in Ethiopia. Traders who did not obtain loan from banks identified lack of collateral, high risk in grain trade and high competition from unlicensed traders as the main reasons constraining access to bank credit. However, it is not clear if the situation has improved in recent years and it is not known if different sources of finance have different impact on the growth and development of grain traders and millers.

Although governments in developing countries try to expand access to formal financial institutions, informal finance remains the main source of credit for majority of firms (Degryse *et al*., 2011; Kan, 2000). However, the

empirical evidence on the impact of informal versus formal credit on firm growth is inconclusive. For instance, while Melzer (2011) indicated that informal credit has not helped firms or poor households, Ayyagari *et al.* (2010) indicated that formal credit is associated with higher firm growth, but informal credit is not. On the other hand, a study by Degryse *et al.* (2012) indicates that informal finance promotes firm growth, especially small firms. There is no consensus on the impact of formal and informal finance on firm growth. This paper aims at assessing the contribution of different sources of finance to firm growth. It assesses the extent to which grain traders and millers access different sources of credit and examines the impact of different sources of finance on firm growth.

The paper is organized as follows. Following the introduction, Section 2 describes the method of data collection. Section 3 discusses the conceptual framework. While Section 4 provides discussions and analysis of results, including the key issues in accessing bank loans by traders and millers, Section 5 provides conclusions and recommendations.

2. Sources of Data

Both secondary and primary data were collected to extract qualitative and quantitative information on the growth and performance of grain trading and processing firms in Ethiopia. Government statistics such as Central Statistical Agency's reports on grain production, consumption, price surveys, government policy documents, and other studies related to grain trading and processing enterprises were reviewed. The study also extensively used secondary information collected from banks, MFIs and cooperatives to assess the supply side constraints. In addition, literature on finance and growth nexus and determinants of firm growth was consulted to put the study in perspective and develop a conceptual framework for the study. Primary data were collected through structured questionnaires designed for

grain traders and processors in early 2011[4]. A total of 200 grain traders and 330 processors were surveyed. Although the main focus of this study was the grain markets in Addis Ababa, nearby towns were also surveyed, especially for millers.[5] In addition, a rapid assessment of traders and processors in selected regions was conducted in order to get better understanding of how firms operate in rural towns. Moreover, a number of discussions were conducted with senior staff of commercial banks, microfinance practitioners, staff of Federal Cooperative Agency (FCA) and regional cooperative promotion bureaus to fill the information gaps of the sample surveys.

3. Conceptual and Theoretical Framework

The main functions of financial system include: (a) pooling savings from disparate depositors allowing producers, processors and traders to access finance that would otherwise be limited to inefficient scale; (b) allocate resources through information acquisition about investment projects and selection of most promising ones, allowing capital to flow to its highest value use; (c) manage liquidity and idiosyncratic risks through aggregation and by transferring these risks to those who are willing and able to bear it; (d) contribute to the monitoring of mangers, so that funds allocated are spent as envisaged, which facilitates the separation of management and ownership, and helps harden budget constraints. Thus, financial systems and institutions can affect growth by promoting capital accumulation and/or by exerting a positive impact on the pace of productivity growth (Levine 1997). However, the financial sector is growth-supportive only if financial institutions are subject to proper governance structure resulting, in particular, in a behavior of banks that is incentive-compatible with that of depositors or borrowers.

[4] The authors would like to thank European Commission –Food and Agriculture Organization (FAO) Global Governance Programme for Hunger Reduction Project and Association of the Ethiopian Microfinance Institutions for funding the survey. The Regional Strategic Analysis and Knowledge Support System for Southern Africa (ReSAKSS-EA) also provided valuable technical support to the research.

[5] See Demeke and Ferede (2005) on the importance of the Addis Ababa grain market.

The reason thereof is that, under asymmetric information, banks are subject to moral hazard and adverse selection problems, which are at the core of "poor" banking practices. This applies in particular to the granting of bad loans, which themselves are conducive to resource misallocation, inflationary finance, bank failure, financial crisis and ultimately significant output losses (Mehi *et al* 2005).

A well functioning financial system is necessary for several reasons: enhancing the efficiency of intermediation, which is achieved by reducing information, transaction, and monitoring costs; promoting productive investment by identifying and funding good business opportunities; monitoring performance of businesses; enabling the trading, hedging, and diversification of risk; and facilitating the exchange of goods and services (Husain, 2004). These functions results in allocating resources to the most efficient sectors, more rapid accumulation of physical and human capital, and faster technological progress, which in turn lead to higher economic growth. However, financial repression such as high inflation, high reserve requirement of central banks, subsidized credit, credit rationing, ceiling of deposit and lending interest rates can hinder the development of financial sector and undermine economic growth. Financial sector reforms (promoting healthy competition, reduction in borrowing cost, broadening access to finance and easing regulatory constraints) that remove these distortions will have direct impact on improving financial access and promote firm growth.

