ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

RURAL LIVELIHOOD STRATEGY SEGMENTS AND DYNAMICS IN ETHIOPIA: EVIDENCE FROM PANEL HOUSEHOLD SURVEY

BY

BEZANEH ALEMU

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A THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY, COLLEGE OF DEVELOPMENT STUDIES CENTER FOR REGIONAL AND LOCAL DEVELOPMENT STUDIES IN THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER'S DEGREE IN REGIONAL AND LOCAL DEVELOPMENT STUDIES.

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Declarations

I, the undersigned, declare that this thesis is my own and original work and has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged, following the scientific guidelines of the university.

Addis Ababa

October 2020

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Bezaneh Alemu Desalegne

CONFIRMATION

This final Thesis has been submitted for examination with my approval as a University supervisor.

Name of Advisor- Yeshitela Wondemeneh (Ph.D.)

Signature……Date…….

Approval

This is to certify that the thesis prepared by Bezaneh Alemu Desalegn entitled "Rural livelihood strategy segments and dynamics in Ethiopia: Evidence from panel household survey" and submitted in partial fulfillment of the requirements for the Degree of Master of Art in Regional & Local Development Studies, it complies with the university regulations and meets agreed standards of originality and quality.

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List Acronyms and Abbreviations

BGLW: *Becketti, Gould, Lillard and Welch test*

CPI: *Consumer Price Index*

CSA*: Central Statistics Agency*

DFID*: Department for International Development*

ESS*: Ethiopian Socioeconomic Survey*

FAO*: Food and Agriculture Organization*

GLM*: Generalized linear model*

LCM: *Latent cluster Model*

LSMS*: World Bank Living Standard Measurement Surveys*

MLM*: Multinomial logit model*

OLM*: Ordered logit model:*

OLS: *Ordinary Least Squares*

PCA*: Principal Component Analysis*

PEN*: Poverty Environment Network*

TPM*: Two Part model*

UNDP*: United Nation Development Program*

ABSTRACT

Rural households are heterogeneous: different socio-economic features and asset endowments of households determine their engagement in various livelihood activities resulting in different livelihood outcomes interims of income. Poverty reduction policies, wellbeing improvement, or households' welfare policy should consider this. The study aims to detect the classification of rural livelihood strategies, investigates the interactions between livelihood strategies and outcomes, livelihood strategies transitions, and Captures the dynamics and underlying factors of long-term changes. Using Ethiopian Socio-Economic survey (ESS) three-wave panel dataset of 2011, 2013, and 2015 years based on 3639 households from the entire country, the study employed two-part model that combines households' assets and income in order to identify different livelihoods strategy clusters and regression estimation to uncover the determinants of livelihood choices and mobility

Based on a Latent Markov Model, the study identifies nine distinct livelihood strategies and analyses households' movements between strategies through time. The study results show that over 42.2% of households change livelihood strategies between 2011 and 2015 year. A common pathway to improve household wellbeing is an intermediate step, in which household's accumulated assets and capital through farming, Livestock rearing, self-employment, wage, and migratory work and Very few households have moved directly from the least to the most remunerative strategy. The study identifies covariates that influence the choices of livelihood strategies and affect the access of households to more remunerative strategies., for instance household adults' size, ownership of physical assets, and access to financial resources. Compared to both the asset and income method, the applied approach of combining income and assets better distinguishes the identified livelihood. These findings Indicted policy implications for improving the livelihood choices range to lower-income groups to enhance their livelihoods.

Keywords: "the combined asset and income approach"; two-part model; latent Markov model; dynamics livelihood strategies

CHAPTER ONE

INTRODUCTION

1.1Background of the study

Livelihood strategies describe what households do for a living. Understanding these strategies thus entails investigation of what assets households own or have access to, and how these assets are allocated to different livelihood activities. A particular asset may have many different uses, e.g. a plot of agricultural land can be used to grow wheat or be leased out, resulting in several possible activities and thus strategies. Understanding livelihood strategies is important to gain insights into what households choose to do, given their asset and enabling and constraining contextual factors such as policies regulating environmental product harvesting. Households are far from homogenous and their problems cannot be solved with uniform interventions. However, In the way they make a living, some rural households have common characteristics and this can form the basis for grouping households into similar livelihood strategies, allowing the development of strategy-targeted policy interventions based on what households do and what they lack, rather than targeting households solely based on livelihood outcomes e.g., income(Walelign,2017).

How can livelihood strategies be quantitatively determined? There are many approaches, with different strengths and weaknesses, making the choice of approach depends on individual study objectives, context, and availability of data. The most common approach to characterizing household strategies is to classify households according to the share of income earned in various sectors of economy. (e.g., Barrett et al., 2005; Dercon & Krishnan, 1996). A major drawback of this approach is that it does not adequately represent the way in which rural households allocate their labor, assets, and credits into different activities. For example, households may pursue different livelihood strategies even if the total outcome of the activities in which they engage, as measured in income, is the same. Another limitation of income-based measures for livelihood strategies cluster analyses is due to the stochastic nature of income. For example, agricultural income shows considerable yearly fluctuations due to climatic variation; but low income in low return years does not necessarily imply less importance of this activity to rural households. Accordingly, income-based measures are not suitable for providing insights into what people do to gain a living, what income options provide the most promising means to escape poverty, and what entry barriers prevent the

accumulation of wealth (Nielsen et al.,2013). In order to minimize problems with income-based method, analysts have turned to asset-based approach (Brown 2006; Jansen et al. 2006; van den Berg 2009 Ansoms and McKay 2010; Nielsen et al. 2012, 2013). This approach uses different types of assets as choice variables. Assets are typically divided into natural, physical, human, social, and financial categories (Ellis, 2000) and the approach is often implemented across the entire spectrum of asset categories. Assets can also be categorized as productive (e.g., land, education) and non-productive (e.g., jewelry), or tangible (e.g., land, jewelry) and intangible (e.g., education, experience). Ansoms and McKay (2010) applied an asset approach in Rwanda, combining it with a few variables reflecting livelihood conditions (e.g., remoteness) and outcomes (e.g., income) as choice variables. Households invest in a combination of their assets used to make income from different sources; since assets are not stochastic, household well-being is arguably more accurately expressed. However, the use of assets as a key measurement of welfare does not make it easy an understanding of how households combine assets to produce income from a range of activities.

another approach is activity choice approach, which is activity choice to base livelihood strategy grouping on activity choice variables; It classifies household livelihood strategies according to households' allocation of assets (including labor and other inputs) into different income-generating activities (Barrett et al, 2001; Nielsen et al, 2013; Jiao et al, 2017). To capture how households, allocate their assets into income-generating activities, the approach uses activity-based variables as proxies. Labor allocation and input costs are arguably the most direct measures of asset allocation to livelihood activities (Nielsen et al, 2013).

The fourth emerged efficient approach that research used approach to classifying livelihood strategies is a method of combining income and asset approach; this approach uses both income and assets as choice variables. However, they are measured in different units. These can be related using a multivariate statistical model where all asset types (using the actual values of the assets that each household owns) are regressed against the income generated from each livelihood activity. This creates a composite asset index that allows predictions of each household's income from each livelihood activity, e.g. the predicted crop income is derived from the composite asset index used in crop production. Both the dependent variable (income) and the choice variables (the predicted values) are expressed in monetary units. Walelign et al (2017) and Walelign and Jiao (2017) applied the combined income and asset approach in Nepal.

The fifth common approach to measuring choice variables in the literature is the choice experiment approach. The choice experiment approach uses stated livelihood strategies. The study units are expected to consider the assets they have and their enabling and constraining contexts before making their stated choice. Unlike the approaches presented above, the choice variables (called attributes, and often comprising a set of livelihood activities, assets, and contextual factors) are selected and defined by the researcher based on literature and focus group discussions. The choice variables are combined through shuffling their attribute levels (using an experimental design) to generate several choices sets, each representing a couple of alternative livelihood strategies. Typically, several choice sets are generated and presented to the study units that select their most preferred livelihood strategy for each choice set. This approach is mainly used to assess (i) responses to changes that affect livelihood strategies, and (ii) the relative value placed on different livelihood activities. Walelign et al (2019) applied this approach to examine preferences for different livelihood activities in connection to the construction of an all-weather road in the Greater Serengeti Ecosystem in Tanzania. Nielsen et al (2014) used it to assess bushmeat hunters' preferences between bushmeat hunting and wage employment in the Kilombero Valley of Tanzania.

Regarding with rural livelihood dynamics, till 2020, only three studies have quantitatively investigated dynamic rural livelihood strategies and their transitions through time across the globe, all of them conducted on Asian counties (Van den Berg, 2010; Walelign, Pouliot, Larsen, & Smith-Hall, 2017, and Jiao et al, 2017). According to xi jiao,70% of Cambodian households change livelihood strategies between 2008 and 2012 year in response to evolving pressures, incentives, and opportunities and also Walelign(2015)found that households in rural Nepal at least once between 2006 and 2012 year changed their livelihood strategies and also Very few households have switched or moved-up directly from the lowest to the most remunerative strategy.

In the context of Africa, until 2020 there is no research that quantitative empirical studies those systematically analyzing rural livelihood strategies and their transitions through time. however, some research conducted on the impact of the positive and negative shock on livelihood dynamism. Motsholapheko et al. (2011) showed that households in Botswana in response to extreme flooding, they changed their livelihood strategies.

In the context of Ethiopia even though there are studies conducted on the impact of the positive and negative shock on livelihood dynamics; e.g. Berhanu et al. (2007) change

observed that is households shifted from pastoralism to a diversified livelihood in the semi-arid environment of Ethiopia in reaction to an external shock in the pastoral system and patterns, There is no any research that quantitative empirical studies that systematically analyzing rural livelihood strategies and their transitions through time. These studies demonstrate that the dynamics of livelihood strategies have been quantitatively analyzed to a limited degree so far. The importance of using panel datasets to better understand rural livelihoods in the tropics and sub-tropics has also been emphasized in recent research. (Angelsen et al. 2014).

Here the study proposes a quantitative approach that used both income and asset data to identify household activity choice variables and which then used as basis for classifying clusters of livelihood strategies and examining the movement of households between clusters over time. The study applied Principal Component Analysis (PCA) to reduce the potential correlation between the choice variables and a latent Markov cluster model to identify or cluster household livelihood strategies. Then Researcher then constructed a livelihood transition matrix to examine households' transition among the livelihood strategies from 2011 year to 2015 year. Finally, employed a multinomial logit model and an ordered logit model, Researcher uncover the determinants affecting the choice/practice of livelihood strategies and the likely pull and push factors leading to upward or downward livelihood strategy mobility (in association with income levels). The research therefore makes two major contributions to the literature on livelihood and rural development. First, it applied combining income and asset approach for livelihood clustering in Ethiopia context and at the macro-level (national level). Second, the approach is applied to a three-wave data panel dataset of the Ethiopian socio-economy survey to provide empirical evidence on rural livelihood dynamics in Ethiopia.

1.2 Statement of the problem

Some rural households invariably exhibit similar characteristics despite substantial heterogeneity within rural households. For instance, the extent of engagement into livelihood activities, in terms of household and/ or household head characteristics, in terms of asset possession, and the resulting productive outcomes. the basis for clustering households into multiple distinct categories could be one or more of these similarities. household livelihood strategies are the resulting classifications. Livelihood strategies are combination of practices

in which households live at a point in time as well as sustain and enhancing their livelihoods over time. (Ellis 2000). Identifying and understanding of livelihood strategies of rural households has been instrumental in the literature on livelihoods in the attempt to answer the three research questions below: which households' income-generating activities do poor households and those who descend into poverty follow? Which activities create opportunities for households to move out of poverty? And which barriers or obstacle prevent poor households from engaging in activities that allow them to escape poverty? Answering these questions is important for formulating effective poverty reduction policies and/ or strategies. Thus, Classification of livelihood strategy and investigation of its transitions in a systemic and quantitative approach is important for understanding the dynamics of rural livelihoods, the determinants of livelihood strategy choices and mobility, and the implications for designing effective poverty alleviation and rural development strategies.

Although several studies have classified households' livelihood strategies (e.g. Walelign 2016; Nielsen et al. 2013; and Brown et al. 2006), they lack dynamic livelihood perspectives (Scoones 2009 and Zoomers 2005) amid ample evidence that in response to the change in asset endowments and mediating factors, rural livelihood strategies are a dynamic process by nature (Motsholapheko et al. 2011; Jones and Thornton 2009; and Berhanu et al. 2007).

Hence, dynamic livelihood studies are required to strengthen the empirical evidence on households' livelihood dynamics and to formulate effective poverty reduction policy and / or interventions and enhance the effectiveness of these policy and / or interventions (Scoones 2009; and de Haan and Zoomers 2005). However, limited studies have quantitatively (e.g. van den Berg 2010) or qualitatively (Sallu et al. 2010; Ulrich et al. 2012) examined rural livelihoods from a dynamic perspective till 2020; mainly because of the limited of panel datasets and the lack of approach conducive to the study of livelihood dynamics impacted for the limited studies has been performed. These dynamic studies are conducted at micro level i.e. focused on sub-national level only. On top of this, existing static and dynamic livelihood strategy studies have been employing livelihoods segmenting approach that have inherent practical limitations. For example, (i) the income approach (e.g. Walelign 2016; Chilongo 2014; Zenteno et al. 2013; and Tesfaye et al. 2011) suffers due to the stochasticity of income and The seasonality of most sources of rural income (e.g. Nielsen et al. 2013; and Jansen et al. 2006), (ii) the activity choice or investment cost approach (e.g. Nielsen et al. 2013; Brown et al. 2006; and Jansen et al. 2006) Fails to account for the broader asset range and (iii) the asset approach (e.g. Ansoms and McKay 2010) lacks association between livelihood

activities/outcomes and assets . So, additional dynamic livelihood studies should have conducted with new innovative livelihood clustering approaches that minimize one or more limitations of Asset, Income and/or Activity choice approaches. Therefore, this study provides one of the first empirical studies of the systemic transformation of livelihood strategies over time and to overcome the limitations that reviewed in the three approaches stated above.

Moreover, these types of work are not attempted so far in Ethiopia based on panel data both at the micro and macro level. Thus, the result of this study is expected to add fresh knowledge in the area of livelihood strategies and dynamics in the Ethiopian context. In addition to that, regarding with the method of research, the research applying the new emerging approaches i.e. the combing income and asset approach to classifying or segmenting livelihood strategies, this method attempted only by two literature (Walelign et al (2017) and Walelign and Jiao (2017) so far. This approach uses both income and assets as choice variables. However, they are measured in different units. These can be related using a multivariate statistical model where all asset types (using the actual values of the assets that each household owns) are regressed against the income generated from each livelihood activity (e.g., grouped under headings such as crop production, livestock rearing, business operation, and wage employment)

The study relies mostly on the Ethiopia Socioeconomic Survey (ESS), which is collected in 2011, 2013 and 2015 year, is also jointly collected by Central Statistical Authority and World Bank Living Standards Measurement Study (LSMS). Therefore, the purpose of the study is to identify the classification rural livelihood strategies classification in Ethiopia rural context, their movement, and factors that affecting these processes and changes.

1.3 Research Objectives

1.3.1 General objective

The general objective of this paper is to empirically apply a dynamic livelihood strategy approach to examine transitions in household livelihood strategies over time and factors influencing these processes and changes

1.3.2 Specific Objectives

The research project is guided by the following objectives:

1. To identify the classification of rural livelihood strategies

2. To examine the association between household livelihood outcomes (income level) with the choice/ practice of livelihood strategies
3. To examine households' transition among the livelihood strategies between 2011 and 2015 year
4. To identify the determinants (i.e. assets, contextual factors) affecting choice/practice of livelihood strategy
5. To examine determinants factors that influence the households' movement among the livelihood strategies over time

1.4 Research Questions

1. What are the rural household livelihood strategies?
2. How do households transit between strategies over time?
3. How household livelihood outcomes (i.e., income level) significantly associated with the choice/ practice of livelihood strategies?
4. What are the determinants (i.e. assets, contextual factors) affecting choice/practice of livelihood strategy?
5. What are the determinants factors that influence the households' movement among the livelihood strategies over time?

1.5 Significance of the study

The government: The researcher hopes the study will inform government policy about Livelihood Strategies and Dynamics in rural Ethiopia.

NGOs: It will help them in development plan formulation, for development projects; by incorporating the needs and engaging activities of all livelihood strategies towards achieving the target outcome in projects.

Academic purpose: The result of the study could serve as a reference for further study on the subject matter.

1.6 Scope of the Study

This study uses panel data of households from three rounds of the Ethiopian Socioeconomic Survey (ESS), which is collected in 2011, 2013, and 2015 year. The spatial scope is limited to rural areas only. Therefore, it has covered all regional states and Dire Dawa City administration rural kebeles. Hence, the scope of this study confined to the investigation of the dynamics of livelihood strategies in the rural Ethiopia for the period of 2011-2015

1.7 Limitation of the study

The study focused only on rural livelihood strategies segmentation. So given different contexts of urban and rural livelihood strategies. Therefore, the findings may not be enough to generalize to livelihood strategies segmentation at country level. Moreover, the latest data available is for 2015/16, which is 4-5 years away from the date that this research is conducted. But it is believed that the data will somehow approximate the current poverty status of the country.

1.8 Definition of significant terms as used in the study

Livelihood: A livelihood encompasses the assets (including both material and social resources), the capabilities, and activities required for a means of living. (Chambers and Conway 1991)

Livelihood strategies: livelihood strategies are consisting of activities that generate household survival means and are planned activities that undertaken by men and women to build their livelihood Ellis (2000)

Income approach: This approach uses income from livelihood activities as choice variables. Income can be defined in many ways but is, in quantitative livelihoods studies, typically counted as the sum of the value of all the products and services from the income source minus the cost of all inputs used (Angelsen et al, 2011, 2014).

Asset approach: This approach uses different types of assets as choice variables. Assets are typically divided into natural, physical, human, social, and financial categories (Ellis, 2000)

Combining income and asset approach: This approach uses both income and assets as choice variables. However, they are measured in different units. These can be related using a multivariate statistical model where all asset types (using the actual values of the assets that each household owns) are regressed against the income generated from each livelihood activity (Walelign et al (2017)

Activity choice approach: The activity choice approach is a common approach to determine livelihood strategies. It classifies household livelihood strategies according to households' allocation of assets (including labor and other inputs) into different income-generating activities (Barrett et al, 2001; Nielsen et al, 2013; Jiao et al, 2017).

The choice experiment approach: The choice experiment approach uses stated livelihood strategies. The study units are expected to consider the assets they have and their enabling and constraining contexts before making their stated choice (Nielsen et al (2014)

Two-Part model: A two-part model is a flexible statistical model specifically designed to deal with limited dependent variables. In the two-part model, a binary choice model is fit for the probability of observing a positive-versus-zero outcome. Then, conditional on a positive outcome, an appropriate regression model is fit for the positive outcome.

Principal Component Analysis (PCA): is the process of computing the principal components and using them to perform a change of basis on the data, sometimes using only the first few principal components and ignoring the rest. PCA is used in exploratory data analysis and for making predictive models. It is commonly used for dimensionality reduction by projecting each data point onto only the first few principal components to obtain lower-dimensional data while preserving as much of the data's variation as possible

Latent Markov cluster analysis (**LMMs):** Latent Markov cluster models (LMMs) are widely employed in sequential data modeling both because they are capable of handling multivariate data of varying length, and because they capture the underlying hidden properties of time-series. Over the years, LMM-based clustering methods have been widely investigated and improved.

Multinomial logit model(MLM): it is a model that is used to predict the probabilities of the different possible outcomes of a categorically distributed dependent variable, given a set of independent variables (which may be real-valued, binary-valued, categorical-valued, etc.).

Ordered logit model(OLM): The ordered logit model is a regression model for an ordinal response variable. The model is based on the cumulative probabilities of the response variable: in particular, the logit of each cumulative probability is assumed to be a linear function of the covariates with Regression Coefficients constant across Response Categories.

1.9 Organization of the Study

the Paper is organized into six chapters; Chapter One included background of the study, research problem, research objective, research questions, significance of the study, delimitation of the study and definition of significant terms. Chapter two presents the review of related literature and empirical literature review while Chapter Three describes Research

philosophy, Data sources, Unit of analysis, Study area coverage and data collection, and finally data analysis techniques. Chapter Four focuses on data analysis, presentation, and interpretation. Chapter Five summarizes the discussion, and finally, chapter six presents a summary of findings, conclusions, and recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of related literature. It consists of various sections including; conceptual literature, theoretical literature, empirical studies, and a summary of previous studies finally, the chapter will be closed with a presentation of identified gaps and conceptual framework of the study. In this section, various materials will be cited after being critically reviewed and analyzed including journals and papers.

2.2 Conceptual Literature

This section discusses the core concepts used in the study, including livelihood, livelihood strategies, and its determinants.

2.2.1. Livelihood

Livelihood is a generic term that involves several components (De Haan 2012). Thus, there is no universally endorsed definition to grasp the term livelihood (Scoones 2009). The most widely used definition of livelihood is the one offered by Chambers and Conway built on participatory research practices of the World Commission on Environment and Development:

A livelihood included the assets (including both material and social resources), the capabilities, and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conway 1991:6)

Vital components of this definition are assets, capabilities, and activities required for means of living. Assets are resources that households combine to choose between available options of living for positive outcomes (Krantz 2001:1). From a livelihood perspective, these resources involve natural, social, financial, human, and physical capitals each having

different elements. Following the above definition, Carney (1998), acknowledges the notion of claims and access that enable households to combine their resources at disposal under wider structures and institutions to make a livelihood.

For Bebbington (1999:2022), resources not only shape livelihood strategies but also bake capabilities to act and to confront the social conditions that produce poverty. They are also the basis of an agent's power to act and to reproduce, challenge, or change the rules that govern the control, use, and transformation of resources. Capabilities are functions of peoples' initial endowments of Different types of capital assets that further strengthen the ability of people to undertake activities for cherished goals (Ellis 2000). For rural households, the ability to produce and feed its members relies on being able to farm or acquire from other sources which in turn depends on the possession of assets like skills, farmland, finance, market, and social networks.

2.2.2 Livelihood strategies

According to DFID (1999), livelihood strategies are defined as the combination of activities that people make to achieve their livelihood target and or goals , including productive activities, investment strategies, reproductive choices, etc. livelihood strategies are consisting of activities that generate household survival means and are planned activities that undertaken by men and women to build their livelihood Ellis (2000)

2.3 Theoretical Literature: The Sustainable Livelihood Approach

This study is guided by a sustainable livelihood approach. This is mainly due to its eclectic tendency to appraise the resource base of rural households, the way they combine their assets and pursue certain livelihood activities to achieve cherished livelihood outcomes (food security in this study). The sustainable livelihood approach looks beyond the sectoral view to addressing the livelihoods of people under consideration (ACF 2010; Morse and McNamara 2013). Moreover, it articulates the way people perform economically, socially, and environmentally viable livelihood (Krantz 2001:5).

Livelihoods perspective to rural life found its roots in 'systems' approaches to sectors such as agriculture. At the core of the approach was the recognition of the 'actors' strength in combining what they have at hand in choosing strategies for their sustenance. It works against the notion of poor people as powerless (Hadju 2006; De Haan 2012). For it is a pro-poor development tool, it was typically applied in poorer countries as a part of policy

planning, project, or perhaps as a base for more in-depth research (Morse and McNamara 2013).

The livelihood approach as a poverty reduction model became the primary focus of much international development work in the 1990s and 2000s (Scoones 2009). Theoretical roots of the sustainable livelihoods approach shifted from the nation-state orientation of prior community development efforts, which focused on modernization and political control, to advocating for the analysis of the realities of poor and marginalized people from their own perspective (Arce 2003:202).

The sustainable livelihood approach stands on the basic premises that people draw on different livelihood resources under certain contexts. Resources are filtered through structures and processes to be employed in activities of making living. As such, the livelihood approach starts with an analysis of people's livelihoods and how these have been changing over time with a basic emphasis on people and impacts of different policies on people's livelihoods (Farrington et al. 1999; Scoones 1998; Carney 1998; Castalonge 2008; Murray 2001).

The sustainable livelihood approach has four fundamental relevance in explaining rural household food security over previous approaches: food availability, food entitlement, and basic needs approach. First, it offers long-term insight into people's livelihood, second, it acknowledges the wider context under which people perform and it gives due attention to the resilience of people in maintaining their living. Moreover, it extends beyond a narrow focus on agriculture, apprehends non-farm activities in enhancing food security. Finally, livelihood approaches provide useful input in disaggregating national-level data giving rise to enable more sensitive and differentiated policies and interventions (Young et al. 2001; Hussein 2002: 5; Burchi and De Muro 2012:16).

2.3.1 The Sustainable Livelihood Framework

The livelihood approach to addressing rural poverty is sketched through a sustainable livelihood framework that is developed, and adapted by various agencies for different interventions. It provides the main factors that influence people's livelihoods and typical relationships between them (Haidar 2009). The framework emanated from focuses on the underlying interest in food security and new interest in sustainability in peasant studies of the 1980s. It is a useful analytical instrument that provides researches an insight to depart from where the people are living and what they are doing to sustain life (Castalonge 2008; Scoones

2009). UNDP, CARE, DFID, and OXFAM are among the main agencies which employ the the livelihood framework (Hussein 2002).

All frameworks base their landmark on the definition of Chambers and Conway (1991) and hence incorporate the fundamental elements of livelihood: assets, capabilities, and activities for making living. However, a slight difference could be noted based on household endowments and micro-macro level interplay which affects the performance of rural livelihoods. DFID is the most widely used framework for analyzing sustainable rural livelihoods (Bennett 2010).

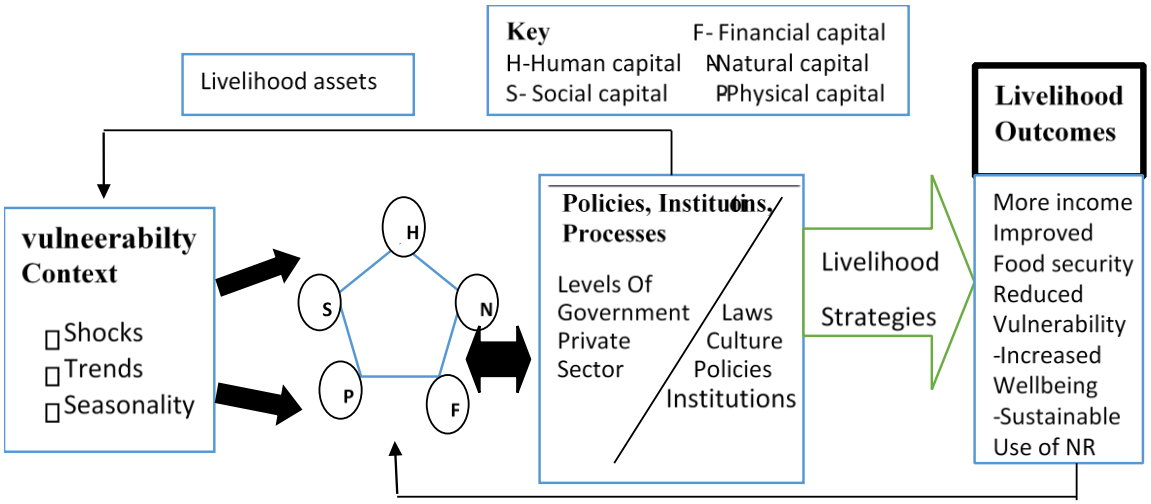


Figure 2. 1 Sustainable livelihoods framework (Source: Farrington et al. 1999)

2.2.2. Components of the Sustainable Livelihood Framework

Assets

Central to the framework is a pentagon of livelihood assets or capitals that can be utilized for achieving desirable outcomes, reducing the vulnerability of households (Farrington et al. 1999). These are resources, combined by households to make living possible (Hadju 2006). The shape of the pentagon depicts the variation in people's access and contribution from different dimensions of resources to the livelihood of households (DFID 1999). Analysis of assets in the rural livelihood, therefore, needs to examine the functions of different asset types held by the poor who undertake different livelihood strategies (Dorward et al. 2001; Arce 2003). Different scholars used different connotation of what constitute resources for rural households (Ellis 2000). As drawn from the DFID framework, five capitals are identified as the major assets. These are natural, social, human, financial, and physical capital.

Natural capital represents capitals from which ecological services flows and resource useful for livelihoods are derived. It includes land, water, wildlife, biodiversity, or environmental resources. Physical capital comprises basic infrastructure (transport, shelter, water, energy, and communications), production equipment, and means which enable people to pursue their livelihoods (DFID 1999). Physical assets make the interface between natural capital and livelihood strategies of rural people possible; it allows human beings to work with their environment.

Human capital involves skills, knowledge, and ability to labor and good health important to the ability to pursue different livelihood strategies (Krantz 2001: 9). It constitutes the capability of individuals to pursue their livelihood strategies. The financial resources which are available to people (whether savings, supplies of credit or regular remittances or pensions) and which provide them with different livelihood options make up financial capital. Finally, Social capital denotes the social resources (networks, membership of groups, relationships of trust, access to wider institutions of society) upon which people draw in pursuit of livelihoods (Farrington et. al 1999; Bennett 2010:9).

