Determinants of Household Income Diversification and Its Effect on Food Security Status in Rural Ethiopia: Evidence from Ethiopia Longitudinal Rural Household Survey

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A Thesis Submitted to Department of Economics Presented in Partial Fulfillment of the Requirements for the Degree of Master of Science in Economics (Economic Policy Analysis)

Addis Ababa University, Addis Ababa, Ethiopia

June, 2014

Addis Ababa University
Department of Economics

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Abstract

This study examines the determinants of household income diversification and its effect on food security status in rural Ethiopia. To accomplish this, we use household panel data from ERHS approximately 896 households for three years data with five years gaps. Analytical tool used were both descriptive statistics and econometric models. In descriptive analysis, from the sample households, the level of household income diversification in rural Ethiopia is 39%.Income diversification of households based on share of income from each sources show that, the share of crop income takes the highest share which accounts 45% of the total household income followed by livestock income which accounts 41% of the total income. The remaining 14% of the household income generates from off-farm activity.

In econometrics model, we use fixed and random effects models to remove the effect of unobserved household characteristics that may be correlated with household income diversification behavior. We also employed instrumental variable in combination of 2SLS to address the possibility of endogenity of the level of income diversification in food security status equation. To examine the determinants of level of household income diversification we used random effect model based on the Hausman test result. The regression result suggests that number of adult household members, access to credit, farm size and livestock holding determines the level of income diversification of households. Positively and significantly while age of the household head, distance from the nearest market, households with higher education and availability soil conservation on their plot determines negatively and significantly. Finally we analyzed the effect of the level of household's income diversification on food security status. To this end, we deliberately used fixed effect model to sweep out time invariant unobserved factor that might be correlated with the instruments. The finding of the study revealed that income diversification of households should be given more focus and attention by policy makers in effort to reduce food insecurity status of households.

Acknowledgements

I would like to thank the almighty God for giving me this opportunity, to explore every kind of endeavor and for opening doors when it seemed impossible.

I wish to extend my gratitude to Ato Atelaw Alemu for the valuable advice the data management issue.

I am indebted to thank Addis Ababa University School of Economics, the International Food Policy Research Institute, and United States Agency for International Development, the Center for the Study of African Economies and university of Oxford for allowing me to use the data.

I am also pleased to address a special acknowledge to my colleague, Tilahun Dessie, Bisrat Abebe, Habtamu Astatkie, Gebremarriyam Anteneh and Habitamu Demilew for th eir consistent encouragement and making available relevant materials for the study.

Finally, my thanks go to my Father Yizengaw Limenie, My mother Tangut Gizachew and my sister Tigist Yizengaw. I am really satisfied with your closer encouragements; follow ups and helps in my study.

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Acronyms

AHM= Agricultural Household Model

EDRI=Ethiopia Development Research Institute

ERHS= Ethiopia Rural Household Survey

FAO=Food and Agricultural Organization

HDI= Herfindahl Diversification Index

HI= Herfindahl Index

IFPRI= International Food Policy Research Institute

NGO=Non-Governmental Organization

PCA=Principal Component Analysis

SIDA=Swedish International Development Agency

USAID=United States Agency for International Development

VIF= Variance Inflation Factor

WB=World Banks

Chapter One

Introduction

1.1. Background of the Study

Agriculture remains the main source of income for the majority of the rural population of developing countries. Nevertheless, a large proportion of rural households modify their economic activities in a variety of ways under different conditions (Ellis, 2000). Firstly, farm households may intensify extensity or diversify their agricultural production . Secondly, they may also diversify their portfolio of economic activities outside agriculture either on or outside of the farm, or some members might migrate to other areas temporarily or permanently in search of better opportunities (Scones, 1998).Bryceson (19 96) calls this process "Deagrarianisation", i.e. the diminishing role of agriculture in the household's income and livelihood strategies. In this study diversification refers to a process in which households voluntarily or involuntarily increase the number of economic activities they are involved in. It is important to note that income diversification is not synonymous with livelihood diversification. The latter is a process by which households construct a diverse portfolio of activities and social support capabilities in order to improve their living standards and manage risk. Income diversification is one of the components of livelihood strategies (Ellis, 1998). Livelihood diversification also encompasses the social institutions, gender relations, property rights, and other non-income support systems that sustain a living. This study abstracts from

these and focuses on the income diversification aspect of livelihood diversification of households.

In order to improve the food security status in sub Saharan Africa households in rural areas largely depend on survival strategies predominantly: on-farm, non-farm, and off-farm (Barrett et al., 2001).

The issue of food security has been on the fore of developmental sciences for many decades. Food security exists when all people at all times have access to safe nutritious food to maintain a healthy and active life (FAO, 1996).There exist four major elements in achieving food security, namely: availability, accessibility, utilization, and sustainability. While availability connotes the physical presence of a large quantity of food, accessibility implies that there is the ability to acquire the required quantity; utilization/adequacy means sufficiency in both quantity and quality of food; and sustainability implies access at all times and not losing such access (Omonona and Agoi, 2007). In this study food security is described along two dimension i.e. food availability, food accessibility.

The contribution of non-agricultural activities to household income in the developing world in general and sub-Saharan Africa in particular is substantial. Haggblade, Hazell, and Reardon (2005), found that local non-farm income constituted between 30 to 45 percent of rural household incomes in developing countries. Reardon et al. (1997) estimated it at 42 percent for sub- Saharan Africa and 32 percent for Asia and 40 percent for Latin America. Ellis (1998) gives higher numbers from case studies in sub-Saharan Africa in a range of 30 to 50 percent.

Ethiopia's economy is based mainly on agriculture, including crop and livestock production, which contributes 45% of the national Gross Domestic Product (GDP), more

than 80% of employment opportunities and over 90% of the foreign exchange earnings of the country (shitarek, 2012). Yet agriculture is the country's most promising resource and majorities of rural household in Ethiopia make a living through agriculture. Apart from farm production; rural households are involved in a wide range income generating activities. From the empirical evidence of the study of, Rijkers et al.(2002) non-farm enterprise makes considerable contributions to rural income and approximately 25% of all households in rural Ethiopia own one or more non-farm enterprises, however, about 2% of households exclusively rely on non-farm enterprises. According to Birhanu and zeller (2012), 42.8% of households are involved in exclusively in their own farms production (not engage in any of off-farm activity), indeed 57.2% of the households have at least one member who engages in a variety of wage work, self-employment or a combination of the two.

General policy framework of the Ethiopian government is poverty reduction; reduced poverty means food secure households in specific terms. The major components in order to improve food security status of household in rural Ethiopia involves: improving the productivity and production of rural households, developing the contribution of the livestock sector in food security, expanding and strengthening irrigation schemes, implement sustainable land-use practices, build-up human and institutional capacity, improve the provision of clean drinking water, expand rural credit services, expand rural market services, expand and strengthen off-farm and non-farm employment opportunities, and implement resettlement program.

1.2 Statement of the Problem

Agriculture is considered as a strong option and fundamental instrument for spurring growth and sustainable development, poverty reduction, and enhancing food security in developing countries like Ethiopia. However, the sector has been continually blamed for its failure to meet the growing food need of the rural population. A considerable body of research shows that rural households in developing countries try to maximize their food security status or minimize food insecurity and their risk exposure through agricultural diversification (Just and Candler, 1985; Dercon, 1996), non-agricultural income diversification (Ito and Kurosaki, 2006; Rose, 2001;Davis et al., 2010) and other mechanisms.

Rural people on their side partake in a number of strategies, including agricultural intensification, and livelihood diversification, which enable them to attain food security. The rural poor struggle to ensure food security status by participating in diversification activities. 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).

Several authors have investigated the role of household income diversification in developing countries. For instance, (Babatunde and Qaim, 2010), in the study of rural Nigeria, off-farm income has a positive net effect on food security and nutrition. Reardon et al. (1998) claim that non-farm income is potentially particularly important for long-term food security in Africa because it may broaden smallholders' access to farm inputs, and consequently increase productivity and intensify production.

Income diversification is also associated with higher incomes and food consumptions, more stable income and consumption over years (Reardon, Delgado, and Matlon 1992).

Determinant of income diversification have been studied in Ethiopia extensively over the years (lemi, 2006; Damite, 2006;Beyene, 2008;Demissie and Legesse, 2013,Asnake, 2010).They found that human capital related variables, education status of the head, availability of credit and transfer income, and infrastructure related variable (proximity to market) affect income diversification of households significantly. The diversity of rural livelihoods is an important feature of survival in rural areas (Legesse, 2002). Diversifying income sources is necessary to create employment for new entrants into the labor force and supplement income of landless and near landless families, but also increasing agricultural production and productivity and are so important means of ensuring food security; they enhance purchasing capacity or in-kind income (Mulat, 2001).

According to (Devereux, 2000, Hagos, 2003) from the point of view of reducing poverty and food insecurity in rural Ethiopia, it is extremely important to reduce vulnerability of the poor through diversification of the source of their income. Diversification can play a crucial role in that regard.

Studies on the determinants of Income diversification in Ethiopia were (lemi, 2006; Dami te, 2006; Beyene, 2008; Demissie and Legesse, 2013, Asnake, 2010). Some of considered income diversification as share of off-farm income or intensification of agricultural activates. This approach has some shortcoming, including the fact that it does not account for heterogeneity in the off-farm income sources. In this study we used, Herfindahl diversification index which accounts the share of each income sources and helps to know the extent of diversification. They also used household survey data to examine the

determinants of household income diversification in Ethiopia at a point in time (i.e. use cross-sectional data) except (Lemi, 2006). However, the use of cross-sectional data in establishing the determinants of household income diversification will not be able to extricate innate household characteristics that are unobservable to the econometrician such as the household's attitude to risk. In addition, the data used was region or village-specific, which limits their broader applicability except (Lemi, 2006).

The desire to increase household income and insure against agricultural production risk has led rural households to increasingly diversify their income sources. Yet the potential roles of income diversification on food security status particularly among the rural farmers have not been adequately examined in Ethiopia. In other words, there is no empirical work available that specifically investigates the effect of the level of household income diversification on food security status by using panel data in rural Ethiopia.

Given the limitation of past research, this study tried to examine the determinant of level household income diversification and its effect on household food security status by using representative household level data that covers a wide range of Ethiopian agro ecosystems. The household survey data was collected by the school of Economics, Addis Ababa University in collaboration with the Ethiopian Development Research Institute(EDRI), International Food Policy Research Institute(IFPRI) and the Center for the Study of African Economies, university of Oxford etc.

1.3 Objective of the Study

1.3.1 General Objective of the Study

The overall objective of this study is to examine the determinant of income diversification and its effect on food security status in rural areas of Ethiopia using panel data.

1.3.2 Specific Objectives of the Study

Based on the aforementioned general objective, specific objective of the study are listed below:-

- To assess the income diversification of farm households in rural Ethiopia.
- To identify socio- economic and demographic determinant's of the level of household income diversification in rural Ethiopia.
- To analyze the effect household income diversification level on food security status in rural Ethiopia.
- To provide policy recommendation based on the empirical result of the study.

1.4 Significance of the Study

The result of the study hopefully, will help the rural development planner, policy makers, NGOs as an input informing the appropriate policies for rural income diversifications. Identifying the determinants of income diversification helps the agricultural development institutions to design policies that increase the diversification pattern of households, which eventually leads to increase total income and food security status of households.

Since the study contains both theoretical and empirical issues, students who are interested on the area can get both aspects from the document. Furthermore, the study can serve as a point of departure for further researches on the area.

1.5 Scope of the Study

Farmers have a number of income diversification strategies that they practice for their means of subsistence. In order to improve food security status of households these include among others: agricultural intensification/diversification, participating in different activities outside agriculture and income from remittance transfer etc. This study focuses on determinants the level of household income diversification and its effect on food security status in rural Ethiopia by using the last three rounds data of Ethiopia rural household survey (ERHS) which was collected 1999, 2004 and 2009.

1.6. Limitation of the Study

The study uses the Ethiopia rural household data. The data is collected for different aspects and characteristics of rural households. But it is not particularly designed to collect data on different income generating activities and food security status in rural Ethiopia. As a result, it does not have deep information about different dimension of food security. For example in 1999 there was no any indicative variable for food utilization aspect of the food security dimension. Due to that we are forced to only relay on food availability and food accessibility dimension of food security.

1.7 Organization of the Paper

The remaining part of the paper is organized as follows. The second chapter deals with review of literature, which inculcates both theoretical and empirical literature review. The third chapter deals with brief description of the research methodology i.e. data source, Method of analysis, theoretical framework of the model and econometrics model specification. The result of the study discussed in chapter four. Finally, conclusion and policy recommendation of the study are presented in chapter five.

Chapter Two

Literature Review

2.1. Theoretical Literature Reviews

2.1.1. Review on Income Diversification

2.1.1.1 Definition of Income Diversification

One definition of income diversification, perhaps closest to the original meaning of the word, refers to an increase in the number of sources of income or the balance among the different sources. Thus, a household with two sources of income would be more diversified than a household with just one source, and a household with two income source each contributing half of the total, would be more diversified than a household with two sources, one that accounts for 90 percent of the total (Joshi .et al., 2002; Ersado 2003). A second definition of diversification concerns the switch from subsistence food production to the commercial agriculture. For example, (Delgado C. and Siamwalla 1997) argue that 'farm diversification' as an objective in African smallholder agriculture should refer primarily to the part of farm household output undertaken specifically for cash generation." A less ambiguous term for this type of diversification is agricultural commercialization. It does not necessarily involve an increase in the number or balance of income sources. For example, a farmer may move from producing various grains, tubers, and vegetables for own consumption to specializing in one or a few cash crops. Third, income diversification is often used to describe expansion in the importance of

non-crop or off-farm income. Non-farm income includes both off-farm wage labor and non-farm self-employment (Reardon. 1997; Escobal 2001).

Diversification into non-farm activities usually implies more diversity in income sources (the first definition), but this is not always the case. For example, if a household increases the share of income from non-farm sources from 30 percent to 75 percent, this represents diversification into non-farm activities but not income diversification in terms of the number and balance of income sources. The share of income coming from non-farm activities often correlates with total income, both across households and across countries. This definition of income diversification is linked to the concept of structural transformation at the national level, defined as the long-term decline in the percentage contribution of the agriculture sector to gross domestic product (GDP) and employment in growing economies. Finally, income diversification can be defined as the process of switching from low value crop production to higher-value crops, livestock, and non-farm activities. "High value crops" are often defined in terms of the value per unit of weight, but it is probably more useful to define them as crops that generate high economic returns per unit of labor or land. This definition focuses on diversification as a source of income growth and a potential means for poverty reduction. Again, diversification from staple crop production into high-value activities often implies greater diversity in crops and income sources, but this is not always the case. For example, if a mixed grain-and-poultry farmer decides to specialize in poultry production, this would represent diversification into a high-value activity, but not diversification in the sense of multiple activities. This paper used the first definition of income diversification i.e. income from different sources

as a definition of income diversification which is the first definition of income diversification (Joshi .et al., 2002; Ersado, 2000).

2.1.1.2. Approaches of Diversification Analysis

There are different approaches for diversification analysis i.e. asset based approach, activity based approach and income based approach. The selection of an object for diversification analysis is discussed in a relatively detailed manner by Barrett and Reardon (2001). Assets are factors that directly or indirectly generate cash or in-kind returns. In portfolio theory, on which the diversification literature is based, assets are emphasized as objects of agent's choice for the sake of income maximization, risk (reducing income variability) minimization or both. Accordingly, assets can be chosen as an object of diversification analysis and a number of authors have used assets to characterize and study diversification. However, Barrett and Reardon (2001) also point out two disadvantages when using assets to approach diversification. First, a productive asset cannot always be allocated to a particular activity instead of being used across activities, so it is relatively hard to sum up assets in a single activity. Second, calculating the true value of some assets is difficult due to insufficient development of asset markets in developing countries. Consequently, it is argued that in order to study asset diversification, assets must be treated as a vector of physical quantities rather than a single, money-metric aggregate (Barrett and Reardon 2001). This is, in turn, unable to fully capture patterns of diversification of households across all income-generating and unearned income options.

As an alternative, activity can be used to study diversification but it also has some drawbacks, according to Barrett and Reardon (2001). First, although we can identify

which assets are used in each activity, they cannot be fully valued as mentioned above. Therefore, as in the case of assets, activities cannot be aggregated in a single money-metric aggregate and hence cannot be used to examine diversification patterns. Second, if based on activities, unearned income sources are completely ignored. This may lead to an incomplete understanding of the relationship between diversification and poverty reduction. However, if researchers purposively ignore unearned income sources and define diversification as participation in income-generating activities, activity diversification can be adopted as a suitable measure. Thus time allocated to, or income earned from each activity may be used to analyze diversification. Unfortunately, another weak point is that reported employment share of nonfarm activities is believed to be understated (Lanjouw and Feder, 2001). Because non-farm activities are widely recognized to provide supplementary work during slack periods of the agricultural cycle, real working time allocated to those activities is often unintentionally added to the total account of agricultural employment—the primary source of income of farmers. This, thus, causes an underestimate of the actual proportion of labor time that is devoted to non-farm activities (Barrett and Reardon 2001).