Access to finance plays a very important role in both firm entry and growth stages of enterprises. Firms use internal and external sources to finance their operations and growth. However, firms in different stages of growth can access financial services from different sources. The main sources of finance for firms at start-up stage include: personal savings, loans or equity from friends and relatives, credit from suppliers and venture capital (usually reserved for high-profit start-ups). Firms in the startup period, when initial investments have not matured yet or whose investment projects are substantially larger than their current earnings, will not have enough

financial means from retained earnings and will face a constraint to their growth project (Hermelo and Vassolo 2007). However, capital constraints could extend beyond the formation stage and limit subsequent firm growth (Variyam and Krabill 1994). Once firms start growing (initial growth) by expanding sales and develop a base of reliable customers, they require more capital which is financed through earned income (reinvest profits from operations) and external finance from local banks, and equity capital by selling shares to local investors, asset-based loans or lease and venture capital.

When firms reach beyond the first phase of growth, a confidence-inspiring record, they can pledge collateral and can be listed as public companies, initial public offering (IPO), and can have access to a broader spectrum of financing opportunities such as selling debt (commercial paper, bonds or stock), banks, etc. But this is not always the case for many small firms. Schiffer and Weder (2002) indicated that even after overcoming the start-up hurdle, a lack of credit frequently hinders the growth of smaller firms during their early years. Once they reach maturity, firms are involved in mergers, acquisitions, restructuring or other activities. Even at this stage, however, firms require external financing and can access it through commercial paper, bonds or stock markets, banks and asset-based loans or lease. The mature firms, which are creditworthy, use their existing assets and cash flow as collateral to lower the cost of loans. However, access to finance alone does not create a viable business opportunity. Access to finance may be necessary but it is not a sufficient condition for firm growth (Nichter and Goldmark 2009).

In the last two decades, there has been a large body of theoretical and empirical literature which shows that the development of the financial sector is crucial for economic growth. Goldsmith's work (1969) provided the first evidence that financial sector development accelerates economic growth. King and Levine (1993) found a strong positive relationship between the financial development indicators with economic growth. Levine and Zervos

(1996, 1998) found out that stock market liquidity and bank development are robustly correlated with economic growth. The study of Rajan and Zingales also supported the hypothesis that the causality runs from financial development to economic growth. Leahy *et al*. (2001) identified a positive and generally significant relationship between financial development and the level of investment. The findings of Koivu (2002) support the view that financial sector development accelerates economic growth. Rousseau and Wachtel (1998) found strong evidence of one-way causality from finance to growth.

There are also research findings which question the one way causality from finance to economic growth. Demetriades and Hussein (1996) found two-way effects between economic growth and financial sector and in some cases the relationship ran from economic growth to financial development. Demetriades (1997) found out that the long-run causality between financial sector and economic growth may vary across countries. Neusser and Kugler (1998) could not find strong evidence that development in financial sector would affect economic growth. In general, when the sample countries of the studies are quite similar in their income level, there is hardly causality running from financial sector to economic growth, and the size of the financial sector does not seem to affect economic growth. Evidence from China reveals that though financial sector and growth in the real sector are cointegrated, the causality runs from growth to finance (Liang and Teng, 2006) which validates the view of Lucas (1998) and Robinson (1952) that financial development follows growth, rather than the finance-growth nexus. In spite of numerous studies, the question of causality between financial sector development and economic growth and identifying the variables to measure financial sector development is not yet settled.

The comparative study of Das and Guha-Khasnobis (2007) on the role of financial sector in the growth process for China and India revealed two different results. The result of the study indicated that India is in a better situation than China so far as the growth potential is concerned due to a more efficient financial system that is likely to suit the changing global scenario.

In order to attain profitability and efficiency, the banks of India have shied away from lending to industry, avoiding risky business projects, and this has affected small and medium (SME) firms more than the large enterprises. The SMEs and new business ventures have virtually no access to capital market, while the corporate sector faces limited constraints of external finance as listed large firms take the path of equity financing, which is also cheaper and with a larger asset base they enjoy a better credit worthy status. The banks may be interested to lend them more but they have alternative cheaper source of finance through the capital market. On the other hand, in China, direct credit program is still a general rule of banks. Often, the government has been issuing directives to the public sector banks to lend to SMEs and state owned enterprises so that they are not forced to close down in the face of loss. This intervention aims at expanding employment opportunities. This has a positive impact on the growth of income, demand and savings, which plays a crucial role for the growth process by accelerating investment. As a result, China's rate of saving and investment has consistently been higher than India and has given it an edge. However, this might result in high non-performing loans (NPLs) of banks in China.

Macroeconomic policies, legal and regulatory framework, information and technology infrastructure have also direct impact on access to finance and firm growth. Rousseau and Wachtel (2004) revealed that when inflation exceeds the 15 to 25% range, financial deepening ceases to increase economic growth. Moreover, well-functioning legal and financial institutions affect firms' ability to get external finance and firm's ability to access finance raise firm's growth opportunities and hence, profit (Maksimovic 1998). In countries with weak legal systems, and consequently weak financial systems, firms obtain less external financing and this result in lower growth. The effect of growth obstacles on firm growth is smaller in countries with better-developed financial and legal systems (Beck et al 2005). Ayyagari *et al* (2005) showed that finance, crime and political instability are the only obstacles that have a direct impact on firm growth and finance is the most robust one among those.

Jonson *et al* (2002) found that firms in transitional economies are more likely to reinvest their profits if they feel more secure about property rights protection in their country. Chinese firms are more likely to reinvest their profits if they are confident in the system of property rights protection and have easier access to credit, with this effect being stronger for small firms (Cull and Xu 2005). Beck *et al* (2004) found that better protection of property rights[6] increases external financing of small firms significantly more than it does for large firms, particularly due to the differential impact it has on bank and supplier finance. Jonson, McMillan and Woodruff (2002) pointed out that it is hard to separate the effects of property rights from external financing because external financing is strongly influenced by the security of property rights.

