The Dynamics of Rural Household Livelihood Diversification: Panel Evidence from Kenya

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Abstract

Livelihood diversification is a norm in rural Sub-Saharan Africa (SSA), and has been recognised an important pathway for promoting economic growth. This study uses household panel data combined with a mixed methods approach to explore the patterns and dynamics of rural livelihood diversification in Kenya. The econometric results show that when we control for household fixed effects and other determinants of diversification identified in previous literature, there is a positive and significant relationship between changes in household welfare in terms of asset wealth and changes in livelihood diversification. Moreover the dynamics in livelihood diversification are also driven by changes in economic assets, household composition and membership to farmer groups. The results have important implications for development policy in rural Kenya – highlighting the importance of harnessing the positive aspects of household livelihood diversification for poverty reduction.

Key words: Livelihood diversification, dynamics, panel data, Kenya

1.0 Introduction

Rural livelihood diversification remains an important subject not least in Sub-Saharan Africa (SSA), where expectations of its contribution to improving livelihoods, reducing poverty, enhancing food security and creating employment is high (World Bank 2007). In the context of Kenya, the phenomenon of livelihood diversification is prevalent for rural households at all levels of income (Kirimi et al 2010; Kimenju and Tschirley 2008), and is associated with ability to escape from poverty (Karugia et al 2006). However, the rural nonfarm economy is dichotomous and characterized by a mix of high-return and low-return sectors, with entry barriers which confine the poor to mostly low-return sectors (Lay et al 2008). Since livelihood diversification strategies are differently motivated, growth in the nonfarm economy in Kenya, like elsewhere in SSA, is currently neither inclusive nor redistributive, with wide implications for poverty and inequality (Alobo Loison, 2015). Moreover, agriculture remains mainly subsistence, and is characterized by persistent low productivity which constrains its transformation (Djurfeldt et al., 2005; 2011; Jirström et al., 2011).

Kenya is at an early stage of structural transformation, and has been going through structural adjustment policies since the 1980s and 1990s which are aimed at liberalizing the economy and increasing economic growth (Kimenju and Tschirley 2008). Moreover, these policies have had varying impacts on smallholders. The economic reforms (Kimenju and Tschirley 2008), increasing population densities (Muyanga and Jayne 2014), coupled with declining farm sizes (Djurfeldt and Jirstrom 2013) and poor weather characterized by shifting rainfall patterns and droughts (GOK 2012); may drive some households to increasingly rely on nonfarm incomes, while others may intensify agriculture depending on the constraints and opportunities they face. Such factors may influence a household's decision to engage in, and their earnings from the labor market outside the farm. However, it seems that most households in Kenya are still mainly combining farm and nonfarm activities (Kimenju and Tschirley, 2008).

Most studies on livelihood diversification in Kenya and elsewhere in SSA have so far been based mainly on cross-sectional rather than longitudinal data, and yet livelihood diversification is a dynamic process (Alobo Loison, 2015). In many regions, further evidence on the patterns of dynamism or stagnation, as well as the drivers of change is still lacking. Consequently, the medium to long term impacts of livelihood diversification on smallholders and its role in the process of structural transformation in SSA have not yet been well

understood. The aim of this paper is to contribute to the understanding of the dynamic patterns of livelihood diversification and household strategies based on a panel of rural households from Kenya. The rural households in the study come from two diverse regions in terms of geographical location, agro-ecological potential, market access, household activity and demographic structure.

The overall objective is to study the dynamics of livelihood diversification in rural Kenya. Specifically, we question: (i) How have the patterns of rural household livelihood diversification changed over time? How do they differ across different types of regions? How do they differ across different socio-economic groups of rural households? (ii) What drives the changes in livelihood diversification? To what extent are the changes in livelihood diversification driven by changes in household welfare?

The rest of the paper is organized as follows: Firstly, the concept of livelihood diversification as a dynamic process is contextualized for the case of SSA, based on previous longitudinal studies. Secondly, the study areas are described, then the different types of data and their sources. Thirdly, the results and discussion are presented, before concluding.

2.0 Overview of the literature on livelihood diversification

2.1 Patterns of rural household livelihood diversification in SSA − evidence from longitudinal data

According to the literature reviewed (Alobo Loison, 2015), the patterns show that although rural households in SSA sustain their livelihoods mainly from farming, diversification of incomes, activities and assets is the norm. In general, household diversification into nonfarm sources of income has been increasing over time, and so has their contribution to rural household incomes (up to about 35% according to Haggblade et al., (2010)). This seemingly increasing levels of household livelihood diversification, albeit without general increases in income levels has fuelled the deagrarianisation thesis (Bryceson, 1999, 2002), which suggests that African farmers are invariably moving away from farming, and that nonfarm income shares in total household income have reached between 60-80%. However, there are contradicting findings in the literature, on the primary motives of livelihood diversification in SSA - whether diversification is mainly driven by distress/survival (as suggested by Bryceson) or by accumulation motives. Generally, there are spatial and geographical differences in the results – depending on the country or region.