Given the shortcomings of the asset and activity based approaches, income has often been used in empirical work on diversification. Using income may offer several advantages. First, since the two main motives of diversification are maximization of income and stabilization of income, or both, discussing diversification in terms of income diversification appears to be a natural candidate (Ellis 2000, Barrett et al. 2001).Second, income is the end outcome of income-generating activities, to which both productive and non-productive assets are allocated, and of unearned income options, for example

transfers, as well. It is also easier to convert in-kind payments into a money-metric due to higher development of goods market compared with asset market (Barrett and Reardon 2001). Third, income is closely related to the concept of absolute poverty as it is more or less used to define the poverty line and measure household wealth. Due to these reasons it seems that, defining diversification in terms of income may be the most suitable approach (for a review of various empirical studies that used income approach,) .As a result of this, paper use income based approach for analysis of income diversification.

2.1.1.3. Reason for Income Diversifications

According to the literature, rural households have various motives for diversifying their income sources and generation patterns instead of concentrating on agriculture with its potential gains from specialization. Barrett et al. (2001a) concluded from several studies that diversification to non-farm activities could be induced by diminishing or time-varying returns on agricultural labor or on land, market failures, or the need to introduce risk management or coping mechanisms.

Ellis (1998) listed the following reasons for income diversification: the seasonal use of labor, differentiated labor markets, household-risk strategies and coping behavior, credit-market imperfections, and household savings and investment strategies. Non-farm income can thus help in overcoming credit and insurance problems. It could also provide income-earning opportunities outside the growing season, employ the household's extra labor, help in managing weather and other risks, and ensure smoother consumption throughout the year**.**

The causes of diversification could be categorized in terms of push factors, such as environmental risks and falling income, and pull factors, such as changing terms of trade

or perceptions of improved opportunities (Hussein and Nelson, 1998). Gordon and Craig (2001) found that push factors such as external shocks could lead to large numbers of people being drawn into poorly remunerated low-entry-barrier activities, while the pull effect is likely to offer a route to improved wealth status through better-paid non-farm activities. In the absence of credit and insurance markets, the rural poor have to find other ways of spreading their consumption, and for many of them income diversification is a potential option (Barrett et al. 2001a).

2.1.1.4. Impact of Income Diversification

Income diversification has both positive and negative impacts on farm households. Reardon et al .(1998), there is a little controversy short run effect of income diversification on food access and the long run effect of income diversification on food security. Short run effect of income diversification on food access described as the households cops with drought and other harvest shortfall by, among other things, working off-farm and raising the cash to fill the food deficit. However, the controversy comes from the long run effect of income diversification on food security status of households. Working in off-farm activity may reduce the availibity of food and eventually leads to food insecurity.

In the study, the researcher recognizes that by its very nature, income diversification provides households the opportunity to increase incomes, reduce risks associated with climate dependent agriculture and consequently food security. However, as noted by Ellis (1999) diversification has both positive and negative impacts on households' way of life. These are explained below.

Positive Impacts

- **Seasonality**: which causes peaks and troughs in labor utilization on the farm may lead to food insecurity due to the mismatch between farm income streams and continuous consumption requirements. Diversification can contribute to reducing the adverse effects, by utilizing labor and generating alternative sources of income in off-peak periods. It would be misleading to see the growth in rural nonfarm income in isolation from agriculture as both form part of complex livelihood strategies adopted by rural households (Carletto et al., 2007). Such activities may serve as a consumption smoothing or risk insurance mechanism, particularly when the returns to these activities are not highly-correlated with agricultural returns, and may also absorb excess labor during agricultural off-peak periods.
- **Risk reduction**: Diversification enables spreading of risk across different activities whereby factors that create risk for one income source are not the same as those that create risk for another.
- **Higher income:** Diversification promotes making better use of available resources and skills (as in seasonality above), and taking advantage of spatially dispersed income earning opportunities.
- **Asset improvement:** Cash resources obtained from diversification may be used to invest in or improve the quality of household assets.
- **Environmental benefits**: Diversification can potentially provide environmental benefits by providing options that make time spent in exploiting natural resources.
- **Gender benefits:** Where activities are equally or better accessed by women, it is possible for diversification to improve the independent income-generating

capabilities of women and in so doing, also improve the care and nutritional status of children.

Negative impacts

- **Income distribution**: Diversification can be associated with widening disparities between the incomes of the rural poor and the better-off. This occurs if the better-off are able to diversify in more advantageous labor markets than the poor.
- **Farm output:** Some types of diversification may result in stagnation on the home farm especially when there is lucrative distant labor markets for male labor, resulting in depletion of the labor force required to undertake peak farm production.
- **Adverse gender effects**: Where it is male labor that is predominantly able to take advantage of diversification opportunities, then women may be even more relegated to the domestic sphere and subsistence food production. Baiphethi et al., (2009) suggests that "one of the major impacts of livelihood diversification is feminization of agriculture, as men frequently pursue migratory labor opportunities." Consequently, women remain home to tend to home gardens and other agricultural tasks to ensure food production for the household. The empowerment of women may yield positive results as women are more likely to invest the additional income in children and family (Ellis, 1999).

The above positive and negative impacts of diversification do not downplay the potential of diversification to increase incomes and consequently food security especially among farming communities.

2.1.1.5. Measurement of Income Diversification

Most studies use either unvariat or multivariate regression models to estimate the determinants of diversification with mainly income diversification as the dependent variable and is regressed against a set of explanatory variables. The extent of household livelihood diversification in the literature is commonly quantified using income diversification. The most common measure of income diversification used in several studies is income using the vector of income shares associated with different income sources (e.g. Barrett et al. 2001; Lay et al. 2008; Escobal 2001; Idowu et al. 2011,).Other studies use an alternative measure of the extent of diversification; the Herfindahl Hirshman index, equal to the sum of the shares across each possible income source (Barrett et al.2001; Barrett and Reardon 2000). The index measures the number of income sources or the level of income diversification. Value of one indicates complete dependence on a single income source while a value of 1/k represents perfectly equal earnings across income sources, where there are k different income source categories analyzed (Barrett et al. 2001).This index measures the degree of concentration of Household income into various sources; and it thus measures the level of income diversification.

Income diversification as prevalence of different income sources in household income at a given time (Reardon et al, 1992; Dunn, 1997; Valdivia et al, 1996; woldehanna, 2000). However these studies differ in measurement of income diversity and categorization of income sources. Some of them use share of non-farm income in total income while others measure income diversity by Simpson's index or Herfindhal diversification index. These differences in measurements of income diversity may be the sources for some

contradicting results with respect to consequences of income diversification. Like Dunn (1997) and Valdivia et al (1996), this study use of Herfindahl income diversification index to measure income diversification.

2.1.1.6. Classification of Household Income Sources

In the literature there has been a wide range of different systems in classifying sources of income. Following income classification proposed by (Benjamin, et.el.2013) in world development report, we classified income generating activities in Ethiopia as agricultural and off-farm income source as a major source of income. Agricultural activities[1]is further divided into agricultural crops and livestock while off- farm activities is sub-divided in to agricultural wage employment, non -agricultural wage employment, non-farm self-employment , other non-labor income(remittance, transfer) generating activities. From this we can group income agricultural wage employment and non-agricultural wage employment as wage income[2]

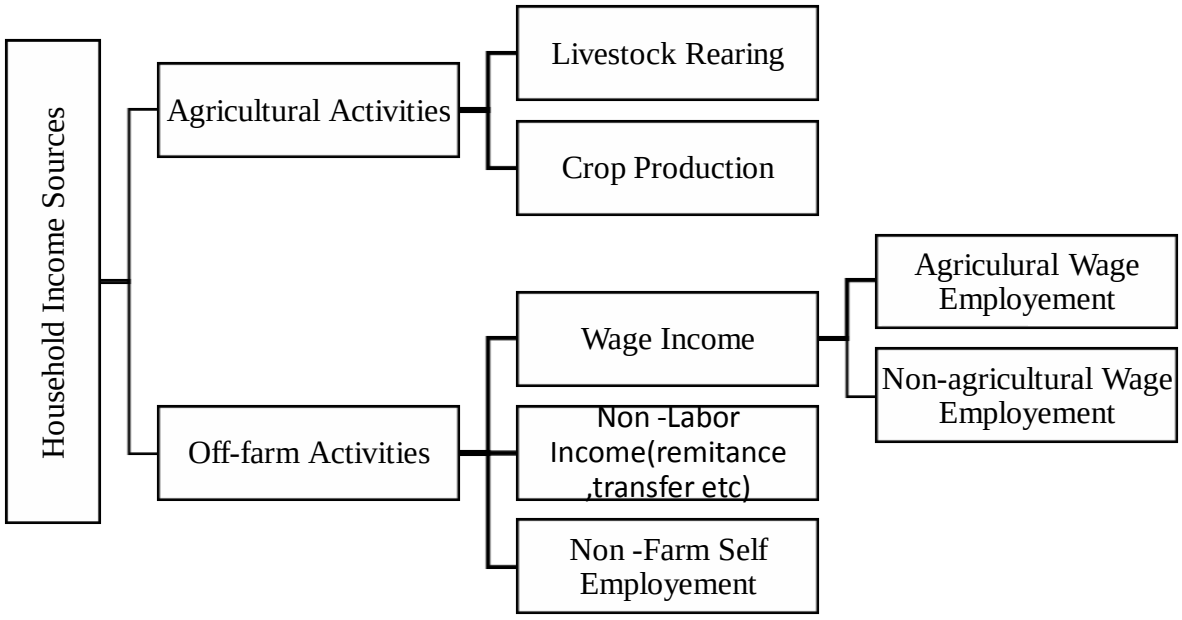
Agricultural activities consist of crop and livestock related activities which are carried out on "household-run farms". Off -farm activates refers to activities other than those related to crops and livestock production that takes place away from household-run farms. Agricultural wage employment refers to agricultural related activities which involve the supply of paid labor on farms other than those owned by household members or working in on other household-farm for payment of wage. Non-agricultural wage employment encompasses a wide range of work for wages and covers employment in public administration, in large corporations, small manufacturing factories, those working in

[1] *Agricultural income may include food crops, cash crops or livestock, and output may be sold to market, retained for home consumption(by using conversion factor exist during the year of survey), or both*
[2]*Since there is a very small number of observations income generated from non-farm wage-employment, agricultural wage- employment, all of them treated as one income as wage income sources for households*

construction and transportation and professionals in various sciences, education and training. Non -farm self-employment includes processing of any kind of goods for sale whose input materials can be either home-produced agricultural commodities or bought from markets. It also includes the provision of agricultural services which are provided on farms not run by the household.

The main sources of non-labor income for households are donation /aid, gift, remittance, compensation, inheritance and other transfers. Generally classifications of household source of income are explained by the following diagram.

Figure 2.1. Classification of Household Income Sources



2.2.2 Food Security: Dimensions and Measurements

2.2.2.1 Food Security and its Dimensions

Food security is a concept that has evolved considerably over time and there is much literature on the potential ho household food security dimensions. According to Hoddinott (1999) there are 200 definitions and 450 indicators of food security.

There are many definitions of household food security that have been proposed, but (Maxwell and Frankenberg, 1992:8,sited by Ncube,2010) suggest that they "all agree that the key defining characteristic of household food security is secure access at all times to sufficient food". For example, the World Bank defines food security as secure access by all people healthy food for an active life. The 1996 World Food Summit also summarized food security as a situation "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 lifestyle" (FAO, 2001).

The term food security has been defined and used in multitude ways over the decades though in 1970.Food security was used with reference to aggregate food production or food availability, often at national and global label. The work of sens(1981) drew attention to the critical importance of access to food, particularly at household and at individual level, as distinct from food availability. Latter a further crucial component of was recognized: individual's ability to utilize the food to which they had access: hence food availability, access, utilization and sustainability are the four general usually mentioned in the definitions of food security today.

There are four dimensions of foods security.

2.2.2.2 Food Availability

This is a concept that explains the quantity of food the households/ regions/nations have at a point in time. It is a function of local food production, food importation, food aid, and other demand and supply factors in food production. Food availability may be constrained by inappropriate agricultural knowledge, technology, policies, inadequate agricultural inputs, family size, etc (Yared 2001, Hoddinott 1995).

2.2.2.3. Food Accessibility

Food accessibility is the ability of the nation, region, household or individual to gain access to the available food. This is thus predominantly a demand issue in food security. The factors that determine this access could be economic in nature or not. In the economic aspect is the purchasing power of the household to acquire the food needed for its nutritional need. This purchasing power issue is embedded in this dimension. However, exchange can also play a vital role in the accessibility of food by the household.

It is clear that the sources of food for a household are different, households typically whether: (a) grow it and consume from their own stocks; (b) purchase it in the marketplace; (c) receive it as a transfer from relatives, members of the community, the government, or foreign donors; or (d) gather it in the wild.

2.2.2.4. Food Utilization

Food utilization: is the concept that determines the quality of food that meets the nutritional requirement for the household. The importance of this is that quantity of food does not necessarily lead to well-nourished households

2.2.2.5 Stability of Access

Stability of access has to do with the ability of the household to have continuous access to the food source, with minimal risks. There are different risks that affect the supply and demand for food, and it is the ability of the group being studied to withstand the shocks that come to play to determine the security/stability of access to the food needed. Shocks arise in form of drought, loss of jobs, death, and loss of productive resources such as land, illnesses and conflicts. Households have different coping strategies to the advent of shocks, usually in the form of diversification of income sources. However, continuous shocks may lead to chronic food insecurity if rural households do not have enough resources to prevent long term risk to replace assets lost in the event of former risks.

The most commonly used indicators which used to measure household food securities are availability, food access and utilization indicators.

Generally according to sen's(1981) food insecurity is not because of there is no enough food, but because people do not have accesses food. Of course, the availability of food near to the household is a prerequisite of food security. Availability is influenced by factors such as a community's proximity to centers of production and supply, or by market forces, restrictions on trade and international policies that affect food supplies. Whereas food accessibility affected by the livelihood sources or exchange entitlement of the household which inculcates production based entitlement (crops and livestock), own-labor entitlement (wage labor and professions), trade based entitlement and transfer entitlements. In this study, the researcher concerned with a sharper focus on the only first two components of food security to generate food security index.

2.2.3 Approaches to Measure Food Security

The most frequently cited definition of food security is still the one that was proposed almost two decades ago by the World Bank (1986: 1), which defines food security as 'access by all people at all times to sufficient food for an active and healthy life'. The operationalization of this concept presents many challenges. Measurements and assessment methodologies and methods can differ considerably, even within the boundaries of the qualitative and quantitative traditions. Food security, as with poverty, is a cross-cutting, complex and multifaceted phenomenon.

The food security literature spans a wide range of disciplines, including anthropology, nutrition, sociology, economics, geography, public health, and epidemiology (Chung et al. 1997). Conceptually, food security is generally broken down into four different components availability, access, utilization, and vulnerability—each capturing different, but overlapping, dimensions of the phenomenon. There is a consensus that no single indicator can capture all aspects of food security while also providing policymakers with relevant and timely information in a cost-effective manner. Following FAO (2003a), the researcher identifies four general types of methods/ indicators variables. The first indicator can be labeled undernourishment, a measure commonly identified with the Food and Agriculture Organization of the United Nations (FAO). This FAO method begins with an estimate of the per M. Migotto, B. Davis, C. Carletto, and K. Beegle capita dietary food energy supply, derived from aggregate food supply data. Assumptions regarding the distribution of this supply across households are made on the basis of income or consumption distribution, or other available data. The proportion of the undernourished in the total population is then defined as that part of the distribution lying

below a minimum energy requirement level (Naiken, 2003). The FAO measure is useful for comparisons across countries and over time.

A second group of indicators, which can be termed food intake, measures the amount of food actually consumed at the individual or household level. Indicators at the individual level can be obtained directly by measuring actual food intake through a number of techniques. Food intake surveys, however, are relatively rare, given its cost considerations. Instead, food consumption is usually measured indirectly through household surveys. Household surveys in general, and multipurpose household surveys in particular, are aimed at assessing living standards, not just food security. Although they are time-, resource-, and skill-intensive, they are now regularly implemented in many countries. Household-level data can be used to construct a number of measures of food insecurity, including food energy deficiency and poor diet quality and diversity.