Demirgic-Kuny and Maksimovic (2005) found that the negative impact of reported financing obstacles on firm growth is stronger for small firms than large firms and stronger in countries with under-developed financial systems. Beck *et al.* (2004) found that small firms and firms in countries with poor institutions use less external finance, especially bank finance, and small firms use significantly more informal finance than large firms. The findings to Beck *et al.* (2008) indicates that under-developed financial systems are particularly detrimental to the growth of small firms. Moreover, small-firm industries grow disproportionately faster in economies with well-developed financial systems.

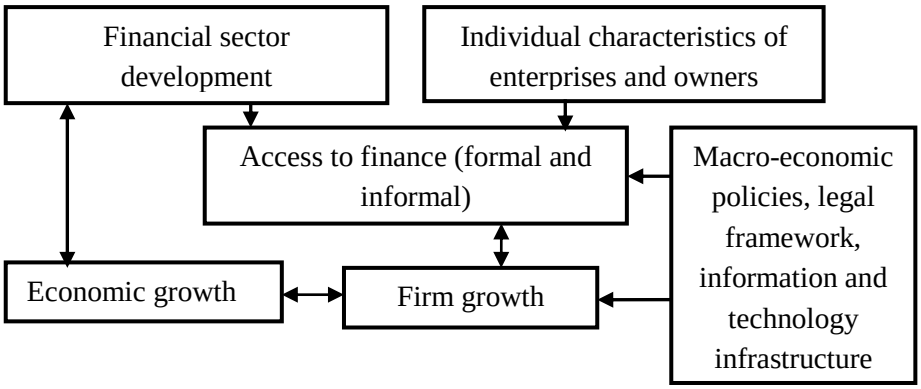
The study of Beck *et al*.(2006) showed that size, age and ownership are the most reliable predictors of firms' financing obstacles. Older, larger and foreign-owned firms reported lower financing obstacles. On the other hand, smaller firms finance a larger share of investment with informal sources of finance, such as moneylenders or family and friends. Moreover, firms in many developing countries get around market failures and lack of formal

[6] The proxies of property rights include the risk of expropriation by the government and those measuring the case and reliability of contract enforcement. Moreover, insecure property rights might compel owners to invest bank funds in their firms and divert internal profits to more secure investment opportunities.

financial institutions by creating private governance systems in the form of long-term business relationships and tight, ethnically-based, business networks (Beck *et al.* 2006). These networks help to overcome the problems of asymmetric information and weak formal contract enforcement systems. However, social networks have a discriminatory effect on non-members who can effectively be excluded from market exchanges.

In Ethiopia, grain traders and millers are expected to generate investable funds from both internal and external sources. Figure 1 indicates that financial sector development, individual characteristics of grain trading and processing enterprises, and personal characteristics of owners such as level of education and social networking influence access to finance in the country. There is also a direct relationship between access to finance and financial sector development and macroeconomic growth. Financial sector can affect economic growth in three ways: (a) it can increase the productivity of investments; (b) more efficient financial sector reduces transaction costs and thus widens the share of savings channeled to productive investments; and (c) the financial sector development can affect saving rates (Pagano, 1999).

Figure 1: Conceptual framework to study the influence of financial access on the growth of traders and millers



Source: Authors' construction

The relationship between firm growth and access to finance is more formally analyzed using econometrics in which firm growth is a dependent variable and the various external financing sources are independent variables. The objective is to test whether or not firm growth is positively associated with access to external financing. Firm growth is measured in terms of changes in employment between time of establishment and survey period (2011). Accordingly, firms are categorized into three groups based on changes in employment. Included in the first category are those experiencing employment contraction between the initial and the survey period, while the second group includes firms that do not show employment expansion or contraction), and the third group includes firms experiencing employment expansion. Among the independent variables hypothesized to explain the employment performance is access to external finance.

Formally, we model firm performance by using an ordered probit approach (see Greene, 1997), and the performance of each firm can be considered as latent variable denoted by y^*. Specifically, the latent variable is related to a battery of observable and unobservable factors of the form:

$$y^* = X'\beta + \varepsilon$$

Where X is a vector of explanatory variables, β is a vector of parameters to be estimated and ε is error term with zero mean and constant variance. We then relate the latent variable to the observable variable y as:

$$y = \begin{cases} 1 & if \quad y^* \leq \gamma_1 \\ 2 & if \quad \gamma_1 \leq y^* \leq \gamma_2 \\ 3 & if \quad y^* \geq \gamma_2 \end{cases}$$

Where γ is a threshold parameter which can be estimated together with other parameters in the model. In terms of probabilities, the empirical model assumes the following:

$$P(y = j / X) = \begin{cases} \Phi(\gamma_1 - X'\beta), \; if \;\; j = 1 \\ \Phi(\gamma_2 - X'\beta) - \Phi(\gamma_1 - X'\beta), \; if \;\; j = 2 \\ 1 - \Phi(\gamma_2 - X'\beta), \; if \;\; j = 3 \end{cases}$$

where Φ is the cumulative normal density function and j is the number of categories (three in our case). Hence we estimate $P(y = j / X)$ model by including a set of explanatory variables which include firms' characteristics, financial variables and other owner-specific attributes. It should be noted that the coefficients estimated by these models cannot be interpreted as the marginal effect of the independent variable on the dependent variable. However, the coefficients can be interpreted by computing the marginal effects.[7]