Literature on the nature and evolution of rural livelihood diversification in SSA (Alobo Loison 2015); and the challenges of transforming subsistence family agriculture into more productive commercial agriculture have been examined in many perspectives (Bosc et al 2015; 2013; Jayne et al 2010; Losch et al, 2012). A few studies have analysed these transformation processes using longitudinal data at household level. For instance, Andersson Djurfeldt and Djurfeldt (2013) use longitudinal household data on eight countries in SSA (including Kenya) to analyse structural and agricultural transformation, specifically the drivers of mobility within and between the farm and nonfarm sectors. They find that the structural transformation process among the smallholders surveyed was mostly stagnant. It seems that the slow structural and agricultural transformation in SSA is not only linked to persistent low agricultural productivity, but to the prevalence of a mostly low-income distress/survival type of diversification at household level. However, there is panel evidence which shows that this survival-led diversification provides a safety net for the rural poor, even when there are shocks, and sometimes offers a means for upward mobility (Bezu and Barrett 2012; Bezu et al 2012).

2.2 Livelihood diversification and its determinants

The determinants of livelihood diversification are mainly capacity factors or a wide range of incentives that are categorized as push or pull factors (Alobo Loison, 2015). Capacity factors include different types of assets (Reardon et al 2006). Whereas push and pull factors are linked to distress/survival-led or accumulation/opportunity-led diversification, respectively (Alobo Loison, 2015).

Push factors (such as seasonality, climatic uncertainty, land constraints, missing or incomplete factor markets, market access problems) - are negative factors that may force households to diversify their livelihood activities. It is viewed as a livelihood strategy of spreading risk to reduce vulnerability to unpredictable shocks and crises such as floods, droughts, illness or seasonal fluctuations of natural resources (Martin and Lorenzen 2016; Scoones 1998). Moreover, push factors tend to dominate in high-risk and low-potential agricultural environments (Haggblade et al., 2007). Due to missing or incomplete factor markets in many parts of rural SSA, household diversification behaviour is viewed mainly in the distress/survival-led perspective in the literature (Alobo Loison 2015; Barrett et al 2001a). According to risk theory, risk aversion tends to decrease in income and wealth (Ellis 1998).

This means that poorer households tend to be more risk averse and hence diversify ex-ante as a coping strategy (Dercon 2002, Barrett et al. 2001a).

On the other hand, pull factors (such as commercialization of agriculture, emergence of improved nonfarm labor market opportunities, better market access, improved infrastructure, proximity to urban areas, improved technology, expansion of education) - are positive factors that attract pro-active households to diversify their livelihood activities in order to improve their standards of living.

2.3 Livelihood diversification and welfare

Regarding the welfare impacts, the literature reviewed (Alobo Loison, 2015) shows that there is generally a positive relationship between nonfarm income and household welfare in rural SSA, based on indicators related to income, wealth, consumption, well-being and nutrition. However, this evidence seems to come mostly from Ethiopia. Moreover, it seems richer households benefit more from livelihood diversification because they are able to exploit the opportunities and synergies between farm and nonfarm activities. The relatively wealthier farmers with sufficient assets can access high-return activities, while the poor tend to be hindered by asset entry barriers. Despite the evidence of a generally positive welfare effect of livelihood diversification on income, wealth, consumption and nutrition; there are spatial and geographical differences - depending on the region or country and its context. Hence there is still need for more panel or longitudinal studies to understand the dynamics of household livelihood diversification in different contexts and across different geographical locations.

2.0 Methodology

2.1 Data and Sources

2.1.2 Quantitative Panel data

The quantitative data is collected from Kenya collected by *Afrint*[1] project. Household level panel data and village level data from Kenya were collected through surveys in 2002 (*Afrint I*), 2008 (*Afrint II*) and 2013 (*Afrint III*). *Afrint II* was aimed at analyzing the drivers of

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[1]*Afrint* is a collaborative project of researchers from Sweden (Lund University and Linköping University), and nine African countries. The objective of the project is to study the performance of smallholders in areas of SSA that have the potential for substantial improvements in production and yields of staple food crops (see Djurfeldt, Aryeetey and Isinika, 2011).

smallholder crop production in the study areas, while *Afrint III* adds components aimed at analyzing gender issues, and aspects of income diversification. The 2008 and 2013 rounds contain detailed data about the farm and nonfarm cash income sources of the sampled households, while this is lacking in the 2002 round. Therefore, in our analysis, we focus on the 2008 and 2013 rounds.