The third approach to the assessment of dietary deficiencies is to measure food utilization through nutritional status. Anthropometric measures of children under age five are regularly collected in random sample surveys in many countries. Anthropometric measures, as outcome measures, are well suited for monitoring and evaluating interventions, and can be collected with socioeconomic information in order to analyses the determinants of malnutrition. Anthropometric attainment, however, is a non-specific indicator, because it is the result not only of food intake, but also of factors such as sanitation, health and childcare practices. Since nutritional status is an individual-level indicator, it has distinct advantages. For example, it does not mask food insecurity in seemingly food secure households when intra-household allocation rules result in unequal distribution of food resources. This is a problem for both objective and subjective

measures, where, for example, one household member responds (e.g. the head) perhaps on basis his/her response on his/her own situation. However, as nutritional status is only available for young children, it has limited power in describing food security for the broad population.

Fourth, food availability is of little use if households or individuals do not have enough financial or productive resources to acquire food. The fourth group of indicators revolves around the concept of access to food and can be proxid by wealth status, measured by total food consumption, expenditures. Access-to-food indicators, and in particular income, have served as the main food security indicator in many countries.

For the purpose of this study the researcher tried to develop a relatively suitable measure of food security which encompasses its availability and accessibility components in the context of rural Ethiopian households and thereby make a contribution to the improvement of food security measurement.

To generate food security index a multivariate statistical technique known as Principal Components Analysis (PCA) is employed. According to Keho(2012) Principal component analysis is a variable reduction procedure. It is useful when obtained data on a number of variables (possibly a large number of variables), and believe that there is some redundancy in those variables. In this case, redundancy means that some of the variables are correlated with one another, possibly because they are measuring the same construct. Because of this redundancy, you believe that it should be possible to reduce the observed variables into a smaller number of principal components (artificial variables) that account for most of the variance in the observed variables. In addition to this PCA is necessary when you have data on a large number of quantitative variables and wish to collapse

them into a smaller number of artificial variables that account for most of the variance in the data. In our case it PCA play an indispensable role to generate food security index from different food security indicators.

In principal component analysis the number of components extracted is equal to the number of variables being analyzed. This means that an analysis of our 5 variables would actually result in 5 components. However, since PCA aims at reducing dimensionality, only the first few components is important enough to be retained for interpretation and used to present the data. It is therefore reasonable to wonder how many independent components are necessary to best describe the data. Eigenvalues are thought of as quantitative assessment of how much a component represents the data. The higher the eigenvalues of a component, the more representative it is of the data.Eigenvalues are therefore used to determine the meaningfulness of components. Several criteria have been proposed for determining how many meaningful components should be retained for interpretation. i.e. .the Kaiser eigenvalue-one criterion, the Cattell Scree test, and the cumulative percent of variance accounted for (Steven , 2008).

The first criterion for determining to retain components for interpretation is **Kaiser Method**. The Kaiser (1960) method provides a handy rule of thumb that can be used to retain meaningful components. This rule suggests keeping only components with eigenvalues greater than 1. This method is also known as the eigenvalue-one criterion. The rationale for this criterion is straightforward. Each observed variable contributes one unit of variance to the total variance in the data set. Any component that displays an eigenvalue greater than 1 is accounts for a greater amount of variance than does any single variable.

The **scree test** is another device for determining the appropriate number of components to retain. First, it graphs the eigenvalues against the component number. As eigenvalues are constrained to decrease monotonically from the first principal component to the last, the scree plot shows the decreasing rate at which variance is explained by additional principal components. To choose the number of meaningful components, we next look at the scree plot and stop at the point it begins to level off (Cattell, 1966; Horn, 1965). The components that appear before the "break" are assumed to be meaningful and are retained for interpretation; those appearing after the break are assumed to be unimportant and are not retained. Between the components before and after the break lies scree

Cumulative percent of total variance: When determining the number of meaningful components, remember that the subspace of components retained must account for a reasonable amount of variance in the data. It is usually typical to express the eigenvalues as a percentage of the total. The fraction of an eigenvalue out of the sum of all eigenvalues represents the amount of variance accounted by the corresponding principal component (Moser c et al, 2007).

2.3 Linkages between Agriculture, Off-Farm Activities and Food Security

According to the agricultural household model, available capital is one of the constraints affecting production decisions. An important economic question concerns, whether the rising income from agricultural production drives the growth of rural non-farm activities, or whether the increasing income from such activities induces agricultural growth through improved investment opportunities. Evans and Ngau (1991) argue that off -farm income serves as insurance against agricultural risks, and enables households to adopt new production technologies and to increase productivity.

Reardon et al. (1994) discovered two sets of variables that affect the decision of whether or not to invest non-farm income in farming. The first concerns the nature of the existing capital market: if rural credit markets function poorly, off -farm income becomes a substitute for borrowed capital for investments. Secondly, it depends on the characteristics of such income, such as its timing and nature in comparison to the needs of agricultural production, and also on the household's internal dynamics in terms of distribution and the control of funds. However, some scholars claim that diversification may also have long-term negative effects because poor farmers who engage in non-farm activities do so in order to survive, not to improve the sustainability of their livelihoods or to invest in production (Hussein and Nelson 1998). They see diversification more as an involuntary coping strategy than a strategic choice related to wealth accumulation. Poor households and low-potential areas often lack access to poverty-alleviating better-paying non-farm employment, and poor people are therefore involved in unstable, low-wage, low-productivity and low-growth off farm activities.

Thus, the evidence concerning the long-term impact of non-farm income on poverty is inconclusive. However, the short-term effects on food security are clearer: RNF income enables households to purchase food during a poor harvest and also serves as a source of saving and of accumulation of assets usable for food during difficult times (Gordon and Craig 2001). On the other hand, when food security is assured people have potential to demand services and goods produced by the RNF sector. Non-farm income may also reduce the need to sell household assets following shocks affecting production, such as droughts and floods. Reardon et al. (1998) claim that non-farm income is potentially particularly important for long-term food security in Africa because it may broaden smallholders' access to farm inputs, and consequently increase productivity and intensify production.

2.4. Empirical Literature Reviews

2.4.1 Determinants of Household Income Diversification

The level and the type of income diversification depend on the accessibility and availability of different income sources and the type risk households are responding to, which may in turn depend on household's geographic location, access to factor and labor markets, human and social capital, and recurring policy changes. Empirical studies show that educational attainment and infrastructure access are strong determinants of diversification (Barrett, et al., 2001a, 2001b; Block and Webb, 2001).

According to Reardon (1997), agro-climatic zone-related factors, the infrastructure and distance from the markets have an impact on earnings from the non-farm sector because increasing population density lowers transaction costs and raises demand for non-farm products. On the other hand, it has been found that competition is tougher between urban products and locally manufactured products near urban areas, which could lead to the displacement of labor-intensive rural manufacturing activities, such as basket making, beer brewing, weaving and pottery (Haggblade et al. 2002). On the household level, Reardon (1997) considered land area, family size and structure, education, and access to capital and labor the most significant determinants of diversification. There is evidence that the initial endowment of resources that creates differences in the capacity to diversify and enter the non-farm labor market may continue to affect household and gender differentiation over time, and could thus lead to unequal distributional results.

Social capital in the form of networks, memberships, and family and gender relations is also recognized as a determinant of diversification according to Ellis (2000) and Davis (2003). These networks may, for example, improve access to market information. The

capacity and potential for diversification also appear to differ between men and women. Women, who are usually responsible for day-to-day household chores, often combine income-generating activities with these tasks. Beer brewing, oil pressing, small trading activities, pottery making and selling food are typical income-earning activities undertaken by women in Sub-Saharan Africa and normally require only a little start-up capital. Women often have limited access to education, which combined with their household responsibilities means that they are more involved in informal rather than formal employment (Haggblade et al. 2002). The critical issue in terms of diversification may not be gender as such, "but rather who lacks the assets and mobility to undertake poverty-alleviating, non-refuge rural nonfarm activities"

Sarah (2012) investigated the determinants of income diversification using data on rural farm households from two Sub-Saharan African countries; Senegal and Kenya. The finds that factors linked to education, market access and agricultural potential are important in determining the level of income diversification. Specifically the study revealed that completing secondary education, completing university education, access to market for farm products, farm characteristics' (farm size and availability of irrigation a) and access to farm capital (availability of animal ploughs).

Studies by Janvry et al. (1991) and Kinsley et al. (1998) indicate that income diversification is not only positively correlated with wealth but also with an increased ability to cope with shocks, or in other words, diversification reduces livelihood vulnerability. Diversification is a way rural households insure themselves against the occurrence of such shocks.

Damite (2006) examine the determinant and the impact of income diversification in Ethiopia the case communities in southern nation, nationalities peoples of the regional state. To analyses the determinants of household's level of income diversity, multinomial logit model that corrects selection bias was estimated for five distinct livelihood strategies. The effects of income diversification on rural equity and consumption insurance against idiosyncratic income shock were analyzed using Gini decomposition technique and linear regression model, respectively. The results indicated that, the asset endowment of the household has a significant effect on households' the level of income diversity. Empirical evidences revealed that farm land holding, distant to market, involvement in cash crop production, ox holding, use of agricultural extension and possession of senior secondary education by head lower the likelihood of involvement in livelihood diversification.

Lemi (2006) analyzed the dynamics of income diversification in Ethiopia by using 1994 and 1997 ERHS panel data. The results show that participation in off-farm activities is mainly driven by demographic factors, whereas land and other asset ownership as well as crop production and income affect intensity of off-farm activities. The dynamic model results show that farm families who have initially diversified to more off-farm activities subsequently realized less income diversification. Families with more initial crop production from slack harvest season subsequently realized greater income from off-farm activities in 1997. The study also confirms that it is only during slack harvest season that off-farm and on-farm activities are complement each other.

2.4.2 Effect of Income Diversification on Food Security

Income diversification affects consumption stability and the overall welfare of households. Oyewole (2012) conducted study on the analysis income diversification strategies and food security stratus of Farmers in Oyo State of Nigeria. The determinants of income diversification in the study area were education, household size, credit and extension contact. These variables were positively related to income diversification. Furthermore, income diversification has significant effect on food security. The estimated coefficient of income diversification was positive and significant at 5 percent level of probability which implied that as income diversification increases, food security status of the farmers also increases.

Agbola et al.(2008) studied on the effect of Income Diversification Strategies on food Insecurity Status of Farming Households in Africa in case Nigeria. The result of the study shows that, income diversification strategies are fruits, vegetables and sold farm labor to supplement cash income and to reduce household food insecurity. Households that combined enterprises were better off and able to meet their capital expenditure. Livestock were sold in times of emergencies such as sickness and for children education. Annual food and cash crops were use to meet daily food and cash requirements. Promising routes out of extreme food insecurity include adding enterprises to a farm, or diversifying into non-farm or wage employment**.**

Zeraia and Gebreegziabher(2011) studied on the effect of non-farm income on food security by using Hickman two stage methodologies in eastern Tigray region. The result indicates that non-farm employment provides additional income that enables farmers to spend more on their basic needs include food, education, closing and health care. This

implies that that non-farm employment has a significant in maintaining household food security.

According to Degefa (2005) households that lead sustainable livelihood often feel food secure throughout the year realigning crop cultivation and/or livestock rising or through running own non-farm ventures or to work with somebody else. As he further explains, a household is food insecure when it is incapable of sufficiently feed its household members from its own production or purchase from the market in return to own cash, which may be earned from the exchange of self-endowment.

Arising from the above reviewed literature, this study will provide value addition to the literature on link between food security in terms of food availability and food access and income diversification in rural household of Ethiopia which other reviewed studies in Ethiopia have failed to provide.

Chapter Three

Research Methodology and Model Specification

3.1. Sources of Data

The data source for this study is Ethiopian Rural Household Survey conducted by the school of Economics, Addis Ababa University in collaboration with the International Food Policy Research Institute, the Center for the Study of African Economies and university of Oxford, the International Food Policy Research Institute (EFPRI) the Swedish International Development Agency (SIDA) and the United States Agency for International Development (USAID). For the current study the fifth, sixth and seventh rounds of the ERHS data were used, which were conducted in 1999, 2004 and 2009, respectively. The survey was made based on qualitative and quantitative fieldwork, secondary sources, and interviews with key informants in each survey area and community level questionnaires (Sepahvand, 2009). The survey covers four regions(Tigray, Amhara Oromia and Southern nation nationalities and peoples representative). However pastoral areas were not included in the survey (due to constant mobility and difficulty of accessing them), hence cannot be considered as fully representative of the entire rural Ethiopia.

3.2 Method of Analysis

Basically the analysis and presentation of the study used both descriptive and econometrics method of analysis. In the first part, the researcher employed descriptive statistics (percentages, ratios, means, and standard deviations) by using tables to asses' income diversification in rural Ethiopia, characteristics of the household and the link between household income diversification, demographic and socio economic variables. These is analyzed and described quantitatively by making use of STATA software-12 version.

In the second part econometric issues, more specifically, either fixed effect or random effect model, this is identified by using Hausman specification test. Variables, which play significant roles for the household income diversification and the impact of household income diversification on food security status analyzed through either of this model by making use of econometric issues.

3.3 Measurements of Income Diversification and Food Security

Definitions and measures of household income diversification (HID) vary within the literature. Some studies measure it as the proportion of income derived from off-farm sources (Reardon et al. 1992; Davis et al., 2010), while others use several different types of income portfolios (e.g. one source of income get a value of one(farming), two sources of income will get the value of two (farm and non-farm activities) and so on. (Dimova and Sen., 2010) note that the use of such measures is problematic because the income diversification variable is sensitive to assumptions about the income thresholds used to assign households to different income categories. Further, it is unclear whether household

that generates, for example, 90 percent of its income from farming is seen as being more diversified than a household, which relies exclusively on farming. In addition to this, this measure unable to take in to account heterogeneity among different non-farm income sources.

To address this concern, following (Dimova and Sen., 2010) Herfindahl diversification index is employed. Herfindahl index constructed as the sum of squares of the shares of different income portfolios in the household is employed: the smaller the index value, the higher the degree of income diversification. This measure is more appropriate than the above measures because it does not need additional assumptions for grouping households into different income diversification categories (Dimova and Sen., 2010; Ellis, 2000b).In addition, this measure show the extent of income diversification of households and takes into account the number of income sources and the income share derived from each source. The formula for Herfindahl index and Herfindahl Diversification Index is given below:

$$HI = \sum_{i=1}^{N} P_i^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

$$HDI = 1 - \sum_{i=1}^{N} P_i^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

Where HI = Herfindahl index

N=number of income source that households engaged

HDI=household diversification index

Pi =the proportion of the i^{th} (=5 in this case) sources of income.

HI is a measure of concentration of diversification. For increasing diversification, “HI” is decreasing. “0” bound it (complete diversification) to “1” (complete specialization).But

here we are interested on diversification, which the reverse of concentration "HDI" is increasing for increasing diversification. The value Herfindahl diversification index increases with the number of different income sources and approaches one if the number of income sources becomes very large (Minot et al, 2006).For the purpose of determining HI, we took in to account different five specific income sources: livestock rearing, agricultural crop, non -farm self-employment, non-agricultural wage employment + agricultural wage employment which together were considered as wage income for the households and non –labor income (income from remittance, transfer etc).

The most commonly used indicators, which used to measure household food securities are availability, food access (food entitlement) and utilization and sustainability indicators. Thus, it is possible to say that, there are no single and one best food security measure that is universally accepted. It is up to the researcher to select an indicator or a combination of indicators that suits objective of the study, the level of aggregation and specific circumstances of the study, study area and the food security definition that the researcher defined. Food security is the complex concept and cannot be able to capture by using a single indicator. Therefore, for the purpose of this study, the researcher employed the combination of the first two indicators .i.e. Availability, and accessibility indicator of food security. Due to limitation data in round five (1999) that indicate food utilization aspect of food security indicator, we are constrain to relay only on food availability and food accessibility indicators of food security. To develop food security index, following (Birhanu et.al, 2009) the researcher employed multivariate analysis which is known as principal component analysis (PCA).

As explained earlier in the approaches to measure food security, PCA linearly transforms the indicator variables of food security into smaller components which account for most of the information contained in the original indicators. The selection of the food security indicator is based on the data availability and based on different literature about food security in Ethiopia Birhanu et.al, (2009) Haddad et al. (1994),Hoddinott and Yohannes(2002), Hoddinott (1999), Smith and Subandoro (2007), Alene and Manyong (2006), Qureshi (2007). Here five indicator variables were used to construct food security index i.e. the number of oxen owned by the households, weather the household stored crops, participation of off-farm activates, size of land under cultivation, per capita food consumption per day in the households. They reflect the access and the availability dimensions of food security.