While most of these assets are considered in terms of the household, they exist under the wider context which necessitates the mediating factors that promote access and utilization (Morse and McNamara 2013:21). Resources can be destroyed or shaped by trends or shocks (Haidar 2009).

Vulnerability Context

Livelihoods are complex and changing and hence confront different risks. Risk factors that surround livelihoods are referred to as the vulnerability context. Vulnerability denotes proneness to a sudden, catastrophic, or fall in the level of living. It manifests as seasonality, sudden shocks, and trends that grapple the consumption smoothing of households. Vulnerable households live in a poverty trap (Løvendal, Knowles and Horii 2004; Ellis and Freeman 2005; Young et al. 2001).

Vulnerability context frames the external environment in which people make living. Shocks

(economic, health, natural El Nino, conflict) can destroy assets directly (Kassa 2015; Defferew 2011; Gutu et al. 2012). Seasonal shifts in prices, employment opportunities, and food availability are the most enduring sources of hardship for rural poor. Other factors involve governance and technological trends (DFID 1999).

Impacts of vulnerability to shocks vary. Drought, for example, impacts natural capital and in turn, reduces crop yields. Population mobility in and out of a household or a community affects the level and intensity of social networks. Demographic trends also have implications for landholding and fragmentation (Morse and McNamara 2013:35). For rural household, changes in a resource like land affect agricultural livelihood activities. Nonetheless, the sensitivity of different livelihoods to shocks is not even. This segment of the sustainable livelihood framework addresses objective that accentuates the challenges facing smallholder farmers in the study at hand.

Mediating Factors: Transforming Structures, Policies and Institutions

Transforming structures and processes within the livelihoods framework are institutions, organizations, policies, and legislations that shape livelihoods. They mediate access to and control of resources by rural households. (DFID 1999; Degefa 2009). Local and national structures arrange access of resources for people to engage in fruitful livelihood activities (Scoones 1998). For a particular rural household, the land tenure system, availability and functioning centers of technology, social services providing structures, participatory decision-making systems constitute a bridge through which household secure access to resources which are considered vital for livelihood.

An uncertain market environment that is noted with fluctuations in producer prices, high input prices, and poor input supply constrains farming activities and investments (Winters, Corral and Gordillo 2001). Rural land administration, rural employment directions, the functional linkages between rural households to the administrative agencies, and agricultural extension are also relevant transforming structures and policies under which rural livelihoods operates (Morris et al. 2002). Lack of an appropriate credit provision system enforces smallholders to pursue pervasive agricultural extensification and hence encroach onto marginal lands. In the same vein, misguided land management, at the local level, results in an informal land transfer which leads to landlessness and hence pushes agrarian households to look for low return activities in the non-farm sector.

Livelihood strategies

livelihood strategies are consisting of activities that generate household survival means and are planned activities that undertaken by men and women to build their livelihood Ellis (2000). They include productive activities, investment strategies, and reproductive choices (Alionovi et al. 2010; Haidar 2009:8). The choice of livelihood strategies depends on access

to assets, policies, institutions, and processes that govern resource utilization to achieve positive livelihood outcomes (Scoones 1998).

Since assets and accesses are unevenly distributed among households, livelihoods portfolio of households within certain locality are various (Dorward et al. 2001). Many differences appear among those who are seemingly practicing the same livelihood strategy. Households with similar capital endowment may pursue different livelihood strategies because of Various objectives, preferences, limitations, and incentives attached to certain livelihood activities (Levine 2014:5). Therefore, besides asset endowments of households, the means through which households derive a livelihood from a particular combination of on-farm and off-farm activities are a more relevant criterion to understand poverty and resource use (Miyuki 2006).

Livelihood Outcomes

Households pursue certain livelihood activities to reduce vulnerability. Hence, the outcome of sustainable livelihood is beyond material needs (Haidar 2009). The outcomes of livelihood strategies include, but not limited to, increased income, more income, enhanced well-being, decreased vulnerability, strengthened food security, and more productive use of the natural resource base. (DFID 1999; Krantz 2001; Scoones 1998; Bennett 2010). These outcomes may be invested back on assets. For instance, increased income boosts financial stock (Castalonge 2008).

2.4 Empirical Literature Review

2.4.1 Approaches to measuring Livelihood segmentation choice variables

Quantitative identification of livelihood strategies involves five steps: 1) selection of choice variables, 2) development of data collection instruments (or identifying existing datasets), 3) data collection and quality control, 4) data analysis of choice variables, and 5) determination of livelihood strategies (and subsequent analyses). The selection of choice variables is thus central to the subsequent identification of strategies. Existing datasets should be used together with an in-depth understanding of how data was generated, including contextual limitations and qualitative information to guide the explanation of findings. Excellent advice is available on the development of livelihood data collection instruments (Angelsen and Lund, 2011; Lund et al, 2011), environmental product valuation techniques (Wunder et al, 2011), conducting high-quality fieldwork (Jagger et al, 2011a, b), and managing data (Babigumira,

2011). In this section, Researcher focus on discussing the selection and analysis of choice variables.

Choice variables often comprise multiple attributes of a single element (e.g. income) in the livelihood framework (Ellis, 2000; Scoones, 2015) or combined elements (e.g. income and assets) to identify livelihood strategies. It should be noted that the nature of the selected variables is closely related to the subsequent possibilities for livelihood strategy analysis, e.g. the dominant income source approach (see below) requires income data. Ideally, the selection of choice variables and approach to livelihood strategy analysis should be decided before data collection to optimize data collection instruments.

There are five common approaches to measure choice variables in the literature: the income, asset, a combination of income and asset, activity choice, and choice experiment approaches. Researcher briefly present and discuss each of these approaches.

2.4.1.1 Income-based approach

This approach uses income from livelihood activities as choice variables. Income can be defined in many ways but is, in quantitative livelihoods studies, typically counted as the sum of the value of all the products and services from the income source minus the cost of all inputs used (Angelsen et al, 2011, 2014). Income is often estimated from the entire spectrum of household activities and includes both cash (also from remittances and pensions) and subsistence incomes (e.g. if a household collects firewood for use in food preparation in their own home, the value of the firewood is counted as subsistence income). While there are no standard headings for aggregating income types, common groupings are crop income, livestock income, environmental income, business income, wage and salary employment, and other income. Either per activity absolute or relative income (the share of the income source in total household income), but not both, can be used as a choice variable. Tesfaye et al (2011) and Zenteno et al (2013) applied the income approach in Southern Ethiopia and in the Bolivian Amazon, respectively. Both used relative income from different sources as choice variables.

Advantages: Availability of income data. Most livelihoods focused (e.g., Poverty-Environment Network, PEN) and welfare focused (e.g., World Bank Living Standard Measurement Surveys, LSMS) surveys contain income data from different livelihood activities, although welfare-based datasets do not contain income from the forest and non-forest environmental resources. Another attractive advantage of this approach is the presence

of standard methods and protocols for measuring income in straightforward ways (e.g., PEN, 2007; Angelsen et al, 2011) that are now also being implemented as part of larger-scale standardized surveys (FAO, 2016).

Disadvantages: Income data does not contain information regarding allocations of inputs and hence does not reflect the use of assets across livelihood activities. Another disadvantage is the stochastic nature of income, e.g. crop income in rain-fed agriculture varies with rainfall and may even be negative in certain years. In such years, households whose main strategy is farm-based may appear to adopt non-farming strategies as they pursue alternative sources of income, making the income approach invalid. As income estimates a livelihood outcome and not livelihood activities, it may often be better suited to measure welfare than to determine livelihood strategies.

2.4.1.2 Asset-based approach

This approach uses different types of assets as choice variables. Assets are typically divided into natural, physical, human, social, and financial categories (Ellis, 2000) and the approach is often implemented across the entire spectrum of asset categories. Assets can also be categorized as productive (e.g., land, education) and non-productive (e.g., jewelry), or tangible (e.g., land, jewelry) and intangible (e.g., education, experience). Ansoms and McKay (2010) applied an asset approach in Rwanda, combining it with a few variables reflecting livelihood conditions (e.g., remoteness) and outcomes (e.g., income) as choice variables.

Advantages: Availability of asset data. As above, many livelihood and welfare surveys contain data on asset types. Another attractive advantage is that assets are less stochastic (compared to income) and more closely aligned to households' choices of livelihood strategies, e.g. households with a high number of cattle pursuing livestock-based strategies. The approach also permits the inclusion of intangible assets (e.g., social capital, education), that may be difficult to assign to specific income-generating activities, as choice variables.

Disadvantages: The approach focuses on assets owned rather than assets allocated to individual activities, weakening the link between household resource investment and livelihood activities. Another disadvantage is that assets are measured in different units (e.g., land in square meters, jewelry in monetary terms, bicycles in numbers) necessitating conversion to a common unit (typically monetary value) before comparisons can be made across the asset choice variables.

2.4.1.3 Activity choice approach

The activity choice approach is a common approach to determine livelihood strategies. It classifies household livelihood strategies according to households' allocation of assets (including labor and other inputs) into different income-generating activities (Barrett et al, 2001; Nielsen et al, 2013; Jiao et al, 2017). To capture how households allocate their assets into income-generating activities, the approach uses activity-based variables as proxies. Labor allocation and input costs are arguably the most direct measures of asset allocation to livelihood activities (Nielsen et al, 2013). Labour allocation in employment activities are commonly included in surveys, e.g. the number of wage labor days for each household member in agricultural and non-farm activities. Labour inputs in self-employed activities, such as the amount of time spent collecting firewood and mushrooms while also herding livestock, are difficult and time-consuming to measure (and hence not included as an input cost in standard income estimates). Instead, input costs (such as for raw materials) are often selected as activity variables for self-employed activities (Nielsen et al, 2013). In cases where self-employed natural resource-based activities require minimal input cost, indirect activity variables may be employed; for instance, the number of times that environmental products are collected can be a proxy variable for environmental activities (Jiao et al, 2017). Transfers, such as pensions and remittances, and business inputs and capital can be included as activity variables to reflect incomes generated from non-productive and other financial assets (Nielsen et al, 2013; Jiao et al, 2017). Jiao et al (2017) and Nielsen et al (2013) applied the activity choice approach in Cambodia, and Bolivia, Mozambique, and Nepal, respectively.

Advantages: The activity choice approach reflects the characteristics of asset investments in each livelihood activity and overcomes the problems related to the stochastic nature of income (Nielsen et al, 2013). The approach also enables analysis of relationships between livelihood strategies and welfare outcomes, e.g. allowing identification of possible push and pull factors that influence household choices of livelihood strategies (Jiao et al, 2017).

Disadvantages: Households in rural areas employ a significant part of their own labor in productive activities, a cost that is difficult to estimate due to lack of accounting of labor use (and sometimes difficulties in estimating appropriate local wage rates because of thin labor markets) and widespread multitasking/co-production. This makes it difficult to assign human asset uses to specific livelihood activities. This approach also oversees the importance of non-productive assets in household livelihood choices, such as social capital.

2.4.1.4 The combined income and asset approach

This approach uses both income and assets as choice variables. However, they are measured in different units. These can be related using a multivariate statistical model where all asset types (using the actual values of the assets that each household owns) are regressed against the income generated from each livelihood activity. This creates a composite asset index that allows predictions of each household's income from each livelihood activity, e.g. the predicted crop income is derived from the composite asset index used in crop production. Both the dependent variable (income) and the choice variables (the predicted values) are expressed in monetary units. Walelign et al (2017) and Walelign and Jiao (2017) applied the combined income and asset approach in Nepal.

Advantages: This approach shares all the advantages of the asset approach. And, in addition, it establishes linkage between owned household assets and income from each source, by indirectly inferring how much of each asset is invested in each livelihood activity. The approach also allows capturing nonlinearities and interaction effects of asset use on income generation.

Disadvantages: This approach overcomes both limitations of the asset approach but retains the disadvantage in the income approach related to the stochasticity of income (e.g., that farm-based strategy households may appear to adopt non-farming strategies: the predicted composite asset indices may be underestimated if income from individual activities have been affected by shocks). It should also be noted that this approach is computationally demanding (running appropriate statistical models to create the choice variables).

2.4.1.5 The choice experiment approach

The choice experiment approach uses stated livelihood strategies. The study units are expected to consider the assets they have and their enabling and constraining contexts before making their stated choice. Unlike the approaches presented above, the choice variables (called attributes, and often comprising a set of livelihood activities, assets, and contextual factors) are selected and defined by the researcher based on literature and focus group discussions. The choice variables are combined through shuffling their attribute levels (using an experimental design) to generate several choices sets, each representing a couple of alternative livelihood strategies. Typically, several choice sets are generated and presented to the study units that select their most preferred livelihood strategy for each choice set. This approach is mainly used to assess (i) responses to changes that affect livelihood strategies,

and (ii) the relative value placed on different livelihood activities. Walelign et al (2019) applied this approach to examine preferences for different livelihood activities in connection to the construction of an all-weather road in the Greater Serengeti Ecosystem in Tanzania. Nielsen et al (2014) used it to assess bushmeat hunters' preferences between bushmeat hunting and wage employment in the Kilombero Valley of Tanzania.

Advantages: The choice experiment approach is useful to uncover people's likely responses to interventions prior to implementation. The approach is also useful to estimate trade-offs – what are people's willingness to forgo one activity to get one unit of another activity. It is also relevant to infer people's preferences for different livelihood activities, particularly sensitive (illegal) activities.

Disadvantages: This approach is highly hypothetical – the choice sets represent hypothetical scenarios of livelihood strategies and people make hypothetical choices. The approach thus involves numerous assumptions, while not directly measuring livelihood strategies. It also involves sophisticated and complicated statistical models for constructing choice sets and inferring trade-offs and preferences. Lastly, it is time and resource consuming to generate data for designing the choice sets and to undertake the piloting and final analysis.

2.4.2 Approaches to Identify livelihood strategies

When the data on choice variables is ready, it can be used to identify livelihood strategies: this requires the application of a selected analysis technique that results in many livelihood strategies to which each household can be assigned. Strategies are often named (labeled) based on the characteristics of choice variables reflecting livelihood activities in a strategy (e.g., Walelign et al, 2017; Walelign and Jiao 2017). For instance, if a strategy is characterized by asset investment in farming combined with many other minor livelihood activities, it could be named diversified small-scale farmers. In this section, Researcher present three approaches to identifying livelihood strategies: the occupation-based, the dominant income source, and the statistical clustering approaches.

2.4.2.1 The occupation-based approach

This focuses on the primary livelihood activity in which a household is engaged. Identification of livelihood strategies, and assignment of study units into strategies, is done based on (i) the primary occupation of the household or more typically the household head, or (ii) scores of the primary and secondary occupations of the household head derived from principal component analysis, a technique to transform a large set of variables into a smaller

one retaining most of the original information. Jacobs and Makaudze (2012) and Pender et al (2004) applied this approach in South Africa and Uganda, respectively.

The advantages of this approach are that it is simple to apply and does not require detailed livelihood investigation, only data on households' primary and secondary occupation (dominant livelihood activities) are required. The major disadvantages are that (i) the determination of (the number of) livelihood strategies is subjective, mainly based on the researcher's contextual understanding, and (ii) the approach often does not consider the wider spectrum of income-generating activities.

2.4.2.2 The dominant income source approach

This approach focuses on each household's dominant income source. The share of each income source in total household income is estimated and households are then assigned to the livelihood strategy corresponding to their dominant income source. For instance, a household with its largest share of income from crop production is assigned to the crop production-based livelihood strategy. Eastwood et al (2006) applied this approach in Limpopo province in South Africa.

The advantage of this approach is that it is relatively simple to apply, only requiring estimation of the share of each income component in total household income, and uses the entire spectrum of income components. The disadvantages are that the determination of the number of livelihood strategies remains subjective, mainly based on contextual understanding of the researcher and that the approach often does not use the entire spectrum of income components when assigning households to strategies.

2.4.2.3 Statistical clustering approaches

This is the most common way to identify rural household livelihood strategies. Each of the clustering approaches uses multiple variables (the choice variables) to produce a single nominal variable (representing livelihood strategy clusters). The approaches are data-driven, allowing the data to speak for itself, thus (i) determining the optimal distinct number of livelihood strategies using statistical methods, and (ii) ensuring that study units in the same livelihood strategy are more similar to each other than to units in other strategies.

Before applying clustering approaches, the choice variables must be adjusted for household size to enable comparison across study units (e.g., Cavendish, 2002; Angelsen et al, 2014) and the correlation among the choice variables must be reduced using data reduction methods

(such as principal component analysis or factor analysis) to minimize distortion during cluster analysis. The latter also reduces the number of variables for inclusion in the cluster analysis. There are several statistical clustering methods. Here, we present two common methods: k-means and latent class clustering.

K-means clustering

K-means clustering is an iterative algorithm that assigns the study units to a predefined number of distinct livelihood strategies (clusters). The number of livelihood strategies is typically determined by visual inspection of a graph called a dendrogram, a tree-like diagram showing the arrangement of each study unit in the clusters. The assignment of individual study units is based on the distance between it and the center of each livelihood strategy – each study unit's sum of squared distances to each livelihood strategy center is calculated and the unit is assigned to the closest strategy (where the sum of squared distances to the center is minimum). Tesfaye et al (2011) and Brown et al (2006) applied this approach in Southern Ethiopia and the Kenyan highlands.

The advantage of this approach is that the assignment of study units to livelihood strategies is objective, based on distance. The disadvantage is the lack of statistical tests for determining the optimal number of livelihood strategies, which remains subjective to the interpretation of the dendrogram which may have consequences for subsequent data analysis. For instance, if an analyst decides on a lower number of livelihood strategies than the actual number of clusters, less similar study units may end up in the same strategy.

Latent class clustering

This method has been employed in a number of recent studies to identify livelihood strategies at a particular point in time (e.g., Nielsen et al, 2013) or over time (e.g., Jiao et al, 2017; Walelign et al, 2017). Unlike other methods, this approach provides statistical tests (Haughton et al, 2009) for determining the optimal number of clusters and allows estimation of the probability that a study unit belongs to a particular livelihood strategy (cluster) thus enabling the assignment of study units to the livelihood strategies that they are most likely to belong to.

The advantages of this approach is that the determination of the optimal number of livelihood strategies and the assignment of households to strategies is objective, based on statistical testing and membership probability. The disadvantage is that the statistically optimal number

of strategies may be too high to be useful in further analysis (theoretically, each household could represent a unique livelihood strategy).

Table 2. 1 list of research those applied five common approaches to measure choice variables and Approaches to identify livelihood strategies

Author	Published year	approaches to measuring choice variables	research-level	sample size	approaches to identify livelihood strategies	research finding on livelihood strategies clusters classification
Tesfaye et al	2011	income approach	Micro-level(cover four villages of Nepal)	336	principal component analysis and cluster analysis	Five livelihood strategies were identified — the forest-based, the crop-based, the livestock-based, the business-based, and the diversified strategy
Zenteno et al	2013	income approach	Micro-level(cover four villages of Nepal)	239	hierarchical clustering method	identified six significantly different strategies based on the relative share of income source to total income
Ansoms and McKay	2010	asset approach	Micro-level(cover four villages of Nepal)	1220	principal component analysis and cluster analysis	Seven livelihood strategies clusters were identified (cluster_1,cluster_2,cluster_3,cluster_4,cluster_5,cluster_6 and cluster_7
Walelign et al	2017	Combining income and asset approach	Micro-level(cover four villages of Nepal)	427		Seven livelihood strategies clusters were identified
Nielsen et al	2013	The activity choice approach	Micro-level(cover four villages of Nepal)	576	latent class cluster analysis	Five livelihood strategies were identified -Small-scale farm, Large-scale farm, Livestock producers and Off farmworkers, off-farm workers & business operators
Jiao et al	2017	The activity choice approach	Micro-level(cover four villages of Nepal)	464	latent class cluster analysis	five livelihood strategies clusters were identified

Nielsen et al	2014	choice experiment approach	Micro-level(cover four villages of Nepal)	325	Choice Experiment Design	livelihood strategies clusters were identified

Source: Different Literatures

2.4.2 Countries Experience on Livelihood Strategies Dynamics in Rural Area

Livelihood Strategies Dynamics Experience in Rural Asian Countries

The study conducted on the Cambodia by xi jiao (2017), by applying the dynamic livelihood strategy framework, and use panel data for 2008 and 2012 covering 464 households in 15 Cambodian villages for latent class cluster analysis and regression estimation for latent class clusters, Five household livelihood strategies have been identified in the study areas, and the findings indicate that over 70% of households are changing their livelihood strategies over time in reaction to changing pressures, opportunities and incentives. On the other hand, Walelign(2015) found that between 2006 and 2012, most sampled Nepalese households modified their livelihood strategy at least once, and very few households switched directly from the least to the most remunerative strategy, which studies used three-wave panel dataset from 427 households in three sites of Nepal, he also used the new innovative method that combines households' assets and income to classify distinct livelihood strategy clusters. He then defines seven different livelihood strategies based on a Latent Markov Model and analyzes the movements of households between strategies between 2006 and 2012 year.

The above studies used first, they have introduced combined income and asset approach for livelihood clustering. Second, the approach has been applied on panel dataset to provide empirical evidence regarding with rural livelihood dynamics in Cambodia and Nepal. However, both are conducted at local level (micro-level study)

Livelihood Strategies Dynamics Experience in Rural African Countries

Till 2020, in global only three studies have quantitatively investigated dynamic household-level livelihood strategy choices and their determinants (Van den Berg, 2010; Walelign, Pouliot, Larsen, & Smith-Hall, 2017 and Jiao, 2017), and all of them conducted in Asian countries. Therefore, in Africa, till 2020, there is no any research that quantitative empirical studies that systematically analyzing rural livelihood strategies and their transitions through time. However, some research was conducted on the impact of the positive and negative

shock on livelihood dynamism. Motsholapheko et al. (2011) showed that in response to extreme flooding, households in Botswana change their livelihood strategies.

However, there are a lot of literature on rural dynamics has focused on rural poverty in Africa (see e.g., Baulch & Hoddinott, 2000; Dhamija & Bhide, 2011; Kedir & Mckay, 2005; Cruces & Wodon, 2003; Woolard & Klasen, 2005; Haddad & Ahmed, 2003; May & Woolard, 2007; Dartanto & Nurkholis, 2013) without any specific focus on rural livelihood strategy dynamics

Livelihood Strategies Dynamics Experience in Rural Ethiopia

In the context of Ethiopia even though there are studies conducted on the impact of the positive and negative shock on livelihood dynamics, there is no research that quantitative empirical studies systematically analyzing rural livelihood strategies and their transitions through time. In response to an external shock and trends in the pastoral area, Berhanu et al. (2007) observed a change from pastoralism to a diversified livelihood in Ethiopia's semi-arid area.

Table 2. 2 list of study about livelihoods strategies dynamics in a rural area

Author	Published Year	Approaches To Measuring Choice Variables	Research Level	Sample Size	Approaches To Identify Livelihood Strategies	Research Finding On Livelihood Dynamics
Walelign	2017	Combining income and asset approach	Micro-level(cover four villages of Nepal)	427	latent Markov cluster analysis	Walelign found that Most of sampled households modified their livelihood strategy between 2006 and 2012 year
Jiao et al	2017	The activity choice approach	Micro-level(cover 15 villages in Cambodia)	464	latent class cluster analysis	The findings show that, in response to evolving pressures, incentives, and opportunities, over 70% of households modify livelihood strategies over time.

Source: Different Literatures

2.4.3 Determinants of livelihood strategy choices

Regarding the determinants (i.e., assets, contextual factors) affecting choice/practice of livelihood strategy, there are various contextual factors influencing choices of livelihood strategies which can help to pinpoint likely entry barriers to poverty-reducing livelihood options Jiao (2017). Moreover, according to Jiao, the Main factors enabling households to access more remunerative strategies are education, physical assets, and access to infrastructure. On the other hand, Barrett (2001) and Nielsen (2013) proved that Household heads with better education appear to be more capable of engaging in knowledge and skill-based activities and non-farm livelihood strategies. Therefore, various studies found that various social-economic determents of livelihood strategy choices for various areas or countries. Livelihood strategies choices thus, each rural area determinates of livelihood strategies choices should be studied and taken into account in rural economic policymaking.

2.4.4 Determinants of livelihood strategy mobility

Household livelihood strategies change over time in reaction to contextual factors (policies, shocks, and/or structures) (Chambers 1995; Ellis 2000). Empirical evidence of the dynamics of livelihood strategy adoption exists: van den Berg (2010) reported that households in rural Nicaragua transited from relatively more remunerative strategies to more defensive strategies in the face of natural hazards; In response to climate change, Jones and Thornton (2009) found that a change in livelihood strategies might be required in some parts of Africa. These studies are a first step in exploring how people respond to long-term changes, a major challenge for livelihoods research (de Haan and Zoomers 2005; Scoones 2009), and indicate the limited extent of quantitative study of the dynamics of livelihood strategies conducted so far. From limited quantitative empirical studies systematically analyzing rural livelihood strategies and their transitions through time, a study done in Nepal using livelihood strategy clusters has shown petty trade as being able to lift people out of poverty (Walelign et al., 2017); such a finding allows for policy interventions targeting the support of trade to the benefit of poor rural households in Nepal.

2.5 Summary of literature review.

From the literature reviewed, it has been noted that the income, asset, a combination of income and asset, activity choice, and choice experiment approaches has been frequently used by the researcher for classifying livelihood strategies. However, there are only a few

researches that are quantitative empirical studies and systematically analyzing rural livelihood strategies and their transitions through time.

While livelihood perspectives have dominated rural development thinking and practices for the past 20 years, they have also recently been criticized for lack of innovation (De Haan & Zoomers, 2005; Scoones, 2009), e.g., leading to inability to address emergent issues such as shifts in rural economies. A key point of criticism has been the propensity for single-time frame analyses that fail to catch changes over time. Moreover, the few available dynamic livelihood studies are analyzed qualitatively (e.g., Mushongah & Scoones, 2012; Wiggins, 2000, Walelign, Pouliot, Larsen, & Smith-Hall, 2017), and household-level quantitative livelihood analysis has been hampered by a lack of data and analysis techniques. Three important recent developments are: (i) the development of data collection instruments that allow for the estimation of environmental income (Angelsen, Larsen, Lund, Smith-Hall, & Wunder, 2011), providing an improved understanding of the composition of total household incomes; (ii) the emergence of multiple-wave environmentally augmented panel datasets, and (iii) advances in data analysis with a focus on activity variables (i.e., variables used as proxies for the amount of labor and inputs allocated to each income-generating activity; e.g., Nielsen, Rayamajhi, Uberhuaga, Meilby, and Smith-Hall (2013)).

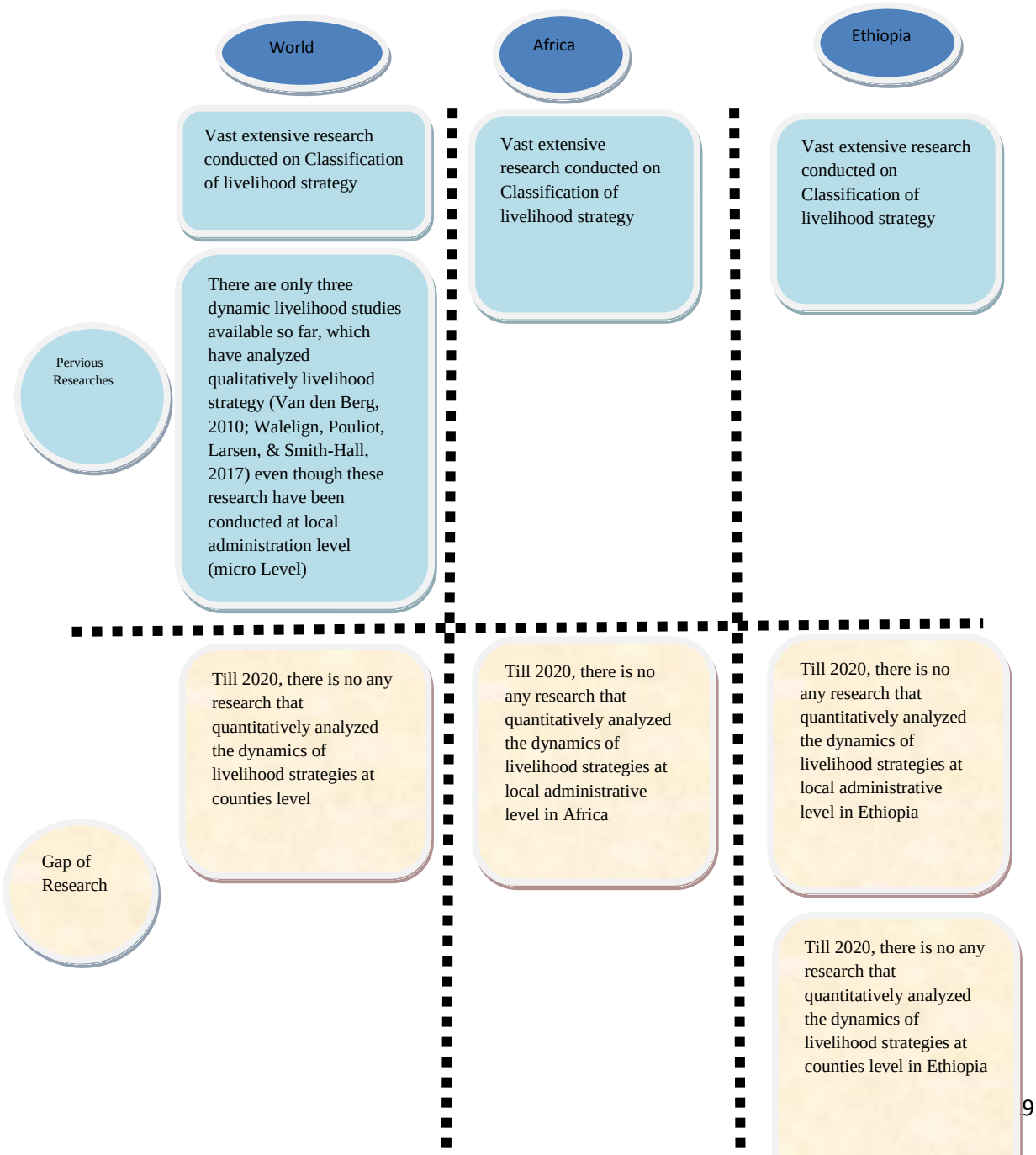
To this date, only three studies have quantitatively investigated dynamic household-level livelihood strategy choices and their determinants (Van den Berg, 2010; Walelign, Pouliot, Larsen, & Smith-Hall, 2017; Jiao et al (2017)), and other livelihood strategy studies have focused on coping and short-term adaptation (Scoones, 2009). However, all three studies that have quantitatively investigated dynamic household-level livelihood strategy choices and their determinants are micro-level research. Therefore, there is no research so far conducted at the national or macro level. hence findings of this study will be important to all stakeholders in the rural economy since it will quantitatively investigate dynamic household-level livelihood strategy choices and their determinants at the national level.