The *Afrint* data were obtained using multi-stage purposive sampling.[2] It was collected to ensure representativeness of the study areas and the farming population in the respective years. The study regions were selected based on the criteria of agro-ecological potential and market access, and were deemed to be above average in these terms, while the most vibrant ones were excluded. The first region is Nyeri district in Central Kenya, which was chosen for its considerable variability in agro-ecological potential and relatively dynamic market access. The second was Kakamega district in Western Kenya, which was selected as an area with a very high population density, but relatively less dynamic in commercial terms. Thereafter, five villages[3] were purposively selected for data collection from each region, also primarily on the basis of differences in agro-ecological potential and market access (Karugia, 2003).

At the village level, enumerators with the help of location chiefs, sub-location assistant chiefs and village elders compiled lists of households in each village which were used as sampling frames. Hence from each of the 10 villages, 30 households were randomly selected from the sampling frame, giving a total of 300 households. In 2008, the attrition rate (number of households who disappeared from the sample population, either by passing away or by emigrating from the area) was 11.3% (Djurfeldt et al. 2011). The problem of attrition in 2008 was dealt with by including in the sample, randomly selected descendant households who were traced in case of partition, and one descendant household sampled to replace the original one. Where village in-migration was sizeable, in-migrant households were sampled to complement the re-interviewed households.

In 2013, a random sample was drawn from compiled lists of households who had settled in the village since 2008. The global 2013 data contains the following categories of households:

[2] A more detailed description of the methodology and questionnaire for Afrint project are given in chapter one of Djurfeldt et al. (2011).
[3] More detailed descriptions of the regions and specific villages, and their characteristics are given in Karugia (2008), Karugia (2003), and Karugia and Wambugu (2009).

(i) *Afrint II* sample re-interviewed (unpartitioned households with the same head as in 2008, the majority) (ii) Descendant households (unpartitioned households with new head or newly sampled offspring households) (iii) Replacement for attrition (in-migrated households sampled from list of in-migrants and out-migrated households). In this study, we focus only on a panel of 250 rural households who were interviewed in both 2008 and 2013.

2.1.3 Qualitative fieldwork

To enrich the analysis for a better understanding of the livelihoods and diversification strategies of the rural households, the quantitative data are supplemented using data from qualitative fieldwork. The fieldwork in Kenya was carried out in January and February 2013 in the districts of Kakamega and Nyeri. Four villages (Ekero and Mukuyu villages in Kakamega district, and Ichuga and Gatagati villages in Nyeri district) were selected for the qualitative fieldwork based on the criteria of differences in agro-ecological potential and market access. The respondents were purposively selected from each study region based on certain criteria in order to obtain a diversity of respondents (e.g. gender, wealth, social status, location, activities, etc). The purpose of the qualitative survey was to obtain additional information beyond the quantitative data to enrich the analysis and to support the interpretation of the results. The data was collected using a variety of qualitative methods to achieve triangulation so as to build in-depth understanding of the research objectives and to increase the validity of results. Data gathering methods included in-depth interviews with rural farm household heads and some of their spouses, key informants (government officials, extension agents, leaders of farmer groups and village chiefs). The purpose of the qualitative survey was not to be representative in the sampling of respondents, but to capture diversity in the types of households and their livelihood activities.

2.2 Analytical Approaches

2.2.2 The components of livelihood diversification

The components of rural livelihood diversification in terms of incomes, activities or assets can be assigned to different categories by sector, function or location (Alobo Loison, 2015). By sector, the "farm" category includes the sale or production or gathering of unprocessed crops or livestock or forest or fish products from natural resources, while the "nonfarm" category includes all other non-agricultural sources. In the classification according to

function, the "off-farm" category typically includes all in the nonfarm category, in addition to wage or exchange labor on other farms.

During the surveys, households were asked to estimate how much money different sources of cash income generated for their household in the course of the past year. Household income sources are disaggregated into 12 categories:

(1) Sale of food staples (includes maize, sorghum and rice),

(2) Sale of other food crops (such as bananas/plantains, cassava, beans, peas, irish potatoes, sweet potatoes, millet, groundnuts, yams, cocoyams, arrow roots, fruits and vegetables), and

(3) Sale of non-food cash crops (such as cotton, sugarcane, nuts, cocoa, tobacco, coffee, tea, sisal, pyrethrum, oil palm, flowers, spices).

 (4) Sale of animals and/or animal produce (value of sales).

(5) Leasing out machinery – income from hiring out mainly farm machinery, including ox-ploughs, push carters, and others.