Regarding the measurements of indicator variables cultivated size of land measured in hectare. The availability of stored crops measured by using dummy variable, household were asked if they had any stored crops for future use and a value of one was assigned if the households had stored crops and zero if not. Similarly, off- farm participation of households also measured by dummy variables takes the value of one if one of household members participates in off-farm activities and zero otherwise. To compute per capita food consumption, first the total amount of food consumed from different sources are changed in to value by using the price of the commodities, then the figure is changed in to monthly amount by multiplying weekly food consumption 4.28. Then the amount is divided household size to get the per capita food consumption. Finally, we have per capita food consumption per day by dividing per capita food consumption per month by 30(days). Oxen owned by households were measured by numbers.

Indicator variables were used as a proxy for agricultural output and thereby access to food. A household's access to food depends on availability of sufficient land and other productive resources to grow its own food. As the cultivated land size increases, the possibility that the household gets more output is high as it remains the basic capital input in food production. Therefore, those households with large cultivated land are less likely to be food insecure and vice versa.

Given households crops with a drought or other harvest shortfalls by among any other reason and during lean season, participate in off -farm activity would raise the cash to the food deficit (Barret, 2000). Households in rural communities commonly store crops for future use in case shortage prevails. Hence, availability of stored crops can show the capability of a household to cope with unexpected food crisis.

From initial set of correlated variables, PCA creates uncorrelated indices or components, where each component is a linear weighted combination of the initial variables (Vyas and Kumaranayake, 2006). For example, from a set of variables X_1 through to X_n.

$$PC_1 = a_{11}X_1 + a_{12}X_2 + \cdots a_{1n}X_n$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{3.3})$$

$$PC_m = a_{m1}X_1 + a_{m2}X_2 + \cdots a_{mn}X_n$$

Where a^{mn} represents the weight for the m^{th} principal component and the n^{th} variable. The variance (∂) for each principal component is given by the eigenvalue of the correspo nding eigenvector. The components are ordered, so that the first component (PC1) explains the largest possible amount of variation in the original data, subject to the constraint that the sum of the squared weights ($a_{11}^2+a_{12}^2+\ldots..a_{1n}^2$) is equal to one. As the

sum of the eigenvalues equals the number of variables in the initial data set, the proportion of the total variation in the original data set accounted by each principal component is given by ∂/n. The second component (PC2) is completely uncorrelated with the first component, and explains additional but less variation than the first component, subject to the same constraint. Subsequent components are uncorrelated with previous components; therefore, each component captures an additional dimension in the data, while explaining smaller and smaller proportions of the variation of the original variables. The higher the degree of correlation among the original variables in the data, the fewer components required to capture common information (Vyas and Kumaranayake, 2006).

Once the first component is identified, we can derive the food security index for each household as follows:

$$FSI_j = \sum W_i\left[(X_{ji} - X_i)/S_i\right] \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (3.4)$$

Where W_i is the weight for the i^{th} variable in the PCA model, X^{ji} is the j^{th} household's value for the i^{th} variable, and X_i and S_i are the mean and standard deviations of the i^{th} variable for overall households.

To estimate principal components the data for the three rounds was pooled together and estimated the principal Components over the combined data, then multiplied the resulting weight by the deviation of the original variable from its mean divided by its standard deviation in order to get food security index. According to Cavatassi et al. (2004) this approach helps to facilitate the index's comparability over time. Variables used to construct the index and their respective weights remained the same in all the three rounds, we can use it to compare changes over time (Vyas and Kumaranayake 2006).

3.4 Theoretical Framework and Model Specification

3.4.1 Theoretical Framework

The household must decide on type, quantity, and intensity of activities in which it participates, given its asset endowment and other exogenous conditions. The household decision process is based on two types of agricultural household models. The first one is unitary ("Benevolent Dictator" model) which uses household a unit of analysis as though it is an individual. Proponents of unitary household model assume that a household's decision process is the result of maximization of a single household utility subject to various household level constraints on production, income and time. The unitary household model includes separable (recursive) and non-separable agricultural household models. The use of unitary household model has both advantages and disadvantages. The first advantage is that it fits exactly into the familiar consumer choice framework. Another advantage is its flexibility to examine a wide variety of issues. However, there are criticisms forwarded to this type model. The first criticism is that it contradicts the basic rule of neo-classical microeconomic analysis that every individual has to be characterized by his/her own preference. The second problem is that it ignores the intra-household inequality and internal decision process (Aldermen et al, 1995, cited in Damitie, 2004).

The second household model is collective household model, which treats individual as a unit of decision-making. Proponents of collective household models relax the assumptions of unitary model and argue that individual member's utility maximizatio n can result into Pareto-optimal allocation of resource in the household (Alederman et

al.1995; Doss 1996, cited in Damite, 2003). But empirically it needs considerable amount of data on individual household members.

According to Woldehanna (2000) it is difficult and costly to collect accurate information on distribution and ownership of the assets and resources within households. Therefore, the unitary household models are recommended as the best representative of the household decision process in agrarian rural economies like Ethiopia. It is also because in most cases the income earner is one or two members of households while other members provide supportive services. In this situation it may become unfair to bargain over allocation of the outcome of work (lemi, 2002). In addition, Ellis (1998) argued that, although unitary household models ignore social institution and risk factors, they yield baseline economic proposition that the household will allocate its labor time in such a way that the marginal returns per unit of labor are the same across different activities; whether on farm, off farm or non-farm. Hence, in this study the unitary model used to specify the estimation model.

In rural area, where markets fail or do not exist, households consume what they produce and decision on their labor, production and consumption are made simultaneously. The situation in which households do not separate consumption and production decision is known as non-separable. On the contrary, in separable household model production decisions are entirely independent of consumption decision and labor supply decision. Lopez (1986) calls separable as recursive. Recursive and separable are synonymies and used interchangeably. However, recursive is possible when market exist for goods and for labor. In addition, there must be perfect substitution between homes produced and purchased goods as well as hired labor and family labor. As Lopez (1986) reason out,

recursive model is not applicable. Transaction cost associated with off- farm activities, difference in skill required by on and off farm work or rationing in labor market, absence of market for some goods make recursive model difficult to apply.

In this study, a non-separable agricultural household model is employed which was applied by (Damite, 2003) based on the following reason. First, subsistence agriculture dominates the farming system in which not only majority portion of their production is used for home consumption but also it is characterized by low level production and productivity. Consequently, the amount that goes to market is small. Second, the division of labor within the household is mostly based by social norms, customs and religion in the society. Family labor is the major form of employment. The model is based on the following basic assumptions:

1) The household is considered as a single decision making unit.
2) The household has a well-behaved utility function with arguments being household's consumption of various goods and leisure.
3) Market is assumed imperfect, commodities are heterogeneous and farm Wage, and off farm Wages are not identical. The farm wage is determined endogenously.
4) Land and other capital inputs are assumed fixed.
5) The household allocates its total family time T to a set of productive activities both on farm and off farm as well as home time (leisure).

The household utility function can be specified as (Sadoulet and de Janvry, 1995; Woldehanna, 2000):

$$U = U(C, L_h, H_c) \quad \ldots\ldots (3.5)$$

Where

C is a consumption goods; L_h is home time/Leisure and Hc household characteristics.

1. cash income constraint rural household

$$\sum P_j\left(Q_j + E_j - C_j\right) + \sum P_i\left(Q_n\right) + v - scLn \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.6)$$

Where

E_j = initial stock and

t= tradable

v = non-labor income

sc = transacting cash cost of off-farm work

$Q_{j=}$Agricultural output

Q_n=non-agricultural output

In situations of market failures, the household faces the constraints of balancing the supply and demands of non-tradable commodities. For tradable goods (t) the prices Pm are exogenous effective market prices. For non-tradable, the decision price is the endogenous shadow prices which are determined by equilibrium conditions (De January et al, 1992).The equilibrium condition, for family labor i.e. family labor allocated across activities under time constraint determines the shadow wage (W_s).

2. Agricultural production functions

$$Q_i = q_i(L_i\ H_i, X_i, K_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (3.7)$$

Where

$i = \{f, a\}$, fis crop production and a is livestock

Q_i = agricultural output (for i=f output from crop production and i=a output from livestock)

H_i= hired labor

X_i = variable farm inputs

Crop production is a risky activity and uses land, family labor, and variable farm inputs. Land is assumed given and fixed for a household. Livestock rearing is the most popular productive activity in rural area. This activity offers high returns and requires, in addition to land and labor endowments, a minimum level of capital input for investment in livestock. Household labor allocated to agricultural activities is equal to the sum of family labor supplies to crop production and livestock production.

$$L = L_f + L_a \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.8)$$

Where L_i=total labor allocated to agricultural activities

L_f = labor allocated to crop production

L_a= labor allocated to livestock rearing

3. Non-agricultural production functions

The rural household has also access to off farm activity with low entry constraints and uses only labor input. This activity offers relatively low return and can be considered as less risky than crop production. Given its low returns, risk averse households are expected to engage in this off- farm activity. In addition, households endowed with much labor but relatively little land, given other things constant, apply some of their labor to take up off-farm activity. Access to high return alternative off-farm activities such as skilled wage employment, and lucrative self-employed micro enterprises have high entry constraints. Entry to these activities requires the possession of specialized assets (for example, marketable human capital) or a minimum level of fixed capital input for

investment. Households who fulfill this requirement are likely to allocate part of their labor to this activity.

For non-agricultural activities using only family labor variable input and fixed assets, Production technology has the form:

$Q_n = q_n(L_n, K_n)$ ……. (3.9)

Where Q_n = non-agricultural output

n = {s,r,o}

S=own-business

r=agricultural wage employment

o= off-farm wage employment

In these equations, L_n is measured in unit of family labor time with an opportunity cost w* equal to the marginal productivity of labor in agriculture. p_n is measured in effective units of family labor in the corresponding activity, with a price equal to the hourly income in that activity. Note here that units of effective labor in the different activities receive different remunerations', which are higher than shadow wage in agriculture.

The household may allocate its labor to off-farm work that include own business, wage employment on-farm and non-farm. The existence of entry barrier (for example, lack of specific skill, absence of credit facilities to set up new high return activities) and of transaction costs such as search, commuting and information costs affect household's access to non-agricultural activities. As a result, labor supply of the household to these activities may be less than or equal to the level of household's labor willingness to supply to off-farm works (Woldehanna, 2000).

Family labor supply to non-agricultural activities

$$L_n = L_S + L_r + L_O \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.10)$$

$L_n < l_{nw}$

Where l_{nw} =Family labor willingness to supply to non-agricultural work.

4. Equilibrium condition for family labor

The allocation of total time endowment of household among agricultural activities, nonagricultural works, and leisure and transacting in off farm activities is written as

$$L_j + L_n + s_{ln} = T \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.11)$$

Where Sln = transacting time cost

5. The exogenous effective market prices for tradable is written as:

$$P_m = \widehat{P_m}, m\varepsilon t$$

The Lagrange function for constrained maximization problem is given by:

$$L = U(C, L_h, H_c) + \pi[Q_i(q_i, H_i, X_i, K_i)] + \rho[Q_n(q_n, L_n, K_n)] + \lambda(\sum P_i(q_i + E_i - C_i) + \sum P_i(q_n) + v - scln] + \psi[T - L_J - L_n - L_h - Scln] + \gamma[L_{nw} - L_n] \quad (3.12)$$

Λ and ψ are the Lagrange multipliers of marginal utility of money and marginal utility of time respectively. Non-negativity constraints are imposed on-agricultural output, labor allocated to non-agricultural activities, on-agricultural output and labor allocated to non-agricultural activities.

The first order condition for interior solution implies that:

$$\frac{\partial L}{\partial C_i} = \frac{\partial U(.)}{\partial C_i} - \lambda P_i = \mathbf{0} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.13$$

$$\frac{\partial L}{\partial L_h} = \frac{\partial U(.)}{\partial L_h} - \psi = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.14$$

$$\left.\begin{aligned} \frac{\partial L}{\partial q_j} = \frac{\phi \partial Q_j(.)}{\partial q_j} + \lambda p_i \leq 0 \\ q_j \geq 0 \;\; and \; q_j{}^* \left\{ \frac{\phi \partial Q_j(.)}{\partial q_j} + \lambda p_i \right\} = 0 \end{aligned}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.15$$

$$\left.\begin{aligned} \frac{\partial L}{\partial q_n} = \frac{\rho \partial Q_j(.)}{\partial q_n} + \; \lambda P_i \leq 0 \\ q_n \geq 0 \quad and \; q_n{}^* \; \left\{ \frac{\partial Q_j(.)}{\partial q_n} + \lambda P_i \right\} = 0 \end{aligned}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.16$$

$$\left.\begin{aligned} \frac{\partial L}{\partial L_j} = \pi \partial \frac{\partial Q_n(.)}{\partial L_j} . - \psi \leq 0 \\ L_j \geq 0 \quad and \; L_j * \; \pi \left(\frac{\partial Q_n(.)}{\partial L_j} - \psi \right\} = 0 \end{aligned}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.17$$

$$\left.\begin{aligned} \frac{\partial L}{\partial l_n} = \frac{\partial Q_n(.)}{\partial L_n} - \lambda Sc - \psi(1 + Sc) - \gamma \leq 0 \\ L_n \geq 0 \;\; and \; L_n{}^* \; \left\{ \frac{\partial Q_n(.)}{\partial L_n} - \lambda Sc - \psi(1 + Sc) - \gamma \right\} = 0 \end{aligned}\right\} \ldots\ldots\ldots\ldots 3.18$$

$$\frac{\partial L}{\partial \gamma} \leq 0, \gamma \geq 0 \; and \;\; \frac{\gamma \partial L}{\partial \gamma} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.19$$

$$\frac{\partial L}{\partial \lambda} = \sum(q_i \; + E_i - c_i) + \sum p_i(q_n) + v - scln \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.20$$

$$\frac{\partial L}{\partial \pi} = Q_i \; (q_i H_i, X_i, K_i) = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.21$$

$$\frac{\partial L}{\partial \rho} = Q_n(q_n, L_n, K_n) = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.22$$

$$\frac{\partial L}{\partial \psi} = T - L_j - L_n - L_h - Scln \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.23$$

In non-separable agricultural household model the optimal value of agricultural output (q^*), labor allocated to agricultural activities (L_i^*), labor allocated to non-agricultural activities (L_n^*), demand of leisure (L_h^*) and consumption(C^*) should be determined by

simultaneously solving the first order conditions of Lagrange function (Huffman, 1980), cited in woldehanna, (2000).

Agricultural-household models have been used to analyses not only the effects of farm-price policy on production and consumption but also various other types of agricultural-policy issues (Taylor and Adelman, 2003), such as off-farm labor-supply decisions, nutrition policy, downstream growth, income streams, migration and savings.

One application of the AHM is in defining the determinants of rural-income diversification, which is described by Escobal (2001). As discussed earlier, the household's problem is to maximize its utility subject to a set of constraints consisting of a cash constraint, existing production technologies for farm and non-farm activities, exogenous prices for tradable, and an equilibrium condition for self-sufficiency in farm production and family labor.

The household-equilibrium function connects the total household income and consumption subject to those constraints. Followed the model developed by Singh et al. (1986), concluding that the first-order conditions of the household-equilibrium function provided a system of supply and demand functions that facilitated the determination of labor allocation between farm and off-farm activities or different income generating activities .

3.4.2 Econometric Model Specification

The present analysis is performed based on three rounds of household panel data sets which are spaced five years apart. Given three rounds panel data, it is not appropriate to assume that observations are independently distributed across time and treats households as the same. Unobserved factor that affect the household in 1999 will affect the

household in 2004 and 2009.Failing to inculcate those unobserved variable may leads to incorrect standard error and inefficient estimations (Greene, 2007; Wooldridge, 2002). In this regard, various approaches have been introduced for estimating panel data models with unobserved effects, namely fixed-effects or random-effects modeling.

3.4.2.1 Fixed Effect Model

Fixed effect model is simply a linear regression of the model in which intercept terms vary over individual (Verbeek, 2004) i.e.

$y_{it} = a_i + x_{it}B + e_{it} \quad e_{it} \sim \text{IID}\ (0,\partial_e^2)$ ..... (3.24)

Where

x_{it} is a K-dimensional vector of explanatory variables, not including a constant term. This means that the effects of a change in X are the same for all units and all periods, but that the average level for unit i may be different from that for unit j i.e., variables which vary among the cross section units but not vary over time. The a_i thus capture the effects of those variables that are peculiar to the i^{th} individual and constant over time. Because of this, any explanatory variable that is constant over time for all is swept away by the fixed effects transformation (Wooldridge, 2002).

