Dynamics of rural livelihoods and rainfall variability in Northern Ethiopia

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Abstract:

This study examines the association of livelihood dynamics of rural households in Ethiopia with rainfall conditions and socio-economic characteristics, using a 15-year panel data set. We employed fixed and random-effect conditional logit models to explain household decision-making processes regarding livelihood strategies. Our finding shows that participation of rural households in non-farm livelihoods has been increasing over the years but with great fluctuations. We also found that rainfall conditions during the main rainy season negatively and significantly affect household decisions to pursue non-farm livelihoods. The motivation of farm households to diversify into non-farm livelihoods is mainly driven by low-performance farming outcomes as well as demographic characteristics (specifically adult household size, human capital and education) and degree of access to financial schemes. These findings suggest policy implications for increasing access to financial schemes and improving household-member skills through vocational training and education to enable them to engage in high-return and profitable non-farm livelihoods.

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Key words: Non-farm livelihoods, rainfall anomalies, households, panel data, Ethiopia.

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1. Introduction

The livelihood security and well-being of rural households continue to be of prime concern for policy and development agendas in Africa (Ziervogel and Calder, 2003; Agrawal, 2008; Ulrich, 2012). Rural households face numerous livelihood security challenges resulting from climate variability, land use change, population growth and political challenges. The expected and increasing frequency of climate variability (Boko et al., 2007) is among the major threats rural households are facing, with rainfall variability in particular being regarded as the most significant climate variable affecting farm household's livelihoods(Brooks, 2003; Hulme, 2001; Teka et al., 2012; Egeru, 2016).

Rural households in Ethiopia are still largely agrarian, and agriculture is a main source of income and employment. Over 90% of producers there are considered to operate small-scale mixed, subsistence farms, relying on rainfall for water. Yet the livelihoods of rural households are not merely dependent on farming but also increasingly on non-farm activities that serve as additional sources of income. In fact, the literature suggests that rural households are becoming less dependent on agriculture and its related activities (Ellis, 2000b; Teka et al., 2012), and there is ample evidence of the growing importance of non-farm livelihood activities over the last two decades (Ellis, 2000; Carswell, 1997, 2000; Lemi, 2006;Barret et al., 2001). In addition, systematic efforts have also been made to investigate the relevance of non-farm livelihoods and their links with policies aimed towards rural poverty reduction strategies (Ellis, 1999;Scoones, 1998; Carswell, 1997;Woldenhanna and Oskam, 2001; Tesfaye et al., 2011).

However, existing studies have mainly used only cross-sectional data to assess livelihoods and their relationships with rainfall variability and/or household socio-economic factors at one point in time(static point of view), without reflecting upon dynamic changes in household livelihoods. These have been recently criticized for lacking the ability to address shifts in rural economies (Mushongah and Scoones, 2012; Addison et al., 2009; Scoones, 2009; Liu and Liu, 2016;). Static analyses have limited explanatory power (De Haan and Zoomers, 2005; Addison et al., 2009; Scoones, 2009; Thiede, 2014) and are ill-suited for livelihood studies in dynamic economic, social, political and environmental scenarios, making them tend towards unreliable conclusions which can further lead to biased economic policies and strategies. To date, only a few studies (Berg, 2010 and D'haen et al., 2014) have investigated the dynamics of rural livelihoods with regard to climate variability conditions such as natural disasters or rainfall variability.

The present study examines the dynamics of non-farm livelihood activities engaged in by rural households in Ethiopia, investigating the effects of variability in rainfall and household socio-economic conditions on household decisions to participate in non-farm activities. Based upon a

15-year panel data set, a dynamic livelihoods approach (De Haan and Zoomers, 2005; Addison et al., 2009; Scoones, 2009; Thiede, 2014) is employed to investigate non-farm livelihood options and their associations with different factors. Such an approach provides powerful analytical tools through incorporating panel data livelihood activities, rainfall and household socio-economic variables. In this way, we aim to address two research questions which we had identified via an extensive literature review. First, we assess how the dynamics of non-farm livelihood strategies of rural households in Ethiopia have changed over the last 15 years. Second, we investigate how rainfall conditions and socio-economic characteristics have affected household decisions to participate in non-farm livelihood activities overtime.

The rest of the paper is organized as follows: after a brief literature review on rural livelihoods and rainfall variability, we describe in more detail the study and methods used, including data set, conceptual framework, model variables and econometric specifications. In the results section, we present both descriptive results on livelihood patterns and rainfall conditions as well as our major findings from the econometric regressions. These results are then further discussed and summarized in a concluding section.

2. Rural livelihoods and rainfall variability in Ethiopia

Non-farm livelihood activities in SSA may serve as additional sources of income, to complement farming, or, for some rural households, as sole livelihood sources (Ellis, 1999, 2000; Reardon, 1997; Lanjouw & Lanjouw, 2001). For a variety of reasons, households are increasingly obliged to take on livelihood activities outside the agricultural sector, generally either to pursue improved and sustainable livelihoods (Barrett et al., 2001) or to cope with diverse types of shocks (Ellis, 2000; Block and Webb, 2001).

Increased capability to diversify livelihood sources can be especially beneficial for households at or below the poverty line (Barrett et al, 2001; Ellis, 1999). However, such households can also face serious barriers to the realization of optimal livelihood strategies (Block and Webb, 2001), which have different return and level of entry barriers or amounts of start-up capital needed for business activities. Unskilled farm labor, for example, has unregulated entry or exit barriers and, consequently, offers low returns, whereas activities with higher entry barriers, such as acquisition of knowledge, skills or equipment, may generate higher returns (Barrett et al., 2001).This means that high-welfare strategies are generally associated with high levels of capital (Berg, 2010).A study by Woldenhanna and Oskam (2001) in the Tigray region of North Ethiopia found that, due to entry barriers, wealthy farm households dominate the most lucrative rural non-farm activities, such as masonry, carpentry and petty trade. Another similar study in Ethiopia showed that wealthier households tended to have more diversified income streams than poor households (Block and Webb, 2011).

Although few in number, some efforts have been made to understand the relationships between non-farm livelihood strategies and environmental, mainly rainfall, variability and

drought. In rural Burkina, household decisions to participate in non-farm activities are said to be determined by adverse rainfall conditions in the major staple food production zone of the country (D'haen et al., 2014). Meanwhile, Demeke et al. (2011) analyze the effect of rainfall on Ethiopian rural households' food security and vulnerability over time, with their results showing that the level and variability of rainfall are important determinants of persistent food insecurity and vulnerability. Using consumption expenditure and multidimensional poverty indices, Kebede (2013) analyses poverty dynamics and their determinants in rural Ethiopia, revealing that shocks from drought affect households' poverty in terms of consumption.

In Northern Ethiopia, Morrissey (2012) finds that environmental stress, in terms of disadvantageous rainfall patterns (variability and reduced amounts),shapes migration through its impact on migration drivers. At the household level, these impacts are principally manifested in decreased household production, but they also express themselves within the broader socio-cultural, political and economic context. The study further emphasizes that environmental stress on human mobility can only be understood within the local context in which it occurs. Gray and Mueller (2012) provide robust evidence that drought increases long-distance and labor-related migration by men in Ethiopia.