(6) Work on others' farms (*kibarua*) – wages or salaries received from labor on other farms.

(7) Nonfarm salaried employment – income from waged or salaried nonfarm employment.

(8) Micro-business - refers to any kind of small-scale cash generating business or self-employment carried out on an individual or family basis, such as beer brewing, petty trade and retailing, selling foods and beverages, crafts, etc

(9) Large-scale business – refers to self-employment activities that in terms of scale, investments and returns surpass those of micro-business e.g. various kinds of transportation, construction, manufacturing and trade belong to this category.

(10) Rent, interest - incomes generated by rental revenues from physical assets or securities.

(11) Pensions - incomes received from government/public bodies.

(12) Remittances - incomes received from absent household members, children or relatives living elsewhere.

2.2.3 Measuring livelihood diversification

The share of nonfarm income in total household income (nonfarm income share) is the most commonly used indicator of income diversification (Barrett et al., 2001a). This definition conceptualizes income diversification as an expansion in the importance of nonfarm income. The number of household income sources at a given point in time measures the diversity of income sources, while the difference in the number of household income sources at different

points in time indicates the level of income diversification (Minot et al. 2006). The assumption is that rural households with greater nonfarm income share have higher levels of diversification, and are less vulnerable to various risks and shocks in the rural environment where agriculture is the main source of livelihood (Ersado 2003). However, the main problem with using the nonfarm income share to measure income diversification is that it gives equal risk-mitigation weight to households deriving a given percentage of nonfarm income from one versus three income sources (Ersado 2003).

There are also a wide range of indices that are employed as measures of diversity or diversification (Patil and Taillie, 1982). Following a previous work (Alobo Loison and Bignebat 2016), we focus on the *inverse Herfindahl index* (Baird & Gray, 2014; Ersado, 2006; Patil & Taillie, 1982), which is given by the formula below:

$$Inverse\ Herfindahl\ index \ = \ \frac{1}{Hefindahl\ index} = \frac{1}{\sum_{i=1}^{n} S_i^2}$$

where S_i represents the share of income source i in total income.

This index gives the effective number of household income sources and the contribution of each income source to the total household income. It rises with increasing number of household income sources and its value is maximized for a given number of income sources when all income sources are equally distributed. This measure of diversification is advantageous because it accounts for both the number of household income sources and the contribution (relative importance) of each source to total household income. However, the drawback is that it is unable to reveal the type of diversification pursued by different households that have the same value of the indices or within a single household at different points in time (Zhao & Barry, 2013). Therefore, in this paper, the concept of livelihood diversification is analysed mainly by employing two measures - the Inverse Herfindahl Index and the nonfarm income share. Some renowned authors on this subject have advocated for the use of multiple indicators as cross checks (Barrett et al 2001a).

2.2.4   High-return versus low-return nonfarm diversification

In analyzing livelihood diversification, we distinguish between high-return and low-return rural nonfarm employment, since they are associated with accumulation/opportunity-led and distress/survival-led diversification, respectively (Alobo Loison, 2015). The rural nonfarm employment activities of interest in our panel data include wage or salaried employment, and business activities (micro-business and large-scale). Following Ferreira and Launjouw (2001)

we distinguish between households engaged in high-return versus low-return nonfarm employment activities using a poverty line[4]. We consider high-return nonfarm employment activities as those which earn annual incomes (per adult equivalent) above the poverty line. Whereas, low-return nonfarm income activities are those that earn annual incomes (per adult equivalent) below the poverty line. Rural employment activities that involve higher skill or capital investment yield higher returns but tend to be accessible to fewer individuals or households (Bezu et al 2012). There are substantial entry barriers (skill and capital requirements) that tend to limit access to high-return nonfarm activities (Barrett et al., 2001; Bezu et al., 2012). High-return employment can enable accumulation of income through saving or investment in assets. These employment activities have high entry barriers, and are sometimes protected from competition like many public sector jobs (Start & Johnson, 2004). Some examples of high return activities according to the qualitative fieldwork from rural Kenya include teaching, administration, clergy, staff in NGOs and local government, repair of motor vehicles, medical services, hair dressing, hotels and restaurants. Whereas, low-return employment activities generally have few entry barriers, hence may enable survival or coping with shocks, but households may be unable to make substantial savings or investments from them (Losch et al. 2012). Examples from qualitative fieldwork include petty trade, selling handicrafts, sand mining, brick making, burning charcoal or collecting firewood, unskilled casual labor (Alobo Loison, 2015; Bezu et al 2012).

