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PROCEEDINGS OF THE FIFTH REGIONAL CONFERENCE OF THE SOUTHERN NATIONS, NATIONALITIES AND PEOPLES' REGIONAL STATE ECONOMIC DEVELOPMENT

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FOREWORD

The Ethiopian Economic Association (EEA) and its Hawassa Chapter are happy to issue the proceeding of the Fifth Annual Conference on the Southern Nations and Nationalities People Regional State Economic Development which was organized on March 27, 2015 at the Central Hotel Conference Hall. EEA organized this important regional conference as one of its objectives of broadening its activities and coverage at regional level so as to contribute to the economic advancement of regional state through enhancing economic policy formulation capability; the dissemination of economic research findings; promotion of dialogue on critical socio-economic issues; promotion of education in economics in higher learning institutions; enhancing national, continental and global networks of professionals and institutions; and advancement of the professional interests of its members.

The Annual Regional Conferences that the Association has organized in collaboration with its Hawassa Chapter has created important forums for presenting and discussing development issues that are highly relevant to the Regional Socio-economy. These forums have also provided incentives for researchers to conduct research and present their findings on regular basis. Indeed, the Annual Regional conferences were organized in an interdisciplinary fashion, thereby widening the interactive coverage involving both economists living here in the region and those living outside the region and non- economists who are working and experiences on the region. The Fifth Annual Regional Conference on Southern Nation and Nationalities People Regional State Economic Development has contributed towards a deeper understanding of the regional economy and the complex challenges it faces. It attracted about 210 participants including the higher officials and expertise from Regional Bureaus, Universities, NGOs, private sector representative and EEA members in the region. The participants of the conference expressed their satisfaction on the organization of the conference and the content of the papers presented. They reflected that the papers largely focused on local issue that can contribute to the development of the region. They also recommended that the issues raised in the discussion are critical that need due attention by policy makers and implementing organs of the region.

In this publication, all papers which were presented at the Fifth Annual Conference, and reviewed by external reviewers and comments and suggestions including editorial comments were communicated to authors for improvement. Finally, the papers which passed all the review and editorial process published in the Proceeding of the Fifth Annual Conference on the Southern Nation and Nationalities People Regional State Economic Development.

I would like to take this opportunity to express my heartfelt gratitude, on my own behalf and on behalf of the Ethiopian Economic Association, to the many people and organizations that made the conference resounding success. First and foremost, I thank the authors of the papers and the audience whose active participations made the Conference meaningful. The staffs of the Economics Department of the Hawassa University which runs the EEA Hawassa Chapter, participants from Wolaita Sodo, Arba Minch and Dilla Universities and the staff of EEA Secretariat deserve a special recognition for their passion and perseverance in managing the conference from inception to completion. Hawassa University also deserves appreciation for hosting EEA Chapter by providing office.

Our special thanks go to our partners who have shared our vision and provided us with generous financial support to materialize the activities of EEA. These include; The Friedrich Ebert Stiftung of Germany, The African Capacity Building Foundation (ACBF), The Think Tank Initiative of International Development Research Center (IDRC) of Canada; Civil Society Support Program (CSSP), The Norwegian Church Aid, The Royal Netherlands Embassy, The Swedish Embassy through SIDA, The Development Cooperation of Ireland (DCI) the Ireland Embassy, and the British Embassy through DFID.

Alemayehu SeyoumTaffesse (DPhil)
President of the Ethiopian Economics Association

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Determinants of Urban Households Vulnerability to Poverty in Ethiopia: Evidence from Hawassa

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Abstract

In this study an attempt is made to examine urban household vulnerability to poverty and its determinants based on a single visit household survey of Hawassa city. Moreover, the study tried to find out which groups of households are more likely to be poor and remain poor in the near future. Hence, primary data was collected from 204 households drawn from three sub-cities using two stage stratified random sampling. Employing the Cost of Basic Need (CBN) approach, general poverty line of the study area is estimated to be Birr 318.7 per month per adult equivalent and 30.5 percent of the population is found to be poor based on this benchmark. The Three Step FGLS estimation result showed that 37.9 percent of the population is found to have fifty or more probability of ending up in poverty next year. An additional of 11.33 percent of the population is found to be relatively vulnerable using the observed poverty rate as a threshold. From the descriptive statistics a household headed by female, less educated, pensioner and unemployed is relatively more vulnerable to poverty. The OLS estimation result showed that vulnerability to poverty is positively influenced by high dependency ratio, low educational attainment of head, and pensioner headiness. Conversely vulnerability is negatively associated with: age of head, asset ownership, and government employee headiness. Observing by the type of negative shocks experienced by households; theft of asset, head illness and head loss of job increases the probability of falling below the poverty line in near future. The results suggest a number of policies and programs that can address the most vulnerable and reduce their probability of becoming poor in the future. These could include: appropriate implementation of family planning programs, increasing investments in employment creation and productivity enhancement, and investment in human capital. For those households who lack economic assets, it will be helpful if development policies prioritize the building up of

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assets through financial services. The study also suggests the importance of policies that protect households from negative impact of shocks and crises

Key Words: Poverty, Household Consumption, Shocks, Vulnerability, Cross-sectional Data

1. Introduction

1.1 Background

Poverty is one of the most serious symptoms of human deprivation and underdevelopment. As it exists today poverty is an issue of global concern and with its multi-dimensional nature it is the world greatest challenge in the twenty first century. This could be why poverty is a priority target of the Millennium Development Goals (MDGs)[2]. According to World Bank, (2007), 985 million equivalent to 18% of the population of the developing world were living on less than a dollar (poverty line) a day. Another 2.7 billion struggle to survive on less than two dollars per day. Around the world, a total of 114 million children do not get even a basic education and 584 million women are illiterate. Every year six million children die from malnutrition before their fifth birthday. More than 800 million people go to bed hungry every day among them 300 million are children Furthermore, over 2.6 billion people, over 40 per cent of the world's population, do not have basic sanitation, and more than one billion people still use unsafe sources of drinking water (UN Millennium Project, 2012).

Although poverty is multi-dimensional, it has always been studied in a world of certainty. Little regard has been given to the implications of exposure to risk, with some exceptions. To reduce poverty sustainably, however, reducing household vulnerability and increasing household resilience are also necessary (Jose *et al*., 2007). This aspect is often overlooked by policy-makers. For instance, most of the traditional measures of poverty, including

[2]**Goal 1:** Between 1990 and 2015, halve the proportion of people whose income is less than one dollar a day.
Between 1990 and 2015, halve the proportion of people who suffer from hunger.

those used to define some of the Millennium Development Goals (MDGs), only weigh the current poverty of a household, with no regard for the probability that a household might fall into poverty in the future. This *ex post* measure of development needs to be replaced by indicators that recognize that anti-poverty policies need to be forward-looking and incorporate the hazards affecting whether individuals or households are in poverty or are likely to fall into poverty – i.e. their vulnerability.

The notion of vulnerability in the development economics literature is introduced in The World Development Report (WDR, 2001). Since then many researchers engaged in assessing vulnerability to poverty, mostly in developing countries, following the definition of that report. According to WDR (2001), vulnerability is defined as "the risk that a household or individual will experience an episode of income or health poverty over time". However, vulnerability can also be understood as the probability of being exposed to a number of other risks such as "violence, crime, natural disasters, and being pulled out of school" (World Bank, 2001).Recently conceptual papers in economics dealing with the concept of vulnerability have emerged tremendously (example, Dercon, 2001; Chaudhuri *et al*., 2002; Ligon and Schechter, 2003; Prowse, 2003; Bernd and Hermann, 2009; Dercon and Calvo, 2012).

As in many developing countries, poverty reduction is a primary development goal in Ethiopia. The country is committed to the Millennium Development Goals (MDGs), which seek, among other things, to eradicate extreme poverty and hunger. Though there is significant achievement in reducing poverty in the country, many of the indicators remained by far the highest in the world. According to the 2010/11 HICES, the proportion of poor people (poverty head count index) in the country is estimated to be 29.6% in 2010/11, while the proportion of the population below the poverty line stood at 30.4% in rural areas, it was estimated to be 25.7% in urban areas (MoFED, 2012).

Survey of literature on poverty suggests that most of the related studies conducted in Ethiopia so far not only focus on poverty at a point in time but also do they hardly give a comprehensive explanation of the determinants of

vulnerability to poverty. Even if there are few studies on the area, they largely focus on rural part of the country and mainly their center of attention is on measuring vulnerability (*Eg.* Abrham and Siegfried, 2012; Yesuf, 2007; Dercon, 2001; Dercon and Krishnan, 2000). Therefore, little is known on the covariates of vulnerability to poverty in urban Ethiopia. The motivation and objectives of the study emanates from the indicated gap in knowledge.

1.2 Objective of the Study

The general objective of the study is to examine urban household vulnerability to poverty and aims to identify the main determinants. More specifically the study aims at:

- Measuring the extent of vulnerability to poverty of the households in the study area
- Identifying the determinants of household vulnerability to poverty in the area
- Identifying the most vulnerable portion of the society in the study area
- To examine the welfare (consumption, income, and asset) inequality in the study area

1.3 Significance of the Study

There are several poverty-related studies conducted in Ethiopia in recent times, mainly because of the accessibility of data from the various household surveys recently made available. However the lion share of the studies focus on poverty at a point in time. Though there are researchers who attempted to study the dynamic nature of poverty in Ethiopia by including topics like vulnerability, they largely focus on rural part of the country and center of their attention is on measuring vulnerability. Little is known on the correlates of vulnerability to poverty in urban Ethiopia. This study makes a humble attempt to fill this gap by investigating the determinants of vulnerability to poverty in urban areas.

Moreover, the study will be a step forward in developing policies, which help not only the peoples who are identified as poor but also those at the

edge of joining the poor. Last but not least, the study will be a stepping stone for those who have interest in conducting further studies on the area.

1.4 Scope and Limitation of the Study

Explicitly mentioning the limitations of the study helps to cautiously judge the findings that come out from the analysis. Having in mind this, there were limitations worth mentioning here.

The study focused on Hawassa town only. The result would have been sounder had it covered some other urban parts of the country. Hence, it will not be possible to infer about the whole urban population of Ethiopia, as different urban areas have heterogeneous characteristics in their population. Another limitation of the study emerges from the information collected through the questionnaire. The questionnaire was designed to provide information on the income and consumption pattern of the households in the study area. Hence, the study does not give information on other dimensions of poverty like: health, infrastructural facilities and other dimensions of standard of living. Moreover, the researcher has made only single visit to the households during the process of collecting data. Accordingly, the credibility of the information collected from the households depends on the recall of respondents in that particular period.

2. Literature Review

2.1 Theoretical Literature

2.1.1 Conceptual Issues of Vulnerability to Poverty

Although much attention has been paid to defining and assessing vulnerability to poverty there is no unique generally accepted definition of vulnerability (Chaudhuri, 2000). Christiansen and Subbarao (2004) define vulnerability as the ex-ante potential of a decline in future well-being, or the ex-ante probability of falling below the poverty line at some point in the future. Along the same line, McCulloch and Calandrino (2003) see vulnerability as the probability of being below the poverty line in any one year. According to Dutta *et al.* (2010), vulnerability at the individual level can be thought in terms of the uncertainty in the outcomes of different

indicators such as income and consumption that the individual faces in the future.

According to Quisumbing (2002), vulnerability is the likelihood that at a given time in future, an individual or household will have a level of welfare below a predetermined line within a fixed time interval. Chaudhuri *et al.* (2002), on the other hand defined vulnerability within the framework of poverty eradication, as the ex-ante risk that a household will, if currently non-poor, fall below poverty line, or if currently poor will remain in poverty. Vulnerability has also been defined as the uncertainty of future income streams, an associated loss of welfare caused by this uncertainty (Ligon and Schechter, 2003). They noted that a household with very low expected consumption expenditures but with no chance of starving may well be poor but still might not wish to trade places with a household having a higher expected consumption risk.

Some researchers conceptualized vulnerability as having two dimensions, i.e. sensitivity and resilience. Sensitivity is the magnitude of a household, individual, community or country's response to an external event (Bayliss-Smith, 1991). The second dimension, resilience, is the ease and rapidity of recovery from shocks. The focal point of this conceptualization of vulnerability is on the response to the damaging fluctuation with little emphasis on the risk of the event happening and the factors that might expose the household or individual to the risk especially if it is an idiosyncratic event.

On the similar line Moser (1998) utilized a two-step model of vulnerability using the concept of sensitivity and resilience. According to him analyzing vulnerability involves identifying not only the threat but also the resilience or responsiveness in exploiting opportunities, and in resisting or recovering from the negative effects of a changing environment. The means of resistance are the assets and entitlements that individuals, households, or communities can mobilize and manage in the face of hardship. Therefore, according to Moser (1998) vulnerability is closely linked to ownership. The more assets people have the less vulnerable they are, and the greater the erosion of the people's assets, the greater their insecurity.

Alwang and Siegel (2000) provided a much broader conceptualization of vulnerability that incorporates the concepts of sensitivity and resilience. According to their analysis vulnerability has four major components. These are risk, exposure, response and outcome. Risk is the probability of an event happening, Exposure may be conceived as the value of the assets at risk or what will be lost from the realization of an uncertain event. Exposure is a function of decisions and actions taken by households, for example, the choice of employment and the asset portfolio. Response on the other hand is defined as the efforts to mitigate and cope with risk and exposure. This will depend on the assets available to the household or the individual.

Dercon (2001) provided a framework for analyzing vulnerability to poverty and shows the importance of assets in terms of its links with risk and vulnerability. Household assets, such as land, labor, as well as physical, human and social capital are deployed to generate income which, in turn, is used to generate well-being largely through consumption. According to Dercon, (2001) assets must be liquid or readily changed into cash at minimum cost and must not lose value in the face of the potentially poverty reducing event in order to mitigate risk and exposure effectively. Conversely, Outcome is defined as end-result of the impact of the damaging fluctuation and is the product of the interplay of risk, exposure and response. Heitzmann, *et al*. (2002) similarly suggested the importance of assets in reducing vulnerability to poverty but through the paradigm of a "risk chain." This framework involves decomposing household vulnerability into several components such as: (1) risk (or uncertain events), (2) options for managing risk (or risk responses), and (3) the outcome (in terms of the resulting welfare loss).

An implication of such a framework is that policies aimed at reducing household vulnerability to poverty ought to be geared toward raising the average level of well-being of households, in the same way that any poverty reduction strategy program would attempt to do.

2.1.1.1 Poverty and vulnerability

Although vulnerability and poverty are conceptually closely related, they are different. Poverty concerns the *ex post* realization of a stochastic focal variable (e.g. well-being) with respect to a socially determined minimum threshold (poverty line), while vulnerability is the *ex-ante* expectation of that focal variable relative to this threshold. The distinction of the two concepts emanates because of the presence of risk–the fact that the level of future well-being is uncertain (Chaudhuri, 2003). Even if the person is not necessarily poor now, being vulnerable is often associated with the effects of "shocks" such as a drought, a large increase in prices, a financial crisis, or the main income earner of the household may become ill, etc. If such risks were absent (and the future were certain) there would be no distinction between ex-ante (vulnerability) and *ex-post* (poverty) measures of well-being (ibid).

Therefore, vulnerability is a key dimension of well-being since it affects individuals' behavior (in terms of investment, production patterns, and coping strategies) and the perceptions of their own situations.

2.2 Empirical Literature

2.2.1 Evidence from Other Countries

Despite how vulnerability is perceived, it has always been a dynamic concept where one needs to estimate ex-ante what happens in the future. While calibrating individual's (household's) poverty level is relatively straight forward, measuring an individual's vulnerability requires information on the possible states of the world in the future and the probability distribution of their occurrences. Information on different future states of the world becomes more complicated as we move further away from the present.

Chaudhury *et al*. (2002) applied his methodology to cross-sectional data for Indonesia. The results showed that the vulnerable population is generally larger than the fraction of population observed as poor at a given point in time, implying that the true poverty cost of risk is higher than the observed

outcome. While 22% of the Indonesian population was observed to be poor in December 1998, however their finding indicated that 45% of the population was vulnerable. The author also found differences between the distribution of vulnerability and poverty across different population characteristics (i.e. regions, educational levels, etc.).

A study by Azam and Imai (2009), estimated *ex ante* poverty and vulnerability of households in Bangladesh using Household Income and Expenditure Survey (HIES) data in 2005. The results of the study showed that poverty is not the same as vulnerability as a substantial share of those currently above the poverty line is highly vulnerable to poverty in the future. Total vulnerability is found to be 47.81 as opposed to the current poverty of around 39 per cent. Vulnerability in rural areas is even higher, which is estimated to be 52.79 per cent. Poverty and vulnerability to poverty are the highest among households headed by illiterate persons; whereas households headed by persons having more than higher secondary level education are significantly better poised to cope with risk and uncertainty.

2.2.2 Evidence from Ethiopia

Earlier studies analyzing the dynamics of poverty in urban Ethiopia are relatively few, reflecting the lack of an appropriate and reliable household survey data that would allow the comparison of welfare across time. Since the early 1990's, however, periodic household surveys have been conducted that have facilitated the analysis of both urban and rural poverty.

One of the earliest attempts to examine urban poverty in Ethiopia was by Tadesse (1996) using the 1994 Ethiopian Urban Household Survey (EUHS). The survey provided, among other things, information on the demographic and consumption behavior of 1,500 households randomly selected from seven urban centers of the country. His study was limited to food poverty in recognition of the fact that satisfaction of basic food requirements remains a major problem for poor households in Ethiopia. The findings proved the hypothesis that there is abject poverty in urban Ethiopia, with 39 percent of the urban population living below the food poverty line. The analysis indicates that the highest incidence of poverty was recorded for the city of

Hawassa, followed by Addis Ababa, Dessie, Mekelle, Jimma, Bahir Dar, and Dire Dawa.

Using five rounds of panel data spanning 15 years Yonas, (2010) investigated the dynamics and persistence of poverty in urban Ethiopia during the period 1994-2009 with a particular focus on household composition. In his study dynamic probit models are used in order to understand the correlates of poverty. In addition, discrete-time proportional hazard models are used to estimate hazard rates of exit out of and re-entry into poverty. The study found that urban poverty has declined over time, with the head count index falling from 52% in 1994 to 34% in the year 2009.

Estimation results from dynamic probit models by (Yonas, 2010), showed that the likelihood of being poor in any round is a direct function of previous poverty. In addition, the results point to the importance of education of household heads in protecting households from being poor. Compared to households headed by illiterate individuals, households headed by individuals with any education have a lower probability of being poor. The same kind of negative relationship with poverty is observed in the case of having employer or civil/public sector employee heads, which shows the importance of engaging in stable jobs. Finally, households that receive remittances from international sources are less likely to be in poverty.

The most recent paper in line with vulnerability to poverty in urban area of Ethiopia is by Endale, (2011), which explored the extent of vulnerability to poverty from urban residents of Arba Minch town, using a single visit cross sectional data from 224 households. To construct the poverty lines he used the cost of basic needs (CBN) approach, the procedure used by Ravallion & Bidani (1994). Besides he employed Chaudhury *et al*. (2002) and Chaudhury, (2003) methodology to estimate the vulnerability level of households. He also used OLS model for analysis of determinants of household vulnerability to poverty against a series of independent variables.

In his study, 44.6 % of the population in the area was highly vulnerable to poverty. He made a distinction between LM-vulnerability (vulnerability caused by a low level of resources), and HV-vulnerability (vulnerability caused by the inability to smooth consumption in the presence of negative

shocks). Accordingly he found that about one fourth of the population is vulnerable due to low level of resources, while for 20 percent of the population vulnerability to poverty stems from high volatility of consumption. The study also indicated that households with small family size, more employed adults, privately owned house, good access to services, high social capital is less likely to fall in to poverty in the near future. On the other hand, households headed by older people, less educated, female and small number of close relatives in the area are relatively more vulnerable to poverty.

In conclusion, a series of studies on vulnerability to poverty are reviewed here and the researcher found some important variables to explain the characteristics of the poor and vulnerable people. Among others: household headed by female, large family size, high dependency ratio, lack of formal education, household with unemployed heads, lack of economic assets to mitigate shocks, low access to credit facilities, low provision of public services, location and urban-rural differences significantly affect vulnerability to poverty.

3. Methodology of the Study

3.1 The Study Area

The study was conducted in Hawassa which is located in the Southern Nation's Nationalities and Peoples Region (SNNPR) on the shores of Lake Hawassa in the Great Rift Valley; 273 km south of Addis Ababa via Debre Zeit. The City lays on the Trans-African High Way-4 an international road that starched from Cairo (Egypt) to Cape Town (South Africa). Geographically the City lays between $7^0 3'$ latitude North and 38^0 28' longitudes east. Hawassa City is bounded by Lake Hawassa in the West, Oromia Region in the North, Wendogenet woreda in the East and Shebedino woreda in the South. The City administration has an area of 157.2 square kilometers and divided in to 8 Sub-Cities and 32 Kebeles. These Eight sub Cities are Hayek Dare, Menehariya, Tabore, Misrak, Bahile Adarash, Addis Ketema, Hawela-Tulla and Mehal Ketema Sub-City.

The mean annual precipitation is 72.21mm. Temperatures vary between 6°C in winter and 34°C in summer. The City experiences sub humid-called 'Woina Dega' in Amharic type of climate. The average annual temperature is 20.6^{o}c. Hawassa gets rainfall twice in a year. According to Hawassa City Administration the projected population of the City in 2013 will reach 329,579 people, out of this 163,039 are males and 153,803 are females. Out of the total number of the Population of the city's administration 210,676 people live in urban area, while the remaining 118,812 people live in the rural area of the administration. The annual population growth rate is 4.02 with 4.8 in urban and 2.8 in rural. According to the Hawassa city administration the potential water coverage of the City has reached 76% in 2004E.C. The potential health coverage of the City administration was 70% in 2004 E.C. There are one referral hospitals, one district hospitals, three private hospitals, seven health centers and 47 private clinics in the City administration (Abinet A., *et al*. 2012).

Hawassa is well known for its attractive tourism destination. It offers a range of natural and cultural attractions that appeal to visitors from a number of major domestic and international markets.

3.2 Data, Data Source, and Sampling

To analyze the incidence and determinants of vulnerability to poverty, the study used primary data collected using a structured questionnaire. The questionnaire was designed to provide statistical information on households' demographic composition, income and consumption expenditure, human capital variable, idiosyncratic and covariate shocks that the household is exposed to in the past five years and other important socio-economic variables. For this, the unit of observation was the household (defined as a group of persons eating and living together for more than six months of the year). The survey in this study has been conducted in October 2013 from 204 sample households in six urban kebeles of Hawassa town.

Secondary data was also collected from Hawassa city Administration Finance & Economic office, the Central Statistics Agency, three sub-cities and other relevant document sources.

3.2.1 Sampling Technique and Sample Size

The study employed two stages stratified random sampling procedure and appropriately allocate the sample to the strata of interest. At the first stage, sub-cities were categorized into two categories based on their heterogeneous characteristics. There are 8 sub-cities and 21 Kebeles in Hawassa town; accordingly the 8 sub-cities were categorized into two groups namely only-residential and residential with shopping centers. Using stratified random sampling technique, three sub-cities, one from only-residential and two from residential with shopping centers, were selected among 8 sub-cities. Finally six sample Kebeles were selected from the three sub-cities by applying random sampling procedure (two Kebeles from each sub-city). At the second stage, sample households were selected using equal probability systematic sampling method by picking every N^{th} household starting from a random start.

The total number of households in the three sub-cities was used to determine the sample size. Using published table by Glenn D., (1992) at 7% acceptable error (precision), the sample size was determined to be 204 (Table 1).

Table 1: Sample Size by Kebeles

S. No.		Sub City	Population	Proportion	Sample Proportion
1	Misrak	Tesso	3119	22.2%	45
		Wukero	3379	24.1%	49
2	Hayek-dar	Gudumale	2580	18.4%	38
		Gebeya-dar	2288	16%	33
3	Bahil-adarash	Adare	1581	11.3%	23
		Harer	1081	8%	16
Total			**14028**		**204**

3.3 Empirical Model Specification

3.3.1 Model Specification and Estimation Technique for Measuring Vulnerability to Poverty

Ideally, the assessment of vulnerability to poverty requires a panel data of households. However, reliable panel data are scarce and only cross-sectional

survey data are available for many developing countries (e.g. Azam and Imai, 2009). Due to the inexistence of longitudinal data in developing country, assessing vulnerability to poverty became difficult. However, different scholars have tried to adopt different methodologies of measuring vulnerability. Among others, (Chaudhuri, *et al*., 2002; Ligon and Schechter, 2003; Bernd and Hermann, 2009; Dercon and Calvo, 2012) are some of the pioneering individuals in the field. Particularly, the works of (Chaudhuri *et al*., 2002) came up with a method of measuring vulnerability from a cross-sectional data. Accordingly, this study adopted the methodology as proposed by Chaudhuri *et al*., (2002) by assuming vulnerability as Expected Poverty (VEP), an *ex-ante* measure. The method has an advantage in terms of its ability to identify households exposed to risks but who are not poor (e.g. Adepoju and Yusuf, 2012). In this approach vulnerability is defined as the probability of being poor in the future and basically can take on two forms. It is either the ex-ante risk that a household that is currently not poor will fall below the poverty line or the risk that a household that is currently poor will remain poor.

3.3.1.1 Vulnerability as Expected Poverty

The model can be formally expressed as follows:
The vulnerability level of a household *h* at time *t* is defined as the probability that the household will find itself poor at time *t +1*:

$$\mathbf{V_{ht} = Pr\ (C_{ht+1} \leq Z^*)} \qquad \mathbf{(3.1)}$$

Where C_{ht+1} is the household's per-capita consumption level at time t + 1 and Z* is the absolute consumption poverty line.

In this framework, the level of vulnerability at time *t* is defined in terms of the household's consumption prospects at time *t+1*. This implies that the probability that a household will find itself poor depends on its expected (i.e. mean) future consumption, and on the volatility of its consumption stream (i.e. variance). Hence, to determine the ways in which certain household characteristics are associated with vulnerability, we need to estimate not only how the expected consumption level of a household varies with these

characteristics, but also how these characteristics affect the variance (and possibly higher moments) of consumption.

Following the works of Chaudhuri, *et al*., (2002), the stochastic process generating the consumption of a household h is given by:

$$\mathbf{lnC_h = X_h\beta + e_h} \qquad \mathbf{(3.2)}$$

Where C_h is per capita consumption expenditure, X_h represents a bundle of observable household characteristics; such as household size, location, educational attainment of the household head, etc., β is a vector of parameters, and e_h is a mean-zero disturbance term that captures idiosyncratic factors (shocks) that contribute to different per capita consumption levels for households that are otherwise observationally equivalent. The variance of the disturbance term e_h is given by the following function:

$$\mathbf{\delta^2 e, h = X_h\theta} \qquad \mathbf{(3.3)}$$

To estimate β and θ in equation (3.2) and (3.3) Amemiya (1977) suggested a three-step feasible generalized least squares (FGLS) procedure (Chaudhuri, *et al*., 2002).

First, the parameters β in equation (3.2) were estimated using ordinary least square (OLS) procedure. Then, the estimated residual from equation (3.2) were used to estimate:

$$\mathbf{\delta^2 e, h = X_h\theta + \mu_h} \qquad \mathbf{(3.4)}$$

Where, μ_h is the estimated residual; then equation 3.4 is estimated using OLS and the predictions from this equation are used to transform the equation as follows:

$$\frac{\hat{\sigma}^2_{OLS}}{X_h\hat{\theta}_{OLS}} = \left(\frac{X_h}{X_h\hat{\theta}_{OLS}}\right)\theta + \frac{\mu_h}{X_h\hat{\theta}_{OLS}} \qquad \mathbf{(3.5)}$$

This transformed equation is estimated using OLS to obtain an asymptotically efficient FGLS estimate $\hat{\boldsymbol{\theta}}_{\mathbf{FGLS}}$. Note that $\mathbf{X_h\hat{\theta}_{FGLS}}$ is a consistent estimate of $\mathbf{\delta^2 e, h}$, the variance of the idiosyncratic component of household consumption.

The estimates:

$\hat{\sigma}_{e,h} = \sqrt{X_h \hat{\theta}_{FGLS}}$, then used to transform equation (3.2) as follow:

$$\frac{\ln C_h}{\hat{\sigma}_{e,h}} = \left(\frac{X_h}{\hat{\sigma}_{e,h}}\right)\beta + \frac{\varepsilon_h}{\hat{\sigma}_{e,h}} \qquad \textbf{(3.6)}$$

OLS estimation of equation (3.6) yields a consistent and asymptotically efficient estimate of β.

Once we get the estimates of $\hat{\beta}$ and $\hat{\theta}$ we will be able to estimate expected log consumption equation (3.7) and variance of Log consumption (3.8) for each household h:

$$E[\ln C_h \mid X_h] = X_h\hat{\beta}. \qquad \textbf{(3.7)}$$

And the variance of log consumption:

$$\hat{V}[\ln C_h \mid X_h] = \hat{\delta}^2_{e,h} = \hat{X}_h\theta \qquad \textbf{(3.8)}$$

Assuming that consumption is log-normally distributed (i.e., that $\ln C_h$ is normally distributed), we are then able to use these estimates to form an estimate of the probability that a household with the characteristics, X_h, will be poor, i.e. of the household's vulnerability level. Letting Φ (.) denote the cumulative density of the standard normal, this estimated probability will be given by:

$$\widehat{Vh} = \widehat{Pr}(\ln C_h < \ln Z \mid X_h) = \Phi\left(\ln Z - Xh\hat{\beta} \,\middle|\, \sqrt{Xh\hat{\theta}}\right) \qquad \textbf{(3.9)}$$

Where $\widehat{Vh}$ denotes vulnerability to poverty, that is the probability that the per capita consumption level (C_h) will be lower than the poverty line (Z) conditional on household characteristics X_h. Meanwhile, Φ (.) denotes the cumulative density of the standard normal distribution and $\sqrt{Xh\hat{\theta}}$ is the standard error of the equation (3.2). Whereas, ln*Z* is the log of the minimum consumption/income level beyond which a household would be called vulnerable.

3.3.1.2 Selecting the Vulnerability Threshold

Following Chaudhuri *et al*. (2002), two threshold measures are used in this study. The *first* is the relative vulnerability (i.e., those households who have

an estimated vulnerability level greater than the observed incidence of poverty in the population but less than 0.5), and *second* is the high vulnerability of households or population (households that have an estimated vulnerability coefficient greater than 0.5). The choice of 0.5 is justified in that it makes intuitive sense to say that a household is vulnerable if it faces a 0.5 (50%) or higher probability of falling into poverty in the next period.

3.3.2 Determinants of Vulnerability

Following the works of Azam and Imai (2009), Linear model with an Ordinary Least Square (OLS) estimation procedure is used to examine, the determinants of vulnerability to poverty in urban Hawassa using the value of vulnerability index estimated for each household (from equation 3.9) as the dependent variable. Due to the fact that the dependent variable is continuous the study used OLS estimation procedure (Gujarati, 2004). The Model is expressed as:

$$\hat{V}i = \beta iXi + ui \qquad (3.14)$$

Where, $\hat{V}i$, Estimated vulnerability level as expected poverty indices,
Xi: Vector of explanatory variables,
βi: Vector of respective parameters,
ui: the error term (with mean zero, $\pm^{2} = 0$)

3.4 Summary of Variables and Hypothesis

Based on theoretical expositions and previous empirical studies, the following explanatory variables are hypothesized to influence the vulnerability of households as follows. Monthly real consumption expenditure per adult equivalent is the dependent variable in the specified three-step feasible generalized least square (FGLS) procedure of estimating vulnerability to poverty index while the estimated vulnerability index is a dependent variable in the linear regression model.

Short names, description and expected signs of the explanatory variables are summarized on Table 2.

Table 2: Summary of explanatory variables and their expected sign

No.	Variable name	Short name	Description	Expected sign
1.	*Age*	*age-head*	Age of the household head	Negative
2.	*Age squared*	*age2-head*	Age squared of the household head	Positive
3.	*Sex*	*sex_ head*	Sex of household head	Negative
4.	*Family size*	*family_ size*	Total number of household members	Positive
5.	*Dependency Ratio*	*dependency_ ratio*	The number of family members not in the labor force (<15years and 65+)	Positive
6.	*Education*	*edu-head*	Maximum level of education achieved by the head of the household head	Negative
7.	*Occupation*	*occup-head*	Occupation of household Head	_
8.	*Shocks*	*shock-exp*	Shocks experienced in the past five years	Positive
9.	Community association	*member_ community*	Membership of community associations	Negative
10.	*Credit*	*credit-avail*	Availability of Credit	Negative
11.	*Transfers*	*transfer-rec*	If transfers received	Negative
12.	*Assets*	*house-asset*	Household assets	Negative
13.	*Home*	*home_ own*	Home ownership	Negative

4. Result and Discussions

4.1 Descriptive Statistics

About 24% (49) of the sample households are female headed while 76% (154) are male headed households. The average age of the household head is 45.6 and ranges from 25 to 75. Average household size is 4.86 and average adult equivalence family size of sample respondents is 4.23. Dependency ratio (the ratio of economically inactive household members with the age of below 15 years and above 64 years to the number of economically active household members) is found to be 0.71. Accordingly, each active member of the household supports 0.71 people on average from household[3].

The result on marital status of the household indicates that 69.95% of the household heads are married where as 3.45%, 10.84% and 15.76% are single, divorced and widowed respectively. Female headed households are more likely to be divorced or widowed. This is supported by the findings of the survey that 9.36% and 12.81% of divorced and widowed household heads are females.

According to the survey, 13.3% of heads of the households are illiterate (unable to even read and write) while the remaining 86.7% of the heads are literate or .able to read and write at minimum. The study also found that 24.63% and 21.18% of the household heads attain primary and secondary education, whereas 29.5% have above secondary education. Moreover, sex wise comparison indicates that female heads of households have low level of educational attainment as compared to their male counter parts. The result shows that only 22.5% of female household heads have educational attainment above primary education.

Owning a valuable asset is one of the most important ways to cope up with shocks. Accordingly, the survey tried to assess status of asset ownership. The result shows that mean value of asset by the household is ETB 101463.6 with large standard deviation of 130596.5 and wide range (how much). The finding indicates high inequality in asset ownership among households.

[3] Summary of the descriptive statics is presented in the appendix

Female headed households are found to own ETB 24171.84 worth of asset on average. However, the standard deviation 37406.22 is considerably large compared to their male counterparts.

Average monthly income of heads of the household is birr 3082.1 and standard deviation of 2698.4. Female headed households earn less income as compared to male headed households. The respective figure is birr 1522.7 for female and birr 3578.3 for male heads. Status of saving and borrowing of the household is assessed in the survey. Accordingly the result shows that on average households saved birr 8367.7 and borrowed birr 6710.6.

In terms of employment status of household heads, 9.36% and 6.4% of heads are unemployed and pensioners respectively. The remaining 38% of the heads are self-employed while 34%, 21% and 7% are government employee, private employee and NGO employee respectively. Among self-employed heads 41.66% of them involved in petty-trade (Gulit) and handicraft. And only 21.67% are engaged in high income generating business like trade and hotel services.

A strong community association is the one that stands out in times of shocks and disasters. In practice there are well known community associations in Ethiopia which helps people in times of disaster. These community associations include 'Idir', 'Iquib', and 'Mahber'. In line with this, the survey tried to assess membership status of households in community association and found that 54.2% of the respondents are members of more than one community association. A small proportion of the households (8.4%) are not member of any community association.

Exposure to shocks is one of the many ways in which households will end up in poverty. It is a major reason for assessing vulnerability of households to poverty. The study made effort to assess major shocks experienced by household over the past five years. According to the findings, households are affected severely by different shocks. Results show that 40.4% of sample respondents in the study have reported negatively affected by large rise in food price. A considerable portion of the respondents also reported that they were negatively affected by household illness, death, loss of job, theft and

divorce accounting for 21.2%, 15.8%, 10.34%, 17.7% and 10.8% respectively.

Consumption expenditure on different food and non-food items is generally used as a main yardstick for measuring the standard of living in developing nations (MoFED, 2011). In line with this, the study tried to measure household consumption expenditure on food and non-food items. The survey shows that the mean monthly consumption expenditure per adult equivalence is birr 644.5. Intra household variation is found to be large (SD=451.4). It implies the existence of high variability of consumption between households in the area. The mean monthly food consumption expenditure per adult equivalence (birr 356.3) is relatively higher than the mean monthly non-food consumption expenditure, birr 288.2.

Sex wise comparison indicates that male headed households enjoy relatively higher welfare than female headed households, which is supported by the finding that the average monthly consumption expenditure per adult equivalence by female headed household is birr 393.85 while it is birr 724.3 for male headed households. Moreover, the share of non-food consumption (27.45%) for female headed household is significantly lower than their male counterpart, (40.9%).

There is also high variability in consumption expenditure by poverty status. The mean monthly consumption expenditure per adult equivalence of poor household is birr 272.5, while non-poor household has spent birr 808.1. Furthermore, non-poor households spend more on non-food items (44.1%) as compared to poor households (22.9%).

4.1.1 Incidence of Poverty in the Study Area

The study set food and total poverty line to identify the poor from the non-poor. To arrive at the food and general poverty line the study made use of CBN (Cost of Basic Needs) approach. First, the food poverty line was defined by choosing a bundle of food typically consumed by the households in the area. The quantity of the bundle of food was determined in such a way that the bundle supplies the predetermined level of minimum caloric

requirement (2200 calorie). This bundle was scaled up and valued at retail prices of 2012/13 period, which were obtained from CSA (Central Statistics Agency) to get a consistent poverty line across different groups. The research gave an allowance for non-food items following the suggestion of Ravallion and Bidani (1994).

Accordingly, based on the CBN method the food and general poverty line in the city was estimated to be birr 252.9 and 318.7 per month per adult equivalence. After giving an allowance the poverty line for non-food item is calculated to be birr 65.8 per month per adult equivalence. Hence, households who can spend no more than 252.9 per month per adult equivalence are deemed to be food poor and those households who spend less than 318.7 on both food and non-food consumption per month per adult equivalence are considered as generally poor.

Table 3: Poverty line in the study area (in birr)

Poverty line	Value at current market price
Food	252.9
Non-food	65.8
Total	318.7

Source: Computed from own survey, 2013

4.1.2 Poverty Profile in the Study Area

After setting the poverty line, an attempt was made to analyze the various measures of poverty. The study used the well-known family of poverty measures proposed by Foster, Greer and Thorbecke (1984). The three indices of poverty include: the head count index, poverty gap and the severity gap. The head count index (P_0) is the proportion of households below the poverty line. The poverty gap index (P_1) is the total proportion of income required to enable poor household below the poverty lines to acquire the minimum recommended daily calorie allowance or their basic needs, thus moving the poverty line. The P_2 captures the severity of poverty by squaring and averaging the gap between the consumption of the poor and poverty line. All three measures together are presented in the Table 4 below for food and total poverty. These indexes are presented as per adult equivalent.

Table 4: Poverty profile

Poverty index	Food poverty	General poverty
Head count (P0)	26.6	30.54
Poverty gap (P1)	8.04	6.5
Poverty gap square (P2)	3.1	2.03

Source: Computed from own survey, 2013

The poverty profile on Table 4 indicates that 26.6% and 30.54% of households in the study area are deemed poor using the estimated food poverty and general poverty line. This shows high incidence of poverty in food as well as total poverty. The relative higher general poverty head count index as compared to the food poverty head count index should not be surprising given the study area is urban in which monetized economy predominantly characterizes society's life. The former index comprises both food and non-food cost of consumption instead of having only cost of food items. Moreover, in urban poverty, the problem is not only for food poverty rather the non-food consumption also has considerable proportion in total consumption of households.