4. Analysis and Discussion of Results

(a) Sources of external finance

The potential sources of external finance for grain traders and millers in Ethiopia include: the formal, semi-formal and informal finance providers. The formal finance includes the provision of financial services through banks which fall under the banking law and regulation and supervision of National Bank Ethiopia (NBE), and MFIs which falls under the microfinance law. Semi-formal sub-sector financing includes the delivery of financial services through the cooperatives which are guided by the general

[7] The marginal effects can be computed as: $\frac{\partial P(y = 1 / X)}{\partial X_l} = -\beta_l \left[f(\gamma_{j-1} - X'\beta) - f(\gamma_j - X'\beta) \right]$ where f is the derivative of the cumulative normal distribution function and X_l is the l-th element in X.

cooperative law and are supervised by Federal Cooperative Agency (FCA) and regional cooperatives bureaus/agencies. The informal financing includes credit delivered through Iqub[8], relatives and friends, supplier credit, traders, moneylenders, etc.

The results of the sample survey indicate that about 82% of the grain traders and millers had checking and/or saving accounts and are familiar with banking transactions. Nonetheless, accessing finance from formal and semi-formal financial institutions is very limited: less than 6% of the respondents borrowed money to finance working or investment capital needs in 2011 (Table 1). By contrast, own savings or retained earnings accounted for nearly 80% of the working or investment needs of respondents. About 9.8% and 4.3% of the respondents met their working and investment capital needs by accessing supplier credit.

Table 1: Main sources of financing working and investment capital of grain traders and processors (2011)

Sources of finance	Working capital		Investment capital	
	No.	%	No.	%
Own savings and retained earnings	417	78.1	423	79.8
Borrowing from formal and semi-formal financial institutions	23	4.3	29	5.5
Borrowing from informal sources	90	16.9	78	14.7
Total	530	100	530	100

Source: Sample surveys of grain traders and processors, 2011

Table 2 indicates that out of the 530 sample respondents, 451 (about 85%) have accessed finance from formal or informal sources over the course of their operation as grain trader or miller. But the share of formal and informal institutions in providing external finance to grain traders and millers is very

[8] *Iqub* is a rotating savings and credit association (ROSCA) in which a group of individuals agree to meet for a defined period with the objective of saving and borrowing together.

small: only about 10% have taken loan from commercial banks, 7% from MFIs and 3% from Saving and Credit Cooperatives (SACCOs). On the other hand, more than half of the respondents (51%) have received loans from relatives and friends. Although about 51% of the respondents belong to Iqub, only 18% had accessed loans from Iqub. Contrary to the general perception that moneylenders play an important role in situations where the role of formal and semi-formal institutions, only one person reported to have accessed finance from such source. It is not clear if this low rate of use is related to underreporting due to the negative connotations associated with moneylenders or recent government crackdown on moneylenders, or the high interest rate charged by the group.

Supplier credit has an attractive feature of not being guaranteed by morgageable assets which is advantageous for enterprises lacking collateralizable loans (Fafchamps 1997). However, only about 9.1% of the respondents reported that they have ever purchased products on credit (i.e. received supplier credit).

Table 2: Ever received credit from external sources (%)

Sources loans	Number of	Percentage
Formal banks	45	10.0
Microfinance institutions	28	6.6
NGOs	4	0.9
Iqub	83	18.4
Suppliers	41	9.1
Moneylenders	1	0.2
Saving and credit cooperatives	14	3.1
Friends and relatives	232	51.4
Other	3	0.7
Total	451	100

Source: Sample surveys of grain traders and processors, 2011

In response to a question that asked most important growth obstacles, grain traders and millers identified financial constraints as the most important

problem. Limited access to finance was perceived as the most binding constraint by 48% of the respondents. By contrast, illegal traders, price instability and lack of adequate business (demand) were viewed as the most important problem by 25, 7 and 7% of the respondents, respectively (Table 3). Access to credit is believed to overcome the problem of premise and to some extent the competition from illegal traders (through making use of scale economies and better services). The discussion below provides the major challenges of accessing external finance.

Table 3: Most important obstacle to the growth/expansion of this business

	Percent of respondents
Financial constraints	47.8
The presence of illegal traders/brokers	24.7
Lack of premise/working place	6.5
Price instability	6.9
Lack of demand	4.0
Lack of business support services	2.4
Others	7.6
Total	100.0

Source: Traders Survey, 2011

(i) Commercial banks

The Ethiopian banking sector consists of one state-owned development bank (Development Bank of Ethiopia, DBE), two state-owned commercial banks (Commercial Bank of Ethiopia - CBE, Construction and Business Bank - CBB), and 13 private commercial banks, about 5 additional new private banks are under formation. There are no foreign banks in Ethiopia because of the policy that restricts bank and insurance ownership to nationals only. The total number of bank branches increased from 389 (232 public and 157 private) in

2005 to 681 (273 public and 408 private) in 2010[9]. Despite the impressive increase in the number of bank branches and capital, grain traders and millers continue to have limited access to finance from the commercial banks.