2.2.5 Diversification and household welfare

Household welfare is commonly measured using monetary dimensions of wellbeing such as consumption and income (Barrett et al 2001a). However, in this paper, an asset-based approach to measuring household welfare is used following other previous studies (Martin and Lorenzen 2016; Dzanku 2015; Dimova and Sen 2010; Filmer and Pritchett 2001). The welfare indicator used is a composite *asset wealth index* constructed from various farm and nonfarm-related, productive and non-productive assets owned by a given household, on which data were collected in both surveys (2008 and 2013). Productive assets owned by the household may be used to generate earned income, while non-productive assets such as household valuables, and provide unearned income. Therefore, assets can capture the long

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[4] We use the World Bank's international poverty line which was $1.25 per day in 2008, using 2005 international prices and adjusted for purchasing power parity (PPP). We also know that since October 2015, it has been updated to $1.90 (using 2011 PPP) to reflect changes in cost of living across the world.

term accumulated welfare of the household, since asset ownership is partially based on economic wealth (Dimova and Sen 2008).

The welfare index is a proxy for the socio-economic position or living standards of a given household and is constructed using the statistical technique of principal component analysis (Filmer and Pritchett 2001). This method has been applied in previous studies examining the relationship between the household diversification and its asset holdings (Dzanku 2015; Dimova and Sen 2008). The first principal component is the linear combination that explains the maximum amount of variation for a set of asset variables and this captures the household's asset wealth (Martin and Lorenzen 2016). This approach provides more accurate weights than the arbitrary approach of weighting multiple assets by summation to obtain a single value of asset holdings (Dimova and Sen 2008). Moreover, with this method we use mainly dummy variables for the assets (yes or no, in terms of ownership), hence we avoid the problems which are frequently encountered in trying to accurately value assets in rural Africa (Barrett et al 2001a). The assets considered to construct the *asset wealth index* are mainly selected based on their importance as wealth indicators in the context of Kenya, based on previous literature and using insights from the qualitative fieldwork. These include: number of livestock units[5], land holdings, type of house, ownership of the following: telephone, television, bicycle, sewing machine, and kerosene stove or other modern stove,

According to other studies (Dimova and Sen 2010), the relationship between diversification and household assets can be used to identify the main motives for diversification. Following this concept, when "survival/distress" is the primary motive for diversification, the expected relationship between diversification and the household's asset wealth index should be negative. This means that poor households will be likely to diversify more than wealthier households, since as wealth increases diversification declines (if households are risk averse). On the other hand, if "accumulation" is the primary motive for diversification, the expected relationship between diversification and the household's asset wealth index should be positive

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[5] In the analysis, livestock units were assigned according to Makeham and Malcolm (1986), based on the energy needs of a 250kg ruminant: Cattle 0.7, sheep and goats 0.1, donkeys 0.5, pigs 0.2, chicken 0.01

Specification of econometric models and the explanatory variables

The relationship between diversification and household welfare is estimated as follows. The reduced form equation is given by:

$$Y_{it} = a + X_{it}\, b + h_i + e_{it}$$

Where:

Y_{it} is the dependent variable - the level of diversification of household i at time t

X_{it} is a vector of exogenous explanatory variables, including the asset wealth index

h_i is the unobserved heterogeneity (unobserved time-invariant household characteristics)

e_{it} is the error term component that is independent over time and across households.

Three models are estimated using three different dependent variables, as indicators of diversification: (a) Inverse Herfindahl Index, (b) nonfarm income share, and (c) high-return nonfarm diversification, dummy (1=households with annual nonfarm employment income above the $1.25 per day poverty line, 0= otherwise). The three models are also estimated for each region as cross-checks.

The explanatory variable of interest is the *asset wealth index*, which is used to capture the household's welfare, in terms of asset holdings. Other explanatory variables which are hypothesized to be important determinants of diversification were mainly selected using insights from the livelihood approach (Ellis 2000a), empirical literature reviewed (Alobo Loison, 2015) and the qualitative fieldwork. The *initial level of diversification* (in the 2008 period) is included as an explanatory variable since other studies (Lemi 2006; Block and Webb 2001) found that the previous year's diversification was an important determinant of the subsequent year's level of diversification. *Household composition* variables in terms of household size, age and gender distribution, including the use of hired labor, are included to capture the different dimensions of human capital. Some studies found that the size and structure of the household is correlated with participation in nonfarm activities (Van den Berg & Kumbi, 2006).