2.6 Research gaps

No research has been conducted yet on rural livelihoods dynamics in Ethiopia both at micro and macro level. Moreover, no research has been conducted on rural livelihoods dynamics in Globe at national level(macro level) even though there are three rural livelihoods dynamics researches which have been conducted at local administration level (micro Level) .in the following figure 2.2 described the gap of research at world Africa and Ethiopia level. On the other hand, regarding to methodologies of research, the study used the combine asset and

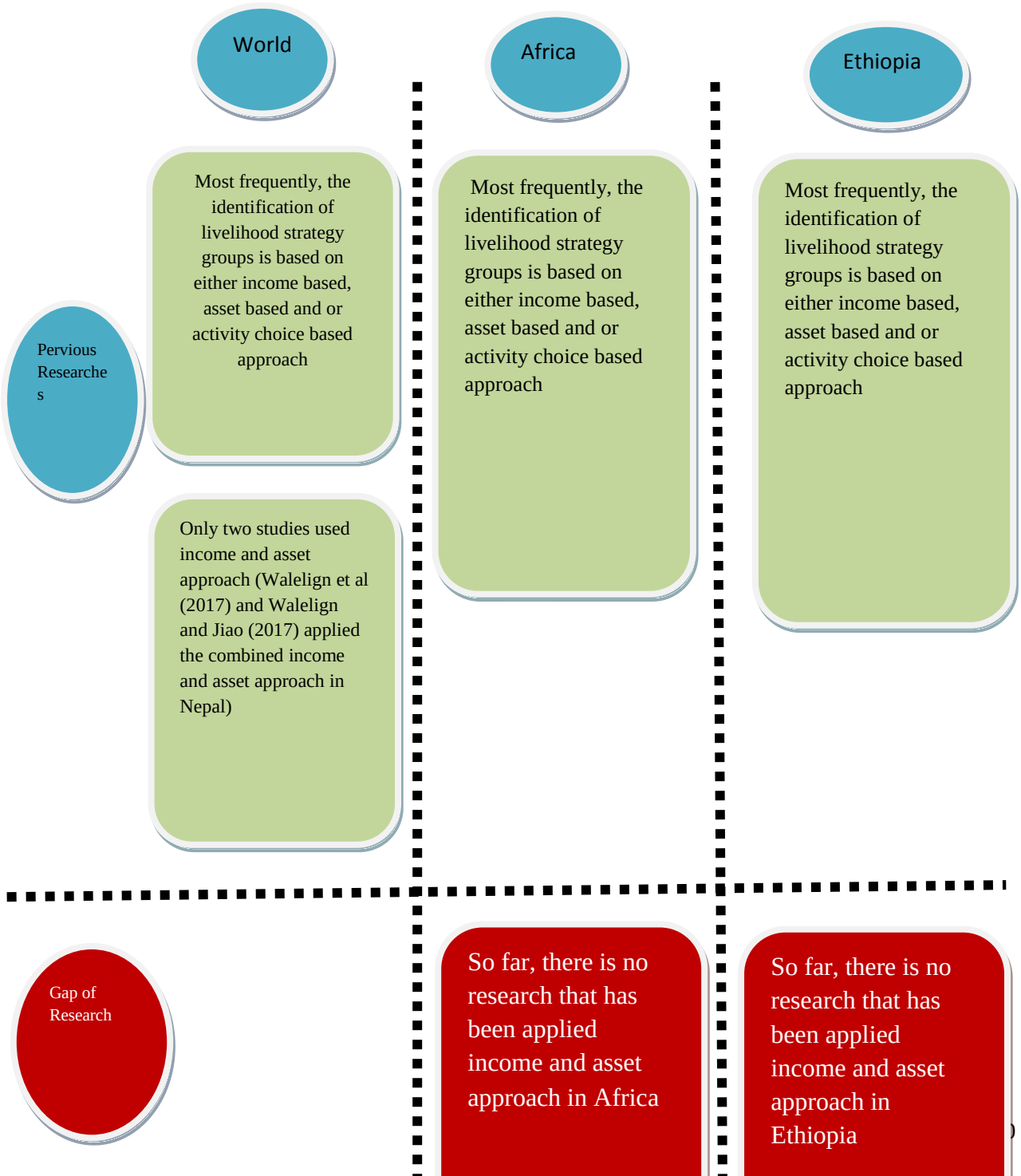
income approach that has not so far implemented or applied in Africa and specifically at Ethiopia level. The gaps of the study related with the study summarized in figure 2.3

Figure 2. 2: Research gaps on dynamic livelihood studies



Source: Derived from Different Literature

Figure 2. 3: Research gaps related with income and asset approach



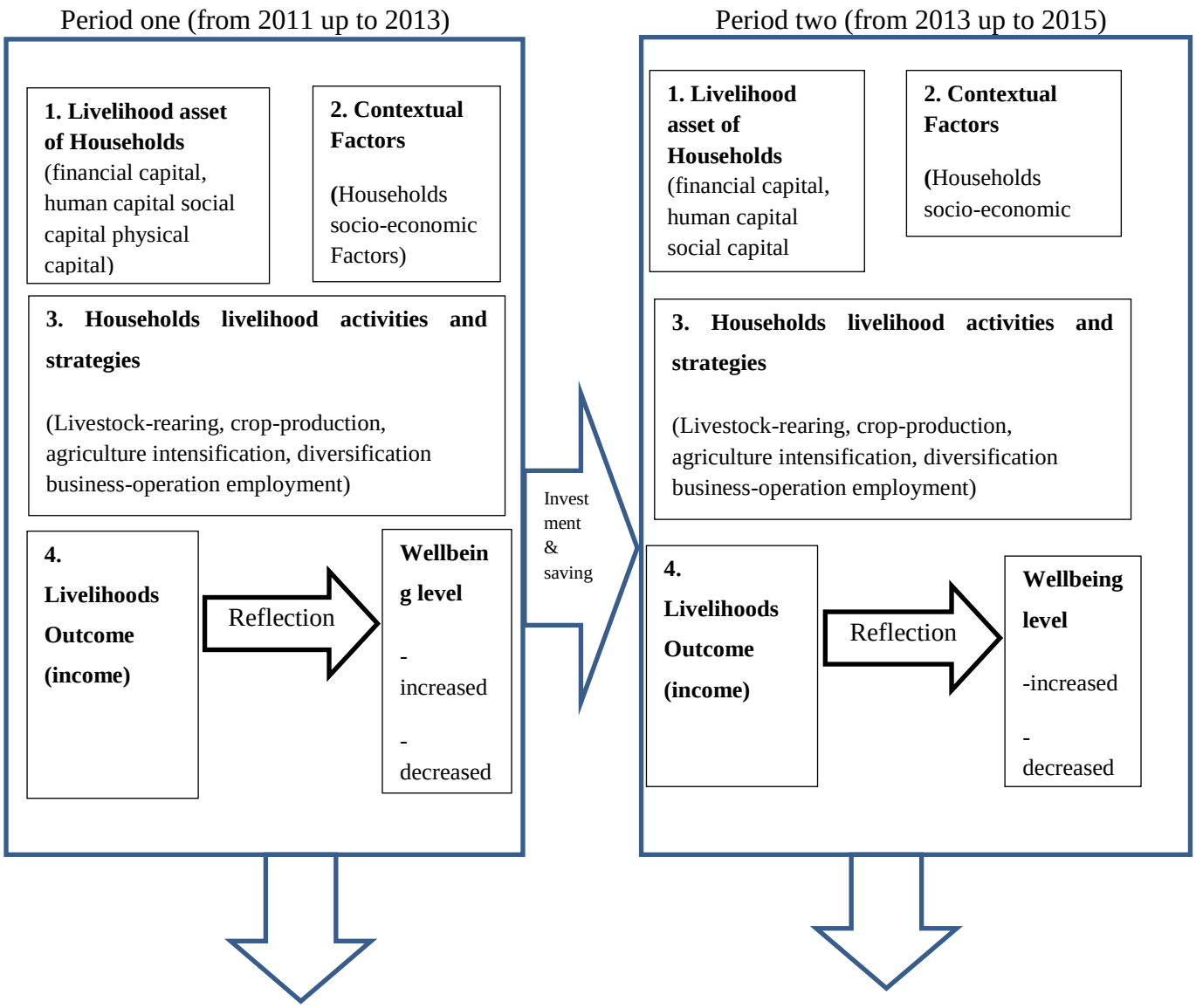
Source: Derived from Different Literature

2.7 Conceptual framework: the dynamic livelihood framework

Figure 2.4 presents the dynamic livelihood strategy framework for two time periods (from 2011 up to 2013, and 2013 up to 2015) that employed for our analysis. The primary concepts used for each period are assets, activities, and outcomes. Between periods, the well-being levels of households rise or fall by choosing a more or less remunerative livelihood strategy while stationary households remain to stay, either by retaining the same livelihood strategy or by changing to an equally remunerative strategy. the decision of households to follow livelihood strategies is influenced by their asset, the context in which they live, and the effects of previous livelihood strategies that decide investments and savings that in turn affect asset endowment in the next period.

The core of the framework is made up of the activates that households choose to participate in to make a living. Such choices are dictated by asset endowments of households. These choices are affected by households' asset endowments, the context in which they live. Adoption of a livelihood strategy in turn influences households' livelihood outcomes

Figure 2. 4: Household dynamic livelihood strategy framework (adapted from Walelign, Pouliot, Larsen, & Smith-Hall, 2017; Jiao et al (2017)



Moving to more remunerative strategies

Stay to more remunerative strategies

Moving to less remunerative strategies

Say to less remunerative strategies

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, the researcher identifies the procedures and techniques that have been used in the collection, processing, and analysis of data. Specifically, the following subsections included: Research philosophy, Data sources, Unit of analysis, Study area coverage and Data collection, and finally data analysis techniques.

3.2 Research Philosophy

In this study, the post-positivism worldview has been adopted as the empirical methods approach, which employed an empirical methods approach to identify rural livelihood strategies and to access the dynamics of rural livelihood strategies from the year 2011 up to 2015.

3.3 Research Design

The overall research strategy has been designed as per the research questions and conceptual framework. The study applied a quantitative approach; the combined income and asset approach, which combined both asset and income variables to identify household activity choice variables (composite asset index). However, the measurement is in different units. Therefore, these can be related using a two-part a multivariate statistical model where all asset types (using the actual values of the assets that each household owns) are regressed against the income generated from each livelihood activity (e.g., grouped under headings such as crop production, livestock rearing, business operation, and wage employment). This creates a composite asset index that allows predictions of each household's income from each livelihood activity, e.g. the predicted crop income is derived from the composite asset index used in crop production. Both the dependent variable (income) and the choice variables (the

predicted values) are expressed in monetary units. Walelign et al (2017) and Walelign and Jiao (2017) applied the combined income and asset approach in Nepal.

Then, to minimize the potential correlation among the predicted choice variables, the researcher employed Principal Component Analysis (PCA) and after that through latent Markov cluster analysis, then, the study identify rural household livelihood strategy cluster groups, which then used as the basis analysis for the movement of households between clusters over time. Then, the researcher constructed rural livelihood transition matrix to access households' strategy dynamics over time (from 2011 up to 2015) using STATA. Finally, using a multinomial logit model and an ordered logit model, to uncover the determinants affecting the choice/practice of livelihood strategies and the likely pull and push factors leading to upward or downward livelihood strategy mobility (in association with income levels).

3.4 Data source

This study used the three rounds of the Ethiopian Socioeconomic Survey (ESS) panel data; the Ethiopia Socioeconomic Survey (ESS), which is jointly Collected by Central Statistical Authority and World Bank Living Standards Measurement Study (LSMS). The ESS is part of the Ethiopian Central Statistical Agency and the World Bank's Living Standards Measurement Study which is the Integrated Surveys of Agriculture program. ESS started as Ethiopia Rural Socioeconomic Survey (ERSS) in 2011/12. The first wave of data collection in 2011/12 included only rural and small-town areas. The survey name dropped the word "Rural" in the second wave (ESS2 in 2013) of data collection when the sample was expanded to include all urban areas. (CSA and World Bank, 2017).

The first wave of the survey (ESS1) covers only rural and small-town areas and the second and third waves (ESS2 and ESS3) of the survey expanded to include urban areas. The urban supplement was done in such a way to ensure that the ESS data can provide nationally representative estimates. Thus, ESS1, ESS2, and ESS3 together create a panel data set of households from rural and small-town areas, whereas ESS2 and ESS3 together represent a panel of households and individuals for rural and all urban areas. Since the analysis of this study is based on a panel of households from all three surveys, the urban sample is automatically excluded since the research objective only focused on rural areas. Therefore, the results are representative at the national level for rural and small-town areas only.

A panel data source has been preferred in this research since panel data, as compared to cross-sectional data, is often considered to be much more informative about levels, profiles, and dynamics of well beings of households than cross-sectional data (Jollife et al, 2016; Kafle et al, 2016).

3.5 Unit of analysis of the study

In this study, household has taken as a unit of analysis; it is the most common and appropriate social unit for social and economic analysis of livelihood studies (Ellis, 2000) and household-level data has been used in this research since several researchers have argued that household survey is the preferred data source to use related with livelihood, wellbeing and poverty analysis, an approach also commonly followed by World Bank (Ravallion, 2000; Chen and Ravallion, 2004; Deaton, 2005; Chen and Ravallion, 2010). However, household survey data is not without critics since some researchers prefer national accounts (Bhala, 2003; Karshenas, 2003; Sala-i-Martin, 2009; Sala-i-Martin and Pinkovskiy, 2010 and Pinkovskiy and Sala-i-Martin, 2014) rather than households. Still, others use the Demographic Health Survey (DHS) data (eg Young, 2009&Young, 2012).

3.6 Study coverage area

The study covered all nine Ethiopia regional states (Afar, Amhara, Oromiya, SNNP, Benshangul Gumuz, Gambella, Harari, Somalie, and Tigray) and rural areas of Dire Dawa administration city. Households' covered in this research, who engaged both in agrarian and non-agrarian livelihood activities.

Table 3. 1 Number of covered households per region in ESS1, ESS2, and ESS3

Region	Number of households in ESS1 (2011)	Re-interviewed households in ESS2 (2013)	Drop out (2013)	Attrition Rate (2013)	Re-interviewed in ESS3 (2015)	Drop out (2015)	Attrition Rate (2015)
Tigray	408	388	20	5%	382	26	6%
Afar	144	123	21	15%	119	25	17%
Amhara	855	809	46	5%	781	74	9%
Oromia	781	757	24	3%	739	42	5%
Somalie	273	245	28	10%	224	49	18%

Region	Number of households in ESS1 (2011)	Re-interviewed households in ESS2 (2013)	Drop out (2013)	Attrition Rate (2013)	Re-interviewed in ESS3 (2015)	Drop out (2015)	Attrition Rate (2015)
Benshagul Gumuz	132	125	7	5%	123	9	7%
SNNP	1004	976	28	3%	933	71	7%
Gambelia	132	115	17	13%	101	31	23%
Harari	120	120	0	0%	119	1	1%
Addis Ababa	0	0	0	0%	0	0	0%
Diredwa	120	118	2	2%	118	2	2%
Total	**3969**	**3,776**	**193**	**5%**	**3,639**	**330**	**8%**

Source: own computation based on ESS Survey

3.7 ESS Data collection

Data was collected in [1]ESS1 (2011), ESS2(2013), and ESS2(2015) by the central statistics agency of Ethiopia. The collection and handling of data followed the guidance given by the World Bank and the Ethiopia Central Statistics Agency (CSA, 2017) to ensure consistency across regions. Detail Questionnaires were prepared and distributed by World Bank and The questionnaires were translated into the local language and field-tested before the survey.

The dataset used in this study contains of a three-wave panel dataset with yearly household income values per income source (cropping, livestock, wage employment, private business, and transfer income) and asset stock endowment. Table 3.2, Table 3.3, and Table 3.4 lists and describes the asset variables used. Household income encompasses both cash and subsistence income (Angelsen et al., 2011; Ellis, 2000). the study used total net income, which is the value of total output sold and consumed minus input costs for each particular income source (own labor cost was not deducted from net income).

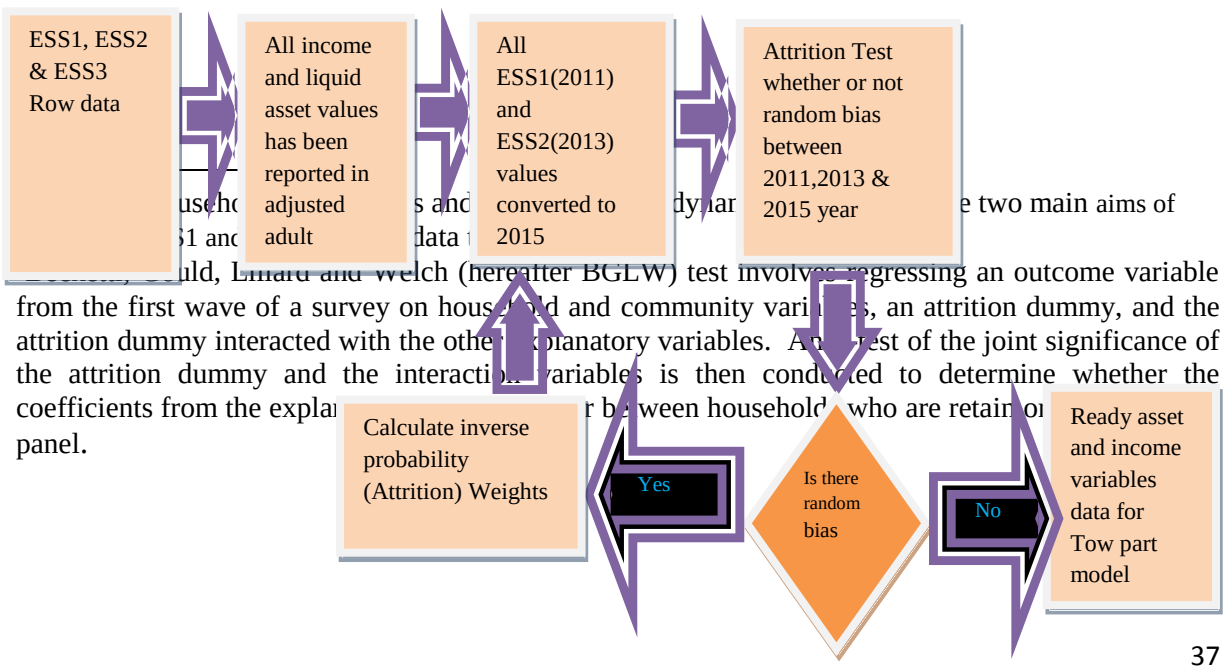
[1] ESS1, ESS2, and ESS3 together create a panel data set of households from rural and small town areas (i.e. the same households that were interviewed in ESS1 were tracked and re-interviewed in ESS2 and ESS3).

3.8 Method of Data Analysis

The detail data analysis methods that the researcher used have seven steps; those are as follows;

Step One: Preparing data for both inter-household comparisons and rural livelihood dynamics analysis

All income variables and household level asset values has been reported in adjusted adult equivalent units (AEU) to allow for both inter-household comparisons and rural livelihood dynamics analysis with all ESS1 dataset of 2011 and ESS2 data set of 2013 values are changed to 2015 level[2] by using the Consumer Price Index (CPI). Then researcher have conducted an attrition test in which the study has checked whether attrition in a panel data model is random or not before researcher proceeded to data analysis since According to table 3.1, the study had an attrition rate of 5 % between 2011 year and 2013 year, 8 % between 2013 and 2015. So, attrition from the panel at the household level is just 8% between 2011 and 2015-year period (see Table3.1 for more explanation of the attrition rate). So, the study had conducted Becketti, Gould, Lillard, and Welch (hereafter BGLW) test [3]to check whether attrition in a panel data model is random or not before researcher proceeded to data analysis. Therefore, the BGLW test the effects of attrition on the estimates from the data show that there is no random bias in the selected household from three-wave of the survey. So, For the current research, it is not relevant (the results of the BGLW test and analysis are attached in chapter four).



e two main aims of

ld, Lillard and Welch (hereafter BGLW) test involves regressing an outcome variable from the first wave of a survey on household and community variables, an attrition dummy, and the attrition dummy interacted with the other explanatory variables. A test of the joint significance of the attrition dummy and the interaction variables is then conducted to determine whether the coefficients from the explanatory variables between households who are retained in the panel.

Figure 3. 1 : Work flow for Data Preparation

Step two: combining asset and income variables to create activity choice variables (composite asset index)

The activity choice variables – used for identifying livelihood clusters – for this study are generated by combining income and asset variables. However, the main challenge is that they are measured in different units. The study, therefore, employed a statistical method two-part model[4]in which all asset variables are regressed against the income earned from each income-generating activity or variables. The study applied a two-part model. According to Cameroon and Trivedi, The first part is a probit model which forecasts a binary outcome of a negative/zero income and positive income, while the second model estimate the positive income using an OLS estimator. Following Cameroon and Trivedi (2005), The two-part model, which in each section has the same explanatory variables, can be defined as:

$$\text{Prob}(Y_{iq} > 0) = \sum_j \beta_j (A_{ijt}) + \beta_l L + \varepsilon_{it1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

[4]According to Cameroon and Trivedi, two-part models has logit and probit specifications for the first part and OLS and GLM regression for the second part. Two-part models can be specified using one of two syntaxes. The first syntax automatically specifies the same regressors (and functional forms in the index) in the first and second parts and is generally recommended. The second syntax allows the user to specify different regressors in the first and second parts. Although not generally recommended, there may be theoretically or statistically motivated situations where such a model may be applicable.

$$Y_{iq} = \sum \beta_j (A_{ijt}) + \beta_l L + \varepsilon_{it2} \text{ if } Y_{iq} > 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where

Yiq **=** household i's income from livelihood activity q.

Aijt **=** household's i' asset j at time t

Bj**=** is the marginal contribution of asset j to income from livelihood activity q

L**=** is location dummies

Bl**=** is the coefficients and

Eit**=** is an error term

Equation (1)Models the possibility of a household receiving income from productive livelihood activity q whereas equation (2) models the household income from livelihood activites q, Conditional on earning an income for the household (>0) from that livelihood activity. Both models have their own error terms, specifically ε_{it1} and ε_{it2}.

For the four income-generating activities, the study ran the two-part model that require household asset investment and the resulting predictions were labeled as asset index used in each of the four activities, which means asset index used in livestock rearing, crop production, self-employment and wage employment. Households has not been allocated any of their assets to earn income from non-productive income-generating activities (e.g., remittances). As a result, the study has not estimated the equation for income from remittances or any other transfers, e.g. pensions. The composite asset index used to generate income from livelihood operation q can be determined from the fit value of the regression once all the coefficients have been estimated.

$$g_{iq} = \sum \beta_j (A_{ijt}) + \beta_l L \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Livestock rearing, Crop production, self-employments, and wage employment were researcher used as choice variables to cluster the livelihood strategy categories as well as income from transfers. Therefore, in total, the study has used five income-generating activity choice variables to generate livelihood strategy clusters. On the other hand, nine asset variables used to cluster livelihood strategies (the list of asset variables and their descriptions attached in below table 3.2

Table 3. 2: Asset variables of households used as input in the two-part model.

Households Asset variables	Explanation
Household_head_Age	Household head Age; an indicator of household experience.
Maximum household Members education	the highest grade completed by the household member
Number of adults_aeu_housholds	Number of adult of household who are 10 years and older
Total land area_aeu	The total number of land owned by the household
Total household livestock holding (TLU)	Total the household's livestock value
Total households item_aeu	The number of many items owned by households?
Debt _aeu_cpi	The total household borrowed money from other households and financial institutions
households Financial sector accessibility	Ordinal variable describing whether the households have accessibility to the financial sector or not: 1 = yes, 0 = no,
Female-headed households	Ordinal variable indicating whether or not the household headed by female: 1 = yes, 0 = no

Source: Adapted from Waleligne and Jiao

Table 3. 3: Income variables used in the two-part model.

Income variables	**Description**
Crop income	households earning an income from crop production

livestock income	households earning an income from livestock rearing
wage	households earning an income from wage employment
business income	households earning an income from business

Adapted from Waleligne and Jiao

Table 3. 4: Fixed effect variables used in the two-part model.

Income variables	**Description**
Rural	Ordinal variable describing whether the household live in rural or not: 1 = rural, 0 = small town,
Region	households live in which region

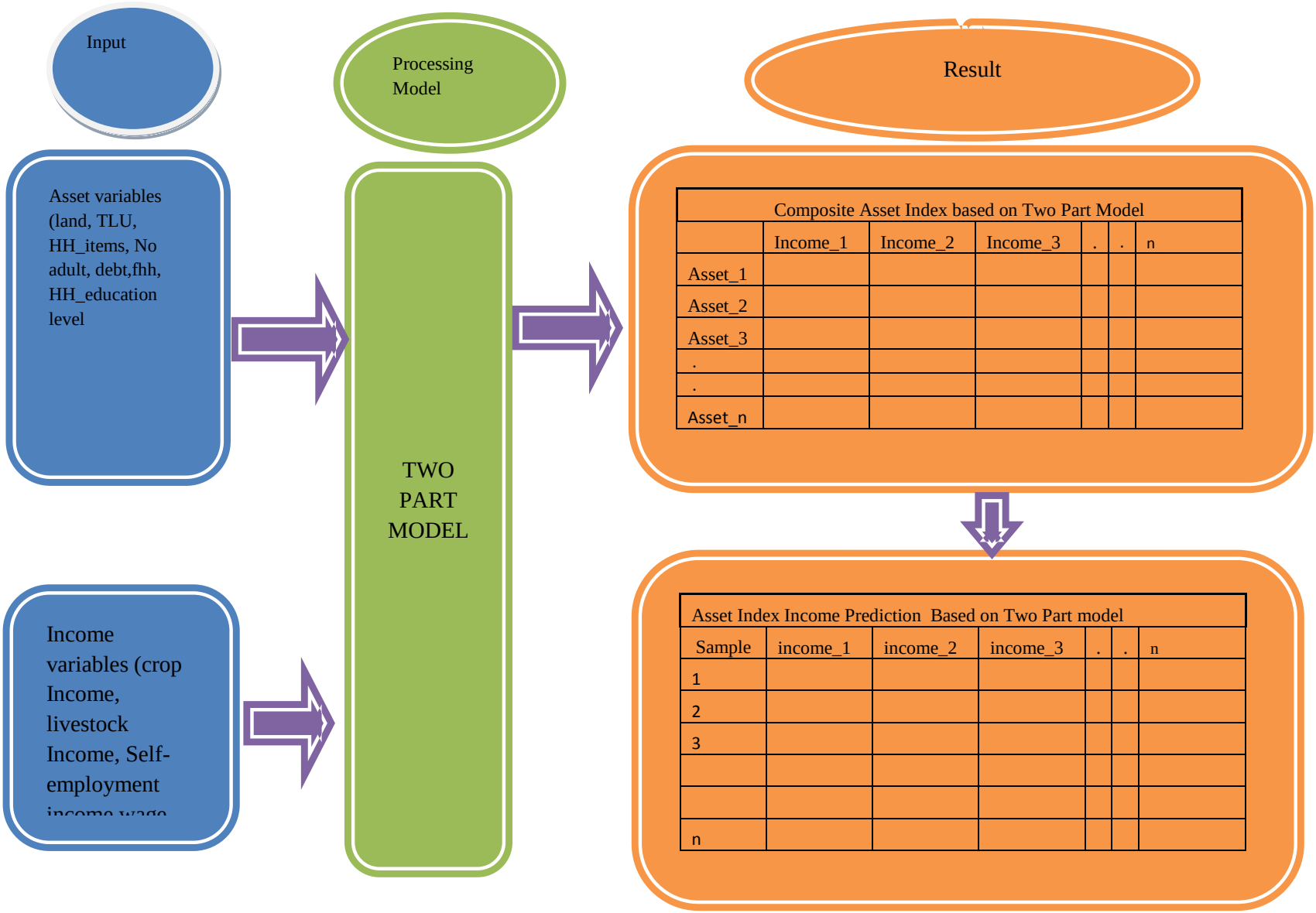
Adapted from Waleligne and Jiao

The rationale behind two-part model selection to combining income and asset variables

There are three Rationale behind the selection of a two-part model for combining asset and income variables to composite asset index when it compares to methods, such as Principal Factor Analysis (PFA) and PCA.