In the central highlands of Ethiopia, rainfall is found to be highly variable, with more extreme rainfall during the start of the *Kiremt*[1] season (Rosell, 2011). According to Teka et al., (2012), rain has been extremely unpredictable and erratic with a coefficient of variation ranging from 18% in the midlands to 42% in the lowlands of the Eastern Tigray region. The same study also shows that livestock possession per household in the last two decades has been negatively correlated with time in most of the studied villages, although the number of pack animals has significantly increased due to farmers shifting to off-farm activities, as they are used to transport grain, salt, sand, stone, firewood and charcoal and for trading in neighboring towns or market places (Teka et al., 2012).

In the central highlands of Ethiopia, rainfall is highly variable with more extreme rainfall during the start of the Kiremt season (Rosell, 2011), though the conditions for growing cereal during that period have been relatively similar during the past 30 years. However, in the last decade it has become almost impossible to produce cereals during the *Belg*[2] season, due to its shortening. Cereal production has also become more problematic over the last decade in other areas, especially in South Wollo where population is high and land is under greater pressure.

Our literature review on livelihoods and rainfall has revealed that there is an important gap regarding the dynamic dimension of rural livelihoods in Ethiopia and a need for more studies

[1] *Kiremt* refers to the primary rainy season and main growing period in Ethiopia, ranging from June to September.

[2] *Belg* refers to the short rainy season, which ranges from January/February to April/May, with slight variations from place to place.

investigating how livelihood patterns change over the years under different contexts. More importantly, there has been a lack of investigation into how rainfall, or lack thereof, affects livelihood patterns and household decisions to take part in different livelihood options. This paper is, thus, particularly aimed towards filling this gap by using a 15-year panel data of rural Ethiopian households, which we believe allows insights into dynamics of livelihood change there over time.

3. Study Areas

The research is conducted in two *Kebele*[3]– Shumsheha and Harresaw – the primary characteristics of which are described below. Shumsheha Kebele is located in the Lasta *woreda*[4] of the North Wollo zone in the Amhara region – one of the drought-prone areas in Ethiopia. The total area of the Kebele is 6,037 hectares, of which 2,679 hectares is cultivated. It is located between 1,500 and 2,000 meters above sea level (masl); is characterized by plain, mountainous and rugged topography; and is adjacent to the tourist destination town of Lalibela. The area has one primary rainy season or Kiremt (June–September) and a short Belg (January–March). According to the woreda extension service, the beginning of the main rainy season is in the first week of July, with annual average rainfall being about 600mm. In recent years, farmers have become almost totally dependent on the main rainy season to grow crops, due to frequent failure or shortage of rain during the Belg not supplying enough water for crop production. It is one of the areas that was affected by the major droughts of 1972, 1984 and 1994 (Ali and Tafesse, 1996). In addition to unreliable rainfall, agricultural production is highly affected by crop and livestock diseases, soil infertility, and lack of modern technology. The community's limited access to irrigation depends on canals constructed on small rivers. During the dry season, availability of water for irrigation is quite low, and the number of households having access to irrigated water thus decreases significantly.

Shumsheha has a total of population of 4,530:2,240 males and 2,290 females. More than 95% of the community are Orthodox Christians and the rest are Muslims. Amharic is the only language normally spoken. Farming and animal husbandry are the dominant economic sectors. The main crops harvested in the area include beans, teff, sorghum, barley and wheat. In recent years, the number of households growing fruits and vegetables using irrigation has been increasing. Oxen, cows, sheep, and chicken are the main livestock in the community. Shumsheha has its own local market once per week and access to a large market in Lalibela. Most of the community has access to all-weather roads. The nearby airport, road construction and other developmental activities create a variety of job opportunities for the community outside farming.

[3] *Kebele* is the smallest administrative unit of Ethiopia and includes several small villages.

[4] is the third administrative unit in Ethiopia which collects to make zone

Harresaw Kebele is located in the Atsbi Wemberta woreda in the Eastern Tigray zone. It has rugged topography with ups and downs through altitudes of 2,700 to 3,000masl, and land degradation is a serious problem for farming. Rainfall is increasingly unpredictable, unreliable and, over time, its amount has decreased significantly. The mean annual rainfall for Harresaw ranges from 300–500 mm, and there is only one main rainy season (July to September), as the *Belg* has often failed for the past two decades. Rivers flow mainly during the rainy season, and there are some small, private, ponds and water points in some parts of the Kebele. The area is frequently affected by drought, strong winds and frost, which severely affect crop production and animal husbandry. The community has very limited and unreliable access to irrigation, with the main source being from a large dam constructed by the government over two decades ago. The dam fills with water only during the main rainy season. Consequently, most of the time, the percentage of household who have access to irrigated water is low, due to shortages in the dam.

The total population of the Harresaw is 6,307: 3,091 male and 3,216 females. The community are entirely Orthodox Christians, and Tigrigna is the main language, as only very few people speak Amharic. The main source of livelihood is mixed farming (crop production and animal husbandry). Crops such as barely, wheat, beans, lentils, peas and sorghum are the main ones harvested. Unlike the Shumsheha community, the area does not grow any fruits or vegetables. The main types of livestock include sheep, goats, oxen, cows and donkeys. The main non-farm activity which households are often engaged in is migrating far distance to find work and send remittances. Other non-farm activities like petty trade or wage employment are very limited in the area.