Table 4: Reasons for not applying to banks to access loans (multiple responses)

Reason for not applying	Yes	No
No demand because:		
Did not need any credit	32.2	67.8
Did not want to incur debt	9.9	90.1
Of religious reasons	4.9	95.1
Had need but:		
No adequate collateral	44.9	55.5
Did not meet all requirements	9.9	90.1
Felt borrowing process is too difficult	29.3	70.7
Believed interest rates and other costs are very high	29.1	70.9
Worried I cannot pay back the loan	21.0	79.0
Did not know where to look for	9.9	90.1
Other	2.1	97.9

Source: Sample surveys of grain traders and processors, 2011

Theoretically, a trader or a miller may have never received a bank loan for either of two reasons: they had no need or they had the need but were discouraged by different factors. The response of the 90% who never benefited from bank borrowing is summarized in Table 4. The proportion of those with no demand for credit is significant: Nearly a third of the respondents indicated that they did not require credit, 10% did not want to incur any debt, and about 5% did not need credit because of religious factors. On the other hand, a number of respondents had interest in credit but were discouraged by several constraints: about 45% were discouraged by high collateral requirements, 29% by high interest rates and other costs, and 29% by the difficult borrowing process, 21% by fear that they cannot pay back the

[9] National Bank of Ethiopia, Annual Report, 2004/05 and 2009/10.

loan, and 10% by the belief that they did not meet all the requirements. In general, both lack of effective demand and unfavorable terms of borrowing have negatively affected access to formal credit.

(ii) MFIs and SACCOs

Introduced in its regulated form in 1996, the MFIs in Ethiopia registered a remarkable growth in terms of outreach and performance. So far, 31 registered deposit-taking MFIs have been operational. As of March 2011, they had a total of 2.4 million active clients with an outstanding loan portfolio of about Birr 6.2 billion (367 million USD). The MFIs mobilized about 3.0 billion Birr (176 million USD) of savings. About 50 percent of the clients are females (AEMFI, 2010). Many of the MFIs provide similar financial products and use predominantly group lending methodology.

The survey results confirm that despite the recent rapid expansion of MFI activities in the last ten years, MFIs in Ethiopia have yet to cater to the needs of grain traders and millers. As explained in Table 2, only about 7 percent of the respondents who sought external finance have ever used MFI loans. Among the most frequently mentioned factors constraining borrowing from MFIs are: lack of awareness about MFI loan facilities (24.5%); difficulties to form groups (22.5%); small loan size (16.0%); and short-term nature of MFI credit (4.5%). Some respondents claimed that they did not need any credit (about 22%) while a few (6%) reported religion as a reason for no interest in credit (Table 5). Lack of information is a major problem but MFIs are unlikely to meet the credit requirements of grain traders and millers who need larger loan sizes over a longer period of time. The average loan size of MFIs in 2011 were about 2,583 Birr (153 USD), which is too small for grain traders or millers. Recently, larger MFIs have expanded the provision of individual loans to MSE operators in urban areas that need relatively larger loans (above 5,000 Birr or US$296) (Amha 2008), but the loan size of MFIs is still too small as it can only buy about 0.5 ton of *teff*.

There has been a significant increase in the number of financial cooperatives or SACCOs, particularly in rural areas, in the last seven years. In 2010, out of the 35,000 primary cooperatives and 212 cooperative unions, about 8,623 were primary SACCOs (4,286 urban and 4,337 rural SACCOs). Out of the 393,658 member of urban SACCOs, about 42 percent (163,756) were women (AEMFI, 2010). However, the cooperatives seem to have limited contribution in improving credit access by grain traders and millers, as only 3% of the respondents reported to have ever borrowed from SACCOs (Table 2).

Table 5: Factors constraining borrowing from MFIs

Reasons for not borrowing	No. of respondents	%
Have need but		
No MFI operates in this area	8	1.6
Not aware of MFI loan facilities	121	24.5
MFI loans are only short term	24	4.5
MFI loan are too small	79	16.0
Difficulties to form a group (for group lending)	111	22.5
MFIs give priority to rural borrowers	9	1.8
Religious reasons	30	6.1
Others (mainly did not require credit)	112	22.7
Total	494	100

Source: Sample surveys of grain traders and processors, 2011

(iii) Informal sources

As shown above, informal sources have played a more important role than other sources in supplying of external finance to grain traders and millers. There are a number of reasons for this but most respondents agree three main attributes of informal finance providers: little or no formalities (59.3%), little or no collateral (17.2%), and a flexible repayment arrangement (15.1%). The ease with which loans are accessed is by far the most important consideration. Formal and semi-formal financial institutions need to realize that their bureaucratic loan administration is a more important constraint than even collateral requirements.

Informal sector loans are coping strategies to meet urgent cash needs. The amount borrowed is often small and of short duration, hence can rarely be used for investment or expansion purposes. The cost of borrowing can also be very high if all associated expenses, including the time and indirect costs required maintaining ties with providers of informal credit, are taken into account.