- The index is stated in a suitable livelihood measurement, i.e. money (Ethiopian birr, Br) that is directly comparable with income, consumption, and other monetary indicators of welfare.
- The two-part model can detect the share of each and every asset variable to income generated from all livelihood activity.
- Since all households will not participate in all possible activities that generating income, so, to minimize negative predictions, the study used two-part model.

Figure 3. 2 : Work flow for combining asset and income variables based Two-part model and prediction asset index



Step three: Principal component (PCA) analysis

Principal component analysis (PCA) was applied for processing the selected activity variables to create a new set of variables that represents the characteristics of the original variables in a simplified way and to reduce the problem of high correlation among the original variables. Thereby, PCA minimizes the possible difficulties and distortions in further data analysis (Hair, Anderson, Tatham, & Black, 1998) such as cluster analysis. The visual interpretation of the scree plot & latent root criterion visual interpretation of the scree plot showed that component scores[5] were optimal. The optimal component scores have been determined in this study by Eigen values.

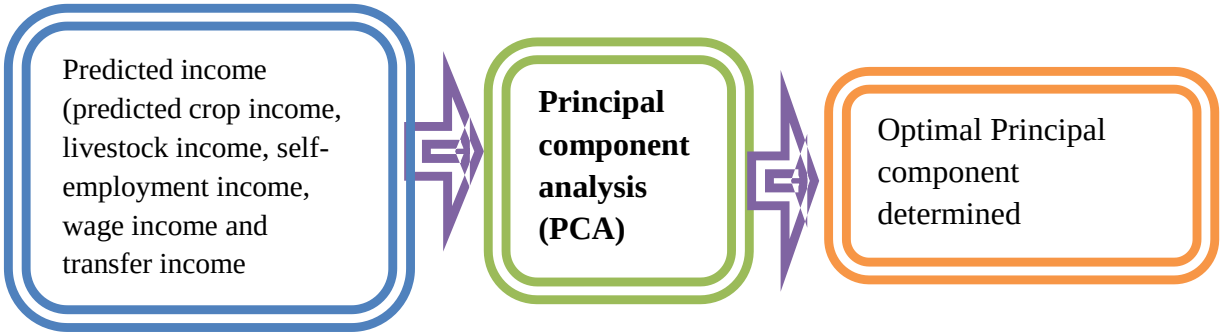


Figure 3. 3 : Work flow for Principal component analysis (PCA)

The mathematical technique used in PCA to determine optimal component is called Eigen analysis: the study solve for the Eigen values and Eigen vectors of a square symmetric matrix with sums of squares and cross products. The eigenvector associated with the largest eigenvalue has the same direction as the first principal component. The eigenvector associated with the second largest eigenvalue determines the direction of the second principal component. The sum of the eigenvalues equals the trace of the square matrix and the maximum number of eigenvectors equals the number of rows (or columns) of this matrix.

Step Four: latent Markov cluster analysis to group the households into livelihood strategies

The study employed latent Markov cluster model to classifying the households into livelihood strategies. If this model compared to hierarchical cluster model and k-means algorithms model, this model-based method produced significance tests for the optimal clusters (Haughton et al. 2009).

Since ESS data is longitudinal, the latent Markov model allows households to switch from livelihood strategies to livelihood strategies between the three years. the latent Markov model for household i, yit with covariates zi has the form:

$$\pi(y_i / z_i) = \sum_{x_0=1}^{K}\sum_{x_1=1}^{K}\ldots\sum_{x_T}^{K}\pi(x_0 \mid x, z_i)\prod^{T_i}\pi(x_t \mid x_{t-1}, z_{it})\prod^{T_i}\pi(y_{it} \mid x_t, \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where xt =is the variable at time t which from 0 to Ti

K = number _ latent states.

(π (yit | xt , zit) =distribution of indicators

(π (x0 | zi)= initial state probabilities

(π (xt | xt−1, zit) = transition probabilities

N.B; - latent Markov cluster analysis has been carried out using Latent Gold 5.0[6].

Step five: construct a rural livelihood transition matrix

Researcher construct a rural livelihood transition matrix through STATA to examinee households' strategy dynamics over time. (From 2011 to the 2013 year, from 2013 to the 2015 year and from 2011 to the 2015 year)

6 Latent Gold 5.0 software which is developed by Statistical Innovations specializes in innovative applications of statistical modeling, especially latent class, discrete choice and other latent variable models to obtain meaningful segments.

Step Six: Determinants of livelihood strategy choices and mobility: Econometric model specification: Multinomial Logit Model (MLM)

Since livelihood strategies are nominal in nature, the study employ the Multinomial Logit model (MLM) to identify the factors influencing household rural livelihood strategy choice. If dependent variables have more than two unordered outcomes, this is the most common model for analysis (Wooldridge, 2002). The MLM for researcher interest lies on what determines household's livelihood choice in the current year (i.e., 2015) given their livelihood strategy in 2011, and the model is specified as:

$$\text{Prob}(y_{it} = j \mid y_{it-1}, x_{it-1}) = \frac{\exp(x_{it-1}\beta_j + y_{it-1}x_j)}{\sum_{K=0}^{m} \exp(x_{it-1}\beta_k + y_{it-1}x_j)}$$

$$= F_j(x_{it-1}, y_{it-1}, \beta) \text{ for } j = 0, 1, 2, \ldots, m;$$

$$i = 1,2,3\ldots, N$$

Where

Yit= is household's livelihood strategy in 2015,

Yit-1=is the is an associated vector of coefficients,

Xit-1= is a vector of other explanatory variables in 2012 and

Bj= is coefficients.

F j =is error term that is assumed to follow the logistic distribution.

In general, various asset and contextual variables, that are believed to influence households' livelihood strategy choice, are included in the MLM (see Table 1 for more explanation of the variables).

Step Seven: Determinants of livelihood strategy mobility: Econometric model Specification-Ordered Logit model (OLM)

Lastly, to identify the factors influencing household livelihood strategy mobility (in association with income generated by each strategy type), the study employed an Ordered Logit model (OLM) and then through Ordered Logit model (OLM), the study identified the determinants factors of livelihood strategy mobility: upward mobility(from a lower remunerative to relatively higher remunerative livelihood strategy), no mobility (remain within same remunerative-level strategies) and downward mobility (from a higher remunerative to a relatively lower remunerative livelihood strategy during 2011–15. Following Cameron and Trivedi (2005), the model can be specified from the unobserved latent variable Y i:

Y i = bxit - 1 +ui; Y= j if cj -1 < j < cj…….5

there are cut-off points for each category. The probability of outcome j occurring given the independent variable can then be defined as:

prob(Y i=j|xit-1) ==F(cj-bxit -1)-F (cj -1-bxit -1……5

Y i =is the livelihood movement category of the ith household that takes ordered values 0, 1, and 2 if the household moved downward, did not move, and moved upward respectively.

xis the associated vector of coefficients;it is the explanatory variables in 2011 and is error term of ui and ui which is assumed to follow a logistic distribution (see Table 3.5 for more explanation of the variables). Similar variables are used in the MLM are also included in OLM, the only differences are initial livelihood strategy types in 2011 are included only in the MLM.

Table 3. 5: List and explanation of the variables included in MLM and OLM

Variable	Type	Description
Household_head_Age	Continuous	an indicator of household experience.
education	Dummy	the highest grade completed by the household
Number of adults_aeu	Continuous	Number of adult under household who have members 10 years and older
Total land area_aeu	Continuous	A total number of land owned by the household,
Total household livestock holding (TLU)	Continuous	Total Livestock owned by household
Total households item_aeu	Continuous	The number of many items owned by households?
Debt _aeu_cpi	Continuous	The total borrowed money by household
households Financial sector accessibility	Dummy	Ordinal variable describing whether the household has accessibility to the financial sector or not: 1 = yes, 0 = no,
Female-headed households	Dummy	Ordinal variable indicating whether or not the household headed by female: 1 = yes, 0 = no

In general, in this study, the household's experience of shocks has not used in the study since the households experiencing negative events (crop failure, livestock, and other asset loss, and costly social events) occurrence was minimal in the year 2011 to 2015.

3.9 Operational Table of variables

Table 3. 6: Operationalization Table

S.N	Specific objectives	Type of variable	Indicators	Measurement scale	Data Source	The main method of data analysis
1	To identify the classification of rural livelihood strategies	-Age -Maximum Education - Number of adults_aeu - Total land area_aeu - Total household livestock holding (TLU - Total households item_ae - Debt _aeu_cpi	Number of rural livelihood strategies clusters	Nominal Interval	ESS	-Two_part_model -Principal_component analysis (PCA) -Latent_Markov_model
2	To examine the association between household livelihood outcomes (income level) with the choice/ practice of livelihood strategies	The average income per livelihood group		Nominal Interval	ESS	-cumulative Density Curve -Table and Chart - Bonferroni Test

S.N	Specific objectives	Type of variable	Indicators	Measurement scale	Data Source	The main method of data analysis
3	To examine households' movement between the strategies over time	>>		Nominal Interval	ESS	Livelihood transition metrics which has created by STATA
4	To identify the determinants (i.e. assets, contextual factors) affecting choice/practice of livelihood strategy	>>		Nominal Interval	ESS	Multinomial Logit Model (MLM)
5	To examine determinants factors that influence the households' movement among the livelihood strategies over time	>>		Nominal Interval	ESS	Ordered Logit model (OLM)

Source: Different Literature

3.10 Ethical considerations

As Mugenda (2003) affirms, ethical consideration is important in ensuring a professional and a non-intrusive in accomplishing a research objective. For this study, the researcher has asked for permission to use data from relevant administrative authorities in the institution. Moreover, the researcher also acknowledged all additional sources of information from other scholars.

CHAPTER FOUR

4. TEST AND PREDICTION PRIOR TO RURAL HOUSEHOLDS' LIVELIHOOD STRATEGY CLASSIFICATIONS AND THEIR DYNAMICS

Before proceeding to data analysis, the attrition bias test has been conducted to determine whether attrition in a ESS panel data is random or not, create and prediction the activity choice variables through two part model by Combining income and asset variables and generated optimal component though principal component analysis in order to minimize the auto correlation among variables

4.1 Testing for attrition random bias in ESS household panel data

Attrition has been described as 'the panel researcher's nightmare' (Winkels and Withers, 2000). This is because if the members who drop out of a panel differ systematically from those who stay in it, then the dataset of continuing members is no longer representative of the original population. So, results based on data in which only continuing panel members are included may be seriously affected by attrition bias. Therefore, before clustering, firstly it is essential to test whether attrition in a panel data model is random

To test whether attrition in a panel data model is random, The Becketti, Gould, Lillard, and Welch (hereafter BGLW) test was conducted on ESS1 (2011), ESS2 (2012), ESS3 (2015) Survey.

According to table 4.1, the probability value of total income is higher than 10% of a significant level, hence, we fail to reject the null hypothesis which says there is no random bias between 2011 and 2015 year. therefore, the impact of attrition on the data estimates indicates that it is not important for the current study. thus, it is concluded that attrition in an ESS panel is random. The results of the Probit regression are presented in the below table 4.1

Table 4. 1: Attrition Probit test for Total income

```
.  xi: probit a_2015 i.fhh i.rural i.region age i.max_edu i.use_fin_serv_all adult hh_item w_farm_s
> ize_agland debt w_value_crop_production w_value_livestock_products w_total_income ,robust
i.fhh              _Ifhh_0-1           (naturally coded; _Ifhh_0 omitted)
i.rural            _Irural_0-1         (naturally coded; _Irural_0 omitted)
i.region           _Iregion_1-10       (naturally coded; _Iregion_1 omitted)
i.max_edu          _Imax_edu_0-3       (naturally coded; _Imax_edu_0 omitted)
i.use_fin_ser~l    _Iuse_fin_s_0-1     (naturally coded; _Iuse_fin_s_0 omitted)

Iteration 0:   log pseudolikelihood = -1064.8343
Iteration 1:   log pseudolikelihood = -881.49788
Iteration 2:   log pseudolikelihood = -861.52281
Iteration 3:   log pseudolikelihood =  -860.9805
Iteration 4:   log pseudolikelihood = -860.97964
Iteration 5:   log pseudolikelihood = -860.97964

Probit regression                                 Number of obs     =      3,897
                                                  Wald chi2(23)     =     263.95
                                                  Prob > chi2       =     0.0000
Log pseudolikelihood = -860.97964                 Pseudo R2         =     0.1914
```

a_2015	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
_Ifhh_1	.0563705	.0803603	0.70	0.483	-.1011329	.2138738
_Irural_1	-.1778564	.0977675	-1.82	0.069	-.3694772	.0137644
_Iregion_2	.443406	.1897671	2.34	0.019	.0714693	.8153428
_Iregion_3	.1067634	.1306441	0.82	0.414	-.1492944	.3628212
_Iregion_4	-.1033355	.1432852	-0.72	0.471	-.3841693	.1774982
_Iregion_5	.0411849	.1325256	0.31	0.756	-.2185606	.3009303
_Iregion_6	.8483807	.1852937	4.58	0.000	.4852117	1.21155
_Iregion_7	-.0151452	.2174808	-0.07	0.944	-.4413998	.4111094
_Iregion_8	-.9623743	.4134585	-2.33	0.020	-1.772738	-.1520105
_Iregion_9	-.9816211	.4095378	-2.40	0.017	-1.7843	-.1789417
_Iregion_10	.4003285	.156958	2.55	0.011	.0926965	.7079604
age	-.0072505	.0022187	-3.27	0.001	-.011599	-.0029019
_Imax_edu_1	-.1932209	.0802719	-2.41	0.016	-.3505509	-.0358908
_Imax_edu_2	.0557004	.1278143	0.44	0.663	-.194811	.3062118
_Imax_edu_3	.4833532	.1473889	3.28	0.001	.1944764	.7722301
_Iuse_fin_s_1	-.4297993	.1836956	-2.34	0.019	-.7898361	-.0697626
adult	-.175232	.029268	-5.99	0.000	-.2325964	-.1178677
hh_item	-.0270447	.0100749	-2.68	0.007	-.046791	-.0072983
w_farm_size_agland	-.0663333	.0546854	-1.21	0.225	-.1735147	.040848
debt	-6.40e-07	4.99e-06	-0.13	0.898	-.0000104	9.14e-06
w_value_crop_production	-.0000285	.0000185	-1.54	0.123	-.0000647	7.72e-06
w_value_livestock_products	4.39e-06	.0000118	0.37	0.710	-.0000188	.0000275
w_total_income	-2.03e-06	4.54e-06	-0.45	0.656	-.0000109	6.88e-06
_cons	-.1072715	.1927709	-0.56	0.578	-.4850955	.2705525

```
.  test w_total_income

 ( 1)  [a_2015]w_total_income = 0

           chi2(  1) =    0.20
         Prob > chi2 =    0.6559

.
```

4.2 Activity choice variables prediction

Creating activity choice variables by Combining income and asset variables to is one of the main per clustering step under income and asset combining approach. However, one of the main challenge is that they are calculated in in different units. The researcher therefore employed a statistical method, two-part model, in which all forms of assets have regressed against the income from each income generating activity of households.

In table 4.2 the study ran the two-part model equations for the four productive livelihood activities (livestock rearing, crop production, wage employment, and self-employment. However, households do not devote any of their current assets to receive income from activities that produce non-productive. therefore, the study has not estimate equation for income from remittances or any other transfers, e.g. pensions. Equations Coefficients of crop production, livestock rearing, self-employment, and wage employment listed in below table 4.2.

Table 4. 2: two-part model equations for the four productive livelihood activities

Two part model livelihood activates income composite index coefficient			
Variables	2011	2013	2015

	Crop	Livestock	Self-employment	Wage	Crop	Livestock	Self-employment	wage	Crop	livestock	Self-employment	wage
Probit												
Fhh												
female household head	-0.2	0.0	0.1	0	-0.4	0.0	0.0	-0.2	-0.2	-0.1	0.1	-0.1
Rural												
Rural	1.1	0.6	-1.0	-0.1	1.2	0.5	-0.9	0.0	1.1	0.5	-0.7	0.0
Regions												
Afar	-1.5	-0.4	-0.4	0	-1.1	0.1	0.2	0.6	-1.7	0.4	-0.3	0.8
Amhara	0.2	0.2	0.1	0	0.3	0.1	0.2	-0.7	0.0	0.0	0.0	-0.5
Oromia	0.3	0.2	0.1	-1	0.3	0.0	0.2	-0.8	0.0	-0.1	-0.1	-0.7
SNNP	0.8	0.1	0.3	-1	0.7	0.0	0.3	-0.8	0.6	-0.1	0.0	-0.9
Gambelia	0.1	0.2	-0.2	-1	0.5	0.5	0.3	-0.6	0.5	-0.3	0.2	-0.8
Benshagul Gumuz	0.5	-1.1	0.8	-1	0.1	0.2	0.8	-0.8	0.2	-0.1	0.7	-0.7
Harari	0.9	0.2	0.8	0	0.9	0.0	0.7	-0.8	0.6	-0.3	0.2	-0.7
Dire dewa	0.4	0.8	1.3	0	0.7	0.6	1.3	0.7	0.1	0.3	1.1	1.0
Somalie	-0.9	0.3	0.2	0	-1.0	0.2	0.2	0.1	-1.5	0.3	0.0	-0.1
HH_Age	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max_edu												
Less than or equal to 8th grade educa..	0.2	0.1	0.3	0	0.3	0.2	0.3	0.4	0.1	0.0	0.1	0.3

Two part model livelihood activates income composite index coefficient												
	2011				2013				2015			
Variables	Crop	Livestock	Self-employment	Wage	Crop	Livestock	Self-employment	wage	Crop	livestock	Self-employment	wage
High school completed	0.2	0.0	0.1	0	0.4	0.2	0.2	0.6	0.0	-0.2	0.2	0.5
Diploma and above	-0.2	-0.3	-0.4	2	0.0	-0.2	-0.4	1.9	-0.4	-0.5	-0.4	1.7
adult_aeu	-0.2	0.0	-0.1	0	-0.6	-0.6	0.0	0.0	0.0	0.0	0.0	0.0
hh_item_aeu	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
w_farm_size_agland_aeu	0.5	0.0	-0.2	-1	1.1	0.0	-0.2	-0.3	0.5	0.5	-0.2	-0.6
debt_aeu	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH_livestock_holding_tlu	0.0	0.5	0.0	0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
_cons	-1.3	-1.2	0.2	1	-0.8	-0.3	-0.1	-0.3	-0.9	-0.4	0.0	-0.2
GLM												
FHH												
Female household head	0.1	0.1	-0.2	0	-0.2	0.1	-0.2	-0.4	-0.3	0.1	-0.1	-0.2
rural												
rural	6.0	4.1	0.3	0	6.5	3.5	-0.8	0.4	6.7	4.5	0.1	0.1
region												
Afar	-2.1	1.9	2.3	1	-0.8	2.0	7.4	1.6	-0.1	2.7	4.7	0.7
Amhara	0.1	0.9	3.6	1	0.2	1.0	6.2	1.2	0.2	1.5	3.8	0.7
Oromia	0.2	1.3	3.5	1	0.4	1.3	6.5	1.3	0.4	1.8	3.9	1.1
SNNP	0.1	0.9	3.7	1	0.0	1.1	6.3	1.0	0.0	1.8	3.8	0.5

Two part model livelihood activates income composite index coefficient												
	2011				2013				2015			
Variables	Crop	Livestock	Self-employment	Wage	Crop	Livestock	Self-employment	wage	Crop	livestock	Self-employment	wage
Gambelia	1.0	1.3	3.7	2	0.2	1.5	7.0	1.4	0.4	2.2	3.8	0.8
Benshagul Gumuz	0.0	0.9	3.6	1	0.2	1.0	6.9	1.2	0.4	1.6	3.3	0.9
Harari	1.3	1.5	4.1	2	1.2	1.5	7.8	1.6	1.2	1.9	4.2	1.1
Dire dewa	0.0	0.9	3.5	1	0.0	1.4	6.8	1.2	-1.1	1.9	4.0	0.7
Somalie	-0.1	1.6	4.4	2	0.2	2.0	7.4	1.8	1.1	2.5	4.0	1.3
HH_age	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max_edu												
Less than or equal to 8th grade educa..	-0.1	0.0	1.0	2	0.0	0.1	0.7	2.5	0.4	0.3	1.8	6.8
High school completed	0.0	0.1	1.3	3	0.0	0.0	0.7	2.8	0.4	0.6	2.5	7.6
Diploma and above	0.2	0.6	1.4	4	0.1	0.5	0.2	4.0	0.2	0.7	2.8	8.3
Adult_aeu	0.9	1.4	2.8	3	0.9	2.1	1.5	4.0	0.0	0.0	0.0	0.0
HH_item_aeu	0.0	0.0	0.1	0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
w_farm_size_agland_aeu	0.2	0.2	-0.4	-1	0.6	0.3	0.1	-0.3	0.4	0.1	0.7	-0.8
Debt_aeu	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HH_Livestock_holding_tlu	0.0	0.0	-0.1	0	0.0	0.0	0.0	-0.1	0.0	0.1	0.0	-0.1

Source: Own Computation (See Annex)

Once all the coefficients are estimated, the activity choices variables or composite asset indexes used in generating the income from livelihood activities are predicted in table 4.3 the resulting predictions were characterized as asset index in each of the four activities. In addition to income from transfers, these were our choice variables to classify the livelihood strategy. Therefore, in total, the study used five activity choice variables to generate livelihood strategy clusters. Activities choices variables index of mean, standard division, rang maximum and minimum values summarized in below table 4.3

Table 4. 3 predicted Asset index

Year	Predicted asset index Variable	Obs	Mean	Std. Dev.	Min	Max
2011	Crop asset index	3,639	832.6474	775.2121	0.000103	16431.86
	Livestock asset index	3,639	827.0927	1057.924	0.102545	28338.62
	Business asset index	3,639	703.5308	1628.47	0.003146	72805.42
	Wage	3,639	754.9653	2363.254	3.58E-14	33712.66
	Transfer income	3,639	189.4751	713.6001	0	13774.61
	Total income	3,639	3307.711	3615.797	16.16883	107557.8
2013	Crop asset index	3,639	1643.86	2040.654	0.00035	46025.99
	Livestock asset index	3,639	974.7306	1281.936	1.722331	40741.18
	Business asset index	3,639	882.8094	1892.685	0.052064	38055.37
	Wage	3,639	833.1568	4973.339	0.000726	241291.6
	Transfer income	3,639	216.0037	961.308	0	21117.7
	Total income	3,639	4550.56	6229.748	23.25228	243985
2015	Crop asset index	3,639	1585.214	1944.297	0.001414	89663.66
	Livestock asset index	3,639	1415.48	2651.576	0.663842	93053.45
	Business asset index	3,639	759.5644	3869.281	1.009588	179636.4
	Wage	3,639	836.6167	2770.112	0	54804.73
	Transfer income	3,639	182.0294	824.8254	0	14864.86
	Total income	3,639	4778.905	6423.781	17.96982	183789.8

Source: Own Computation

4.3 Principal component analysis

Before livelihood strategies clustering, in order to minimize distortion due to the possible correlation and measurement as well as scale effects among the six activity choice variables, the researcher conducted Principal component analysis. PCA was employed to generate a new set of uncorrelated variables called component scores. The latent root criterion and visual interpretation of the screen plot showed that two-component scores were optimal. The two-component scores totally explain about 53 percent.

Table 4. 4: Principal Component analysis

```
. pca crop_index livstock_index self_employment_index wage_index transfers_index

Principal components/correlation                  Number of obs    =     10,917
                                                  Number of comp.  =          5
                                                  Trace            =          5
    Rotation: (unrotated = principal)             Rho              =     1.0000
```

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	1.46679	.297167	0.2934	0.2934
Comp2	1.16962	.196982	0.2339	0.5273
Comp3	.97264	.134474	0.1945	0.7218
Comp4	.838166	.285382	0.1676	0.8894
Comp5	.552784	.	0.1106	1.0000

Principal components (eigenvectors)

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Unexplained
crop_index	0.6902	0.1364	0.0208	0.0230	0.7100	0
livstock_i~x	0.6747	0.2177	0.0416	0.0650	-0.7010	0
self_emplo~x	-0.1191	0.6686	-0.1895	-0.7090	0.0159	0
wage_index	-0.1926	0.6201	-0.2975	0.6978	0.0542	0
transfers_~x	-0.1308	0.3202	0.9346	0.0750	0.0358	0

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CHAPTER FIVE

5. RESULTS

the aimed of this study was to identify the classification of rural livelihood strategies, their transitions between strategies over time, and factors of rural livelihood strategies that affecting these processes and changes. This chapter presents an analysis and discussion on the data obtained from the ESS survey to answer the research questions raised in chapter one and supports the objectives of the study. From the data which has been collected earlier, the attrition bias test has been conducted to determine whether attrition in a panel data model is random or not before proceeding to data analysis.

The analysis is conducted using STATA version 14 and Latent Gold 5.0 with MS Excel and the results that have taken from the ESS survey generated. Attrition bias test, t-test, two-part model-regression, multinomial regression and ordered regression Analysis has been conducted and /or used to answer the research questions.

5.1 Rural Livelihood strategy classifications

with nine clusters, the variation in households' combined income and asset activity variables was best described: For the 9 latent Markov state class model, the BIC was the lowest (16194.15). Based on the latent cluster analysis, nine livelihood strategies are identified and the results are summarized in below Table 5.1. Each household is assigned to one unique livelihood strategy for all 2011, 2013, and 2015 year based on characteristics of the activity variables.

Table 5.1: latent Markov cluster Model

Model	*Cluster*	*LL*	*BIC(LL)*	*Npar*	*Class.Err.*
Model1	1-Cluster	-33926.4	67889.92	4	0
Model2	2-Cluster	-16846.5	33832.54	15	0.0248
Model3	3-Cluster	-11964.1	24160.61	25	0.0784
Model4	4-Cluster	-10374.8	21056.46	33	0.117
Model5	5-Cluster	-9340.01	19061.24	41	0.1081
Model6	6-Cluster	-9538.71	19533.02	49	0.1734
Model7	7-Cluster	-8546.66	17623.32	57	0.145
Model8	8-Cluster	-8323.19	17250.76	65	0.1712
Model9[7]	9-Cluster	-7757.7	16194.16	73	0.1824
Model10	10-Cluster	-7864.37	16481.89	81	0.2309

Source: own computation

[7] the BIC was lowest (16194.15) for the nine latent state class Markov model

Livelihood strategy clusters were named after the activities in which households spent the most compared to other cluster members (Table 5.2). For example, households in the ninth cluster invested relatively more in Business operators and large-scale farmers (Cluster 9) and therefore this cluster is labeled “large-scale farmers”. “Subsistence farmers **(Cluster 3)**” has lowest mean values in all asset index categories, while “Small-scale crop and livestock producers (Cluster 1)” had similar asset index values with cluster 3 except for crop and livestock income which was more than two times of cluster 3. Therefore, all Livelihood strategy names are related to the most prominent activity variable(s) and based on Bonferroni tests of (see appendix D). However, the results also show that every livelihood strategy involves various activities reflecting their diversified nature. Means of asset indexes for each livelihood steratgy and total transfers by the livelihood strategy cluster are presented in Table Table 5.2 and Table 5.3 and the distribution of the rural households in each Rural Livelihood strategy clusters, or the number of rural households in each cluster for 2011, 2013, and 2015 years respectively.

Table 5.2: Means of asset indexes for all livelihood activity and total transfers by livelihood strategy cluster; values are the standard deviation of mean values in parenthesis.