The result from the survey shows that the poverty gap (deficit) in Hawassa is 8.04% and 6.5% for food and general poverty respectively. Theoretically it means, if the city mobilizes resources equal to 8.04% (for food poverty) and 6.5% (for total poverty) of the poverty line for every adult equivalent individuals and distribute these resources to the poor in the amount needed so as to moving each per adult equivalent to poverty lines. Hence, other things remain constant, at least in theory; poverty could be mitigated. The result from the survey also shows that the severity of poverty (P_2) in the city is 3.1 % for food and 2.03 % for total poverty respectively.

4.1.3 Incidence of Vulnerability in the Study Area

After generating estimates of the probability of being poor in the future, it is then important to choose a vulnerability threshold. Following Chaudhuri *et al*., (2002), the study considered two natural thresholds for the vulnerability estimates as discussed in the methodology part: the observed national poverty rate and the threshold 50%. The rationale for choosing a threshold of 50% has to do with considering a household having at least an even chance of being poor in the next time period. Employing a vulnerability threshold equal to the

national poverty rate, i.e., the relative vulnerability to poverty means that a household has an equal probability of the national poverty rate than the typical household to be poor in the next period. Using these two thresholds, the study operationally defined households to be vulnerable if the predicted vulnerability level is greater than 0.5; highly vulnerable (HV) if the vulnerability level is greater than 50% and relatively vulnerable (RV) if the vulnerability level is greater than observed poverty rate (30.5%) but less than 50%.

The overall picture of household poverty and vulnerability in Hawassa is shown on Table 5. Although 30.5% of households were poor, the incidence of household vulnerability is found to be 37.9%. Of the total non-poor households, 31.1% were highly vulnerable to poverty and additional 7.1% households were found to be relatively vulnerable. Among the poor, about 53.2% of households are more likely to end up in poverty next year. An additional of 20.96% of the poor households will enter the vulnerable group using the relative vulnerability threshold. As the result indicates vulnerability to poverty is more widespread than poverty. One implication is that targeting of vulnerable households is certainly more difficult, as more households have a significant likelihood of falling into poverty.

Table 5: Vulnerability status

Poverty status	Non vulnerable	Highly Vulnerable	Relatively Vulnerable	Total vulnerable
Non poor (freq.)	87	44	10	141
Between (%)	61.7	31.2	7.1	100
Overall (%)	42.9	21.67	4.93	69.46
Poor (freq.)	16	33	13	62
Between (%)	25.81	53.23	20.96	100
Overall (%)	7.88	16.26	6.4	30.54
Total (freq.)	103	77	23	203
(%)	62.07	37.93	11.33	100.00

Source: Computed from own survey, 2013

4.1.4 The Vulnerability Profile

Demographic Characteristics of the Vulnerable

There is a considerable variation on demographic characteristics among vulnerable and non-vulnerable households. As shown in a table, the mean

family size and dependency ratio is higher among vulnerable households than non-vulnerable households. The result clearly indicates that vulnerability to poverty increases with the increase in family size and dependency ratio.

In general we can conclude that vulnerability to poverty is high among households with large family size and high dependency ratio. Incidence of vulnerability to poverty seems to decline as age of the head increases. However, we cannot conclude that this negative relationship continues indefinitely as age increases.

Vulnerability by Sex of Head

When we look at vulnerability incidence by sex of the household head, female headed households appear to be more vulnerable than their male counterparts. Nearly 45% of female headed households are highly vulnerable to poverty while highly vulnerable male-headed households are 35.71%. As the vulnerability threshold is lowered to the observed level of poverty, an additional 18.37% of the female headed households will end up being poor as opposed to 9.1% male headed households. The result is in line with the hypothesis of the study.

Vulnerability over Selected Age Groups

If we divide up the sample population according to the age of household heads, we would not get a clear trend in the incidence of vulnerability. However, there is relatively little difference as one moves up through different age groups. Results of the study found that, households headed by individuals with age 45-55 are comparatively less vulnerable. Vulnerability incidence is found to be higher for households with heads younger than 35 years old. One interesting result here that the vulnerability incidence declines with increased age of the head and suddenly starts to increase for head age groups 50 and above.

Vulnerability by Educational Level of the Head

Education can affect people's standard of living through a number of channels: it helps skill formation resulting from higher marginal productivity of labor Furthermore, if people acquire skills through education, then a higher level of educational attainment is associated with higher marginal

productivity of labor. Hence, it is expected that education is negatively correlated with poverty and vulnerability to poverty, i.e. the higher the education level, the lower the poverty and vulnerability rate.

The highest concentration of vulnerability is observed in households headed by illiterate followed by only read and write and heads attained primary education. In general, people who live in households headed by individuals having lower education are more vulnerable to poverty. For example, 73.08% of the total population that lives in households headed by illiterate individuals is vulnerable to poverty. The figure decreases as one move up the education ladder. Of the 50.25% sample households with secondary and above educational level heads only 11.75% were vulnerable to poverty.

Vulnerability across Occupational Groups of the Head

Based on the results of FGLS estimation an effort is made to show the dynamics of vulnerability across some occupational groups that household heads belong. The self-employed occupational group accounts for 32% of the sample population and it contributes for 10.84% and 5.91% of the highly vulnerable and relatively vulnerable portion of population respectively. Pensioner and unemployed head households registered the highest incidence of vulnerability in the sample. A considerable high proportion (89.7%) of households headed by government employees are expected to escape poverty in near future. Somewhat surprisingly, of the households included in the sample with NGO employee heads, none of them are expected to escape from being poor in near future. Though, there are a range of explanation[4] why this might happen, the most appealing reason will be the under representation of the group in the sample.

[4] *Sometimes NGO employees are contract workers which might result loss of job in near future. However, the relative importance of such hypothesis depends on how the explanatory variable is entered in the data and how power-full the model to predict such differences. We would have been able to find some difference, if a separate variable was used to differentiate contract and permanent workers. Unfortunately such consideration was not made during data collection.

**The other reason might be the low asset value of households headed by NGO employee. It is observed that, the relative asset ownership of the households in the group is low as compared to the group of households in the sample.

*** The last but not the least, such result may indicate high volatility of income by heads of the households under consideration due to the first reason. In general, the topic needs further research.

4.2 Econometrics Results and Discussion

4.2.1 Regression Result for Determinants of Vulnerability to Poverty

In any developing country poverty alleviation is widely acknowledged as the crucial policy objective of development. The assessments poverty, grouping who is poor, who is not, and the characteristics of those who are, have been the focal point of development scholars. However, in thinking about suitable forward-looking anti-poverty policy interventions, there is a need to identify the vulnerable to poverty and through which anti-poverty policy will be effective up on implementation. Accordingly the study made an attempt to find the determinants/correlates of vulnerability to poverty in the study area. OLS regression analysis is employed to identify the factors, which affect household's vulnerability to poverty. The dependent variable is the vulnerability level of each household estimated using 3 step FGLS as described in the methodology part.

Table 6: OLS Estimation Result for Correlates of Vulnerability to Poverty

Vulnerability	Coef.	Std. Err.	t	P>t
Sex head	.0660968	.0425816	1.55	0.122
Age head	-.0053474***	.0014035	-3.81	0.000
Family size	.0092226	.0121759	0.76	0.450
Dep. Ratio	.0529454*	.0306938	1.72	0.086
Transfer rec.	.0412812	.0316495	1.30	0.194
Credit availability	1.50e-06	.0000456	0.03	0.974
Amount saved	-9.86e-07	1.08e-06	-0.92	0.361
Log asset	-.0426023***	.0150595	-2.83	0.005
Indi. Per room	.0064368	.022742	0.28	0.777
Head illiterate	.1664795**	.0661491	2.52	0.013
Head read write only	.1953503***	.0581244	3.36	0.001
Head primary	.2990959***	.0448147	6.67	0.000
Head secondary	-.2125446***	.0428153	-4.96	0.000
Head gov.	-.199337***	.0344364	-5.79	0.000
Mem. Community	.1313896***	.0316475	4.15	0.000
Head pensioner	.4228968***	.0633949	6.67	0.000
Head death	-.0241074	.0414544	-0.58	0.562
Head illness	-.0032427	.0399397	-0.08	0.935
Theft of asset	.0745099**	.0376087	1.98	0.049
Large rise price food	.0061683	.0378811	0.16	0.871
Divorce	.004907	.0529761	0.09	0.926
_cons	.7494657***	.1866494	4.02	0.000
Number of obs. = 200			R-squared = 0.7253	
F(21, 178)= 22.38	Prob> F = 0.0000***		Adj R-squared = 0.6929	

Source: computed from own survey, 2013 "*, ** and *** indicates that the variable is significant at 10%, 5% and 1% significance level respectively

As it is evident from the table R-square of the model is 0.725 indicating that, the explanatory variables included in the model explained 72.5% of the variation in the dependent variable. The F statistics also shows that the variables are jointly significant. Moreover, a diagnostic test is made to check if the result obtained qualifies the assumption of the model under consideration[5]. Accordingly, test results are all fine where there is no Hetrosckedasticity problem, very small Multicollinearity with mean Vif of only 2.02, no Endoginity problem and others. However, variables such as age squared, house ownership, extra income and borrowing are dropped due to high Multicollinearity.

The explanatory variables used in the model include socio economics characteristics of a household head like: sex, age, family size, dependency ratio, educational attainment, asset holding, and household level shocks. The OLS estimation result of regression is presented in Table (6).

Household Level Characteristics

As can be noted from the above table there is no significant difference between sexes of the head. Though a considerable proportion of female headed households found to be vulnerable in the descriptive part, the result of OLS estimates does not tell anything about the relative probability to vulnerability between the two sexes. There are also large empirical findings which support the above result[6]. For example, Chaudhuri *et al*., (2002), a study in Indonesia found that, households headed by female are as likely to be poor and vulnerable as male-headed households. Perhaps the only difference they found is that higher fraction of female headed households was estimated to be highly vulnerable. As noted by Szekely cited in Mohammed (2008) gender should be viewed with care because female-

[5] See appendix for details of the diagnostic tests

[6] See (Jadotte E. 2010), in his study "Vulnerability to Poverty: A Micro econometric Approach and Application to the Republic of Haiti", vulnerability to poverty estimated about 56 per cent for female and about 53 per cent for male headed households. The study found a slight difference between female and male headed households.

* Similar result is also found by Suryahadi and Sumarto, (2003)

* (Jah and TuDhang, 2008) in their study "Vulnerability to poverty in Papua New Guinea", they can't find any significant evidence that gender of household heads are associated with future probability of vulnerability to poverty.

headed households could be under represented in the sample because there are cultural reasons to believe that many of the households that declared to be headed by males are in fact headed by women.

A closer look at the above OLS estimation result, it is evident that, age of the household head is negatively correlated with vulnerability level. The variable is highly significant at 1%. Accordingly, an increase in head household age by 1 year is followed by a decrease in vulnerability to poverty in near future of that household by 6.6%. Theoretically, as the age of the household head increases the individual acquire more skill and experience and accumulates assets which will be used in times of adverse shocks that the household might face in the future and thereby minimize the household's vulnerability incidence.

There is no significant difference in the probability of being poor in the near future, between households with large family size as compared to households with small family size. However, in many circumstances the variable found to have a positive impact on vulnerability to poverty of a household.[7]

The effect of family size, on vulnerability level of a given household better understood with other composition of a household like dependency ratio of that household. There is significant association between dependency ratio and vulnerability level of a household. High dependency ratio in the household is followed by high vulnerability incidence[8].

Asset Ownership[9]

There is plain evidence show that ownership of valuable asset is negatively associated with vulnerability level of a household. Controlling for all other variables, a 1% increase in asset value decreases the risk of ending up poor

[7] See for example: Jah and Tu Dhang, (2008): Jose R. *et al.* (2008): Endale, (2011): Yesuf, (2007)

[8] Similar result can be found in A. S. Oyekale and T. O. Oyekale, (2004)

[9] Asset value is calculated for durable (including house) items of the household at their estimated current price, this is done due to the fact that assets must be liquid, i.e. readily changed into cash at minimum cost and must not lose value in the face of the potentially poverty reducing event in order to mitigate risk and exposure effectively. See Dercon, (2001). "Assessing Vulnerability to Poverty", Report prepared for DFID

in near future by 4.3%. The result provides an empirical support for the existing literature, for example, Moser (1998).

Education Attained by Head of the Household

The education level and literacy of head of household is an important determinant of vulnerability (as well as poverty). As it is noticeable from the table, the coefficients on different level of educational attainment reflect the prime role that human capital plays in determining poverty. Controlling for all other determinants, high educational attainment significantly reduces the risk of household vulnerability to poverty. It is observable from the regression result clearly that households with a secondary education heads have lower probability of vulnerability to poverty. The other three dummies (illiterate, only read and write, and primary education) have a positive and significant coefficients indicating that lower educational attainment of the head is positively associated with high vulnerability.[10]

In fact, education is an important dimension of poverty itself, when poverty is broadly defined to include shortage of capabilities and knowledge deprivation. It has important effects on the poor children's chance to escape from poverty in their adult age and plays a catalytic role for those who are most likely to be poor. Education is expected to lead to increased earning potential and to improve occupational mobility; hence, it deserves an important place in formulating any poverty reduction strategies.

Occupation of Head

The occupation of the household head is another important determinant of the vulnerability status of a family. A family whose head involved in an activity that is low paid and/or highly volatile flow of income is probably more vulnerable to poverty than a head engaged in high paid and/or less volatile activity[11]. The incidence of vulnerability is understandably lower for salaried workers in the public sectors than it is for those in other employment categories. As expected, the vulnerability to poverty is negatively correlated with the household headed by a government employee. Being a household headed by government employee reduces the likelihood of vulnerability to

[10] Similar results can be found in, Jamal H., (2009): Chaudhuri *et al*., (2002: Azam, S. and K. Imai. (2009)

[11] See (Chaudhuri, 2003) and (Chaudhuri *et al*, 2002)

poverty by 19.9%. This is due to the fact that the income and consumption flow of a government employee is relatively stable.

The study also found that households with pensioner heads have high probability to end up in poverty in near future. The coefficient for pensioner head indicates that these households have a significant higher vulnerability incidence. This might be justified with the low mean consumption of pensioner headiness[12].

Membership of Community Association

There is a logical deduction that being a member of local community association reduces vulnerability of households in times of shocks. It is indicated by (Moser, 1998) that social institutions are an important means of perpetuating reciprocity of households in their microeconomic life. In contrast to this, the result of the survey shows a positive and highly significant association between membership of local community association and vulnerability level of households in the study area. The possible explanation for this might be: as households find themselves in low mean consumption they tend to join more community association, as there is no rational to be a member of this community association having high mean consumption and less volatile source of income. For example, unless for its social value it is less likely to find a member of 'Idir' who is very rich as to curb any shocks by his own. In Ethiopian case it is apparent to find poor people in many of the local associations like: 'Idir', 'Iquib', and 'Mahber'[13]. In general the topic needs further studies.

Welfare Shocks

Exposure to risks, whether idiosyncratic or covariate, is a major reason for assessing vulnerability of households to poverty (Christiaensen and Subbarao, 2004). According to Holzmann and Jorgensen (1999), a high percentage of households move into poverty due to temporary shocks (such as illness or loss of employment) that are reversed just one or two years later. Accordingly, the study made an effort to see the relative importance of

[12] Similar result can be found in Endale, (2011)

[13] In Ethiopia there are people, who are members of 'Iqub', having very high income and less volatile source. However, these types of associations are mainly organized with the aim of mobilizing resources for investment not for mitigating risks.

shocks on the vulnerability level of a household. Among the six variables included in the first vulnerability model only one variable (Theft of asset) is found to have a positive and significant association with vulnerability of a household.

A separate OLS regression of the shocks against vulnerability; without including other explanatory variables, however shows that, head illness, head loss of job, and theft of asset significantly affect the likelihood of being poor in near future. Hence, a 12.2 %, 18% and 13.7% more vulnerability can be observed with households suffered with head illness, head loss of job, and theft of asset respectively, compared with those who did not report these shocks during the survey period.

4.2.2 GLM estimation of Vulnerability to Poverty

How robust are the previous findings? The robustness of the determinants of vulnerability to poverty is checked by estimating a Generalized Linear Model (GLM). It is a competing estimation technique when the dependent variable is a fraction bounded between 0 and 1, as it makes use of quasi-maximum likelihood estimation procedure. Hence, an effort was made to see if there is any significant difference between OLS and GLM estimation results of the vulnerability model. As shown in Annex Table 1[14] there is no considerable difference between the two procedures both in terms of magnitude and statistical significance.

4.3 Welfare Inequality in the study area

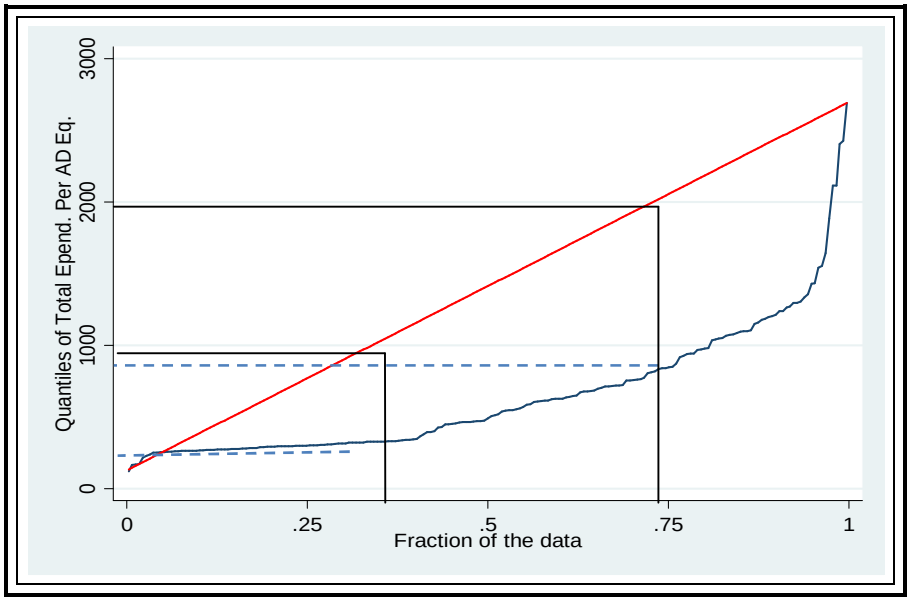
The main focus of this study was on poverty and vulnerability of households, which looks at the situation of households who find themselves at the bottom of the income distribution and at the top of the vulnerability estimate; typically this requires information both about the mean and variance of (say) expenditure per adult equivalence as well as its distribution. But sometimes we are more interested in measuring inequality other than poverty. For that reason the study made a simple comparison of consumption, income and asset ownership status of the sample population as to measure inequality.

[14] See Annex Table 1.

4.3.1 Result of the Quantile Plot for Inequality

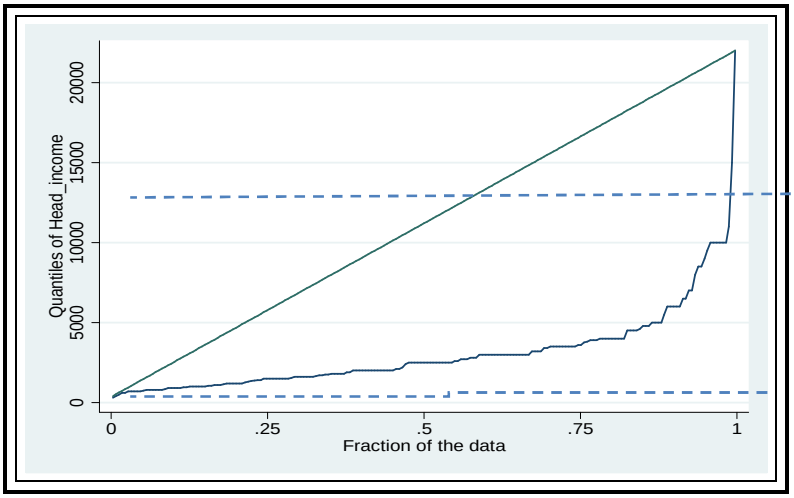
Figure 1 below shows the proportion of the expenditure that goes to the different quintile groups (poorest, middle-income, and richest people). It is evident from Figure 1; consumption expenditure is not evenly distributed among the sampled households in the study area. The graph indicates that nearly 40% of the sample population spends less than 350 birr on consumption per adult equivalence per month (see the dotted line). As one moves up to the next quantile of the sample the consumption line moves further away from the diagonal (equality) line indicating high consumption inequality among households in the study area.

Figure 1: Consumption distribution of the sample population over the fraction of the data



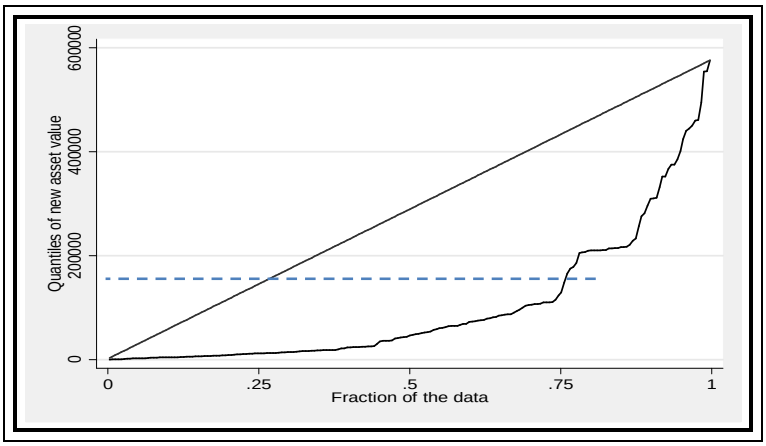
A similar pattern can be observed if the analysis is made for income over the fraction of the population. It is clearly illustrated by Figure 2 there is high income inequality in the sample population. Almost less than 1% of the population in the area earns income above 10,000 birr a month. Significantly very large portion of the sample households earn monthly income below 5000 (see the dotted line in the Figure 2).

Figure 2: Income distributions between the sample populations



In a similar fashion the study made effort to identify the inequality level of households in owning valuable asset over some selected quintiles. Accordingly, a high level of inequality has been observed in ownership of asset in the study area. As indicated by the dotted line a sizeable high portion (75%) of the households own an asset only worth of less than 100 thousand birr, while less than 10% of the population own assets worth of 400 thousand and above (Figure 3). The finding plainly indicates how assets are unevenly distributed in the study area.

Figure 3: Asset distribution of the sample population over Fraction of the data



5. Conclusion and Policy Recommendation

5.1 Conclusion

The study provided an assessment of urban household vulnerability to poverty in Ethiopia using single visit cross-sectional data from Hawassa for the year 2013. The cost of basic needs (CBN) approach was employed to find the poverty line as proposed by Ravallion and Bidani (1994). Vulnerability was defined at the household level, within the framework of poverty eradication, as the probability that a household will be consumption poor in the near future. Accordingly, the methodology proposed by Chaudhuri *et al*. (2002) was used for estimating household-level vulnerability using cross-sectional data. Following the estimation of vulnerability level for each household, OLS regression was employed to find the correlates of vulnerability to poverty in the study area. Based on the results obtained from the survey the following main conclusions are drawn.

Regression result of the welfare (consumption) model shows that, household's welfare significantly associated with: family size, dependency ratio, asset value, educational attainment of the head, and saving. But the direction of association is different in which; large family size and high dependency ratio are negatively correlated with welfare, while high asset value and saving are positively correlated with welfare of households,

Parallel to other similar studies the vulnerable population in the study area was found to be considerably larger than the number of currently observed poor. Although 30.5% of households were observed to be poor, the FGLS estimation result indicates that 37.9% of household were highly vulnerable. Substantial proportion households, who were observed to be non-poor, also entered the vulnerable category. It is logical to conclude that vulnerability is more widespread than poverty.

From the findings of the study, education was found to be a key element in reducing poverty. Poverty and vulnerability was the highest among households headed by illiterate persons; whereas households headed by person having more than secondary level education were observed to have low incidence of poverty and vulnerability.

By the same token, the OLS estimation (econometric analysis) result has shown that dependency ratio is one of the contributors to high probability of being vulnerable to poverty.

Moreover, the study concludes that asset ownership is one of the most important variables in determining vulnerability level of a household.

A simple comparison was made on some important variables with the aim of measuring inequality in the study area. And the study concluded that, there exists a high level of inequality among households in terms of consumption, income and value of asset entailing their vulnerability difference.

5.2 Policy Recommendations

It is evident from the findings of the study that a sizeable portion of households that are now non-poor are certainly vulnerable to falling into poverty in the future. This has policy implications and therefore such results should be taken into account, particularly when policy makers design social policies. Ex-ante measures should be enhanced to prevent as many households as possible from becoming poor, so should be ex-post measures to alleviate those already in poverty.

Households with large family size and high number of dependents were found to have significant positive association with the probability of being poor in near future. The result is fair enough to indicate the need to ensure appropriate implementation of family planning programs. In addition, creating awareness on the negative impact of large family size through all means of Medias might produce significant reduction on household's vulnerability incidence. To reduce the positive effect of dependency on household vulnerability level, policies like: increasing investments in employment creation and productivity enhancement to mobilize the idle labor can be potential remedy.

In this study, education was found to be a key variable in explaining vulnerability of households. Poverty and vulnerability to poverty were the highest among households headed by low educational attainment headiness; whereas households headed by person having more than secondary level

education were significantly better poised to cope with risk and uncertainty. So, investment in human capital along with other means of social protection and promotion could help for poverty reduction.

It is also found that households with limited asset are more susceptible to vulnerability. Hence, for those household who lack economic assets, it will be help-full if development policies prioritize the building up of assets through a combination of protective and promotional programs. Access to financial services, for example, through micro credit programs, might help poor households build up assets as it smoothies income and consumption. It also enables the purchase of inputs and productive assets, and provides protection against crises. Moreover, vulnerable non-poor households are most likely to benefit from some combination of prevention, protection, and promotion (for example through insurance programs) which would give them a more secure base to diversify their activity into higher return, high risk activities.

This study further suggests the importance of coming up with a profile of vulnerability in Ethiopia. It is highly recommended that the Ethiopian Statistical System to adopt ways to institutionalize vulnerability measurement and measure trends in vulnerability, aside from providing ex-ante on the incidence of poverty. Producing exclusive information at national level might increases the efficiency and effectiveness of measures used to tackle poverty. It is not expected to give the whole picture of the problem by studying vulnerability at one place.

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Annex

Annex Table 1: GLM and OLS estimation for correlates of vulnerability

GLM Estimation					OLS Estimation			
Vulnerability	**Coef.**	**Std. Err.**	**Z**	**P>z**	**Coef.**	**Std. Err.**	**t**	**P>t**
Sex head	)660968	)425816	1.55	0.121	.0660968	.0425816	1.55	0.122
Age head	0053474***	)014035	-3.81	0.000	-.0053474***	.0014035	-3.81	0.000
Family size	.0092226	.0121759	0.76	0.449	.0092226	.0121759	0.76	0.450
Dep. Ratio	.0529454*	.0306938	1.72	0.085	.0529454*	.0306938	1.72	0.086
Transfer rec.	.0412812	.0316495	1.30	0.192	.0412812	.0316495	1.30	0.194
Credit availability	1.50e-06	.0000456	0.03	0.974	1.50e-06	.0000456	0.03	0.974
Amount saved	-9.86e-07	1.08e-06	-0.92	0.360	-9.86e-07	1.08e-06	0.92	0.361
Log asset	0426023***	.0150595	-2.83	0.005	-.0426023***	.0150595	-2.83	0.005
Indi. Per room	.0064368	.022742	0.28	0.777	.0064368	.022742	0.28	0.777
Head illiterate	.1664795**	.0661491	2.52	0.012	.1664795**	.0661491	2.52	0.013
Head read write only	.1953503***	.0581244	3.36	0.001	.1953503***	.0581244	3.36	0.001
Head primary	)990959***	.0448147	6.67	0.000	.2990959***	.0448147	6.67	0.000
Head secondary	2125446***	.0428153	-4.96	0.000	-.2125446***	.0428153	-4.96	0.000
Head gov. Mem.	199337***	.0344364	-5.79	0.000	-.199337***	.0344364	-5.79	0.000
Community	.1313896***	.0316475	4.15	0.000	.1313896***	.0316475	4.15	0.000
Head pensioner	.4228968***	.0633949	6.67	0.000	.4228968***	.0633949	6.67	0.000
Head death	-.0241074	.0414544	-0.58	0.561	-.0241074	.0414544	-0.58	0.562
Head illness	-.0032427	.0399397	-0.08	0.935	-.0032427	.0399397	-0.08	0.935
Theft of asset	.0745099**	.0376087	1.98	0.048	.0745099**	.0376087	1.98	0.049
Large rise price food	.0061683	.0378811	0.16	0.871	.0061683	.0378811	0.16	0.871
Divorce	.004907	.0529761	0.09	0.926	.004907	.0529761	0.09	0.926
_cons	.7494657***	.1866494	4.02	0.000	.7494657***	.1866494	4.02	0.000
log likelihood =75.086623						R-squared = 0.7253		
AIC =-.5308662						Adj R-squared = 0.6929		
BIC =-937.5739								

Source: computed from own survey, 2013 "*, ** and *** indicates that the variable is significant at 10%, 5% and 1% significance level respectively

Determinants of Smallholders Livelihood Diversification and its Implication on Households Food Security: The Case of Shebedino Woreda in Sidama Zone

Aschalew Kifle[1], Asfaw Yilma and Debela Geleta

Abstract

This study identifies and analyzes the determinants of smallholders' livelihood diversification and its implication on households' food security in Shebedino Woreda, SNNPRS. The study employed cross sectional survey with quantitative and qualitative methods. Multistage sampling technique was used to collect primary data for the study. First, food secure and insecure kebeles from Shebedino woreda were purposively selected, and then two kebeles from each were randomly selected. Using simple random sampling, 198 farm households were selected employing closed end questionnaires. Secondary data was also used to supplement the primary data. Simpson Diversity Index and Berger-Parker Diversity Index were used to measure the level of livelihood diversification, and food accessibility index was used to measure the implication of livelihood diversification on food security. Binary logistic regression model was used to examine key determinants of livelihood diversification and their implications on food security. The regression result indicated that access to information, education level of household-head, land size of household head in hectare, livestock ownership in Tropical Livestock Unit (TLU), credit utilization, membership in organization, and annual income of household head were the key determinants of livelihood diversification. This in turn implies that social and financial capital assets were found to be dominant determinant of livelihood diversification at study area. The level of diversification results indicates that 64.6% of households diversify 2 to 5 livelihood sources. The over-all level of diversification when compared to potential available opportunities was found to be low. It was found that there is positive relationship between livelihood diversification and food security that is more diversify households are the more likely to increase or improve their food security status. Therefore, the local and regional government should give due attention on dominant livelihood capital assets to improve the wellbeing of households through livelihood diversification.

Key words: Smallholder, Livelihood Strategies, Food Security, Simpson Index, Logit.

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1. Introduction

1.1 Background of the study

Currently, nearly 1.2 billion people live on less than $1 USD a day in the world, from whom more than 75% dwell in rural areas. Nearly 97% of the poor in the continent live in Sub-Saharan Africa (SSA). According to the World Bank (2013), 300 million people in SSA lived just less than $1 USD/day in 2009 alone. In only two decades and a half, the number of people in the continent below the poverty line nearly doubled from 200 million in 1981 to 380 million in 2009 (WB, 2013). On the other hand, according to Food and Agriculture Organization 925 million people are undernourished in the world and studies demonstrate that about 906 million people are living in developing countries (FAO, 2012). In response to the shocks over time, the rural households came to implement diversified livelihoods (Ellis, 1999). According to Ellis, rural households in different parts of the world engage in multiple activities and depend on diversified income portfolios.

Even though African farmers are opt to diversify their livelihood strategies through on-farm and off-farm activities (Iiyama *et al.*, 2007), significant number of farmers in developing countries depend on rain fed traditional farming system which exposed their production to climatic change (Nyambara, 2003) and the problem is more acute in rural areas of developing countries where the major economic activities hinge on agriculturally-based livelihoods. On the other hand, a study conducted by Adugna (2012) in pastoralists community in Southern Ethiopia on determinants of livelihood diversification indicate that households engage on different income sources to smooth consumption and ensuring food security and the study shows that farm households diversified their activities to agriculture, off-farm and non-farm activities. According to this study, 64.1% of income came from agriculture, followed by non-farm (22.8%) and off farm (13.1%).

Furthermore, the rural people participate in a number of strategies including agricultural intensification and livelihood diversification to attain their livelihoods goal. However, promoting livelihood diversification in the rural

livelihoods has often been given less attention by policy makers who have chosen to focus on agriculture (Carswell, 2002). Understanding what factors have led to livelihood change and key determinants that affect livelihood diversification opportunities are an important on-going question in the research.

1.2 Statement of the Problem

A number of studies explicated that policy makers were favoring agriculture as means of rural economic development for a long time in Ethiopia. Indeed, there are some researches made in related area. Tassew (2002) explained that farmers were not allowed to engage in off-farm activities and labor employment was restricted. According to him, the role of the rural non-farm sector is the least understood component of the rural economy in the one hand and its role in the broad development process and poverty reduction is not well recognized on the other. Similarly, Carswell (2000) pointed out that Ethiopia's rural development policy has a dismal failure to incorporate other livelihood alternatives in addition to off farm activities. It is apparent that participating in different alternative livelihood activities has paramount importance not only to generate household income but also to bridge up the gap of rural household food security. However, the contribution to be made by livelihood diversification to rural livelihoods has often been ignored by policy makers who have chosen to focus their activities on agriculture (Carswell, 2000) where the SNNPR in general and the study area in particular are not an exception.

In SNNPRS over 79 woredas with 1.396 million people facing food gap which are being supported by regional food security program particularly through Productive Safety Net Program (PSNP). Of these, 12 woredas are found in Sidama Zone including Shebedino Woredas (ZOFED, 2013). In other way, PSNP is a necessary but not a sufficient condition to reverse food insecurity in the one hand and the farm sector is not adequate to support the over dense population in the study sites on the other. Smallholder rural households whose source of livelihood is dependent on rain fed agriculture face enormous risks on income as a result of weather variability. Therefore, lack of research findings on the determinants of livelihood diversification,

magnitude of diversification and implication on food security of smallholders' farmers in the study area. Thus, it needs to conduct a study for an in-depth understanding of the determinants of smallholders' livelihood diversification and its implication on household food security in the rural area of Shebedino Woreda remain important.

1.3 Objectives of the Study

The general objective of this study is to identify and analyze the determinants of smallholders' livelihood diversification and its implication on households' food security of Shebedino Woreda in Sidama Zone. Specific objectives are to:

- Identify and analyze predominant livelihood diversification activities in Shebedino Woreda
- Examine livelihood diversification implication on household food security
- Identify and examine the determinants of smallholders livelihood diversification in Shebedino Woreda

2. Literature Review

There are a number of definitions of livelihoods and food security. According to Chambers (1989) who defined livelihood as ''adequate stocks and flows of cash to meet basic needs''. This is later expanded by Chambers and Conway (1992) who describes livelihood as the capabilities, assets and activities required for a means of living. Though this definition does not clarify how these adequate stocks and flows of cash come about, Ellis (2000) in attempt to bring together various definitions defines livelihood as: "A livelihood comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household." The other most widely accepted definition of a sustainable livelihood is that propounded by Chambers and Conway (1991): "A livelihood comprises the capabilities, assets and activities required for a means of living: a livelihood is sustainable which can cope with and recover

from stresses and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; which contributes net benefits to other livelihoods at the local and global levels and in the short and long run". The food security definition was taken from a World Bank (1986) "food security is access by all people at all times to enough food for an active, healthy life". This was later expanded in 1996, during the World Food Summit to indicate that "food security at the individual, household, national, regional and global levels, exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."

The theoretical review of this study was stem from economic theory that attempts to estimate the economic value to improve wellbeing through which individuals or households place on various livelihood activities by diversification. The livelihood diversification status of households was measured by using Simpson diversity and Barger Parker diversity Indices (Berger-Parker, 1970). According to Berger-Parker, the diversity index is to be given in the form of $[1 \leq D \leq N]$ where N is the maximum possible number of income activities available in the area and D is the maximum number of income activities (sources of income) that a household undertake. The other household diversity level will be measured by Simpson Index choosing different livelihood activities or option given individuals' resource endowment. Let the Simpson Diversity Index SDI, where SDI = 0, that household do not diversify income sources i.e., household lives with a single income source and when its value approaches to 1, the level of diversification increases. The Index is given by: SDI = 1 – D, where D is a measure of diversity; [retrieved from Simpson (n.d) www.utk.edu].

Commonly used dependent variable econometric models in the assessment of determinants are Logit and Probit (Bekele and Drake, 2003) In addition; Simpson Diversity and Barger Parker diversity Indices are well established approaches in studies on livelihood diversification (Burton et al., 1999). The choice of whether to use a probit or logit model, both widely used in economics, is a matter of computational convenience (Greene, 1997). Logistic regression is used when the dependent variable is a dichotomy and

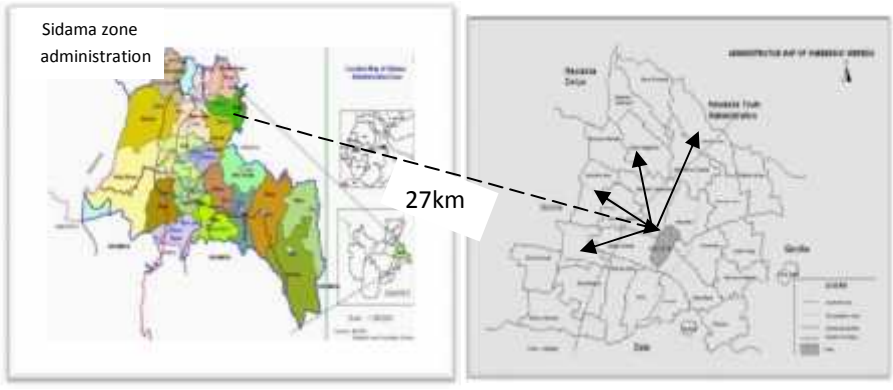
the independent variables are of any type. It applies maximum likelihood estimation after transforming the dependent into a logit variable (Garson, 2008). Both Simpson Diversity and Barger Parker diversity Indices are employed to assess livelihood diversification among sample households.

3. Methodology of the study

3.1 Description of the Study Area

Shebedino Woreda (SHW) is found in SNNPRS, Sidama Zone Administration and located 27km south of the capital city of the regional government seat (Hawassa). The neighboring woredas is located around South by Dale, on the West by Boricha, on the North by Hawassa Zuria, on the East by Gorche, and on the South by Wonsho Woreda respectively (Figure 1) (ZOFED, 2011). According to ZOFED (2011), the estimated total population size of the Woreda is 269,931 (male 136,233 and female 133,698). The total area is 341.14 km^2 with estimated population density of 791.3 persons/ km^2. The woreda has 32 rural and 3 urban kebeles and total households of the woreda is 53,986 (27,533 males and 26,453 females) (ZOFED, 2011). Agro-ecology of the woreda includes Woinadega, Kola and Dega which accounts 45.4%, 26.9% and 27.7% respectively. It is also one of food insecure woreda in the region that 15,318 (6% of total woreda population) are assisted by food security program of the region (ZOFED, 2011)

Figure 1: Sidama Zone and Shebedino Woreda Administration Map



Source: SZoFED

3.2 Data Sources

The main data for this study were generated through both primary and secondary sources. Primary data were collected through household interview, key informant interview, and field observation. In supporting the information gathered through primary sources, secondary data related to institutional issues pertains to the management and other pertinent data was collected from concerned bodies of regional, zonal and woreda offices.

3.3 Sampling Technique

In order to capture representative sample, multi-stage sampling techniques was employed.