Social capital is proxied by *membership to local farmer group*/organisation dealing with agriculture. While having a *land title* is a natural capital indicator which captures the land tenure and ownership rights (Lay et al 2008). Financial capital is included using the variable for *agricultural input credit* which is important for acquisition of inputs necessary for farming. This will enable households to intensify farming (crops and/or livestock rearing). Hence lack of such credit can also lead to distress diversification, if households are unable to fund their agricultural inputs. Following Andersson Djurfeldt and Hillbom (2016), we include food security variables proxied by the number of *meals eaten during the lean season*[6] to capture the effect of food insecurity on diversification and hence capture risk coping or distress diversification behavior. One of the coping strategies of food-insecure households is reducing the number of meals and diversifying their income sources (Giesbert and Schindler 2012). Moreover, recent studies have found a strong positive relationship between diversification and food security in SSA (Frelat et al 2015). We also include a variable concerning whether a *household borrowed money* to be able to cover their expenditures in the past year to capture the livelihood strategy of poorer households.

Fixed effects (FE) panel data models are selected for the estimation based on our results of the Hausman specification test[7]. The FE model allows correlation between the individual household effects and the explanatory variables (Wooldridge, 2010). The FE model controls for all time-invariant differences between the households, so the estimated coefficients of the FE models cannot be biased because of omitted time-invariant characteristics such as religion, gender, culture, education, among others. For panel data models, the FE estimator makes it possible to minimise omitted variable biases (Cameron and Trivedi, 2010) and to control for unobserved heterogeneity such as household's unobserved attitude towards risk (Dimova and Sen 2010). Hence by using household panel data and FE methods, we control for unobserved household characteristics that do not change over time, which may be correlated with household diversification behaviour.

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[6] The lean season is the season between harvests, with dry spells in many regions of Kenya. Hence in the lean season, the risk of food insecurity increases, with many rural farm households becoming vulnerable to hunger (Andersson Djurfeldt and Hillbom, 2016). Food prices increase, and yet many smallholders tend to depend on the market for their food needs during this period (Andersson Djurfeldt 2012; Oluoch-Kosura and Karugia, 2005).

[7] (Wooldridge, 2010; Cameron & Trivedi 2005).

3.0 Results and Discussion

3.1 Patterns of change in livelihood diversification

Patterns of change in the sources of household cash income

The mean cash incomes, in US dollars per adult equivalent[8], that households earned from different farm and nonfarm sources over the study period (excluding the value of output retained for own consumption) are presented in Table 2. The aggregated results show that there was a significant drop in farm income. This was mainly due to a significant decline in the sale of other food crops. Whereas farm income from the sale of food staples and leasing out of machinery increased significantly. Overall, nonfarm income did not change significantly, despite a significant increase in micro-business activities. Thus, it appears that there was an overall stagnation in the total household incomes over the study period. However, at the regional level, there are significant differences which we will turn to later.

The results showing a significant decline in farm incomes are consistent with what other Afrint researchers (Jirstrom et al 2011), found using the 2002 and 2008 data indicating a crisis in the smallholder sector, characterized by declining farm sizes and low productivity. Moreover, the significant drop in farm incomes over the study period may be linked to increased climatic risks and poor weather conditions such as shifting rainfall patterns and droughts that have faced Kenya during the study period. According to GOK (2012), Kenya suffered intense and widespread drought periods between the 2008 and 2011, in which drought was responsible for economic losses valued at several billions of Kenya shillings in reduced food and cash crops. Moreover, the economic damage and losses suffered was higher in Central Kenya compared to the Western Kenya. In 2012, there were poor rains coupled with frost in the months of March, April and May which affected especially the tea growing areas. Furthermore, the Kenya human development report (2013) indicates that there were also high economic losses in livestock production because of the drought in 2008/2011 which led to depletion of pasture and water, and triggered massive migration of livestock from the affected areas to higher altitude areas such as Mount Kenya and even to national parks. The process of livestock migration led to many livestock deaths due to outbreaks of Foot and Mouth disease and Newcastle disease.

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[8] Following Djurfeldt and Hillbom (2016), household cash incomes are converted into cash incomes per adult equivalent, to account for both household size and age composition. Adult household members (male and female) aged between 16 and 60 years are assigned a value of 1, children less than 15 years were assigned a value of 0.50, while elderly household members of more than 61 years are given a value of 0.75.

Returning to the patterns at regional level- in Nyeri, we find a significant drop in total household incomes of the panel households over the study period, which was due to a significant drop in farm income, mainly due to a significant reduction in the sale of other food crops and animals/animal produce. This negative change in farm income is what influenced the overall pattern. Qualitative results indicate that this may be attributed to difficult market access and climatic conditions. During the rainy season, transport to some of the villages in this region is very difficult because of bad roads. Some roads become impassable and it becomes difficult to take produce to the market. For instance in Gatagati village, it was reported that a lot of vegetables (especially cabbages) were left to rot on the farms because buyers (mainly brokers) could not access the village in 2013.