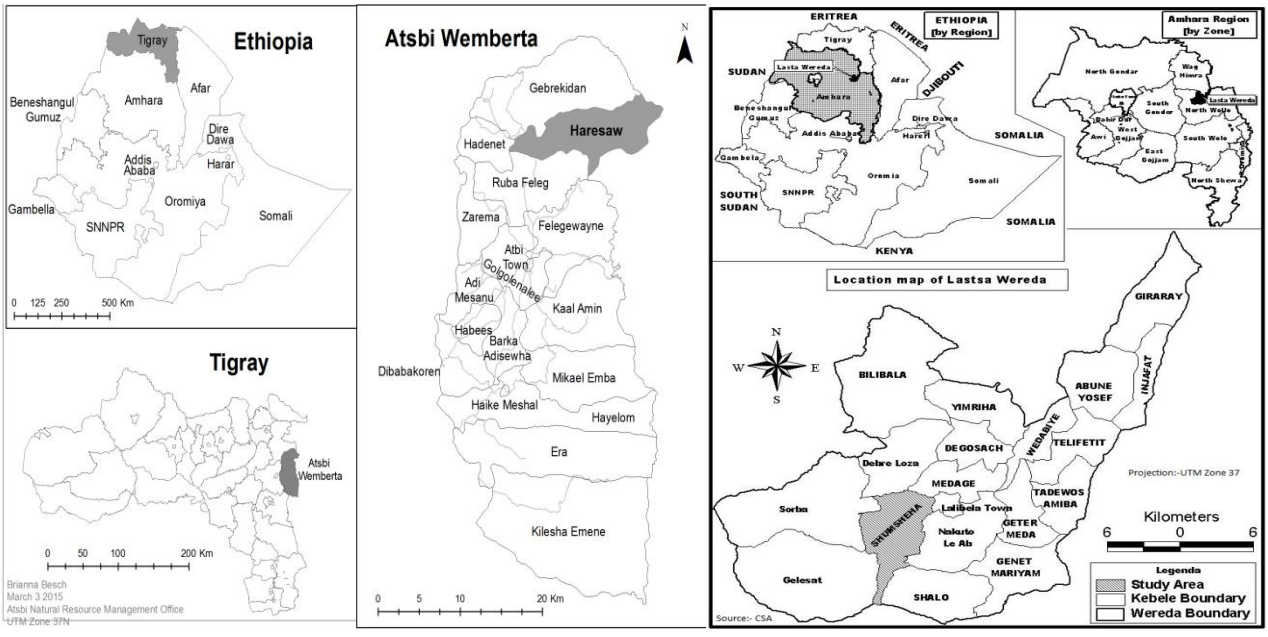

Figure 2. 1: Study areas map: Harresaw(Left) and Shumsheha (Right)

4. Methods

4.1. Data set

This study used two panel data sets: three rounds of the Ethiopian Rural Household Survey (ERHS)[5] (1999, 2004 and 2009) and our own household survey (2015). These data sets and rounds were chosen due to their consistency and availability for comparing the livelihood strategies of rural households over the course of 15 years, in order to examine the real effects of changes made over time. The five year gap between each round gives a consistent and appropriate time spacing. The ERHS data set has information on household characteristics, demography, asset ownership, farm input use, outputs, livestock production, non-farm activities, and perception of rainfall. Its duration, low attrition rate at the household level, representation of the mixed farming system, and sample size make the ERHS a unique and very important survey in Ethiopia.

Our own household survey was collected using the same Kebeles and sample households of the ERHS. The data was collected in early 2015 from 204 households during three months of field work, using structured and semi-structured questionnaires. A pre-test for the questionnaire was undertaken, and it was adjusted accordingly. The questionnaire has information on: (a) basic socioeconomic, demographic, and asset characteristics of households; (b) household perceptions of climate change, adaptation strategies for climate change/variability and evaluation criteria; (c) livelihood strategies and income; (d) agricultural practices, technology and extension; (e) local institutions. Semi-structured questionnaires, focus group discussions and key informant interviews were also conducted with extension workers, local elders, farm associations, cooperatives, farmers and women's groups.

In addition, rainfall data sets for over 30 years (from 1983 to 2014) were collected from the Ethiopian National Meteorological Agency (ENMA), which provides rainfall records in ten-day intervals. The study was complemented by different secondary data set when needed.

4.2. Conceptual Framework

The combination of resources endowments (or access), policy and institutional settings, and biophysical conditions (rainfall in particular) result in the ability of a household to decide which kind of livelihood or combination of livelihood to pursue (Figure 2.2). A livelihood comprises of assets (resources, claims and access) and activities (farm, non-farm, migration, etc) that together determine the way of living a household can afford (Chambers and Conway, 1992 and Ellis, 1999). Livelihood resources or access to them refer to assets including (1) natural (soil, water), (2) economic (cash, saving, credit, remittance and other basic infrastructure and production equipment or technologies), (3) human (education, skill), and (4) social (networks,

[5] The ERHS is a unique longitudinal data set. It was launched in 1994 by the Department of Economics at Addis Ababa University and the Centre for the Study of African Economics at Oxford

social claims, social relations, affiliations, associations) resources. Livelihood activities of rural households belong to either of two broad categories: farming and non-farm activities. Farming refers to household activities from own-account farming, whether on owner-occupied land or on land accessed through cash or share tenancy. Non-farm activities refer to household participation in non-agricultural activities, including wage employment, business activities, and migration.

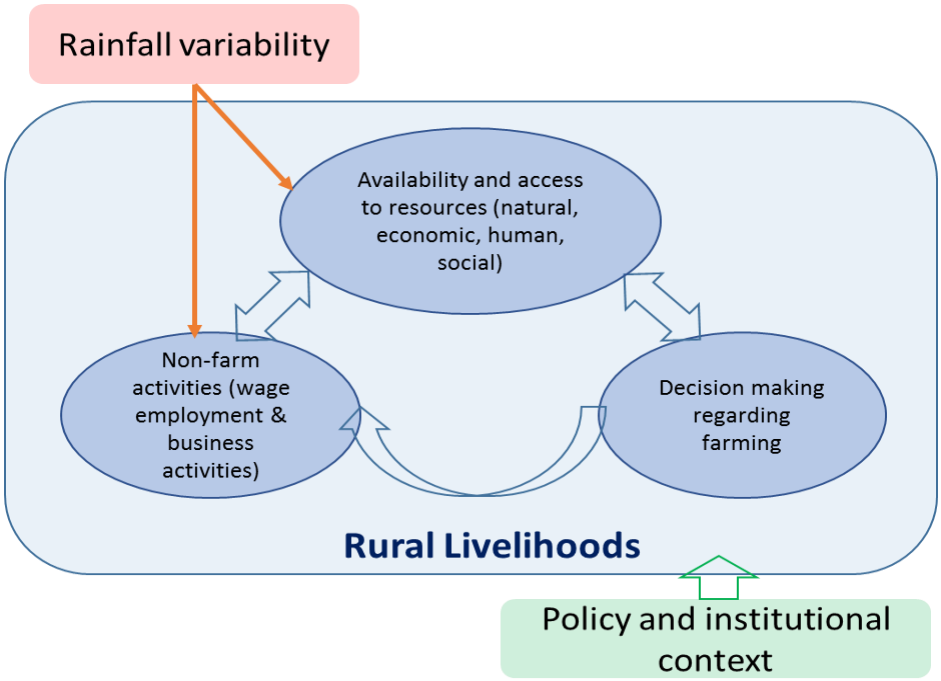

Figure 2. 2:Conceptual framework for the study of rural households livelihood strategies in Ethiopia.

The household[6] is the level at which most resource-allocation decisions are made. Rural household decisions to work in non-farm activities are broadly categorized according to endowment with resources or access to them as well as in terms of biophysical factors (especially rainfall). Given the nature of rain-fed farming in rural Ethiopia, the amount and distribution of rainfall during the cropping season do significantly affect crop and animal-husbandry productivity. Thus rainfall conditions; amount and distribution in the growing season, affect primarily households' decision to engage in farming or not (Brooks, 2003; Hulme, 2001; Teka et al., 2012). This is because the households' main livelihood depend on farming and it heavily depends on rainfall conditions during the growing season. In turn, household decisions to do farm work or not directly affect their respective decisions to work at non-farm activities, mainly because of the limited available resources households own and can distribute among the

[6]Households are the unit of analysis for this study. A household is defined as one or more individuals, related or unrelated, who live in the same dwelling and share meals and/or accommodation; it may consist of a single family or some other grouping of individuals

livelihood activities. Policy and institutional context refers to available policies and strategies at the local level regarding property right like land, community's access to agricultural inputs and financial schemes, and availability of other schemes to households' livelihood conditions.