- Sidama zone was selected out of 14 zones and 4 special woredas of the SNNPRS with a purposive sampling technique because the zone encompasses a number of food insecure woredas;
- Shebedino woredas was selected using purposive sampling technique from 19 rural woredas and two City Administration of the Sidama Zone because of chronic food insecurity and high population density compared to other woredas in the zone
- Stratified random sampling technique was employed to classify total rural kebeles into two groups; food secure and food insecure
- Simple random sampling technique was employed to select two kebeles from the food secured and two kebeles from the food insecure stratum. Finally, four kebeles namely; Morocho Shondolo, Morocho Nagasha (food secure), Midire Genet and Konsore Anno (food insecure) were selected for the study. Therefore, this could provide chances to the researcher to view the issue of food security in relation with livelihood diversification.
- Finally, systematic sampling technique was employed to select final unit of analysis from four kebeles. A total of 198 households of respondents were selected from the respective complete list of households in each kebeles obtained from the Woreda Administration and kebeles offices in the 4 kebeles.

- Finally, the list of kebeles covered by the size of ultimate sampling unit was determined by using proportionate sampling technique, giving a size of 49, 45, 55 and 49 from Morocho Shondolo, Morocho Nagasha, Midire Genet and Konsore Anno respectively.

Table 1: Sample kebeles and sample size distributions

Kebele	Number of Household	Sample size	Percent
MorochoShondolo	1652	49	25
MorochoNegasha	1502	45	22
Midire Genet	1848	55	28
Konsore Anno	1664	49	25
Total	6666	198	100%

Source: Author's calculation from ZOFED, 2013

This study was adopted Yamane's, (1967) formula for sample size determination given as:

$$n = \frac{N}{1 + N(e)^2}$$

Where: n = Desired sample size

N = Total population size

e = Accepted error limit (7%) on the basis of 93 percent degrees of confidences.

$$n = \frac{6666}{1 + 6666(0.07)^2} = 198\text{HHDs}$$

3.4 Data Processing and Analysis

The collected data was cleaned, coded and verified by using statistical techniques; principally descriptive statistics and logistic regressions were estimated using STATA 12.

3.4.1 Descriptive Statistics

Descriptive statistics is used to identify the general pattern of the data set with the use of percentage, mean and standard deviations. Chi-square and F-tests are employed to measure the discrete and continuous explanatory variables degree of association between dichotomous dependent and independent variables to screen the variables for logistic regression.

3.4.2 Econometric Model Specification

In order to assess the determinants of smallholders' livelihood diversifications and its implication on households' food security logit model was employed on the different means of livelihood defined by Simpson's diversification index as dependent variables (Patil and Taillie, 1982). The Diversification Index, the dependent variables, was computed using Simpson's diversification index formula given by Heckman two-stage selection model was used.

$$SDI = 1 - D \quad \textbf{(1)}$$

$$D = \frac{n1(n1-1)+n2(n2-1)+n3(n3-1)+\cdots nk(nk-1)}{Nk(Nk-1)} \quad \textbf{(2)}$$

$$SDI = 1 - \frac{n1(n1-1)+n2(n2-1)+n3(n3-1)+\cdots nk(nk-1)}{Nk(Nk-1)} \quad \textbf{(3)}$$

Where, D - is measure of livelihood diversity,

SDI - Simpson Diversity Index

n_i - income from activities i

N - Household total income

D - Livelihood Diversification

The value of Simpson index lies between 0 and 1. When the value of the Index is 0, that household did not diversify income sources i.e., household specialized on a single income source (not diversify) and when its value approaches to 1, the level of diversification increases. On the other hands,

Berger Parker Index of livelihood sources can range between minimum of 1 and maximum of eight activities [1≤ D ≤ 8]. Alternatively, D ranges from 0.125 ≤ D ≤1.00 where, D = 1/ N and N is the maximum possible number of livelihood activities that available in the rural areas based on different literature review. These are On-farm, Off-farm, Non-farm, Wage (farm wage and non-farm wage activities), Salary (government and private employment), Seasonal migration (local and abroad), Food for work and other activities. The other food accessibility index was employed to measure the implication of household food security by using household calorie acquisition method. Food security status of the area was computed through the analysis of quantitative data collected on food consumption pattern of the households. The amount and type of food consumed per household per week converted into amount of energy in kcal consumed per Adult Equivalent (AE) per household per day.

Therefore, the logistic regression model was employed to investigate the Determinants of Smallholders Livelihood Diversifications used the dependent variable is a dichotomy and the independent variables are of any type. It applies maximum likelihood estimation after transforming the dependent into a logit variable (Garson, 2008). It estimates the odds of a certain event occurring. The dependent variable with a logit, which is the natural log of the odds, is stated as;

$$\ln\left[\frac{p}{1-p}\right] = \alpha + X \qquad \textbf{(4)}$$

$$P = \frac{e^{\alpha+\beta X}}{1+e^{-\alpha+\beta X}} \qquad \textbf{(4)}$$

Where, *P* is the probability of the event occurring, *X* are the independent variables, *e* is the base of the natural logarithm and, α and are the parameters of the model. The empirical form of the model used in the study is as follows:

$$\Pr(Y=1) = \frac{1}{1+e^{-(\alpha+\beta X)}} \qquad \textbf{(5)}$$

The probability that an event occurs (when Y=1) relative to an event not occurring (when Y=0).

Y= ln(odds(event)) = ln(prob(event)/[prob(nonevent)] = ln(prob(event/[1-prob(event)]).

Therefore;

$$Y = \alpha o + \beta 1X1 + \beta 2X2 + \cdots \beta nXn \quad \textbf{(6)}$$

Where α_0 is the constant with $X_1 \ldots X_n$ independent variables of livelihood diversification probability of choice and $_1 \ldots _n$ were the coefficients estimated. The dependent variable was dichotomous variables and modeled as: Y= Livelihood Diversification = Pr Y; (1 = Smallholders livelihood diversified, 0 = otherwise). Similarly, smallholders livelihood diversified [1] or not diversified [0] with the items related to implication on households food security. The goodness-of-fit of the logit model was measured by the McFadden (2002) with likelihood ratio statistics as the basis of inference with a chosen significance level of 10%, 5% and 1% probability level.

Multicollinearity can be problem for multiple regressions (Hinton, 2004). The case of an exact linear relationship among the regressed is a serious failure of the assumption of the model, not the data. It is diagnosed by checking related statistics such as tolerance value, Variance inflation Factor (VIF), Eigen value and condition number (Greene, 2003). In this study, multicollinearity between the independent variables was tested using Variance Inflation Factors (VIF) for continuous and contingency coefficient tests for discreet variables respectively. The multicollinearity was tested using variance inflation factor (VIF) for all continuous independent variables given by;

$$VIF\ (Xi) = \frac{1}{1-Ri^2}$$

Where:

Ri^2 is multiple coefficient of determination i a regression of the i^{th} predictor in all other predictor. VIF (Xi) is the Variance inflation factors associated with the i^{th} predictor.

3.4.3. Key Variables Selection and Definitions

The key Determinants of Smallholders Livelihood Diversification and its Implication on Households Food Security" are as follows:

Sex of Households Heads (SEXHHD*)*: Sex is dummy representing household heads and it takes the value 1 if male, 0 otherwise. Men and female have different access to resources and opportunities (Ellis, 2000). Therefore, the study hypothesized that male households more likely diversified their livelihood than female households.

Age of households head (AGEHHD*):* Age of households represents continuous variables and it refers to the sample households head in years. As a result, households' age more likely shows mixed result on livelihood diversification.

Marital Status of households head (MARTST*):* Marital status is categorical representing household heads and it takes the value 1=Married; 2=unmarried; 3=divorced; 4=widowed. Therefore, the thesis hypothesizes that married households head more likely to diversify their livelihood activities than single, widowed or divorced and positive effect on Livelihood Diversifications.

Information Access (ACCESINF): It represents the dummy variables that takes 1, if information accessible, 0 otherwise. Information access on, off, non-farm activities or market and/ or job opportunities more likely expected to positive relation with Livelihood Diversification. Because it provide information for households that helps for his decision to participate on multiple livelihood sources.

Dependency Ratio (DEPRATIO*)*: Dependent ratio refers to the continues variables proportion of economically inactive labour forces (less than 15 and above 65 years) to the active labour force (between 15 and 65 years old) with in a households. Therefore, the relationship between Livelihood Diversification and dependency ratio more likely hypothesize to be positive.

Educational level of households head (EDUCHHD*)*: Education refers to continuous variables of the households' was last grade completed. This study hypothesizes that education level of households more likely to diversify their livelihood activities than illiterate households. So, education of households head is more likely to be positive relation with livelihood diversifications.

Family size (FSIZE): The size of family is also one of important continuous variables that affect households' livelihood diversifications. Therefore, a family size of households will be expected positive relationship with livelihood diversification.

Land Size of Household in Hectare (LSIZE1*)*: Land size in hectare is continuous variables of livelihood diversification and the size of land increases; it requires more labor to be employed on-farm activities. Thus, the study hypothesized that land size of households is more likely to negative with livelihood diversification.

Livestock ownership in Tropical Livestock Unit (TLU): A Livestock ownership in TLU is continuous variable. It is measured by TLU. So, the study hypothesized that, Livestock ownership is more likely negative relation with livelihood diversification.

Access to safety net (SAFETYBE): Access to safety net programs is dummy variables that provide some resources such as farm equipment and loans which widen opportunities to participate on non-farm activities and on-farm income sources. Thus, the study hypothesize access to safety net is more likely to positive relation with livelihood diversification.

Access to irrigation (USEIRRG*):* Access to irrigation is a dummy variable that provides opportunities to households and individuals to grow multiple cropping of agricultural products. In turn, it helps to create surplus output. So, it hypothesized that access of irrigation is more likely to positive relation with Livelihood Diversifications.

Distance of Market in km (MARKET2): Distance of market from urban center to households home is continuous variables and measured by

kilometers (km). So, it hypothesized that distance of the market more likely negative relation with livelihood diversification.

Credit Utilization (CREDITUT*):* Credit Utilization is a dummy variables that influencing variable in livelihood diversifications. Therefore, the study hypothesize that credit utilization is more likely positive relationship with Livelihood Diversifications.

Membership in the Organizations (MORGANIZ)*:* Membership of households in the organization is a dummy variables that influencing smallholders livelihood diversification. Therefore, the study hypothesized that membership is more likely to diversify their livelihood than their counterparts.

Training of Households (TRAING*):* Training of households on livelihood diversification is dummy variables that influence smallholders' livelihood diversification positively. Therefore, this study hypothesize that non-farm activities, being skill based training, increases the possibility of getting non-farm jobs. So, access to training and Livelihood Diversification is more likely to be positively related.

Income (LACTIVIN*):* Household income is a continuous variable that influence smallholders' livelihood diversification positively. So, the study is hypothesis that income level of households increase more likely to have positive relation with livelihood diversification.

Agricultural input use in kg (AGRINPUT): The use of agricultural input use in kg is dummy variables that affect smallholders' livelihood diversification negatively. Therefore, this study hypothesize that agricultural input use is more likely to negative relation with livelihood diversification.

Household Food Shortage Experiences (FOODSHEX): The household food shortage experience is a dummy variable that influence smallholders' livelihood diversification positively. So, the study hypothesized that the experience of food shortage of household is more likely to positive relation with Livelihood Diversifications.

Table 2: Expected sign of the predictors of Livelihood Diversifications

Variable Definition	Symbols	Measurements	Type of variables	Hypothesized sign
Smallholder Livelihood Diversification Status	SHLIDIVE	1= if diversified; 0= otherwise	Dummy	independent variables
Sex of households	SEXHHD	1=Male;0=Female	Dummy	(+)
Age of households Head	AGEHHD	In year	Continuous	(+/-)
Marital Status	MARTST	1=Married;2=unmarried; 3=divorced; 4=widowed	Categorical	(+)
Information access	ACCESINF	1=YES , 0= otherwise	Dummy	(+)
Dependency ratio	DEPRATIO	Ratio of dependency	Continuous	(+)
Education level of households head	EDUCHHD	Last grade completed	continuous	(+)
Family size	FSIZE	In number	Continuous	(+)
Land size of households in hectare	LSIZE1	In hectares	Continuous	(-)
Livestock ownership in TLU	TLU	In TLU	Continuous	(-)
Access to safety net	SAFETYBE	1= if yes, 0=otherwise	Dummy	(+)
Access to irrigation	USEIRRG	1= if yes, 0=otherwise	Dummy	(+)
Distance of Market in km	MARKET2	In Km	Continuous	(-)
Credit Utilization	CREDITUT	1= if yes, 0=otherwise	Dummy	(+)
Membership in Organization	MORGANIZ	1= if yes, 0= otherwise	Dummy	(+)
Training of Households	LTRAING	1= if yes, 0= otherwise	Dummy	(+)
Income	LACTIVIN	In Ethiopians Birr	Continuous	(+)
Agricultural input use	AGRINPUT	1= if yes, 0= otherwise	Dummy	(-)
Household Food Shortage Experiences	FOODSHEX	1= if yes, 0= otherwise	Dummy	(+)

4. Result and Discussion

4.1 Descriptive Analysis

This study was analyzed key variables under livelihood capital assets. This livelihood capital asset includes Human capital, Natural capital, Physical capital, Social capital and financial capital assets.

4.1.1 Human Capital

Human capital represents the skill, knowledge, education, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. In this study of human capital assets incorporated the education level of households was discussed under this section.

4.1.1.1 Education level of households

Educational attainments of household and family members are considered as one of the key determinants of improving households' wellbeing. The study reveals among total sampled household, 66.16% of households were illiterate, 23.74% of household sample were educated primary school (1-8), 5.56% of households were learned secondary education, 3.03% educated preparatory school and 1.52 were educated diploma and above(Table 3). The result indicated that majority of household head were illiterate and less diversified than their counter parts. The statistical test shows that there is significant difference between livelihood diversification or not and education level of households. The difference between the households those who have diversified their livelihood activities and their counter parts in their educational status at a probability level of 99% confidence interval (Table 3)

Table 3: Education level of households

Education level	Frequency (n=198)		Percentage (n=198)		Total	
	LD	LND	LD %	LND %	Freq	%
Illiterate	66	65	51.6	92.9	131	66.16
1-8	43	4	33.6	5.7	47	23.74
9 and 10	11	0	8.6		11	5.56
11 and 12	5	1	3.9	1.4	6	3.03
Diploma and above	3	0	2.3		3	1.52
Mean					1.5	
St. deviation					.853479	
$\chi 2$					35.1	
p-value					0.002***	

*, **, *** significant at 10%, 5% and 1% probability level

Note: LD denotes livelihood diversified; and LND denotes livelihood not diversified

Source: Own survey, 2014

4.1.2 Natural capital

Natural capital is the term used for the natural resource stocks from which resource flows and services useful for livelihoods are derived. None of us would survive without the help of key environmental services and food produced from natural capital (DFID, 1999). In this study, natural capital comprises land size in hectare held by the households was the key variable of the study.

4.1.2.1 Land size of households in hectare

From any other productive resources land is by far the most important resource in agriculture production. That is why the community wealth ranking begun with consideration of land in wealth breakdown. The study reveals that from total sample size 58.75%, 21.24%, 12.8% and 6.2% households were owns 0.1 to 0.5, 0.51 to 1.0, 1.01 to 2.00 and 2.1 to 7 hectares of land size respectively (Table 4). However, only 1.01% of household heads were non land ownership. Average land holding of households was 0.727 hectare. The F test revealed that the mean difference between the households those who have diversified and those have not

diversified their livelihood with respect to the land size is statistically significant at 5% probability level (Table 4).

Table 4: Land size held by sample households

Land size held by HHs in hectare	Frequency (n=198)		Percentage (n=198)		Total	
	LD	LND	LD %	LND %	Freq	%
0 hectare	0	2	0	2.9	2	1.01
0.1-0.5	90	27	70.3	38.6	117	58.75
0.51-1.0	22	20	17.2	28.6	42	21.24
1.01-2.00	11	14	8.6	20	25	12.8
2.1-7	5	7	3.9	10	12	6.2
Mean					0.727	
St. deviation					0.67	
F					0.1495	
p-value					0.050 **	

*, **, *** significant at 10%, 5% and 1% probability level

Note: LD denotes livelihood diversified; and LND denotes livelihood not diversified

Source: Own survey, 2014

4.1.3 Physical Capital

Physical capital comprises capital asset that can be created by economic production processes. Under this livelihood asset physical capital includes livestock ownership in TLU was described.

4.1.3.1 Livestock Holding in Tropical Livestock Unit (TLU)

Livestock is one of the most important and crucial assets that farmers heavily depend on to safeguard their household from any sort of crises. Livestock is considered as a security during crop failure and additional income for farmers in Ethiopia. The role of livestock as a source of food is critical for human kind. Livestock's are also considered as a measure of wealth in the rural areas. Farm household having more number of livestock are considered as wealthy farmers in the farm community and they were not interested to diversify their livelihood activities. The study explicated that out of 198 sampled households, 166 (83.84%) own livestock though the number of

livestock were not large. The mean livestock holding in Livestock Tropical Unit (TLU) for the sample households is 1.74. The statistical analysis showed that the difference between households who have diversified and those who have not diversified in their livestock owning conditions is significant at less than 1% probability level (Table.5).

Table 5: Livestock ownership in TLU

Livestock ownership in TLU	Frequency (n=198)		Percentage (n=198)		Total	
	LD	LND	LD %	LND %	Freq	%
None of Livestock	11	21	8.6	30	32	16.2
0.13-1.0	65	11	50.8	15.7	76	38.4
1.13-2.0	40	25	31.25	35.7	65	32.83
2.13-5.13	12	13	9.4	18.6	25	12.65
Mean					1.74	
St. deviation					1.37	
F					0.1214	
p-value					0.008***	

*, **, *** significant at 10%, 5% and 1% probability level

Note: LD denotes livelihood diversified; and LND denotes livelihood not diversified

Source: Own survey, 2014

4.1.4 Social Capital

Social capital refers to community and wider social claims on which individuals and households can draw by virtual of their belonging to social groups of varying degree of inclusiveness in society at a large. Social capital may be defined as ability of actor to secure benefits by virtue of membership in social networks or social structures (Krishna, 2000). It entails reciprocity within communities and between households based on trust deriving from social ties (Moser, 1998). Social and cultural institutions can have a major impact on poor households' access to resources. Social capitals incorporated information access and membership in organization were described under this topic.

4.1.4.1 Access of Information

Information plays an indispensable role to encourage the households to participate in income generating activities. In this specific study, information could play a key role to improve the households' wellbeing by diversifying their livelihood activities. The survey result shows that 72.22% of households obtained information of livelihood diversification from different sources. The remaining 27.78% was not found any information about livelihood diversification by other sources. The mean value of access of information about livelihood diversification of households was 0.72 (Table 6). The chi-square test of the data reveals that statistically significant difference between the households who have diversified and those who have not diversified in the level of information access at probability level of 1%.

Table 6: Access of Information of Sample Households

Access of information	Frequency (n=198)		Percentage (n=198)		Total	
	LD	LND	LD %	LND %	Freq	%
Yes	115	28	89.8	40	143	72.22
No	13	42	10.2	60	55	27.78
Mean					.72	
St. deviation					.45	
$\chi 2$					56.04	
p-value					0.000***	

*, **, *** significant at 10%, 5% and 1% probability level

Note: LD denotes livelihood diversified; and LND denotes livelihood not diversified

Source: Own survey, 2014

4.1.4.3 Membership in Organizations

In the study areas almost every one is a member of either of the traditional local institutions such as Iddir, Ikub, cooperatives and so on. Membership to such institutions increases the social networks of households that in turn enable to obtain pooled labour and cash in credit where individual households are incapable otherwise. The result of the study shows that 79.3% of households were members of one or more organization and the remaining 20.71% were not member of any organization (Table 7). The Chi

square of the data reveals that there is statistically significant difference of households those who have diversified and not diversified their livelihood at less than 1% probability level in their condition of membership in respective social institutions.

Table 7: Membership in Organizations

Membership in organization	Frequency (n=198)		Percentage (n=198)		Total	
	LD	LND	LD %	LND %	Freq	%
Yes	119	38	92.97	54.3	157	79.29
No	9	32	7.03	45.7	41	20.71
Chi square					62.24	
p-value					0.000***	
Mean					1.9	
St. deviation					2.1	

*, **, *** significant at 10%, 5% and 1% probability level

Note: LD denotes livelihood diversified; and LND denotes livelihood not diversified

Source: Own survey, 2014

4.1.5 Financial capital

Financial capital refers to stocks of money to which the household has access. This mainly involves credit use in the form of loans, saving ability, and receiving remittance. The study thus analyzed credit utilization and income of households under this section.

4.1.5.1 Credit Utilization

The most commonly reported obstacle to investment and entrepreneurship is access to capital (Davis, 2003). The availability of agricultural credit to subsistence farmers who have little or no capital or savings to invest in farming is important components of small farm development programs. Moreover, credit is an important source of earning future income. Those households who received farm credit have possibility to invest in farming activities, which is important component in small farm development programs. In line with this, an attempt was made to assess the number of

households who had benefited from credit. The study result showed that 45.45% of households received credit while 54.55% did not receive due to various reasons (Table 8).The chi square test of the data reveals that there is statistical difference between the households who have diversified and have not diversified their livelihood in relation with the credit utilization status at less than 1% probability level.

Table 8: Credit Utilization

Credit Utilization	Frequency(n=198)		Percentage(n=198)		Total	
	LD	LND	LD %	LND %	Freq	%
Yes	67	23	52.34	32.86	90	45.45
No	61	47	47.66	67.14	108	54.55
Mean					.455	
St. deviation					.499	
$\chi 2$					6.9307	
p-value					0.008***	

*, **, *** significant at 10%, 5% and 1% probability level Note: LD denotes livelihood diversified; and LND denotes livelihood not diversified

Source: Own survey, 2014

4.1.4.2 Income of Households

In all places of rural Ethiopia, the households income is attributed to farm; agricultural and livestock production. However, some of the households diversify their activities and get more income to improve their livelihood. In the study area, 51.5%, 37.4% and 11.1% of households earn the annual income with category of 500 to 5000, 5002 to 10,000, and 10,300 to 22,100 ETB respectively. This implies that majority of households earn low level income. The mean value of households' annual income was 6,188.3 and standard deviation was 3,928.8. This shows that the households earn an average annual income of 6,188.3 (Table 9). The chi square result revealed that there was significant difference between the two groups with their livelihood diversification status in relation with their income level at a probability of 1%.

Table 9: Income of Households

Households annual income	Frequency (n=198)		Percentage (n=198)		Total	
	LD	LND	LD %	LND %	Freq	%
500 to 5,000	54	48	42.2	68.6	102	51.5
5,002 to 10,000	60	14	46.9	20	74	37.4
10,300 to 22,100	14	8	10.9	11.4	22	11.1
Mean					6,188.3	
St. deviation					3,928.8	
F					0.000	
p-value					0.000***	

*, **, *** significant at 10%, 5% and 1% probability level Note: LD denotes livelihood diversified; and LND denotes livelihood not diversified

Source: Own survey, 2014

4.2. Econometric Result

As it is discussed in section 3.4.2, the binary logistic regression model is used to estimate and identify the determinant of smallholders' livelihood diversifications and its implication on households' food security in the study area. Before fitting into logit model, it is essential to check whether there was high degree of association among and between continuous and discrete explanatory variables which might produce incorrect results or not. To check the same, variance inflation factor (VIF) and contingency coefficient were used for continuous and discrete variables respectively. Examination of the existence if inter-correlation among and between selected independent variables was carried out before fitting the binary regression models. The existence of this effect in the model can be checked by using tolerance or variance inflation factor (VIF). For the regression of independent variable, tolerance is $1\text{-}R^2$ ignoring the dependent variable. The higher inter-correlation of the independent variables, the more the tolerance level will approach to zero. As a rule of thumb, if a tolerance is more than 10multicollinearity problem is indicated (Schwarz, 2007). Tolerance for the model is less than 10 there is no effect of multicollinearity on the model. The variance inflation factor (VIF), which is the reciprocal of tolerance

($\frac{1}{1-R^2}$) shows whether or not the explanatory variables are related to each other. When VIF is high, there will be high multicollinearity and instability of beta (ß) coefficients (Annex 2).

4.2.3 Model Adequacy Checking

Before giving interpretation for each estimate of parameter in the model, it is better to assesses model if it is good fit or not. The various goodness of-fit measures validate that the model fits the data well. The value of Wald Chi-square test shows the overall goodness-of-fit of the model at less than 1 percent probability level. Additionally, goodness-of-fit in logistic regression analysis is measured by pseudo R^2, which works on the principle that if the predicted probability of the event is greater than 0.5, the event will occur, otherwise not occur (Annex 7 - 9).

4.2.4 The Determinants of Smallholders Livelihood Diversification and Its Implication of Household Food Security in Shebedino Woreda

The determinants of smallholders' livelihood diversification and its implication on households' food security was examined and reported by using logistic regression model (Floyd et al., 2003). The binary logistic regression model was estimated the values fitted the observed data reasonably well. Measures of goodness-of-fit of the model results indicated that the independent variables were simultaneously related to the log odds ratios of livelihood diversification index (with Simpson Index, and Berger-Parker Index) and food accessibility index. Simpson index correlated with independent variables predicted that households' livelihood diversification were measure goodness-of-fit positively, negatively and correctly classified by 91.54%, 86.76% and 89.90 respectively(Annex 7). This is more than adequate for cross-sectional data. Livelihood diversification index (DI) as a dependent variable was calculated based on the amount of income earned from each individual livelihood sources and the number of actual livelihood activities per actual livelihood sources (Berger Parker Index) undertaken by farm households to maximum possible livelihood activities in the study area. On the other hand, to analyze implication of livelihood diversification on

households' food security, the food accessibility index was taken as dependent variable because it was affected by various independent variables. Thus, these three dependent variables were regressed separately against expected independent variables by using binary outcome of logistic regression (reporting odd ratios) (Annex 8 - 10).

Table 10: Econometric Result of Binary Logistic Regressions for Determinants of Livelihood Diversification, Shebedino *Woreda,* 2014 (n = 198)

Variables	Simpson Index			Berger Parker Index			Food Accessibility Index		
	Odd Ratio	Z	P	Odd Ratio	Z	P	Odd Ratio	Z	P
AGEHHD	.9741038	-1.76	0.078	.9918371	-0.50	0.620	.9880803	-0.80	0.423
ACCESINF	14.13602	4.25	0.000	11.84365	3.82	0.000	8.009478	3.61	0.000
DEPRATIO	.8560536	-0.39	0.698	.8702853	-0.38	0.707	.731514	-0.97	0.333
EDUCHHD	4.317502	3.53	0.000	4.154115	3.39	0.001	3.748966	3.43	0.001
LSIZE1	.6151016	-2.56	0.010	.5944452	-3.10	0.002	.7176401	-1.65	0.098
TLU	1.828203	2.77	0.006	1.51351	2.03	0.042	1.579413	2.48	0.013
$Market_2$	.9898507	-0.10	0.924	1.006414	0.06	0.951	.977002	-0.25	0.804
CREDITUT	3.240004	2.01	0.044	2.955421	2.05	0.040	2.704914	2.12	0.034
MORGANI	10.45358	3.51	0.000	8.828643	3.17	0.002	6.202976	3.05	0.002
LITRAING	1.280722	0.34	0.733	1.680861	0.80	0.425	1.40506	0.56	0.574
LACTIVIN	1.000141	1.70	0.088	1.000155	2.13	0.033	1.000158	2.29	0.022
cons	.0051854	-3.69	0.000	.0027	-4.28	0.000	.0078071	-4.03	0.000

*, **, *** significant at 10%, 5% and 1% probability level

Note: LD denotes livelihood diversified; and LND denotes livelihood not diversified

Source: Own computation, 2014

From the eleven variables included in the Simpson Index, the Wald $\chi 2$ test results for eight of these indicated that statistically significant influence on livelihood diversification (Table 10). These included age of households head, information access, education level of household head, land size of households in hectare, livestock ownership in TLU, credit utilizations, membership in organizations, and income of households heads were statistically significant influence on livelihood diversification. The dependency ratio, distance of market in km and training of household had been statistically non-significant.

The results from the model tell that characteristics of households could be a good source of knowledge on the reasons why households may or may not livelihood diversified. Many programmes aimed at promoting a given technology on agricultural intensification has tended to focus more on the extension package dissemination of improved seeds and fertilizers. The effect of the significant Explanatory variables on food security status of the household is discussed as follow.

Age of households head (AGEHHD): In this study, age of household head was hypothesized that it might have mixed (negative or positive) influence on smallholders livelihood diversification and statistical significant. As far as Simpson index is concerned, the result explicated that age of households have negative correlation with smallholders livelihood diversification and statistically significant at P<0.1, while in the case of Berger Parker and Food Accessibility Indices age of households is not statistically significant. As age of households increased by 1 year, smallholders' households' livelihood diversification based on Simpson index decreases by the factor of 0.974 odds, i.e., the probability of older ages household heads diversified the livelihood less than that of their counterparts. This result also does coincide with findings with Somda *et al.* (2002) where farmer age was negatively related to the probability of adopting new technology or innovation. In the study area, older households bring forward many useful insights and are able to analyze trends of the food security problems and how to mitigate the problems (FGD). This implies that older household heads have higher economic status and higher capability to afford food security.

Information Access (ACCESINF): Information Access of livelihood diversification from different sources was hypothesized to have a positive relationship between information and livelihood diversification because information helps households to allocate surplus labor and to take job opportunities that available within and outside the study area. The results reveals that access of information was influenced the livelihood activities positively and statistically significant at (P<0.000). In favor of households who could access information, livelihood diversification was increased by a factor of 14.14, 11.84 and 8.01 odds of dependent variable with respect to Simpson index, Berger Parker Index and food accessibility index

respectively. It is a reasonable to believe that well informed households might move on the right direction if they are interested to reduce food insecurity through undertaking of different livelihood activities. Other similar studies conducted by Mathewos (2013) confirmed that access of information was positively related and statistically significant with livelihood diversification.

Education Level of Households Head (EDUCHHD): for livelihood diversification skill development through education has a vital importance. As predicted in the hypothesis, education affect smallholders livelihood diversification positively and significantly with Simpson index, Berger Parker Index and food accessibility index at $P<0.001$, $P<0.001$ and $P<0.001$ respectively. In favor of those who are educated households, their livelihood increased by factors of 4.32, 4.15 and 3.75odds of Simpson index, Berger Parker Index and food accessibility index respectively. The result reveals that the more the educated household, the more tend to diversify household livelihood activities to ensure their families wellbeing. This result implies that livelihood diversification, which could be favoured by household education, increases food supply for smallholders' households of the study area. In support of this result, educational attainments of household and family members are considered as one of the key determinants of non-farm earnings. The skilled and educated labor may be self-employed or can secure stable long-term employment at fairly high salaries than unskilled and uneducated one who rely on more unreliable and lower paying temporary wage labor in the farm sector. In this regard, educational attainment can be seen as an entry barrier to enjoy to better paying non-farm employment or self-employment in rural Africa (Barrett *et al.*, 2001).

Land Size of Households in Hectare(LSIZE1): As hypothesized, the size of land owned by the household has a significant ($p<0.01$, $p<0.001$ and $p<0.1$) with Simpson index, Berger Parker Index and food accessibility index respectively and negative correlation with the likelihood of choosing livelihood diversification. The result of this study indicates that as land size increased by 1 hectare, livelihood diversification of households decreased by a factor of 0.615, 0.594 and 0.718 odds with Simpson index, Berger Parker Index and food accessibility index respectively. The results of this study

suggest that rural households with more land tend to follow agricultural intensification rather than diversifying from agriculture since they draw incentives of land productivity. Discussant also confirmed that households who have more land size do not have interests to diversify their livelihood activities because the households feel they could obtained enough income and improve families' living standards based on agriculture (FGD). This implies the chances of choosing agriculture in the context of having large land size decrease the probability of diversifying to off farm and nonfarm activities. In support of this result, Mathewos (2013) avowed that land size owned by household was found to be negative, strongly and significantly related to livelihood diversification. This shows that farmers just switch away from off-farm activities when the farm activity is promising; and hence, this supports the necessity argument as opposed to the choice argument. Farmers consider off-farm activities as a last resort income source if crop production fails. Therefore, it plausible to declare that spacious land size would not allow households to diversify their livelihood and hence large size of land may not be a mere guarantee for sufficient supply of food for smallholders livelihood rather diversifying livelihood activities remain important in study area.

Livestock ownership in TLU (TLU)*:* Contrary to the hypothesis, livestock ownership in TLU was positively influence households choice of diversification and statistically significant at less than 1%, 5%, and 5% probability level with respect to Simpson index, Berger Parker Index and food accessibility index respectively. In favor of a household whose ownership of livestock increased by 1 unit of TLU, livelihood diversification of households increased by the factors of 1.83,1.51 and 1.58 odds of Simpson index, Berger Parker Index and food accessibility index respectively. That means the farmer with higher livestock holding would be obliged to diversify livelihoods into off and nonfarm in order to meet family needs. This would also help increase food accessibility as it could increase income to undertake different livelihood diversification activities. At this juncture, most of the discussants believed that more Livestock ownership of households enable to earn more income by renting ox, horse and donkey cart and sales of animals and animals products which in turn enable to diversify livelihood activities (FGD). The result is in line with the findings of

Abraham (2004), and Smith (2001) indicated that livestock possession have significant and positive impact on livelihood diversification.

Credit Utilization (CREDITUT): The actual borrowing from institutional as well as non-institutional sources is considered as a determinant of livelihood diversification. Analogous to expectation, credit use is found to have a positive impact on the likelihood of choosing diversified livelihood strategy which combines agriculture, off farm and nonfarm and statistically significant ($p< 0.05$) in terms of three indices of livelihood diversification. In favor of the households those who are able to utilize credit diversify livelihood activities by the factor of 3.24, 2.96, and2.71 odds of Simpson index, Berger Parker Index and food accessibility index respectively. This positive influence may be attributed to the fact that credit use allows farmers to follow agricultural intensification by accessing farm inputs which in turn improves productivity and run other livelihood activities. This more implies that the formal and informal credit facilities that avail for rural farmers are a very important asset in rural livelihoods not only to finance agricultural inputs activities, but also to protect loss of crucial livelihood assets such as cattle due to seasonal food shortage, illness or death (Tesfaye, 2003). The result of the study, therefore, strongly suggest that farmers' access and use of credit would play important role in promoting agricultural development as well as livelihood diversification. The result is also in agreement with that of Oluwatoyo (2009). This implies that the incentive for accessing credit accelerates agricultural production and hence livelihood diversification of smallholders which would ensure food security in their setting.

Membership in Organization (MORGANIZ): This variable as hypothesized was found to be significant at $p<0.001$ with respect to Simpson index, Berger Parker Index and food accessibility index, and positively determine choice of livelihood diversification. In favor of the households who have membership in one or more social organization, livelihood diversification increased by factors of 10.45, 8.83, and 6.2 odds of Simpson index, Berger Parker Index and food accessibility index respectively. That means the household who participated in one or more social institutions would diversify livelihoods into off and nonfarm since social institutions promote access to social capital in which off/ nonfarm options are gained.

Culturally, appropriate forms of social capital also appear to have the potential to aid rural income generation and reduce vulnerability to income shocks. As group discussants revealed, cooperation in the form of credit unions, producer organizations, ikub, idir, and churches have positive effects on the income generating capacity of their members and, through production linkages, on the wider local economy in the study area. These social capital assets would also be equally important to motivate rural people in their setting of the study area to win the bread through hard working. The result is in line with that of Warren (2002), Bezemer, Lerman (2002), Nassi *et al* (2010) and Mathewos (2013).

Income of Household (LACTIVIN): Livelihood diversification requires income and it also enable households to produce more income to ensure family well being. As it was anticipated, income influences livelihood diversification positively and statistically significant at $p<0.1$, $p<0.05$, and $p<0.05$ with the respect to Simpson index, Berger Parker Index and food accessibility index respectively. Surprisingly, odds of the three indices increased by 1 factor infavour of livelihood diversification for smallholders who had more income to undertake different livelihood activities. In similar indication, increases of household income by 1 birr while livelihood diversification increased by the factor of 1 odd of the three dependent indices. The result implies that household income is very decisive factor that make smallholders undertake different livelihood activities which would in turn commensurate with food accessibility of the households in the study area. The result is in line with Smith (2001) who indicated that household head agricultural income, non-farm activity and income gain from remittance and gift have positive and significant impact on household livelihood diversification.

5. Conclusion and Recommendation

5.1 Conclusion

There is no difficulty of underdevelopment that can be more serious than food insecurity that has an important implication for long term economic growth of low income countries. Ethiopia is one of the low income country has been overwhelmed with food insecurity for decades. The problem is

worsening, despite massive resources invested each year into humanitarian aid and food security programs. Food insecurity in the long run may cause irreparable damage to livelihoods of the poor, thereby reducing self-sufficiency. Rural poor on their part struggle to ensure food security status by participating in diversification activities. The contribution made by livelihood diversification to rural livelihoods has often been ignored by policy makers who have chosen to focus their activities on agriculture. This study was carried out to contribute the determinant of smallholder's livelihood diversification and implication on household's food security in Shebedino Woreda.

The main objective of this study was to identify and analyze the determinants of smallholders' livelihood diversification and its implication on households' food security in Shebedino *Woreda*. The study employed "cross sectional survey" with quantitative and qualitative methods. Simple random sampling technique was employed to select two kebeles from the food secured and two kebele from food insecured stratum purposively. As a result, four *kebeles* namely; MorochoShondolo, MorochoNegasha, Midire Genet and Konsore Anno were selected for the study out of 32 rural *kebeles* of the *Woreda*. The ultimate targets of the study, 198 households' were selected using simple random sampling. Primary data were collected using close ended questionnaires, Key Informants Interview (KII) and FGD, while secondary data on livelihood activities were collected from books, office records and journal articles. The study employed Simpson Diversity Index and Berger-Parker Diversity Index to measure level of livelihood diversification and food accessibility index was used to examine the implication on food security at household level. The binary logistic regression (reporting Odd ratio) model was examined the key determinants of smallholders' livelihood diversification and its implication on households' food security.

The result of the study indicates that 64.6%, and 35.4% of households was diversify their activities into multiple livelihood activities and not diversify livelihood activities respectively, which means non diversified livelihood activities of households have engaged only in one livelihood activity to lead healthy and productive life. The diversification index for these household 0

to 0.49 and 0.5 to 1 was implying no diversifying and diversifying livelihoods activities at household's level respectively. In general, diversification of livelihoods has been found very limited among the rural households in Shebedino *woreda.* This attributes very little support towards rural enterprise development. Consequently, source of smallholders' livelihood would be constrained if they failed to increase crop production due to different reasons; for instance climatic conditions and provided that they failed to engage in alternative source of livelihood activities.

Binary logistic regression analysis was employed to examine the key determinants of livelihood diversification. Simpson Diversity Index (SDI) and Berger Parker Diversity Index (BPDI) were employed to identify key determinants of LD. The result of both indices (SDI and BPDI) shows that information access, education level of household head, land size of households in hectare, livestock ownership in TLU, credit utilizations, membership in organizations, and income of households heads were significantly determine the livelihood diversification of household in the study area. In the case of SDI, age of households was found negative statistically significant and related to household level of livelihood diversification but remaining two indices (BPDI and FAI) age of household was not significant with household livelihood diversification. Therefore, information access, education level of household head, land size of households in hectare, livestock ownership in TLU, credit utilizations, membership in organizations, and income of households heads were key determinants of livelihood diversification in the study site.