Table 6: Main reasons for borrowing from informal sources

Reasons for borrowing	Number of respondents	Percentage
More favorable interest rate	23	6.8
Little process (little or no formalities) or easily available	200	59.3
Little or no collateral requirement	58	17.2
Flexible repayment arrangement	51	15.1
Other	5	1.5
Total	337	100

Source: Sample surveys of grain traders and processors, 2011

Although moneylenders are rarely reported as source of informal loans, they are known for their high interest rate among the business community. Discussions with key informants have indicated that moneylenders often provide loans at 10% interest rate per month or 120% per annum. Some of the prominent moneylenders had even nicknames such as ”World Bank” and “IMF’ in view of their dominance and strict and harsh enforcement mechanism. Since any interest rate above 12% is prohibited by the Civil Code (Article 2479 of the Civil Code), the moneylenders would use an agreement in such a way that a person who actually borrowed 100,000 Birr for one year will sign as if he/she borrowed 220,000 Birr, without mentioning the loan amount and interest rate in the agreement. Recognizing the problem, the government started anti-moneylenders campaign in 2010 and many of prominent ones were brought to court. The cases were televised on national TV and the bank accounts and other properties of the suspects

were frozen until the final verdict, and the most known were sentenced to 25 years of imprisonment along with a large sum of fines. It is not clear if the measure has reduced or simply pushed the practice underground. The prison sentences and fines have also panicked microfinance institutions that charge more than 12% interest rate (per year). Informal lending and borrowing between friends and relatives could also be discouraged. A different approach may be required and one way to protect the business community against usury is to regulate the sector and expand access to formal financial institutions. In the absence of developed inclusive finance sector, such as South Africa, Malawi, Lesotho and others, moneylenders are regulated to establish money lending companies. In China, for instance, informal loan contracts can be protected by law if the interest rates charged are four times the official rate (central bank) or less (Degryse, et al., 2012). Moreover, the 12% cap on interest rates in Ethiopia does not help even the financial sector, given the high rates of inflation (exceeding 30% in 2008 and 2011, for instance) in the country. It should also be noted that average lending rates of commercial banks were 12.25% (above the limit) in 2008/09 and 2009/10 (National Bank of Ethiopia).

(b) Firm growth and access to finance

The growth and expansion of firms is a precondition for economies to grow and generate employment and wealth. Through growth and expansion, firms are able to benefit from scale economies and become efficient and competitive. Firm growth is a way to introduce innovations, increase competitiveness and ensure survival in the market. Nonetheless, growth and expansion is very limited among the grain traders and millers surveyed for this study. As shown in Table 7 below, the majority of the firms have maintained the same level of employment and storage capacity since their establishment: 52% of the sample firms reported no change in their employment. Similarly, 88 and 43% of grain traders and processors reported no change in their warehouse and milling capacity, respectively. Level of employment and capacity of store increased in only 29 and 12% of the cases, respectively. Employment and milling capacity contracted in about 10 and

18% of the respondents, respectively. Overall - it appears that there seems to be growth stagnation, at best, as reflected by indicators of firm growth: close to 61 percent of respondents indicated that employment has either deteriorated or stagnated.

Table 7: Change in employment and storage capacity between start-up and 2011

	Percent of respondents
Change in employment levels (both traders and processors)	
Reduced workers	9.80
No change	51.51
Increased	28.68
Change in storage capacity: traders	
Reduced	0.40
No change	88.00
Increased	11..60
Change in daily milling capacity: processors	
Reduced	18.0
No change	43.2
Increased	38.8

Source: Sample surveys of grain traders and processors, 2011

Table 8 provides the regression results of determinants of firm growth under different sources of finance: credit from formal banks, microfinance institutions (MFIs) including saving and credit associations, and informal sources (see annex for description of variables). The distinction between banks (e.g. commercial banks) and MFIs is due to differences in terms of their focus. While MFIs focus mainly on poverty alleviation, banks are more business oriented and credit allocation is entirely collateral-based. In addition, MFIs and informal lenders may have comparative advantage over banks because they engage in lending relationship that relies on soft information acquired through personalized direct contacts.

To test the nexus between access to external finance and firm growth, we made a distinction between three sources of finance: firms that accessed credit from (i) banks, (ii) MFIs, and (iii) informal sources. Since a small number of firms reported accessing credit in any one year (e.g. the year the survey was conducted (2011)), response to 'Have you ever accessed credit' was used for the analysis. The coefficient for formal banks is negative but insignificant. Credit from MFIs has a positive but statistically insignificant coefficient. The evidence does not support that access to banks or MFIs is strongly and positively correlated with firm growth performance. This could be attributed to lack of regular access to credit from these sources. Irregular access to meet occasional or urgent needs is unlikely to contribute to growth or expansion activities.

Credit from informal sources has a negative and statistically significant, suggesting that informal sources of finance retards the probability of growth. Contrary to the previous studies (e.g. Du and Girma, 2009), credit from informal channels is negatively associated with firm growth.This result is consistent with that of Ayyagari *et al*. (2010) that showed credit from informal sources does not support firm growth or neither offers an alternative substitute to formal financing institutions in terms of the size of loan and of loan period. Degryse *et al*. (2012) also found that informal credit reduces firm growth, especially large firms. On the other hand, only desperate and severely finance-constrained firms may borrow from relatives and friends. Borrowers often need to convince their friends or relatives that they have no other sources and are in a difficult situation, a possible reason for the negative coefficient of informal credit. Hence, prior poor conditions rather that accessing informal credit could be the reason for observed negative and significant coefficient.