In fixed effects estimator allows for arbitrary correlation between a_i and the explanatory variables in any time i.e. $\text{cov}(x_{it,}a_i) \neq 0$ while continuing to assume that x_{it} is uncorrelated with the idiosyncratic error i.e. $\text{cov}(x_{it,}e_{it}) = 0$ (Greene, 2007; Wooldridge, 2002).

Fixed effect model is either Individual Fixed Effects Model or Time Fixed Effects Model. Individual Fixed Effects is fixed effects model in which slope is same across all cross section unit and overtime and intercepts differ across section units but are constants

overtime for each cross section unit. While Time Fixed Effects Model is also fixed effect model in which the slopes are the same across all cross section units and overtime and the intercepts differ according to time but are the same for all cross section units at any given time (Schmidheiny. et al. 2013).

3.4.2.2 Random Effect Model

The rationale behind random effects model is that, unlike the fixed effects model, the variation across individuals is assumed to be random and uncorrelated with the predictor or independent variables included in the model. It is common to assume that in regression analysis that all factors that affect the dependent variable, but that have not been included as regressors, can be appropriately summarized by a random error term. This leads to the assumption that the a_i are random factors, independently and identically distributed over individuals. Therefore, we can write random effects model as follows:

$$y_{it} = \mu + x_{it}B + a_i + e_{it}, \qquad e_{it} \sim IID[0, \partial_e^2]; \qquad a_i \sim IID[0, \partial_a^2] \dots\dots\dots\dots\dots 3.25$$

Where $a_i + e_i$ is treated as an error term consisting of two components: an individual specific component, which does not vary over time, and a remainder component, which is assumed uncorrelated over time. A small assumption for random effect model is $cov(a_i, e_i) = 0$. A huge assumption is that $cov(a_i, x_i) = 0$, which means that the things that make a unit's intercept different are unrelated to the individual specific characteristics.

3.4.2.3 Functional Form of the Model

This section discusses how to implement empirical models to estimate first, the determinants of household's income diversification and secondly, specification to

examine the effect of household income diversification on food security status in rural households of Ethiopia.

Based on the above fixed effect and random effect model, the determinants household's income diversification level is determined by the following functional form:

$$\mathrm{HDI_{it}} = \psi \mathrm{X_{it}} + \Theta \mathrm{Z_{it}} + \mathrm{b_i} + \mathrm{Uit} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3.26)$$

Where:

$\mathrm{D_{it}}$ is income diversification index observed for household i at time t,

$\mathrm{X_{it}}$ is time variant explanatory variables such as household characteristics variables, farm characteristics, community variables etc. which are common two both food security and income diversification equations.

$\mathrm{Z_{it}}$ is variables that affect income diversification but affect food security of households i at time t only indirectly through their effect on income diversification(transitory income factors),

bi Captures unobserved time invariant such as region characteristics effects, Uit is random error term and ψ and Θ are parameters that the researcher intends to estimate.

After identifying the determinant of income diversification of rural household by using equation (3.26), the effect of income diversification on food security status of households, which can be determined by using income diversification (HDIi) index as explanatory variable in the following equation.

$$\mathrm{FSI_i} = \mathrm{aHDIit} + \mathrm{BXit} + \mathrm{ai} + \mathrm{vit} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (3.27)$$

Where $\mathrm{FSI_{it}}$ is food security index which is taken to indicate food security status of households i at time t

,$X_{it}$is characteristics for household's i at time t which is synonyms with households characteristics in income diversification, ai captures unobserved time invariant.

vit is the error term which assumed to be normally distributed with mean(μ) and variance ($\partial_u{}^2$); a and , β are the parameters that intends to estimated.

But Income diversification index HDI_i is often viewed as an endogenous variable because household income diversification behavior can be correlated with a household's ability or risk perception, which is not observed by equation (3.27) (Ersado, 2005; Dimova and Sen, 2010). If Di is correlated with vi, ordinary least squares (OLS) estimation of equation (3.27) generally generates inconsistent estimators of a and β (Wooldridge, 2002).

A common econometric fix for endogenity concerns is to use instrumental variables estimation such as a two-stage least squares regression (2SLS).2SLS presupposes that appropriate instruments exist, i.e., the instruments are relevant in the sense that they are correlated with suspected endogenous variable and uncorrelated with error term in the structural equation. To address the problem of endogenity, the researchers employed the instrumental variables (IV) method and 2SLS. The IV approach with HDI_i endogenous variables requires an observable variable, not in equation (3.27 that satisfy two conditions: (a) Zi must be uncorrelated with unobservable variables in equation (2.27). (b) Zi Must be correlated withHDI_i. Wooldridge (2002) notes that the covariate between Zi and vi can never be checked or even tested. In practice, one must maintain this assumption by appealing to economic theory. In this study the researcher use shock variables(covariant shocks ,idiosyncratic shocks) as instrumental variable by assuming

variables will cause income shock and impact on income diversification but have no direct impact on food security status of households.

Therefore, the best instrumental variable for HDI_i is the linear combination of Xi and Zi,which is the fitted value of equation (3.26).Once the fitted value of equation (3.26) estimated, then plug in the fitted value ($\widehat{HDI_i}$.) in equation (3.27) in order to examine the effect of household income diversification on household food security status.

$$FSI_{it} = a\widehat{HDI_{it}} + BX_{it} + a_i + V_{it} \ldots\ldots\ldots\ldots\ldots (3.28)$$

3.4.2.4 Random Effect Model versus Fixed Effect Model

In empirical work, one has to decide whether a fixed- or random-effects estimator is more efficient. If fixed effect is consistent, random effect is inconsistent. The FE estimator (or within estimator) is less desirable because it assumes only within variation which leads to less-efficient estimation results and it is not able to estimate coefficients of time invariant regressors. With the Hausman test, the choice between fixed-effects and random effects models can be tested with the null-hypothesis is that individual are fixed or the individual effects are uncorrelated with the other regressors in the model (Hausman, 1978). The null hypothesis is rejected if the probability of the X^2 (k) is smaller than 0.05 where k is the number of coefficients to be tested in the model. This means that the RE model estimation is preferred over the FE model estimation

In our cases this largely depends on the assumption of $a_i(b_i)$. If $a_i(b_i)$ is uncorrelated with the variables in $X_{it(}X_{it}$ and Z_{it}) respectively, the random-effects model is appropriate. But if $a_i(b_i)$ is correlated with the variables in X_{it}(X_i and Z_i) respectively, the fixed-effects model is the appropriate estimator. To verify this assumption, the Hausman specification

test helps to decide whether fixed or random effects are the preferred specification (Greene, 2007; Wooldridge, 2002).

3.4.3 Description of Variables

Before proceeding to the detail analysis part, it is very indispensable to define and describe the variables, which are employed for the analysis. This study focused on the rural households of Ethiopia. Thus, variables employed here are household level characteristics or the characteristics of household head. First, the outcome variables (variables used as dependent variable) are defined and described. Next, those variables that are used as explanatory will be defined.

Dependent variables:

1. **Income diversification:** This is measured by herfindahl diversification index. It is ranges between 0 and 1. Household income diversification decreases as HDI approaches to zero and increase as HDI approaches to one.
2. **Food security status (FSI):** In this study food security status of household is indexed by food availability and food access. As explained above, it is calculated using multivariate principal component analysis (PCA) by using farm size of households, number of oxen that the household own, availability of stored crops, participation in off-farm activities and per capita food consumption per day as indicator variable. Food security status of household is expected to be influenced by level of income diversification of households positively. since as the level of income diversification increases households can mitigate risks easily since risks are not the same in different income generating activities and provide additional income at the time of food deficit**.**

Explanatory Variables:

1. **Household Characteristics**

Age of the Household Head: This is a continuous variable and that is measured in years representing experiences in rural way of life. Since in a rural society decisions are mostly taken by a household-head, we have considered the age of household-head only. Older heads have higher accumulated experience in rural way of life and hence help their households to diversify their income activities**.**

Sex of Household Head:-Household head is a person who economically supports or manages a household or for reason of age or respect is considered as head by other members of the household and it is a dummy variable (i.e. =1 if household head is male and =0 if household head is female). Male headed households are expected to diversify their income more than female headed households because of cultural differentiation of activities for men and women. In addition, most of women's time is occupied by home activities and do not participate in activities outside the village such as long distance trade and wage employment.

Education Attainment of Household Head :-Educational attainment proves one of the most important determinants of income diversification , especially in more remunerative salaried and skilled employment in rural Africa (Barrett et al, 2001).Educational attainment is measured as five dummy variables categorizing as (1=illiterate, 2=primary, 3=secondary, 4=above secondary and 5=other informal education)[3] .As the education level of the head of household increases, so does his range of work-related skills and his

[3] *Level of education can be categorized in different cycle based on years of schooling. Primary education of Ethiopia is eight years education(1-8) ,secondary education is 4 years education (9-12), higher education includes college and university education and informal education inculcates adult education , religious education etc .*

ability to acquire new skills. Thus, the researcher hypothesize that higher education of the household head, to be associated with a greater the participation in different income generation activities and the greater the level of income diversification.

Household Size:-Household size is measured by the number family member in the household. The larger family size and household labor or corresponding higher demand for food in the household which implies that while an additional member to the household increases the odds to participate in different income generating activities. So, number of family size expected to have positive impact on level income diversification of household.

Dependant Ratio:-Dependency ratio is obtained by dividing inactive labor force by economically active labor force**.** The age limit to include a member as dependent differs from research to research; some take children aged less than 15 years. In case of Ethiopia, Beyene (2008) takes this to be less than five years and above sixty five as dependent. Mekonnen(2011) uses age limit less than seven years and greater than and equals to sixty five years as economically inactive household members. The questionnaire has one question "At what age did they (children) participate in farm/household activities for the first time? The answer for this varies from household to household and from region to region, but the most frequently expressed year is 5-7 years. In addition when the questionnaire ask about marital status it specify age >=7 years. Therefore this study used the economically inactive labor force interpreted as, those members of farm households whose age is 7 years or younger and 65 years or above as economically dependent household members. It implies that those individual above seven years old can participate in labor force. While the economically active labor are those aged between 15 and 65

within the household. When there is a dependent ratio, household has to raise more money and the marginal value of leisure will be decline, hence they will have diversified their income activity to get money. Therefore, the number of dependents within the households is expected to have positive impact on diversification of income.

2. **Farm characteristics**

Farm size (in hectares): Size of cultivated land is a continuous variable measured in hectare. Farm size is a measure of the availability of land for agricultural production. Household with more land to have a larger number of crops and more marketed surplus which results increase in total income of the household's which will be inurn invested in to other income generating activities. Therefore, availability of cultivated land hypothesized to have positive effect on the level of household income diversification.

Number of Oxen holding:-It is a continuous variable measured in number. Oxen power is the main source of traditional means to cultivate land in Ethiopia. The number of ox holding expected to have negative effect on income diversification because holding of a pair of oxen is expected result in high crop production timeliness and thoroughness of cultivation and allows inflow of land, labor and grain from households who lack draft power to its holders.

Land Quality:-Measures farmers' perception of the fertility of their farmland. Households were asked to indicate whether they consider their land as very fertile, medium fertile, and not fertile, average. Under optimal management, better land quality boosts crop production (Sah, 2002), this will increase the overall income of the farmers to invest in diverse income generation activity other than agriculture.

Irrigation:-Irrigation is Dummy variable, 1 if the household has access to irrigated land 0 otherwise. Irrigation opportunities make multiple cropping possible which will create agricultural surplus. This surplus can be used for doing non-farm activities, particularly self-employment activities. So the researcher hypothesized irrigation will correlate with income diversification positively.

Availability of Soil Conservation Measure on their Plot

A soil conservation measure is a dummy variable taking value 1 if a household is practicing soil conservation activities on their plot and 0 otherwise. In Ethiopia, erosion and soil degradation are constraints to food production. The availability of soil conservation mechanism boosts the farm household crop production. This results increase the overall income of households, which will be reinvested in any other income generating activities. Therefore, availability of soil conservation measure expects to have positive impact on the level of household income diversification.

Participation in Agricultural Extension Program

This dummy variable taking the value of 1 if household participate in agricultural extension program and zero otherwise. The main objective of the extension program is working to diversify the income sources of the households. It induced income diversification at the household level and to increase the crop production by using modern agricultural technologies like chemical fertilizer, irrigation etc. Therefore, anticipating in agricultural extension service expected to have positive impact on the level of income diversification.

Access to Credit:-It is a dummy variable taking the value 1, if the household has either access to credit and 0 otherwise. Thus, hypothesized that a household, which has access

to credit is more likely diversify their income. This a priori expectation is drawn from a study by Zeller (2001) that emphasizes the role of in enhancing the level of households' productive capital, and the role of savings in the accumulation of assets, which provide capital for the income earning process. Thus, with the necessary capital and credit a household engage in diverse income generating activate.

3. **Community Variables**

Distance of the nearest market in kilometer:-Households residing far from market centers have less probability to access and participate into different income generating activities. Therefore, it hypothesized that there is positive association between access to the nearest market center (availability of market near to the peasant association) and household income diversification.

4. Household Wealth Variable

Livestock Holding (measured in Tropical Livestock Unit[4]):- livestock holding is included to proxy household wealth. The wealth status of the household head is measured by the number of livestock owned, since livestock is the most important indicator of wealth in rural Ethiopia. Household livestock holding is expected to have positive effect on income diversification through different channels: reducing risk aversion of household, relieving liquidity constraints and generating income through sale of its product and services.

[4]*TLU= Tropical Livestock Unit (equals 1 for camel, cattle 0.7, sheep and goats 0.1, horses 0.8, mules 0.7 , donkey 0.5, and chickens 0.01(*

5. Shock Variables

It is a dummy variable that assumes the value of 1 if a household face flooding and illness of the household head and 0, otherwise. Households experiencing health problems or crop failure are expected to link positively with income diversification strategies. Shock variables are divided in to two

Covariant Shocks: covariant shocks are shocks that are occurred in the in the community such as occurrence of flooding/water logging, too early availability of rain at the beginning of summer , lack of enough rainfall at growing season of crops, to early or too late stop of rain at the for their farm ,which affect their crops **.**

Idiosyncratic Shocks: These shocks are shocks that are peculiar to the households such as damage of crops by insects, livestock's and birds, damage due to weed infestation, illness of household members etc which might be hinder or push households diversify their income activities.

6. Other variable

Primary Occupation of Farm Households

This is dummy variable takes the value of one if the primary occupation of farm households is farming and zero otherwise. Farm households whose primary occupation is relay on agricultural activity expected to diversify less than other occupation.

7. Location Dummy

The incentives to diversify may vary due to agro-ecological characteristics and socioeconomic development of a region. To capture the effect of differences in agro-ecological and socioeconomic development between regions on income diversification and food security status, the researcher include regional dummy as a regressor. Therefore,

here we have four regions (Tigray, Amhara Oromia and southern nation nationalities and people's representatives) that have diverse agro-ecology and climate condition.

Chapter Four

Descriptive Analysis and Empirical Model Estimation

4.1. Descriptive Analysis

The study basically based on 1999, 2004 and 2009 ERHS involving 1597, 1597 and 1574 households respectively. Of these, 484 households that were in the survey 1999 dropped out in 2004 and 484 households were new entrant during 2004 survey. In addition, 701 households were in both 1999 and 2004 surveys and dropped out in 2009 and 678 households were new entrants during the 2009 survey (table 4.1).Hence, total sample sizes of 896 households have been used to create a balanced data for analysis.

Table. 4.1. Number of Households and Attrition

Year		**1999**		**2004**			**1999/2004**		**2009**	
No.HH		Exit	Present	Exit	Present		exit	Presents	Exit	Present
1999	1597	-	1597	484		1999/04	-	1113	217	896
2004	1597	484	1113	-	1597	2009	678	896	-	1574
Balanced Panel Data Set										896

Source: own computation from ERHS 1999, 2004 and 2009

4.1.1 Composition of Household Income in Rural Ethiopia

As we explained in the literature, in a rural setting, income sources can be broadly divided in two: agricultural income (livestock rearing and crop production and off-farm income. There are also different income sources within off-farm income sources such as, non-farm wage-employment, agricultural wage- employment and non-farm self - employment and non- labor income. However, here income from agricultural wage employment and non-agricultural wage employment were merged together as wage income, since there is a very small number of observations that generate income from each source of income**.**

Table (4.2) shows how different income sources contribute to the overall household income. From the total sample size, on average the total income of rural households is 9549 Ethiopian birr (ETB) generated from a wide variety of income generating activities. All households drive income from agricultural activity, which on average accounts 86% of the total household income. Within this category the most important source of income is crop production, which is mainly subsistence in nature, providing about 45% of the total household income. In addition to this, income from livestock rearing activities contributes about 41% of the total income. Livestock income refers to any income generated by the household from livestock by-product, livestock sells, or rental services (such as ox or pack animals rental services).