In line with livelihood diversification implication on food security, the regression result in Food Accessibility Index (FAI) found among eleven variables that were entered into the model, seven predictors namely information access, education level of household head, land size of households in hectare, livestock ownership in TLU, credit utilizations, membership in organizations, and income of households heads were found significant and related to household level food security. Similarly, the dominant livelihood capital assets more likely influence households livelihood diversification were social capitals and financial capitals. The other livelihood capital assets less likely dominates on households'

livelihood diversification were physical capital, natural capital and human capitals. In other words, these variables were found implications on food security in the study area. In the same way, livelihood diversification was found to have positive relationship to household food security. To put it differently, as the level of livelihood sources or livelihood activities increases, the food security of households is improved.

5.2 Recommendations

Understanding livelihood assets and determinants of choices of livelihood diversification would help policy makers to design and implement more effective policies and programs for the poor and there by helps to pave away to improve food security. In this respect, this study provides a base and point of departure for similar studies in the future. Therefore, the following recommendations were made in order to benefit those who need to intervene with the issue under consideration.

Due attention should be given to exploit the opportunities that are available in the study area. Local administration as well as policy maker at local and regional level should design appropriate policy to motivate farm households to engage on multiple livelihood sources because this would solve household income short fall and critical land constraints in the area.

Government should critically design situation fitting non-farm strategies that supplement farm income because land size owned by farm household regardless of its fertility level is considered as one of the key determinants of livelihood diversification. As a result, income from farm sources was not found to provide sufficient livelihood for smallholder farmers. In addition to agriculture product that could be obtained from land, diversification and intensification capacitate smallholder farmers to diversify their livelihood sources effectively.

Government should intensify its role in the countries educational system particularly in basic and vocational education to provide in rural areas. To be more effective, enhancing the role of stakeholders who involved in rural development would be vital strategies for increasing livelihood

diversification into non-farm income sources particularly salaried jobs, wage, off farm and remittance income from seasonal migration. Thus, promoting educational access even for those household who are illiterate through informal education and formal education for present and future generation and skill development by opening training opportunities on livelihood activities in the rural areas is likely to have relatively large impact on their ability to diversify livelihood sources outside agriculture.

The livestock ownership in TLU was found to have significant implication on livelihood diversification and food security. Additional units of livestock increases the households' chance to diversify their livelihoods activities and advanced the chance of food security. Therefore, the local and regional governments and non government organizations should focus on productivity of livestock's by improving feeding, poor management practices and introducing appropriates livestock packages that could be feasible in the area.

The membership in the organization was found to have significant implication on livelihood diversification and food security and play a significant role in the rural households which would ease experience sharing and supports each others. Strengthening rural organizations, helps not only to preserve the values of a particular society but also to facilitate livelihood diversification and hence improve food security. Therefore, local government and non government organizations should consider and advocate the benefits of membership for households in the rural area.

It is strongly recommended that credit facilities should be improved and made easily accessible based on household demand by effective follow up of its utilization for productive purpose rather than consumption because addressing this determinants means concurrently addressing the food security problems of the poor households. This is because lack of credit facilities and poor access to institutional credit are overwhelmingly recognized as the important enter barrier or impeding livelihood diversification. The credit and finance bottleneck should be resolved and serious effort should be made to overcome its short comings on the basis of more conventional banking criteria.

Access of information was found to be statistically significant and have positive correlation on livelihood diversification. This implies that whenever the households get full and credible information on livelihood diversification, they would be attracted more to diversify livelihood activities and earn additional income. As a result, food security status would be improved at household level. Therefore, the government should focus on infrastructure development like telecommunication, road and transportation, radio, television and printed media services to create awareness on livelihood diversification and experiences share for rural households.

At the study area, the dominant livelihood capital assets more likely influence households livelihood diversification were social capitals and financial capitals. The other livelihood capital assets less likely dominates on households' livelihood diversification were physical capital, natural capital and human capitals. Therefore, the local and regional government and non government organization should give due attention for dominant livelihood capital assets to improve the wellbeing of households through livelihood diversification.

Livelihood diversification was positively correlated with food supply. This implies that a household those who diversify their livelihood activities could increase households' income and, concurrently, could improve food security status at family level. A great deal of the determinants of livelihood diversification and implication on households' food security at rural areas has been remained for further investigation and exploitation. Therefore, further study should be conducted so as to bring about rapid and consistent growth in income share of the non-farm sector as well as rural enterprise development that enhance economic transformation from primary sector to secondary sectors.

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Annex 1: Contingency coefficient test result of discreet variable

	sexhhd	agrinput	litraing	creditut	foodshex	accesinf	morganiz
sexhhd	1.0000						
agrinput	0.1839	1.0000					
litraing	0.1702	0.4687	1.0000				
morganiz	0.2811	0.4805	0.3385	1.0000			
creditut	0.1333	0.2115	0.0526	0.1511	1.0000		
accesinf	0.0594	0.3268	0.3382	-0.0000	-0.3718	1.0000	
foodshex	-0.6745	-0.5593	-0.4346	-0.3736	-0.1719	-0.3718	1.0000

Annex 2: Multicollinearity Test Result of continuous variables

S. No	Variable	Vif	1/vif
1	fsize	2.12	0.471698
2	agehhd	1.47	0.678918
3	tlu	1.33	0.753947
4	lsize1	1.28	0.779919
5	Educhhd	1.24	0.809103
6	Lactivin	1.08	0.927215
7	market2	1.08	0.928938
8	DEPRATIO	1.04	0.961066
	Mean VIF	1.33	

Source: Own computation, 2014

Annex 3: Binary Outcomes Logistic Regression (Reporting Odds Ratios) Estimates of Livelihood Diversification (SDI)

Simpson ($MODEL_1$)	Odds Ratio	Robust Std. Err.	Z	P>|z|	[95% Conf. Interval]	
AGEHHD	.9741038	.014495	-1.76	0.078*	.9461044	1.002932
ACCESINF	14.13602	8.809064	4.25	0.000***	4.167626	47.94746
DEPRATIO	.8560536	.3423189	-0.39	0.698	.390951	1.874475
EDUCHHD	4.317502	1.789275	3.53	0.000 ***	1.916348	9.727264
LSIZE1	.6151016	.1166479	-2.56	0.010**	.4241554	.8920079
TLU	1.828203	.3988344	2.77	0.006***	1.192146	2.803623
$Market_2$	.9898507	.1060171	-0.10	0.924	.8024214	1.22106
CREDITUT	3.240004	1.892904	2.01	0.044**	1.030977	10.18221
MORGANIZ	10.45358	6.999428	3.51	0.000***	2.813999	38.83346
LITRAING	1.280722	.9289557	0.34	0.733	.3090628	5.307173
LACTIVIN	1.000141	.0000827	1.70	0.088*	.9999788	1.000303
cons	.0051854	.0073863	-3.69	0.000	.0003179	.0845813

*** (* *) * denotes significant difference at P<0.01, 0.05 and 0.1, respectively

Logistic regression Number of obs = 198

Wald chi2(11) = 59.54

Prob> chi2 = 0.0000
Pseudo R2 = 0.5953
Log pseudo likelihood = -52.057596
% of correct prediction for Livelihood Diversified = 91.54% (119 households out of 130)
% of correct prediction for non Livelihood Diversified = 86.76% (59 households out of 68)
% of total correct prediction = 89.90% (178 households out of 198)

Source: Own computation, 2014

Annex 4: Binary Outcomes Logistic Regression (Reporting Odds Ratios) Estimates of Livelihood Diversification (BPDI)

Berger Parker (Activities) MODEL$_2$)	**Odds Ratio**	**Robust Std. Err.**	**z**	**P>|z|**	**[95% Conf. Interval]**	
AGEHHD	.9918371	.0163928	-0.50	0.620	.9602227	1.024492
ACCESINF	11.84365	7.663199	3.82	0.000 ***	3.332212	42.09579
DEPRATIO	.8702853	.321188	-0.38	0.707	.4221985	1.793935
EDUCHHD	4.154115	1.743303	3.39	0.001 ***	1.825012	9.455645
LSIZE1	.5944452	.0998936	-3.10	0.002***	.4276335	.8263272
TLU	1.51351	.3087338	2.03	0.042**	1.014735	2.257449
Market$_2$	1.006414	.1055393	0.06	0.951	.8194338	1.236059
CREDITUT	2.955421	1.56293	2.05	0.040**	1.048272	8.332294
MORGANIZ	8.828643	6.069542	3.17	0.002***	2.294602	33.96882
LITRAING	1.680861	1.093469	0.80	0.425	.4696672	6.015522
LACTIVIN	1.000155	.000073	2.13	0.033**	1.000012	1.000298
Cons	.0027	.0037348	-4.28	0.000	.0001794	.0406249

*** (* *) * denotes significant difference at P<0.01, 0.05 and 0.1, respectively
Logistic regression Number of obs = 198
Wald chi2(11) = 53.15
Prob> chi2 = 0.0000
Pseudo R2 = 0.5681
Log pseudo likelihood = -55.802564
% of correct prediction for Livelihood Diversified = 91.41% (117 households out of 128)
% of correct prediction for non Livelihood Diversified = 85.71% (60 households out of 70)
% of total correct prediction = 89.39% (177 households out of 198)

Source: Own computation, 2014

Annex 5: Binary Outcomes Logistic Regression (Reporting Odds Ratios) Estimates of Food Accessibility Index (FAI)

Food Accessibility Index	Odds Ratio	Robust Std. Err.	z	P>|z|	[95% Conf. Interval]	
AGEHHD	.9880803	.0147909	-0.80	0.423	.9595117	1.017499
ACCESINF	8.009478	4.61736	3.61	0.000***	2.587603	24.79196
DEPRATIO	.731514	.2361826	-0.97	0.333	.3885051	1.377363
EDUCHHD	3.748966	1.445029	3.43	0.001***	1.761238	7.980037
LSIZE1	.7176401	.1440566	-1.65	0.098*	.4842163	1.063589
TLU	1.579413	.291365	2.48	0.013**	1.100193	2.267371
$Market_2$	.977002	.0914779	-0.25	0.804	.8131982	1.173801
CREDITUT	2.704914	1.267572	2.12	0.034**	1.079605	6.777069
MORGANIZ	6.202976	3.711171	3.05	0.002***	1.920153	20.03846
LITRAING	1.40506	.850429	0.56	0.574	.4290375	4.601448
LACTIVIN	1.000158	.000069	2.29	0.022**	1.000023	1.000293
cons	.0078071	.0093926	-4.03	0.000	.000738	.0825195

*** (* *) * denotes significant difference at P<0.01, 0.05 and 0.1, respectively
Logistic regression Number of obs = 198
Wald chi2(11) = 55.16
Prob> chi2 = 0.0000
Pseudo R2 = 0.5032
Log pseudo likelihood = -63.281543
% of correct prediction for Livelihood Diversified = 0.91% (120 households out of 132)
% of correct prediction for non Livelihood Diversified = 84.85% (56 households out of 66)
% of total correct prediction = 88.89% (176 households out of 198)

Source: Own computation, 2014

Annex 6: Classification Table (SDI)

Classified	True/Predicted		Total
	Diversified	Not diversified	
Diversified (+)	119	11	130
Not diversified(-)	9	59	68
Total	128	70	198
Sensitivity	Pr(+| D)	92.97%	
Specificity	Pr(-|~D)	84.29%	
Positive predictive value	Pr(D| +)	91.54%	
Negative predictive value	Pr(~D| -)	86.76%	
False + rate for true ~D	Pr(+|~D)	15.71%	
False - rate for true D	Pr(-| D)	7.03%	
False + rate for classified +	Pr(~D| +)	8.46%	
False - rate for classified -	Pr(D| -)	13.24%	
Correctly classified		89.90%	

Source: own computation, 2014

Annex 7: Classification Table (BPDI)

Classified	True/Predicted Diversified	Not diversified	Total
Diversified (+)	117	11	128
Not diversified(-)	10	60	70
Total	127	71	198
Sensitivity	Pr(+| D)	92.13%	
Specificity	Pr(-|~D)	84.51%	
Positive predictive value	Pr(D| +)	91.41%	
Negative predictive value	Pr(~D| -)	85.71%	
False + rate for true ~D	Pr(+|~D)	15.49%	
False - rate for true D	Pr(-| D)	7.87%	
False + rate for classified +	Pr(~D| +)	8.59%	
False - rate for classified -	Pr(D| -)	14.29%	
Correctly classified		89.39%	

Source: computed by own survey, 2014

Annex 8: Classification Table (FAI)

Classified	True/Predicted Food secured	Not Food secured	Total
Food Secured (+)	120	12	132
Not Food Secured (-)	10	56	66
Total	130	68	198
Sensitivity	Pr(+| D)	92.31%	
Specificity	Pr(-|~D)	82.35%	
Positive predictive value	Pr(D| +)	90.91%	
Negative predictive value	Pr(~D| -)	84.85%	
False + rate for true ~D	Pr(+|~D)	17.65%	
False - rate for true D	Pr(-| D)	7.69%	
False + rate for classified + Pr(~D| +)		8.09%	
False - rate for classified -	Pr(D| -)	15.15%	
Correctly classified		88.89%	

Source: computed by own survey, 2014

Impact of Local Seed Business on Risk Aversion and Crop Choice in Southern Nations, Nationalities & Peoples Regional State: *Evidence from Boricha and Lanfero Woreda*

Ashenafi Duguma Feyisa[1] and Seid Nuru[2]

Abstract

Low income, limited access to credit, lack of insurance market and thin or non-existent labor markets have restricted poor rural households to protect themselves against and manage risk in developing countries. On the contrary, households with ability to cushion themselves from risk take advantage of more profitable but risky opportunity than the poor. Local Seed Business was a programme consisting diverse projects executed by different stakeholders (such as Ethiopian Seed Enterprise, Integrated Seed Sector Development, and Regional Bureau of Agriculture). Improving the livelihood of farmers through development, dissemination, and commercialization of improved seed in order to increase agricultural productivity and hence contribute towards food security and poverty reduction in Southern Nations, Nationalities & Peoples Regional state was the aim of the programme.

Objectives of this paper was assessing impact of participation in Local Seed Business Program on risk aversion behavior and crop choice of farm households in Boricha and Lanfero districts, in Sidama and Silti Zones of SNNPRS. Using primary data collected from 185 sample respondents the impact of participation on risk aversion behavior as been estimated by adopting control function approach and using generalized ordered logit model. Generalized linear model has been applied to examine the impact of risk aversion behavior on crop choice. From the analysis, participation is found to negatively impact higher degrees of risk aversion behavior. Non-participants were found relatively higher risk aversive than their counter parts. Lower risk aversion behavior among participants enabled them to

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take risky opportunities with promising higher return. As a result, participants have better per capita income and consumption pattern. From auxiliary probit regression; access to participation, access to media (Television& Radio) and contact with extension agents are statistically significant and they are positively related with participation. On the other hand, distance from main road and farm output market negatively affect participation. Majority of non-participants were found in the categories of higher degrees of risk aversion and most of them were poor, women, and young headed households. So, enhancing participation through scaling up the programme and giving special consideration to the poor, women and young headed households will have favorable impact on poverty reduction.

Key words: Local seed Business, Risk aversion, Crop choice, Generalized Ordered Logit

1. Introduction

According to the Report of (WB, 2011), 48% of world population lives in rural area in which the least developed countries constitute the highest figure (71%). In Sub-Saharan Africa, 64% of the population lives in country side. In this region, agricultural land constitutes 43.3% and about 60% of rural people depend on agriculture for their livelihoods. As a result, agriculture is a viable option for spurring growth, overcoming poverty, and enhancing food security. Improving the productivity, profitability, and sustainability of smallholder farming is therefore the main pathway out of poverty in using agriculture for development.

Bekele (2010) argues that development and dissemination of yield-increasing technologies are the bases for agricultural productivity growth and are means to meet the needs of increasing population. This implies agricultural research and technological improvements are therefore crucial to increase agricultural productivity and thereby reduce poverty and meet demands for food by rapidly growing population.

Due to its importance for food security and poverty reduction, different governmental and non-governmental organizations give due emphasis to agricultural sector. Many projects and programs executed by GOs and NGOs

in one or another way linked with improving livelihood of rural population via promoting agricultural technologies and by disseminating them towards the end users. Specifically, Ethiopian Seed Enterprise (ESE) and Integrated Seed Sector Development (ISSD) Ethiopia encourage development and distribution of improved seed to farmers in order to increase productivity and production of agricultural products as a means to improve the livelihood of farmers. For the above reasons, ISSD Ethiopia supports Seed Producing Cooperatives (SPCs) under Local Seed Business programme in terms of building capacity and commercialization of their products.

In this paper, Local Seed Business is defined as a program consisting of diverse projects executed by different stakeholders (such as ESE, ISSD, and Regional Bureau of Agriculture) with the aim of improving the livelihood of farmers through development, dissemination, and commercialization of improved seed in order to increase agricultural productivity and hence contribute towards food security and poverty reduction. In SNNPR, the program focuses on the development, dissemination, and commercialization of major crops such as Maize, Wheat, Teff, and Haricot bean. Participants of the program are organized in different forms (mainly as SPCs and Individual out-growers) under the mandate and follow-up of diverse organizations.

Many small-scale farmers in the developing world face significant income uncertainty due to factors that affect decision to crop choice and land allocation. Variables beyond the farmers' control, such as adverse weather, fluctuating demand and crop prices, can make a significant difference in how much a family earns for the year. Farmers may be unwilling to take on additional risks by borrowing and making long-term investments due to this uncertainty. As identified by Karlan (2011), this reluctance is thought to contribute to the decision of many farmers not to invest in technologies such as hybrid seeds, fertilizer, or irrigation that could potentially improve crop yields. If insurance and credit markets are absent, one possible strategy for household is to take up low-risk activities, even if they imply lower returns.
It was believed that participants of local seed business benefit more than farmers who were not part of the programme due to special treatments they received. Participants have better access to input loan, secured price, market and price incentive (receiving up to 15% mark-up on prevailing market

price), secured market for their product and dividends from their union. Particularly, access to credit, secured market and price with price incentive can serve as price insurance against market risk and possibly have significant impact on farmers' behavior towards resource allocation and crop choice (i.e. in allocating share of their land between more risky but more profitable crop such as cash crops and less risky but less profitable crop such as staple crops). In addition, secured market and higher farm output price provides incentives for income enhancing strategies which are consistent with better welfare outcomes such as, intensification of use of fertilizer and other inputs. Such decision increase land productivity and higher crop income.(Dercon, 1996); (Udry, 1999); and (Binswanger, 1986).

Several studies were undertaken by different scholars on local seed business in SNNPR but they focused on "assessing seed sources, quality, and variety of improved seed" by Alemseged Satanaw, 2011; Abrham Mulu, 2011; and Mesfin Mulugeta, 2012, "determinants of adoption" by Million Kasaye, 2011 and Bikila Adugna, 2012, "value chain and technical efficiency" by Shimels Araya, 2012 and Abebayehu Girma, 2011. But, impact of local seed business on risk aversion and crop choice was not assessed and analyzed. Filling this research gap is the main motivation behind this study. The main objective of this study is to assess the impact of local seed business on risk aversion behavior of farm households and crop choice in Boricha and Lanfero districts.

It was expected that the programme contributes towards wealth accumulation of participant via higher and secured crop price compared to non-participants. In relation to this, Wik(2004) found that partial risk aversion reduced significantly as the wealth of rural household in Zambia increased. It was hypothesized that non-participants who were undertaking their farm business under crop price risk make sub-optimal investment decisions. As a result, they will be unwilling to undertake crop choices which are more risky but promises high profitability (Eswaran, 1990).

Mailosi (2011) found that wealthier farmers choose more risky but more profitable crops in Tigray, the northern part of Ethiopia. In this study, it is

expected that participants will be largely from wealthier households with better endowment of land and livestock.

2. Literature Review

2.1 Theoretical Framework

Agricultural activity is, by nature, a business that involves risk. Farmers face a variety of price, yield, and resource risks, which make their income unstable from year to year. The risk can be reduced through several techniques of farm risk management, such as the diversification of the agricultural production activities or the transfer of agricultural risk to other sectors of the economy, such as insurance (Hazel, 1996).

Many small-scale farmers in the developing world face significant income uncertainty, and rural farmers who live from harvest to harvest don't have much room for error. Variables beyond the farmers' control, such as fluctuating crop prices, and drought can make a significant difference in how much a family earns for the year. Farmers may be unwilling to take on additional risks by borrowing and making long-term investments due to this uncertainty. As identified by (Karlan, 2006), this reluctance is thought to contribute to the decision of many farmers not to invest in technologies such as hybrid seeds, fertilizer, or irrigation that could potentially improve crop yields.

As presented under (Dercon, 1996), rural households engaged in agricultural activities face considerable risks in their income process. These income risks are especially important if they result in consumption fluctuations. This is likely if insurance and credit markets are absent. One possible strategy for household is to take up low-risk activities, even if they imply lower returns.

Though there are a number of risks that encounter farmers in farm business, in this paper we examine the existence of any association between price risks and their impact on farmers' behavior and the resulting resource allocation. For example, variations in the price of marketed output can cause farm profits to vary and hence welfare (welfare in terms of income and

consumption). Fluctuations in income can present an acute threat to people's livelihoods even if, on average, incomes are high enough to maintain a minimal standard of living. Occasional famines provide the most egregious examples of the consequences of risk in poor societies, but risk also generates more commonplace worries such as the consequences of a bad harvest for a family's ability to afford school fees for children, or the implications of a wage-earner's illness for the ability to provide a healthy diet for the household (Rosenzweig and Binswanger, 1993).

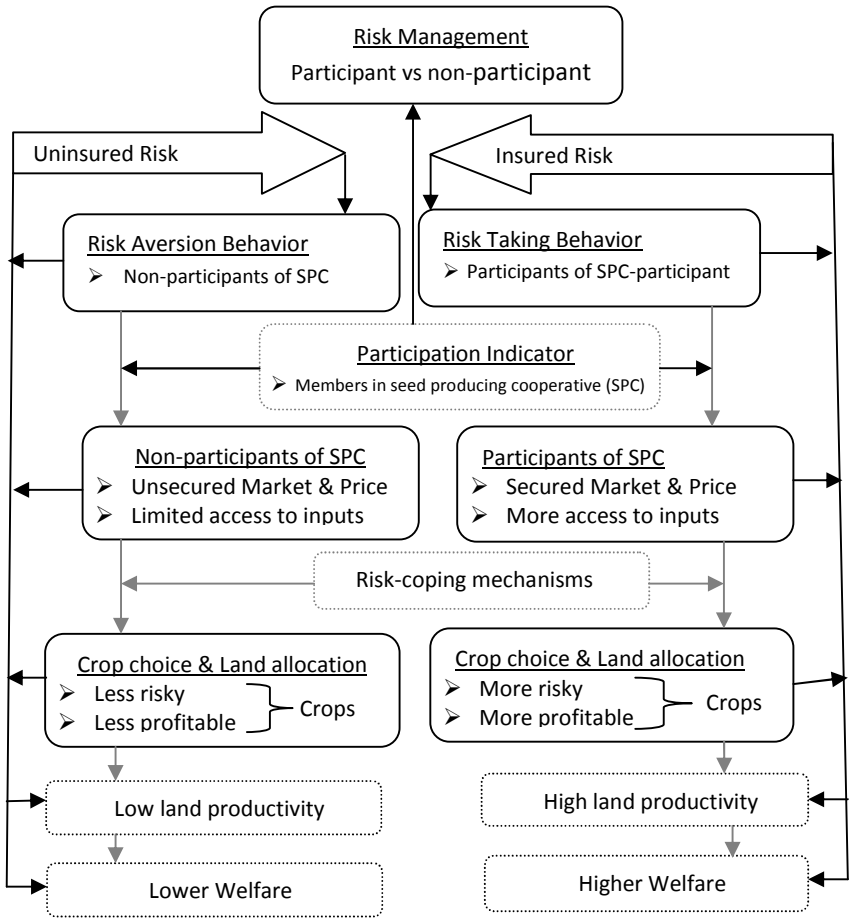
If a risk-averse household is not able to achieve an entirely smooth consumption path through ex-post mechanisms such as insurance, saving, and credit transactions, it has an incentive to devote resources in an effort to secure a more stable income stream. In an agricultural economy, households might farm a diversified portfolio of land, adopt technologies (such as intercropping or drought-resistant crops) and contractual arrangements (such as sharecropping) that reduce the variance of income, or diversify their activities (through migration or local non-agricultural employment). Any of these ex-ante actions might be costly, so that the households would be sacrificing income, on average, in order to assure a less risky stream of income (Fafchamps, 1992).

In farm societies, the cultivation of different crops and often combining crop and livestock farming are important strategies for diversifying. The choice of agricultural activities can be induced by varying attributes in terms of maturity period, drought tolerance, timing, quantities of labor and other input needs, and so forth. Other income-diversifying strategies can be the hiring out of human labor and bullocks, earnings and remittances from migrated members of the extended family-in general off-farm income, and on-farm non-agricultural income such as earnings from handicrafts (Dercon, 1996).

Poor households respond to risks by making sub-optimal investment decisions which limit them from exploiting investment choices promising high expected rate of return (Lipton 1968). Low income and market imperfection for labor, insurance and credit disables farm households to shift these risks to third party and insure their consumption risk. Risk aversion behaviours observed in households were not only as a result of wealth but

also due to failure of the other markets limiting substitution across the type of wealth (Holden et al. 1998). Ability of farm households to protect themselves from risk enables them to take advantage of profitable but risky opportunities unlike the poor whose choices are limited to low-risk and low-return opportunities to secure themselves from risk.

Figure 1: Theoretical framework



Source: Adopted from (Mailosi, 2011) and modified by the author.

In this paper, the risk aversion algorisms are expanded to analyze how such behavior affect crop choices, land productivity and welfare. Risk aversion assumptions are used in assessing the behavior of participants and non-participants and their effect on crop choices, land productivity and household

welfare. Participants are expected to be wealthier than non-participants since they are expected at least better off in having advantage of secured market and price. As a result, there will be higher probability of insuring their consumption through their wealth (wealth in terms of livestock and other valuable assets) compared to non-participants which will help them to undertake crop choices that are more profitable and more risky.

2.2 Empirical Review

Income risk-management strategies cannot be viewed independently of risk-coping strategies. The opportunities available for consumption smoothing can be expected to influence the ways in which households respond to income risks. At the theoretical level, Eswaran and Kotwal (1990) analyzed the effects of credit constraints on the risk behavior of households. Empirical studies on India found evidence to support this view. Rosenzweig and Binswanger (1993) found that in semiarid India the wealth of the household increased the riskiness of the activities' portfolio to which productive assets were allocated. J. Murdoch (1993) found that liquidity constraints affected the degree of diversification and the adoption of risky activities.

A crop choice depends on both economic and agro-ecological factors. (Pender, 2006)found market access, price of the crop, income strategy, land management practices, rainfall pattern, temperature, land quality, altitude, and other policy relevant factors such as irrigation, technical assistance, education, and gender and tenure status to influence crop choices on land in East Africa highlands. Better access to market in Kenya was driving preferences for crops choices by farmers noting that farm households close to urban centres choose cash crops unlike those far from urban centres who opt for food crops cereals like maize.

Seid and Holger (2011) also found that proximity to urban centres influence decision of farmers on crop choice in Wollo, Amhara regional state of Ethiopia. As cited under (Mailosi, 2011), Kruseman *et al* (2006) also found *teff* production (a common cash and food crop in the northern part of Ethiopia) common than maize crops in areas around urban markets. Using bio economic model (Holden, 2003), found increased profitability on tree-

planting activities close to roads and markets in the northern part of Ethiopia. Proximity to roads or markets provides incentives for income enhanced strategies which are consistent with better welfare outcomes. Market access was found to influence non-farm opportunity, intensification of use of fertilizer and other inputs and enhanced collective action towards land management (Pender *et al*. 2006)

Staple crops in developing countries are always cultivated by small farmers to achieve food self sufficiency (Fafchamps, 1992). In fact, food markets are often thin and isolated, resulting in prices that are volatile and highly correlated with farmers' own production patterns. On the other hand, cash crops provide a means to relax the household's liquidity constraint because formal credit markets are often absent.

Rich farmers were found exhibiting low risk aversion in their investment and production activities unlike poor farmers who exhibited higher levels of risk aversion (Eswaran and Kotwal 1990). The observation expected to be consistent with absolute risk aversion assumptions implying that as farm households become wealthier their risk aversion behavior decreases (Yesuf, 2009).

3. Data and Methods

This study entirely depends on primary data that was collected from Boricha and Lanfero districts in Sidama and Silti zones of Southern Nations Nationalities and People's Region (SNNPR) using structured questionnaire and focused group discussion in September, 2013. The Boricha district is located 32 km North- East of, Hawassa, the SNNPR state capital. It is located at 60 54′ 00′′ latitude in the North and 340 20′ 00′′ longitude in the East. It is one of the two food insecure Woredas in Sidama zone. The main cash crop in this study site was haricot bean. On the other hand, Lanfero district is located 172 km North West of Hawassa. The major cash crops in this site are wheat and chill (Berbere[3]).

[3] Local name for chill

3.1 Estimating Average Treatment Effect (ATE) under binary treatment

Most approaches to estimate treatment effects fall in to one of the following approaches. The first approach is based on Ignorability Assumption or unconfoundedness of treatment conditional on a set of observed covariates which are analogues to the proxy variable solution to the omitted variable problem. In fact one approach to estimate treatment effect is to use linear regression with many controls: in effect, the treatment is exogenous once we control for enough observed factors. Important benefit of ignorability of treatment is that no functional form or distributional assumptions are needed to identify population parameters of interest (Wooldridge 2003).

A second approach allows selection in to treatment to depend on unobserved (and observed) factors. Traditionally, we would say that treatment is "endogenous". In this case we rely on the availability of IVs in order to identify and estimate ATEs. Sometimes standard IV estimators identify the effects of interest, but in other case we rely on control function methods. Depending on the quantity we hope to estimate, we generally need to impose restriction on functional forms or distributions or both (Ibid).

Randomized treatment guarantees that difference-in-means estimator from basic statistics is unbiased, consistent and asymptotically normal. But the problem is that randomization of treatment is often infeasible in program evaluation (although randomization of eligibility sometimes is feasible). In most cases, individuals at least partly determine whether they receive treatment, and their decision may be related to the benefits of or gain from treatment, y_1-y_0. In other words, there is self-selection into treatment. This is evident for the theme of this paper where formation of seed producing cooperatives was mainly based on the willingness of the farmers for membership Wooldridge (2010).

To evaluate impact of the programme, methods such as difference in difference (DID), propensity score matching and instrumental variable (IV) are competing methods. However, interest variable was participation and its impact on degree of risk aversion which suspected of endogeneity at least for

the reason of self selection problem. In such case, IV method produce consistent estimate but it needs the model in the structural equation to be linear. On the other hand, the response variable in the structural model of this paper is ordered categorical variable which needs non-linear model. Therefore, control function approach is followed in this paper as suggested by Wooldridge (2010) which yields consistent estimates for non-linear models. This approach mimic two stages least square (2sls) technique but differs on the following grounds.

Firstly, it does not replace *participation* with fitted probabilities from first stage probit of reduced form like two-stage least squares because it is not justified due to the nature of response variable; if this was the case, it would produce inconsistent estimators of the parameters and (probably) the average partial effects (APEs) (Ibid).

Secondly, it includes *participation* dummy and *standard residual* from first stage probit of participation in structural model and estimate model of degree of risk aversion as a function of exogenous participation, standard residual from first stage probit and other explanatory variables. The nice feature of this technique is that test statistics on the coefficient of residual in the structural equation serve as test for endogeneity i.e., significant test statistics in coefficient of residual in the structural model supports existence of endogeneity problem (Wooldridge, 2010)

Model 1: Impact of participation on degree of risk aversion behavior

Hypothetical question from (Mailosi, 2011)was adopted in order to assess whether participants are less risk averse than non-participants. Mean, frequencies and comparison statistics are used on hypothetical data about risk aversion responses of farmers and regression analysis of participation over degree of risk aversion to quantify this relation. The household head was given an option to choose among crops with different risk portfolio between good and bad season scenario. The hypothetical question was used to compare risk preference, for example, between crops which give high return (20,000 Birr) in good year but no return (0 birr) in bad year and a crop giving comparatively less return (19,500 Birr) in good year and some return (2,000 Birr) in bad year. The preference for type of crop to plant will stopped

at the minimum level of choice combination at where the return is birr 7,000 in both case scenarios. All the choices were assumed to have the bad year occurrence of one out of four years. The risk aversion categories were ranked from 1 to 5 (1 representing least risk-aversion and 5 represents extreme risk aversion.

In order to quantify the relation between participation and degree of risk aversion behavior, we developed the following model.

$$DR = \beta_0 + \alpha_1 P_1 + \beta_i \boldsymbol{x}_i + u_i \quad \textbf{(1)}$$

Where, *DR* is degree of risk aversion, P_1 participation status, $\boldsymbol{x}_i$ is a vector of other explanatory variables where as β_0, α_1 *and* β_i parameters and u_i is an error term.

Response variable under equation (2) is limited ordered categorical variable with increasing order of degree of risk aversion behavior as the attached number become larger in magnitude. For such dependent variable, a technique such as Ordinary Least Squares Regression is invalid because this technique requires that dependent variables have interval or ratio level measurement. When the dependent variable is ordinal, other types of methods should be used. Perhaps the most popular method is the ordered logit/probit model, which is also known as the proportional odds model[4].

On the other hand, interest variable is participation and its impact on degree of risk aversion. However, participation is suspected for endogeneity problem at least for the reason of self selection. Therefore, control function method is used as suggested by (Wooldridge, 2010). First, write the model

$$y_1^* = \boldsymbol{z}_1 \boldsymbol{\delta}_1 + \gamma_1 y_2 + \boldsymbol{u}_1. \quad \textbf{(2)}$$

$$y_2 = 1[\boldsymbol{z}\boldsymbol{\delta}_1 + v_2 > 0] \quad \textbf{(3)}$$

[4]The ordered probit model is a popular alternative to the ordered logit model. The terms "Parallel Lines Assumption" and "Parallel Regressions Assumption" apply equally well for both the ordered logit and ordered probit models. However the ordered probit model does not require proportional odds.

Where, y_2 represents participation, $\boldsymbol{z}_1$ vector of other exogenous variables and $(\boldsymbol{u}_1, v_2)$ are error terms which are independent of $\boldsymbol{z}$ and jointly normally distributed. In keeping with the typical ordered probit approach, $\boldsymbol{z}_1$ does not contain an intercept. Instead, there are cut points, α_j, j = 1, ..., J. we defined the ordered response, y_1, in terms of the latent response, y_1^*.

To estimate the above equations, a two stage approach that replaces y_2 with fitted probabilities from first stage probit is not justified; it produces inconsistent estimators of the parameters and (probably) the average partial effects (APEs). In such case, Wooldridge (2010) suggests the following procedure. Assume that a single (estimable function of $(\boldsymbol{z}_1, y_2)$ is correlated with the unobservable in the structural ordered logit model. In case of equation 4, v_2 plays the role of single (estimable) function. Suppose we explicitly introduce unobservable, r_1, thought to be correlated with y_2. Then, we are interested in the response probabilities;

$$\boldsymbol{P(y_1 = j|z_1, y_2, r_1) = P(y_1 = j|z, y_2, r_1)} \qquad \textbf{(4)}$$

Where, equality simply implies exclusion restriction. Because r_1 is not observed, we integrated r_1 out of the response probabilities when computing partial effects. We defined the standardized residual for y_2 as;

$$\boldsymbol{e_2 \equiv [y_2 - \Phi(z\delta_2)]/\{\Phi(z\delta_2)[1 - \Phi(z\delta_2)]^{\frac{1}{2}}} \qquad \textbf{(5)}$$

Under assumption that $D(y_2|\mathbf{z})$ follows a probit model where Φ stands for fuctional distribution and δ_2 is parameter. By construction, $\mathsf{E}(e_2|\mathbf{z}) =$ 0 and Var $(e_2|\mathbf{z}) = 1$. Unlike v_2 in Equation 4, e_2 cannot be independent of z because its support depends directly on z. Nevertheless, suppose we simply assert that:

$$\boldsymbol{D(r_1|z, y_2) = D(r_1|e_2)} \qquad \textbf{(6)}$$

From equation 7, it follows that we can consistently estimate the APEs of $(\boldsymbol{z}_1, y_2)$ on $P(y_1 = j|\boldsymbol{z}_1, y_2, r_1)$ by estimating $P(y_1 = j|\boldsymbol{z}_1, y_2, e_1)$and then averaging out$e_1$. Now the approach to estimating APEs is, in principle,

straightforward. In first stage, we estimated a probit of y_{i2} on $\mathbf{z}_i$ and constructthe standardized residual $\hat{e}_{i2} \equiv (y_{i2} - \hat{\Phi}_{i2})/[\hat{\Phi}_{i2}(1 - \hat{\Phi}_{i2})]^{1/2}$. Next, we estimate a model for the $p_j(\mathbf{z}_1, y_2, e_2)$ by inserting $\hat{e}_{i2}$ for the unobserved e_2. Because y_1 is an ordered outcome, any estimation approach which takes into account the ordered nature of y_1 can be applied.

Given the standard normal assumption for *e*, conditional distribution of y given x can be easily derived by computing probability of each response. The parameters, α_1 and β_i can be estimated by Maximum Likelihood Estimation (MLE). For each i, the log-likelihood function is

$$\begin{aligned}\ell_i(\alpha,\beta) &= 1[y_i = 0]\log[\Phi(\alpha_1 - \boldsymbol{x_i\beta})] \\ &= 1[y_i = 1]\log[\Phi(\alpha_2 - \boldsymbol{x_i\beta}) - \Phi(\alpha_1 - \boldsymbol{x_i\beta})] \\ &+ \cdots + 1[y_i = J]\log[1 - \Phi(\alpha_J - \boldsymbol{x_i\beta})], \end{aligned} \quad \textbf{(7)}$$

This log-likelihood function is well behaved, and many statistical packages routinely estimate ordered probit/logit models. The difference between probit and logit is that a matter of distribution function. If we replace Φ with the logit function Λ, we have ordered logit model.

Based on this ground, thus, we will apply ordered logistic regression with the assumption that the relationship between each pair of outcome groups is the same. In other words, we assume that the proportional odds assumption holds. Since the relationship between all pairs of groups is the same, there is only one set of coefficients (only one model).

In the ordered logit model, there is an observed ordinal variable, Y. Y, in turn, is a function of another continuous, unmeasured latent variable Y*, whose values determine what the observed ordinal variable Y equals. The continuous latent variable Y* has various threshold points, which we represented it here using the Greek letter kappa (κ). Thus our value on the observed variable Y depends on whether or not we have crossed a particular threshold. In this paper, we consider four possible responses for the observed ordinal variable Y (degree of risk aversion),

$$\left.\begin{array}{l} Y_i = 1 \text{ if } Y^*i \text{ is} \le \kappa 1 \\ Y_i = 2 \text{ if } \kappa 1 \le Y^*i \le \kappa 2 \\ Yi = 3 \text{ if } \kappa 2 \le Y^*i \le \kappa 3 \\ Y_i = 4 \text{ if } Y^*i \ge \kappa 3 \end{array}\right\} \quad \text{for i= 1,2 and 3Where } k_i \text{ is cut points.} \qquad \textbf{(8)}$$

Unfortunately, experience suggests that the assumptions of the ordered logit model are frequently violated (Long and Freese, 2006). Hence, Brant test has been undertaken on parallel regression assumption (the assumption which states that the betas are the same for each categories) and it has failed (see Appendix 5). When such case occurs, options will be:

1. Just ignore it!
2. Go with a non-ordinal alternative, such as multinomial logit
3. Go with an ordinal alternative, such as the original general ordered logit
4. Try an in-between approach: partial proportional odds (gologit2 with restriction)

In this paper, Generalized Ordered Logit2 model with restriction is applied. For an ordinal dependent variable with M categories, the Generalized Ordered Logit2 model (Williams 2006) can be written as;

$$P(y_i > j) = \frac{\exp(\alpha_j + X_i\beta_j)}{1+[\exp(\alpha_j + X_i\beta_j))}, j = 1, 2, \dots, M - 1 \qquad \textbf{(9)}$$

An unconstrained go logit model, or a multinomial logit model, both generates many more parameters than an ordered logit model does. The reason is that, with these methods, all variables are free from the proportional odds constraint, even though the assumption may only be violated by one or a few of them. The ordered logit model is a special case of the Generalized Ordered Logit model, where the betas are the same for each j. In between these two extremes is the Partial Proportional Odds model (PPO). With the PPO, some of the beta coefficients are the same for all values of j, while others can differ because it is possible to relax the parallel lines/proportional odds assumption only for those variables where it is violated (see Richard Williams, 2013).