Table 2. Changes in household cash incomes per adult equivalent

Income source	mean incomes 2008 (US$ per adult equivalent)			mean incomes 2013 (US$) per adult equivalent			change (2013-2008) (US$) per adult equivalent				
	All	Nyeri	Kakamega	All	Nyeri	Kakamega	All		Nyeri		Kakamega	
1. Sale of food staples	13.8	10.7	16.9	66.7	94.9	38.8	52.8	***	84.2	***	22.0	***
2. Sale of other food crops	135.8	249.3	24.2	54.7	80.1	29.7	-81.1	***	-169.1	***	5.5	
3. Sale of non-food cash crops	150.4	229.1	72.9	123.1	142.4	104.2	-27.3		-86.8		31.2	
4. Sale of animals/animal produce	173.8	299.8	49.7	126.1	199.9	53.6	-47.6		-99.9	*	3.8	
5. Leasing out machinery	0.28	0.02	0.53	4.2	2.9	5.5	3.9	**	2.9		4.9	**
6. Work on others' farms	34.9	25.1	44.6	17.9	26.8	9.2	-17.0		1.7		-35.5	
7. Nonfarm salaried employment	108.7	195.5	23.3	119.2	145.3	93.6	10.5		-50.2		70.3	**
8. Micro-business	15.7	30.5	1.1	40.6	42.4	38.9	25.0	**	11.9		37.8	***
9. Large-scale business	12.7	25.6	0.0	0.0	0.0	0.0	-12.7		-25.6		0.0	
10. Rent, interest	3.7	0.003	7.3	14.9	19.2	10.6	11.2		19.2	*	3.2	
11. Pensions	22.2	40.9	3.9	16.7	14.4	18.9	-5.6		-26.5		15.1	
12. Remittances	16.5	18.9	14.1	23.9	22.3	25.4	7.4		3.5		11.3	*
Farm income (1-6)	509.0	814.0	208.9	392.8	547.1	240.9	-116.3	**	-266.9	***	32.0	
Nonfarm income (7-12)	179.4	311.3	49.6	215.2	243.6	187.3	35.8		-67.7		137.7	**
Total household income (1-12)	688.5	1125.3	258.6	608.0	790.7	428.2	-80.5		-334.6	**	169.6	**
Total number of households	250	124	125	250	124	125	500		248		250	

Source: Afrint data 2008-2013. T-tests used to examine changes. ***, **, * represent statistical signficance at 1%, 5% and 10% respectively

Whereas in Kakamega, there was a significant increase in total household income over the study period - driven by a significant increase in nonfarm income. There were similar patterns at the village level for Kakamega, especially in two villages – Ekero and Chegulo (Appendix 1). Hence there was dynamism in the nonfarm sector, driven by a significant increase in nonfarm salaried employment, micro-business and remittances. However, the dynamism in the nonfarm sector in Kakamega was too small to influence the overall pattern of nonfarm income. Both nonfarm incomes and total household incomes in Kakamega were significantly lower than in Nyeri in both periods of the study. Moreover in 2008, the mean total household incomes in Kakamega were below the $1.25 per day international poverty line, but not in 2013. Thus the dynamism in nonfarm income diversification in Kakamega over the study period seems to be related to improvements in household incomes.

Patterns of change in income composition

Generally, based on the changes in the contribution of different income sources to total household incomes, the results from the panel data (Table 3) show that over the study period, there has been some structural changes. The overall farm income share fell significantly by 7.3% (from 82.4% in 2008 to 75.1% in 2013). The share of household income from the sale of food staples increased significantly, indicating increased grain marketing. In addition, share of income from the sale of animals/animal produce and leasing out of machinery increased significantly. Whereas the share of income from the sale of other food crops and work on other farms declined significantly. Moreover income share from sale of non-food cash crops remained stagnant. These patterns are consistent with the findings of A.A. Djurfeldt and G. Djurfeldt (2013) when comparing the 2002 and 2008 Afrint panel of eight countries (including Kenya), and found that commercial diversification either declined significantly or remained unchanged between 2002 and 2008, whereas Kenya was one of the countries which was above average in terms of grain intensification.

At the regional level, the farm income share in Nyeri did not change significantly over the study period. While the farm income share patterns in Kakamega were consistent with the overall pattern. The share of income from sale of other food crops and work on other farms declined significantly. Moreover, these patterns suggest that a number of households, especially those in Kakamega, may have adopted coping strategies due to the significant decline of farm income over the study period. Such coping strategies indicated by the results include – retaining more food crops for home consumption, selling more livestock, and diversifying into low-return micro-business activities. These patterns in Kakamega can be attributed to push factors, such as seasonality, drought, lack of crop diversification and food insecurity in the lean seasons. This interpretation is supported by our qualitative fieldwork and by previous literature from Western Kenya where it is reported that lack of crop diversification is linked to persistent food insecurity (Waswa et al., 2009), while heavy dependency on maize pushes many farm households to depend on the market during the lean seasons (Oluoch-Kosura and Karugia, 2005).