Based on our definition of off- farm income,73% of households receive income from off farm activities and contribute 14 % income to the total income .Under off-farm activities there are three type of income sources i.e. non -farm self employment, wage income and

non -labor income. Non-farm self employment activities accounts nearly 4.3% of the total income and 38% of households receive income from this income sources.

These non-farm self emplacement activities mainly include handicrafts, trade in livestock, trade in grain, making and selling charcoal, collecting and selling firewood's or dung cakes etc. About 37% of households receive income by supplying labor to agricultural and non -agricultural wage employment activities, which accounts 6% of the total income.

Wage income refers to all types of income derived from both agricultural and non-agricultural wage employment, around their living area or migrates to any other areas. Agricultural wage employment is supplying household labor force in any other farm land in payment of wage either in cash or in kind. Non–agricultural wage employment includes formal and informal jobs in building, professionals (teachers, government worker, administration, and health worker), working in another house as domestic servant etc.

The other dimension of off-farm income is receiving income from non-labor income sources, which accounts 4% of the total income and 37% of households receive income from this activity. Non-labor income is income received from the government, non-governmental institutions (NGOS), family /friends in the form of remittance, gift, inheritance, donation, compensation, transfer etc.

Generally, when we look at the income composition of rural households in Ethiopia, crop income takes the highest share followed by income from livestock rearing either selling livestock products or livestock themselves.

Table 4.2: Composition of Household Income in Rural Ethiopia

Variable	Mean	Sd.err	Participation rate (%)
Total income of households	9549	21473	100
Agricultural income share	0.86	0.19	100
Livestock income share	0.41	0.28	94
Crop income share	0.45	0.29	100
Off -farm income share	0.14	0.18	73
Wage income share	0.06	0.14	37
Non- labor income share	0.04	0.10	37
Non-farm self employment income share	0.043	0.11	38

Source: own calculation from 1999, 2004 and 2009 panel data

4.1.2. Trend of Income Diversification

Table. 4.2. Indicates how the overall household income diversification and the income share of each income sources changed from 1999 to 2009 in rural Ethiopia. When we see the trend of agricultural sector, in 1999 88% of the total income generated from this sector. Of which crop income contributes 24% while 64% of agricultural income coming from income from livestock rearing. As per the study done by lemi (2006) by using 1994 and 1997 ERHS, the contribution of crop income is around 77%. But here we found that, the share of crop income in the total as well as in agricultural income is very low. This might be because of the quarrel between Ethiopia and Eritrea during 1999. Due to that agricultural income from crop production reduces since majority of the productive labor force in agricultural sector could be at war and labor force facilitates crop production might not available within the household. Moreover, the government might not give emphasis in servicing rural community such as in delivering agricultural extension service, on-time supply of fertilizer etc. Therefore, in order to fulfill basic needs or for their livelihoods, household member may sell livestock's, which eventually increase the livestock income share in agricultural income in this year.

In 2004 the share of crop income increase, which contributed about 65% of the total income while the share of income from livestock rearing is shrunk to 22% from 64 % in 1999.In addition, in 2009 the share of income from crop production still dominant over livestock income but declines to 49%.In contrary, the share of income from livestock rearing increase to 37%.

The trend of income diversification, in terms of off-farm activity, only income source from wage employment (from non-agricultural and agricultural wage employment),

continuously increase over time from 4% in 1999 to 5% and 8% in 2004 and 2009 respectively. This may be due to the facts that increase in government expenditure for expansion of rural infrastructure in rural areas, thereby increase the job opportunity of farm household for wage employment While income from non-farm self employment declines over time.

The overall income diversification level in Ethiopia is 39 % which is too small .The level of income diversification in 1999 is 34 % while by 2004 the had increased to 43 % and this had shrunk to 41 % in 2009.The possible explanation for the decline in the level of income diversification in 2009, it might be the result of the food price hikes observed since 2007 in Ethiopia. This might be initiate farm households to divert their income source only crop production.

Table 4.3.Trend income diversification in rural Ethiopia during harvest season in 1999, 2004 and 2009

		1999		2004		2009	
No	Categories	Mean	SD	Mean	SD	Mean	SD
1	Share of Crop Income	0.24	0.19	0.62	0.23	0.49	0.27
2	Share Livestock Income	0.64	0.23	0.22	0.18	0.37	0.24
3	Share Wage Income	0.04	0.11	0.05	0.11	0.08	0.17
4	Share of Non-Labor Income	0.023	0.08	0.06	0.11	0.03	0.09
5	Share of Non-Farm Self Employment Income	0.06	0.13	0.04	0.10	0.03	0.07
6	Herfindahl Diversification Index	0.34	0.17	0.43	0.19	0.41	0.18

Source: *own computation based on ERHS 1999, 2004 and 2009*

4.1.3. Pattern of Income Diversification by Selected Variables

Table (4.5) shows the variability of herfindahl diversification index (level of income diversification by selected demographic characteristics of household's variables, farm characteristics and food security index. From the table below, the sex of household head does not bring any significant difference in the level of income diversification since t-value (1.31) is small sufficiently to accept the null hypothesis no mean difference between two groups (p-value 0.1876) at 95% confidence interval. Age of household head is divided based on the mean age of household head as age less than or equals to 50 and greater than 50. Age of household head also had no any significant influence on the level of income diversification.

Participating in non-farm wage employment and non-farm self employment requires educated household heads. According to table 4.5, there is a significant difference in the level of income diversification between literate and illiterate household's heads.

The other interesting result is there is significance mean difference of dependency ratio, and household size in terms of level of diversification Households with more household size and dependency ratio diversify their income more than those households having low dependency ratio and household size. This confirms the study of Dimova(2010) in Tanzania, households find better income diversification strategies to ensure the survival of dependent members of the family.

Finally the level of income diversification and food security status of households can be determined in descriptive approach. Applying the index derived earlier, sample households classified in to food secure and food insecure households. Those households with a positive index values are categorized as a food secured whereas those with

negative index values food insecure. From the sample 42% of household grouped as food insecure while the remaining 58% considered as food secure (see appendix. 2).The level of household income diversification in terms of food security status, level of income diversification of households for food secure households greater than that food insecure significantly. Since t-value is large sufficiently to reject null hypothesis of mean difference between foods secure and insecure households in terms level of income diversification.

Table: 4.5. Pattern of the level of income diversification by selected variables

Variables	Mean	Mean difference	t-value(95%)
Sex of Household Head			
Male headed households(=1)	0.40	0.18	-1.31
Female headed households(=0)	0.39	0.19	
Age of Household Head			
<=50	0.39	0.19	-1.68
>=51	0.40	0.18	
Education of household head			
Illiterate Household head(=0)	0.39	0.18	3.60
Educated household head(=1)	0.41	0.19	
Dependant Ratio			
<=1.58	0.39	0.18	4.68
>1.58	0.45	0.16	
Household Size			
<=7	0. 39	0.19	2.37
>=8	0.41	0.17	
Access of Financial Capital			
Access to credit (=1)	0.41	0.18	-4.83
No accesses of credit (=0)	0.37	0.18	
Food Security Status			
Food secure households(=1)	.41	.18	-2.09
Food insecure households(=0)	.39	.19	

Source: own calculation from ERHS 1999, 2009 and 2004

4.2. Summary Statistics of the Variables for Empirical Estimation

This section describes the definition and the summary statistics of selected demographic and socio- economic variables which is derived from sample households, which were later used in econometrics estimation.

The survey result depicts that the average age of the household head in the sample is about 51 years with the minimum and maximum age of 16 and 120 years respectively. The mean family size of the sample households are 5.81 with minimum of 1 and 18 maximum family members.

Education of household head is important variable that can determine the level of income diversification. In most of the rural parts of Ethiopia where illiteracy is pervasive different researchers found that the illiteracy rate is high. Categorization of farm households based on education exhibit that, from the total sample 56% of households did not have any formal and informal education 25% have primary level of education and 8 % of the samples have secondary level of education, 10 % have informal education and the remaining 1% of households have higher education level. This result consistent with the study by Mekonen (2012), where formal education concentrated on secondary and primary education and the number of educated households decline as the level of education increases.

When we see farm characteristics of households, the first one is the size of land measured in hectares by changing the local unit land measurement in to hectare using conversation factor in to each peasant association. The farm sizes of the households differ from households to households. The average farm size is 1.55 hectares.

The other farm characteristic is availability of irrigation in their plot of land. Different researcher shows that availability of Irrigations activity plays an indispensable role in rural areas in order to produce cash crops, to mitigate from crop shocks due to climate variability, enable farmers to adopt new technologies and intensify cultivation, leading to increased productivity, overall higher production, and greater returns from farming etc.

According to Tesfaye (2006), Irrigated production is far from satisfactory in the country. The country's irrigation potential is estimated at 3.7 million hectare, of which only about 190,000 hectare (4.3 percent of the potential is actually irrigated. Here we found that those only 14 % households have irrigated land. Looking at credit use, from the total sample about 56 % of households have access to credit. The other variable s summary statics is found in the following table

Table 4.7. : Summary Statics of Variables Used In Empirical Analysis

			1999/2004 panel			
Variable	Description of Variables	Obs	Mean	Std. Dev.	Min	Max
HDI	Herfindahl Diversification index	2688	0.39	0.18	0	1
FSI	Food security index	2688	0.59	1.75	-2.71	19.79
HHSIZE	Family size	2688	5.81	2.67	1	18
NAHM	Adult household members	2688	3.4	2.38	0	14
AHH	Age of household head	2688	51	14.8	16	120
DRATIO	Dependent Ratio	2688	1.58	2	0	4
DSEHH	Male headed dummy	1970	0.73	0.44	0	1
DIL	Illiterate dummy	1498	0.56	0.49	0	1
DPE	Primary education dummy	663	0.25	0.43	0	1
DSE	Secondary education dummy	222	0.08	0.17	0	1
DHE	Higher Education dummy	25	0.013	0.21	0	10
DOTHEREDU	Other education Dummy	280	0.11	0.30	0	1
DPOHH	Farm occupation dummy	2688	0.74	0.43	0	1
DACRI	Access to credit	1527	0.56	0.49	0	1
FASIZE	Farm size	2688	1.55	1.79	0	42.5
NOXEN	Number of oxen	2688	0.73	0.95	0	11
DTIGRAY	Tigray dummy	294	0.11	0.31	0	1
DAMHARA	Amhara dummy	648	0.24	0.42	0	1
DOROMIA	Oromia dummy	708	0.26	0.44	0	1
DSOUTH	SNNPR dummy	1038	0.38	0.48	0	1
DAIRA	Availability of irrigation on farm household plots	387	0.14	0.35	0	1
TROLIVU	Tropical livestock unit	2679	2.87	3.29	0	46.62
DSELF	Non-farm self employment	2688	0.11	0.32	0	1
DQL	Quality of land dummy	2688	0.53	0.49	0	1
DSOILCON	Soil conservation dummy	1145	0.42	0.49	0	1
DAGRIEXT	Agricultural extension dummy	687	0.25	0.43	0	1
DIDIOSHOCK	Idiosyncratic shock	1419	0.52	0.49	0	1
DCOVSHOCK	Covariant shock	1279	0.47	0.49	0	1
SHAREOFF	Share off-farm income	2688	0.13	0.188	0	0.99
TOTALINCOME	Total household income	2688	9849	21473	300	484720

4.3 Econometric Estimation

4.3.1 Model Specification Test (Diagnostics)

A model specification error can occur when one or more relevant variables are omitted from the model or one or more irrelevant variables are included in the model. If relevant variables are omitted from the model, the common variance they share with included variables may be wrongly attributed to those variables, and the error term is inflated**.** On the other hand, if irrelevant variables are included in the model, the common variance they share with included variables may be wrongly attributed to them. Model specification errors can substantially affect the estimate of regression coefficients.

4.3.1.1 Multicollinarity Test of Explanatory Variables

When there is a perfect linear relationship among predictor variables, the estimate for a regression model cannot be uniquely computed. The term co linearity implies that two variables are near perfect linear combinations of one another.

The primary concern is that as the degree of Multicollinarity increases, the regression model estimates of the coefficients become unstable and the standard errors for the coefficients can get wildly inflated. We can use the VIF (variance inflation factor) command after the regression to check for Multicollinarity. VIF stands for variance inflation factor. As a rule of thumb, a variable whose VIF values are greater than 10 may merit further investigation. Tolerance, defined as 1/VIF, is used by many researchers to check on the degree of collinearity. A tolerance value lower than 0.1 is comparable to a VIF of 10 (Gujarati, 2003). It means that the variable could be considered as a linear combination of other independent variables. Based on this rule of thumb, the maximum

VIF is less than 10(see appendix .7).Therefore, our model is free from Multicollinarity problem.

4.3.1.2 Test of Hetroscedasiticity

In the classical linear regression the error term is assumed to be homoscedastic – constant across observations. Violation of this assumption is pernicious. Estimates of standard errors for the regression coefficients are biased and the direction of the bias is not known a priori – may inflate or deflate t-tests (Davidson R. et al 1999.).

The model was diagnosed to identify whether problems of heteroscedasticity occur on it. The first test on heteroscedasticity given by imtest is the White's test and the second one given by hettest is the Breusch-Pagan test. Both test the null hypothesis that the variance of the residuals is homogenous. Therefore, if the p-value is very small, we would have to reject the hypothesis and accept the alternative hypothesis that the variance is not homogenous (see appendix 5). The remedy for heteroscedasticity is simple. White developed an estimator for standard errors that is robust to the presence of heteroscedasticity.

4.3.1.3. Model Selection Test

The result of fixed effect and random effect model of equation (3.26), for the determinants of the level of household income diversification is presented in table 4.6. For the model, Because of the Hausman test suggests that random effect is superior (since the Prob>chi2 is greater than 0.05) to random effect (see appendix 11).The rho in the random effect regression is zero. This shows that the effect of specific individual effect is negligible rather the idiosyncratic error term.

For the second model, to estimate the effect of the level of income diversification on food security status, we purposely use fixed effect model. Since the instrument might be correlated with individual fixed effect (incorporated under composite error term in random effect)

4.3.1.4. Endogenity and Instrument Test

Before the discussion we address, the econometrics specification issue. Since we expect Income diversification is an endogenous variable, while we estimate the food security Status equation. The 2SLS estimator is less efficient than OLS when the explanatory variables are exogenous. Therefore, it is useful to have a test for Endogenity of an explanatory variable that shows whether 2SLS is even necessary and test of the validity of the instruments.

To test the Endogenity of the suspected endogenous variables, we use Wu-Hausman F - test under the null hypothesis of explanatory variables are exogenous. The Wu-Hausman F- test confirms that herfindahl income diversification index is indeed endogenous due to the fact that the p-value of the test is not different from zero. Therefore, using 2SLS approach is appropriate and inconsistency of OLS regression is justified.

To verify the validity of the instrument, the instruments are tested using Sargan test under the null hypothesis that the instruments used are jointly valid and the excluded instruments are correctly excluded from the estimated equations. Since a p-value of different from zero confirming that instruments are valid. Moreover, the relevance test of the instrumental variable in the first model regression shows ,under the null hypothesis of the coefficients of the instruments are jointly zero, instruments are relevant in affecting

the endogenous variable, since the probability is very low we can reject the null hypothesis (see table below).

4.3.2 Determinants of Household's Income Diversification

Income diversification in this study refers to the number of income sources. This is examined in the first model, where we analyze the determinants of the level of income diversification by using herfindahl diversification index as a measure and dependent variable in rural Ethiopia. These indexes take in to account the number of income sources and their share in the total household income. It increases with the number of income sources and when income is evenly distributed among income. It is calculated based on activities explained in chapter three. Herfindahl Diversification Index are continuous variables but with limited range between zero and 1 (see appendix 2). Moreover, there is a large share of observations with zero values meaning that households do not participate in off-farm activities and that they derive their income from agricultural income source only.

The result of fixed effect or random effect models for equation (3.25) for the household income diversification determinants appeared in Table 4.5 below. Because of hauseman test suggests that fixed effect is superior (Prob>chi2 is greater than 0.05 see appendix 11) to random effect. we interpreted the regression result is primarily based on random effect model.