Demerit of using Generalized Ordered Logit2model is that it produces more parameters compared to usual ordered logit. Apart from Brant test, other criteria can be used for assessing which model fits best. In particular, information measures such as BIC (Raftery 1995) and AIC (Hardin & Hilbe 2007) can be used to compare the relative plausibility of two models rather than to find the absolute deviation of observed data from a particular model. BIC and other information measures have penalties for including parameters that do not significantly improve fit. Particularly with large samples, the information measures can lead to more parsimonious but adequate models. Hence, one needs to be cautious and for this reason measure of fit test was undertaken. From measure of fit, Bayesian Information Criterion (BIC) supports Generalized Ordered Logit model compared to the standard Ordered Logit model (Appendix 3).

Model 2: Risk Aversion and Crop Choice

To estimate the relationship between the risk aversion behavior and crop choice, share of land allocated to Cash Crop is used as response variable. Categorical variable measuring degree of risk aversion and other explanatory variables are used as independent variables. As presented under Seid & Holger (2011), household's decision to allot a plot of land to cash crop production is an attempt to maximize household income. In this paper a plot of land allotted to cash crop production is a function of, among others, risk aversion behavior, Distance from main road and market and other variables which are specified as follow;

$$L_i^c = \boldsymbol{\beta_0} + \boldsymbol{\beta_i x_i} + \boldsymbol{\alpha_1 R_1} + \boldsymbol{u_i}. \qquad \textbf{(10)}$$

Where, L_i^c refers to share of land allocated to cash crop by household *i*, $\boldsymbol{x_i}$ represent a vector of household characteristics (gender of household head, literacy, family size), household wealth (Land and Livestock endowments), and distance from main market. R_1 represents degree of risk aversion whereas β_0, β_i, *and* $\boldsymbol{\alpha_1}$ are parameters and u_i is an error term.

In order to estimate equation 10, OLS procedure can be used but Generalized Linear Model (GLM) would be more appropriate. The reason is that the

response variable in equation 10 was percentage of land allocated to cash crop out of total land endowment of the household which have a value between 1 and 0. Therefore, we applied GLM estimation technique following. Seid & Holger (2011) because this model has some advantages over OLS such as its nature accounts non-linearity relationship.

4. Results and Discussion

4.1 Descriptive Statistics

4.1.1 Household Characteristics

Majority of surveyed households (90%) are male headed Average family size among participants was 12 where as it was 10 for their non-participating counterparts. The figures are higher than the regional average which stood at 7 probably due to existence of polygamous marriage in the selected research sites. The mean education level among participants was 4 years where as it was only 1.5 for non-participants. We also found that on average participants allotted 55% of their land for cash crop while non-participants allotted only 26% of their land for such crops.

According to some findings, for example, Seid and Holger (2011), proximity to urban center positively affect decision to allot share of land for cash crop. These was evident from our finding that the nearest market for participants was on average only 2.1 kilometres far but it was 6.2 kilometres for non-participants. Hence, this could be possibly a reason for difference on amount of land allotted to cash crop between participants and non-participants. In addition, participants on average grow 3 types of major crops on their plot of land; however, non-participants grow on average 6 types of crops possibly because of uncertainty. This leads to land fragmentation and perhaps for lower land productivity. Furthermore, participants on average spend 9 hours per day on their farm while non-participant spends 6 hours per day. For more detail, one could see Appendix 1.

4.1.2 Wealth by participation status

In this thesis we used yearly saving, land endowment, number of oxen and other livestock as proxy for wealth. In the study area, oxen and land

endowments are basic means of farming, especially, oxen used as traction power. Cash savings are used for investment on agricultural inputs. On average, participants own 2.8 hectare of land and 3 oxen while the non-participants own only 1.1 hectares of land and 1 ox.

Average yearly saving among non-participants was only Birr 542, however, it was 3,235 for participants. Furthermore, farm households under seed producing cooperative averagely own 6.9 livestock in tropical livestock unit but it was 3.8 for those outside the cooperative. The difference on these assets (wealth) possibly leads to difference on level of risk aversion between participants and non-participants because these assets could be used to caution from variable income at the time of yield and market risks. In addition, difference on wealth among participants and non-participants was a possible reason that leads to difference on share of land allotted to cash crops because we found that participants allotted higher share of their plot of land for cash crops (which are riskier but more profitable compared to staple crops) than their counter parts (Appendix 2).

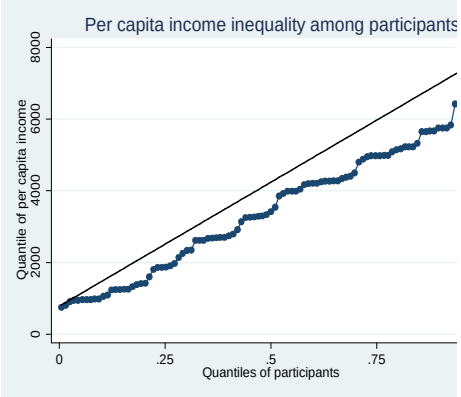
4.1.3 Welfare by participation status

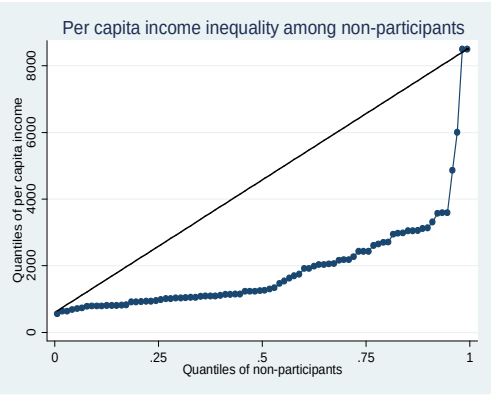
There are different ways of measuring welfare but in this paper, it is measured in terms of per capita income and consumption these in turn measured as total income and consumption of each HH divided by the number of family members adjusted to adult equivalence. To shade light on welfare impact of participation, we have tried to see possible relation between participation and welfare of sample respondents. We found statistically significant positive correlation between participation and welfare (with correlation coefficient of 0.43 and 0.17 for per capita income and consumption per adult equivalent respectively). However, it needs further and deep investigation to validate causal effect of participation on welfare.
The mean estimation on per capita income and consumption per adult equivalent based on participation status showed considerable variation. Yearly average per capita income of participants was birr 3,507 where as it was birr 1,893 for non-participants. There was also difference on calorie per day per adult equivalent among participants and non-participants. It was on average 2,843 calorie among participants and 2,497 among non-participants.

We found higher welfare variation between participants and non-participants in terms of per capita income compared to welfare in terms of consumption. The possible reason for such variation was due to the fact that major source of household income in the study area was farm business and most of member households in seed producing cooperative allotted higher share of their plot of land to cash crops. However, households outside seed producing cooperative allotted higher share of their plot of land to staple crops that are mostly produced for home consumption. As a result, variation in welfare in terms of consumption between participants and non-participants is lower compared to variation based on per capita income.

In addition to difference in welfare among sample respondents based on their participation status, there is viable variation within the group itself, especially, within non-participants. As the following quintile plot revealed, there is higher welfare inequality between non-participants compared to their counter parts which was somewhat modest among them. Probably, the cause for such variation may depend on the approaches followed by non-participants to manage risk. The finding of this research supports the case because we found higher land fragmentation and lesser motivation to invest on improved agricultural technologies by non-participants.

Figure 2: Welfare disparity among participants and non-participants





Furthermore, proximity to main road and markets provides incentives for income enhanced strategies which are consistent with better welfare outcomes. Market access was found to influence non-farm opportunity,

intensification of use of fertilizer and other inputs and enhanced land management among participants.

4.1.4 Participation and degree of risk aversion behavior

To assess the degree of risk aversion behavior among sample respondents, we developed hypothetical question designed to rank degree of risk aversion behavior. The question asks choice of crop based on expected return which in turn based on the occurrence of yield and market risk. Based on respondents' choice of crop, they are classified from 1 to 5 indicating the level of risk aversion behavior which is ranked as least risk-averse, low risk-averse, moderately risk-averse, highly risk-averse, and extremely risk-averse respectively. Though degree of risk aversion behavior variable has five categories, due to small number in the first and second categories they are merged into one category as low risk aversion. The result indicates that, both participants and non-participants of the programme are risk averse but there is statistically significant difference on the mean of degree of risk aversion behavior among participant and non-participants. Non-participants are more risk averse than participants with mean of degree of risk aversion of 3.4 showing high risk aversion behavior. The mean risk aversion among participants was 1.8 which is almost moderately risk-averse. (The detail is presented in the following Table 1).

Table 1: Degree of risk aversion behavior among sample respondents

Participation status	Degree of risk aversion				Total
	Low	Moderate	High	Extreme	
Non-participant	3 (1.6%)	2 (1.1%)	42 (22.7%)	37 (20%)	84 (45.4%)
Participant	51 (27.6%)	26 (14%)	14 (7.6%)	10 (5.4%)	101 (54.6%)
Total	54 (29.2%)	28 (15.1%)	56 (30.3%)	47 (25.1%)	185 (100%)

Source: Own computation based on own survey (2013)

Majority of participants were low risk-averse constituting 27.6% of participants sub-sample while most of non-participants are highly risk-averse

constituting 22.7% of non-participants sub-sample. From participants 14%, 7.6%, and 5% are moderately, highly, and extremely risk-averse while from non-participants 20%, 1.6% and 1.1% are extremely, low and moderately risk-averse respectively.

4.1.5 Risk aversion behavior and share of land allotted to cash crop

Mean estimation of share of land allotted to cash crops based on categories of risk aversion presented under (Table 4) indicate that on average share of land allotted to cash crop declines as risk aversion behavior of the sample respondents rises. Respondents who were low risk averse on average allocate 0.6 (60%) of their land holdings to cash crop where as those under extremely risk averse category allocate on average only 0.24 (24%) of their land. Maximum share of land allotted to cash crop among low risk averse category was 0.80 (80%) and the minimum was 0.3 (30%) where as it was respectively 0.50 (50%) and 0.10 (10%) among extremely risk averse respondents.

4.2 Econometric Result

4.2.1 Impact of participation on degree of risk-aversion behavior

Following steps mentioned in the methodology part, in order to measure the impact of participation on risk aversion, first, probit ofparticipation on access to participation, contact with farm extension agent, access to mass media, dependency ratio, land endowment, distance from farm output market, age of household head, and sex of household head and literacy status of household head was regressed. At this stage, apart from literacy and land endowment, all variables affect participation in statistically significant level.

Access to participation, contact with extension agent, access to mass media, and distance from main road, proximity to market, age of household head and sex of household head were significant at 1% level with expected signs. From those variables which determined participation, access to participation, contact with extension agent, access to mass media and dependency ratio positively affect participation whereas distance from main road negatively affect participation. Here the focus is only to show the sign and significance

of explanatory variables in determining participation. (The detail is presented in Appendix 4).

To sum up, access to participation (existence of SPC in respective Kebele), contact with farm extension agents, proximity to market and access to road were major variables which determined participation from the first step of control function estimation technique.

In the structural model, impact of participation and other covariates on degrees of risk version behavior was regressed. Considering nature of response variable in the structural equation, ordered logistic regression applied assuming that the proportional odds assumption holds. However, the assumption has failed. As a result, generalized ordered logit model is applied which puts restriction on parameters of covariates at each level of odds ratio. Restriction in this paper implies partial proportional odds (PPO) assumption. With the PPO, some of the beta coefficients are the same for all values of j, while others differ because it is possible to relax the parallel lines/proportional odds assumption only for those variables where it is violated.

Apart from Brant test, other criteria for assessing which model fits best was considered. In particular, information measures such as Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC) have penalties for including parameters that do not significantly improve fit. Hence, measure of fit test undertaken and Bayesian Information Criterion (BIC) statistically supports Generalized Ordered Logit model compared to ordered logit model (Appendix 3). Generalized ordered logit 2 model is applied in order to describe the relationship between each pair of outcome groups.

General Ordered Logit2of degree of risk aversion on participation in seed marketing program, standard residual from the probit model of participation, membership in political party, land endowment, sex of household head, age of household head and literacy status of household head is regressed and results on odds ratio are presented in Table 5. Household size and tropical livestock unit is excluded from the model due to multi-co-linearity problem.

4.2.2 Average marginal effects

Effect of participation in seed marketing program on risk aversion are different across the different dichotomizations of the dependent variable in terms of magnitude and direction. Test statistics on the coefficients of residual in the respective category of response variable supports existence of endogeneity problem as evident from test statistics of coefficients of residual in the second and fourth category of response variable, which are statistically significant at 1% level. The endogeneity problem is controlled by applying control function approach.

Retrieving marginal effect after Generalized Ordered Logit model, we found that decision to participation significantly increase probability of being low risk-averse and moderately risk averse. On the other hand, participation in the program implied to reduce probabilities of being highly risk averse and extremely risk-averse.

In the very first panel of second model with controlled participation, the effect of participation is statistically significant suggesting that there is considerable difference in the probabilities of participants and non-participants who are low risk averse versus higher degrees of risk aversion. But, for those who are more risk-averse, non-participants are more likely to be in the high and extreme risk-averse categories than are participants. This means that non-participants are less motivated to take risky but more profitable opportunities than participants. Specifically, participation would change the probability of being low risk averse by +33%and the probability of being moderately risk averse by +19%. In contrast to this, participation would change the probability of being highly risk averse by -52%. However, participation is statistically insignificant in changing the probability of being extremely risk averse.

Generally, participation in seed producing cooperative negatively affects higher degrees of risk aversion behavior of the participants in the study area by making price and demand of their produces certain and via its contribution for their wealth. This finding supports result found by (Lipton 1968). According to him, poor households respond to risks by making sub-

optimal investment decisions which limit them from exploiting investment choices promising high expected rate of return (The detail is presented under the following Table 6).

Membership in political party affects probability of being low risk averse by +31%, the probability of being moderately risk averse by +17%, and the probability of being highly risk averse by -46%. This is probably increased exposure of the members for new policies and programmes during party meetings which increase their trust on new changes. Wealth, especially land endowment, would change probability of being low risk averse by +4.6%, the probability of being moderate risk averse by +07.5%, the probability of high risk-averse by -6.1% and the probability of extremely risk averse by -5.9%. Household with large farm size are willing to choose more risky and more profitable crop because of certainty of at least minimum return from the farm even in bad years as opposed to small farm size. The result is in line with the finding Age of household head affect probability of being low risk averse by -1.4%, the probability of being moderately risk averse by -2.3%, the probability of being highly risk averse by +1.9% and the probability of being extremely risk averse by +1.8%. Being male would significantly change the probability of being low risk averse by +10.5%, being moderately risk averse by +21.9%, the probability of being highly risk averse by +26.4% and being extremely risk averse by -58.9%.

Table 2: Marginal effects after Generalized Ordered Logit

Degree of risk aversion	Explanatory Variables	Uncontrol-led participation		Control-led participation	
		Coefficients	Standard. Error.	Coefficients	Standard. Error
Low	Participation(*)	0.3442779***	(0.063090)	0.333035***	(0.106856)
	Residual (			0.0196575	(0.098745)
	Mebshippolprty (*)	0.2854539***	(0.068984)	0.309685***	(0.072765)
	own land	0.0542068***	(0.018344)	0.0462273**	(0.017188)
	Literacy (*)	0.0454237	(0.031952)	0.0197359	(0.028118)
	HH age	-0.01421***	(0.003823)	-0.014332***	(0.003964)
	HH sex (*)	0.126134***	(0.036270)	0.1052247***	(0.032517)
Moderate	Participation (*)	0.436245***	(0.068067)	0.1926976*	(0.102565)
	Residual (			0.7023528***	(0.202059)
	Meshippolprty (*)	0.200515***	(0.075685)	0.1780006**	(0.079722)
	own land	0.078001***	(0.024897)	0.0752265***	(0.026211)
	Literacy (*)	0.065265	(0.044129)	0.0321948	(0.045235)
	HH age	-0.02045***	(0.005110)	-0.023322***	(0.005692)
	HH sex (*)	0.239337***	(0.054090)	0.2194278***	(0.052686)
High	Participation(*)	-0.42917***	(0.077376)	-0.5213228***	(0.095423)
	Residual (			-0.2895192	(0.204538)
	Meshippolprty (*)	-0.45568***	(0.094020)	-0.4659756***	(0.097221)
	Own land	-0.06150**	(0.037018)	-0.0619573*	(0.029569)
	Literacy (*)	-0.04984	(0.037018)	-0.0261683	(0.037071)
	HH age	0.016121**	(0.006573)	0.0192086*	(0.007925)
	HH sex (*)	0.317934***	(0.112772)	0.2649213*	(0.147427)
Extreme	Participation (*)	-0.35135***	(0.072815)	-0.0044098	(0.086271)
	Residual (			-0.4324911***	(0.129609)
	Meshippolprty (*)	-0.03029	(0.056769)	-0.0217097	(0.052863)
	own land	-0.07071***	(0.020258)	-0.0594965**	(0.019960)
	Literacy (*)	-0.06084	(0.041633)	-0.0257623	(0.037123)
	HH age	0.018538***	(0.003538)	0.0184457***	(0.003969)
	HH sex (*)	-0.6834***	(0.113105)	-0.5895737***	(0.154956)

Legend:(*) dy/dx is for discrete change of dummy variable from 0 to 1
** p<.1; ** p<.05; *** p<.01*

In general, from the above analysis we found that farm households outside seed marketing program were more likely to be highly risk averse than their counter parts. In addition, Women, older, illiterate and poor household heads were more likely to be highly risk averse. As a result, they prefer less risky opportunities even though those opportunities yield lower returns.

4.2.3 Impact of risk aversion behavior on share of land allotted to cash crop

To examine impact of risk aversion behavior on share of land allotted to cash crop, we applied Generalized Linear Model (GLM) for the reason we presented in the methodology. From the analysis in Section 4.1.1 , we found that participation significantly affects higher degrees of risk aversion behavior in opposite direction. In light of our theoretical framework, we tried to examine whether risk aversion behavior in turn affects the share of land allotted to cash crop or not. To check this, we run share of land allotted for cash crop over degree of risk aversion, total land endowment, distance from main road and other household characteristics. We hypothesized and found that higher degrees of risk aversion behavior negatively affects share of land allotted to cash crops.

The overall sign and significance of degree of risk aversion behavior on affecting the decision of farmers to allot part of their land for cash crops is presented in Table 7. Since degree of risk aversion is categorical variable with four categories, we generated three dummies and used the remaining category as a base to escape from the problem of dummy variable trap. In addition, we estimated two competing models; GLM and OLS of fraction of land allotted to cash crops and made a comparison of results to select the more reliable model. In the process we found almost similar results showing that an increase in degrees of risk aversion behavior consistently reduces share of land allotted to cash crops.

Stata result after GLM and OLS indicates that degree of risk aversion behavior, land ownership, distance from main road, age of household head and livestock endowment significantly affect share of land allotted to cash

crop at 1% significance level. Whereas, literacy and sex of household head significantly affect the response variable at 5% of significance level.

Table 3: Stata result after GLM and OLS estimation

Generalized linear models	No. of obs. =	185		
Optimization: ML	Residual df. =	175		
	Scale paramr. =	0.00853		
Deviance = 1.492549699	(1/df) Deviance =	0.00853		
Pearson = 1.492549699	(1/df) Pearson =	0.00853	Number of obs.	185
Variance function : V(u) = 1	[Gaussian]		F(9, 175)	115.56
Link function : g(u) = u	[Identity]		Prob. > F	0.000
	AIC =	-1.87388	R-squared	0.7961
Log likelihood = 183.33434	BIC =	-912.069	Root MSE	0.09235

Share of land allotted to cash crop	**GLM Estimates**		**OLS Estimates**	
	Coef.	**OIM Std. Err.**	**Coef.**	**Robust Std. Err.**
Moderate risk averse	-0.2746479***	0.060143	-0.2746479***	0.059573
High risk averse	-0.2996054***	0.032723	-0.2996054***	0.036146
Extreme risk averse	-0.5606875***	0.049197	-0.5606875***	0.049323
Land endowments	0.0437234***	0.012325	0.0437234***	0.010221
Distance from main road	-0.0094290***	0.003014	-0.0094290***	0.003427
Literacy	0.0373277**	0.016127	0.0373277**	0.016531
Sex of household head	0.0510326**	0.024142	0.0510326**	0.024330
Age of household head	0.0054320***	0.001420	0.0054320***	0.001147
Livestock (TLU)	0.0137841***	0.002416	0.0137841***	0.002108
_Cons	0.4514260***	0.048429	0.4514260***	0.049240

Legend: p<.1; ** p<.05; *** p<.01*

Degree of risk aversion has a statistically significant effect on farmers' decision in allotting their land for cash crop in opposite direction. The finding was in line with that of (Mailosi, 2011) who found negative relationship between risk aversion behavior and choice of risky but high profitable cash crops in Northern parts of Tigray region. Rationale behind negative impact of risk aversion behavior on share of land allotted to cash crop possibly came from the nature of cash crops in the study area which were highly prone to yield and market risk compared to staple crops. As a

result, share of land allotted to cash crop declines with higher degree of risk aversion behavior. The coefficient on dummies of degree of risk aversion categories shows consistently negative and higher magnitude as the degrees of risk aversion behavior rises. Specifically, being moderately risk averse, highly risk averse and extremely risk-averse behavior reduces share of land allotted to cash crops by 27%, 30% and 56% respectively.

Land ownership positively affect share of land allotted to cash crop and its sign was as expected. When amount of land owned by farmer is higher, there is higher possibility of land to be allotted to cash crops. The reason is that household with large farm size are willing to choose more risky and more profitable crop because of certainty of at least minimum return from the farm even in bad years as opposed to small farm size. The finding was in line with that of (Pender et.al, 2006) who found that land endowment increase probability of taking risky but profitable opportunities in East Africa Highlands.

Literacy status of household head positively affect share of land allotted to cash crop. When a household become literate (able to read and write), share of land allotted to cash crop increases by 4% because literate farmers are less risk averse compared to their counter parts due to better exposure towards new changes.

In contrast to land ownership and literacy, however, distance from main road has negative influence on the decision of allotting land to cash crops. Distance from main road significantly reduce share of land allotted to cash crop and the finding was in line with that of (Seid & Holger, 2011) who found proximity to urban center positively affect decision to allot share of land for cash crop in villages of Wollo, Ethiopia.

From the previous analysis we have seen that participants were less risk averse compared to their counter parts and they allot higher share of their land to cash crops. In line with this, most of the participants found averagely at 2.1 kilometres away from main road while non participants averagely 6.2 kilometres far away. Due to this fact, those who are far from main road less advantageous in terms of access to market information and transportation

cost which make them reluctant to adopt risky but more profitable opportunities such as growing cash crops. The result from GLM shows that keeping other variables constant, the farther farm household found from main road, the less plot of land allotted for cash crop-in line with Tuennen's argument.

Households headed by male and elder also significantly affect share of land allotted to cash crops in the study area. Positive impact of being headed by male and elder on share of land allotted to cash crops stem from the fact that elder and male headed households were wealthier in terms of land and livestock ownership compared to younger and female headed households. Being male increases share of land allotted to cash crops by 5%.

Finally, livestock endowment significantly increases share of land under cash crops by 1.2%. The reason for such impact was that households who endowed with livestock were more likely to take risky opportunities than those who lack such asset because they can sell their livestock at the time of crop failure.

5. Conclusion and Policy Implication

5.1 Conclusions

Objective of this paper was assessing impact of participation in Local Seed Business Program on risk aversion behavior and crop choice of farm households in Boricha and Lanfero districts which found in Sidama and Silti Zones of SNNPRS. Using primary data collected from randomly selected 185 sample respondents of the two districts, the researcher tried to identify impact of participation on risk aversion behavior adopting control function approach and using generalized ordered logit model. To examine the impact of risk aversion behavior on crop choice, generalized linear model was used. From the analysis, statistically significant negative impact of participation on higher degrees of risk aversion behavior was confirmed. Non-participants were found relatively higher risk aversive than their counter parts and chose less risky and low return alternatives. Lower risk aversion behavior among participants enabled them to take risky opportunities with higher return. As a

result, participants have better per capita income and consumption pattern. From auxiliary probit regression of participation on some explanatory variables it was found that access to participation, access to media (Television & Radio) and contact with extension agents are variables that positively and significantly determine participation whereas distance from main road and farm output market has negative effect on participation. Majority of non-participants were found in the categories of higher degrees of risk aversion and most of them were poor, women, and young headed households.

To sum up, it was found that participation in local seed business significantly reduce risk aversion behavior. As a result, less risk aversion behavior in turn induces households to allot more plot of land to production of cash crops which are more risky but promising higher profit. Allotting higher share of land for cash crops possibly has motivated farmers to invest on yield enhancing agricultural technologies and raise their effort. Consequently, productivity of plot of land of participants was relatively higher than that of non-participants. This could be the possible reason for higher welfare enjoyed by participants compared to their counter parts.

5.2 Policy Implication

Market uncertainty for produces of farm households in the study area was a limiting factor to invest on risky but more profitable opportunities. Hence, reducing risk aversion behavior of the farmers via enabling them to participate in local seed business will help them to take risky opportunities and enjoy higher profit from those opportunities.

As the result shows, increasing access to local seed business via forming seed producing pool of farmers at district level and reducing knowledge gap by providing short term trainings on adoption of improved agricultural technology has effect of reducing risk aversion behavior. In addition, improving proximity to farm output market by constructing rural roads which connect rural villages with urban centres will have welfare enhancing effect by reducing transaction cost and increasing incentive to produce marketable surplus. Likewise, strengthening the link between farm extension

agent and farmers, creating awareness on the importance of local seed business via television and radio possibly increase choice of risky opportunity with better return and hence better welfare. Moreover, interventions which focused on women and young headed poor households will have relatively higher welfare enhancing effect.

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Appendix 1: Summary statistics of variable in this thesis by participation status.

Summary statistics of variables included in this paper		
Variable	**Participant**	**Non-participant**
Household Age	42.7	37.8
Education level of HH head	4	1.6
Number of children	9	8
Household size	12	10
Dependency ratio	2.4	1.9
Own land in hectare	2.4	1.1
Rented land in hectare	0.5	0.3
Distance from main road	2.1	6.2
Share of land allotted to cash crop	0.55	0.26
Share of land allotted to staple crop	0.4	0.7
Number of type of crops grown	3.5	5.3
Degree of risk aversion behavior	2.7	4.3
Effort in terms of time spent on farm	8.8	5.5
Land productivity per hectare	7,303	3,282
Total farm income	38,651	16,702
Per capita income	3,507	1,894
Calorie/day/adult equivalent	2,843	2,497
Number of oxen	2.7	1.2
Tropical livestock unit	6.8	3.8
Level of saving	3,235	542

Source: Own computation

Appendix 2: Wealth by participation status

Wealth components	**Mean**		**Std. Dev.**		**Min**		**Max**	
	Participant	**Non-participant**	**Participant**	**Non-participant**	**Participant**	**Non-participant**	**Participant**	**Non-participant**
Land endowment	2.826733	1.4375	1.298433	0.7818296	0.25	0.25	5.75	5.25
Livestock (in TLU)	6.856238	3.834405	4.700104	2.891509	0	0	18.72	12.6
Number of oxen	2.693069	1.154762	1.847932	1.256252	0	0	7	4
Yearly saving	3235.554	542.0238	3662.679	776.1378	0	0	13500	3500

Source: Own computation based on own survey (2013)

Appendix 3: Measure of fit test

Measure of Fit for gologit of degree of risk aversion			
Warning: Current model estimated by gologit, but saved model estimated by ologit			
Model:	**Current**	**Saved**	**Difference**
	gologit	Ologit	
N:	185	185	0
Log-Lik Intercept only	-250.682	-150.682	0.000
Log-lik Full model	-123.972	-167.37	43.398
D	247.943(161)	334.739(175)	86.796(14)
LR	253.421 (21)	166.626 (7)	86.796(14)
Prob > LR	0.000	0.000	0.000
McFadden's R^2	0.505	0.332	0.173
McFadden's Adj R^2	0.410	0.292	0.117
ML (Cox-Snell) R^2	0.746	0.594	0.152
Cragg-Uhler (Nagel kerke) R^2	0.799	0.636	0.163
AIC	1.600	1.918	-0.318
AIC*n	295.943	354.739	-58.796
BIC	-592.534	-578.823	-13.711
BIC'	-143.794	-130.083	-13.711
BIC used by stata	373.232	386.943	-13.711
AIC used by stata	295.943	354.739	-58.796
Difference of 13.711 in BIC' provides very strong support for current model.			
Note: p-value for difference in LR is only valid if models are nested			

Source: Own computation

Appendix 4: Determinants of participation in local seed producing cooperative

Probit regression	**Number of obs =**	**185**
	Wald chi2(9) =	1396.13
	Prob > chi2 =	0.000
Log pseudolikelihood = -36.214808	Pseudo R2 =	0.7159
Participation	**Coef.**	**Std. Err.**
Access to participation	6.497668***	0.410779
Contact with extension agent	1.491558***	0.9757105
Access to mass media	1.912952***	0.3868589
Dependency ratio	0.1093863**	0.0466081
Land endowment	-0.0980243	0.2611489
Market distance	-0.2520686***	0.050374
HH age	0.050859***	0.0197728
HH sex	-6.878751***	0.9757105
Literacy	-0.4197677	0.2785002
_cons	-2.139425*	1.12038

Legend: p<.1; ** p<.05; *** p<.01*

Appendix 5: Brant test

Estimated coefficients from j-1 binary regressions			
	y>1	y>2	y>3
Participation	-3.526621	-2.745565	0.9732492
Residual	0.0309725	-4.939521	-7.099311
HH age	0.1748101	0.1918265	0.2095546
Membership in political party	-3.427868	-3.248139	-0.673461
Land endowment	-0.7077	-0.015312	0.3108928
Literacy	-0.431676	0.4056073	0.3108928
_cons	0.4523876	-0.938029	-6.545932

Brant Test of Parallel Regression Assumption			
Variable	**chi2**	**p>chi2**	**df**
All	61.74	0.000	12
Participation	22.27	0.000	2
Residual	24.55	0.000	2
HH age	0.45	0.799	2
Membership in political party	10.73	0.005	2
Land endowment	10.03	0.007	2
Literacy	2.37	0.305	2

A significant test statistic provides evidence that the parallel regression assumption has been violated.

Source: Own computation

Appendix 6: Generalized ordered logit estimation of degree of risk aversion behavior

Degree of risk aversion	**Generalized ordered logit with uncontrolled participation**		**Generalized ordered logi with controlled participation**	
Beta ( )	**Coef.**	**Std. Err.**	**Coef.**	**Std. Err.**
Participation	-3.64422***	(0.6832213)	-3.83286***	(1.013574)
Residual (			-0.25451	(1.284620)
Membership in political party	-3.37805***	(0.6607526)	-3.10313***	(0.751978)
Land endowment	0.62122***	(0.1529687)	0.59852**	(0.163248)
Sex of household head	-3.49992***	(0.7091318)	-3.10313***	(0.751978)
Age of household head	0.162858***	(0.0240106)	0.185558**	(0.026430)
Literacy	-0.52548	(0.3422165)	-0.25707	(0.359529)
Gamma( )				
Participation	-1.32722**	(0.508716)	0.898278	(0.880902)
Residual (			-3.30351***	(1.084436)
Membership in political party	0.709598	(0.598498)	1.130998	(0.700248)
Gamma( )				
Participation	0.965857	(0.7496087)	3.78857***	(1.147175)
Residual (			-4.09621**	(1.375791)
Membership in political party	3.116734***	(0.7577538)	3.738861***	(0.830407)
Alpha( )				
_	4.185243***	(1.075955)	3.454831**	(1.146819)
_	3.069383***	(1.007101)	2.654124**	(1.092831)
_	-2.30644**	(0.953545)	-3.0263**	(1.026682)

Alternative parameterization: Gammas are deviations from proportionality
*Legend: * p<0.1; ** p<0.05; *** p<0.01*

Does Gender Matter in Technical Efficiency of Crop Production in Wolaita Zone, Ethiopia? A Stochastic Meta-frontier Approach

Samuel Tekalign[1] and Eyob Bekele[2]

Abstract

This study compared the TE scores of FHHs and MHHs farmers; measured the production technology gap ratio (TGR) between these household groups; and identified factors determining their farm level TE scores in Wolita Sodo Zone. We used 153 MHH and 147 FHH crop producers' using stratified random sampling from four woredas in 2013. We utilized Stochastic Metafrontier Model (SMFM) to measure the TE and TGR between MHHs and FHHs. Stochastic Frontier Models (SFM) for MHHs, FHHs and pooled data were first estimated before adopting the SMFM. To estimate determinants of TE, Two-Limit-Tobit model was employed. The result showed that mean TE for MHHs (71%) was greater than for FHHs (45%). The mean TGR of FHHs (98%) were more close to the potential output than MHHs (93%). The mean Metafrontier-level TE (TE) revealed that MHHs (66%) once again achieved greater score than FHHs (44%). This revealed that FHHs were more technically inefficient than MHHs. The mean TE* for the total sample was about 55% indicating that production can be further enlarged by 45% if appropriate measures are taken to improve their efficiency. Results of the Tobit model found gender, education, farm-experience, livestock, off-farm income, family size, credit, climate Dega and Weina-Dega to have positive and significant while age was found to have negative effect. Finally, we recommended agricultural development programmes and resource management strategies to more robust gender-oriented-efficiency-enhancing approaches that will result high crop productivity and food self-sufficiency in the short-run and a more sustainable zonal development in the long-run.*

Key Words: Wolaita Zone, TE, TGR, FHHs, MHHs, SFM, SMFM, Crop Productivity

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1. Introduction

The sound performance of agriculture in LDCs promises the availability of food crops. In Ethiopia, over the past decade, cereal production has more than doubled to nearly 15 million tonnes, as a result of horizontal expansion and increased yields (MoARD, 2010). However, the rate of increasing in productivity might not be proportion to the rate of growing of the population and increasing of the demands for crops, led to don't smoothen the food security issue. According to Alemayehu, *et al.* (2011) stated this, since yields or/and productivities are low by international standards and overall production is highly susceptible to weather shocks, food security remains a critical challenge to many and poverty doesn't show significant improvement at national level. Therefore, it is necessary to support the small farm holders, who accounts third of rural households and major crop producer of the country (MoARD, 2010), as long as the ultimate goal of development is to bring about improvements in the life of poor. Moreover, understanding of the rural women, who constitutes some little less than half (49.4%) (CSA, 2008) of the agriculture poor society and contributes 60-80 % for the food crop production of the country (SIDA, 2005) is crucial.

A lot of evidences have shown that the number of households that headed by females (FHHs) (de facto & de jure)[3], particularly those in rural areas of LDCs, are growing rapidly (Buvinic, 1998; Lingam, 1994). As result, agriculture is being 'Feminized" in many LDCs (Javed & Asif, 2011). In general, FHHs (*De jure*) living in LDCs are at risk of living in poverty than male headed households (MHHs) and disproportionately represented among the poorest of the poor in any aspects (Javed & Asif, 2011). In Ethiopia, rural FHHs were estimated to share 23% of total household (MoFED, 2002a sited in Assefa, 2003). In the study area, Wolaita, of the total of 1.5 million people live in rural areas, almost half of the populations (50.5%) are women

[3] 'De facto' female headed households are those households where the male heads are absent for more than 50 percent of the time. In 'de jure' female headed households, women are legal and customary heads of the households (Ellen, 1992 sited in Tamiru, 2004)

(CSA, 2008) and about 15.3% of the total farm households are headed by females (Zone Agricultural Administration, 2012).

Large and increasing proportion of FHHs farmers in rural areas accompanied with above mentioned social, cultural and economic biases entail goal of maintaining sustainable development (and food security) through improving agricultural productivity can hardly be achieved if a policy/program designed with this respect unable to account these segments of society and unable to solve their core gender specific problems. Theoretically, crop productivity can be improved through the development/adoption of new technology and efficient use of existing technologies and resources. In the early 1960s, many were advocating use of newly arrived technologies as the only means to boost agricultural productivity in LDCs (1964; Kuznets, 1966). However, in developing economies like Ethiopia where resources are meagre and capacity for developing and adopting new technologies are limited, improving efficient use of existing resources and technologies is the most viable option to increasing productivity (Oyeranti, 2000).

There are evidences that show FHHs framers can perform equally as male framers, once individual characteristics and input level differences are controlled for (Sirdhar, 2008; Njuki *et al.*, 2006; Makombe *et al.*, 2011). Almost all of these authors unanimously agreed that if MHHs and FHHs had equal access to inputs; it is likely their level of productivity would be similar. However, there are some exceptional findings (Dimelu *et al.*, 2009 & Dadzie & Dasmani, 2010) who reported that FHHs are more technically efficient than MHHs in different kinds of crop production. As far as evidences from Ethiopia and the study area is concerned, it is hard to come by any study that determine gender differences in TE of crop production where male and female manage separate farm lands and act as an independent head of a household. Thus, the objective of this study is to assess the technical efficiency (TE) difference that could exist between male and female-headed crop producing households in Wolaita zone given the possible production technology gap between them.

2. Materials and Methods

2.1 Technical Efficiency

In this study, we employ the stochastic Metafrontier model (SMFM) technique to assess the TE difference between MHH and FHH farmers in Wolaita zone. The SMFM is appropriate because the Metafrontier function concept is best to use for groups, like MHHs and FHHs that could operate in different production technology. In such specification we first control the existing technology (TGR) difference in production system between MHHs and FHHs farmers and then we try to estimate TE scores using a single-pooled production function. Therefore, the following procedure is used to assess efficiency of the Wolaita Zone under a stochastic Metafrontier function framework:

1. Specify production functions for the two groups (Full and Partial package farmers).
2. Estimate stochastic frontier for each group.
3. Perform Likelihood Ratio (LR) tests to determine whether the technological difference between the two categories of farmers is statistically significant.
4. Construct the Metafrontier if the test shows significant difference.
5. Estimate Technology Gap Ratio (TGR) and Metafrontier TE Ratio (TE*).
6. Estimate a Tobit model to verify the determinants of TE* for crop sector as whole.

The two commonly used functional specifications in the literature are the Cobb-Douglas (CD) & the trans-log (TL) stochastic frontiers. The choice between the two functional forms doesn't matter if the primary objective is to estimate efficiency (TE) (Koop & Smith, 1980) and CD specification has an advantage over TL in its robustness and the parametric linearity nature (Afriat 1972 sited in Medhin & Köhlin, 2009). Therefore, the CD model specification is selected for this study. The specification is as follows:

$$\ln Q_{ik} = \beta_{0k} + \beta_{1k} \ln X_{1ik} + \beta_{2k} \ln X_{2ik} + \beta_{3k} \ln X_{3ik} + \beta_{4k} \ln X_{4ik} + \beta_{5k} \ln X_{5ik} + V_{ik} - U_{ik} \quad \textbf{(1)}$$

Where: ln *:* natural logarithm; i : i^{th} *hh* and *k*: the kth group (MHH or FHH); Q :Value of Crop harvested (Birr); X_1 :Land size (hectare); X_2 :Labor power employed (labor days); X_3 :Draft power employed (oxen days); X_4 : Value of seed utilized (improved & local seed) (Birr); X_5 :Value of fertilizer (Dap & Urea) used (Birr); $'s$:Parameters to be estimated*;* $U_{ik}'s$:Non-negative technical inefficiency component of the error term, assumed to be independent of the $V_{ik}'s$ (stochastic noise term) and to follow half normal distribution with mean α_{ik} and variance, σ_{α}^{2}.