Wage employment refers to income from rural wages, where a household head or any other member of a household works for others to obtain payment in cash or in kind. It includes (1) labor payments in cash or kind, such as harvest share systems and other non-wage labor contracts that remain prevalent in the respective localities, and (2) other wage work in the local community, outside of agricultural and related activities. Business activities refer to income generated from non-agricultural activities, including (a) non-farm rural self-employment, sometimes called business income or petty trade; (b) rental income obtained from leasing land or property; (c) artisanal or handcraft work; (d) local business ownership (bar, tea shop); and (e) technician. Migration remittances refer to other income sources, including (a) urban-to-rural remittances arising from within national boundaries and (b) international remittances arising from cross-border and overseas migration. However, household income received through aid from governmental and non-governmental organizations is not considered as a remittance.

4.3. Model Variables

Based on the conceptual framework presented above, this section lays out the explanatory variables for the panel regression model employed and our a priori expectations about their relationships with household participation in non-farm livelihood activities. We consider participation in an activity as a dichotomous variable constructed from a households' response to a specific question regarding non-farm livelihood strategies. A household is considered to be participating in a particular kind of activity if at least one of its members has generated income (in cash or in kind) during the last 12 months from that activity. Our choices regarding the dependent variables has been guided by the idea of providing scientific evidence-based implications for assisting policy makers and other development-organizations in making decisions regarding the improvement of small-farm livelihoods through diversification of their economic activities. For this reason, we have separately considered wage employment and business activities, as these are motivated by different institutional and policy incentives and asset capacities.

The explanatory variables of household participation in non-farm livelihood activities are categorized into rainfall conditions, asset holding and access, and demographic characteristics. The choice of these variables is based on the literature and data availability. Measuring rainfall patterns is based on the ENMA rainfall data set, based on 10-day intervals (hereafter referred to as 'decades') and covering a period of over 30 years (1983 to 2014). Specifically, our analysis focuses on the main rainy season, Kiremt, from the beginning of June to the end of September, as this period of the year is the main and only growing season for farmers in both areas under investigation.

For household crop production, it is not only the total amount of rainfall which matters but also its distribution and regularity across growing seasons. Thus, prior to each survey, we calculated the anomalies of decadal rainfall (Lebel& Ali, 2009), which enabled us to characterize the wetness and dryness of a particular decades (e.g. 10–20 August),and the total rainfall amount of the rainy season prior to each survey (D'haen et al, 2014). The anomaly of a specific decades is the deviation of the rainfall in a particular year from the long-term mean decadal rainfall (in our case 1983 to 2014), calculated as shown in the following formula:

$$Anomaly = \left(\frac{Decadal\ rainfall\ -\ long\ term\ mean\ decadal\ rainfall}{Standard\ deviation\ of\ long\ term\ mean\ decadal\ rainfall}\right)$$

Values between −0.49 and +0.49 indicate normal conditions, and values between |0.5| and |0.99| indicate wet/dry conditions. Decades were categorized as 'very wet' or 'very dry' if their anomaly in a particular year was larger than 1 or smaller than −1, respectively (D'haen et al, 2014).

Under the category of asset holding and access, we selected different variables to be included in our estimation, including total asset value, total livestock owned value, total land size in *Timad*[7] and household access to loans. Farmland availability is an important source of capital for rural households, and landless households are more obliged to work off-farm and pursue other non-farm livelihood strategies. So we do expect a negative relation between land size and household participation in non-farm livelihood strategies. When households have more land, they tend to spend more time on agricultural production than earning income on casual or other low-reward business activities. Access to loans is expected to have a positive relation with non-farm livelihood strategies, because it can provide the initial capital for poor rural households to undertake business activities.

Under the category of demographics, variables such as education and age of the head of a household and adult household size are included in the model. Education is expected to have a positive correlation with better payoffs for non-farm livelihood strategies, whereas wage employment which is casual and with low payoffs is expected to have a negative correlation with education. Adult household size is expected to have a positive relation with wage employment. In need of a better indicator for experience we considered household age to be a good proxy indicator for experience.

4.4. Econometric model

Given the overall objective of our analysis – investigating the dynamics of livelihoods in rural Ethiopia as related to rainfall variability and household socio-economic characteristics – two prominent panel econometric formulations will be tested: fixed effects (FE) and random effects

[7] *Timad* is a local measure for farm size which is equal to 0.25 hectares.

(RE) models. Due to the binary nature of the dependent variables, we have employed a conditional logit modeling specification (Allison, 2009).

The conditional logit model can be presented in its simplest formulation as follows:

$$Y_{it} = \beta_1 X_{it} + \alpha_i + u_{it} \qquad \text{[eq. 1]}$$

where:

- α_i (i=1….n) is the unknown intercept for each entity (n entity-specific intercepts);
- Y_{it} is the dependent variable observed for households, where i = entity and t = time, in our case household participation in wage employment or business activities;
- X_{it} represents explanatory variables for household i at time t;
- β_1 is the coefficient for the explanatory variables; and
- u_{it} is the error term

The essential difference between the FE and RE models is the assumptions we make about X_{it} and α_i. The αi are either correlated or uncorrelated with the regressors in X_{it}. When the u_i are correlated with some of the regressors in the model, one estimation strategy is to treat them like parameters or FE. The FE approach assumes that α_i is treated as non-random and, hence, makes a correction between the observed explanatory variables (X_{it}) and α_i. However, including a parameter for every individual is not feasible, because it would imply an infinite number of parameters in N large-sample approximations. The solution is to remove the u_i from the estimation problem by a transformation that can still identify some of the coefficients of interest. However, the RE approach is applicable under the assumption that α_i is random and not correlated with $X_{it,}$ putting it into the error term (Wooldridge 2002: 257). When α_{it} is uncorrelated with everything else in the model, the individual-level effects are simply parameterized as additional random disturbances (Baum, 2006). The sum $\alpha_i + u_{it}$is sometimes referred to as the composite error, and the model is sometimes known as an "error-components model". We used a Hausman test to check whether there is such correlation between the observed explanatory variables and α_i so as to determine the suitable model specification. Furthermore, specification of the model as being fixed or random effect has relevance for the spatial and temporal variability of the tested function. This is particularly meaningful for our empirical study, where we aim to depict the effects of rainfall variability on changing farmers' livelihoods strategies. The validation of the RE of our model would indicate temporal variability of these livelihood strategies to be higher than the spatial, while the verification of the fixed effect assumption would indicate the inverse. If regressors are correlated with the $\alpha_{i,}$ the FE estimator is consistent but the RE is not. If regressors are uncorrelated with the $\alpha_{i,}$ the FE estimator is still consistent, albeit inefficient, whereas the RE estimator is consistent and efficient (Baum, 2006).