Table. 4.7. Random Effect Model Estimation Result

Explanatory Variables	Random Effect		
	Coef	Z-value	.Std.Err.
Age of household head	-.00064**	-2.54	.00025
Household Size	-.0017	-0.95	.0018
Number of Adults in the household	.0123***	4.51	.0027
Dependent Ratio	.0027	1.25	.0022
Sex of household head	.0036	0.35	.0102
Primary education dummy	.0125	1.35	.0092
Higher education dummy	-.0265**	-2.43	.0109
Secondary education dummy	.0268	1.45	.0185
Informal Education dummy	.0175	1.51	.0116
Market Distance(KM)	-.0032***	-4.32	.00075
Availability of Irrigation dummy	-.01343	-1.26	.0106
Farm Size	.0081***	2.64	.0030
Tropical Livestock Unit	.0034**	2.31	.0014
Access to Credit Dummy	.0132*	1.78	.0074
Quality of Land Dummy	.00198	0.27	.0073
Farm Occupation Dummy	-.0132	-1.29	.0103
Number of Oxen	-.0029	-0.57	.0050
Agricultural Extension Program	-.0128	-1.45	.0088
Soil Conservation Measure Dummy	-.0301***	-3.65	.0082
Occurrence Idiosyncratic shock Dummy	.0136*	1.73	.0078
Occurrence Covariant shock Dummy	.0306***	3.9	.0078
Tigray	.0387***	2.54	.015
Amhara	.0355***	2.79	.0127
Oromia	.0276***	2.63	.0105
_cons	.3702**	17.89	.0206997

Note: ***/**/* indicates statically significant at 1 %, 5% and 10% respectively

Source: own estimation from ERHS 1999, 2004 and 2009

1. Age of Household Head

In contrary to our expectation, ages of household head have been found negative and significant at 5% level of significant influencing the level of income diversification. Keeping other factors constant, for one year increase in age of the households head among household's and over time, on average the level of income diversification decreased by 0.0006% which, is not strong enough. This might be due to the fact that even if experience increases with age of household head, at the same time the capacities of households to do multiple jobs decrease. Moreover, old age induce household not to participate in different income generating activities rather to consume more leisure.

2. Household Size

Household size had a negative and insignificant impact on the level of income diversification among households and over time which is not in line with our prior expectation. This could be explained by the fact that large household size depresses the household income and reduce the level of income diversification of the households. Moreover, large household size also implies higher consumption expenditure and this will reduce the available resources needed to diversify into other activities

3. Number of Adult Household Members

We found number of adult household members positively influence the level of income diversification and significant 1% level significance. Keeping other factor constant, for one person addition adult household member between household's and over time, on average the level of income diversification increased by 1.3%

4. Sex of Household Head

As expected the coefficient of sex of household head is positive. It is insignificant and statistically not different from zero implying that there is no significance difference between male headed and female headed household in the level of income diversification which, is congruent with our the descriptive statistics explained above. The positive sign indicates that, the level of household income diversification of male headed households is greater than female headed household which confirms the study done by Gebreegziaber K et al. (2011) in Northern Ethiopia. This might be due to cultural differentiation of activities for men and women in Ethiopia. In addition, most of women's time is occupied by home activities and do not participate in activities outside the village such as long distance trade and wage employment.

5. Dependency Ratio

In line with our expectation, dependence ratio was found positively related with the level of income diversification. Meaning that, as dependency ratio increases the ability to meet the household needs decreases. Therefore, in order to fullfill the needs of the household members; households are induced to increase the level of income diversification.

6. Educational Attainment of Household Head

Households those having primary education, secondary education, and other education diversify their income greater than as compared to household head those households without any level of education. This is probably because school education increases the human capital levels and provides the necessary skills which enable the entry into more remunerative labor markets especially for non-farm activities such as non-farm wage labor or self-employment and increasing the productivity of agricultural sector which will

be invested in any other income generating activities. The coefficient of the variables is statistically insignificant. This might due to the fact that, the majority of households were not attending any schooling and 56% of household heads never attended any schooling while the remaining 44% of household head attend primary, secondary and other informal education which confirms the study of (Asenake, 2010) (see appendix 2).

The unexpected result here in this regression is the income diversification of household head who attend higher education like University and College lower than those who are illiterate. This might be due to having higher education forces household to totally drive out of agricultural sector and relay on only wage income. This supports the results of Damite(2003), where the higher level of education of head helps the household to raise productivity of specific activity and that activity generates the largest share of household income, which lowers income diversity.

7. Farm Size

As expected, the size of farm land used for cultivation purpose, were found to be positive in determining the level of household income diversification. The coefficient of farm size was significant at 1% level of significant, implying that farmers diversify more into other income generating ventures as the farm size increases. Keeping other factor constant, for one hectare increase in land to be cultivated, on average the level of diversification among households and overtime increased by 0.8%.

The positive sign indicates that, farm households with larger farmland were more likely to have more diversified sources of income. The result confirms the study of Barrett, Reardon and Webb (2001, indicated that there is a positive relationship between the share of rural income generating from non-farm income sources and the size of land holding, indicating the presence of entry barriers into high income nonfarm activities for those

households that lack such assets. Since, as farm households increase in non-farm activity, their level of income diversification might be increase. In addition to this, result suggests that abundant farmland endowment helps household to undertake higher crop production, part of which can be used for investment in livestock rearing. Our result is contradicting the study of Amoke (2012) in Nigeria. According to him land ownership in developing countries; particularly in Africa is the most important productive asset available to rural households. Hence, those farmers that have adequate access to land in terms of ownership and size are less likely to diversify into non-farm activities. This could also suggest that diversification into non-farm income sources might be related to lack of access to land for farming.

8. **Access to Credit**

We found access to credit affect the level of income diversification of household's positively and significant at 10% level of significance. The result not defies to our prior expectation. This shows that credits in rural areas used for financing other income generating activities outside agriculture or for purchase of agricultural input to increase the agricultural productivity. In other words household income diversification driven by accumulative motive not by survival motive which is in contrary with the finding done by Dimova et al. (2010) in Tanzania.

9. Availability of Irrigated Land

The result of the regression result shows that households with irrigated land diversify their income less than those households does not have any irrigated land. The coefficient of availability of irrigated land also insignificant. The possible explanation for unexpected sign might be to show, farm households with larger farmland areas under

irrigation were more likely to have less diversified sources of income. This suggests that such households with irrigated land were more focused on agricultural production as the only source of income.

10. Quality of Land

In line with our prior expectation, qualities of land were found positive influence on the level of income diversification but the coefficient is not statistically different from zero. Farm households having fertile of land, farm can produce more and increase their total income which will be invested in different income generating activities.

11. Participation in Agricultural Extension Program

Participation in agricultural extension program found to be influence the level of income diverfication negatively but it is insignificant. The sign is defies to our prior expectation and study done by Gebreegziaber K.(2011). The insignificance of the participation in agricultural extension program could be, due to small number of households participate in agricultural extension program which accounts around 25% of households (see appendix)

According to Gebreegziaber (2011), there are two way of interpretation for the effect participation in agricultural extension program on level of income diversification. The first one is agricultural extension program expects to increase labor productivity and returns of labor. The second one is the aim of agricultural extension program is to induce rural households to diversify their income sources. He found that participation in agricultural extension program had positive influence on the level of income diversification (the dominance of the second effect).however, in contrary, in this study

we found that income diversification is negatively affected by participation in agricultural extension program the dominance of the first interpretation.

12. Availability of Soil Conservation Measure

Availability of soil conservation measure on their plot, were found negative impact and significant at 1% level of significance which is in contrary to our prior expectation. The possible explanation for the negative sign indicates, since soil conservation practice requires labor force which share time allocated to other income generating activities.

13. Distance from the Nearest Market Center

Contrary to our expectation, distance from the market from the peasant association, which is linked to transport accessibility and the ability to sell farm products in the market were negative and significant at 1 % level of significance. The larger the distance of peasant association from the nearest market center, the lower the level of income diversification. Household living far away from the market center, have lower level of income diversification since there is no any other income generating activities without agriculture.

14. Livestock holding

In line with our prior expectation, livestock holding were found positive impact on the level household income diversification**.** The coefficient of livestock holding is significant at 5 % level of significance. For one unit increase in the value of livestock, between individual and over time , level of income diversification of households increased by 0.34% which not strong enough. As we explained above, livestock is the most important indicator of wealth in rural Ethiopia. The positive sign of the regression result indicates that, by reducing risk aversion of household, relieving liquidity constraints and

generating income through sale of its product and services livestock holding increase the level of income diversification.

15. Number of Oxen

Oxen are the main source of traction power among rural households. In contrary to our expectation the number of oxen that the household owned affect the level of income diversification negatively and its coefficient is statistical not different from zero.

16. Primary Occupation of the Household Head

From the regression result above, we found farm households mainly engaged in primary occupation or where agricultural sector is their livelihood less likely diversify the income their income compared to other occupation.

17. shocks Variables

As we explained in chapter three there are various types of covariant and idiosyncratic shocks. Among them, the occurrence of flooding/water logging from covariant shocks and illness among household among household members collinear with herfindahl income diversification thereby used as instrumental variable**.**

As expected, the existence of idiosyncratic and covariant shocks positively influences the overall diversification at level of significance (α=0.1 and 0.01).This supports the hypothesis of diversification as an ex-post reaction on the occurrence of shocks not ex-ant reaction of risks or shocks.

18. Region dummy

Regional dummies are used to capture the regional differences in the level of income diversification. There is a significant difference between regions concerning the level of income diversification. When we compare the level of income diversification between regions by taking southern nation nationalities and peoples, we found that there is significant

difference between regions in the level of income diversification. Being in Amhara, Tigray and Oromia region ,level of income diversification greater than southern nation nationalities which reinforce the results of the descriptive statics discussed earlier.

4.3.3 Effects of Household Income Diversification Level on Food Security

In this section, we present the effect of the level household's income diversification on food security status of the household. The dependent variable is the food security index which is calculated by using multivariate principal component analysis (PCA) as we explained in chapter three. To calculate food security index, first from the three years pooled data principal components have been estimated. To select meaningful components there are four criteria's i.e. Kaiser Method, Cattell screed test and Cumulative percent of total variance (Steven, 2008).Among criteria's, we use cumulative percent of total variance for a reasonable amount of variance in the data. It is recommended that the components retained account for at least 70% of the variance (Keho, 2012). The principal components that offer little increase in the total variance explained are ignored; those components are considered to be noise. When PCA works well, the first two eigenvalues usually account for more than 60% of the total variation in the data (Steven, 2008).

In this case the percentage components accounted for by each component and the cumulative percent variance appears in appendix 9. From this, we can see that the first component accounts alone 28.84% of the total variance and the second and the third component 19.83% and 19.54% of the total variance respectively. By adding the percentage of the component loading together results 84.54% of the total variance. Based on these among five components the first three components considered to be the index of food security. To select weights/eigenvectors from the component loading for each variable, a coefficient greater than 0.4 in absolute value is considered as significant (Steven, 2008) see appendix 9.

By using equation (3.4) food security index has been developed for analysis purpose.

As explanatory variable, we use the same household characteristics, farm characteristics as above in the determinants of the level of household's income diversification. However, unlike before we use IV and 2SL for this estimation. This because herfindahl income diversification which is the measure of the level of income diversification treated as endogenous as we tasted using Wu-Hausman F -test (see table 4.6 above).

Table 4.9.The Effect of level income diversification on food security status

Explanatory variables	Food security index		
	Fixed effect		
	Coeff	z-value	Std. Err.
Herfindahl diversification index	.092**	2.12	.044
Age of Household Head	-.0009	-1.29	.0007
Household Size	-.013***	-3.81	.0035
Number of Adult in the household	.016***	2.86	.0056
Dependant Ratio	.002	0.71	.003
Male Headed dummy	-.028	-1.35	.021
Primary education Dummy	.011	0.49	.023
Higher education Dummy	.013	0.8	.016
Secondary Education Dummy	.035	0.6	.058
Informal Education Dummy	-.017	-0.75	.024
Market Distance (KM)	-.006***	-3.16	.0019
Availability of Irrigation dummy	-.039	-1.6	.024
Tropical Livestock Unit	.025***	7.75	.0028
Access to credit Dummy	.016	1.43	.0110
Quality of land dummy	-.002	-0.19	.011
Agricultural extension program	0.059***	4.64	.012
Soil conservation measure	-.033*	-1.86	.017
_cons	-.42*	-1.85	0.22

Note: ***/**/* indicates statically significant at 1 %, 5% and 10% respectively

Source: own estimation from ERHS 1999, 2004 and 2009

Table (4.8) presents our estimate of equation 3.27, where the key explanatory variable is herfindahl income diversification. The coefficient of herfindahl diversification index is positive and significance at 5% level of significance. In other words, the higher the level of the household income diversification, results with, the more food secure of the households. The possible explanation for this as our prior expatiation, diversification of income sources provides an additional income that enables farmers to spend more on their basic needs include food consumption, education, closing and health care .Increase in the level of income diversification helps the households to revitalize from different shocks which make farm households food insecure. This result also consistent with the study of Oyewole (2012)) in Nigeria with estimated coefficient of income diversification (0.877) was positive and significant at 5% level of significance. This implies that, as income diversification increases, food security status of the households. According to Birhanu (2009) Participation in off-farm activities was found to be significantly and positively associated with food security, a finding similar with Nyariki et al. (2002) who found involvement in off-farm activities positively and significantly affect food security in Kenya.

The age of the household head is negatively but insignificantly associated with food Security. The result is contradicted to the study done by Birhanu et al. (2009) where age of household head is associated with food security positively.

The number of number of adult household members in the household has been found to affect food security positively yet significant at 1 % level suggesting that increases in household endowment with more of active and capable labor force affects its food

security status positively. Labor is one of the most important capitals rural families possess.

The parameter estimates for household size is significant at 1% level of significance and negative reflecting that household with more family members tends to be food insecure.

The gender of the household head is negatively and insignificantly associated with food security. A negative gender variable implies that male-headed households tend to be more food secured than female headed. This result is in contrary to the study done by Birhanu et al. (2009) and Riber and Hameric (2003), where male headed households more food secure than female headed households.

Education seems to play an important role in improving food status of households as well, but only if household head attains at least higher education. But the food security status of household's having informal education lower than those illiterate households. This might be because of in rural Ethiopia farm households participate in different unpaid jobs or less paid in their community such as, being Keble administrators and religious issues. However, the time allocated to this activity greatly affects their agricultural production and eventually leads to food insecurity for the households.

Livestock asset endowments has been found positively and significantly at 1 % level significance associated with food security implying that the more livestock a household has the better its food security position. This is similar to the finding of Ramakrishna and Demeke (2002) in Ethiopia. In addition, households with more livestock produce more milk, milk products and meat for direct consumption. Besides, livestock enables the farm households to have better chance to earn more income from selling livestock which enables them by increasing purchasing power of stable food during food shortage and

could invest in purchasing of farm inputs that increase food production, and able in ensuring household food security.

Access to credit associated with to household food security positively but its coefficient is insignificant. Households who are members of these associations are in a better condition to access financial resources for making investments in their farm and/or for bridging the food gap in times of scarcity.

Access to agricultural extension service found to have positive relation with food security status of households and its coefficient is significant at 1 % level of significance. The positive effect of access to extension service might be to indicate those households who get technical advice and training or those who participated in field demonstrations are well aware of the advantage of agricultural technologies and adopt new technologies and produce more, thereby improving the household food security status.

A number of unexpected result have been found in this estimation for instance availability of irrigated land, soil conservation mechanism and quality of land influence food security status of households negatively .

Chapter Five

Conclusion and Policy Recommendation

4.1 Conclusion

The study attempts to examine the determinants of household income diversification and its effect on the food security status in rural Ethiopia by using the ERHS panel data. The analysis reported here was based on three years cross -sectional data and panel data with a sample of 896 covering ten years. Previous study on this area focus on specific region's within Ethiopia. This limits the broader applicability of the study. They also use cross sectional data without controlling time invariant household and regional effects. In addition to this, potential roles of income diversification on food security status among the rural farmers have not been adequately examined in Ethiopia. Having these, this study is structured to overcome the shortcoming of the previous studies.

The specific objective of the study are; to asses income diversification of farm households in Ethiopia, to identify the socio economic determinants of the level of income diversification of farm households and finally to analyze the effect of the level of household income diversification on food security status in rural Ethiopia.

The first attempts were made to assess the income diversification in rural Ethiopia .Based on the sample households the overall level of household income diversification in Ethiopi a is 39%. Income from mixed farming (income from livestock and crop income) accounts for the largest sources of income for each group which accounts 86% of the total income. Income from crop production contributed about 45 % of the total income while 41 % of income is generated from livestock rearing. The trend of mixed income declines over

time from 88% in 1999 to 87% in 2004 and reaches to 86% in 2009.The importance of off-farm income and employment is increasing among the livelihood strategy of households in rural Ethiopia and it accounts 14% of the total income.