There are two approaches of estimating inefficiency effects. These are simultaneous equation (one stage) modelling and the two-stage modelling (Battese & Coelli, 1993). The advantage of the simultaneous equation technique over the two stages is that it incorporates farm specific factors in the estimation of the production frontier because those factors may have a direct impact on efficiency (Wadud, 2002). Hence, inefficiency effects are defined to be the explicit functions of firm's specific factors and all parameters were estimated in a single stage maximum likelihood (ML). Following single stage ML estimation procedure, the two set of variables that need to be included in the stochastic frontier model (SFM) are input variables that determine farm output levels and efficiency determinant variables. The function with its output determinant variables are specified as shown in Eq. (1) above and the technical inefficiency effects function (where α_i is the mean level of technical inefficiency for household in group k) estimated from Eq. (1) can be specified using the following formula:

$$\alpha_{ik} = \sigma_{0k} + \sigma_{1j}Z_{1ik} + \sigma_{2k}Z_{2ij} + \sigma_{3k}Z_{3ik} + \sigma_{4j}Z_{4ik} + \sigma_{5k}Z_{5ik} + \sigma_{6k}Z_{6ik} + \sigma_{7k}Z_{7ik} + \sigma_{8k}Z_{8ik} + \sigma_{9k}Z_{9ik} + \sigma_{10k}Z_{10ik} + \sigma_{11k}Z_{11ik} \quad \textbf{(2)}$$

Where i and k are as described above; α_{ik} : the technical inefficiency score of household i in k group; $Z_1, Z_2 \ldots Z_{11}$: are socio-economic characteristics

that could affect farmers' efficiency (these variables are well explained in the last section of this chapter); and W_{ik}: a random error term for efficiency effect model; ¢'s: parameters to be estimated.

The stochastic frontiers for MHH and FHH farmers were estimated from Eq. (1) and Eq. (2), using the Frontier 4.1 program by employing a single stage ML estimation procedure. In addition to the β and δ coefficients, γ, TE of each farm group and the log-likelihood functions are also estimated. Estimates for pooled data are also estimated in the same manner. γ is important to decide if farmers in each group are efficient or not (H_0: γ = $0V_sH_1$: γ > 0). Moreover, pooled estimation helps us to determine whether the Metafrontier is really necessary for estimating the efficiency levels of the famers. If the two groups share the same technology, then the stochastic frontier production model is enough to estimate the efficiency of the famers. A likelihood ratio (LR) test is calculated to this hypothesis as:

$$LR = -2\left\{ Ln\left[\frac{LH_0}{LH_1}\right]\right\} = -2\{Ln(LH_0) - Ln(LH_1)\} \qquad \textbf{(3)}$$

Where, Ln (LH_0) is the value of the log likelihood functions for the stochastic frontier estimated by pooling the data for all the two groups, and Ln (LH_1) is the sum of the values of the log-likelihood functions for the two SFM (MHHs + FHHs) estimated separately. If the test statistics is statistically significant, it indicates that the SFM for the two groups is different and therefore we need to construct Metafrontier. If this is the case, we obtained estimates of $\hat{}^*$ for the * parameters of the SMFM. This is done in a way that the estimated function best envelops the deterministic components of the estimated SFMs for the different groups. Battese *et al.* (2004)'s minimum sum of absolute deviations method is used to construct of the Metafrontier as the following linear programming (LP):

$$\begin{aligned} &Min \quad L^* = \overline{X}^* \\ &s.t \quad X_i^* \geq X_i \hat{}_j \end{aligned} \qquad \textbf{(4)}$$

Where $\overline{X}$ is the row vector of means of the elements of the vectors for all observations in the data set, $\hat{}_{j}s$ are the estimated coefficients of the group stochastic frontiers and * are parameters of the SMFM. Excel Solver was used to solve the LP problem in Eq. (4). The technical efficiency relative to the stochastic frontier for each group, the technology gap ratio (TGR) and the TE of the i[th] farmer relative to the metafrontier (TE_i^*) are then estimated as:

$$TE_{ik} = \frac{Q_i}{e^{\beta_{0k} + \beta_{1k}\ln X_{1ik} + \beta_{2k}\ln X_{2ik} + \beta_{3k}\ln X_{3ik} + \beta_{4k}\ln X_{4ik} + \beta_{5k}\ln X_{5ik} + v_{ik} - u_{ik}|}} = e^{(-U_{ij})} \quad \textbf{(5)}$$

$$TGR_i = \frac{e^{\beta_{0k} + \beta_{1k}\ln X_{1ik} + \beta_{2k}\ln X_{2ik} + \beta_{3k}\ln X_{3ik} + \beta_{4k}\ln X_{4ik} + \beta_{5k}\ln X_{5ik} + v_{ik} - u_{ik}}}{e^{\beta^{*}_{1i}\ln X_{1ik} + \beta^{*}_{2ik}\ln X_{2ik} + \beta^{*}_{3ik}\ln X_{3ik} + \beta^{*}_{4ik}\ln X_{4ik} + \beta^{*}_{5ik}\ln X_{5ik}}} \quad \textbf{(6)}$$

$$TE^{*}_{i} = \frac{Q_i}{e^{\beta_0 + \beta^{*}_{1i}\ln X_{1ik} + \beta^{*}_{2ik}\ln X_{2ik} + \beta^{*}_{3ik}\ln X_{3ik} + \beta^{*}_{4ik}\ln X_{4ik} + \beta^{*}_{5ik}\ln X_{5ik}}} \quad \textbf{(7)}$$

$$TE^{*}_{i} = TE_{ik} * TGR_i \quad \textbf{(8)}$$

To identify source of technical efficiency variation among farmers in the total sample, the estimated Metafrontier level technical efficiency scores (TE^{*}_{i}) (of the two group) can be regressed against various household, institutional and farm level characteristics using the *Two-limit Tobit model* procedure. Tobit model specification is specified as:

$$TE^{*}_{ik} = Z_i\sim + W_i \quad \textbf{(9)}$$

Where W_i are a random error terms; $\sim S$: are parameters to be estimated, Z_i are vector of farm specific variables associated with meta-technology level technical efficiency TE^*_{ik}.

2.2 Data Source and Collection

The target population for the study was all food crop producing farmers in Wolaita zone of four woredas: Sodo Zuria, Umbo, Damot Gale and Boloso Sore. Two kebele administrations from each woreda were candidate for this study. Each woreda agriculture office was contacted for a list of some food crop farmers in each kebele. Sampling of the respondents was done using simple random sampling technique. The study involved 300 respondents (153 male and 143 female farmers). Data was collected using structured interview. With the help of FRONTIER version 4.1, STATA computer software, and EXCELL-solver collected data was analyzed. For easy and fast comparison of MHHs and FHHs producer, descriptive statistics (frequencies, percentages, means and standard deviations) were run to obtain the summary of the data.

3. Results and Discussions

3.1 Descriptive Analysis

Summary statistics result of this study indicates that the average household size in a MHHs farmer was 6.34 persons compared to 4.99 persons in FHHs. The result also shows that the average age for the total sample households was 43.90 while for MHHs was 41.72 years compared to 46.16 years for FHHs. Regarding economically active family members (15 to 65 years), the MHH had larger economically active members (3.48) than FHH (3.05). Similarly, the mean non-active family members were found to be 2.94 (inMHHs) and 1.92(in FHHs) in number indicating that number of both active and non-active family members exceeds in MHHs than in FHHs. Comparisons made between MHHs and FHHs with regard to their education achievement reveals that about 30% of the MHHs and 79% of FHHs were illiterate, about 25% of MHHs and 13% of FHHs could read and write, about 24% of MHHs and 7% of FHHs attended primary education, about 16% and

1% could involve in secondary schooling, and only 5% of MHHs and 1% of FHHs had education above secondary education level. Statistically evaluated, there are quite significant differences between MHHs and FHHs in all kinds of education categories implying that FHHs are disadvantageous at lower educational standard to acquire and utilize relevant information at least to synthesize different agricultural extension packages introduced by policy makers. This finding is line with other studies (FAO, 2011; Tamiru, 2004).

The average land owned by both MHH and FHH was about 0.72 hectare, showing at least for the sample households under discussion, there is no significant difference in average land holding between MHHs & FHHs in the study area. Summary statics also portrays that the mean value spending on total seed inputs in MHHs was 643.69 Birr and in FHHs was 490.90 Birr. The result also shows that a given sample household in the study area used an average of 1369.24 Birr valued total fertilizer (Dap and Urea) input. As far as use of fertilizer by the two groups is concerned, it seems that MHHs had large spending on total fertilizer (1472.15) than FHHs (1262.13) but it was statistically insignificant. The average labour days[4] that MHHs required for ploughing, weeding and harvesting was 158.38 and for FHHs were 111.40. Similarly a given MHH in the study area required an average of 44.99 oxen[5] days for its farming activities and 26.84 oxen days in FHHs but this difference between MHH and FHH is statistically not significant. Combining all inputs quantities used in the production process, MHHs and FHHS could produce an average of 17559.69 and 13032.80 Birr valued crop output annually. This implies that MHHs generated on average more income from crop production than FHHs did, but the differences can only highlight "gross" yield variation not "efficiency" differences; which is in detail analyzed in econometric manipulation section of the this paper.

The survey result also reveals that about 44% of MHHs and about 37% of FHHs could access credit services delivered in the area which is in

[4]Man-days refer the total number of days a typical farmer used in plowing, weeding and harvesting practices using his own family labor, hired labor as well as from traditional labor sharing arrangement.

[5]Oxen-days again define as the total number of days of pair of oxen used in all farming activities (Ploughing, weeding, threshing and trucking)

conformity with other findings (King et al., 2007 as sited in Klasen *et al.,* 2009). Extension services by Development Agents (DA) are delivered in the study area to fill the technical gaps in agricultural practices. To this end the mean annual number of extension contact days of DAs with MHHs was 4.52 and with FHHs was 3.67 days; implies that MHHs are once again more advantageous than FHHs with respect to advisory services on major agronomic practices.

3.2 Econometrics Estimations and Results

It is evident from Table 1 in the next page that all production inputs-parameter estimates both in MHHs and FHHs cases, except the input-seed, are statistically significant. Unexpected sing on the variable "Log_labor_days" in all estimation case might arise due to the effect of congested use of this input on the available small fragmented land in the study area. The values of $\gamma = 0.689$ and 0.481in Table (1) above for MHHs and FHHs, respectively measure the relative deviation of actual households' harvest from their respective group frontier due to the inefficiency in their production. Thus, about 69% in MHHs and 48% in FHHs of the variation in production was due to the differences in level of efficiency among crop producers of the study area. The remaining 31% in MHHs and 52% in FHHs, therefore, are as a result of the usual noise disturbances. Discussion of the lower panel inefficiency effect model coefficients is left un-interpreted because Tobit model at end can does the same thing.

Table 2 reveals that the mean TE score for MHHs is about 71 % and for FHHs nearly 45%. These TE indices proves first, the presence of wide variation in TE scores among crop producers of the study area and second the presence of around 26% higher average TE achievement in MHHs group than in FHHs group. However, it is important to note the fact that MHHs have higher mean TE does not necessarily mean they are more productive than FHHs; it means crop producer under male group operate closer to their group-specific technology frontier than female farmers do. Therefore, efficiency comparisons are only possible only if we know the position of each group frontier relative to the best technology, or the Metafrontier.

Table 1: The ML Estimates of the Cobb-Douglas SFM and Inefficiency Effect Models for MHH and FHH Crop Farmers in Wolaita-zone, together with Estimates of Parameters of the SMFM

Variable	Symbol	MHHs		FHHs		Pooled Data		Meta(LP)†
		Coefficient	(t-ratio)	Coefficient	(t-ratio)	Coefficient	(t-ratio)	
Constant	β_0	7.588*	(17.14)	10.556*	(21.12)	9.840*	(21.93)	10.202
Log_land	β_1	0.187**	(2.05)	0.641*	(7.87)	0.433*	(6.57)	0.537
Log_labor_days	β_2	-0.169**	(1.87)	-0.342*	(3.55)	-0.074	(0.97)	-0.301
Log_oxen_days	β_3	0.258*	(3.02)	0.253*	(2.81)	0.193*	(2.80)	0.360
Log_seed	β_4	0.019	(1.17)	0.066	(0.92)	0.165*	(2.66)	0.067
Log_fertilizer	β_5	0.318*	(6.90)	0.062*	(3.53)	0.006	(0.22)	0.072
Sigma Square	$\pm^2$	0.967*	(4.94)	0.329*	(6.79)	0.484*	(9.11)	
Gamma	¥	0.689*	(7.93)	0.481*	(2.73)	0.895*	(6.49)	
Log Likelihood	LR	-145.61		-119.66		-297.95		
Inefficiency Effect								
Constant	δ_0	2.686*	(3.99)	1.138*	(2.64)	2.123*	(5.86)	
Sex of HH head	δ_1					0.039	(1.50)	
Age of HH head	δ_2	-0.048	(1.89)	0.026*	(3.31)	0.009	(1.39)	
Edu. Dummy	δ_3	-0.591*	(6.11)	-0.136*	(3.69)	-0.111**	(2.43)	
Household Size	δ_4	0.024	(0.73)	-0.017**	(1.99)	-0.0051	(0.76)	
Farm experience	δ_5	-0.005**	(2.01)	-0.027	(0.16)	0.001	(0.54)	
Plot Numbers	δ_6	-0.001*	(3.23)	0.001	(0.98)	-0.000***	(1.65)	
Livestock (TLU)	δ_7	-0.000	(1.12)	-0.001	(-2.10)	-0.000***	(1.89)	
Off-farm Income	δ_8	-0.172*	(1.86)	-0.068	(-1.37)	-0.058**	(2.13)	
Credit Dummy	δ_9	-4.311*	(5.05)	-0.359**	(-2.26)	-0.514*	(4.58)	
Climate-Dega	δ_{10}	-1.956*	(4.13)	0.158	(0.43)	-0.496**	(2.12)	
Climate W-Dega	δ_{11}	-0.981	(-2.22)	-0.585*	(-3.00)	-0.470*	(3.41)	

* p<0.01,** p<0.05, *** p<0.1

Source: Survey Data (2013);

NB: †parameter estimates of the Metafrontier function obtained using computer program-EXCEL SOLVER.

Technical Efficiencies of Crop Farmers in Wolaita Zone

Table 2: Frequency Distribution of TE Indices of the two Groups

Efficiency Score	MHHs		FHHs	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Total	153	100	147	100
Mean (SD)	0.7104(0.2304)		0.4472(0.2592)	
Maximum	0.9335		0.9581	
Minimum	0.0149		0.0027	

Source: Survey Data (2013)

3.3 Likelihood Ratio Test

In order to determine whether MHHs and FHHs farmers in Wolaita zone are currently operating at similar technology (i.e. the pooled estimation results in Table 1 are valid and appropriate for inference) or have different positions so that efficiency comparison has to be made only with reference to their meta-technology, a likelihood ratio (LR) test is carried out as follows:

$$LR = \text{a} = -2\left\{Ln\left[\frac{LH_0}{LH_1}\right]\right\} = -2\{Ln(LH_0) - Ln(LH_1)\} \quad Ln(LH_0) = -297.95,$$

$$Ln(LH_1) = -265.27 \quad , \text{a} = 65.36$$

With 5 degrees of freedom[6], the ¡ ^{2} distribution from the table at 99% confidence level is 19.696. Our estimated value of 65.36 is completely outside this range. At this point, we fail to accept our presumed null hypothesis that says the pooled SFM is a correct representation of the data. This proves, once again, that male and female farmers in study zone are currently operating at different production environment so that we required applying SMFM for the analysis of TE difference between MHHs and FHHs crop farmers in the study area, Wolaita.

[6] The number of restrictions are 6.

Estimates of Metafrontier TE and Technology Gap Ratios (TGRs)

Table 3: Summary Statistics for TE, TGR and Metafrontier level Technical Efficiencies (TE*)

Group	Variable of Interest	Mean	Std. Dev.	Minimum	Maximum
MHHs	TE	0.7104	0.2304	0.0149	0.9335
	TGR	0.9266	0.0440	0.7525	1.0000
	TE*	0.6642	0.2208	0.0113	0.8933
FHHs	TE	0.4472	0.2592	0.0027	0.9581
	TGR	0.9764	0.0153	0.9287	1.0000
	TE*	0.4353	0.2506	0.0026	0.9208
Mean TE* for the total sample is 0.5519					

Source: Survey Data (2013)

From the above Table (3), the mean values of the technology gap ratios (TGR) are 0.9266 and 0.9764 for MHH and FHH farmers, respectively. These results imply that, MHH and FHH farm groups attain, on the average, about 93% and 98%, respectively, of the potential output income given the technology available to the total sample used in this study. Here, the maximum TGR value, 1, in both cases points that; at least one farmer from each group was producing the frontier output level that is defined by the sector meta-technology.

The table also portrays that Metafrontier-level TE (TE*) for FHHs are now subjected to have lower mean score (0.4353) than for MHHs (0.6642). this suggests that, even after we have controlled variations in production technologies between MH and FHH farmers , applying the TGR method, the lower SFM-TE score achieved in FHHs (45%) compared with in MHHs (71%) remained unchanged. From this finding, it can be conclude that, crop production system under FHHs control is generally technically inefficient compared to crop production system under MHHs control, no matter how resource endowments and accesses to services differences between them are controlled for. The result, in fact, is in contrary to the conclusions that made by Dadziel and Dasmani (2010), who applied the same methodological approach to study male-female TE differences in food crop production in Ghana.

Estimates of the Tobit Model to Verify the Determinants of TE

Table 4: Tobit Model Estimation of Metafrontier Technical Efficiency Effects

Variables	Coefficients	Standard Error	t-scores
Sex	0.1289*	0.0231	6.04
Age	-0.0049*	0.0013	-3.91
Education Dummy	0.0766*	0.0235	3.38
Household Size	0.0104**	0.0042	2.30
Farm Experience	0.0049*	0.0012	3.91
Plot Number	-0.0072	0.0131	-0.41
Livestock (TLU)	0.0202*	0.0055	4.04
Off-farm Income	0.00002*	0.00000	4.52
Credit Dummy	0.1975*	0.0224	10.07
Climate- Dega	0.1589*	0.0442	3.59
Climate- W-Dega	0.1771*	0.0219	7.27
Constant	0.2873*	0.0437	5.92
Sigma	0.1477	0.0060	
* p<0.01, ** p<0.05, Observations = 300 Log likelihood = - 148.15			

Source: Survey Data (2013)

From Table (4) above, variable sex is a dummy variable for the gender of the household head with value 1 if male headed and 0 if female headed household. The positive sign on this variable implies that keeping all other factors constant, MHHs are more efficient than FHHs in crop production system. With different methodological approach to the present study, several empirical works have proved the impact of sex of household headship on efficiency to be positive and significant if the head is male (e.g. Düvel, *et al.*, 2003 & Tamiru, 2004 in Ethiopia; Marinda *et al.*, 2006 & Njuki *et al.*, 2006 in Kenya).

It is also observed from estimates of the Tobit models that technical efficiency scores were significantly and positively influenced by educational level, household size, years of farm experience, livestock ownership, income from off-farm activity, dummy for access to credit, dummy for climate-dega

and climate woina-dega as compared to climate-kola while it is negatively influenced by age of the farm household head.

5. Conclusions and Recommendations

MHHs were found to have relatively larger family size in all age categories, less aged, more literate, cultivated more hectare of land, used more labor days for farming and spend more money for seed inputs compared to FHHs. In general, women farmers in the study area were disadvantageous in access to and control over agricultural resources and achieved on average lower valued crop output (income) than their men counterparts.

The separate stochastic frontier ML estimations showed that the mean TE scores for MHHs was 0.7104 and for MHH was 0.4472. Result from SMFM estimation also proved that MHHs had higher mean TE (0.6642) than FHHs (0.4353). The implication is that crop production system by FHHs in the study area was generally technically inefficient compared to crop production system by MHHs, no matter how resource endowments and accesses to services differences were controlled for. To write the other way round, "gender" - the basic concern in this study-potentially matter level of crop production efficiency in Wolaita zone. The mean TE* for the total sample was about 55% indicating that crop production in the study area can be further enlarged by about 44% if appropriate measures are taken to improve farmers' efficiency status.

The Tobit model estimation in the last stage makes easy an in-depth look at the determinants of TE* at a sector level. Thus, the positive and significant value obtained on the dummy variable "sex" once again validated the finding that MHHs are more technically efficient than FHHs in crop production in the study area. All explanatory variables in the model (sex, education, farm-experience, livestock (measured in TLU), off-farm income, family size, credit dummy, climate Dega and Weina-Dega-dummy as opposed to climate (Kolla) except the variable 'age' were found to affect TE score at the Metafrontier level (TE*) significantly and positively.

On the bases of the above major conclusions drawn from the study, we make the following recommendations. To the extent that the average farmers are currently operating below the crop-sector's production potential in the area, it is possible to achieve higher crop yield and earn higher crop income through improving farmers' ability of efficient use of existing resource endowments and technologies. The lower farm level efficiencies observed in FHHs as compared to MHHs on the other hand suggests any efficiency-enhancing strategies designed by a policy makers must also needs to be more engender so as to make agricultural development all rounded. In this respect, strengthening the exiting training centres and the teaching methods in way that can reduce the cultural and social barriers associated with women farmers' access to new farming technologies is an important prerequisite. It is also recommended that interventions should take into account their resource base; financial and extension services should be targeted specifically to them; and the decision-making power of FHHs should be harnessed by exposing them to different opportunities. These efforts necessitate not only creating safe environments for FHHs groups alone, but also widening all communities' understanding of how gender-oriented agricultural practices would be beneficial for them, too.

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Household Energy Choice and Demand in Urban Ethiopia: The Case of Wolaita Zone

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Abstract

In the context of developing economies, urban centres have long been dependent on rural areas for their fuel. This dependence of urban centres on surrounding rural areas has aggravated forest devastation and degradation. Besides, the use of biomass fuels has a significant impact on health. This study looks into household energy choice and demand in selected urban areas using a survey data of 251 urban households in Wolaita zone. The survey indicates that the use of traditional fuels dominate households' energy consumption. Probit analysis of decision to consume fuel energy reveals that the probability of consuming modern fuels in general increases with increase in prices of traditional fuels, income/expenditure and household education whereas the probability of consuming traditional fuels in general increases with increase in price of modern fuels, household size and house hold head age. Moreover, the probit regression showed kerosene is a substitute for both fuel wood and charcoal and fuel wood substitutes saw dust. The result that kerosene is a substitute for charcoal and fuel wood gives an indication that efforts to ensure energy transition to electricity (for cooking) are needed. We applied an almost-ideal demand system (AIDS) to analyze demand for fuels and seemingly unrelated regression (SUR) is used to estimate the adopted AIDS. This SUR estimation indicates that demand for charcoal and kerosene are price inelastic whereas demand for fuel wood and saw dust are price elastic. Demand for electricity was somewhat unitary elastic. Moreover, SUR estimation of the AIDS specification shows the expenditure/income elasticities of each fuel good except electricity is expected to be 1 indicating that these fuel goods are normal goods whereas income elasticity of electricity is 3.9 implying it is found to be a luxury fuel good. This study recommends to local governments to emphasize the energy transition from the traditional to the modern ones taking household income, household education and household size into consideration.

Key Words: Elasticity, AIDS, SUR, Probit regression

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1. Introduction

1.1 Background

In developing countries, 2.5 billion people rely on biomass, such as fuel-wood, charcoal, agricultural waste and animal dung, to meet their energy needs for cooking. For many of these countries, biomass fuels account for over 90% of household energy consumption. In Ethiopia, also energy consumption per capita is estimated to be very low. This implies that only 5 percent of the modern energy source is supplied from petroleum and electricity (OECD, 2006).

Heavy reliance of urban households in Sub-Saharan Africa on biomass fuels (such as woody biomass and dung) contributes to deforestation, forest and land degradation. This is partly because use of these fuels in urban areas is an important source of cash income for people in both urban and rural areas. While use of woody biomass as fuel and construction material contributes to deforestation and forest degradation, use of dung as fuel contributes to land degradation and consequent reduction in agricultural productivity (Mokonnen & Kohlin, 2008).

Use of biomass fuels is also a major cause for health problems in developing countries due to indoor air pollution (Bruce et al. 2000). According to the World Health Organization (WHO), it is estimated that 1.5 million premature deaths per year are directly related to indoor air pollution from the use of solid fuels. This is more than 4000 deaths per day, more than half of them children under five years of age. More than 85% of these deaths (about 1.3 million people) are due to biomass use and the rest due to coal (OECD/IEA, 2010).

Therefore, an important way of reducing the harmful effects of biomass fuel is improving the way biomass is supplied and used for cooking. This can be achieved either through transformation of biomass into less polluting forms or through use of improved stoves and better ventilation (OECD, 2006).

The United Nations Millennium Project set an international target which halves the number of households using traditional biomass for cooking in the year 2015 by switching to alternative fuels and technologies. Providing LPG stoves and cylinders, for instance, has a significant impact on energy demand (OECD, 2006). The Ethiopian government on its part indicated in the first Growth and Transformation Plan (GTP) to by adopt alternative energy sources to ensure environmental protection and conservation related to deforestation and land degradation; and to prevent indoor air pollution that leads to health problems both in urban and rural areas of the country. This paper attempts to examine the choice of energy and to assess the determinants of household fuel demand in the urban areas of Wolaita zone by using cross-sectional data.

1.2 Statement of the Problem

Urbanization and economic development cause changes in consumption patterns and increases in household income in developing countries, which in turn lead to major changes in the household energy sector (Girard, 2002). Urban centres have long been dependent on rural areas for their fuel. This dependence of urban centres on surrounding rural areas has aggravated forest devastation and degradation (Gebreeg ziabher, J. Oskam, & Ba you, August 2010). Besides, the use of these biomass fuels has a significant impact on health (OECD/IEA, 2010).Considering these fuel related problems the government of Ethiopia has been working to switch from traditional to transitional (biogas, solar and traditional wood saving stoves) and modern fuels (FDRE, November 2010).

In line with this plan, Wolaita zone, dependent on the biomass fuel for more than 94% of traditional energy consumption, is engaged alternative energy development activities like biogas beginning from last year, solar energy expected to be constructed within short period of time and improved traditional wood saving stoves (WoEM, 2012).

Studies on energy demand by (Gebreeg Ziabher, J. Oskam, & Ba you, August 2010)reveal that a household's decision to consume a particular kind of fuel is determined not only by household income but also other household

characteristics, such as family size, and age and education of a household head. Another r study analyzed by (Samuel, 2002) indicates that the use of traditional fuels dominates households' consumption pattern. The probability of consuming traditional fuels in general declines with increase in income and prices of the traditional fuels. It also increases with increase in the prices of the modern fuels and vice versa. Studies by Mokonnen and Kohlin suggest that as households' total expenditures rise, they increase the number of fuels used and spend more on the fuels they consume (Mokonnen & Kohlin, 2008).

Despite these studies at the national and regional levels, there are no studies undertaken in Wolaita zone related to energy With the exception of some studies conducted by the Zonal Energy and Mineral Office focusing for the purpose of awareness creation; on a household's willingness to use different alternative energy sources. Therefore, this study will focus on the choice and demand for energy by using qualitative and quantitative analyses techniques to help policy formulation and implementation in Wolaita zone, particularly in the urban areas.

1.3 Objective of the Study

The overall objective of the study is to assess the determinants of household energy consumption in urban areas of Wolaita zone. Specifically, the study aims at:

I. assessing the energy choice of urban Wolaita zone, and
II. analyzing the determinants of household energy demand in the zone

1.4 Significance of the study

This study provides evidence to:

- forecast fuel demand at household level,
- help decision makers to formulate policy based on its findings, and
- to implement adoption of different energy sources.

2. Methodology of the Study

2.1 Analytical Framework: Comparative Static Analysis

Consider a consumer who derives utility from consumption of a vector of n commodities denoted by q. Furthermore, assume that vector q includes broader categories of consumption goods, such as food, fuel, and other goods or services. Let u denote the utility the consumer derives from consuming these goods. Following the standard formulation of utility function of (Deaton & Muellbauer, 1980) and(Sadoulet & de Janvry, 1995), the household's utility function can be written as:

$$u(q; h) \quad \textbf{(1)}$$

where: h stands for the vector of individual characteristics of the household
The budget constraint is given as:

$$p'q = y \quad \textbf{(2)}$$

where: p' is an n-dimensional row vector of prices; y is the amount of income that can be spent on different commodities.

The objective of the household is to maximize utility by choosing q, subject to the budget constraint given in Equation 2. Therefore, the Lagrangian of the consumer's maximization problem can be rewritten as:

$$L = u(q; h) + \lambda (y - p'q) \quad \textbf{(3)}$$

where: λ is a Lagrange multiplier.

Solving for the Lagrangian function in Equation 3, we get a set of observed demand equations:

$$q_i = q_i (p,y;h) \quad \textbf{(4)}$$

where: there are n commodities, i = 1… n

Upon partially differentiating Equation 4 with respect to income y and prices pj, we get n income and n2 price slopes. Then, multiplying the income slopes and price slopes by their respective income/quantity and price/quantity ratios, we get n income elasticities and n2 price elasticities that are useful for comparative statics:

$$\frac{\partial q_i}{\partial y}\frac{y}{q_i}=\eta_i \qquad \textbf{(5)}$$

$$\frac{\partial q_i}{\partial p_j}\frac{p_j}{q_i}=\varepsilon_{ij} \qquad \textbf{(6)}$$

In comparative-static analysis, the objective is to determine how an economic variable of interest, quantity demand in our case, responds to changes in the value of some parameter or exogenous variables. In other words, we need to know how the optimal choice changes as a parameter changes.

Deaton assumed that "geographically clustered households", face the same prices (Deaton A., 1990). For Wolaita zone, we do not make this assumption and allow households to face different prices. This makes sense because the markets for fuels in the study area are fragmented and far apart. Note that, if preferences are separable, the n vector of commodities q in Equation1 can be partitioned into groups and that the utility function can be represented as:

$$u = v\,(q_i) = f(v_i\,(q_i)) \qquad \textbf{(7)}$$

Where: f ( ) is an increasing function and *v* is are the sub utility functions associated with food, fuel goods, and other goods or services. The idea is that, due to the complexity for consumers in making choices among a large array of alternatives, first income is allocated to broad groups of goods, such as food, fuel, and other goods. In the second stage, the budget for fuel is then allocated to specific items, such as electricity, kerosene, wood and charcoal. The implication of this step-by-step budgeting process is that decisions made at each stage can be regarded as corresponding to a utility maximization

problem of their own (Deaton & Muellbauer, 1980) and (Sadoulet & de Janvry, 1995).

2.2 Empirical Framework: Model specification for household energy demand and Choice

This empirical framework will be used with demand equations and budget shares of specific fuel goods (such as electricity, kerosene, charcoal and wood), in relation to a household's total expenditure.

For the empirical demand analysis, we will use almost-ideal demand system derived from a utility function specified as a second-order approximation to any utility function (Sadoulet & de Janvry, 1995).The demand functions are specified in the budget share as follows:

$$w_{Fi} = a_F + \sum_J b_{FJ} \ln p_J + c_{Fi} \ln \frac{y_i}{P} \quad \textbf{(8)}$$

where $w_{Fi} \equiv \frac{y_{Fi}}{y_i}$ is fuel F's budget share in household i's budget; y_{Fi} is household i's expenditure on the fuel F (wood, charcoal, kerosene, and electricity) consumed by the household; p_J is price of J^{th} good; y_i is household i's total expenditure on all goods; and P is the consumer price index. This share, as specified in equation 8, is assumed to be a linear approximation of the logarithm of the price of J^{th} good, p_J and the logarithm of the ratio of total expenditure to price index, $\frac{y_i}{P}$.

However, some of the households may not consume some of the fuel goods implying zero values for corresponding observations of budget shares in Equation 8. The dependent variable is thus censored; rendering ordinary least squares estimates to be biased. With censoring or zero observations, it fails to comply with the standard assumptions with respect to the disturbance term. This problem is solved by using a two-step estimation procedure that combines a probit analysis with standard seemingly unrelated regression (SUR). Therefore, we can rewrite the system of fuel demand equations to be estimated as (Sadoulet & de Janvry, 1995):

$$w_{Fi} = a_F + \sum_J b_{FJ} \ln p_J + c_{Fi} \ln \frac{y_i}{P} + \mu_F \xi_{Fi} + \upsilon_{Fi} . \quad \textbf{(9)}$$

Where the additional terms ξ_{Fi} and υ_{Fi} on the right hand side of Equation *9,* respectively, stand for the inverse Mill's ratio and the residual term of fuel *F* for household i; and μ_F is the coefficient corresponding to the inverse Mill's ratio. Once we estimated the coefficients with the restrictions imposed[3], then the price and income elasticities will be calculated from the coefficient estimates (Sadoulet and de Janvry 1995):

$$\varepsilon_{FF} = -1 + \frac{b_{FF}}{w_F} - c_F, \varepsilon_{FJ} = \frac{b_{FJ}}{w_F} - \frac{c_F}{w_F} w_J, \eta_F = 1 + \frac{c_F}{w_F}. \quad \textbf{(10)}$$

where ε_{FF} and ε_{FJ}, respectively, stand for own-price and cross-price elasticity; and η_F is income elasticity of demand for fuel *F*. The income elasticity enables us to characterize whether a specific fuel good is normal, inferior, or a luxury good, depending on the value and sign of the coefficient.

Note that the inverse Mill's ratio ξ_{Fi} comes from the first-step estimation of household *i*'s decision to consume a specific fuel good *F*. For simplicity, consider a decision involving a choice between consuming and not consuming. That is, the decision whether or not to consume a specific fuel good *F*, such as wood, by household *i* essentially involves a choice between yes or no. Such dichotomous choices are best modelled as probit. Hence, we can specify the probit model as:

$$\text{Prob } (q^*F_i = 1) = \text{Prob } (f(F_i, p_F, y_i, h_i) + e_{Fi} > 0) \quad \textbf{(11)}$$

where q^*F_i is equal to 1 if household i consumes fuel good F, and zero otherwise; p_F, y_i, and h_i, respectively, are the prices of related fuel goods, income, and characteristics that apply to the household; and e_{Fi} is a residual term. Then, the inverse Mill's ratio is generated from the probit estimation as:

[3]Coefficients in the ADIS specification are subjected to restrictions: Adding up restrictions - $\sum_F a_F = 0$, $\sum_F b_{Fj} = 0$, $\sum_F c_F = 0$, Homogeneity restriction- $\sum_j b_{Fj} = 0$ and symmetry restriction -$b_{Fi} = b_{jF}$

$$\xi_{Fi} = \varphi(f_{Fi})/\psi(f_{Fi}) \quad \textbf{(12)}$$

where, φ is the probability density function and ψ the cumulative density function of the standard normal distribution of the residual term, e_{Fi}.

2.3 Study Area, Data Description and Sampling

The data was obtained from a survey conducted from the residents of urban households in Wolaita zone. Wolaita zone is found in southern nations, nationalities and peoples region. The total population of the zone is estimated to be 1,796,436 (374,258 households). Biomass fuel, used by 94% of the surveyed households, was the main source of energy for cooking .However, electricity consumption has been increasing with urbanization.
Data was collected from a sample of urban households using stratified random sampling. First, all Woredas in the zone were stratified based on their urban nature (Sodo, Areka and Boditi). Then, a simple random sampling was used, based on proportional allocation, to select 251 respondents as a sample[4]. Based on this, the sample households were 148 in Sodo, 58 in Areka and 45 in Boditi.

3 Results and Discussions

3.1 Descriptive Analysis

3.1.1 Household Characteristics

Our survey covers the three most urbanized towns of Wolaita zone, namely Sodo, Areka and Boditi. Out of these 251 selected households, 70.5% were male-headed and 29.5% female headed. They were 4.8%, 65.7%, 17.5%, 7.57% 4.4%, respectively unmarried, married, widowed, divorced and separated (Table 1).

[4]Sample size is determined as: $n = \frac{\frac{NZ^2_{\frac{\alpha}{2}} P(1-P)}{ME^2}}{\frac{Z^2_{\frac{\alpha}{2}} P(1-P)}{ME^2} + N - 1} + 5$ Where ME=5% is the margin of error, P =80% is the sample proportion, N = 374,258 is total household population, Z = 1.96 and 5 is the assumed nonresponsive (i.e. about 2% nonresponsive rate).

Table 1: Descriptive Statistics of Household Socioeconomic Characteristics.

Variables	Mean	Std. Dev.	Min.	Max.
Sex of household head (%)				
Female	29.48	N/A	N/A	N/A
Male	70.52	N/A	N/A	N/A
Marital status of the household (%)				
Single	4.78	N/A	N/A	N/A
Married	65.74	N/A	N/A	N/A
Widowed	17.53	N/A	N/A	N/A
Divorced	7.57	N/A	N/A	N/A
Separated	4.38	N/A	N/A	N/A
Education of household head (%)				
Illiterate	29.08	N/A	N/A	N/A
Literate	70.92	N/A	N/A	N/A
Occupation of household head (%)				
Unemployed	18.33	N/A	N/A	N/A
Employed	81.67	N/A	N/A	N/A
Formal Sector	30.27	N/A	N/A	N/A
Informal Sector	51.39	N/A	N/A	N/A
Age of household head	43.131	12.567	80.000	20.000
Household size in number	4.737	2.330	14.000	0.000
Household income in Birr	3518.633	4149.226	31700.000	100.000
Household Expenditure in Birr	4737.454	2750.271	20178.000	611.000
Fuel Expenditure in Birr	2911.805	2356.586	19200	165
Non Fuel Expenditure in Birr	1825.649	1012.395	7664	198
Price of Wood per *Chinet* in Birr	31.085	12.207	100.000	10.000
Price of Charcoal per *Kesha* in Birr	59.361	26.117	120.000	8.000
Price of Kerosene per Litre in Birr	12.333	7.304	118.000	5.000
Price Saw Dust per *Kesha* in Birr	10.403	3.013	20.000	5.000
Price Electricity	0.350	0.000	0.350	0.350

Source: Own Survey, 2013

As showed in Table 1, the mean age of the household heads is 43.1 and about 71% of these household heads are literate[5]. Out of the total household heads 30% are employed in the formal-sector. Moreover, a separate household head has an average of 4.7 family members expending an average of ETB 4,737.45 per annum out of which ETB 2,911.81 accounts for fuel (fuel wood, charcoal, kerosene and saw dust with 27.1%, 24.2%, 1.8%, 2.7% and 2.3% budget shares, respectively.)

3.1.2 Fuel Types, Fuel End Use and Household Food Habit

In the SNNP context in general and Wolaita zone in particular, traditional biomass fuels are the most important source of households cooking energy (MEGEN Power Plc, 2011). Firewood and charcoal were most frequently used types of cooking fuels in the study area with 96.0% and 95.2% users, respectively. However, the crop residue (less than 2%), dung cake (less than 6%) and saw dust (about 26%) were rarely used for cooking purposes (Table 2).

Regarding modern fuel energy consumption, only 15% and 14% of the sample households used kerosene and electricity, respectively (Table 2). It is only 14% of the households that used firewood, charcoal, kerosene and electricity jointly. This indicates that households still depend on traditional biomass fuels. Moreover, the survey shows that 65% of the total households took fuel wood as their first choice followed by charcoal (31%). Around 3% of the households also prefer electricity as a first choice for cooking purposes.