Livelihood strategies	Crop asset index	Livestock asset index	Business asset index	Wage asset index	Transfer income	Number of households			
						2011	2013	2015	Total
Small-scale Crop farmers and livestock producers(Cluster 1)	1207.1	810.2	151.5	106.6	6.9	911	127	1456	2494
	10.2	9	2.2	2.2	0.6				
Medium scale Crop and livestock producers (Cluster 2)	2024.9	1626.5	455.3	241.3	37.5	446	634	965	2045
	21.8	18.3	6.5	6.1	2.6				
Subsistence farmers (Cluster 3)	1063.7	566.5	315.7	153.1	22.5	842	1462	0	2304
	9.4	7.2	4.1	3.1	1.4				
Diversified small- scale farmers (Cluster 4)	825.6	771.3	898	587.3	242.8	957	501	170	1628
	13.8	15.1	14.5	15.1	10.1				
Medium-scale Diversified farmers (Cluster 5)	2600.2	2481.6	1359.9	942	327.7	145	337	517	999
	59.9	58.1	35.4	45.3	21.2				
wage employment and remittance (Cluster 6)	454.4	441.7	2066.5	5347.7	1378.3	306	227	155	688
	23	24.7	93.6	200.1	77				
Medium Business and wage employment (Cluster 7)	0.9	12	1577.5	767.4	56.7	0	280	307	587
	0	0.5	53.8	43.1	7.7				
Business operators and wage employment (Cluster 8)	1912.4	1812.1	11079.1	14661.4	2436.5	28	44	42	114
	194.6	188	2050.1	2440.2	424.3				
Business operators and large-scale farmers(Cluster 9)	12165.4	13854.1	1193.2	228.1	175.7	4	27	27	58
	1985.8	2160.9	215.9	90.5	69				
Total	1353.9	1072.4	782	808.2	195.8	3639	3639	3639	10917
	16.5	17.5	25.5	34.1	8				
Average (2011)	832.6	827.1	703.5	755	189.5				
	12.9	17.5	27	39.2	11.8				
Average (2013)	1643.9	974.7	882.8	833.2	216				
	33.8	21.3	31.4	82.4	15.9				
Average (2015)	1585.2	1415.5	759.6	836.6	182				
	32.2	44	64.1	45.9	13.7				
Average (overall)	1353.9	1072.4	782	808.2	195.8				
	16.5	17.5	25.5	34.1	8				

Source: own computation

In terms of household members size, the largest share contributors are cluster 2(Medium-scale Crop farmers and livestock producers) and cluster 3(Subsistence farmers), and their share of contributions are 23% and 21% respectively. On the other side, the least share occupied by cluster 9 (Business operators and large-scale farmers). However, In terms of income, cluster 8 (Business operators and wage employment) have the highest average income. The detail of the share of each cluster analyzed shown in below figure 5.1 clusters share distribution.

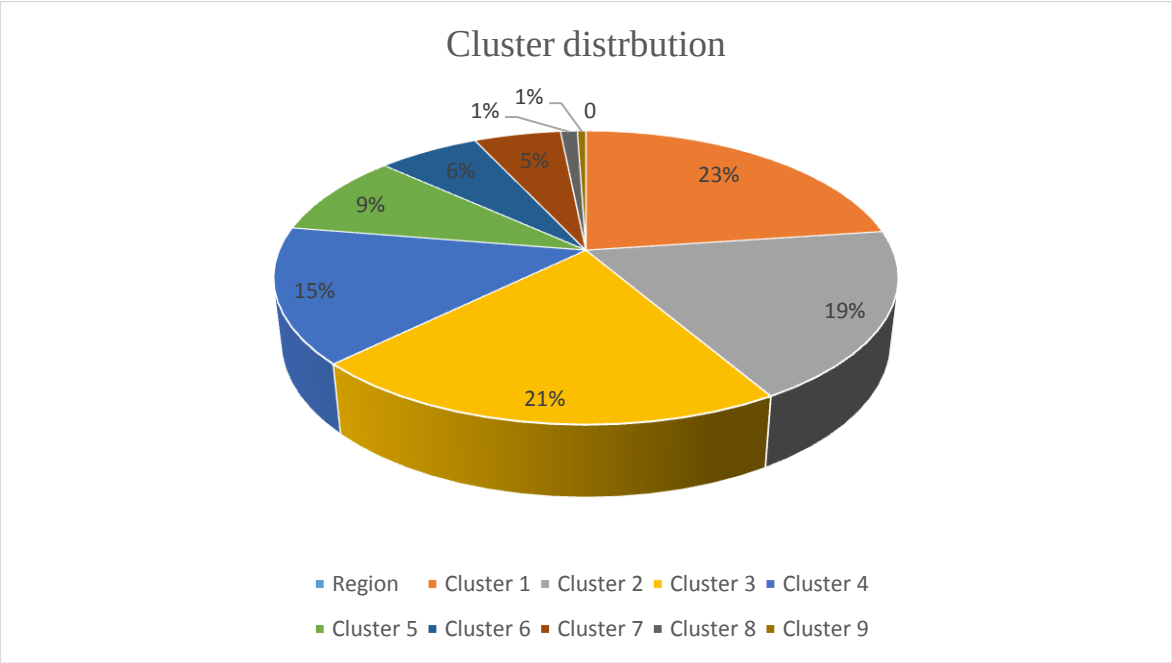


Figure 5. 1: rural livelihood clusters distribution share

The first strategy ***(Cluster 1), Small-scale Crop farmers and livestock producers,*** households in this cluster invested relatively more in crop farm and in livestock production. Therefore, this cluster is labeled *"**Small-scale Crop farmers and livestock producers**"*. It consists of 2494 households, which has 22% of share from the total sample and it is also the largest cluster in terms of the numbers of households share. On average, they have 2.29 TUL and 0.29 hectares of land.

The households in cluster 2, ***Medium-scale Crop farmers and livestock producers***, *"**Medium-scale Crop farmers and livestock producers**"* has similar asset index values like Small-scale Crop farmers and livestock producers (cluster 3) except for income, 32% of them are from the Oromia region. They farm a bit more than twice as much land (0.45 acres) if those are compared within cluster 1. On the other hand, nearly 22.1% of cluster 2 households are headed by females. Cluster 2 households' total livestock holdings are two times higher than cluster 3.

The third strategy (cluster 3**), *Subsistence farmers,*** has low mean values in all asset index categories, represents just over 22% of the total sample. On average, they have farm 0.19 acres of land, 24% of households under cluster 3 headed by a female household. 38.6% of them are from the SNNP region. However, these households engage in all five income-generating actives

The distinguishing feature of the fourth, ***Small-scale Diversified farmers***, representing 14.91% of households from the total sample, they have engaged in all income-generating activities (crop production, livestock production, self-business, and wage) but they are small scale farmers. On average, they have 2.90 acres of land.

The fifth cluster exhibits characteristics best described as ***Medium-scale Diversified farmers,*** invested resources into each activity. Their average per capita income is twice that of (cluster 4). Households in this cluster put more emphasis on all livelihood activities when it compares with cluster 4.

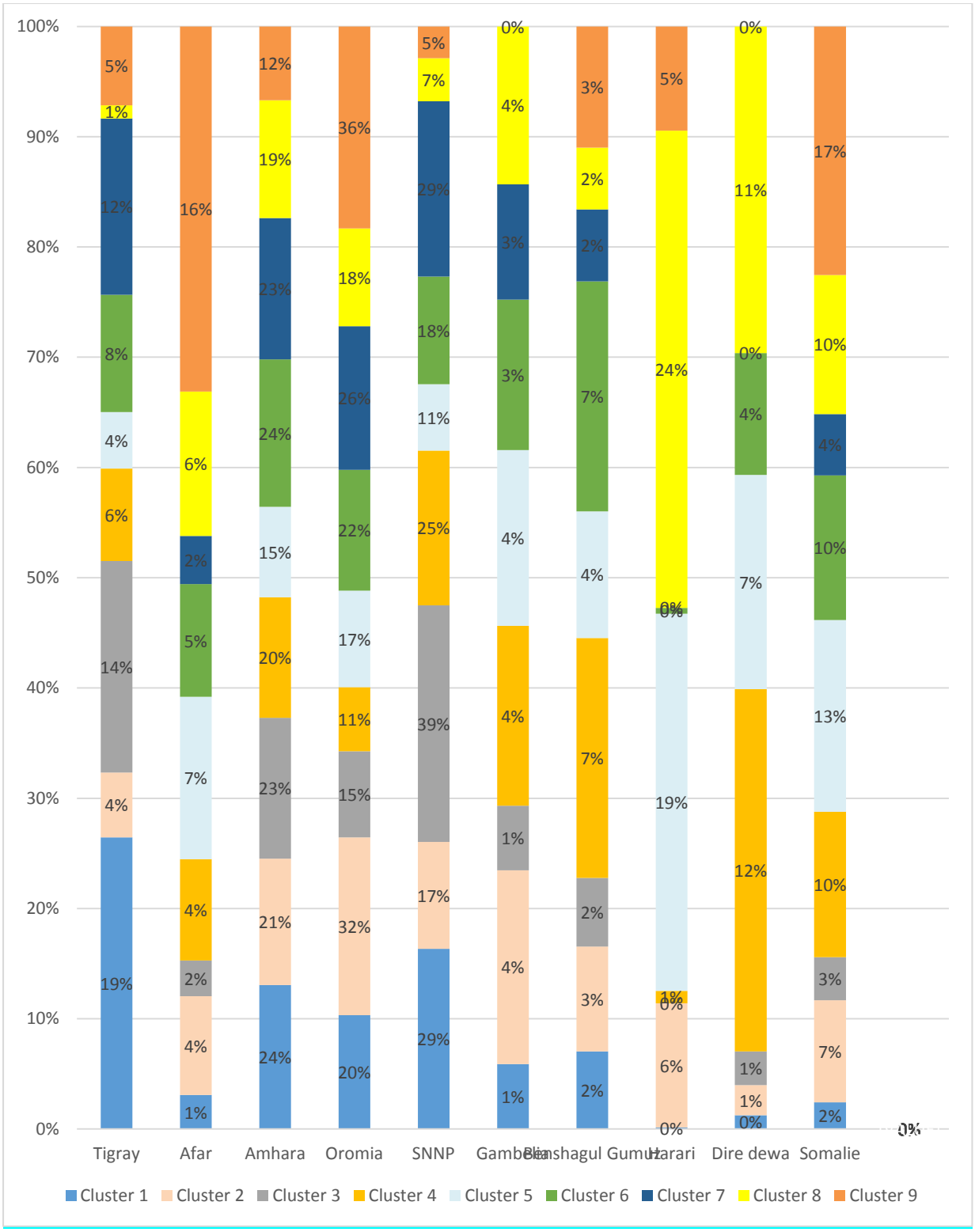
The households in cluster 6, **Wage *employment, and remittances***, households in this cluster invested relatively more in remittances and wage employment. Therefore, this cluster is labeled as "***Wage employment and remittances***", and it represents 6.3% of the total sample. The largest share contributors are the Amhara region (24%) and 24% of households are only headed by females.

Cluster 7, ***Medium Business, and wage employment***, households in the seventh cluster invested relatively more in businesses, and wage employment represents just over 5.3% of the total sample. On average, they farm 1.6 acres of land, i.e., three times more than cluster 1

Cluster 8, ***Business operators, and wage employment***, households in the eighth cluster invested relatively more in businesses and wage employment. 35% of households' heads are female. Most of Cluster 8 (23.68%) are from the Harari region.

Cluster 9, ***Business operators, and large-scale farmers (Cluster 9)***, households in the ninth cluster invested relatively more in businesses and large-scale farmers. 26% of households' heads are female. 36.21% of them are from the Oromia region. Regional distribution of rural livelihoods strategies are quantified and analyzed in the below figure

Figure 5. 2 Rural Livelihood Strategies' Per Region



Source: Own Computation

5.2 Livelihood strategies and outcomes (income) Associations

Table 5.3 and 5.4 presents the average income from major and subcomponent sources, and total income generated by each livelihood strategy and year, both in terms of absolute values and their relative shares. Bonferroni pair wise tests of incomes between the five livelihood strategies (Appendix D) are applied to examine the statistical difference of income composition between strategies. In average, ***Subsistence farmers (cluster 3), Small-scale Crop farmers and livestock producers (cluster 1), and Diversified small- scale farmers (Cluster 4)*** generate significantly less income than other livelihood strategies. Total income earned by ***Medium scale Crop and livestock producers (Cluster 2), Medium-scale Diversified farmers (Cluster 5), wage employment and remittance (Cluster 6), and Medium Business and wage employment (Cluster 7)*** is slightly above the sample mean values of both years (their income is 1.10 up to 2.3 times of the mean of income); thus they belong to the medium level income groups. The highest remunerative livelihood strategy is ***Business operators & wage employment (Cluster 8) and Business operators & large-scale farmers (Cluster 9).*** The average total income of cluster 8 and cluster 9 is nearly Four times that of the sample mean.

The findings are further confirmed by first-order stochastic dominant analysis. The cumulative density of total household annual income (per adult equivalent unit) was plotted for each livelihood strategies. Similar patterns were observed in 2011, 2013, and 2015; hence, an overall figure combining the three years is presented (Figure5.3). Figure 5.3 in general indicated that Business operators & wage employment (Cluster 8) and Business operators & large-scale farmers (Cluster 9) is stochastically a dominant strategy with the highest income generated and characterized by the lowest cumulative density compared to other strategies. Similarly, Subsistence farmers (cluster 3), Small-scale Crop farmers and livestock producers (cluster 1), and Diversified small- scale farmers (Cluster 4) are stochastically inferior to other livelihood strategies, even though there are some overlapping points along the curves. The cumulative density curves of gross income for the individual years followed the ternd in Figure 5.3.

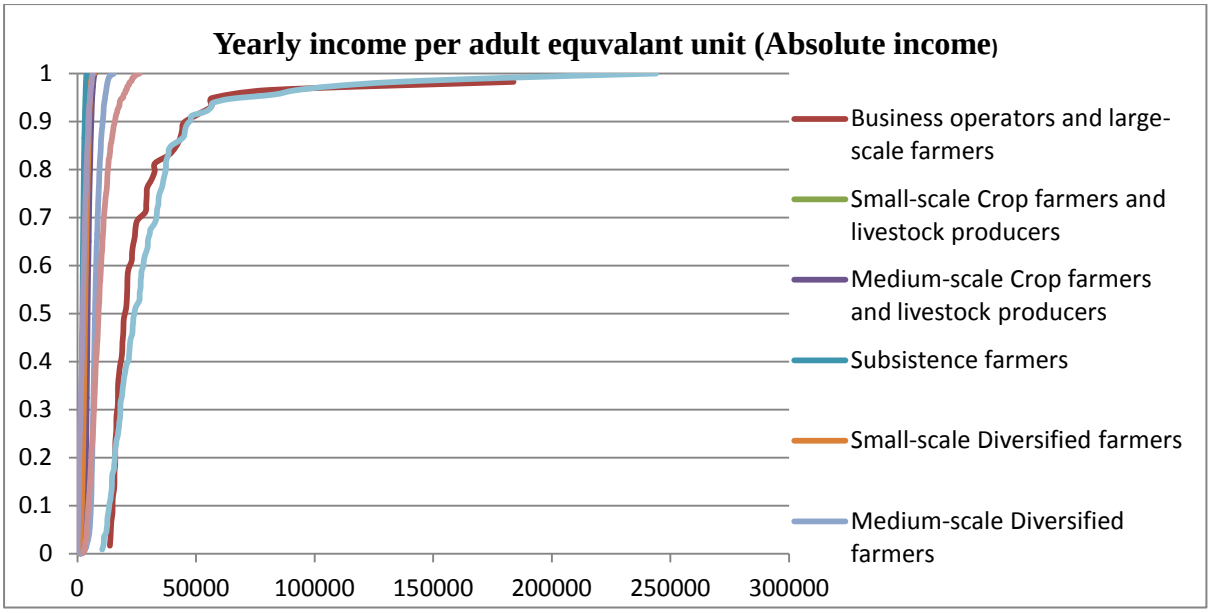


Figure 5. 3: *Cumulative density functions of gross or total average income by each livelihood strategy.*

Source: Own Computation

Comparison of incomes during 2011–2015 shows that average total household income was increased on average by 48 %(see figure 5.4). The highest growth registered in highly remunerative livelihood strategies (Cluster 8 and cluster 9) and Cluster 8 and cluster 9 households on average increased their income by 90% and 200% respectively.

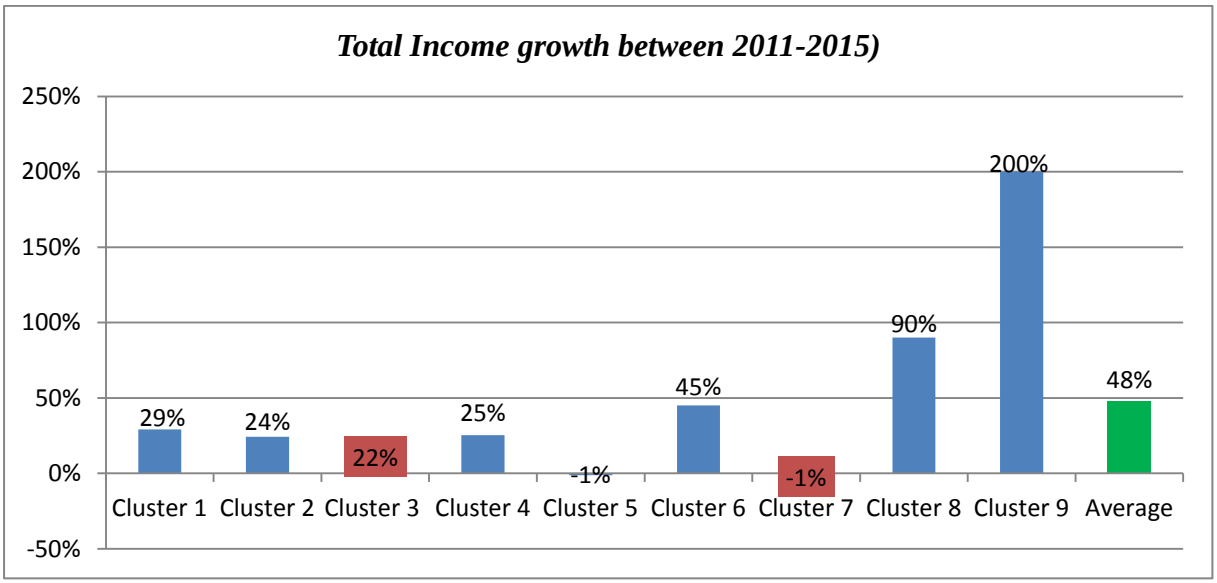


Figure 5. 4: *Total income growth per strategies*

Therefore, there are strong associations between household livelihood outcomes (income level) with the choice/ practice of livelihood strategies among 2011-2015 since high remunerative livelihood strategies on average have high total income. Conversely, low

remunerative livelihood strategies have been registered low income.**Table 5.3: predicted income based on the composite index**

Livelihood str	Crop income	Livestock income	Self-employment	Wage Income	Transfers income	Total income	Total income rank
Small-scale Crop farmers and livestock	1399.1	1113.1	401.5	212.3	6.9	3132.9	8
	49.8	50.3	50.9	27.1	0.6	93.1	
Medium scale Crop and livestock	2257.7	1734.7	410.4	189.1	37.5	4629.3	6
	109	70.1	42.4	22.9	2.6	136.5	
Subsistence farmers (Cluster 3)	1007.1	707.2	432.2	220.9	22.5	2389.7	9
	32.4	26.1	47.7	21.7	1.4	65.9	
Diversified small- scale farmers	672.4	708.2	1099.5	698.7	242.8	3421.7	7
	35.9	39.9	88.5	64.4	10.1	117.5	
Medium-scale Diversified farmers	2555.9	2118.7	805.6	763.1	327.7	6571.1	4
	144.5	115.7	114.3	98.8	21.2	227.1	
wage employment and remittance	321.2	552.4	1621.6	6000.4	1378.3	9873.9	3
	39.6	89.9	189.5	348.3	77	361.2	
Medium Business and wage	254.8	703.8	3007.7	1421	56.7	5444.1	5
	33.1	107.4	287.3	192.8	7.7	349.5	
Business operators and wage	1626.8	1216.4	2918.7	9312.8	2436.5	17511.3	1
	369	462.8	992	1662	424.3	1848.9	
Business operators and large-scale	6107.1	9153.7	1385.6	84.9	175.7	16906.9	2
	1213.7	2388.8	1112.5	35	69	2893.4	
Total	1372.6	1162	799.2	856.8	195.8	4386.5	
	30.3	28	33.9	37.2	8	64	
Average (2011	845.7	883.5	734.3	806.9	189.5	3460	
	34.1	31.1	49.3	54.9	11.8	86.1	
Average (2013	1669	1055.1	899.3	814.8	216	4654.1	
	51.2	35.8	66.4	58	15.9	106.6	
Average (2015	1603.2	1547.3	764.1	948.7	182	5045.3	
	66.2	68.8	59	78.1	13.7	133	
Average (overa	1372.6	1162	799.2	856.8	195.8	4386.5	
	30.3	28	33.9	37.2	8	64	

Source: Own Computation

Table 5.4: Mean of income and standard deviation (in 2015 prices in Birr, aeu adjusted)(total and by source) for livelihood strategy clusters;

Livelihood strategies	**Total income (2011)**	**Total income (2013)**	**Total income (2015)**
Small-scale Crop farmers and livestock producers(Cluster 1)	2578.52	4829.53	3331.77
	112.92	379.05	137.98
Medium scale Crop and livestock producers (Cluster 2)	3804.85	5062.56	4725.77
	213.64	203.15	235.97
Subsistence farmers (Cluster 3)	2097.78	2557.88	-
	122.64	75.78	
Diversified small- scale farmers (Cluster 4)	3088.52	3906.14	3869.14
	152.13	221.88	312.25
Medium-scale Diversified farmers (Cluster 5)	6499.23	6826.03	6425.09
	517.99	391.99	326.26
wage employment and remittance (Cluster 6)	8342.34	10421.01	12096.34
	530.54	604.68	794.96
Medium Business and wage employment (Cluster 7)	-	5473.8	5417
		512.83	477.97
Business operators and wage employment (Cluster 8)	10680.12	19189.15	20307.78
	1701.19	2863.26	3777.85
Business operators and large-scale farmers(Cluster 9)	7136.33	13847.36	21414.02
	2268.05	3191.1	5241.12
Total	3459.95	4654.14	5045.35
	86.12	106.64	132.98

Source: Own Computation

Table 5. 5: each asset endowment mean by livelihood strategy; values are the standard deviation of the mean in parenthesis.

Livelihood strategies	tropical livestock unit	Total land	Number of adults	Number of hh item	Average of HH debt
Small-scale Crop farmers and livestock producers(Cluster 1)	2.3	0.3	8.4	2.7	164.5
	0	0	0.2	0.1	13.9
Medium scale Crop and livestock producers (Cluster 2)	4	0.5	9.2	3.4	199.3
	0.2	0	0.4	0.1	11.8
Subsistence farmers (Cluster 3)	1.7	0.2	0.9	2.4	197.4
	0	0	0	0.1	12.2
Diversified small- scale farmers (Cluster 4)	1.5	0.1	2.6	2.9	320.4
	0.1	0	0.2	0.1	113.4
Medium-scale Diversified farmers (Cluster 5)	4.2	0.5	11.4	4.4	341.3
	0.2	0	0.6	0.2	41
wage employment and remittance (Cluster 6)	0.5	0.1	5.6	6	684.2
	0	0	0.5	0.2	191.5
Medium Business and wage employment (Cluster 7)	0.9	0.1	8.9	4.5	218.2
	0.1	0	0.6	0.2	38.9
Business operators and wage employment (Cluster 8)	1.1	0.2	12.7	15.6	1904.4
	0.2	0	1.9	1.8	675.2
Business operators and large-scale farmers(Cluster 9)	15.6	2.1	15.8	8.1	794.5
	2.3	0.3	3.6	2.1	273.4
Total	2.4	0.3	6.3	3.4	274.5
	0.1	0	0.1	0	23
Average (2011)	2.1	0.3	1.1	3	304.8
	0.1	0	0	0.1	62.1
Average (2013)	2.4	0.3	0.9	3.6	273
	0.1	0	0	0.1	22.2
Average (2015)	2.7	0.3	17	3.7	245.7
	0.1	0	0.3	0.1	19.8
Average (overall)	2.4	0.3	6.3	3.4	274.5
	0.1	0	0.1	0	23

Sources own computation

5.3 Livelihood Transitions

5.3.1 Rural households Livelihood Strategies Transitions Trends – In Year

The prominence of various clusters of livelihood strategy reveals variation over time (Table 5.6). In 2011, the majority of the households fall in Small-scale Diversified farmers

(Cluster 4) (about 26 percent), Small-scale crop farmers and livestock producers (Cluster 1) (about 25 percent), and Subsistence farmers (Cluster 3) (about 23 percent) respectively. However, Business operators and large-scale farmers (Cluster 9) were the smallest groups in terms of size (about 0.11 percent of households). Hence, a majority of households has been fall in small-scale farmers (about 74 percent) in 2011. On the other hand, In 2013, the distribution of households across the livelihood strategies were more equal, except for Subsistence farmers (Cluster 3) its share decreased by 17% households. In 2015, Small-scale crop farmers and livestock producers (Cluster 1) had lion share (40 percent of households), and the Business operators and large-scale farmers (Cluster 9) also persisted in having smallest share.

Regarding clusters size of rural livelihood strategies, the distribution of households across the livelihood clusters was substantially different between 2011 and 2015 with a chi-squared statistic of Pr=0000, Pr=0000, and Pr=0000, respectively (chi-squared test attached in table 5.7). This means that the size of the clusters has not been constant over the years and that livelihood transition pathways can be identified. So, due to this, a new cluster is created in 2013 (cluster 7) which has no share in the 2011 year and also the number of clusters decreased to 8, in 2015 all households in cluster 3 moved to other rural livelihood strategies since households' engagements livelihood areas increased.

Table 5.6: Rural households Livelihood Strategies Transitions by Year to year

Cluster	2011		2013		2015	
	No of household	Share(%)	No of household	Share (%)	No of household	Share(%)
Small-scale Crop farmers and livestock producers(Cluster 1)	911	25.03	127	3.49	1456	40.01
Medium scale Crop and livestock producers (Cluster 2)	446	12.26	634	17.42	965	26.52
Subsistence farmers (Cluster 3)	842	23.14	1462	40.18	0	0
Diversified small- scale farmers (Cluster 4)	957	26.3	501	13.77	170	4.67
Medium-scale Diversified farmers (Cluster 5)	145	3.98	337	9.26	517	14.21
wage employment and remittance (Cluster 6)	306	8.41	227	6.24	155	4.26
Medium Business and wage employment (Cluster 7)	0	0	280	7.69	307	8.44
Business operators and wage employment (Cluster 8)	28	0.77	44	1.21	42	1.15
Business operators and large-scale farmers(Cluster 9)	4	0.11	27	0.74	27	0.74
Total	**3639**	**100**	**3639**	**100**	**3639**	**100**

Source own computation

5.3.2 Rural households Livelihood strategies transitions Trends-by Clusters

Between and 2015, the majority of households (more than 42 percent) adjusted livelihood strategy clusters. Between 2011 and 2013, the main transition happened under Subsistence farmers (Cluster 3), and Small-scale Crop farmers and livestock producers (Cluster 1). Another notable transition in the 2013-2015 period is between the Small-scale Crop farmers and livestock producers (Cluster 1) and Medium-scale Crop and livestock producers (Cluster 2), showing that medium-scale farmers increasingly invested more labor in all five livelihood activity areas.

In general Table 5.7 show the transition of households between the livelihood strategies from 2011 to 2012 and from 2013 to 2015 respectively. Cluster3 and Cluster 1 were primary livelihood strategies in 2013, while cluster 1and cluster 2 became the main livelihood strategies in 2015. Across a four-year time, frame, 57.8 % of households maintained their original livelihood strategy; this indicates that in reality a 42.2% of the households modified their livelihood strategy in adapting to various conditions and opportunities.

Table 5.7: Livelihood transition matrices (percentage of households, 2011-13 and 2013-15) & number of households in parenthesis.