Firm-specific attributes such as age of the business, firm size, etc. and owner characteristics such as human capital are factors influencing the growth of traders and millers. Age of owner is positively associated with probability of firm growth. The impact of owner's age on firm growth is characterized by

inverted-U curve, indicating that on average firm growth tends to decline at higher age level. The education variables suggest that firms owned and managed by people with a high school education level experience better growth compared with those with less than primary level of education, suggesting the crucial role of human capital in fostering firm growth. By contrast, the evidence does not support that membership in association or social capital has a positive impact on growth. Weak associations with limited capacity and empowerment to protect the interest of their members or provide valuable services do not contribute to growth.

Initial size as proxied by initial working capital does not matter for firm growth. However, small grain traders and millers grow significantly less compared with large scale processors. For instance, the coefficient for traders is negative and statistically significant, suggesting that small grain traders grow less compared with large scale processors. The latter are likely to take advantage of their economies of scale in terms of both human and physical capital for growth.

The way firms have been established or acquired does matter for firm growth. Specifically, firms that have been established by the owner or purchased tended to grow relatively faster than those inherited (the estimated coefficients are statistically significant). It is likely that mainly entrepreneurial-oriented and proactive people may establish their own or purchase businesses with the intention and investment plan for firm growth (Wiklund, 1998; Zahra and Covin, 1995). Other variables such as perception about risk, and policy uncertainty do not seem to have significant impact on growth. Notice that coefficient on perception about corruption is negative and statistically significant, indicating that corruption seems to hinder firm growth regardless of different finance indicators. This is consistent with other studies elsewhere (e.g. Aseidu and Freeman, 2009; Kimuyu, 2007; Fisman and Svensson, 2001). Firms were asked the following question regarding their perception about corruption: *In your opinion, how true is the following statement: "It is common for enterprises in this line of business to*

pay some irregular additional payments to various government bodies to get things done". Only six responses were allowed: always, mostly, frequently, sometimes, seldom and never. Taking the first four responses together, about half of respondents reported that they needed to pay bribes to government officials to get things moving. This seems to suggest that corruption discourages the incentive for firms to expand their business activities.

Table 8: Determinants of firm growth

Variables	1		2		3	
	Coef.	Z	Coef.	Z	Coef.	Z
Gender (=1 if male)	0.2624*	1.89	0.2448*	1.76	0.278*	1.93
Age of owner	0.0455**	2.36	0.0416**	2.13	0.043**	2.26
Age of owner squared/ 100	-0. 0450**	-2.46	-0. 0417**	-2.24	-0.0428**	-2.33
Age of business	-0.0001	-0.04	-0. 00025	-0.01	-0.0004	-0.02
Age of business squared/100	0. 0108	0.21	0.0066	0.13	0.0003	0.01
Logarithm of initial working capital	0.0372	0.65	0. 0411	0.71	0.033	0.56
Dummy for primary education	0.2632	1.31	0.2469	1.24	0.319	1.58
Dummy for high school	0.4484**	2.08	0.4345**	2.03	0.484**	2.25
Dummy for technical and above	0.4705*	1.71	0. 4670*	1.71	0.507**	1.85
Dummy for grain millers	-1.1237**	-2.34	-0.9394*	-1.90	-0.913*	-1.85
Dummy for grain traders	-1.2993**	-2.67	-1.1160**	-2.24	-1.079**	-2.16
Dummy for innovation	0. 1117	0.69	0.0815	0.51	0.118	0.73
Dummy for membership in trader association	0.0972	0.79	0.0917	0.75	0.121	0. 97
Dummy for risk (high risk taker=1)	-0.0681	-0.45	-0.0733	-0.48	-0.096	-0.63
Dummy for corruption	-0.2274**	-2.11	-0.2071*	-1.94	-0.223**	-2.06
Dummy for policy uncertainty (=1 if unpredictable)	-0.0444	-0.43	-0.0285	-0.27	-0.027	-0.26
Dummy for how business started-self	0. 2764**	2.16	0.2727**	2.15	0.276**	2.16
Dummy for how business started-purchased	0. 5594**	2.75	0.5564***	2.72	0.593***	2.86
Dummy for credit-banks	-0.3373	-1.50				
Dummy for credit-MFIs			0.1504	0.0615		
Dummy for credit-informal					-0.228**	-1.99
/cut1	-0.4920	0.9567	-0.2934	-0.3758	-0.4239	
/cut2	1.1952	0.9557	1.3840	1.3063	1.266	
Number of observations	520		520		520	
Wald chi2(19)	54.08***		47.69***		50.16***	
Pseudo R-squared	0.0616		0.0592		0.0608	

** p<0.1, ** p<0.05, *** p<0.001*

5. Conclusions and Recommendations

The findings of this study indicate that own savings/retain earnings and informal credit account for a significant proportion of the working and investment capital of grain traders and millers. The sample survey results reveal that the contribution of formal financial institutions such as banks, MFIs, and Saving and Credit Cooperatives (SACCOs) is very limited. Relatively more number of firms have accessed credit from friends and relatives (informal credit) but the nature of such loans is likely to be very useful: they are often small with short period of repayment. Purchasing and selling grain on credit is not common among grain traders and millers. Cash flow or liquidity challenges have limited the activities of traders to instant buying and selling with little or no stocking and value additions. Moreover, the requirement of property collateral is the main factor constraining access to bank loans. Respondents have also complained about the bureaucratic and long borrowing processes and high interest rates. Lack of trust, limited awareness, and religious beliefs have also prevented respondents from applying to bank loans.