Secondly, we examined the socio-economic and demographic determinants of the level of household's income diversification in rural Ethiopia using random effect model based on the Hausman test (see appendix 11).The result shows that factors such as educational attainment of household head, sex of household head, dependent ratio, farm size, quality of land, livestock holding and shock variables (idiosyncratic and covariant shocks) confirmed the prior hypothesis.

Lastly, we estimated the effect of household's income diversification levels on food security status of households in rural Ethiopia. To attain this objective, instrumental variable (IV) and two–stage least square (2SLS) methods are used since income diversification level index (HDI) was found endogenous in estimating this model (see appendix 4). Fixed effect model is employed to remove the bias due to correlation between time invariant household characteristic or farm characteristic or location with the instrumental variables. By using idiosyncratic and covariant shocks, the levels of income diversification were found to affect food security status of households positively and significantly at 5% level of significance. Therefore, income diversification were found to be important for farm households to serve as additional source of income and complementing the income earned from agriculture and serve as a great contributor to household food security restricting their probability of selling of food grains and cover the extra household expenses.

4.2 Policy Recommendation

The following are the possible areas of intervention which might improve food security status and level of income diversification of households.

- Educational level was found to be one of the important determinants the level of household income diversification. The educated peoples diversify their income through opting for salaried jobs, self-employment activities, etc., illiterate persons engage themselves in agricultural activities which are mostly valuable to weather and other damage. Therefore, investing in education and increasing access up to secondary education will help the rural households in getting alternative income. In Ethiopia context educating farm households at higher education might be induce them to relay on only wage income which reduce the diversification level of households.
- From both regressions, we found that distance from the nearest market affect food security status of the household and income diversification negatively. This shows that market is rarely accessible to the farm household. Therefore, infrastructure environment which is important for market access, especially in terms of transport facilities need to be improved to increase access to a range of opportunities both on the farm and outside the farm to improve the livelihoods of rural households.
- Household size had negative impact on the food security status of households and level of income diversification. The family planning program should be further focus on and more awareness should be created among the rural farmers on the need to reduce their family size for food insecurity reduction and improvement in households' welfare. Proper attention should be given to limit the increasing

population. This could be achieved by proper awareness creation about practicing family planning.

- Livestock ownership had positive significant impact on the level of income diversification. Moreover, Farm households with larger livestock holdings are more food secured than farmers with less livestock holdings. Therefore, farmers should be encouraged to engage in livestock husbandry through providing with improved livestock production technologies (health service, improved breeds and feeds) to improve production and productivity of the sector, this will ultimately increase food security status.
- Generally the study revealed that having income generating activity apart from agriculture, the potential to increase food security status increase. Therefore, it is important to encourage farm households to have income outside agricultural income since agricultural income is vulnerable to different shocks. Policy makers should look for means of improving these activities and make policies that will promote them without having negative effects on farming.
- Finally, the author of this study recommends further detail analytic investigations weather income diversification is due to accumulative motive or survival motive based on the relation between income diversification and total household income.

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Appendices

Table A1: Description of Variables

Region	Region
Woreda	Woreda
Peasant	Peasant Association
Hhid	Household ID number
Wnew	Woreda new
Pnew	Peasant Association new
Hhidnew	Household ID new
HHIDNEW	Household ID new
Year	Year
HHSIZE	Number of family members
AHH	Age of household head
NEDM	Number of economically dependant household members
DRATIO	Dependant ratio
DSEHH	==1 if sex of hh head is Male ,= 0 otherwise
DIL	==1 if hh head is illiterate ,=0 otherwise
DPE	==1 if hh head has primary level of education,=0 otherwise
DSE	==1 if hhs has secondary level of education,=0 otherwise
DHE	==1 if hh head has higher education, =0 otherwise
DOTHEREDU	==1 if hh head has other education level (religous,adult...)=0 otherwise
DPOHH	=1 if the primary occupation of hh head is farming,=0 otherwise
DACRI	==1 if on hhs are either acess to credit =0 otherwise
DFM	Distance of peasant association to the nears market in kilometers
PFC	Food consumption per household size
PFCD	Household per capita food consumption per day
FASIZE	Household cultivated lad size in terms of hectar
DOFF	==1 if hhs are participate in off -farm activities,=0 otherwise
NOXEN	Total number of oxen owned

DSTORE	==1 if the hhs storing any cereals ,pulses or any other food crops or cash=0
NLIVU	Nominal livestock value
LTROLIVU	Tropical livestock unit
DAGWE	==1 if hhs participate in agricultural wage employment ,=0 otherwise
DNLI	==1 if hhs have non-labor income,= 0 otherwise
DNAGWE	==1 if hhs participate in non-agricultural wage employment ,=0 otherwise
LIVEINCOME	Income from the sale of livestock and livestock product
OFFINCOME	Total household income generated from off-farm activity
CROPINCOME	Total household income from food crops and cash crops
NONLABINCOM	Households non-labor income
SELFINCOME	Households income from non-farm self employment
WAGEINCOME	Households Wage income
SHARELIV	Share of livestock income in the total household income
SHARECROP	Share of crop income in the total household income
SHAREOFF	Share of off-farm income in the total household income
SELFSHARE	Share of non-farm self employment to the total income
WAGESHARE	Share of wage income to the total household income
NONLABSHAR	Share of non-labor income to the total household income
TOTALINCOME	Total household income
DTIGRAY	==1 if region is Tigray,=0 otherwise
DAMHARA	==1 if region is Amhara,=0 otherwise
DOROMIA	==1 if region is Oromya,=0 otherwise
DSOUTH	==1 if region is Southern nation nationalities and peoples,=0 otherwise
DAIRA	==1 if land of hhs is irrigated,=0 otherwise
DAOXEN	==1 if any oxen owned
TROLIVU	Tropical livestock unit
DSELF	==1 if hhs participate in self-employment activities =0 otherwise
DQL	=1 if the hhs land quality is lem,=0 otherwise
DFFW	==1 if households participate in food-for-work activities,=0 otherwise
HDI	Herfindhal Diversification Index
DAGRIEXT	==1 if hhs was under agricultural extension program,=0 otherwise

DSOLCON	=1 if hhs practice any soil conservation measure on his/her plots, =0 other
FSI	Food security index
IDIOSHOCK	==1 if hhs members too ill to critical harvest period,=0 otherwise
COVSHOCK	==1 if the community face flooding in the community,=0 otherwise
DPSP	==1 if households participate in productive safety net program,=0 otherwise

Appendix 2

Table A2. Test of instruments and Endogenity

Type of tests	Hypothesis	p-value	Decision
Wu-Hausman F test:	Regerssor expected to be endogenous is exogenous	0.0035	Reject
F-test	The coefficients of the instruments in the first regression is jointly zero(instruments are relevant in explaining the endogenous variable)	0.0015	Reject
Sargan statistic	The instruments used is valid	0.86	Accept

Appendix 3.

Table A4: Tests of over identifying restrictions:

Sargan (score) chi2(3) = .714361 (p = 0.8698)

Basmann chi2(3) = .708681 (p = 0.8712)

Appendix 4

Table A5:Tests of endogeneity

Ho: variables are exogenous

Durbin (score) chi2(1) = 8.60062 (p = 0.0034)

Wu-Hausman F(1,2658) = 8.5639 (p = 0.0035)

Appendix 5

Table A6 :Heteroscedasity Test

Cameron & Trivedi's decomposition of IM-test			
Source	chi2	df	p
Heteroskedasticity	437.52	237	0.0000
Skewness	157.18	21	0.0000
Kurtosis	37.32	1	0.0000
Total	632.03	259	0.0000

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of HDI

chi2(1) = 20.08

Prob > chi2 = 0.0000

Appendix 6

Table A7: Multicollinarity diagnostics using Variance Inflation Factor

Variable	VIF	1/VIF
NAHM	3.21	0.311152
TROLIVU	2.39	0.418443
NOXEN	2.21	0.451703
HHSIZE	2.11	0.473246
DRATIO	1.68	0.593622
DSEHH	1.62	0.618628
DPOHH	1.57	0.638551
DFM	1.37	0.728448
DPE	1.33	0.74988
IDIOSHOCK	1.32	0.759911
DHE	1.3	0.768184
DAGRIEXT	1.29	0.775993
COVSHOCK	1.29	0.777964
AHH	1.25	0.800903
FASIZE	1.22	0.819477
DSOILCON	1.16	0.859953
DOTHEREDU	1.13	0.881097
DAIRA	1.13	0.888445
DACRI	1.11	0.90408
DSE	1.09	0.916817
DQL	1.08	0.924332
Mean VIF	1.52	

Appendix 7.

Table A8: Principal component

Components	Eagienvaues	Proportion	Cumulative variance
Comp1	1.44224	.450993	0.2884
Comp2	.991251.	0.1983	0.4867
Comp3	.976829	0.1954	0.6821
Comp4	.817483	0.1635	0.8456
Comp5	.772193	0.1544	1.0000

Appendix 8

Table A9: Component Loading

	Component loading		
Variables	Comp1	Comp2	Comp3
FASIZE	**0.5592**	-0.0891	-0.1532
PFCD	0.3129	0.0163	**0.8830**
NOXEN	**0.5030**	-0.3412	-0.3971
DSTORE	0.2088	**0.9348**	-0.1785
DOFF	**0.5411**	0.0389	0.0857

Appendix 9

Table A10: Pair Wise Correlation among Variables Utilized In the Estimation

	HHSIZE	DRATIO	DAGRIEXT	DSOILCON	IDIOSH~K	COVSHOCK	AHH
HHSIZE	1.0000						
DRATIO	0.3404	1.0000					
DAGRIEXT	0.0799	0.1945	1.0000				
DSOILCON	0.0096	0.0870	0.1507	1.0000			
IDIOSHOCK	-0.0026	-0.2168	-0.1698	-0.0984	1.0000		
COVSHOCK	-0.0448	0.1119	0.0361	0.0801	0.2151	1.0000	
AHH	-0.0552	0.0273	0.0030	0.0212	-0.0681	0.0653	1.0000
DPE	0.1729	0.0991	0.0783	-0.0862	-0.0134	-0.0371	-0.3282
DHE	0.0960	-0.2098	-0.1725	-0.1021	0.2153	-0.1667	-0.1474
DSE	0.0809	0.0339	0.0615	-0.0343	0.0010	0.0110	-0.1161
DOTHEREDU	0.0181	0.0066	-0.0323	0.0658	0.0115	0.0092	0.0298
DIL	-0.2101	-0.1370	-0.0976	0.0089	0.0405	0.0258	0.2824
NAHM	0.5992	0.6261	0.2926	0.1217	-0.2744	0.1737	0.0007
DSEHH	0.2879	0.1341	0.0029	-0.0751	0.0365	0.0314	-0.0225
DFM	-0.0426	-0.1772	-0.2170	0.1381	0.0954	-0.1177	-0.0688
NOXEN	0.2431	0.1220	0.1253	0.1195	-0.0510	0.0021	-0.0210
FASIZE	0.1192	0.1370	0.2409	-0.0072	-0.0957	0.0173	-0.0038
TROLIVU	0.2964	0.1561	0.2314	0.1360	-0.1178	-0.0098	0.0367
DPOHH	0.2521	0.1207	0.0983	-0.0019	-0.0171	0.0466	-0.1258
DACRI	0.0492	0.1182	0.1717	0.0084	-0.0139	0.1074	-0.0871
DQL	0.0564	0.0243	0.0423	-0.1797	-0.0537	-0.0295	-0.0048
FSI	-0.1286	0.0162	0.1617	0.0700	-0.0444	-0.0328	0.0064
DPSP	-0.0278	0.1755	0.1242	0.2222	-0.0427	0.2573	0.0046
HDI	0.0912	0.1571	0.0622	-0.0262	-0.0175	0.1253	-0.0395

	DPE	DHE	DSE	DOTHER~U	DIL	NAHM	DSEHH
DPE	1.0000						
DHE	-0.0127	1.0000					
DSE	-0.1046	0.0441	1.0000				
DOTHEREDU	-0.1810	0.1137	-0.0624	1.0000			
DIL	-0.6420	-0.0774	-0.2052	-0.3752	1.0000		
NAHM	0.1570	-0.2634	0.0833	-0.0277	-0.2023	1.0000	
DSEHH	0.1991	0.0773	0.0486	0.0820	-0.2554	0.1594	1.0000
DFM	-0.1325	0.2274	-0.1032	0.2464	0.0224	-0.2659	0.0087
NOXEN	-0.0129	0.0105	0.0335	0.1276	-0.1225	0.1630	0.1850
FASIZE	0.0592	-0.1109	0.0328	0.0470	-0.1158	0.2291	0.0771
TROLIVU	0.0311	-0.0749	0.0460	0.0818	-0.1569	0.2942	0.1528
DPOHH	0.1782	0.0465	0.0545	0.0638	-0.2254	0.1792	0.5673
DACRI	0.0773	-0.0841	0.0576	-0.0321	-0.0726	0.1875	-0.0155
DQL	0.0927	-0.0482	0.0021	-0.0578	-0.0223	0.0639	0.0857
FSI	-0.0065	-0.0561	0.0232	0.0443	-0.0573	-0.0100	0.0175
DPSP	-0.0451	-0.2021	-0.0516	0.0493	0.0230	0.2097	-0.0679
HDI	0.0611	-0.1191	0.0464	0.0008	-0.0694	0.2188	0.0254

	NAHM	DSEHH	DFM	NOXEN	FASIZE	TROLIVU	DPOHH
NAHM	1.0000						
DSEHH	0.1594	1.0000					
DFM	-0.2659	0.0087	1.0000				
NOXEN	0.1630	0.1850	0.1284	1.0000			
FASIZE	0.2291	0.0771	0.0371	0.2101	1.0000		
TROLIVU	0.2942	0.1528	-0.0010	0.7137	0.3165	1.0000	
DPOHH	0.1792	0.5673	-0.0095	0.1965	0.0729	0.1523	1.0000
DACRI	0.1875	-0.0155	-0.1802	-0.0537	0.1068	-0.0028	-0.0121
DQL	0.0639	0.0857	-0.1507	-0.0369	0.0668	0.0086	0.0783
DPOHH	0.1792	0.5673	-0.0095	0.1965	0.0729	0.1523	1.0000
DACRI	0.1875	-0.0155	-0.1802	-0.0537	0.1068	-0.0028	-0.0121

	DACRI	DQL	DPOHH	DACRI
DACRI	1.0000			
DQL	0.0251	1.0000		
DPOHH	-0.0121	0.0783	1.0000	
DACRI	1.0000	0.0251	-0.0121	1.0000

Appendix: 10

Table 11:Hausman Model Selection Test

	Coefficients			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fe	re	Difference	S.E.
AHH	-.0000502	-.0006473	.0005971	.0005446
HHSIZE	-.0046401	-.0017545	-.0028857	.0019647
NAHM	.0129556	.0122889	.0006667	.0019587
DRATIO	.002652	.002763	-.000111	.0016858
DSEHH	.0068642	.0035896	.0032746	.01601
DPE	.0227427	.0124866	.0102561	.0178904
DHE	-.0077376	-.0264892	.0187516	.0085039
DSE	.0251553	.0268582	-.0017029	.0449744
DOTHEREDU	.0292757	.0175417	.011734	.0169118
DFM	-.0051104	-.0032675	-.001843	.0006224
DAIRA	-.0249254	-.0134318	-.0114936	.0111447
FASIZE	.0116449	.0081068	.0035381	.0017734
TROLIVU	.002517	. 0033625	-.0008455	.0016366
DACRI	-.00244	.0131784	-.0156184	.0062147
DQL	.0072392	.0019831	.0052561	.0064706
DPOHH	-.0018884	-.013253	.0113646	.0094982
NOXEN	.0006007	-.0028737	.0034744	.0058368
DAGRIEXT	-.0238009	-.0128112	-.0109897	.0069727
DSOILCON	-.0341942	-.0301432	-.0040511	.007062
IDIOSHOCK	.0163734	.013597	.0027764	.0059985
COVSHOCK	.0359269	.0305713	.0053556	.0056238
	b = consistent under Ho and Ha; obtained from xtreg			
B =	inconsistent under Ha, efficient under Ho; obtained from xtreg			
Test: Ho:	difference in coefficients not systematic			
	chi2(21) = (b-B)'[(V_b-V_B)^(-1)](b-B)			
	32.48			
	Prob>Chi2 = 0.1567			

Declaration

I, the undersigned, declare this thesis is my own work and has never been presented in any other university. All sources of materials used for this thesis has been duly acknowledged.

Declared by:

Bassie Yizengaw

Signature_____

Confirmed by Advisor

Name: Tassew Woldehanna (PhD)

Signature: _____

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June, 2014