5. Results

5.1. Socio-economic characteristics of rural households

Table 2.1 provides a description of the set of variables used for the present study, with both variations of these variables –between one household and another (between) and overtime (within) –being considered. The mean age of the sample household head in both study areas is above 51 years; only 19% of farmers are younger than 40 in Shumsheha, though this proportion increases to about 25% in Harresaw. The illiteracy rate in both Kebeles is very high, with more than 78% and 59% of the sample household heads in Harresaw and Shumsheha, respectively, being illiterate. The average adult household size in Harresaw is 2.63 and that of Shumsheha is 2.37. Household farm size is quite low in both study areas, though Shumsheha, with an average farm size of 1.1 hectares, has better access to land than households in Harresaw(0.57 hectares).

Households in Harresaw have better access to loans(56% of households) than Shumsheha (43%). The loan coefficient of variation (CV) for a household overtime (within) is greater than the coefficient of variation between households (between) in both Kebeles. The high CV within the same households over time indicates that household access to loans varies significantly over time, indicating that provision of credit to farm households is inconsistent and unreliable from year to year. On the other hand, *Iqub*[8]groups are not available in Harresaw, whereas in Shumsheha over 8% of the sample households are members of an Iqub.

[8]*Iqub* is an informal-traditional financial association in which members voluntarily form themselves into a group and make mandatory financial contributions at a regular interval (per week or month). The "pot" is distributed on a rotating basis, determined by drawing lots.

Table 2. 1: Socio-economic characteristics of rural households

Variable		Harresaw Kebele			Shumsheha Kebele		
		Mean	Std. Dev.	CV	Mean	Std. Dev.	CV
Household head age	overall	51.32	14.94	0.29	51.41	13.26	0.26
	between		13.18	0.26		11.45	0.22
	within		7.47	0.15		7.57	0.15
Adult household size	overall	2.63	1.54	0.59	2.37	1.41	0.59
	between		1.08	0.41		1.14	0.48
	within		1.13	0.43		0.87	0.37
Land size in Timad	overall	2.27	1.19	0.52	4.41	2.94	0.67
	between		0.85	0.37		2.35	0.53
	within		0.85	0.37		1.96	0.44
Rainfall (decadal)	overall	-0.06	0.38	-6.33	0.13	0.18	1.38
	between		0	0		0	0
	within		0.38	-6.33		0.18	1.38
			%			%	
Illiterate household head education	1999	47	78.3		69	67.65	
	2004	48	71.6		76	71.7	
	2009	64	79		55	47.4	
	2015	69	83	0.06	47	46.1	0.23
Loan taken	1999	39	48.75		48	44.86	
	2004	43	51.2		55	44.35	
	2009	49	59		60	50	
	2015	53	64.6	0.13	30	29.4	0.21
Iqub	1999	-	-		5	3.45	
	2004	-	-		7	5.65	
	2009	-	-		17	14.2	
	2015	-	-		15	10	

5.2. Rainfall patterns in recent decades

Between 1983 and 2014, rainfall for the main rainy season (June to September) in Harresaw ranged from 190to 998millimeters(mm) and from 296to 937 mm in Shumsheha, with high temporal variation (Figure 2.3 below). During this period, the average rainy season rainfall was 624 mm in Shumsheha, which was higher thanHarresaw's361 mm. During this period, a high coefficient of variation (CV) can be observed for the average main rainy season in Harresaw, with a value of 42 and Shumsheha at 22,indicating high rainfall variability from season to season, particularly in Harresaw.

The rainfall pattern of the main rainy season for the last three decades has shown significant variation among the two Kebeles, with decreasing and increasing patterns in Harresaw and

Shumsheha, respectively (Figure2.3 below). The pattern in Harresaw Kebele matches the findings of Araya and Stroosnijder (2011), who observed a decreasing trend in the 1980s and a slightly above-average trend in the years after 1990.Likewise, decreasing rainfall has also been observed across selected historical-event years in the Eastern Tigray zone (Teka et al.,2012).

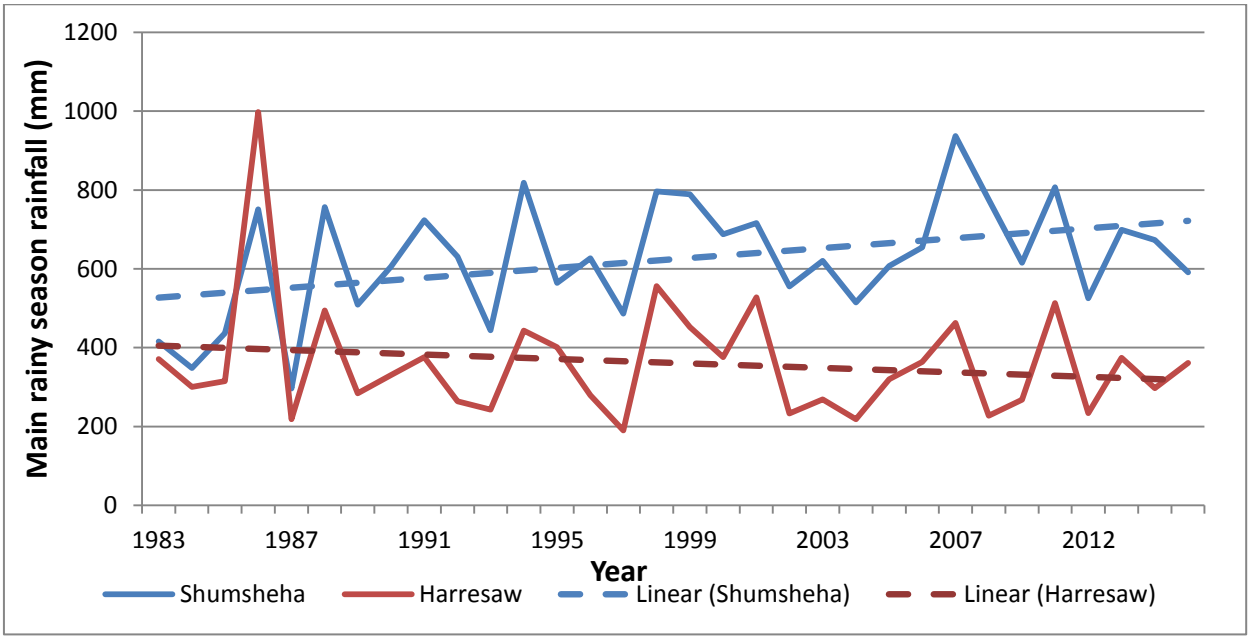

Figure 2. 3:Main rainy seasonrainfall in Harresaw and Shumsheha, 1983–2014

The anomaly decadal rainfall of the study years (1998, 2003, 2008 and 2013) indicates high degrees of variation. The number of very dry or very wet periods also reveals significant differences across the study years. The number of very wet anomaly decadal rainfall periods decreased significantly since 1998 in both Kebeles. In 1998, there were four and five very wet decadal rainfall periods in Harresaw and Shumsheha, respectively, which significantly decreased to 0 or 1 in the following periods. This is also confirmed by the decreasing trend line for both Harresaw and Shumsheha (Figure 2.4).