The quantitative evidence indicates that neither formal nor informal credit has a strong positive influence on growth of grain traders and millers. With no regular and/or long-term access to credit, the opportunity to finance investment is severely constrained. The use of credit appears to be limited to financing emergency cash requirements.

Without a well-functioning financial sector, grain traders and millers cannot invest in storage, marketing and processing facilities, or transport vehicles and machines (for cleaning, milling, etc.). Access to credit is essential in keeping adequate stocks that can smooth out fluctuations in grain prices. It is essential to design a holistic framework to have a deeper financial system, thereby enhancing availability and lowering the cost of credit. First, banking regulations and government policies need to support credit availability to businesses that link smallholders to market and achieve the goal of

commercializing agriculture, which is one of the twin targets of the Agricultural Transformation Agency (the other being raising productivity of smallholders). High reserve and government bond purchase requirements as well as the implicit categorization of grain trading and milling as non-priority sectors need to be reconsidered. Government support in the form of credit guarantee to improve availability and lower the risk of credit should be given particular attention. It should also be noted that a stock market can significantly reduce the demand of large corporate businesses for bank loans. Equity financing is cheaper source of finance for listed large companies. Establishing a stock market in Ethiopia could thus be viewed as an important instrument to increase credit availability for medium and small enterprises such as grain traders and millers.

Second, an enabling environment must be created with the objective of ensuring that property rights are clearly defined and enforceable, reducing information asymmetry, improving the predictability and stability of government policies, and ensuring grain market and price stability. The impacts of the new urban land proclamation on financial sector development needs to be evaluated and amended. Commercial laws that effectively assign and protect property rights and their efficient enforcement are crucial for financial transactions. These include laws, regulations and institutions to create, register and enforce collateral, and establish an effective bankruptcy system. Consultative approaches (with stakeholders) in the formulation of policies and regulations or intervention in grain markets would ensure policy predictability and stability. The government and the banking sector also need to work together in institutionalizing credit registries (to give reliable access to clients' credit history) and ensuring that businesses benefiting or aspiring to benefit from bank loans provide transparent financial statements.

Third, the banking sector needs to develop innovative financial products. Traditional supply-driven financial instruments have failed to meet the cash flows and investment needs of grain traders and millers. Inventory credit, for instance, can be a very important instrument in financing commercial stocks

of grain. The system is often implemented through a three way arrangement between a bank, a borrower (e.g. grain trader or miller) and warehouse operator. Leasing is a good alternative to both debt financing and lack of proper collateral/ guarantee. Leasing overcomes collateral constraints as it requires no collateral or less collateral than commonly required by loans. Finance providers should invest in capacity building to improve and modernize their services.

Fourth, value chain financing approach needs to be adopted in identifying variety of integrated interventions. Such approach strengthens linkages between producers, grain traders, processors, input suppliers and finance providers through a dedicated transaction platform and a fully integrated finance, production, delivery and payment process. This would also assist finance providers to increase outreach, reduce risks and develop innovative products.

Finally, the role of the informal sector needs to be recognized. Eliminating informal finance on the ground that interest rate charges are high when a well-functioning formal finance is not in place may not be a good strategy. A regulated informal finance can compensate for the limitations of the formal sector in serving small and medium firms such as grain traders and millers. Policies need to recognize the information advantage of informal credit and ensure that informal sources complement formal sources. Addressing the problem of high risk and the associated excess interest charges through regulation and licensing can be a step in the right direction.

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Annex

Description of variables used in the regression

Description of variables	Mean	Std. Dev.	Min	Max
Owner and business attributes				
Dummy for gender (=1 if male)	.890566	.3124778	0	1
Age of owner (years)	39.7656	13.52543	18	99
Age of business (years)	10.05245	8.621629	.4	50
Logarithm of initial working capital	9.864842	1.660706	5.703783	17.72753
Education (ref: unskilled)				
Dummy for primary education	.4415094	.4970362	0	1
Dummy for high school	.3509434	.4777161	0	1
Dummy for technical and above	.1226415	.3283352	0	1
Business size (ref: Processors)				
Dummy for grain millers	.4716981	.49967	0	1
Dummy for grain traders	.4716981	.49967	0	1
Policies, innovation and networking				
Dummy for innovation	.1916509	.3939738	0	1
Dummy for membership in trader association (=1 if member)	.3358491	.4727326	0	1
Dummy for risk (high risk taker=1)	.8377358	.3690413	0	1
Dummy for corruption (=1 if paid irregular additional payments to get things done)	.4914286	.5004033	0	1
Dummy for policy uncertainty (=1 if unpredictable)	.5716981	.4953002	0	1
How the business started (ref: inherited)				
Dummy for how business started-self	.6566038	.475291	0	1
Dummy for how business started-purchased	.1018868	.3027852	0	1
Finance indicators				
Dummy for credit-banks	.140625	.3481788	0	1
Dummy for credit-MFIs	.0528302	.2239057	0	1
Dummy for credit-informal	.5056604	.5004403	0	1