This preference of households to particular fuel energy may be affected by accessibility of the energy source, familiarity with it, and the price of the fuel and its effectiveness. Price for a particular fuel is different across towns except for electricity for which a uniform price is set throughout the country. The average price for fuel wood, charcoal, kerosene and saw dust were

[5] Literate household head means household head at least who can read or write

31.085 per "Chinet", 59.361 per Kesha[6], 12.333 per litre and 10.403 per, kesha respectively. Accessibility, familiarity and household's perception regarding effectiveness could also vary across the towns in Wolaita zone.

In situations where there is a huge preference for traditional biomass fuels, looking in to the status of adoption of improved stove is important not only to minimize the amount of fuel use but also to reduce health risks related to the production of large quantities of smoke and toxic compound. According to this study, it is only 33% of the households that adopt fuel efficient technologies. The main reasons for this lower performance, as reported by the respondents, are limited access to improved stoves in their town, unaffordability of the price and lack of awareness about the technologies. This inefficient use of fuel energy is also aggravated by the use of open fire. Among the total households, 135 (53.78%) and 79 (31.47%) use open fire to bake Injera and for cooking purposes, respectively.

Table 2: Percentage Distribution of Survey Households by Types of Fuels

Type of Fuel	Sodo	Areka	Boditi	All
Firewood	94.6	100	95.55	96.0
Charcoal	96.6	93.1	93.33	95.2
Kerosene	11.5	34.48	4.44	15.5
Electricity	14.2	17.24	11.11	14.3
Crop residue	2.02	1.72	2.22	1.98
Dung cake	6	1.72	10.1	5.94
Saw dust	23.7	39.66	17.78	26.3

Source: Own Survey, 2013

Injera baking and general cooking are the two most common end uses of urban domestic energy consumption in Ethiopia (Gebreegziabher, J. Oskam, & Bayou, August 2010). General cooking includes preparing sauce, soup, vegetables or other food. Moreover, boiling water and making coffee or tea also involves use of fuel energy several times a day. In Ethiopia over 50% of the overall households energy consumption is for Injera baking. In most

[6] Fiber container of grain which has 50kg net content and approximately contains 25 kg of charcoal and 15 kg of Saw dust

cases, urban households use firewood and electricity for baking, but only kerosene is excluded for this purpose (World Bank, 1984 as cited by (Samuel, 2002)). Likewise, households in the study area mainly use fuel wood; saw dust and electricity for Injera baking and electricity, charcoal and kerosene for cooking. However, firewood and electricity are required for both baking and cooking purposes and kerosene is also used for lighting fire wood and charcoal in both baking and cooking.

The study also collected information on the food habit of the sample households. In the study area, the majority (80.48%) of households take Injera as their favourite food followed by bread (12.75%). Few (6.77%) of the households favour other local food of Wolaita such as Bokolo Kita and Kocho. The mean number of meal per day is 3 times with a minimum of two and a maximum of four times per day based on their favourite food consumption. This is the main determinant factor to increase the consumption of fuel. That is, if the number of food consumption is high the consumption of fuel is also high especially if the household size is large. Besides, the consumption of fuel becomes higher if they bake many times. Normally, this is directly related to the number of members of the family living in a particular household.

3.2 Empirical Analysis

Although the study considered all possible fuel types and categories, fuel use in the study area is mainly limited to firewood, charcoal, kerosene, saw dust and electricity. In addition, some of the households use crop residue (about 2%) and dung cake (6%) for cooking and baking purposes which was mainly collected free of charge. Therefore, the empirical analysis focused only on five fuel goods: firewood, charcoal, kerosene, saw dust and electricity.

3.2.1 Household Fuel Choice

As outlined above the most common end uses of fuel energy consumption in the study area are baking and cooking, and it is observed that fuel wood, saw dust and electricity are preferred for baking and kerosene and charcoal for cooking. Thus, we expect interdependencies among fuel choices as the types

of stoves used by households (baking and cooking) are differentiated. Therefore, fuel energy choice dependencies between combinations of fuel wood, saw dust and electricity and between kerosene, charcoal and electricity are handled by the use of bivariate probit models.

We first run bivariate probit regression between combinations of fuel wood, saw dust and electricity and then between fuel wood, charcoal and kerosene. However, we could not reject the null hypothesis that the error correlation was zero (rho=0) for all cases except for bivariate regression of fuel wood and electricity. This suggests that only the choices between fuel wood and electricity were dependent. As a result the individual probit model is adopted to analyze choice of charcoal, kerosene and saw dust. Results of the bivariate probit and individual probit regressions are shown in Table 3.

According to Table 3 the overall validity of the bivariate probit regression has turned out to be quite significant. The likelihood ratio test of the bivariate probit regression (with chi^2 (1) = 11.5241 higher than the critical value or P - value = 0.0007) conclusively rejects the null hypothesis that the probit models for fuel wood and electricity choice are independent signifying that the two probit equations should be taken as a system and estimated jointly. Moreover, the Wald chi^2 (22) = 40.78 is higher than the critical value (P - value = 0.0088) shows that all the explanatory variables included in both equations helped explain the variations.

Though many explanatory variables in the bivariate probit estimation found to be insignificant, household head education and household expenditure significantly and positively influenced the decision to consume electricity (though the expenditure effect is small in magnitude). Likewise household size, household head age and price of kerosene influenced the decision to consume fuel wood positively and significantly. Moreover, household head education and marital status, being single, influenced decision to consume fuel wood negatively and significantly.

Table 3: Biprobit and Probit Estimates of the choice to Consume Fuel Energy.

Explanatory Variables	Dependent Variable (Consume Fuel=1,0 otherwise)				
	Electricity[a]	Fuel wood[a]	Charcoal	Kerosene	Saw Dust
Constant	-2.81256	-0.60159	1.974951	-0.15056	-1.113656*
	(0.9338471)	(1.486566)	(01.264502)	(0.6788958)	(0.4825371)
Price of wood in Birr			-0.02285**	-0.00628	0.0146835*
			(0.0127371)	(0.0086961)	(0.0074551)
Price of charcoal in Birr	0.008446	0.009674	-0.01628*	0.009147**	
	(0.0057031)	(0.0132022)	(0.0072563)	(0.0052177)	
Price kerosene in Birr	-0.01056	0.177526*			
	(0.033796)	(0.0727607)			
Price saw dust in Birr	0.000261	-0.07956		-0.0227	
	(0.0366703)	(0.0748071)		(0.0348239)	
Household Expenditure in Birr	0.000125*	0.000115	0.000050	0.00011*	0.0001009
	(0.0000363)	(0 .0001129)	(0.00005)	(0.0000355)	(0.0000737)
Charcoal Expenditure in Birr					-0.0003932*
					(0.0001523)
Wood Expenditure in Birr					-0.0001561
					(0.0000996)
Dummy single	-0.06302	-0.39124**	-0.21528		
	(0.1495755)	(0.2037641)	(0.2219207)		
Sex of house hold head	-0.20706	0.161792	-0.5453	-0.65343*	
	(0.2830576)	(0.4032545)	(0.4754755)	(0.2509402)	
Education of household head	0.124177**	-0.37301*	0.254687*	-0.00504	-0.0651651
	(0.0699733)	(0.1772712)	(0.1125494)	(0.0610653)	(0.0490156)
Dummy Sodo	-0.2343	-0.82977	0.735898**	-0.72149*	
	(0.3173097)	(0.794431)	(0.38386)	(0.307398)	
Dummy Salaried	-0.03025	0.6575	-0.25037	0.5734**	0.4058714
	(0.3579195)	(0.5859886)	(0.5337835)	(0.3376147)	(0.2795627)
Age	0.009012	0.074079*	0.019573	-0.02268	0.0030828
	(0 .0097942)	(0.0271895)	(0.0152161)	(0.0102241)	(0.00771)
Household Size	0.017873	0.348883**		0.010216	0.0479235
	(0.0497299)	(0.2023932)		(0.0498223)	(0.0404515)
Sample size	251	251	251	251	251
Share of Zero (%)	85.66	3.98	4.78	84.46	73.71
Predicted Probability	0.1432382	0.9634162	0.9521677	0.1545762	0.2629827
Pseudo-R^2			0.1875	0.1525	0.0471
LR χ^2			18.07	33.08	15.68
Wald χ^2	40.78				
Prob > χ^2	0.0088		0.0344	0.0003	0.0542

[a] Results based on Biprobit Regression with Likelihood-ratio test of rho=0: chi^2 (1) = 11.5241 Prob > chi^2 = 0.0007

*Significant at 5% level of significance and **Significant at 10% level of significance

Similarly, the overall validity of the probit regressions in all cases turned out to be quite significant. The likelihood ratio chi-square in all regressions is higher than the respective critical value implying all the explanatory variables included in each regression helped explain the variation. Moreover,

the predicted probabilities were quite substantial in predicting the sample proportions (Table 3).

According to Table 3 no price parameter significantly influenced decisions to consume electricity but the decision to consume charcoal was significantly and positively influenced by household head education but negatively affected by its own price and price of wood. Moreover, residents of Sodo town were found to prefer charcoal more as compared to residents of Areka and Boditi. When we look into the determinants of decisions to consume kerosene, price of charcoal and household expenditure, though small in magnitude, were found to have a significant positive effect. A household headed by a salaried person, being a resident of towns other than Sodo and being headed by a female is to inclined to use kerosene as compared to a household headed by an unsalaried person, resident of Sodo town and male headed. Lastly, the price of wood was found to have a significant positive influence on decisions to consume saw dust. However, household expenditure on charcoal, though small in magnitude, influenced decisions to consume saw dust negatively and significantly.

The fact that household head education has a positive significant effect on decisions to consume electricity and charcoal and a negative significant effect on decision to consume fuel wood may imply possible transition of energy consumption from fuel wood to electricity and/or charcoal, as household heads become more educated. Similarly the positive significant effect of household expenditure on decisions to consume electricity and kerosene, though small in magnitude, shows the tendency of households to shift to modern energy fuels as income (proxied by expenditure) rises. Moreover, households with large family size, as indicated by a significant positive effect of household size on decisions to consume fuel wood, were inclined to fuel wood which was taken as first choice by a majority (65%) of households due to its relatively accessibility and cheapness. Similarly, the fact that age of a household head influenced the decision to consume fuel wood positively and significantly shows that fuel wood is also preferred more as age of household heads rises.

The fact that price of related fuel goods have a significant effect on decisions to consume fuel type helps to detect if related fuel goods are substitutes or complements. As a result, the insignificance of price of related fuel goods in determining decision to consume electricity shows less substitutability of other fuel goods by electricity but the significant positive effect of price of kerosene on decision to consume fuel wood implies kerosene and fuel wood are substitutes and this can be due to the fact that fuel wood in the study area is used for both baking and cooking purposes. The significant positive effect of price of fuel wood on decisions to consume saw dust shows that fuel wood and saw dust are substitutes. Similarly, the significant positive effect of price of charcoal on decision to consume kerosene shows that charcoal and kerosene are substitutes.

However, the fact that price of fuel wood has a significant negative effect on decisions to consume charcoal literally shows that both are complements but such a relationship may be due to the fact that charcoal is the byproduct of fuel wood in which a rise in the price of fuel wood could cause a rise in the price of charcoal that may imply a reduced interest in the decision to consume charcoal.

3.2.2 Household Fuel Demand System

Assuming a step-by-step budgeting process that could lead to utility maximization of groups of goods to be consumed, this study formulated a system of demand equations that explain demand for goods of our interest, fuel goods. Particularly, the study specified this system of demand equations as an Almost Ideal Demand System (AIDS) and used Seemingly Unrelated Regression (SUR) estimation procedure to arrive at efficient and consistent estimates. Price (own and of related good), household expenditure and inverse mills ratio were the main explanatory variables included in the AIDS specification. Inverse mills ration is introduced as an explanatory variable to correct for the problem of censoring (zero observations).

The main philosophy behind the adoption of SUR estimation procedure is that error terms in different demand equations are related. To check this setting we constructed correlation matrix of error terms of the system of demand equations obtained from SUR and found a considerable degree of correlation (Table 4). This is also approved by the rejection of Breusch - Pagan test of independence (P – value = 0.0001).

Table 4: Correlation Matrix of Residuals from SUR estimation

Demand	Wood	Charcoal	Kerosene	Saw dust
Wood	1			
Charcoal	- 0.5030	1		
Kerosene	- 0.9777	0.5449	1	
Saw dust	0.4977	- 0.7031	- 0.4413	1

Breusch – Pagan test of independence: chi^2 = 29.314 P-value = 0.0001

According to Table 5 price of fuel wood and inverse mills ratio influenced demand for fuel wood positively and significantly whereas price of kerosene has a negative significant influence on fuel wood demand. With regard to the charcoal demand, price of kerosene was found to influence it negatively and significantly. The inverse mills ratio also influenced charcoal demand significantly and positively.

Table 5: SUR Results of Almost-Ideal Fuel Demand System

Explanatory Variables	Dependent Variable				
	Share of Fuel Wood in total Expenditure	Share of Charcoal in total Expenditure	Share of Kerosene in total Expenditure	Share of Saw Dust in total Expenditure	Share of Electricity in total Expenditure[Δ]
Constant	1.226054 (1.359082)	-0.1156961 (0.4353129)	-0.6749364 (0.553122)	-0.2145536 (0.6377216)	-0.2208679
Ln (Price of Wood)	0.1920175** (0.1031149)	-0.009159 (0.0303893)	-0.1649772* (0.0546248)	-0.0178812 (0.0580537)	-0.0000001
Ln (Price of Charcoal)	-0.009159 (0.0303893)	0.0252138 (0.0193892)	-0.0308155** (0.0165443)	0.0147608 (0.022165)	-0.0000001
Ln (Price Kerosene)	-0.1649772* (0.0546248)	-0.0308155** (.0165443)	0.1167074* (0.0330039)	0.0790854* (.0295277)	-0.0000001
Ln (Price Saw Dust)	-0.0178812 (0.0580537)	0.0147608 (0.022165)	0.0790854* (0.0295277)	-0.0759649** (0.041882)	-0.0000001
Ln (Price Electricity)	-0.00000010	-0.00000010	-0.00000010	-0.00000010	0.00000040
Ln (Real Expenditure)	-0.2624186 (0.1668109)	0.0124406 (0.0530688)	0.1029647 (0.066963)	-0.0010526 (0.0756639)	0.1480659
Inverse Mills Ratio	1.502905* (0.1483277)	0.1785933* (0.0890679)	1.219801* (0.0862647)	1.799577* (0.3395924)	
R^2	-0.3838	-0.1249	-0.1865	0.093	
χ^2	142.48	63.53	261.42	97.8	
P-Value	0.0000	0.0000	0.0000	0.0000	

[Δ] Results recalculated from the SUR results based on adding up restrictions[7]
*Significant at 5% level of significance and **Significant at 10% level of significance

[7]With homogeneity and symmetry imposed, iterated seemingly unrelated regression estimates were calculated while dropping one equation to avoid singularity of the error covariance matrix. The parameters of this omitted equation are obtained by utilizing the imposed theoretical restrictions noted above, while the selection of which equation to be omitted in this study is based on the unavailability of electricity price data

Table 5 also signifies that both price of wood and price of charcoal impacted kerosene demand negatively and significantly whereas price of kerosene, price of saw dust and inverse mills ration influenced demand for kerosene positively and significantly.

Moreover, saw dust demand is positively and significantly influenced by price of kerosene and inverse mills ratio but negatively and significantly influenced by its own price. For more convenient interpretation of the results from the SUR estimation, we calculated own price, cross price and income elasticities of each fuel demand as presented in Table 6.

Estimation results in Table 6 revealed that all own price elasticities were found to have the expected negative sign. Specifically, charcoal and kerosene were price inelastic (with own price elasticity of less than unity) whereas fuel wood and saw dust were price elastic. Demand for electricity was somewhat unitary elastic. The fact that demand for charcoal and kerosene was found to be price inelastic was consistent with the finding of (Gebreeg ziabher, J. Oskam, & Ba you, August 2010) for urban areas of Tigray region.

Table 6: Price and Income Elasticities of Demand for Fuel.

Variables	Elasticity (Own price, cross price and Income Elasticities)				
	Wood	Charcoal	Kerosene	Saw Dust	Electricity
Price of Wood	-1.83483932	-0.039309723	-1.635800733	-0.456942232	-1.422317188
Price of Charcoal	0.188959853	-0.947511796	-0.537384743	0.399181511	-1.125309141
Price of Kerosene	-0.265683645	-0.083574632	-0.21713175	2.08475365	-0.381785106
Price of Saw Dust	-0.016113439	0.036793547	0.570575137	-2.997936912	-0.110123591
Price of Electricity	0.027318105	-0.001637169	-0.039933273	0.00141266	-1.148058072
Income	0.465350769	1.032036158	1.781523056	0.972301203	3.897811907

However, the fact that demand for fuel wood and saw dust are negatively and significantly (at a 10% level of significance) elastic in our study area may indicate possible transition of energy consumption from traditional energy fuels (fuel wood and saw dust) to modern energy fuels (kerosene and electricity) in cases when prices for traditional energy fuels rise. This argument can be supported by the fact that there is a fixed electricity price

and the fact that demand for kerosene is negatively price inelastic with respect to its price indicates the potential tolerance of consumers to the rise in the global kerosene price even where government subsidies are not available.

With regard to the cross price elasticities, all cross price elasticities, except cross price elasticity of demand for kerosene with respect to price of fuel wood, charcoal and saw dust, were found insignificant at 10% level of significance or less. The elasticity of demand for kerosene with respect to the price of fuel wood and charcoal were found to be negative and significant. However, as outlined in the analysis of household fuel choice, fuel wood and charcoal were found to substitute kerosene (which may be with respect to cooking). Hence, it may be that the rise in fuel wood and charcoal prices does not directly affect the amount of kerosene demanded. On the other hand, Table 6 indicates that the elasticity of saw dust demand with respect to kerosene price was found to be positively elastic and significant (2.085). This fact may show us saw dust and kerosene are substitutes (may be in terms of igniting).

However, results of SUR in Table 5 showed no statistical evidence to reject the null hypothesis that demand for each fuel type except demand for electricity is not influenced by real expenditure implying zero slope coefficients for real expenditure in these demand equations. Hence, by the definition of income elasticity[8] we outlined in model specification the expenditure/income elasticities of each fuel good except electricity is expected to be 1 indicating these fuel goods are normal goods. On the other hand, the coefficient of electricity obtained by adding up restrictions considering the insignificance of impact of income/expenditure on the rest of fuel goods may imply the income/expenditure of electricity is higher than unity. This can be intensified by the case where the income elasticity of electricity is 3.9. Hence, electricity is found to be luxury fuel good.

[8] $\eta_F = 1 + \frac{C_F}{W_F}$ where C_F is coefficient for real expenditure and W_F fuel F's budget share in total budget

4. Conclusions and Policy Implications

4.1 Conclusion

In low income countries (like Ethiopia) where people cannot afford to use modern fuels, the most immediate policy concern should be to insure sustained supply of biomass fuel. However, ensuring sustained supply of biomass fuels creates pressure on rural areas. Hence, in this study we investigated options to reduce such pressures of urban centres on rural areas. To achieve such goal we first analyzed households' decisions to consume specific fuel goods using probit (Biprobit) regression and an almost-ideal demand system for fuel goods is estimated using seemingly unrelated regression (SUR).

Our analysis of households' decisions to consume fuel good asserts, besides price and income (expenditure), household characteristics like household head education, household size, age of household head, household head marital status, household head sex, household head employment and urbanization (proxied by Sodo town) play important roles in the energy consumption decisions.

The positive significant effect of household head education on decision to consume electricity and charcoal and its negative significant effect on decision to consume fuel wood indicates a possible transition of energy consumption from fuel wood to electricity and/or charcoal. Similarly the positive significant effect of household expenditure on the decision to consume electricity and kerosene shows the tendency of households to shift to modern energy fuels as income rises. On the other hand, households were found to be inclined to fuel wood as their size get larger and their heads gets older.

The probit regression of decision to consume fuel wood also showed kerosene and fuel wood are substitutes and this can be due to the fact that fuel wood in the study area is used for both baking and cooking purposes. Moreover, results of this regression showed fuel wood and saw dust; and charcoal and kerosene are substitutes. Nonetheless, the fact that the decision

to consume electricity does not significantly depend on price of related fuel goods implies that is less substitutable.

The fact that price of fuel wood has a significant negative effect on decisions to consume charcoal literally shows that both are complements but such a relationship may be due to the fact that charcoal is the byproduct of fuel wood in which case a rise in the price of fuel wood could cause a rise in the price of charcoal that may less interest to consume charcoal. Results of the fuel wood demand (Almost Ideal Demand System) showed all own price elasticities were found to have the expected negative sign. Charcoal and kerosene were price inelastic whereas fuel wood and saw dust were price elastic. Demand for electricity was somewhat unitary elastic. The fact that demand for fuel wood and saw dust are elastic may indicate a possible transition of energy consumption from traditional energy fuels to modern energy fuels in cases where prices for traditional energy fuels rise. This argument can be supported by the fact that there is a lower fixed electricity price and the fact that demand for kerosene is negatively price inelastic with respect to its price indicate the potential tolerance of consumers to the rise in the global kerosene price even where government subsidies are not available.

The significant negative cross price elasticity of demand for kerosene with respect to the price of fuel wood and charcoal should indicate a rise in fuel wood and charcoal prices does not directly affect the amount of kerosene demand as fuel wood and charcoal were found to substitute kerosene (which may be with respect to cooking) in our household fuel choice analysis. On the other hand, the significant positive elasticity of saw dust demand with respect to kerosene price (2.085) may show us that saw dust and kerosene are substitutes (may be in terms of lighting).

Our results of SUR found no demand for energy fuel except demand for electricity is influenced by real expenditure implying zero slope coefficients for real expenditure in these demand equations. Hence, the expenditure/income elasticities of each fuel good except electricity is expected to be 1 indicating these fuel goods are normal goods. On the other hand, the coefficient of electricity obtained by adding up restrictions considering the insignificance of impact of income/expenditure on the rest of

fuel goods may imply that the income/expenditure of electricity is higher than unity. This can be intensified by the case where the income elasticity of electricity is 3.9. Hence, electricity is found to be a luxury fuel good.

Policy Implications

The long-run objective of the local government should be to emphasize the energy transition from the traditional to the modern taking household income, household education and household size into consideration.

Local governments should follow substitutability patters i.e. substitutability between fuel wood and kerosene; charcoal and kerosene; and saw dust and fuel wood when they think of the fuel energy use transition.

The study also recommends to local governments to look into household income raising mechanisms to help the transition to electricity.

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Improving Water Supply Service in Urban Ethiopia Using Choice Experiment Approach: A Case Study of Yirgalem Town in SNNPR, Ethiopia

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Abstract

It is evident that improving the existing drinking water supply services in developing countries depends critically on the available financial resources. The cost recovery rates of these services are generally low, while the demand for more reliable services is high and growing rapidly. This study examines households' willingness to pay for improved drinking water supply services in Yirgalem town in the Southern Nations, Nationalities and Peoples Region, SNNPR, using primary data with the help of a choice experiment approach. The design of the choice experiment enables to estimate the values of drinking water supply reliability and the water quality. The estimated values are crucial in policy appraisals pertaining to improved drinking water supply investment decisions. Although the respondents have significant income constraints, they are willing to pay for improved drinking water supply services above the present monthly water bill and those living in the part of the town with the lowest service levels are ready to pay even more. In general, women give the highest value to the improvement of water quality.

Key Words: Drinking water supply, choice experiment, improved water quality, water supply investment, Willingness to pay, Ethiopia.

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1. Introduction

Water supply services in Ethiopia are among the lowest in Africa, with an average consumption of only 15 litres per person per day in urban areas, which is far below the World Health Organization (WHO) standard of 45 litres per person per day. In this respect, (EWSRFA, 2004) indicated that safe drinking water supply is estimated to be available to 36 percent of the population in rural areas and 80 percent in urban areas. According to WHO, Ethiopia had the lowest level of water supply coverage in Sub-Saharan Africa in 2000 (39% compared to an average of 56% in Sub-Saharan Africa) and the second-lowest level of sanitation coverage (EPER,2004).Unprotected water supply sources are one of the most important problems related to water supply quality. Consequently, a majority of Ethiopians use unsafe and polluted water and are exposed to a variety of water-borne diseases.

Reliable drinking water supply is a vital constituent of primary health care which plays a crucial role in reducing poverty. According to the World Bank (2004), insufficient water supply and poor sanitation services affect the lives of billions of poor people in the developing world. In this respect, out of every ten persons, two lack access to safe drinking water, five lack proper sanitation, and nine lacks properly treated water. Nevertheless, these estimates are likely to be understated compared to the prevailing problems of drinking water supply. The quality of service provision is poor in several countries where water supply systems are installed since consumers with water connection face erratic supply and impure water which is unsafe to drink.

In addition, financial constraints adversely affect the current state of water supply in Ethiopia. Consumers cover investment in drinking water supply facilities only partially. Teshome (2007) noted that the central government contributes more or less the same as the consumers but financial sources from outside Ethiopia, mainly through international aid, provide funds to cover the highest part of the costs. There is a big gap between the finance required to operate and maintain the water supply system and the revenue

obtained through the prevailing water tariff. As a result, additional source of funding is required to sustain the existing drinking water supply system.

Financing of drinking water supply services can be taken as an important ingredient to ensure improved water access to the urban poor and broaden livelihood options. Moreover, free provision of basic water supply service entails risk, unless it is carefully controlled and managed, which could place unsustainable demand on a resource already under pressure. For example, according to the five-year national programme of action of the Ethiopian government for children and women, which extended from 1996 to 2000, out of the financial requirement of the water supply programme, 44 percent was expected to be provided by the government and the remaining by external support agencies. Besides, the needed public investments to provide water would represent a financial burden for the local and central governments. In general, a big gap exists between the finance required and that allocated from the federal and local governments for the entire water supply programme in urban Ethiopia. Hence, the study is intended to address this problem.

The main objective of the study is to investigate urban households' demand for improved water supply services and identify their willingness to pay for the service using Choice Experiment approach with special reference to Yirgalem Town in SNNPR. Currently, the existing empirical evidence on urban households willing to pay for improved water supply services in the context of Ethiopia is inadequate to make water supply investment decision or set water tariff. One of the published works on stated preference is by Kinfe and Berhanu (2007) in which they took 240 randomly selected households in Addis Ababa in a contingent valuation survey for their willingness to pay for a bucket of extra water. They found positive values for willingness to pay. Another study in the area of contingent valuation of drinking water supply in developing countries is the work by Whittington (e.g. Whittington et al., 1990; Whittington, 1998). Nonetheless, most of these studies were conducted in rural areas while a limited number of studies on contingent valuation exist for urban areas in the developing world with the exception of Soto Montes de Oca and Bateman (2006) and Vásquez *et al.* (2009) in Mexico.

This study employs an advanced stated preference choice experiment (e.g. Blamey et al., 1999; Scarpa *et al.*, 2007), where households are asked to choose between two scenarios of improved water supply services at different price levels. In the design of the choice experiment, a distinction is made between reliable improved water supply and water quality. The limited number of studies using choice experiments conducted in developed countries focused on willingness to pay to avoid water restrictions, for instance due to droughts (Hensher *et al*., 2006). In the analysis of the results, special attention is paid to the stability of the respondents' choice behavior as they go through the sequence of choice tasks and their demographic characteristics.

2. Overview of the Choice Model

In general, all human activities involve a *choice* including the option not to choose. Some choices are the result of a habit while others are original decisions made with great care, based on available information at the time of choice either from past experience or current inquiry. In this respect, interest in the development and application of quantitative statistical techniques has been growing so as to study the choices that individuals make since the 1970s.Accordingly, some literature has evolved which enables to understand how choices are made and then forecast future choice behaviours of individuals. For example, the works of Louviere, Hensher, and Swait (2000), and Train (2003) represent some of the contributions in this area.

In effect, individuals' preferences are modelled in terms of McFadden's (1974) Random Utility Model, which entails the separation of total utility (U_{ijt}^{c}) into a deterministic component (V_{ijt}^{c}) and a stochastic component ($£_{ijt}^{c}$). Choice experiments belong to the class of attribute-based methods where the deterministic part of the utility of individual derived from good *j* in choice task *t* is a linear function of its attributes, X_{ijt} and other explanatory variables, Z_{ijt} (Train, 2003):

$$U_{ijt} = V_{ijt} + £_{ijt} = \quad X_{ijt} + \sim Z_{ijt} + £_{ijt} \qquad \forall j \in D_{it} \qquad \textbf{(1)}$$

In each choice task respondents are presented with a limited set of policy options D_{it}, each proposing an improvement in drinking water supply and water quality. The stochastic term is assumed to follow identically and independently distributed extreme value distribution of type 1.

To account for preference heterogeneity, the parameters for the non-price attributes are allowed to vary across respondents, applying different distributions. Equation (2) describes the probability of individual *i* selecting alternative *j* in choice task *t* over other alternatives *k*. The utility coefficients β vary according to individual (hence β_i) with density $\Delta(\ _i \mid b)$ for the non-price attributes. This density can be a function of any set of parameters and represents in this case the mean and covariance of β in the sample population.

$$P_{ijt} = \int \left(\frac{\exp[(\ _i X_{ijt} + \sim Z_{ijt})]}{\sum_{j \in D} \exp[(\ _i X_{ikt} + \sim Z_{ikt})]} \right) \Delta(\ _i \mid b) d\ _i \ \forall j \in D_{it} \qquad \textbf{(2)}$$

According to Scarpa *et al.* (2005), the model assumes heterogeneity to be continuous over the interval of time which the presumed distribution follows for the preference parameters. Treating preference parameters as random variables requires estimation using simulated maximum likelihood. The maximum likelihood procedure seeks to find a solution by simulating the draws from distributions with the given means and standard deviations. Then, probabilities are computed by integrating the joint simulated distributions. Recent applications of such a model have shown that this model is superior to the standard logit model in terms of overall fitness and accuracy of welfare estimates (e.g., Provencher and Bishop, 2004; Brouwer *et al.*, 2010a).

Train (2003) indicated that the logit model accounts for respondents' preference heterogeneity and repeated choices. Although unobserved heterogeneity is accounted for in the logit model, it may fail to explain the sources of heterogeneity (Hynes *et al.*, 2008). In this case, interactions of

respondent specific household features can be included with choice specific attributes in the utility function to improve the model fit (Revelt and Train, 1998). One can test the extent to which the data from repeated individual choices could be combined into an aggregate choice model using the Swait and Louviere (1993) approach. As part of this approach, the equality of scale parameters is tested. Scale parameters may differ across repeated choice sequences as a result of choice variance, for example, due to preference of learning (Brouwer *et al.*, 2010b).

Brownstone and Train (1999) noted that error component models accommodate the correlation between the utilities of alternatives. Correlation between alternatives is accounted for by including an error component with zero mean in the specification of utility function in order to allow for heteroscedasticity between those alternatives which are likely to be correlated. Further, Scarpa *et al*. (2005) recommend applying the error component models when comparing the less familiar hypothetical alternatives with better existing ones.

It was indicated that if a price attribute is included in the choice experiment, welfare estimates can be derived (e.g., Hensher et al., 2005). The welfare measure represents the monetary value that occurs whenever there is a change in the bundle of water supply services which is known as consumer surplus. In this study, the economic welfare implications are estimated for various water supply improvement options. The design of the choice experiment is presented as follows.

3. Design of the Choice Experiment

The choice experiment was designed in collaboration with the Yirgalem Town Water Supply and Sewerage Office. This office is responsible for maintaining and operating drinking water supply system in the town and collecting water fees from the households with water supply connections.

In the choice experiment, two possible water supply improvement options were presented to the sample respondents, which vary in the level of water supply increment and water quality, at different rates of increase in water

fee. Then, respondents were asked to choose the preferred alternative. Based on interviews and focus group discussions, two relevant attributes for the water supply services were selected together with the corresponding levels. Drinking water supply was supposed to increase by 1, 2 or 3 days per week while water quality was stated as needs boiling for infants only or needs no boiling. Furthermore, five price levels were indicated with an increase in the households' monthly water fee of Birr 3, 5, 10, 15 or 20.

Alternative policy options are created by combining these three variables based on their different attribute levels. Since the choice options of the respondents cannot be shown, the number of possible combinations was reduced to 24 choice sets of 12 choice tasks each based on an orthogonal fractional factorial design generated in the statistical software SPSS, which enables the estimation of main effects and two-way interactions. Each respondent was randomly shown one of these 24 choice sets of 12 choice cards. Each choice card shows two hypothetical options discerning a future policy option together with the decision to choose none of the options. Addition of this 'status quo' option is instrumental to estimating welfare measures which are consistent with the consumer demand theory (Bateman et al., 2003). In fact, it was indicated that respondents do not have to pay extra money if they choose the status quo. Table 1 shows an example of a choice card which was presented to the sample respondents during the interview.

Table 1: Sample choice card presented to the respondents

	Option 1	**Option 2**	**Current situation**
Extra days per week	2	1	0
Needs boiling	No	For infants	For infants
Increase in monthly water fee	Birr 10	Birr 3	Birr 0
I prefer	□	□	□

The design of the choice experiment was first pretested and then implemented in July 2013 through 182 face to face interviews in the nine Kebeles of Yirgalem town. The response rate was 100 percent, which is common to such kind of stated preference study in a developing country (Whittington, 1998). Even if statistical data on household characteristics is

not available for the various Kebeles of the town to date, the Kebeles differ noticeably in terms of the socio-economic status of the respondents. A list of customers with water supply connections was obtained from the Yirgalem Town Water Supply and Sewerage Office, which comprises 3631 households and 87 organisations in the nine Kebeles. A sample of 182 customers was drawn only from the households, which accounts for 5% of the total households. Trained enumerators were employed to conduct the interviews. After data screening, 181 of the 182 interviews were used in the analysis (17 from Kebele 1; 23 from Kebele 2; 27 from Kebele 3; 19 from Kebele 4; 28 from Kebele 5; 27 from Kebele 6;17 from Kebele 7; 10 from Kebele 8 and 14 from Kebele 9). The results are presented in the next section.

4. Results and Discussion

4.1. General characteristics of respondents

The general characteristics of the sample respondents are summarized in Table 2 below. It can be seen that the majority of sample respondents (67%) are female. As far as age distribution of respondents is concerned, the average age of the sample respondents is 38 years. The actual age of the respondents ranges between 18 and 78 years. The average monthly household income is Birr 2595.71.

Table 2: Demographic and water supply characteristics of the sample respondents

Characteristic	Mean	St. dev.	Min.	Max.
Share of female respondents	0.67	0.47	0	1
Average age of respondents	38.30	14.50	18	78
Average household size	4.87	2.38	1	12
Household income (Birr/month)	2595.71	1813.04	350	10000
Average daily water consumption (litres)	71.77	37.17	20	200
Average number of days water supply	3.78	1.41	1	7
Average monthly water fee (Birr)	26.71	19.63	9	140

The households' drinking water consumption varies between 20 and 200 litres per day. On average, a household has access to drinking water supply 4 days per week and pays a fee of Birr 26.71 per month for water. Further, some households (6.6%) spend between Birr 40 and 140 per month on bottled water.

a. The collective choice model

All of the respondents are willing to pay extra money for improved water supply services and completed all the 12 choice tasks. No protest voters were encountered in the data, i.e. respondents who consistently chose the opt-out alternative on all choice occasions. Across all 2184 choice occasions, the opt-out was chosen in 12 percent of the cases. As expected in unlabelled choice experiments, an equal distribution of choices is found between the two hypothetical alternatives. Choice behaviour was modelled using a combination of random parameter and error component models, accounting for the panel data structure of the choice model. For efficiency purposes, the models were estimated using a Halton sequence of 100 replications in a quasi-Monte Carlo maximum likelihood simulation (Bhat, 2001) in NLOGIT version 4.0.

Several possible interactions between the attributes and socio-demographic characteristics of respondents were tested for their statistical significance. The model that was found to be the best from the point of view statistical analysis after systematic testing of all possible interactions, i.e. including only statistically significant variables at the 10 percent level, is presented in Table 3.

Table 3: Estimated choice model

Variable	Coefficient	Standard Error	b/St.Er	P[|Z|>z]
ASC	0.835	0.128	6.541	0.0000
Water Supply	0.207	0.045	4.638	0.0000
Water Quality	1.318	0.074	17.809	0.0000
Water Price	-0.024	0.006	-4.063	0.0000

The estimated model is highly significant. The estimated error component is significant at one percent level, indicating that respondents perceived the two

hypothetical alternatives distinctly from the existing situation. The significant positive outcome of the alternative specific constant (ASC) in the model implies that respondents prefer a change instead of the current situation.

The attribute parameters are highly significant and have the expected signs. Households value the additional days of drinking water supply and improved water quality. An increase in the water bill per month is valued negatively, which is consistent with a priori expectations. This implies that the utility of households decreases as the monthly water bill increases. Water supply is included as a continuous variable while water quality is treated as a dummy variable with the value of one if the water needs no boiling and zero otherwise. The attributes are characterized by significant preference heterogeneity. The coefficient of water supply attribute is highly significant at 1% significance level and is positive as can be seen from the above table. The coefficient of water quality attribute is also highly significant at 1% level and is positive as expected. The coefficient of price is also highly significant at 1% level and is negative as expected. Based on these coefficient estimates marginal willingness to pay and standard deviations were calculated using the Krinksy and Robb (1986) procedure. Marginal willingness to pay for one extra day of domestic water supply is around Birr 6 per month, while marginal willingness to pay for water that requires no boiling is around Birr 23 per month.

The value of the log likelihood function is 1846.435 to this model. As expected, women who usually prepare food and take care of the children in the household value water quality improvements more than men to a level where it does not have to be boiled anymore for infants. However, no significant effect could be detected for any of the other general characteristics of respondents (e.g., age, education or household size).

b. Tests of preference stability

One of the most important assumptions underlying stated preferences is that respondents know their preferences and that these preferences are stable and coherent (e.g. Brown et al. 2008). This implies that individuals always know

their preference ordering for a set of goods or services and the rate at which they are willing to exchange one thing for another in terms of the various characteristics, such as price and quality. Hence, it is assumed that the individual can choose the most preferred alternative from a set of characteristics based on its level of utility. Choice behavior at the beginning of the choice experiment is expected to be consistent with choice behavior at the end of the experiment (Brouwer *et al.,* 2010b). However, lack of familiarity and experience with the good or service involved and the hypothetical choice setting may undermine these a priori assumptions (Shaikh *et al*. 2007).

One can examine the possible learning and preference enhancement effects by comparing the scale parameter over the choice sequence using the Swait and Louviere (1993) procedure. The scale parameter is inversely related to the variance of the error term (Louviere *et al.,* 2000). If the scale rises, variance falls, this means that in other words, people tend to make a more precise choice between the available options. Hence, obtaining estimates for the scale parameter provides an insight into preference enhancement during a choice sequence (Holmes and Boyle 2005). Through repetition, respondents are expected to make more precise and consistent decisions, because they learn about the survey format, the associated hypothetical market and their own preferences (List, 2003).

c. Economic welfare measures for water supply improvement

The welfare implications of different water supply improvement policy scenarios were calculated based on the estimated model in Table 2 including household characteristics. Currently, consumers receive, on average, drinking water four days per week. In most cases, they have to boil the water before they can drink it. Table 4 presents the estimated mean willingness to pay values associated with improvements in urban water supply services for the average respondent. The willingness to pay for drinking water supply improvement policy scenarios is presented in Birr.