The rainfall pattern for the main rainy season (June to September) indicates significant change, with a decreasing trend for both study areas (Figure 2.4). High variation is also observed from one to the next decadal of rainfall in the same rainy season within the same community (Table 2.1 and Figure 2.4), further showing the uncertain and highly variable nature of rainfall in the study areas. Such rainfall patterns make it difficult for farmers to predict the nature of rainfall in the way they used to do in previous years, which was mentioned frequently during interviews with key informants, who reported that rains are becoming more erratic and difficult to predict by farmers.

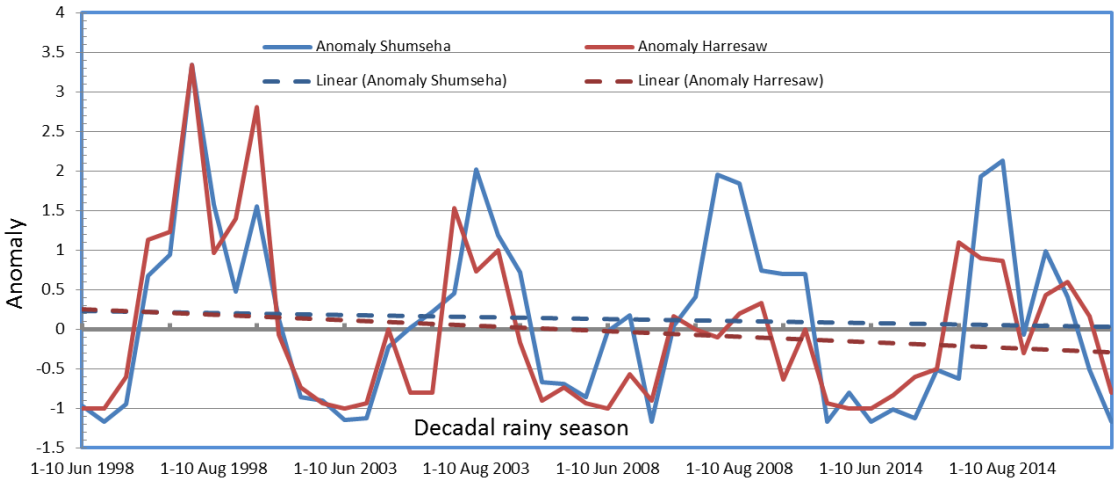

Figure 2. 4: Anomalies of decadal rainfall in Shumseha and Harresaw forthe studyyears 1998, 2003, 2008 and 2014

5.3. Non-farm livelihood patterns in the study areas

Results from the panel data show that non-farm livelihoods are a growing and vital source of income for rural households. Yet both study areas have different non-farm livelihood strategies, and households in the Shumsheha community have been found to have better access to non-farm livelihoods.

Wage employment has been found to be the most common non-farm livelihood strategies. In 1999,an average of 8% and 30% of the households in Harresaw and Shumsheha, respectively, engaged in wage employment (Table 2.2). In Shumsheha, except for the 2009 round, wage employment has exhibited a significant rising trend such that, in 2015, almost half of the respondents in Shumsheha reported that at least one or more members of their household were working as a wage worker in the community. During the same study period, however, the growth trend of wage employment in Harresaw has been much slower, with only 15% of the sample households reporting wage employment as a source of income in 2015.

The trend of business activities has also exhibited different patterns for the two study areas. In Shumsheha, there has been an increasing, consistent and high growth of business activities during the study periods. In 1999, only 8% of households were engaged in business activities. This figure slightly increased to 14.5% and 19% in the 2004 and 2009 rounds, respectively, before it significantly increased to 34.4% in 2015. In contrast, business activities in Harresaw have exhibited a decreasing and inconsistent trend, and a low proportion of households were engaged in business activities in 2009 and 2015 as compared to the 1999 and 2004 rounds (Table 2.2).

In 1999, 23% and 6% of the households in Harresaw and Shumsheha, respectively, had received remittances in the 12 months prior to the study period. In Harresaw, the trend has been both

decreasing and increasing, whereas in Shumsheha the trend has been increasing throughout the study years. Thus, in 2015, almost a quarter of the respondents reported that they had received remittances from someone living outside their Kebele.

Table 2. 2: Household engagement in non-farm sector: Shumsheha and Harresaw

Year	Wage employment(%)		Business activities(%)		Received remittance(%)	
	Harresaw	Shumsheha	Harresaw	Shumsheha	Harresaw	Shumsheha
1999	7.4	29.8	17.3	8.3	22.2	5
2004	7.2	35.5	15.5	14.5	7	10
2009	49.4	23.3	3.6	19.2	18.1	11.7
2015	14.6	49	13.4	34.37	20.7	24.5
Pearson chi2 (P-Value)	63.36 (0.000)	17.47 (0.001)	8.47 (0.037)	26.76 (0.000)	8.24 (0.041)	21.11 (0.000)

5.4. Determinants of Livelihood Strategies

This section explores the determinants of wage employment and business activities in the study areas based upon a strongly balanced panel data set. Initially, our panel model employs fixed effects, random effect and pooled ordinary least squares (OLS) estimations separately for the two study areas: Shumsheha and Harresaw. The appropriateness of these estimations are then tested using a Hausman test and Breusch-Pagan Lagrange multiplier (LM). The null hypothesis is that unobserved household effects are not correlated with explanatory variables included in the model. In other words, we test here whether unique error terms (u_i) are correlated with the described regressors (Equation 1). Regarding the first model on business activities, the Hausman test rejected the hypothesis in both study areas with a *p* value of less than 1%. Accordingly, the initial hypothesis that the individual-level effects can be adequately modeled by a RE model is resoundingly rejected, and a FE model is the preferred specification (Wooldridge 2002), as it can control for time-invariant differences in samples, such as macroeconomic conditions and institutions, religion, gender, and culture. By using household panel data with a FE specification, we can control for unobserved household characteristics that do not change over time but which may be correlated with household diversification behavior. A Hausman test confirming FE specification indicates that individual differences within our sample are more significant than inter-temporal differences, also meaning that the spatial variability of our data is higher than its temporal variability.

The Hausman test applied to the second model, wage employment, provided two different results for both study areas. For Harresaw, the test rejected the null hypothesis with a *p* value of less than 1% and, thus, we used a fixed effect model. However, in Shumsheha the null hypothesis was not rejected. So we ran the Breusch-Pagan Lagrange multiplier (LM) test to decide between a random effects model and a simple pooled OLS regression. The null

hypothesis in the LM test was that variances across entities should be zero, meaning no significant difference across units (no panel effect). Again, we rejected the null hypothesis due to a *p* value of higher than 10% and concluded to use a pooled OLS regression. Table 2.3 reports detailed estimation results of the wage and business activities in both study areas.