Livelihood strategies			2013									Joint Test
			CLU-1	CLU-2	CLU-3	CLU-4	CLU-5	CLU-6	CLU-7	CLU-8	CLU-9	Total	
2011	CLU-1	Number of HH	73	198	512	76	41	4	1	3	3	911	Pearson chi2(56) = 2.1e+03 Pr = 0.000
		%	8.0%	21.7%	56.2%	8.3%	4.5%	0.4%	0.1%	0.3%	0.3%	100.0%	
	CLU-2	Number of HH	23	172	83	48	101	5	0	3	11	446	
		%	5.2%	38.6%	18.6%	10.8%	22.6%	1.1%	0.0%	0.7%	2.5%	100.0%	
	CLU-3	Number of HH	16	143	464	105	35	26	45	5	3	842	
		%	1.9%	17.0%	55.1%	12.5%	4.2%	3.1%	5.3%	0.6%	0.4%	100.0%	
	CLU-4	Number of HH	13	79	344	209	67	73	159	10	3	957	
		%	1.4%	8.3%	35.9%	21.8%	7.0%	7.6%	16.6%	1.0%	0.3%	100.0%	
	CLU-5	Number of HH	2	27	21	21	61	2	0	7	4	145	
		%	1.4%	18.6%	14.5%	14.5%	42.1%	1.4%	0.0%	4.8%	2.8%	100.0%	
	CLU-6	Number of HH	0	11	36	39	24	112	74	8	2	306	
		%	0.0%	3.6%	11.8%	12.7%	7.8%	36.6%	24.2%	2.6%	0.7%	100.0%	
	CLU-8	Number of HH	0	4	1	2	7	5	1	8	0	28	
		%	0.0%	14.3%	3.6%	7.1%	25.0%	17.9%	3.6%	28.6%	0.0%	100.0%	
	CLU-9	Number of HH	0	0	1	1	1	0	0	0	1	4	
		%	0.0%	0.0%	25.0%	25.0%	25.0%	0.0%	0.0%	0.0%	25.0%	100.0%	
	Total	Number of HH	127	634	1,462	501	337	227	280	44	27	3,639	
		%	3.5%	17.4%	40.2%	13.8%	9.3%	6.2%	7.7%	1.2%	0.7%	100.0%	

Livelihood strategies	2013										Joint Test
	CLU-1	CLU-2	CLU-3	CLU-4	CLU-5	CLU-6	CLU-7	CLU-8	CLU-9	Total	2.1e+03 Pr = 0.000

	Livelihood strategies		2015 CLU-1	CLU-2	CLU-4	CLU-5	CLU-6	CLU-7	CLU-8	CLU-9	Total	Joint Test
2013	CLU-1	Number of HH	82	37	0	8	0	0	0	0	127	Pearson chi2(56) = 4.3e+03 Pr = 0.000
		%	64.6%	29.1%	0.0%	6.3%	0.0%	0.0%	0.0%	0.0%	100%	
	CLU-2	Number of HH	223	255	13	129	4	0	3	7	634	
		%	35.2%	40.2%	2.1%	20.3%	0.6%	0.0%	0.5%	1.1%	100%	
	CLU-3	Number of HH	957	340	60	91	8	0	1	5	1,462	
		%	65.5%	23.3%	4.1%	6.2%	0.5%	0.0%	0.1%	0.3%	100%	
	CLU-4	Number of HH	137	172	65	106	16	0	3	2	501	
		%	27.3%	34.3%	13.0%	21.2%	3.2%	0.0%	0.6%	0.4%	100%	
	CLU-5	Number of HH	37	133	23	116	8	4	6	10	337	
		%	11.0%	39.5%	6.8%	34.4%	2.4%	1.2%	1.8%	3.0%	100%	
	CLU-6	Number of HH	15	12	8	35	78	61	18	0	227	
		%	6.6%	5.3%	3.5%	15.4%	34.4%	26.9%	7.9%	0.0%	100%	
	CLU-7	Number of HH	0	0	0	11	29	238	2	0	280	
		%	0.0%	0.0%	0.0%	3.9%	10.4%	85.0%	0.7%	0.0%	100%	
	CLU-8	Number of HH	2	7	1	10	10	4	9	1	44	
		%	4.5%	15.9%	2.3%	22.7%	22.7%	9.1%	20.5%	2.3%	100%	
	CLU-9	Number of HH	3	9	0	11	2	0	0	2	27	

Livelihood strategies		2013									Joint Test
		CLU-1	CLU-2	CLU-3	CLU-4	CLU-5	CLU-6	CLU-7	CLU-8	CLU-9	Total	2.1e+03 Pr = 0.000
	%	11.1%	33.3%	0.0%	40.7%	7.4%	0.0%	0.0%	7.4%	100%		

Source: Own Computation

5.3.3 Household livelihood Transitions Trends- by Movement Type

To identify households' livelihood transitions by movement type, three wider livelihood strategies have identified: High remunerative livelihood strategies (clusters 8 and 9), Medium remunerative livelihood strategies (clusters 2, 5,6 & 7), and Low remunerative livelihood strategies (clusters 1, 3, and 4) based on Figure 5.3 and Table 5.3

In table 5.8 below, the results are presented by form of movement, ie (downward movements, stays, and upward movements to a higher remunerative livelihood strategy). 34.7% of households with fewer remunerative livelihood strategies have moved more to medium-level remunerative strategies. Conversely, Within four years, limited direct transition change was observed between a low remunerative livelihood strategy and a high remunerative livelihood strategy.

Regarding downward movement, out of 5.9 % moved to downward, 89.77% moved from medium to low remunerative strategies, only 0.1 % of households jumped downwards to low remunerative livelihood strategy from high remunerative livelihood strategy. 57.8% of Households staying at the same livelihood strategy from 2011 up to 2015, out of which 68.1% are low remuneration strategies.

In general Table 5.8 shows that 5.9%, 57.8%, and 34.3% of households have registered a downward, stay and upward movement respectively. activities. During the study period, the shift from low to moderate remunerative livelihood strategies was prevalent, and a few households with a low remunerative strategy in 2011 obtained a high remunerative strategy in 2015, which may be attributed to positive shocks that build a rural households asset base.

Table 5.8 Household livelihood transitions Trend - Movement type

Year	Remunerative livelihood strategies Change	Change	Number of Households	Total Share	Share from sub-average
2015	Downward movement	high to low	3	0.10%	1.40%
		High to medium	19	0.50%	8.84%
		medium to low	193	5.30%	89.77%
		Sub-average	**215**	**5.90%**	**100%**
		Low	1430	39.30%	68.00%
		Medium	663	18.20%	31.53%
		High	10	0.30%	0.48%
	Stay	**Sub-average**	**2103**	**57.80%**	**100.00%**
	Upward movement	low to Medium	1262	34.70%	95.53%
		Medium to High	41	1.10%	3.10%
		low to High	18	0.50%	1.36%
		Sub-average	**1321**	**36.30%**	**100.00%**
	Total		**3639**	**100.00%**	**100.00%**

Source: Own Computation

5.3.4 Household livelihood transitions per region

Table 5.9 show the transition of households between the livelihood strategies from 2011 to 2015 per regional state. A common pathway of transition is the change from low to intermediate remunerative livelihood strategies that have been prevalent across the country over the study period. However, In 2015, few households who were on in a low remunerative strategy in 2011 reached a high remunerative strategy and a high remunerative strategy moved to a low remunerative strategy. Therefore, a common pathway movement is intermediate step .

Table 5.9: Household livelihood transitions per region by movement type

Livelihood transitions per region between 2011 and 2015								
Region	high to low	High to medium	medium to low	Stay at existing cluster	low to Medium	medium to High	low to High	Total
Tigray	0	0	9	265	108	0	0	382
Afar	0	0	5	47	59	7	1	119
Amhara	0	3	31	405	330	8	4	781
Oromia	1	4	49	420	252	10	3	739
SNNP	1	1	60	593	271	4	3	933
Gambelia	0	1	7	57	34	2	0	101
Benshagul	0	0	0	5	64	53	0	123
Harari	0	7	0	107	3	1	1	119
Dire dewa	0	0	1	9	66	37	3	118
Somalie	1	2	18	79	115	6	3	224
Total	3	19	193	2,103	1,262	41	18	3,639

Source: Own computation

5.4 livelihood strategy choices determinants

Table 5.10 shows the results from the MLM regression identifying factors of households' choice of livelihood strategies. LS1 is the base category for the multinomial regression analysis ; thus the coefficients indicate that explanatory variables relative effect when it compared to the choice of being diversified subsistence farmers. Households are likely to remain within their original livelihood strategy as the coefficients of the initial Medium scale Crop and livestock producers (Cluster 2) and Medium-scale Diversified farmers (Cluster 5) clusters (2011) are positively associated with their respective destination cluster (2015) in all cases. However, the other seven clusters are negatively associated with their respective destination cluster (2015). Tropical livestock units, number of an adult under each household, debt, household asset, and farmland owned by households have different impacts on all of nine clusters.

Tropical livestock units: is positively associated with Business operators and large-scale farmers (Cluster 9) and negatively associated with Medium-scale Diversified farmers (Cluster 5), wage employment and remittance (Cluster 6), Medium Business and wage employment (Cluster 7), and Business operators and wage employment (Cluster 8). This may imply that land concessions may impose restrictions on choices for agriculture-related livelihood clusters.

Number of adults: is positively associated with Medium scale Crop and livestock producers (Cluster 2) and wage employment and remittance (Cluster 6) and negatively associated with Diversified small- scale farmers (Cluster 4) and Medium Business and wage employment

(Cluster 7), which means number of adults under households is the main determinant factors for medium remunerative strategies.

Debt: is positively associated with Diversified small- scale farmers (Cluster 4), Medium-scale Diversified farmers (Cluster 5), wage employment and remittance (Cluster 6), and Business operators and wage employment (Cluster 8). This may imply that financial accessibility has a high impact on medium and high remunerative strategies.

Asset owned by households: is positively associated with wage employment and remittance (Cluster 6), Medium Business and wage employment (Cluster 7), Business operators and wage employment (Cluster 8) and negatively associated with Business operators and large-scale farmers (Cluster 9).

Firm land size: associated with all rural livelihood strategies clusters except Medium scale Crop and livestock producers (Cluster 2) This may imply that land concessions by households have a strong influence on all least high remunerative strategies, medium-high remunerative strategies, and high remunerative strategies.

Female-headed households: negatively associated with Medium-scale Diversified farmers (Cluster 5), wage employment and remittance (Cluster 6), Business operators and wage employment (Cluster 8), and Business operators and large-scale farmers (Cluster 9). High remunerative strategies dominated by male-headed households.

Table 5. 50: MLM regression results for livelihood strategy choice determinant

Livelihood strategy (2015)	Small-scale farmers and petty traders (Cluster 2)		Diversified subsistence farmers (Cluster 4)		Medium-scale Diversified farmers (Cluster 5)		wage employment and Remittance Oriente worker (Cluster 6)		wage employment and petty traders(Cluster 7)		Business operators & wage employment (Cluster 8)		Business operators & large-scale farmers(Cluster 9)	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
clu2011														
2	0.38	0.01	-1.020**	0.02	0.18	0.23	-1.14	0.12	-15.12	0.98	-0.54	0.33	-0.89	0.01
3	-0.760*	0	-1.340*	0	-1.720*	0	-1.730*	0	-0.700*	0	-3.310*	0	-5.06	0
4	-0.530*	0	-0.23	0.15	-0.830*	0	-0.890*	0	0.900*	0	-2.680*	0	-2.73	0
5	1.110*	0	-0.44	0.49	1.330*	0	-0.84	0.42	-15.43	0.99	-0.92	0.38	-0.26	0.69
6	-0.18	0.47	-0.34	0.35	0.26	0.27	1.560*	0	1.52	0	-0.32	0.38	-0.69	0.37
8	0.48	0.51	-15.76	1	0.91	0.19	1.680**	0.03	-15.6	1	1.460**	0.07	1.29	0.29
9	19.08	1	16.83	1	3.62	1	16	1	16.13	1	14.94	1	42.63	1
tlu2015	0.01	0.27	-0.090**	0.01	-0.01	0.7	-0.460*	0	-0.300*	0	-0.650*	0	0.020**	0.06
adult2015	0.010**	0.04	-0.020*	0	0	0.28	-0.010***	0.07	-0.030*	0	-0.01	0.19	-0.01	0.33
debt2015	0	0.59	0.000***	0.09	0	0.000*	0.000*	0	0	0.33	0.000*	0	0	0.5
hhitem2015	-0.01	0.29	0.01	0.75	0.02	0.18	0.070***	0	0.050*	0	0.100*	0	-0.870*	0
farmsize2015	0	0.99	-5.230*	0	-0.46	0.000*	-8.420*	0	-6.820*	0	-5.200*	0	1.310*	0
fhh2015	-0.08	0.45	-0.11	0.55	-0.5	0.000*	-0.670*	0	-0.09	0.55	-1.360*	0	-1.290*	0

***Significant at 1%. **Significant at 5%. *Significant at 10%.

Source: Own Computation

5.5 Determinants of livelihood strategy mobility

In Table 5.11, the results of the ordered logit regression model further examine factors that may influence the transition to a more (upward mobility) or less (downward mobility) remunerative livelihood strategy during 2011–2015. The coefficient of Household Age, TLU, and household asset indicates that Household age, tropical livestock unit, and household own assets have strongly associated with downward mobility. On the other hand, Number of an adult, credit accessibility, farmland size, and household home resources have positively associated with the upward mobility, which implies that when increasing Number of an adult under each household, credit accessibility, farmland size, and household home resources, the probability of households' movement to high remuneration strategies increased. However, household head age, tropical livestock unit of household, credit accessibility, and the household asset have strong association with the household who have not transit to other clusters. Therefore, there are different factors for household movement upward, downward, and no change. See Table 5.11

Table 5. 61: Determinants of livelihood strategy mobility

Variables	Ordered logit		Marginal effect					
			no mobility		downward mobility		upward mobility	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Age	0.0302*	0.0037	0.0248*	0.0042	-0.0131	0.0396	0.007	0.0145
Fhh	0.2066**	0.0937	0.1542	0.1301	-0.9118	0.6332	-0.3253	0.3899
TLU	0.0574	0.0699	0.1540*	0.02	0.3962**	0.1886	0.0116	0.0099
Adult	0.0049	0.0044	0.0039	0.0039	-0.0107	0.0233	0.0187**	0.0074
Debt	0.0002*	0	0.0001**	0.0001	-0.0001	0.0004	0.0003*	0.0001
HH item	0.0927*	0.0095	0.1148*	0.0148	0.1868*	0.0671	0.0650*	0.0156
Farm size	0.3612***	0.1962	0.0642	0.152	-2.2064	2.1068	0.6106**	0.2498
/Cut1	1.9484	0.1558	2.8555	0.2044	0.9713	1.2801	4.7155	0.7378
/Cut2	6.6974	0.2437	8.2405	0.4926				

***Significant at 1%. **Significant at 5%. *Significant at 10%.

Source: Own Computation

CHAPTER SIX

6. DISCUSSION OF RESULTS

Based on the research finding, the study will now discuss how results of this study support the objectives; identifying distinct rural livelihood strategies group, examining households' movement among the livelihood strategies over time, examining household livelihood outcomes (i.e., income level) association with the choice/ practice of livelihood strategies, identifying the determinants of households' livelihood strategy and its movement and testing the approach of combining income and assets for livelihood clustering.

6.1 Rural Households' livelihood strategy classifications

The study identified nine distinct livelihood strategy clusters in rural Ethiopia; those strategies mainly involve various agricultural practices and non-farm employment opportunities (e.g., business, employment). The findings provide empirical evidence that Households are using their asset base to engage in various livelihoods. Strategies Strategies (Ellis 2000; DFID 1999; Scoones 1998). The results also provide evidence that livelihood outcomes (i.e., income levels) are significantly associated with livelihood strategy choices (Nielsen et al., 2013; Walelign et al., 2017). Other empirical studies from Cambodia (jiolo, 2017) also offer similar results.

On average, Subsistence farmers (Cluster 3) were the lowest remunerative livelihood strategy. Therefore, this strategy low mean values in all asset index categories. The second less remunerative livelihood strategy was Small-scale Crop farmers and livestock producers (Cluster 1)); this strategy has similar characteristics with cluster 3 but a higher share of both crop and livestock income contributed to higher average household income and the strategy was the second most common in 2011 (25.03%), it gained importance and one was not prominent in 2013 (3.4%). The third less remunerative solution was diversified small-scale farmers (Cluster 4); households that followed this strategy displayed a high degree of income diversification; the strategy was the most common in 2011. Asset endowment of cluster 4 households is higher than that of cluster1; the most remarkable examples are wage employment, self-business, and transfer income. Medium-scale Crop and livestock producers (Cluster 2) was the fourth less remunerative strategy; households who fall in this category under this strategy generated high income from crop and livestock production. However, self-

employment, wage employment, and transfer income are the dominant sources of income for Medium Business and wage employment (Cluster 7)

Regarding Medium-scale Diversified farmers (Cluster 5); this strategy was similar to Diversified small- scale farmers (Cluster 4) in terms of livelihood activities but a higher share of income generated from a self-business, wage employment, and transfer income. Also, households in cluster 6 showed the third-highest average total income earned. Medium-scale Crop and livestock producers (Cluster 2), Medium-scale Diversified farmers (Cluster 5), wage employment and remittance (Cluster 6), and Medium business and wage jobs (Cluster 7) became increasingly relevant as more households switched to these strategies over time. Nepal has seen this pattern of rural households changing their livelihood strategies by moving their agricultural occupation to non-farm activities by Bhandari (2013). The most remunerative livelihood strategies were, on average, Business operators and wage employment (Cluster 8) and Business operators and large-scale farmers (Cluster 9); With time, the two highly remunerative livelihood strategies gained prominence: while cluster 8 and cluster 9 accounted for just 0.77% and 0.11% of the sample in 2011, 1.15% and 0.74% used those livelihood strategies in 2015 respectively. The higher remunerative livelihood strategies were adopted by only a minority of households; this is consistent with the fact that rural areas of developing countries are primarily populated by poor asset households with few other choices than the adoption of lower or intermediate remunerative livelihood strategies (Abdulai and CroleRees 2001). It is also in line with Ethiopia's national realities, where the majority of households practice small-scale subsistence farming (IFAD 2013).

In general, Business operators and wage employment (Cluster 8) generate the highest mean total annual income, followed by Business operators and large-scale farmers(Cluster 9) and wage employment and remittance (Cluster 6) on the other hand, Subsistence farmers (Cluster 3) and Small-scale Crop farmers and livestock producers(Cluster 1) have the lowest mean of total income respectively.

In Ethiopia in terms of share of a household, the less remunerative and most practiced livelihood strategy is Diversified small- scale farmers (Cluster 4). Agricultural income remains a major pillar in the rural economy of Ethiopia though the share of non-farm livelihood activities and its generating income dramatically increases since 2011. However, agriculture still plays a prominent role in explaining and differentiating livelihood outcomes for each livelihood strategy.

6.2 Livelihood strategies and outcomes Associations

The results also provide evidence that livelihood outcomes (i.e., income levels) are significantly associated with livelihood strategy choices (Walelign et al., 2017; jiolo, 2017). Business operators and wage employment (Cluster 8) generate the highest mean total annual income, followed by business operators and large-scale farmers (Cluster 9). In the study period, the less remunerative and most practiced livelihood strategy is Diversified small-scale farmers (Cluster 4). Agricultural income remains a major pillar in the rural economy of the study areas, though the share of agricultural income dropped dramatically in 2015. However, agriculture still plays a prominent role in explaining and differentiating livelihood outcomes for each livelihood strategy. Furthermore, increasing reliance on non-farm income (mainly from business and wage income, and remittances) through time reflects its importance to local livelihoods in helping to strengthen diversification and resilience (Barrett et al., 2001)

In general, The transitions in household livelihoods mirrored the livelihood outcomes of households and the accumulation of physical and financial assets: households with an upward movement on average had a higher positive increase in income, and households with a downward movement on average had a higher decrease in income. Similarly, households with a downward trend experienced a decrease in asset endowment, while households with an upward movement raised their income and asset endowment. This finding is in line with studies that report the importance of assets as a pathway to engage in more remunerative livelihood strategies (Nielsen et al. 2013) to improve the wellbeing of households. This has implications for interventions to alleviate rural poverty. Households with a rise in the provision of assets are more likely to escape poverty (Krishna 2006) via the adoption of more remunerative livelihood strategies. Policy initiatives to increase the accumulation of assets would therefore enable rural households to adopt a more remunerative, resilient and sustainable livelihood strategy.

6.3 Household's livelihood transitions

Similarly, to Walelign (2017), The findings of the study show that over 42.2% of households change their livelihood strategies over time in response to evolving pressures, incentives, and opportunities through time. More generally, Households belonging to the less remunerative livelihood strategies more commonly moved to another low remunerative strategy (e.g. from Subsistence farmers (Cluster 3) to Small-scale Crop farmers and livestock producers (Cluster

1) to Diversified small- scale farmers (Cluster 4) and the other way round). Therefore, the common pathway to improve household livelihoods appears to have required an intermediate step during which the accumulated assets and capital of households through agriculture, petty trade, and migratory work i.e. 34.7% of households transited from low to intermediate remunerative livelihood strategy, which was common over the study period. however, limited direct change between a low remunerative livelihood strategy and a high remunerative livelihood strategy (only 0.5%) was observed over four years from 2011 up to the 2015 (only a few households (0.5%) from total households).

limited households belonging to the most remunerative livelihood strategies in 2011 and 2013 (i.e. Business operators and wage employment (Cluster 8) and Business operators and Large-scale farmers (Cluster 9)) have switched to low remunerative livelihood strategies. This might be illustrated by the relative resilience of those strategies to shocks. Cash accumulation from high net farming and business income, for example, can be saved and used in times of need or further invested in household livelihood asset, beyond household consumption needs. Nevertheless, there has been a common movement between high remunerative livelihood strategies and the intermediate strategies. and a few households who were in Business operators and wage employment (Cluster 8) and Business operators and large-scale farmers (Cluster 9) in 2011 move down to a low remunerative livelihood strategy in 2015, especially if they were hit by a serious shock that depleted the livelihood assets of households. (e.g. livestock loss).

Interestingly, intermediate remunerative livelihood strategies (Medium-scale Crop and livestock producers (Cluster 2), Medium-scale Diversified farmers (Cluster 5), wage employment and remittance (Cluster 6), and Medium Business and wage employment (Cluster 7)) appeared as a stepping stone for households in the low remunerative livelihood strategies trying to improve household wellbeing. However, not all intermediate remunerative strategies have fulfilled their purpose equally. Results indicate that households shifted more frequently to cluster 2 and cluster 7 than to cluster 5 in the low remunerative livelihood strategies. his pattern indicates that there are comparatively less entry barriers for cluster 2 and cluster 7 than for cluster 5 and cluster 6.

6.4 Determinants of livelihood strategy choices

In addressing the third research question of the study: what are the determinants (i.e., assets, contextual factors) affecting choice/practice of livelihood? The study results show that

several factors shape, constrain, or influence choices of livelihood strategies. Households are likely to remain within their original livelihood strategy as the coefficients of the initial Medium scale Crop and livestock producers (Cluster 2) and Medium-scale Diversified farmers (Cluster 5) clusters (2011) are positively associated with their respective destination cluster (2015) in all cases. However, the other seven clusters are negatively associated with their respective destination cluster (2015). Tropical livestock units, number of an adult under each household, debt, household asset, and farmland owned by households have a different impact on all of nine clusters. This finding is in line with studies that report the importance of assets as a way to engage in more remunerative livelihood strategies. (Walelign et al., 2017;jiolo, 2017) to improve the wellbeing of households.

6.5 Determinants of livelihood strategy mobility

Returning to the fifth research questions of the study: what are the entry barriers preventing certain households to access more remunerative strategies? The study results show that several factors that may influence the transition to a more (upward mobility) or less (downward mobility) remunerative livelihood strategy during 2011–2015. From various variables, Household age, tropical livestock unit, and household own asset have strongly associated with downward mobility. On the other hand, Number of adult, credit accessibility, farmland size and household home resources have positively associated with the upward mobility, which implies that when Number of adults under each household, credit accessibility, farmland size, and household home resources, the probability of households move to high remuneration strategies increased and this result more or less similar to Walelign (2017) and jiolo (2017) research finding. However, household head age, tropical livestock unit of household, credit accessibility, and the household asset have strong association with the household who have not transit to other clusters. This finding also similar to Walelign (2017) and jiolo (2017) research finding.

6.6 the method of combining asset and income for livelihood clustering

Income and assets each has their advantages and disadvantages in measuring rural welfare and livelihood (Fields et al. 2003; McKay 2000; Moser and Felton 2007). Combining income and assets enable a better welfare or livelihood understanding as one overcomes the limitations of the other (Nielsen et al. 2012). The study took a statistical approach (regression-based) to regress income from each livelihood activity against each asset type in

order to create a composite asset index and activity choice variable. A similar technique was used by Walelign (2017) and jiolo (2017) to create a composite asset index to classifying rural household's livelihood strategies. This approach has been identified as superior to other statistical methods for data reduction, such as PCA and PFA, as it has attractive advantages based on economic theory (Adato et al. 2006; Giesbert and Schindler 2012). The individual asset coefficients indicate the marginal contribution of the assets to the income from the livelihood activity under consideration.

Walelign Adato et al. 2016 undertook statistical analysis to judge the performance of the combinin income and asset approach in clustering households into different livelihood strategies. He used income and asset choices variables separately to cluster households using a similar latent cluster model. (the BIC suggested the 1 class-7 state and 1 class-6 states model for both income and asset approaches, respectively,) and compared the performance of our approach with income as well as assets. He estimated intra-cluster correlation coefficients for income and asset variables – as a measure of the similarity of households in a cluster and the results are presented in Appendix F. The results suggest that income and asset-based approaches sets the two extremes in livelihood strategy clustering: using an income approach, households in a cluster are relatively more similar in income variables while using an asset approach household in a cluster are relatively more similar in asset variables.

For the three methods using Bonferroni multiple comparison test, Walelign also compared the mean total revenue of each cluster. The mean total income was meaningfully different for the five (from 15 possible pairs), 10 (from the 21 possible pairs) and 12 pairs (from the 21 possible pairs) of livelihood strategies using asset, income and combined income-asset approach, respectively This indicates that Compared to both the income and the asset approach, the combining income and asset approach superior in distinguishes the livelihood strategies identified.

CHAPTER SEVEN

7. SUMMARY, CONCLUSION, AND IMPLICATIONS FOR FURTHER RESEARCH, POLICY AND INTERVENTION

This chapter concludes the main objective of the study. It synthesizes the major findings of the study based on presentations and triangulation of results in previous chapters. Firstly, the finding of the study are summarized based on the previous chapters then, based on findings of the study are incorporated into concluding remarks. Contingent upon the major findings of the study, this chapter also suggested implications for further research, policy, and theory that are believed to enhance the comprehensive understanding and intervention of the theme under rural livelihood strategies classification and dynamics of household livelihood strategies.

7.1. Summary of the study

This study addresses one of the major challenges in rural livelihood analysis to quantitatively examine rural livelihood strategies classification and the dynamics of household livelihood strategies over time. It investigates the interactions among rural household's livelihood assets, activities, and outcomes, and Captures the dynamics and underlying factors of long-term changes that affecting choice/practice of livelihood strategy and households' livelihood strategy movement. The study aims to identify the classification of rural livelihood strategies, their transitions over time, and factors affecting these processes and changes. The study employs the dynamic livelihood strategy framework and use Ethiopian socio-economic survey (ESS) panel data for 2011,2013 and 2015 covering 3639 households in 9 Regional state and rural kebeles of Dire-Dewa rural part in Ethiopia, for class cluster analysis and regression estimation. In this study, rural livelihood strategies are quantified by the method that combines households both income and assets to classify different livelihood strategy, which overcomes the limitations of the income-based analysis and asset-based analysis. Based on latent Markov cluster model, nine different livelihood strategies were identified in the study, and the findings indicate that over 42.2% of households are changing their livelihood strategies from 2011 to 2015.However, 57.8% of Households remaining at the

same livelihood strategy showed little income variation across all income sources. The research identifies covariates that influence the choices of livelihood strategies and affect the access of households to more remunerative strategies, such as the number of an adult under each household, credit accessibility, farmland size, and household home resources

The study used the novel approach to study the dynamics of livelihoods: it used combined asset and income to studying livelihood dynamics; This approach helps us to distinigush between livelihood strategies better than more widely used income or asset-based approaches and is therefore suitable for livelihood strategy-based targeting. This new approach statistically combining income and asset variables based on the relationship defined in the livelihood framework and the theory of rural household revenue optimization. While stochasticity weakens the conventional income-based approach, the asset-based approach does not pay attention to the relation between assets and livelihood outcomes. the study proved that combining asset and income benefits from the advantages of both the income and asset-based approaches while minimizing their disadvantages.

7.2. Conclusions

This paper is one of the very first quantitative empirical studies systematically analyzing rural livelihood strategies and their transitions through time; the study identified nine household livelihood strategies based on the households of all nine regional states of Ethiopia and Dire Dewa rural kebeles.

In general, the following are the main conclusion of the study based on the research finding the study.

Based on latent Markov model, the study identified nine distinct livelihood strategy clusters in rural Ethiopia; those strategies mainly involve various agricultural practices and scales and non-farm activity (e.g., business, employment). The findings provide empirical proof that households are using their asset base to engaged in various livelihood strategies.

The prominence of different livelihood strategy clusters revealed variation through time, and most households changed or modified their livelihood strategy between 2011 and 2015. The study results show that over 42.2% of households change livelihood strategies from 2011 up to 2015. Households belonging to the less remunerative livelihood strategies more commonly moved to another low remunerative strategy (e.g. from cluster 1 to cluster 3 to cluster 4 and the other way around). However,34.7% of households shift from low to intermediate remunerative livelihood strategy, which was common pathway over the study

period. Therefore, the common pathway to improve the livelihood of households is intermediate step during which households accumulated assets and capital via farming, petty trading, and migratory work i.e. 34.7% of households moved-up from low to intermediate remunerative livelihood strategy, which was common over the study period from 2011 up to 2015. However, very few direct transition between a low remunerative livelihood strategy and a high remunerative livelihood strategy (only 0.5%) was occurred within four years from 2011 up to the 2015. In 2015, just a few households (0.5 percent) out of the total households that were in a low remunerative strategy in 2011 achieved a high remunerative strategy which could be due to positive shocks that build rural households asset base (e.g. sudden remittance, self-employment). and also regarding downward movement, very few households belonging to the most remunerative livelihood strategies in 2011 and 2013 (i.e. Cluster 8and Cluster 9) transited directly to low remunerative livelihood strategies in 2015. This might be occurred due to shocks.