Table 4: Estimated willingness to pay (WTP) for water supply improvements

Variable	Coefficient	Standard Error	b/St. Er	P[|Z|>z]
ASC	34.231	8.237	4.156	0.0000
WTP Water Supply	8.484	2.592	3.273	0.0011
WTP Water Quality	154.064	12.692	4.260	0 .0000

In case only water supply improves, not water quality, urban households are willing to pay, on average, about Birr 8.48 extra over and above their current monthly water bill of Birr 26.71. If water quality improves at the same time, the increase in the water bill that households would be willing to pay increases to Birr154 on the average, as shown in the above table.

If the sample is representative, these values can be aggregated across the population from which it was drawn so as to calculate a total economic value for the policy scenarios. This total economic value can then be compared to the required investment and maintenance costs for the improvement of current drinking water supply services in Yirgalem town. Based on the factors that turned out to be statistically significant in the choice model, women are expected to benefit most from improvement scenarios that include water quality. Given the fact that we also found a significant spatial effect for one of the towns, investments in water supply improvement will be most beneficial to households living in the poorest Kebeles of the town.

4. Conclusion

Reliable drinking water supply service is crucial to expanding urban areas in all countries in general and in the developing countries in particular. Improving the existing drinking water supply service is critically dependent up- on available financial resources. The cost recovery rates of drinking water supply services provided by public utilities in developing countries are naturally low, while the demand for more reliable services is high and keeps on growing. This study examined the households' preferences for improved drinking water supply services in an urban area in Ethiopia with the lowest water supply coverage in Sub-Saharan Africa. The aim of the study was to estimate households' willingness to pay for improvements in drinking water

supply service with particular attention to the case of Yirgalem town in the Southern regional state of Ethiopia. The findings of the study can be used in project appraisals of improved drinking water supply investment decisions.

In effect, this study helps to expand the limited stock of applied water supply reliability valuation studies. A number of contingent valuation studies were conducted focusing on willingness to pay for improved drinking water supply services in developing countries, mostly in rural areas and only a few in urban areas. The findings of this particular study indicate that currently, households have, on average, access to drinking water 4 days per week and consume about 71.77 litres per day for which they pay Birr 26.71 per month. Based on the average household size of 4.87, the daily per capita drinking water consumption is about 14.74 litres. This is very low compared to the estimated average per capita consumption levels in the rest of the developing world (UNESCO, 2003). The majority of sampled households boil the water before they drink it. Further, they reported that water quality is erratic and often the water is unsafe to drink.

Regardless of the prevailing income constraints, almost all households are willing to pay extra for improved drinking water supply, especially those households living in the part of the town with the lowest service levels who are forced to pay more for bottled water. Even if estimated preference parameters vary throughout the choice sequence in the choice experiment, choice variability decreases significantly towards the end of the choice experiment. This suggests that the presence of learning effects while going through the choice tasks. The mean willingness to pay for more reliable drinking water supply is Birr 8.48 above the current household water bill. If water quality is improved at the same time, there will be an increase in the additional amount of willingness to pay based on the extra days of water supply availability. Women who are responsible to take care of infants in the household value the improvement of water quality to a level that boiling for infants is no longer required.

Taking the summation of estimated individual household's willingness to pay for improved drinking water supply across the total number of households with drinking water supply connections in Yirgalem town (3631)

under the assumption that the sample is representative, gives a rough indicator of the total benefits of future investment plans in improved drinking water supply services. The total value of these benefits will be Birr 30, 805.40 per month or Birr 369, 664.80 per year. Furthermore, if water quality is improved at the same time, the value of the total benefits equals Birr559, 406.38 per month or 6,712, 876.56 per year. These benefits can be compared to the capital costs of any future investment decision in improved drinking water supply services in the town.

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Climate Change, Variability and Adaptation Strategies: Implications for Household Food Security in Southern Ethiopia

Tsegaye Ginbo Gatiso[1]

Abstract

Currently, Ethiopia is facing food insecurity and problems pertaining to the climate change. This study investigates impacts of climate change, variability and adaptation strategies on household food security in southern Ethiopia. For this purpose, Two-Stage Least Square estimation framework is employed based on cross-sectional data collected from 208 households. Food security index constructed using Principal Components Analysis from various indicators representing four dimensions of food security indicates substantial food insecurity problem among the sampled households. Empirical results reveal that climate change and variability affect households' food security. Rainfall changes in amount and time of coming, and higher temperature have significant negative impact on household food security. Moreover, results confirm that climate adaptation strategies namely soil and water conservation, modern varieties and crop diversification are effective in reducing climatic risks and ensuring household food security. Results also show that education, access to agricultural extension, credit, climate information and market significantly enhance adaptation decisions. Consequently, programs enhancing households' skills, awareness, adaptations decision and farm yield would be helpful.

Keywords: Climate Change and Variability, Adaptation Strategies, Household Food Security, Two-Stage Least Squares (2SLS), Boricha, Southern Ethiopia

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1. Introduction

Climate change has become one of the great challenges to the development of countries. It is now affecting agriculture and food production worldwide. There is evidence of declining crop yield due to climate change in many countries (Mendelsohn *et al.,* 2004; Orindi *et al.,* 2006; Stige *et al.*, 2006, Muamba and Kraybill, 2010 and Di Falco, 2011a, b and c). This challenge appears to be more devastating in the case of low-income countries. This is partly because high vulnerability of poor countries to climatic shocks due to their limited capacity to adapt and that agriculture accounts for a larger fraction of their economy. Besides, agriculture in these countries is climate sensitive due to generally already high temperature and that it is largely rain-fed. As a result, significant proportions of people living in poor countries are facing the risks of food insecurity.

However, research based knowledge on the direct impact of climate change on household food security at micro-level is limited. A number of studies so far estimate economic impacts of climate change on agriculture and factors affecting adaptation strategies at regional or country levels. For instance, Molua (2002), Muamba and Kraybill (2010), Deressa *et al.* (2005), Krishna (2011), Mendelsohn *et al.* (2004), Deressa (2007), Yesuf *et al.* (2008), Deressa *et al.* (2005), Deressa *et al.* (2008), Deressa and Hassan (2009) and Di Falco *et al.* (2011*a, b and c*) dealt with the impact of climate change on agriculture focusing on crop production and net farm revenue. Both crop production and farm revenue show only availability dimension of the food security. But, food security has four dimensions namely availability, access, utilization and stability (FAO, 1996 and FAO, 2013). According to FAO (2008), any analysis aiming to examine the impacts of climate change on food security must be considered within the larger and multidimensional framework encompassing all of the indicators. However, studies examining climate change – food security nexus within multidimensional framework are lacking.

Though growing, to our knowledge, there is also little evidence on the effectiveness of climate change adaptation strategies to ensure household

food security. This is particularly important to inform policy makers in identifying most effective adaptations that could reduce households' vulnerability to climate induced food insecurity. Therefore, this study aims at investigating impacts of climate change and variability on household's food security. It also finds factors affecting household decision regarding climate adaptations and tests the effectiveness of implemented strategies.

2. Description of the Survey Instruments and Data

The study utilizes both qualitative and quantitative data from primary as well as secondary sources. Cross-sectional data is generated from surveying 208 farm households from selected villages of Boricha district in Southern Ethiopia using questionnaire. Based on feedbacks from the pre-testing stage, further improvements on the questionnaire were made before the survey.

Two climatic variables namely precipitation and temperature are chosen to measure the vulnerability of farm households to climatic shocks. Rainfall time series data is obtained from Ethiopian National Meteorology Agency. However, there is lack of household level variation in rainfall data. To partially solve this problem, qualitative information on farmers' climate experience is collected. For this purpose, five questions regarding rainfall situation are included in the questionnaire following Abera *et al.* (2011). These questions include: Did the rainfall come on time? Was there enough rain on your fields at the beginning of the rainy seasons? Was there enough rain on your fields during the growing seasons? Did the rains stop on time on your fields? Did it rain during the harvest periods? A household was asked each of these questions. Then, value 1 is assigned if a household experience timely, regular and sufficient rainfall during ploughing, planting, crop growing and harvesting periods and 0 otherwise.

Finally, all responses were added up and divided by 5 to form subjective rainfall satisfaction index. The index value is specific to observed rainfall variability at each household's farm where lower values indicate higher vulnerability to rainfall shock and higher values indicate good farm-level rainfall conditions. Though subjective, this seems to be an appealing

measure of observed climatic condition because farmers have been doing farming for a generally long period and experienced real conditions of climate on their specific farms.

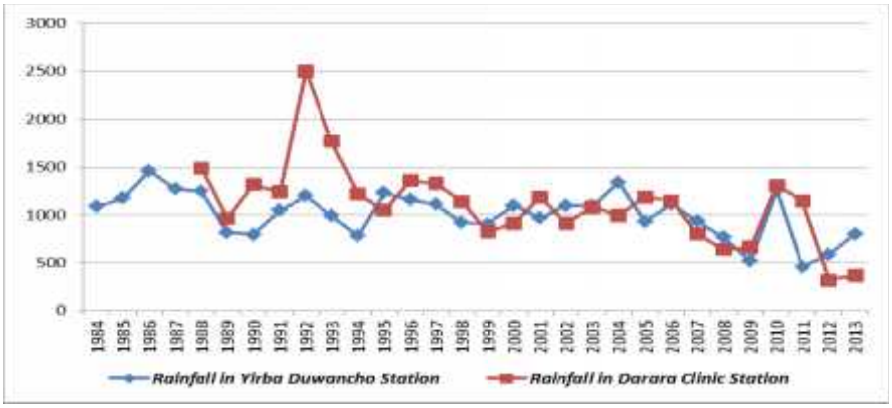
Besides, respondents were asked whether they have used different adaptation strategies to climate change and variability. For this reason, various strategies were identified and included in the questionnaire. These include crop diversification, varying planting and harvesting dates, diversifying from farm to non–farm activities, water and soil conservation, use of irrigation scheme, reforestation, and the use of modern varieties. The identification of these adaptation strategies is based on previous literature particularly Deressa *et al.* (2008), Hassan and Nhemachena (2008), Mary and Majule (2009), Seo (2010) and Di Falco *et al.* (2011 b and c).

Moreover, data on socioeconomic background of households, production inputs including the amount of labor and fertilizer used per hectare of land is collected. Total daily labor hour each household spent during ploughing, planting, weeding, harvesting and postharvest activities is also obtained.

3. Climate Change, Variability and Adaptations in the Study Area

Rainfall trend analysis for the long period of 30 years indicates high variability with gentle decline in amount of annual rainfall in both stations available in Boricha District. In Darara clinic station, it started declining since 1992 when a maximum amount of 2500.4 millimetres had been recorded and reached 319.6millimeter in 2012. The trend of rainfall in Yirba Duwancho station shows relatively slight decline over the whole period and the maximum amount of 1456.4 millimetres was recorded in the year 1986.

Figure 1: Total annual rainfall trend in study area (1984 – 2013)



Source: Computed based on data obtained from National Meteorology Agency

Similarly, rainfall variability is also proven using farmer subjective observation regarding timeliness and amount of rainfall in the area. Responses indicate high rainfall variability and unpredictability during the planting, crop growing, harvesting and post harvesting periods. As evidenced by Von Braun (1991) and African Development Bank (2010) for Ethiopia, and Muamba and Kraybill (2010) for Tanzania, the variability and unpredictability of rainfall have devastating effect on food production.

Table 1: Observed rainfall amount and regularity in study villages

On your farms	Favorable conditions (%)	Unfavorable conditions (%)
Rainfall coming on time	*Yes (on time)*	*No (too early + too late)*
	70.9	29.1
Enough rain at the beginning of rainy seasons	*Yes (enough)*	*No (too little + too much)*
	50.3	49.7
Enough rain during growing seasons	*Yes (enough)*	*No (too little + too much)*
	45.3	54.7
Rains stopping	*On time*	*Too early + too late*
	39.8	60.2
Rain during harvest periods	*No*	*Yes*
	47.3	52.7

Source: Computation based on survey data

Though majority of the respondents report that rainfall is coming on time, about half of the respondents experience insufficient rainfall during the crop planting period (Table 1). This is unfavorable condition for agricultural production that can reduce crop yield by affecting the early stage of growth including seed germination. It also harms livestock production through affecting forages and grasses recovery, and growth immediately after the end of the dry season.

Moreover, majority of the respondents have not been observing enough amount of rainfall during crop growing periods. 54.7% of sample households in Boricha district respond that rainfall during growing season is sometimes too little and/or too much. Neither of the two conditions is favorable. Besides, large majority of households respond that rains are not stopping on time at the end of rainy season. Too early or too late stopping of rainfall is not good for agriculture. Early stop leads to fewer crop yields and late stop damages the harvest. This unfavorable rainfall conditions have aggravated food insecurity problem leaving significant proportion of sampled farm households (52.7%) vulnerable to risks pertaining to climate change.

Sample farm households are also asked whether they adopted or not adaptation strategies in response to climate change and variability. Analysis of the responses reveals that about 91% of the respondents employed at least one adaptation strategy. The remaining 9% of sample households did not use any mechanisms at all in response to climate change and variability. Households who did not undertake any of adaptations options cited shortage of sufficient financial resources, lack of climate related information and shortage of land as main reasons for not adopting.

Table 2: Household's Climate Adaptation Strategies in Study Area

Climate change adaptation strategies	Farmers adopted (%)*
Using modern varieties of farm inputs	67
Crop diversification	51
Varying planting and harvesting dates	44
Soil and water conservation mechanisms	22
Income diversification to non-farm income	12
Harvesting rain water	7
Use of Irrigation	6

**Note: ***Significant number of households employ more than one adaptation strategies

Source: Computation based on survey data

Main adaptation strategies used so as to reduce risks pertaining to climate are use of modern varieties, crop diversification, varying planting and harvesting dates, and soil and water conservation. Only few households adopt income diversification into non-farm sources, harvesting rain water and irrigation options (Table 2).

4. Household Food Security in the Study Area

To identify multidimensional food security status of the households, an index is constructed using four indicators conforming availability, access, utilization and stability dimensions of food security. The indicators used include availability of food stock in household, affordability of prevailing food price, access to pure drinking water and periodic shortfall of food items. Different weights are obtained using principal component analysis and attached to corresponding indicators owing to the facts that various factors can influence food security differently. Then, multidimensional food security index is calculated as sum of weighted deviations of each variable from its mean values divided by that variable's whole sample's standard deviation.

Principal component analysis results indicate that the first component explains relatively the largest variance in the data among the other components and hence it is taken as principal component. Moreover, all of the variables load well on the first component. That means all loadings in the first principal component exhibit positive signs (Table 3). These results are fairly consistent with the prior expectations.

Table 3: Descriptive statistics of food security indicators

Indicator variables	Mean	Standard deviation	Component loading*
Availability of food stock	0.513	0.501	0.7079
Affordability of food price	0.365	0.483	0.6435
Access to pure water source	0.419	0.495	0.0609
Periodic shortfall of food items	0.459	0.500	0.2845

Note: *Loadings corresponding to first component taken from factors pattern matrix

Source: Computation based on survey data

The implication of the result is that availability of food stock in household guarantees the households' possibility of being food secure. This is confirmed by positive correlation of this variable with the index as anticipated. Food stock availability can be associated with the households' capability to pay for the prevailing price of food items from the market. Households can purchase food from the market during a period of shortage and hence nonexistence of periodic shortage of food items from the household. It also implies higher probability of access to infrastructural services like water. Therefore, the first component is considered to be the main index of food security for the purpose of this study.

In order to test the validity of index in measuring relative food security position, correlation analysis is undertaken between the index and household income. This is because income is commonly used as one of the measures of household's capability to acquire food and hence it can imply food security status. The result shows that the index is significantly and positively associated with the household income. Pearson correlation value of 0.5878 with $P < 0.000$ between income and index value indicates the validity of constructed index, to some extent, in measuring multidimensional food security status of sample farm households.

Finally, food security status of the sample household is judged based on the multidimensional index value taking zero as decision point[2]. Households with positive index value are categorized as food secure whereas those with negative value are considered as food insecure. Results show that there is considerable prevalence of food insecurity in the study villages. About 52.7% of the total sample households are found as food insecure while the remaining 47.3% are food secure. A study conducted on the coping strategies to food insecurity and hunger among households in the same selected district in Sidama zone of Southern Ethiopia found (54%) slightly larger proportion of food insecure households (Nigatu, 2011).

[2]The mean value of multidimensional food security index is 0.008 which is slightly different from zero. This can be attributed to the small sample property which is the case in this study.

5. Empirical Framework

Climate Adaptations Model: In this study, climate change adaptation strategies are modelled under the standard farm technology adoption framework. Representative risk-averse farm household face problem of choosing one or more climate change adaptation strategies that maximize the expected utility from final yield given production function, climatic condition, land, labor and other constraints. Optimization solution would result in an optimal adaptation measures undertaken by the representative farm household. Hence, the household's choice of climate change adaptation strategy is affected by a set of climatic as well as various socio-economic factors. That is:

$$A_{ih} = f(H_h, I_h, C_h, F_h,) \quad \textbf{(1)}$$

where, $A_{ih} = i^{th}$ adaptation strategy to climate change adopted by household h, H_h = is a vector of h household's characteristics including household size, household head's gender, age and educational level, I_h = vector of access to both formal and informal institutions such as access to formal government and informal farmer-to-farmer extension services, access to credit and local market for input and output, C_h = vector of climatic variables and access to climate related information and F_h = amount of fertilizer input used per hectare of cultivated land.

Besides, representative utility maximizing household is supposed to choose one climate change adaptation strategy over another if and only if the expected utility or gain in farm yield derived from one adaptation strategy is greater than the expected utility or gain in farm yield from the other. For instance, a rational farm household chooses soil and water conservation over changing planting and harvesting dates if he/she expects more yield gain from adopting the former strategy than the latter.

Furthermore, in this study, it is assumed that household's decision to adopt or not to adopt a given adaptation measure is made at household level but not at specific plot level. Moreover, different adaptation measures adopted by

farm households are considered independent from one another. That means, household's decision to use one strategy cannot be affected by a decision to use another strategy though she/he could use different strategies even on one plot. A dummy variable is designed to measure whether farm households had adopted each adaptation in any of their plots so as to cope with observed climate change and variability. Hence, each adaptation strategy is measured at household level and modelled independently. Finally, logistic regression model is used to investigate the factors affecting households' decision regarding choice of adaptation strategies to climate change and variability as identified in equation 1 above.

Household Food Security Model: The second empirical model that is estimated is to analyze effects of socioeconomic variables, climate and adaptation strategies on household food security. Household's multidimensional food security is modelled as a function of multiple socioeconomic and climatic factors. For this purpose, multidimensional food security index is used as a dependent variable.

In order to examine the effectiveness of climate adaptations in helping households ensure food security, four dominant strategies are selected. Dummy variables assuming value one if a household employs a given method and zero otherwise are created. These adaptation dummies are included in the food security model separately per se and not as a package. This is because household's decisions regarding different adaptation strategies are assumed to be independent, as discussed in the preceding section. Separate inclusion of each adaptation in food security model is important to identify most effective strategy.

However, household's decision to use climate adaptation strategies can be affected by unobserved individual heterogeneity such as farmers' skills or ability to learn and adopt new technologies. In turn, unobserved heterogeneity would result in the endogeneity problem where some of the explanatory variables may be correlated with the error term of regression model. Therefore, the endogeneity of adaptation variables is checked before empirical analysis of food security model using Durbin-Wu-Hausman test. Test results show that adaptation decisions are endogenous (Table 5).

Endogeneity of adaptation variables would result in biased and inconsistent estimation of food security model parameters. This can lead to the failure of measuring true effects of adaptation strategies. Therefore, controlling for endogeneity problem is an appropriate task to obtain consistent estimates. In this regard, using Two-Stage Least Squares (2SLS) estimation framework would help obtain robust estimates because it controls for endogeneity bias.

Consequently, 2SLS estimation framework is employed to estimate food security model. Following Kelejian (1971), Angrist (2001), and Angrist and Krueger (2001), predicted values of endogenous adaptation dummy variables are used as an instrument. In this case, it would be wrong to use predictions from nonlinear first-stage regression directly to second-stage estimation procedure. Rather, consistent estimate can be obtained by using linear first-stage regression regardless of the nature of outcome variable. This is because the consistency of second-stage estimates does not depend on the condition that the functional form for first-stage or reduced form equation is right (Kelejian, 1971). Angrist (2001) also argues that consistent estimator can be obtained by using nonlinear prediction of endogenous dummy variable given instruments and other exogenous variables, as an instrument. In this study, therefore, fitted values from a nonlinear logit model are used as an instrument for an endogenous dummy variable. This approach of using predicted values as an instrument was employed in previous studies by Pender *et al.* (2004), Abera *et al.* (2011) and Di Falco *et al.* (2011c).

In this regard, some of the explanatory variables in the logit model such as access to formal government and informal farmer-to-farmer agricultural extension services, access to rural credit services, access to input and output market, fertilizer and access to climate information are used as instruments. These variables are measured using the farmers' subjective response to the questions whether they do have accesses. Predictions were undertaken from the logit model including the excluded variables from the food security model.

The standard requirement for the instrumental variables' appropriateness is that instruments should not be correlated with the error term in structural equation but instead be correlated with the endogenous variables. In this

case, excluded instrument should not be correlated with farmers' unobservable individual skills. Instead, they should be correlated with farmers' decision concerning climate change adaptations. To test instrument relevance, F-test of overall significance of excluded instruments is used. Finally, a multivariate econometric model is specified as follows:

$$MFSI = f(H, L, S, LO, I, SRI, LARF, T, D_i) \quad (5)$$

Where; MFSI = Household's multidimensional food security index calculated using four indicators representing four dimensions of household food security. H = Vector of household characteristics such as age, sex and education of household head, household size and dependency ratio, L = Total amount of labor hours spent per hectare of cultivated land. S = Size of the cultivated land held by household measured in hectares, LO = Dummy variable for household's livestock ownership, I = Total amount of income earned by the household, SRI = Subjective observed rainfall satisfaction index used as a measure of rainfall variability. LARF = Long term average amount of village level annual rainfall. T = Household specific temperature variable proxied by altitude. D_i = Dummy variables for each common adaptation strategies used by each farm household.

Before executing regression analyses, multicollinearity problem among the explanatory variables is checked using Variance Inflation Factor (VIF) for continuous variables and Contingency Coefficient (CC) for discrete variables. Results of VIF less than 10 and CC less than 0.75 imply no serious multicollinearity problem among the variables. Besides, the problem of heteroskedasticity is tested using standard Breusch-Pagan/Cook-Weisberg test for heteroskedasticity. Resulting P-value of 0.98 indicates that the null hypothesis of homoscedasticity among the explanatory variables included in both models cannot be rejected.

6. Results and Discussion

6.1 Determinants of Adaptations to Climate Change and Variability

Household's decision to use climate change adaptations was hypothesized to be affected by household head characteristics, land size and fertilizer use, access to agricultural extension, market and credit service, information about climatic conditions, and climate factors. Regression results from logit model are reported in Tables 4 and 5.

Explanatory variables included in the model are jointly significant at $P < 0.0000$, $P < 0.0007$, $P < 0.0000$ and $P < 0.0002$ with the Pseudo R^2 of 0.322, 0.312, 0.392 and 0.394, respectively, indicating the specification fits the data well (Table 4). This implies that the hypotheses stating all coefficients except the intercept are equal to zero are rejected in all models. Therefore, it is possible to interpret the regression results meaningfully. Moreover, out of the total twelve explanatory variables, eleven have statistically significant influence on the probability of using one or other adaptation strategies. However, age of the household head is found to be insignificant in any of adaptation models.

Among household head characteristics, education has significant positive effect on all adaptation strategies. Positive significant effect of household head education on climate adaptation strategies is consistent with the findings of Deressa *et al.* (2008). Gender also has significant impact on the probability of using modern varieties and soil and water conservation strategies. Marginal effects indicated that male headed households are 6.4% more likely to use modern varieties and 11% more likely to implement soil and water conservation mechanisms than their female headed counterparts. This may be because male-headed households have more information than female-headed households. In addition, most female-headed households are formed either as a result of death of husbands or divorce which may lead to the situation of having fewer resources like labor.

Table 4: Marginal Effects of Determinants of Adaptations: Logit Estimates

Variables	Crop diversification	Varying planting& harvesting dates	Modern variety	Soil and water conservation
Age	-0.00248	-0.00196	-0.00346	-0.00192
	(0.00373)	(0.00343)	(0.00281)	(0.003)
Gender	-0.0553	0.0613	0.0643***	0.110***
	(0.121)	(0.114)	(0.0084)	(0.0117)
Head's education	0.0626***	0.0221*	0.0258*	0.00613**
	(0.0206)	(0.00171)	(0.0015)	(0.0016)
Household size	-0.0322	0.0175	-0.0133	0.0283***
	(0.0307)	(0.0282)	(0.0245)	(0.00243)
Land size	0.472***	0.285**	0.0325	0.192*
	(0.174)	(0.0148)	(0.128)	(0.116)
Fertilizer	0.00122	0.000146	0.00799***	0.000694
	(0.00172)	(0.00165)	(0.00189)	(0.00139)
Access to agricultural extension service	0.0273*	0.0582*	0.247***	0.459***
	(0.0121)	(0.0109)	(0.0922)	(0.0922)
Access to credit service	-0.115	-0.231	0.0259***	0.0797
	(0.131)	(0.104)	(0.0104)	(0.121)
Access to market	0.450***	0.269**	0.00714***	0.00124
	(0.106)	(0.118)	(0.00119)	(0.034)
Climate information	0.0685	0.0159***	0.0962	0.0918
	(0.122)	(0.00113)	(0.0878)	(0.0931)
Subjective rainfall satisfaction index	-0.0372**	-0.255**	-0.117	-0.203***
	(0.0189)	(0.0172)	(0.148)	(0.0142)
Average long-term rainfall	0.00119	-0.000761	-0.000220	0.000654**
	(0.00088)	(0.0018)	(0.00068)	(0.00071)

Note: *, ** and *** indicate statistical significance at the probability levels of 10, 5 and 1 percent, respectively. Figures in the parentheses are standard errors

Source: Author's analysis based on survey data

Size of the household is also found to be significantly and positively correlated with the household's probability to employ soil and water conservation mechanisms. This result is consistent with the finding of Di Falco *et al.* (2011c) who found positive and statistically significant coefficient for household size using probit model to analyze adaptation

options in Nile Basin of Ethiopia. Likewise, the size of cultivated land owned by sampled households has a positive and significant impact on crop diversification, changing planting and harvesting dates and conserving soil and water.

As expected, household's access to both formal government and informal farmer-to-farmer extension services are found to have positive and statistically significant impact on the probability of employing all adaptation strategies. A study by Di Falco *et al.* (2011c) in the case of Nile Basin also found similar result of positive and significant impact of agricultural extension on farmers' climate adaptation decisions.

Access to credit services has positive and significant impact on using modern varieties. Marginal effect results of logistic regression model presented in Table 4 indicate that farmers with access to credit services have 2.6% more probability to use modern varieties on their farms than those who do not have access to credit. This result is consistent with the predictions of economic theory and prior expectation. Having access to credit reduces financial constraints for farmers and enables them purchase modern varieties to be used as inputs for their farm production.

Household's access to both input as well as output market have significant positive impact on crop diversification, changing planting and harvesting dates, and using modern variety. Farm households with access to market have 45%, 27% and 0.7% more likelihood of using crop diversification, changing planting and harvesting dates and modern variety respectively than those who do not. These results are statistically significant at 1%, 5% and 1% probability levels (Table 4). Access to climate related information has positive and statistically significant effect on varying planting and harvesting dates. Farmers who have access to climatic information were found to have 1.6% more probability to vary planting and harvesting dates. These results are in line with the prior expectations and with the findings of previous studies by Deressa *et al.* (2008) and Di Falco *et al.* (2011c) for Ethiopia, and Hassan and Nhemachena (2008) for 11 African countries.

Moreover, the parameter estimates of climatic variables indicate that farmers use adaptation strategies in response to climate change and variability. Rainfall variability measured by farmers' subjective rainfall satisfaction index was found to have negative and statistically significant impact on all adaptation strategies except for using modern varieties. Marginal effects shows that farmers who observe favorable rainfall conditions have less probability of using adaptation strategies (Table 4). This implies that farmers use adaptation strategies if they observe unfavorable rainfall conditions. If there is favorable rainfall condition, farmers production would be good and hence no motivation to adopt the options.

On the other hand, average long-term rainfall is found to have significant positive relationship with the use of soil and water conservation mechanisms. But, the coefficients of crop diversification, varying planting and harvesting dates, and using modern varieties are statistically insignificant. This implies that sample farm households use adaptation strategies in response to the observed rainfall variability instead of changes in long-term average rainfall.

6.2 Factors Affecting Household Food Security

In this study, households' food security is recognized as a multidimensional concept and modelled as a function of multiple socioeconomic and climatic factors. Twelve explanatory variables are included in the regression model as possible determinants of household's food security. As farmers' decision to use adaptation strategies can be affected by their unobserved individual ability, the endogeneity problem is suspected. Hence, endogeneity of climate adaptation variables is tested using Durbin-Wu-Hausman test before the estimation of model parameters. The results show that we can reject the null hypothesis of exogenous adaptation decisions implying endogenous nature of adaptation variables.

Table 5: Results of Endogeneity and Over-identification Tests

Tests	Score	P-value
Tests of endogeneity (Ho: variables are exogenous)		
Durbin chi2(4)	34.2415	0.0000
Wu-Hausman F(4,128)	9.63204	0.0000
Tests of over-identifying restrictions		
Saran chi2(1)	0.080905	0.7761
Basmann chi2(1)	0.071651	0.7889

Source: Analysis based on survey data

In order to test the relevance of the chosen instruments, *F*-test of joint significance of variables included in first-stage regression is used. The value of *F*-test of excluded instruments is equal to 9.60 with $P = 0.0000$, 2.60 with $P = 0.0019$, 4.39 with $P = 0.0000$ and 4.52 $P = 0.0000$ under crop diversification, varying planting and harvesting dates, using modern varieties and soil and water conservation adoption scenarios. Hence, we can reject the null hypothesis of jointly zero coefficients of excluded instruments and confirm that the instruments are relevant.

Moreover, over-identification restriction is tested using Sargan - Hansen test of over-identifying restrictions. The result reveals that there is an over-identified equation in which the number of instruments exceeded the number of endogenous covariates (Table 5). This implies that we cannot reject the null hypothesis that the excluded instruments are valid. Hence, the instrumental variables are uncorrelated with the error term indicating the validity of the instruments.

Table 6: 2SLS Estimation Results of Multidimensional Food Security Model

	Crop Diversification and harvesting	Varying planting dates variety	Modern	Soil and water conservation
Explanatory variables				
Adaptation	0.238***	-0.139	0.161***	0.130**
	(0.0257)	(0.324)	(0.0218)	(0.0593)
Altitude	0.00143	0.00102*	0.00623	0.00237*
	(0.00193)	(0.00140)	(0.00169)	(0.00189)
Rainfall variability	0.0166**	0.0811*	0.163 *	0.185*
	(0.00144)	(0.00152)	(0.0185)	(0.0218)
Long-term average rainfall	-0.000525	-0.00872	-0.000105	-0.00163
	(0.00101)	(0.00102)	(0.00112)	(0.00137)
Age	-0.00266	-0.00595**	-0.00749***	-0.00668**
	(0.000266)	(0.00248)	(0.00286)	(0.00296)
Gender	0.0282	0.0108	-0.0548	0.111
	(0.100)	(0.0782)	(0.0860)	(0.121)
Head's education	0.00351*	0.0307**	0.0442***	0.0335*
	(0.00173)	(0.0148)	(0.0159)	(0.0194)
Explanatory variables				
Household size	-0.0447 *	-0.0734***	-0.0740***	-0.104***
	(0.00245)	(0.0184)	(0.0221)	(0.0313)
Dependence ratio	-0.092 *	-0.00502	-0.00610	0.0619
	(0.0696)	(0.0604)	(0.0636)	(0.0734)
Land size	0.748***	0.687***	0.670***	0.555***
	(0.146)	(0.128)	(0.153)	(0.186)
Daily labor hour	0.146	0.0380***	0.0421***	0.0344**
	(0.0149)	(0.0149)	(0.0147)	(0.0164)
Income	0.00484	0.0926*	0.0104*	-0.0111
	(0.00551)	(0.00453)	(0.00597)	(0.0104)
Livestock ownership	0.267***	0.275***	0.274***	0.238**
	(0.0905)	(0.104)	(0.0937)	(0.116)
Constant	2.711	-2.265	0.282	-6.416
Number of Obs.	*208*			
Wald chi2(13)	*201.17*	*234.96*	*210.65*	*106.37*
Prob. > chi2	*0.0000*	*0.0000*	*0.0000*	*0.0000*
R-squared	*0.677*	*0.669*	*0.693*	*0.708*

Source: Analysis based on survey data

Regression results indicated that all included explanatory variables are jointly significant in explaining food security condition of households at $P < 0.000$ with R^2 fairly above 66% in all specifications (Table 6). Therefore, the coefficients obtained from Two-Stage Least Square regression analysis can be interpreted meaningfully. Results show that age and education of household head, household size, land size, labor, and livestock ownership, climatic variables such as rainfall variability and temperature, and adaptation strategies are found to be significant determinants of multidimensional food security of households.

The parameter estimate for altitude which is a temperature proxy variable is positive and statistically significant under changing planting and harvesting dates, and soil and water conservation adaptation scenarios. From the negative relationship between altitude and temperature, and positive effect of altitude on food security, we can deduce that temperature has a negative impact on household food security. More specifically, one unit change in temperature can lead to 0.1 and 0.2% deterioration of household's food security position under stated adaptation scenarios, respectively. Higher temperature can harm crop production. It also affects livestock production negatively because extreme temperatures lead to drying of grasses and water sources. This negative impact of temperature on food security is consistent with the findings of previous studies such as Muamba and Kraybill (2010) for Mt. Kilimanjaro areas in Tanzania, Deressa and Hassan (2009), and Di Falco *et al.* (2011c) for Blue Nile Basin in Ethiopia, which reported negative marginal impact of temperature on net farm revenue and crop production.
Rainfall variability in terms of time and amount during the beginning of rain season, crop growing and harvesting periods affect household food security significantly. Favorable rainfall condition has positive and statistically significant impact on food security. This implies that if rainfall is favorable in terms of arrival time, amount and distribution, households' food security condition improves. Favorable rainfall condition in a production year significantly improves household's food security position by 1.6% under crop diversification, 8% under varying planting and harvesting dates, 16.3% under modern varieties and 18.5% under soil and water conservation scenarios (Table 6). Significant impact of rainfall variability on household food security is reasonable in Ethiopian agricultural setup where production

is highly dependent of natural rainfall. Good rainfall condition implies good agricultural production and better food security.

Hence, there is significant evidence for the notion that climate variability is one of the critical causes of food insecurity of households in study area. This result is consistent with the finding of previous studies like Abera *et al.* (2011) in Ethiopia, and Molua (2002) in Southern Cameroon. Unlike the case of rainfall variability, the parameter estimates for long-term average rainfall is statistically insignificant under all adaptation scenarios. This indicates that rainfall variability is a more binding constraint for household food security than long-term average amount of rainfall.

Furthermore, results show that climate adaptations have positive impact on household food security. Households who adopt crop diversification, modern varieties, soil and water conservation strategies are found to be more food security position as compared with those who do not adopt the strategies (Table 7). Diversifying crop and using modern varieties reduce climate vulnerability and increase farm production and productivity thereby helping households improve their food security status. Besides, soil and water conservation measures help mitigate soil erosion and conserve rain water which both increases crop production which can contribute to better food security status. Therefore, adaptation strategies such as crop diversification, modern varieties, and soil and water conservation strategies are effective in reducing risks pertaining to climate change and variability thereby helping households ensure food security.

Unexpectedly, however, the coefficient of varying planting and harvesting dates becomes statistically insignificant. This result contrasts with the study by Molua (2002) which found significant positive association between changing dates and farm income in Southern Cameroon. The implication of this result can be explained in the manner that sample households might not be changing dates exactly in line with actual climatic variations. This can be partly attributed to the lack of relevant and timely information on current as well as future forecasts of weather and climate.

Among the other variables, age of household age, household size and dependency ratio are found to have significant negative impact on household food security. Result shows the food security position of a household deteriorates as the age of household head increases. This is perhaps because as the household head grows old, he/she might be unable to carry out demanding farming activities resulting in lower farm production and productivity. Households with large size and more dependent family members are also more food insecure. These households need more resources, beyond what they produce, to fulfil their food needs. Negative impact of household size on food security is consistent with the finding of Shiferaw *et al.* (2005) in Southern Ethiopia. However, it contrasts with the study by Abera *et al.* (2011) which found significant positive coefficient for household size in food security model. The differences in these results may be attributed partly to the differences in household composition. If the proportion of economically inactive members of the household increases, household food security position will deteriorate. This is because the marginal contribution of economically inactive household members in food production is less than their marginal consumption.

Level of education attained by household head was found to be positively related with household's food security position. This is due to the fact that education can imply better farming skill and easier learning of new techniques. Besides, education can also reflect better farm management, decision making and adaptive capacity. A study by Deressa and Hassan (2009) also found similar positive and significant relationship between household head education and net farm revenue in the case of Nile basin in Ethiopia.

As expected, production inputs such as daily labor and size of cultivated land held by the household are found to have statistically significant positive impact on household's food security. The implication of this result is that the more the size of land held and the more the amount of labor working, the more the food production and the better the food security status of household.

Furthermore, in line with prior expectation, household wealth indicators such as non-livestock total income and livestock ownership have positive impact on household food security. Livestock are important capital assets in rural areas of Ethiopia serving multiple purposes. They are sources of food and income. They can also ensure food stability through serving as safeguard against shocks such as hardship periods like production shortfalls. Livestock can be easily sold and changed into cash thereby reduce problems of food availability through generating income. This result is consistent with the findings of Abera *et al.* (2011) which used panel data framework utilizing Ethiopian Rural Household Survey data set.

7. Conclusion and Policy Implications

This study examines implication of climate change, variability and adaptation strategies for household multidimensional food security in Boricha woreda of Southern Ethiopia. Farm households in study area observe climate change and variability, and adapt using different strategies. Two-Stage Least Square regression framework is employed to investigate the impact of climate change and adaptation strategies using the cross-sectional data collected from the selected 208 farm households. Empirical analysis indicates that household head's gender and education, household size, land size, agricultural extension services, access to market, credit and climatic information are key factors affecting household's decision regarding climate adaptations.

The study also found that there is substantial prevalence of food insecurity problem among the sample farm households. Results from Two-Stage Least Square estimation show that increases in temperature and rainfall variability have significant negative impact on household food security. Moreover, results reveal that adaptation measures like crop diversification, using modern varieties, and soil and water conservation have significant positive impact on household food security. This suggests that adaptation strategies are effective in ensuring household food security through reducing risks pertaining to climate change and variability. Besides, household head's education, labor input, size of cultivated land, total non-livestock income and

livestock ownership affect household food security positively. But, household characteristics such as age of head, household size and dependency ratio have significant negative impact on household food security.

Several policy implications can be suggested from this study. Though tone needs to be careful in making generalizations, the implications could be helpful in reducing climatic risks and ensuring food security in similar areas to the study sites. As rainfall variability is a critical constraint to household food security, risk reducing measures and programs would be helpful. In this regard, strengthening current government's rural development strategies such as agricultural extension, adult education and introducing modern high yield and climate resilient crop and livestock varieties have paramount importance. Provision of relevant timely information on current as well as future climate forecasts, access to credit and market will enhance farmers' climate adaptation decisions and help reduce food insecurity problem.

Furthermore, promoting soil and water conservation measures and crop diversification would also help reduce households' vulnerability and enhance food security. Further micro-level research on food security addressing multiple dimensions, climate and adaptations within various agro-ecological settings would generate more insights into household welfare impacts. In view of that, efforts should also be devoted to address the problem of micro data on key climate variables.

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