The FE model enabled identification of a few relevant correlations between individual household effects and a set of explanatory variables in each case and model (wage vs business). The age of the household head, which represent the experience and accumulation of assets for non-farm livelihood strategies, positively and significantly (at 10% level) affect household decisions to engage in business activities in Shumsheha. A unit increase in age of household head results in a 4.3% increase in the probability of a household's engagement in business activities. However, such an effect was not observed in Harresaw. Similarly, age of household head does not appear to have a significant impact on household decisions to take on wage work in either study area. Differently from age, the parameter estimates of adult household size is positively and significantly (at 5% and 1% in Harresaw and Shumsheha, respectively) correlated with wage employment decision but has no effect on decisions to engage in business activities. This indicates that households with more adult members are in a better position to participate in wage employment. Regarding education, and in line with our expectations, household head's level of education was found to affect positively and significantly business activities in Harresaw. When the household head has better education, this would seem to increase its chances of being engaged in business activities. This effect was only observed in Harresaw, however, and household head education level does not seem to significantly affect household participation in wage employment in either study area.

From a structural perspective, household farm size has been found to have a positive and significant effect only on wage employment decisions in Harresaw, seeming to indicate that households with large farms can more easily work as wage workers. Given the very low average farm size in the community (0.56 hectares), having a relatively large farm might help farmers to look for wage work not only in their community but also in the neighboring communities. Farm size does not appear to have a significant impact on household participation in business activities, though, as the coefficient is negative. We infer from this that households with large farms do not prefer to engage in business activities in either study area.

Table 2. 3: Panel estimation for the two study areas

	Wage employment						Business activities					
	Harresaw			Shumsheha			Harresaw			Shumsheha		
Variables	OLS estimator	Fixed effect	Random effect	OLS estimator	Fixed effect	Random effect	OLS estimator	Fixed effect	Random effect	OLS estimator	Fixed effect	Random effect
Household headage	-0.003*	0.017	-0.022*	-0.002	0.006	-0.011	-0.000	0.034	-0.003	-0.000	0.043*	0.002
	-0.002	-0.027	-0.013	-0.002	-0.016	-0.009	-0.001	-0.032	-0.017	-0.001	-0.025	-0.017
Adult household size	0.051***	0.355**	0.353***	0.095***	0.344***	0.460***	0.014	-0.004	0.149	-0.009	0.165	0.021
	-0.016	-0.159	-0.113	-0.017	-0.132	-0.089	-0.013	-0.239	-0.143	-0.0146	-0.211	-0.155
Land size in Timad	0.022	0.462**	0.131	-0.011	-0.047	-0.049	-0.020	-0.217	-0.295	-0.021***	-0.031	-0.207**
	-0.021	-0.235	-0.138	-0.008	-0.059	-0.041	-0.017	-0.305	-0.226	-0.007	-0.101	-0.085
Illiterate household head education	0.012	-0.192	0.055	-0.025	-0.247**	-0.13	0.053**	0.862**	0.542**	0.006	-0.08	0.046
	-0.03	-0.254	-0.181	-0.018	-0.119	-0.092	-0.024	-0.363	-0.231	-0.015	-0.207	-0.16
Rainfall (decadal)	-0.237***	-1.803***	-1.867***	-0.432***	-1.809**	-2.134***	0.150***	1.859***	1.603***	-0.290***	-2.214*	-2.865***
	-0.069	-0.649	-0.574	-0.133	-0.721	-0.662	-0.055	-0.695	-0.586	-0.112	-1.18	-1.05
1.Loantaken	-0.032	0.606	-0.181	0.043	0.033	0.222	0.017	0.051	0.197	0.051	1.013**	0.757*
	-0.049	-0.457	-0.336	-0.047	-0.295	-0.228	-0.04	-0.591	-0.433	-0.039	-0.505	-0.404
1.Iqub	-0.293			0.074	0.255	0.354	0.486**		2.576	0.183***	2.463**	1.503**
	-0.235			-0.078	-0.512	-0.358	-0.189		-1.584	-0.065	-1.241	-0.618
1.Remittance	0.045	1.261**	0.386	-0.044	-0.389	-0.208	0.099*	0.271	0.795*	0.120**	1.320**	1.207**
	-0.062	-0.582	-0.422	-0.07	-0.439	-0.348	-0.05	-0.61	-0.475	-0.059	-0.639	-0.513
Constant	0.176*		-1.776**	0.312***		-0.75	0.125		-2.410**	0.328***		-2.075*
	-0.104		-0.759	-0.112		-0.548	-0.084		-1.016	-0.094		-1.159
Observations	285	152	282	411	289	411	286	100	286	411	142	411
R-squared	0.096			0.113			0.095			0.095		

Household access to loans exhibits a positive and significant impact on their likelihood of participating in business activities in Shumsheha, implying the important role of household access to loans for starting up businesses at the local level. Given that credit institutes are the sole loan providers, it also implies the essential role of credit institute support in promoting small business activities at the local level.

Remittances were found to positively and significantly impact household participation in business activities in Shumsheha. In Harresaw, meanwhile, they also have a positive but not significant effect. In contrast, remittances have a positive effect on household participation in wage employment in Harresaw, but they do not have any significant impact in Shumsheha. Membership in local saving groups, Iqub, significantly contribute to household participation in business activities in Shumsheha Kebele, indicating the importance of financing startup capital for business activities. The results further reveal that, in line with our expectation, there is no significant effect of Iqub on household participation in wage employment.

The results of our model also indicate that decadal rainfall has a significant impact on household participation in wage employment and business activities in the study areas. In Shumsheha, a good amount and distribution of decadal rainfall has a negative and significant impact on household participation in wage employment and business activities. Similarly, a good distribution of rainfall has a negative effect on household participation in wage employment in Harresaw as well. This means that, when the amount and distribution of rainfall across the growing season is good, households are less likely to engage themselves as casual wage workers or for less well-paying business activities. Rather, during such periods they prefer and decide to work on their own farm, which offers them more attractive conditions.

6. Discussion, conclusions and perspectives

6.1. Livelihood patterns

We have explored rural household livelihood patterns and factors affecting household choices regarding non-farm livelihood activities, based on four rounds of panel data set between 1999 and 2015. Our results show that rural household non-farm livelihoods are in a state of constant dynamic change. The non-farm livelihood dynamics of households in the two study areas have exhibited an overall upward pattern over the study years, except for business activities in Harresaw, where the trend has been downward. The proportion of households engaged in non-farm livelihoods has been increasing over the years. This finding is in line with studies in Ethiopia (Carswell, 2000; Lemi, 2006) and other sub-Saharan African countries (Barret et al., 2001; Ellis, 2000; Ulrich et al., 2012) that have reported an increasing proportion of rural households engaged in non-farm livelihood.

Even though the livelihood patterns have shown a rising non-farm livelihood trend, fluctuation has also been found to be common during the entire study period in both

Shumsheha and Harresaw, with significant differences from one study period to another. The main reason for the great fluctuation of households becoming involved in non-farm livelihood patterns is the conditions of rainfall during the main growing season, which will be discussed in the next section.

The livelihood patterns found also exhibited significant difference between the two study areas. Shumsheha, which has its own local market, access to a larger market and all-weather roads is relatively better equipped for engaging a greater proportion of households in both wage employment and business activities. This finding is particularly revealing with regard to the importance of public investment in market infrastructure and institutions for the livelihoods of local populations. In contrast to Shumsheha, households in Harresaw have a strong tendency to migrate to neighboring regions or countries, mainly due to a lack of wage work or opportunities to start their own businesses locally.