The results also provide evidence that livelihood outcomes (i.e., income levels) are significantly associated with livelihood strategy choices. Therefore, in general, Business operators and wage employment (Cluster 8) generate the highest mean total annual income, followed by Business operators and large-scale farmers (Cluster 9) and wage employment and remittance (Cluster 6) on the other hand, Subsistence farmers (Cluster 3) and small Small-scale Crop farmers and livestock producers (Cluster 1) have the lowest Mean of total income respectively. Even though Agricultural income remains a major pillar in the rural economy of Ethiopia, the share of agricultural income dropped dramatically in 2015. However, agriculture still plays a prominent role in explaining and differentiating livelihood outcomes for each livelihood strategy. Furthermore, increasing reliance on non-farm income (mainly from business, wage income, and remittances) through time

The study results show that several factors shape, constrain, or influence choices of livelihood strategies. In particular, Tropical livestock units, number of an adult under each household, debt, household's asset, and farmland owned by households are the main determinants (i.e., assets, contextual factors) that affecting choice/practice of livelihood

Regarding rural livelihood strategies movement determinants factors, the study results show that several factors that may influence the transition to a more (upward mobility) or to a less (downward mobility) remunerative livelihood strategy during 2011–2015. From various Factors, Household age, tropical livestock unit, and household own asset have a strong

association with downward mobility. On the other hand, In particular, entry barriers to highly remunerative livelihood strategy exist. The main factors enabling households to access more remunerative strategies are the Number of an adult under each household, credit accessibility, farmland size, and household home resources have positive association with upward mobility.

The applied approach to the study of livelihood dynamics makes it possible to better differentiate between livelihood strategies than more widely used income or asset-based approaches, and hence, it is suitable for livelihood strategy-based targeting. This approach uses both income and assets as choice variables. However, they are measured in different units. These can be related using a multivariate statistical model where all asset types (using the actual values of the assets that each household owns) are regressed against the income generated from each livelihood activity (e.g., grouped under headings such as crop production, livestock rearing, business operation, and wage employment). This creates a composite asset index that allows predictions of each household's income from each livelihood activity, e.g. the predicted crop income is derived from the composite asset index used in crop production. Both the dependent variable (income) and the choice variables (the predicted values) are expressed in monetary units.

This approach shares all the advantages of the asset approach. And, in addition, it establishes linkage between owned household assets and income from each source, by indirectly inferring how much of each asset is invested in each livelihood activity. The approach also allows capturing nonlinearities and interaction effects of asset use on income generation.

7.3 Implications for further research and policy

As stated under the limitation of this study, it needs to be investigated further, by incorporating the latest year ESS survey when it published. This work, however, informs more researches and policy orientations that could address the livelihood of rural people of Ethiopia. Under this section, implications for research, policy, and theory are discussed.

7.3.1. Implication for further research

I. This study employed the combined income and asset approach in quantitatively examined the dynamics of household livelihood strategies at the nationwide household level (macro-level). The employed approach for livelihood clustering (used both asset and income data through statistical models) performed better than the other approaches (both income or asset approch). Hence, micro-level research should be conducted by employing

the combined income and asset approach, and developing questionnaires by considering regional, zonal, woreda context, to find more of the livelihood characteristics of households that helps to improve livelihood strategy and improved policy intervention identification

II. Although Environmental income allows rural households to accumulate assets and move out of poverty, the study did not include environmental income in this study due to a lack of data. Hence, further research should be conducted by incorporating environmental income at both nationwide and micro-level income with a crop, livestock, self-employment, and wage income variable those have been used in this research

7.3.2. Implication for policy and interventions

I. Governments should segment its households in order to improve the effectiveness of poverty reduction policies, welling improvement policy and welfare policy.

II. Government and NGOs should give due attention to policy which focus improving the alternative of livelihood choices available to lower-income groups to improve their livelihoods.

III. Government should implement two policy measures; promotion and protective policy at individual level. promotion policy for households with low income group and protection policy for those households who have high income at the individual level while protecting households for high remunerative livelihood strategies and medium remunerative livelihood strategies from falling into low remunerative livelihood strategies (e.g. through asset protection).

IV. Factors requiring attention to rural developments are: (i) better access to formal and non-formal education and skills-building; (ii) need for improving access to resources (i.e., financial and technical), alternative income opportunities, and improved infrastructure and communication enabling respondents suffering from downward mobility to override obstacles and seek better-paying livelihood strategies; and (iii) land policy changes and the investigation of alternative livelihood strategies for those who are negatively affected by land concessions.

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Appendix

Appendix A:2011-livelihoods activities income predication

Two-part model

Log pseudolikelihood = -2142923.8		Number of obs	= 3639
Part 1: probit			
		Number of obs	= 3639
		Wald chi2(20)	= 635.64
		Prob > chi2	= 0.0000
Log pseudolikelihood = -2065.6997		Pseudo R2	= 0.1776
Part 2: glm			
		Number of obs	= 1959
Deviance	= 4265450.067	(1/df) Deviance	= 2199.82
Pearson	= 34101538.9	(1/df) Pearson	= 17587.18
Variance function: V(u) = u		[Poisson]	
Link function : g(u) = ln(u)		[Log]	
		AIC	= 2185.685
Log pseudolikelihood = -2140858.093		BIC	= 4250752

crop_income_nonneg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	-.1886908	.0553882	-3.41	0.001	-.2972497	-.080132
rural						
rural	1.078787	.0875581	12.32	0.000	.9071764	1.250398
region						
Afar	-1.541596	.2464459	-6.26	0.000	-2.024621	-1.058571
Amhara	.2286656	.0831347	2.75	0.006	.0657247	.3916065
Oromia	.2944871	.0860316	3.42	0.001	.1258683	.4631059
SNNP	.8096902	.082982	9.76	0.000	.6470485	.9723319
Gambelia	.0808299	.1485609	0.54	0.586	-.2103442	.3720039
Benshagul Gumuz	.4603852	.1444274	3.19	0.001	.1773127	.7434576
Harari	.8724461	.1403218	6.22	0.000	.5974204	1.147472
Dire dewa	.375717	.1346973	2.79	0.005	.111715	.6397189
Somalie	-.8636085	.133509	-6.47	0.000	-1.125281	-.6019358
age	.0054421	.0014939	3.64	0.000	.0025141	.00837
hh_max_edu						
less than or equal to 8th grade education	.1720524	.0563713	3.05	0.002	.0615666	.2825381
High school completed	.2017249	.0860702	2.34	0.019	.0330304	.3704194
Diploma and above	-.1616123	.1221588	-1.32	0.186	-.4010392	.0778145
adult_aeu	-.2459369	.1173167	-2.10	0.036	-.4758733	-.0160004
hh_item_aeu	-.0222598	.0088842	-2.51	0.012	-.0396724	-.0048471
w_farm_size_agland_aeu	.4687452	.1011377	4.63	0.000	.2705189	.6669715
HH_debt_aeu_ppp	1.19e-06	4.77e-06	0.25	0.803	-8.15e-06	.0000105
hh_livestock_holding_tlu	.0268604	.0076035	3.53	0.000	.0119578	.041763
_cons	-1.324088	.1886454	-7.02	0.000	-1.693826	-.9543497
glm						
fhh						
female household head	.0649772	.1193456	0.54	0.586	-.1689358	.2988903
rural						
rural	5.956133	.3814799	15.61	0.000	5.208446	6.70382
region						
Afar	-2.072282	.4223812	-4.91	0.000	-2.900134	-1.24443
Amhara	.0548018	.173242	0.32	0.752	-.2847463	.3943499
Oromia	.2008167	.176087	1.14	0.254	-.1443076	.545941
SNNP	.0576588	.1742368	0.33	0.741	-.2838391	.3991566
Gambelia	1.045761	.2685624	3.89	0.000	.519388	1.572133
Benshagul Gumuz	.009516	.19795	0.05	0.962	-.3784588	.3974909
Harari	1.321371	.222875	5.93	0.000	.8845442	1.758198
Dire dewa	-.0425759	.3010079	-0.14	0.888	-.6325405	.5473887
Somalie	-.0683788	.3007239	-0.23	0.820	-.6577868	.5210292
age	-.0005487	.0023781	-0.23	0.818	-.0052098	.0041124
hh_max_edu						
less than or equal to 8th grade education	-.0576182	.1094691	-0.53	0.599	-.2721737	.1569373
High school completed	-.0026736	.1355414	-0.02	0.984	-.2683299	.2629827
Diploma and above	.2178005	.2095716	1.04	0.299	-.1929522	.6285533
adult_aeu	.9440676	.2098712	4.50	0.000	.5327276	1.355408
hh_item_aeu	.0199475	.0079721	2.50	0.012	.0043226	.0355725
w_farm_size_agland_aeu	.2403221	.0613277	3.92	0.000	.1201221	.3605221
HH_debt_aeu_ppp	-2.14e-07	4.06e-06	-0.05	0.958	-8.17e-06	7.74e-06
hh_livestock_holding_tlu	.0389614	.0151933	2.56	0.010	.0091831	.0687396

Two-part model

Log pseudolikelihood = -2371832.1 Number of obs = 3639

Part 1: probit

Number of obs = 3639
Wald chi2(20) = 407.82
Prob > chi2 = 0.0000
Log pseudolikelihood = -1661.5881 Pseudo R2 = 0.3280

Part 2: glm

Number of obs = 2120
Deviance = 4722904.218 (1/df) Deviance = 2249.002
Pearson = 30631669.97 (1/df) Pearson = 14586.51

Variance function: V(u) = u [Poisson]
Link function : g(u) = ln(u) [Log]

AIC = 2236.029
Log pseudolikelihood = -2370170.496 BIC = 4706820

livestock_income_nonneg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	.040335	.0580077	0.70	0.487	-.073358	.1540279
rural						
rural	.5686882	.101289	5.61	0.000	.3701653	.767211
region						
Afar	-.4360048	.2125869	-2.05	0.040	-.8526675	-.0193421
Amhara	.1607004	.0865374	1.86	0.063	-.0089097	.3303106
Oromia	.227431	.0957482	2.38	0.018	.0397679	.415094
SNNP	.1167618	.0833317	1.40	0.161	-.0465653	.280089
Gambelia	.2149509	.1840261	1.17	0.243	-.1457336	.5756354
Benshagul Gumuz	-1.094753	.1963417	-5.58	0.000	-1.479575	-.7099302
Harari	.2377746	.1371608	1.73	0.083	-.0310556	.5066049
Dire dewa	.7754726	.1488672	5.21	0.000	.4836982	1.067247
Somalie	.263875	.1275944	2.07	0.039	.0137945	.5139554
age	.0005704	.0016344	0.35	0.727	-.002633	.0037737
hh_max_edu						
less than or equal to 8th grade education	.1167511	.066901	1.75	0.081	-.0143724	.2478746
High school completed	-.035017	.1012967	-0.35	0.730	-.2335548	.1635209
Diploma and above	-.2957777	.1365631	-2.17	0.030	-.5634364	-.0281189
adult_aeu	-.0099951	.1168833	-0.09	0.932	-.2390821	.2190919
hh_item_aeu	-.0073418	.0077577	-0.95	0.344	-.0225465	.0078629
w_farm_size_agland_aeu	.0226617	.059231	0.38	0.702	-.093429	.1387523
HH_debt_aeu_ppp	.0000145	6.00e-06	2.41	0.016	2.72e-06	.0000262
hh_livestock_holding_tlu	.4703877	.0626154	7.51	0.000	.3476638	.5931115
_cons	-1.19295	.1942495	-6.14	0.000	-1.573672	-.8122282
glm						
fhh						
female household head	.081558	.0796874	1.02	0.306	-.0746264	.2377424
rural						
rural	4.084989	.8564786	4.77	0.000	2.406322	5.763656
region						
Afar	1.930395	.5471998	3.53	0.000	.857903	3.002887
Amhara	.8726641	.5204353	1.68	0.094	-.1473703	1.892699
Oromia	1.276004	.525172	2.43	0.015	.2466855	2.305322
SNNP	.898593	.5267783	1.71	0.088	-.1338736	1.93106
Gambelia	1.277961	.5556282	2.30	0.021	.1889496	2.366972
Benshagul Gumuz	.9045901	.545126	1.66	0.097	-.1638373	1.973017
Harari	1.488339	.5506909	2.70	0.007	.4090047	2.567673
Dire dewa	.8606006	.5282356	1.63	0.103	-.1747222	1.895923
Somalie	1.551579	.5391264	2.88	0.004	.4949105	2.608247
age	.0054849	.0025094	2.19	0.029	.0005665	.0104033
hh_max_edu						
less than or equal to 8th grade education	.0319451	.1139031	0.28	0.779	-.1913009	.2551912
High school completed	.0620912	.14777	0.42	0.674	-.2275326	.3517151
Diploma and above	.6079944	.2996007	2.03	0.042	.0207879	1.195201
adult_aeu	1.437253	.2664847	5.39	0.000	.9149529	1.959554

Two-part model

Log pseudolikelihood = -3127821.6 Number of obs = 3639

Part 1: probit

Number of obs = 3639
Wald chi2(20) = 372.88
Prob > chi2 = 0.0000
Log pseudolikelihood = -1740.8949 Pseudo R2 = 0.1107

Part 2: glm

Number of obs = 833
Deviance = 6244866.935 (1/df) Deviance = 7681.263
Pearson = 36627065.09 (1/df) Pearson = 45051.74

Variance function: V(u) = u [Poisson]
Link function : g(u) = ln(u) [Log]

AIC = 7505.644
Log pseudolikelihood = -3126080.688 BIC = 6239399

self_employment_income_nonneg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	.0823636	.0586711	1.40	0.160	-.0326295	.1973568
rural						
rural	-.9666366	.0798887	-12.10	0.000	-1.123216	-.8100577
region						
Afar	-.4489832	.2234308	-2.01	0.044	-.8868995	-.0110669
Amhara	.0882504	.0949785	0.93	0.353	-.097904	.2744048
Oromia	.0879755	.0990073	0.89	0.374	-.1060753	.2820263
SNNP	.3325446	.0914503	3.64	0.000	.1533054	.5117838
Gambelia	-.1917473	.1899916	-1.01	0.313	-.5641239	.1806294
Benshagul Gumuz	.7797606	.1438708	5.42	0.000	.4977791	1.061742
Harari	.8238235	.1403917	5.87	0.000	.5486608	1.098986
Dire dewa	1.261924	.1442168	8.75	0.000	.979264	1.544583
Somalie	.2363848	.1338473	1.77	0.077	-.0259511	.4987207
age	-.0081197	.0016298	-4.98	0.000	-.0113141	-.0049254
hh_max_edu						
less than or equal to 8th grade education	.2795188	.0639558	4.37	0.000	.1541677	.4048698
High school completed	.1035157	.0965168	1.07	0.283	-.0856536	.2926851
Diploma and above	-.3639443	.1322803	-2.75	0.006	-.6232088	-.1046797
adult_aeu	-.0671268	.1260644	-0.53	0.594	-.3142085	.1799549
hh_item_aeu	.0029405	.0066576	0.44	0.659	-.0101082	.0159892
w_farm_size_agland_aeu	-.1521829	.0915874	-1.66	0.097	-.331691	.0273251
HH_debt_aeu_ppp	5.11e-06	5.22e-06	0.98	0.328	-5.12e-06	.0000153
hh_livestock_holding_tlu	-.031278	.0137917	-2.27	0.023	-.0583093	-.0042467
_cons	.1671797	.1953117	0.86	0.392	-.2156242	.5499835
glm						
fhh						
female household head	-.2464994	.1602147	-1.54	0.124	-.5605145	.0675157
rural						
rural	.3248327	.2666477	1.22	0.223	-.1977871	.8474525
region						
Afar	2.263744	1.522244	1.49	0.137	-.7198	5.247287
Amhara	3.550798	1.447563	2.45	0.014	.7136267	6.387969
Oromia	3.518399	1.47697	2.38	0.017	.6235919	6.413206
SNNP	3.734946	1.386634	2.69	0.007	1.017193	6.4527
Gambelia	3.722618	1.525546	2.44	0.015	.7326029	6.712634
Benshagul Gumuz	3.569057	1.42706	2.50	0.012	.7720711	6.366044
Harari	4.051763	1.373885	2.95	0.003	1.358997	6.744529
Dire dewa	3.546182	1.461483	2.43	0.015	.6817286	6.410636
Somalie	4.354012	1.352955	3.22	0.001	1.702269	7.005755
age	.0016435	.0065289	0.25	0.801	-.011153	.01444
hh_max_edu						
less than or equal to 8th grade education	.9622202	.4134283	2.33	0.020	.1519156	1.772525
High school completed	1.308267	.4746658	2.76	0.006	.3779392	2.238595
Diploma and above	1.377377	.5480772	2.51	0.012	.303165	2.451588
adult_aeu	2.831954	.6859054	4.13	0.000	1.487604	4.176304
hh_item_aeu	.0539951	.0166442	3.24	0.001	.021373	.0866172
w_farm_size_agland_aeu	-.3515855	.4161967	-0.84	0.398	-1.167316	.464145
HH_debt_aeu_ppp	.0000209	4.20e-06	4.97	0.000	.0000127	.0000291
hh_livestock_holding_tlu	-.0502205	.0462765	-1.09	0.278	-.1409207	.0404797

.

Two-part model

Log pseudolikelihood = -2104512.9 — Number of obs = 3639

Part 1: probit

Number of obs = 3639
Wald chi2(20) = 549.56
Prob > chi2 = 0.0000
Log pseudolikelihood = -1665.7647 — Pseudo R2 = 0.1653

Part 2: glm

Number of obs = 865
Deviance = 4198024.073 — (1/df) Deviance = 4968.076
Pearson = 16227450.57 — (1/df) Pearson = 19204.08

Variance function: V(u) = u — [Poisson]
Link function : g(u) = ln(u) — [Log]

AIC = 4862.12
Log pseudolikelihood = -2102847.098 — BIC = 4192310

wage_nonneg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	-.1504323	.0621331	-2.42	0.015	-.2722109	-.0286536
rural						
rural	-.1336253	.0824743	-1.62	0.105	-.2952718	.0280213
region						
Afar	-.3099174	.1502473	-2.06	0.039	-.6043967	-.0154381
Amhara	-.4910063	.0878766	-5.59	0.000	-.6632413	-.3187713
Oromia	-.8841407	.0940114	-9.40	0.000	-1.0684	-.6998816
SNNP	-.9008749	.0876694	-10.28	0.000	-1.072704	-.7290461
Gambelia	-.5157212	.1643593	-3.14	0.002	-.8378594	-.1935829
Benshagul Gumuz	-1.071426	.1638898	-6.54	0.000	-1.392644	-.7502083
Harari	-.2903074	.1495079	-1.94	0.052	-.5833375	.0027228
Dire dewa	.4865887	.1389258	3.50	0.000	.214299	.7588783
Somalie	.0778535	.1207699	0.64	0.519	-.1588512	.3145582
age	-.0076479	.0016796	-4.55	0.000	-.0109399	-.0043559
hh_max_edu						
less than or equal to 8th grade education	.217643	.0648159	3.36	0.001	.0906061	.3446799
High school completed	.401213	.0948847	4.23	0.000	.2152425	.5871835
Diploma and above	1.725123	.1290374	13.37	0.000	1.472215	1.978032
adult_aeu	-.4343227	.1243928	-3.49	0.000	-.6781281	-.1905174
hh_item_aeu	-.0027753	.0071713	-0.39	0.699	-.0168308	.0112802
w_farm_size_agland_aeu	-.5840727	.1118211	-5.22	0.000	-.8032381	-.3649072
HH_debt_aeu_ppp	.0000186	7.74e-06	2.40	0.016	3.44e-06	.0000338
hh_livestock_holding_tlu	-.0288567	.0099601	-2.90	0.004	-.0483783	-.0093352
_cons	.6399101	.1963735	3.26	0.001	.2550251	1.024795
glm						
fhh						
female household head	-.1261799	.1323443	-0.95	0.340	-.3855699	.1332101
rural						
rural	.2262005	.1641673	1.38	0.168	-.0955614	.5479625
region						
Afar	1.442311	.4524549	3.19	0.001	.5555161	2.329107
Amhara	1.290481	.3803284	3.39	0.001	.5450508	2.035911
Oromia	1.290215	.4017451	3.21	0.001	.5028086	2.077621
SNNP	1.104434	.4183127	2.64	0.008	.2845564	1.924312
Gambelia	1.601256	.422052	3.79	0.000	.7740495	2.428463
Benshagul Gumuz	1.459745	.4938591	2.96	0.003	.4917993	2.427691
Harari	1.685496	.4213796	4.00	0.000	.8596073	2.511385
Dire dewa	1.277519	.4451051	2.87	0.004	.4051294	2.149909
Somalie	1.671202	.419809	3.98	0.000	.8483916	2.494013
age	.0056145	.0050681	1.11	0.268	-.0043188	.0155478
hh_max_edu						
less than or equal to 8th grade education	2.345508	.6887145	3.41	0.001	.9956523	3.695363
High school completed	3.368893	.6912306	4.87	0.000	2.014106	4.723681
Diploma and above	4.160339	.6681547	6.23	0.000	2.85078	5.469899
adult_aeu	3.196431	.3612089	8.85	0.000	2.488474	3.904387
hh_item_aeu	.0195917	.0123214	1.59	0.112	-.0045578	.0437411
w_farm_size_agland_aeu	-.5775269	.5344291	-1.08	0.280	-1.624989	.4699349
HH_debt_aeu_ppp	9.84e-06	6.70e-06	1.47	0.142	-3.29e-06	.000023
hh_livestock_holding_tlu	-.0642171	.0526529	-1.22	0.223	-.1674149	.0389807

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Appendix B:2013-livelihoods activities income predication

crop_incom~g	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female ho..	-.3562837	.059776	-5.96	0.000	-.4734426	-.2391249
rural						
rural	1.166526	.0860235	13.56	0.000	.9979232	1.335129
region						
Afar	-1.144165	.16494	-6.94	0.000	-1.467442	-.8208886
Amhara	.2991091	.0906822	3.30	0.001	.1213753	.4768429
Oromia	.2689498	.1000461	2.69	0.007	.0728629	.4650366
SNNP	.6995894	.0991088	7.06	0.000	.5053398	.893839
Gambelia	.4649799	.170689	2.72	0.006	.1304356	.7995242
Benshagul..	.1237817	.1925115	0.64	0.520	-.253534	.5010973
Harari	.900792	.183005	4.92	0.000	.5421087	1.259475
Dire dewa	.7152663	.1682595	4.25	0.000	.3854838	1.045049
Somalie	-.9751908	.1228966	-7.94	0.000	-1.216064	-.7343179
age	.0123359	.0020466	6.03	0.000	.0083247	.0163471
hh_max_edu						
less than..	.3073455	.0650819	4.72	0.000	.1797874	.4349036
High scho..	.4063356	.0941728	4.31	0.000	.2217603	.590911
Diploma a..	-.0080785	.1196426	-0.07	0.946	-.2425738	.2264167
adult_aeu	-.6427959	.1416157	-4.54	0.000	-.9203577	-.3652342
hh_item_aeu	-.0275017	.0057678	-4.77	0.000	-.0388065	-.016197
w_farm_siz~u	1.11718	.2245273	4.98	0.000	.677115	1.557246
debt_aeu_ppp	-.0000151	.000021	-0.72	0.474	-.0000563	.0000262
hhlivestoc~u	.0033396	.0081146	0.41	0.681	-.0125647	.0192438
_cons	-.7946273	.1743038	-4.56	0.000	-1.136256	-.4529982
glm						
fhh						
female ho..	-.1772199	.0863762	-2.05	0.040	-.3465143	-.0079256
rural						
rural	6.513083	.2354298	27.66	0.000	6.051649	6.974517
region						
Afar	-.7727734	.2642175	-2.92	0.003	-1.29063	-.2549165
Amhara	.171523	.1041102	1.65	0.099	-.0325292	.3755752
Oromia	.3723612	.1208189	3.08	0.002	.1355604	.6091619
SNNP	.0002617	.1163439	0.00	0.998	-.2277681	.2282916
Gambelia	.2071797	.1861303	1.11	0.266	-.157629	.5719885
Benshagul..	.1765384	.1997569	0.88	0.377	-.2149778	.5680547
Harari	1.206293	.1406701	8.58	0.000	.9305843	1.482001
Dire dewa	-.0255739	.1293917	-0.20	0.843	-.2791771	.2280292
Somalie	.1874741	.295315	0.63	0.526	-.3913326	.7662808
age	-.0045803	.0022677	-2.02	0.043	-.009025	-.0001356
hh_max_edu						
less than..	.0386335	.0793711	0.49	0.626	-.116931	.194198
High scho..	-.0311036	.1132382	-0.27	0.784	-.2530463	.1908392
Diploma a..	.149687	.2039336	0.73	0.463	-.2500156	.5493895
adult_aeu	.8671493	.1798523	4.82	0.000	.5146452	1.219653
hh_item_aeu	.0262726	.0046764	5.62	0.000	.0171071	.0354381
w_farm_siz~u	.5605563	.0399956	14.02	0.000	.4821665	.6389462
debt_aeu_ppp	.0000535	.000038	1.41	0.159	-.0000209	.0001279
hhlivestoc~u	.0201419	.0080141	2.51	0.012	.0044345	.0358494

livestock_income_nonneg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	-.0450141	.05891	-0.76	0.445	-.1604755	.0704473
rural						
rural	.4592478	.0790427	5.81	0.000	.304327	.6141687
region						
Afar	.0532455	.1671316	0.32	0.750	-.2743263	.3808174
Amhara	.0637059	.0932148	0.68	0.494	-.1189917	.2464035
Oromia	-.0109623	.1008104	-0.11	0.913	-.208547	.1866224
SNNP	-.0149743	.0930624	-0.16	0.872	-.1973733	.1674246
Gambelia	.534715	.1632197	3.28	0.001	.2148102	.8546198
Benshagul Gumuz	.1556845	.1485041	1.05	0.294	-.1353782	.4467472
Harari	-.0395212	.1526037	-0.26	0.796	-.338619	.2595765
Dire dewa	.5674323	.1837937	3.09	0.002	.2072033	.9276614
Somalie	.1935571	.1611665	1.20	0.230	-.1223234	.5094375
age	.0049146	.0018844	2.61	0.009	.0012212	.0086079
hh_max_edu						
less than or equal to 8th gr..	.152493	.0635386	2.40	0.016	.0279596	.2770264
High school completed	.1661016	.0926661	1.79	0.073	-.0155206	.3477238
Diploma and above	-.2384024	.1223077	-1.95	0.051	-.4781211	.0013164
adult_aeu	-.6472857	.1342595	-4.82	0.000	-.9104294	-.3841419
hh_item_aeu	-.004502	.0047923	-0.94	0.348	-.0138948	.0048907
w_farm_size_agland_aeu	.0258935	.0732476	0.35	0.724	-.1176691	.1694561
debt_aeu_ppp	1.06e-06	.0000142	0.07	0.940	-.0000267	.0000288
hhlivestock_holding_tlu	.5108213	.040832	12.51	0.000	.430792	.5908506
_cons	-.3410895	.169485	-2.01	0.044	-.6732739	-.0089051
glm						
fhh						
female household head	.1062914	.0833111	1.28	0.202	-.0569953	.269578
rural						
rural	3.483233	1.266551	2.75	0.006	1.000839	5.965628
region						
Afar	2.03394	.684033	2.97	0.003	.69326	3.37462
Amhara	.952555	.5848066	1.63	0.103	-.1936448	2.098755
Oromia	1.316447	.6222453	2.12	0.034	.0968683	2.536025
SNNP	1.089047	.6261083	1.74	0.082	-.138103	2.316197
Gambelia	1.47923	.6562601	2.25	0.024	.1929839	2.765476
Benshagul Gumuz	.9535738	.6445686	1.48	0.139	-.3097574	2.216905
Harari	1.534884	.6222142	2.47	0.014	.3153666	2.754401
Dire dewa	1.35937	.6413979	2.12	0.034	.1022529	2.616487
Somalie	2.002288	.7633601	2.62	0.009	.5061295	3.498446
age	.0021438	.0037924	0.57	0.572	-.0052892	.0095768
hh_max_edu						
less than or equal to 8th gr..	.0904354	.1345149	0.67	0.501	-.173209	.3540798
High school completed	.0358537	.1454765	0.25	0.805	-.249275	.3209825
Diploma and above	.4564613	.2415499	1.89	0.059	-.0169679	.9298904
adult_aeu	2.115918	.5106571	4.14	0.000	1.115048	3.116787
hh_item_aeu	.0393326	.0088722	4.43	0.000	.0219435	.0567217
w_farm_size_agland_aeu	.3255607	.0708171	4.60	0.000	.1867617	.4643597
debt_aeu_ppp	.0000615	.0000406	1.51	0.131	-.0000182	.0001411
hhlivestock_holding_tlu	.0311701	.0089479	3.48	0.000	.0136326	.0487077