6.2. Rainfall and socio-economic livelihood decision making

Rural household non-farm activity engagement in Ethiopia is influenced by socio-economic factors. Household characteristics, such as household head age and education and adult household members in family, appear to have a significant impact on household decisions to pursue non-farm livelihood strategies or not. In particular, demographic characteristics significantly determine household participation in wage employment. A large number of adult household members has a positive and significant correlation with wage employment. This is also in line with several other studies (Berg and Kumbi, 2006; Abebaw et al., 2012) which reported that larger sized households tend to have more diverse income sources, including fuel-wood collection, honey and/or gum collection from forests, and other labor-intensive sources of income. The strong positive correlation between adult household size and wage employment in both study areas indicates that households are using wage employment opportunities as a means to occupy surplus labor away from farming. This further indicates that low-paid wage employment is the most likely option for poor households (Seaman et al., 2014) when they are not able to overcome entry barriers to more highly productive rural non-farm livelihood activities that require financial capital and skills (Reardon, 1997; Martin and Lornzen, 2016).

Access to financial assets and means – represented by household access to loans, remittances or membership in an Iqub – significantly and positively affect household participation in business activities, a result which has also been confirmed in previous studies (Aklilu et al., 2008). The strong association between access to financial means and assets and the ability to undertake business activities can be observed in Shumsheha, where households engaging in business activities are relatively better off. This, seeming to indicate the importance of initial capital for business activities at the local level. Meanwhile, lack of financial assets is considered one of the entry barriers for rural households, usually preventing them from engaging in self-employed non-farm activities, such as business activities. This is in line with findings of other studies (Martin and Lornzen, 2016; Seaman et al., 2014;Woldenhannaand Oskam, 2001; Bezu et al., 2012) reporting that rich households

may dominate the most lucrative rural non-farm activities, whereas the poor are generally engaged in low-paid activities. Thus, support of credit institutes to prompt small businesses at the local level may not only enable increased household participation in business activities but also high-return ones.

However, some differences exist among the study areas, likely indicating that structural differences and effectiveness of labor markets exist, even among neighboring rural areas of Ethiopia. Households in the relatively more developed Shumsheha appear to have better access to both labor markets and self-employment business activities. When opportunities for non-farm activities are low, however, the possibility that migration will occur is high. In this vein, we found that more than 42% of the households in Harresaw reported at least one or more member of their household having migrated in search of employment –a figure reduced to only 10% in Shumsheha. Taking the logic of this situation one step further, Bezu and Holden (2014) have concluded that an inability to address rural livelihood possibilities in Ethiopia may result in socio-economic crises, not only in rural areas but also in urban ones where a rapidly increasing number of rural residents have migrated in search of employment.

Rainfall conditions also have significant implications for household participation in wage employment and business activities in both study areas. Our study's negative and high correlation (at 1%) between rainfall and wage employment strengthens previous evidence (Ulrich, 2012; Barrett et al., 2001; Woldenhanna and Oskam, 2001) that many available non-farm activities offer low returns. Similarly, rainfall has a negative and significant effect on business activities in Shumsheha. When households only have access to very low paying casual wage employment, their main focus will tend to be on farm activities (Ulrich et al., 2012). Such low-wage employment is, then, rather be used as a supplementary sources of income. This would seem to indicate that a good amount of rainfall during the growing season will cause households to prefer working on their own farm rather than becoming engaged in low-return wage employment or business activities. This result is in line with the work of D'haen et al., (2014) in rural Burkina Faso, which reported household participation in non-farm activities being determined by adverse rainfall conditions in the major staple-food production zone of the country. Thus, the motivation of rural households to diversify into non-farm livelihoods can be seen as being mainly driven by rainfall conditions during the main growing season. When these conditions are adverse, rural household production from farming becomes significantly low. During such periods, household members prefer to pursue non-farm work such as wage employment and business or other non-farm activities within the community. In areas where such non-farm livelihood opportunities are low at the local level, they rely on migration as a way out for accessing additional sources of income.

6.3. Conclusions and perspectives

Based on two case studies, we have aimed to reveal the livelihood dynamics of rural households in Ethiopia and their association with rainfall conditions and household socio-economic characteristics. Employing a rural household panel data set from 1999 to 2015, our

results show that non-farm livelihood patterns in both study areas exhibit rising trends, except for business activities in Harresaw. However, even if these patterns indicate increasing pursuit of non-farm livelihoods, significant fluctuation has been observed throughout the study period. Meanwhile, the two study areas differ in terms of their ease of entry into non-farm livelihoods, which is mainly determined by their access to markets, roads and developmental activities that have the potential to create jobs and provide incentives towards business activities.

Our econometric estimations have shown that rainfall conditions during the main rainy season in Ethiopia significantly and negatively affect household decisions to engage in non-farm livelihoods, specifically wage employment. This result has two implications: First, wage employment in rural Ethiopia is mainly casual and generally offers a low return. Second, household decisions to engage in non-farm livelihoods are primarily driven by expected low returns from farming, due to adverse climatic conditions (rainfall).

Our analysis has also indicated that household socio-economic characteristics strongly influence decisions about pursuing non-farm livelihoods. Household demographic characteristics such as adult household members appear to positively and significantly determine their decisions regarding whether to engage in wage employment or not. On the other hand, access to financial resources from credit institutes, remittances or Iqub have been found to play a role in positively and significantly determining their decisions about undertaking business activities. We have observed high and significant variation between the study communities with regard to the proportion of households engaged in non-farm livelihoods. These differences are primarily driven by structural differences in terms of access to all-weather roads, markets or developmental means being available in the community.

The study has demonstrated that the main reason for household decisions to pursue non-farm livelihoods is adverse rainfall conditions during the main growing season, which consequently affect the profitability of farming. We have also observed the potential that non-farm livelihoods offer to rural households: either as the main source of income or as a substantial supplement during adverse rainfall conditions. D'haen et al (2014)suggest, however, that non-farm livelihoods should not be viewed as a buffer during adverse climate conditions but rather as a core strategy for rural development. However, we restrain ourselves from such claims until deep societal and economic change is observed, as such significant changes need policy and strategic interventions towards non-farm livelihood in rural communities.

For policy-making, it is important to understand how designing policy and strategic interventions contribute towards the enhancement of non-farm livelihoods and the ways in which they can, in turn, make significant contributions to rural development. Their contribution could be either as a supplement to farming through enabling rural households' to invest in farming or as a core livelihood strategy by themselves. The findings of this study have a variety of policy implications. First, increasing the access of households

to financial schemes through local credit institutes or local groups, such as Iqub, may enable them not only to take part in business and self-employment activities but also to be able to readily choose the profitable ones which offer the highest returns. This may, in turn, improve household capacities to invest in agriculture and, subsequently, improve overall income (Bezu et al., 2012). Second, there is a need to increase household-member skills through vocational training and education to increase competitiveness, which would enable rural households to more successfully pursue business activities and increase their chances of getting well paid wage work. Third, increasing household access to markets, through developing appropriate institutions, communication technologies, and infrastructure, would likely generate important livelihood opportunities.

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