self_employment_income_nonneg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	-.0370877	.058799	-0.63	0.528	-.1523316	.0781562
rural						
rural	-.9334274	.0787206	-11.86	0.000	-1.087717	-.7791379
region						
Afar	.1601375	.160732	1.00	0.319	-.1548914	.4751665
Amhara	.1834744	.0958598	1.91	0.056	-.0044074	.3713562
Oromia	.2375025	.1009377	2.35	0.019	.0396683	.4353367
SNNP	.3228988	.095343	3.39	0.001	.1360301	.5097676
Gambelia	.2792921	.1633362	1.71	0.087	-.040841	.5994252
Benshagul Gumuz	.759064	.1465955	5.18	0.000	.4717421	1.046386
Harari	.6907348	.1483224	4.66	0.000	.4000283	.9814412
Dire dewa	1.258102	.1448194	8.69	0.000	.974261	1.541943
Somalie	.2340943	.1355634	1.73	0.084	-.0316052	.4997937
age	-.0057109	.001838	-3.11	0.002	-.0093133	-.0021086
hh_max_edu						
less than or equal to 8th grade ed..	.3090574	.0652272	4.74	0.000	.1812144	.4369004
High school completed	.2100346	.0884365	2.37	0.018	.0367022	.3833669
Diploma and above	-.3996062	.1327989	-3.01	0.003	-.6598872	-.1393251
adult_aeu	-.0185889	.1309293	-0.14	0.887	-.2752056	.2380279
hh_item_aeu	.0094349	.0048962	1.93	0.054	-.0001614	.0190313
w_farm_size_agland_aeu	-.1535151	.0831605	-1.85	0.065	-.3165068	.0094765
debt_aeu_ppp	.0000211	.0000156	1.35	0.177	-9.55e-06	.0000518
hhlivestock_holding_tlu	-.0225797	.0096227	-2.35	0.019	-.0414398	-.0037195
_cons	-.074397	.1648824	-0.45	0.652	-.3975606	.2487666
glm						
fhh						
female household head	-.218602	.1845547	-1.18	0.236	-.5803225	.1431185
rural						
rural	-.7975686	.2192586	-3.64	0.000	-1.227308	-.3678296
region						
Afar	7.395669	.701593	10.54	0.000	6.020572	8.770766
Amhara	6.228914	.778465	8.00	0.000	4.703151	7.754677
Oromia	6.474154	.8154373	7.94	0.000	4.875926	8.072382
SNNP	6.292616	.7581786	8.30	0.000	4.806613	7.778619
Gambelia	7.016937	.8986656	7.81	0.000	5.255585	8.778289
Benshagul Gumuz	6.947834	.8117043	8.56	0.000	5.356922	8.538745
Harari	7.813628	.7669581	10.19	0.000	6.310418	9.316838
Dire dewa	6.815937	.7920676	8.61	0.000	5.263513	8.368361
Somalie	7.398381	.7802876	9.48	0.000	5.869045	8.927716
age	-.0040047	.0048302	-0.83	0.407	-.0134717	.0054623
hh_max_edu						
less than or equal to 8th grade ed..	.7029427	.2881257	2.44	0.015	.1382266	1.267659
High school completed	.6724135	.3070677	2.19	0.029	.0705719	1.274255
Diploma and above	.2004506	.3803972	0.53	0.598	-.5451142	.9460154
adult_aeu	1.525738	.5697768	2.68	0.007	.408996	2.64248
hh_item_aeu	.0736095	.0072218	10.19	0.000	.059455	.087764
w_farm_size_agland_aeu	.1389336	.2490189	0.56	0.577	-.3491345	.6270017
debt_aeu_ppp	.0000288	5.00e-06	5.76	0.000	.000019	.0000386
hhlivestock_holding_tlu	.0035792	.0274392	0.13	0.896	-.0502006	.0573591

wage_income_nonneg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	-.175205	.0649665	-2.70	0.007	-.302537	-.0478731
rural						
rural	-.000371	.0874969	-0.00	0.997	-.1718619	.1711199
region						
Afar	.5590675	.1517361	3.68	0.000	.2616702	.8564647
Amhara	-.6624911	.0928781	-7.13	0.000	-.8445288	-.4804534
Oromia	-.8128682	.0965166	-8.42	0.000	-1.002037	-.6236991
SNNP	-.8293831	.0932786	-8.89	0.000	-1.012206	-.6465604
Gambelia	-.571327	.1640202	-3.48	0.000	-.8928007	-.2498533
Benshagul Gumuz	-.7717342	.1610098	-4.79	0.000	-1.087308	-.4561607
Harari	-.7799003	.1814078	-4.30	0.000	-1.135453	-.4243475
Dire dewa	.7023344	.1436374	4.89	0.000	.4208102	.9838587
Somalie	.1063076	.1196378	0.89	0.374	-.1281782	.3407934
age	-.008326	.0020414	-4.08	0.000	-.0123271	-.0043248
hh_max_edu						
less than or equal to 8th grade ed..	.3727049	.0770097	4.84	0.000	.2217686	.5236411
High school completed	.5790375	.0990225	5.85	0.000	.3849569	.7731181
Diploma and above	1.938207	.1273929	15.21	0.000	1.688522	2.187893
adult_aeu	.032083	.1354105	0.24	0.813	-.2333166	.2974827
hh_item_aeu	-.0009376	.0049792	-0.19	0.851	-.0106966	.0088214
w_farm_size_agland_aeu	-.2832442	.1183751	-2.39	0.017	-.5152551	-.0512333
debt_aeu_ppp	-4.81e-06	.0000194	-0.25	0.804	-.0000428	.0000332
hhlivestock_holding_tlu	-.0327931	.0099599	-3.29	0.001	-.0523141	-.0132722
_cons	-.2726142	.1783283	-1.53	0.126	-.6221314	.0769029
glm						
fhh						
female household head	-.441302	.2199323	-2.01	0.045	-.8723613	-.0102427
rural						
rural	.3778827	.2054272	1.84	0.066	-.0247472	.7805125
region						
Afar	1.620172	.5289225	3.06	0.002	.5835029	2.656841
Amhara	1.171182	.5061747	2.31	0.021	.1790982	2.163266
Oromia	1.318059	.5415288	2.43	0.015	.2566822	2.379436
SNNP	1.039925	.5191201	2.00	0.045	.0224687	2.057382
Gambelia	1.417125	.5991799	2.37	0.018	.2427544	2.591496
Benshagul Gumuz	1.239853	.5573091	2.22	0.026	.147547	2.332159
Harari	1.628273	.5245436	3.10	0.002	.6001865	2.65636
Dire dewa	1.168663	.4880734	2.39	0.017	.2120567	2.125269
Somalie	1.826458	.5893392	3.10	0.002	.6713748	2.981542
age	.0003382	.0058121	0.06	0.954	-.0110532	.0117296
hh_max_edu						
less than or equal to 8th grade ed..	2.495883	1.076213	2.32	0.020	.3865439	4.605222
High school completed	2.79376	1.125888	2.48	0.013	.5870601	5.00046
Diploma and above	3.981628	1.085449	3.67	0.000	1.854187	6.109068
adult_aeu	3.987819	.8109169	4.92	0.000	2.398451	5.577187
hh_item_aeu	.0179928	.0067954	2.65	0.008	.0046739	.0313116
w_farm_size_agland_aeu	-.3133339	.3231366	-0.97	0.332	-.9466701	.3200022
debt_aeu_ppp	.0001986	.000062	3.20	0.001	.0000771	.0003202
hhlivestock_holding_tlu	-.1119643	.0290877	-3.85	0.000	-.1689751	-.0549535

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Appendix C:2015-livelihoods activities income predication

crop_income_nonneg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	-.1973451	.0625133	-3.16	0.002	-.3198688	-.0748214
rural						
rural	1.118095	.0841522	13.29	0.000	.9531599	1.28303
region						
Afar	-1.666988	.1601364	-10.41	0.000	-1.98085	-1.353126
Amhara	.0456592	.0888541	0.51	0.607	-.1284916	.2198099
Oromia	.0336624	.0953687	0.35	0.724	-.1532568	.2205816
SNNP	.5833177	.0961708	6.07	0.000	.3948265	.771809
Gambelia	.4916634	.1623915	3.03	0.002	.173382	.8099448
Benshagul Gumuz	.2256629	.1617802	1.39	0.163	-.0914205	.5427462
Harari	.5756691	.1718848	3.35	0.001	.238781	.9125572
Dire dewa	.0590395	.1494071	0.40	0.693	-.233793	.351872
Somalie	-1.47385	.1275842	-11.55	0.000	-1.72391	-1.223789
hh_age	.0161605	.0021659	7.46	0.000	.0119154	.0204055
max_edu						
less than or equal to 8th grade educa..	.0853813	.0831561	1.03	0.305	-.0776017	.2483644
High school completed	.0121332	.1052368	0.12	0.908	-.1941272	.2183937
Diploma and above	-.3935263	.1267359	-3.11	0.002	-.6419242	-.1451284
adult_aeu	-.0149987	.0020366	-7.36	0.000	-.0189903	-.011007
hh_item_aeu	-.0164128	.005559	-2.95	0.003	-.0273082	-.0055173
w_farm_size_agland_aeu	.5088016	.1308676	3.89	0.000	.2523058	.7652973
debt_aeu	-.0000231	.0000216	-1.07	0.285	-.0000655	.0000193
hh_livestock_holding_tlu	-.0031881	.002522	-1.26	0.206	-.008131	.0017549
_cons	-.8705824	.1591885	-5.47	0.000	-1.182586	-.5585788
glm						
fhh						
female household head	-.2625358	.0925	-2.84	0.005	-.4438324	-.0812392
rural						
rural	6.682598	.2227552	30.00	0.000	6.246006	7.11919
region						
Afar	-.0912711	.3142155	-0.29	0.771	-.7071221	.52458
Amhara	.1857308	.1272224	1.46	0.144	-.0636205	.435082
Oromia	.3873354	.1278322	3.03	0.002	.1367888	.6378819
SNNP	-.0013969	.1512916	-0.01	0.993	-.297923	.2951292
Gambelia	.4439965	.5028147	0.88	0.377	-.5415023	1.429495
Benshagul Gumuz	.4033898	.201882	2.00	0.046	.0077084	.7990713
Harari	1.245159	.1504965	8.27	0.000	.9501909	1.540126
Dire dewa	-1.075103	.2110889	-5.09	0.000	-1.48883	-.6613764
Somalie	1.062549	.2574308	4.13	0.000	.5579936	1.567104
hh_age	.0004504	.0025423	0.18	0.859	-.0045324	.0054332
max_edu						
less than or equal to 8th grade educa..	.4089704	.1326702	3.08	0.002	.1489416	.6689991
High school completed	.4035343	.1540204	2.62	0.009	.1016598	.7054089
Diploma and above	.2408227	.2007247	1.20	0.230	-.1525905	.6342359
adult_aeu	.0198676	.0049378	4.02	0.000	.0101897	.0295454
hh_item_aeu	-.0073168	.009596	-0.76	0.446	-.0261246	.0114911
w_farm_size_agland_aeu	.3688712	.0748194	4.93	0.000	.222228	.5155144
debt_aeu	.0000303	.0000216	1.40	0.161	-.0000121	.0000727
hh_livestock_holding_tlu	.0033566	.0010781	3.11	0.002	.0012437	.0054696

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self_employment_income_nonneg	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	.1141732	.0596	1.92	0.055	-.0026407	.230987
rural						
rural	-.6879825	.0778135	-8.84	0.000	-.8404941	-.535471
region						
Afar	-.2535371	.1683946	-1.51	0.132	-.5835845	.0765103
Amhara	-.0159391	.0893868	-0.18	0.858	-.191134	.1592557
Oromia	-.1202109	.0950161	-1.27	0.206	-.306439	.0660172
SNNP	.0378086	.0892707	0.42	0.672	-.1371589	.212776
Gambelia	.2263835	.1588906	1.42	0.154	-.0850363	.5378034
Benshagul Gumuz	.6649425	.1376664	4.83	0.000	.3951214	.9347636
Harari	.226579	.1507625	1.50	0.133	-.06891	.522068
Dire dewa	1.079773	.1405788	7.68	0.000	.8042435	1.355302
Somalie	.0065206	.1262248	0.05	0.959	-.2408753	.2539166
hh_age	-.0060883	.0019524	-3.12	0.002	-.0099149	-.0022617
max_edu						
less than or equal to 8th grade educa..	.1360066	.0840784	1.62	0.106	-.028784	.3007972
High school completed	.180063	.1024397	1.76	0.079	-.0207151	.3808411
Diploma and above	-.4365465	.1368696	-3.19	0.001	-.704806	-.1682869
adult_aeu	-.0062803	.00239	-2.63	0.009	-.0109647	-.0015959
hh_item_aeu	.0093471	.0051172	1.83	0.068	-.0006824	.0193765
w_farm_size_agland_aeu	-.2035651	.0892852	-2.28	0.023	-.3785608	-.0285694
debt_aeu	.0000486	.0000211	2.30	0.021	7.19e-06	.00009
hh_livestock_holding_tlu	.0010691	.0030865	0.35	0.729	-.0049803	.0071185
_cons	.0112912	.1529224	0.07	0.941	-.2884312	.3110135
glm						
fhh						
female household head	-.128597	.1994481	-0.64	0.519	-.5195081	.2623142
rural						
rural	.1399815	.3754859	0.37	0.709	-.5959575	.8759204
region						
Afar	4.684111	1.644127	2.85	0.004	1.461682	7.90654
Amhara	3.81007	1.658033	2.30	0.022	.560386	7.059755
Oromia	3.876945	1.732629	2.24	0.025	.4810551	7.272834
SNNP	3.759574	1.723927	2.18	0.029	.3807385	7.138409
Gambelia	3.811631	1.65491	2.30	0.021	.5680662	7.055195
Benshagul Gumuz	3.264293	1.639818	1.99	0.047	.0503088	6.478278
Harari	4.216962	1.616585	2.61	0.009	1.048514	7.38541
Dire dewa	3.983017	1.724608	2.31	0.021	.602848	7.363187
Somalie	3.991358	1.687434	2.37	0.018	.6840482	7.298668
hh_age	.0283203	.0142031	1.99	0.046	.0004827	.0561578
max_edu						
less than or equal to 8th grade educa..	1.841944	1.173022	1.57	0.116	-.4571367	4.141024
High school completed	2.485944	1.247817	1.99	0.046	.0402672	4.93162
Diploma and above	2.788577	1.224986	2.28	0.023	.3876478	5.189506
adult_aeu	.0212221	.0087275	2.43	0.015	.0041166	.0383277
hh_item_aeu	.0628407	.0145565	4.32	0.000	.0343105	.0913709
w_farm_size_agland_aeu	.7051091	.3828876	1.84	0.066	-.0453369	1.455555
debt_aeu	.0001495	.0000617	2.42	0.015	.0000286	.0002703
hh_livestock_holding_tlu	.0015605	.0025028	0.62	0.533	-.0033448	.0064659

livestock_income_nonneg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	-.1491044	.055328	-2.69	0.007	-.2575453	-.0406634
rural						
rural	.5298071	.0754308	7.02	0.000	.3819654	.6776488
region						
Afar	.3883408	.1504379	2.58	0.010	.0934879	.6831938
Amhara	-.0458675	.0855141	-0.54	0.592	-.2134721	.121737
Oromia	-.1155775	.0884365	-1.31	0.191	-.2889099	.0577548
SNNP	-.0725382	.0847332	-0.86	0.392	-.2386123	.0935359
Gambelia	-.3096145	.1547555	-2.00	0.045	-.6129297	-.0062994
Benshagul Gumuz	-.1079426	.1446077	-0.75	0.455	-.3913684	.1754832
Harari	-.2971784	.1385806	-2.14	0.032	-.5687915	-.0255653
Dire dewa	.3076606	.1528909	2.01	0.044	.008	.6073212
Somalie	.3159425	.1262344	2.50	0.012	.0685276	.5633574
hh_age	.0153255	.0019014	8.06	0.000	.0115989	.0190521
max_edu						
less than or equal to 8th grade educa..	-.0105775	.0751288	-0.14	0.888	-.1578273	.1366722
High school completed	-.193454	.0939616	-2.06	0.040	-.3776154	-.0092927
Diploma and above	-.4801953	.1130578	-4.25	0.000	-.7017846	-.258606
adult_aeu	-.0197228	.0020443	-9.65	0.000	-.0237295	-.0157161
hh_item_aeu	.001373	.0048075	0.29	0.775	-.0080495	.0107954
w_farm_size_agland_aeu	.4572639	.0883277	5.18	0.000	.2841447	.630383
debt_aeu	-.0000247	.0000223	-1.11	0.267	-.0000684	.0000189
hh_livestock_holding_tlu	.0056443	.0078244	0.72	0.471	-.0096912	.0209798
_cons	-.3747079	.1462709	-2.56	0.010	-.6613937	-.0880222
glm						
fhh						
female household head	.0987663	.136831	0.72	0.470	-.1694174	.3669501
rural						
rural	4.500819	.9490033	4.74	0.000	2.640807	6.360831
region						
Afar	2.700989	.73709	3.66	0.000	1.256319	4.145658
Amhara	1.529703	.6886579	2.22	0.026	.1799588	2.879448
Oromia	1.80636	.7118112	2.54	0.011	.4112358	3.201484
SNNP	1.775567	.7286219	2.44	0.015	.3474938	3.203639
Gambelia	2.152538	.8527417	2.52	0.012	.4811944	3.823881
Benshagul Gumuz	1.59121	.7427823	2.14	0.032	.135384	3.047037
Harari	1.945461	.7360186	2.64	0.008	.5028911	3.388031
Dire dewa	1.943955	.7085107	2.74	0.006	.5552999	3.332611
Somalie	2.487062	.7371842	3.37	0.001	1.042207	3.931916
hh_age	.0074411	.0039281	1.89	0.058	-.0002577	.0151399
max_edu						
less than or equal to 8th grade educa..	.2962459	.219975	1.35	0.178	-.1348971	.7273889
High school completed	.6416834	.2702611	2.37	0.018	.1119814	1.171385
Diploma and above	.6994163	.3208526	2.18	0.029	.0705567	1.328276
adult_aeu	.0171606	.0052652	3.26	0.001	.0068409	.0274802
hh_item_aeu	.0212598	.01695	1.25	0.210	-.0119616	.0544813
w_farm_size_agland_aeu	.1385083	.1117962	1.24	0.215	-.0806083	.3576248
debt_aeu	.0000777	.0000249	3.13	0.002	.000029	.0001265
hh_livestock_holding_tlu	.067839	.0079346	8.55	0.000	.0522874	.0833905

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wage_nonneg	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
probit						
fhh						
female household head	-.0689207	.0679811	-1.01	0.311	-.2021612	.0643198
rural						
rural	-.0231645	.0874443	-0.26	0.791	-.1945521	.1482231
region						
Afar	.8157473	.1515908	5.38	0.000	.5186349	1.11286
Amhara	-.5432493	.0916539	-5.93	0.000	-.7228878	-.3636109
Oromia	-.7414095	.0967122	-7.67	0.000	-.930962	-.5518571
SNNP	-.8940574	.0950168	-9.41	0.000	-1.080287	-.707828
Gambelia	-.8392665	.1865199	-4.50	0.000	-1.204839	-.4736943
Benshagul Gumuz	-.6782426	.162558	-4.17	0.000	-.9968504	-.3596348
Harari	-.7167452	.173378	-4.13	0.000	-1.05656	-.3769305
Dire dewa	.9658831	.1444843	6.69	0.000	.682699	1.249067
Somalie	-.0594387	.1232175	-0.48	0.630	-.3009406	.1820632
hh_age	-.0080124	.0022188	-3.61	0.000	-.0123611	-.0036637
max_edu						
less than or equal to 8th grade educa..	.3448668	.100704	3.42	0.001	.1474907	.542243
High school completed	.5145254	.1203518	4.28	0.000	.2786403	.7504106
Diploma and above	1.737456	.1361682	12.76	0.000	1.470571	2.00434
adult_aeu	-.0030329	.0027037	-1.12	0.262	-.008332	.0022661
hh_item_aeu	-.0045875	.0055796	-0.82	0.411	-.0155234	.0063484
w_farm_size_agland_aeu	-.616321	.1333575	-4.62	0.000	-.8776969	-.3549451
debt_aeu	-.0000202	.0000232	-0.87	0.382	-.0000657	.0000252
hh_livestock_holding_tlu	-.0250366	.0103438	-2.42	0.016	-.04531	-.0047632
_cons	-.1802769	.1705607	-1.06	0.291	-.5145697	.1540159
glm						
fhh						
female household head	-.1892471	.1390152	-1.36	0.173	-.461712	.0832177
rural						
rural	.0867277	.1776989	0.49	0.626	-.2615557	.4350111
region						
Afar	.7010011	.3953846	1.77	0.076	-.0739385	1.475941
Amhara	.7276617	.4236915	1.72	0.086	-.1027584	1.558082
Oromia	1.090408	.3744287	2.91	0.004	.3565414	1.824275
SNNP	.5101593	.3726201	1.37	0.171	-.2201627	1.240481
Gambelia	.8034534	.4171085	1.93	0.054	-.0140643	1.620971
Benshagul Gumuz	.9435226	.4367154	2.16	0.031	.087576	1.799469
Harari	1.146279	.4372692	2.62	0.009	.2892473	2.003311
Dire dewa	.6610008	.3776374	1.75	0.080	-.0791549	1.401157
Somalie	1.277032	.4321549	2.96	0.003	.4300244	2.124041
hh_age	-.0101338	.0070094	-1.45	0.148	-.0238721	.0036045
max_edu						
less than or equal to 8th grade educa..	6.841543	.6950994	9.84	0.000	5.479174	8.203913
High school completed	7.55147	.5954627	12.68	0.000	6.384385	8.718556
Diploma and above	8.340546	.5889533	14.16	0.000	7.186218	9.494873
adult_aeu	.0456384	.0048413	9.43	0.000	.0361496	.0551272
hh_item_aeu	.0020095	.0056331	0.36	0.721	-.0090312	.0130502
w_farm_size_agland_aeu	-.7648142	.402739	-1.90	0.058	-1.554168	.0245397
debt_aeu	2.03e-06	.0000213	0.10	0.924	-.0000398	.0000438
hh_livestock_holding_tlu	-.0627052	.0247114	-2.54	0.011	-.1111386	-.0142718

Appendix D:Bonferroni multiple comparison test

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	1.1621e+10	8	1.4526e+09	756.06	0.0000
Within groups	2.0957e+10	10908	1921272.15		
Total	3.2578e+10	10916	2984424.37		

Bartlett's test for equal variances: chi2(8) = 2.3e+04 Prob>chi2 = 0.000

Comparison of crop_index by clu
(Bonferroni)

Row Mean-Col Mean	1	2	3	4	5	6
2	817.78 0.000					
3	-143.356 0.012	-961.136 0.000				
4	-381.457 0.000	-1199.24 0.000	-238.101 0.000			
5	1393.11 0.000	575.333 0.000	1536.47 0.000	1774.57 0.000		
6	-752.729 0.000	-1570.51 0.000	-609.372 0.000	-371.272 0.000	-2145.84 0.000	
7	-1206.14 0.000	-2023.92 0.000	-1062.78 0.000	-824.683 0.000	-2599.25 0.000	-453.411 0.000
8	705.342 0.000	-112.439 1.000	848.698 0.000	1086.8 0.000	-687.772 0.000	1458.07 0.000
9	10958.3 0.000	10140.5 0.000	11101.7 0.000	11339.8 0.000	9565.2 0.000	11711 0.000

Row Mean-Col Mean	7	8
8	1911.48 0.000	
9	12164.5 0.000	10253 0.000

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	1.3992e+10	8	1.7490e+09	854.83	0.0000
Within groups	2.2318e+10	10908	2046048.77		
Total	3.6310e+10	10916	3326353.45		

Bartlett's test for equal variances: chi2(8) = 2.3e+04 Prob>chi2 = 0.000

Comparison of livstock_i~x by clu
(Bonferroni)

Row Mean- Col Mean	1	2	3	4	5	6
2	816.287 0.000					
3	-243.688 0.000	-1059.97 0.000				
4	-38.8468 1.000	-855.133 0.000	204.841 0.000			
5	1671.45 0.000	855.168 0.000	1915.14 0.000	1710.3 0.000		
6	-368.428 0.000	-1184.71 0.000	-124.74 1.000	-329.581 0.000	-2039.88 0.000	
7	-798.178 0.000	-1614.46 0.000	-554.49 0.000	-759.331 0.000	-2469.63 0.000	-429.75 0.000
8	1001.9 0.000	185.614 1.000	1245.59 0.000	1040.75 0.000	-669.554 0.000	1370.33 0.000
9	13044 0.000	12227.7 0.000	13287.7 0.000	13082.8 0.000	11372.5 0.000	13412.4 0.000

Row Mean- Col Mean	7	8
8	1800.08 0.000	
9	13842.1 0.000	12042.1 0.000

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	1.5670e+10	8	1.9588e+09	347.22	0.0000
Within groups	6.1536e+10	10908	5641405		
Total	7.7207e+10	10916	7072814.55		

Bartlett's test for equal variances: chi2(8) = 4.1e+04 Prob>chi2 = 0.000

Comparison of self_emplo~x by clu
(Bonferroni)

Row Mean- Col Mean	1	2	3	4	5	6
2	303.787 0.001					
3	164.272 0.601	-139.515 1.000				
4	746.522 0.000	442.734 0.000	582.249 0.000			
5	1208.45 0.000	904.665 0.000	1044.18 0.000	461.931 0.000		
6	1915.08 0.000	1611.29 0.000	1750.8 0.000	1168.55 0.000	706.623 0.000	
7	1426.06 0.000	1122.27 0.000	1261.79 0.000	679.537 0.000	217.606 1.000	-489.017 0.009
8	10927.7 0.000	10623.9 0.000	10763.4 0.000	10181.2 0.000	9719.22 0.000	9012.6 0.000
9	1041.75 0.035	737.958 0.707	877.473 0.197	295.223 1.000	-166.707 1.000	-873.33 0.258

Row Mean- Col Mean	7	8
8	9501.62 0.000	
9	-384.313 1.000	-9885.93 0.000

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	2.1073e+10	8	2.6342e+09	291.78	0.0000
Within groups	9.8477e+10	10908	9027929.58		
Total	1.1955e+11	10916	10951806.6		

Bartlett's test for equal variances: chi2(8) = 4.9e+04 Prob>chi2 = 0.000

Comparison of wage_index by clu
(Bonferroni)

Row Mean- Col Mean	1	2	3	4	5	6
2	118.295 1.000					
3	-.25366 1.000	-118.548 1.000				
4	184.685 1.000	66.3904 1.000	184.939 1.000			
5	724.474 0.000	606.179 0.000	724.728 0.000	539.789 0.000		
6	3149.48 0.000	3031.18 0.000	3149.73 0.000	2964.79 0.000	2425 0.000	
7	682.442 0.000	564.147 0.002	682.696 0.000	497.757 0.021	-42.0322 1.000	-2467.03 0.000
8	11783.2 0.000	11664.9 0.000	11783.5 0.000	11598.5 0.000	11058.7 0.000	8633.73 0.000
9	143.813 1.000	25.5188 1.000	144.067 1.000	-40.8716 1.000	-580.661 1.000	-3005.66 0.000

Row Mean- Col Mean	7	8
8	11100.8 0.000	
9	-538.628 1.000	-11639.4 0.000

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	1.7762e+09	8	222027448	409.40	0.0000
Within groups	5.9157e+09	10908	542322.259		
Total	7.6919e+09	10916	704641.882		

Bartlett's test for equal variances: chi2(8) = 3.6e+04 Prob>chi2 = 0.000

Comparison of transfers_~x by clu
(Bonferroni)

Row Mean- Col Mean	1	2	3	4	5	6
2	30.5935 1.000					
3	15.5375 1.000	-15.056 1.000				
4	235.903 0.000	205.309 0.000	220.365 0.000			
5	320.83 0.000	290.237 0.000	305.293 0.000	84.9277 0.148		
6	1371.37 0.000	1340.78 0.000	1355.84 0.000	1135.47 0.000	1050.54 0.000	
7	49.811 1.000	19.2175 1.000	34.2735 1.000	-186.092 0.000	-271.019 0.000	-1321.56 0.000
8	2429.62 0.000	2399.03 0.000	2414.09 0.000	2193.72 0.000	2108.79 0.000	1058.25 0.000
9	168.79 1.000	138.196 1.000	153.252 1.000	-67.1132 1.000	-152.041 1.000	-1202.58 0.000

Row Mean- Col Mean	7	8
8	2379.81 0.000	
9	118.979 1.000	-2260.83 0.000