The qualitative interviews revealed that a number of farm households are heavily dependent on sugarcane as the main cash crop, and on mainly maize for food and cash income. Moreover, most of the farmland is locked up in sugarcane production and hence there is low production of other food crops. There are two maize harvesting seasons: the first is between

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July and August, and the second is between November and December. Hence there are periods of maize shortage when prices become very high, and there are periods of high supply after harvest when prices are lower. It was reported that the common pattern in the months between March and June, was a shortage of maize supply in Kakamega – with high maize prices and high risks of food insecurity. During this period, most of the food (mainly maize) consumed in Kakamega comes in from other surplus producing areas such as Trans Nzoia, Uasin Gishu where farmers have larger plots and are engaged in commercial production of maize and wheat.

Table 3. Changes in the contribution of farm and nonfarm activities to total household income

Income sources	mean income shares 2008 (%)			mean income shares 2013 (%)			change (2013-2008)%						
	All	Nyeri	Kakamega	All	Nyeri	Kakamega	All		Nyeri		Kakamega		
1. Sale of food staples	8.3	1.6	16.0	12.7	11.7	13.8	4.4	**	10.0	***	-2.2		
2. Sale of other food crops	23.3	25.1	21.3	13.6	14.3	13.0	-9.7	***	-10.8	***	-8.3	**	
3. Sale of non-food cash crops	24.1	26.0	21.9	20.2	21.3	19.2	-3.9		-4.7		-2.7		
4. Sale of animals/animal produce	16.0	25.5	5.2	20.7	30.0	11.5	4.7	*	4.5		6.3	**	
5. Leasing out machinery	0.0	0.0	0.1	1.1	0.3	1.9	1.1	***	0.3		1.8	**	
6. Work on others' farms	10.6	2.5	19.8	6.8	4.9	8.7	-3.8	*	2.4		-11.2	***	
7. Nonfarm salaried employment	8.8	12.7	4.3	7.2	7.1	7.3	-1.6		-5.6	*	3.0		
8. Micro-business	2.1	3.2	0.9	6.6	5.1	8.0	4.4	***	2.0		7.1	***	
9. Large-scale business	0.3	0.5	0.0	0.0	0.0	0.0	-0.3	*	-0.5	*	0.0		
10. Rent, interest	0.1	0.0	0.2	2.0	2.0	1.9	1.9	***	2.0	***	1.7	*	
11. Pensions	1.0	1.5	0.5	1.1	1.0	1.2	0.1		-0.5		0.7		
12. Remittances	5.3	1.4	9.8	8.0	2.4	13.7	2.7		1.0		3.9		
Farm income share (1-6)	82.4	80.8	84.3	75.1	82.4	67.9	-7.3	**	1.6		-16.4	***	
Nonfarm income share (7-12)	17.6	19.2	15.7	24.9	17.6	32.1	7.3	**	-1.6		16.4	***	

Source: Afrint data 2008-2013. T-tests used to examine changes. ***, **, * represent statistical signficance at 1%, 5% and 10% respectively. Note that a household can have more than one income source.

On the other hand, the overall contribution of nonfarm income to total household income (nonfarm income share) increased significantly by 7.3% (from 17.6% in 2008 to 24.9% in 2013). Overall, micro-business[9] and rents/interest were the most important sources of nonfarm income over the study period. Kakamega region followed a similar pattern - nonfarm income share increased significantly by 16.4%, whereas there was no significant change for Nyeri. Generally, our results do not provide enough evidence to support the 'de-agrarianization' thesis (Bryceson 2002). Our results (with a nonfarm share of only 24.9% in 2013) are much less than the figures indicated by other authors in this field - Haggblade et al. (2010) indicate that nonfarm sources have grown in importance, accounting for up to 35% of rural household incomes in SSA. Moreover, Valbuena et al. (2015) who studied the

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[9] Some common microbusiness activities reported during the qualitative fieldwork include petty trade, transport (boda boda), masonry, tailoring, brick making, sand harvesting, stone quarrying, mechanics, restaurants, etc

trajectories of change in rural livelihoods at household-level between 2003 and 2013 in Western Kenya, found a 30% increase in nonfarm income among their surveyed households.

3.2 Changes in diversification and changes in household welfare

As shown in the previous section, in general, there were dynamic changes in the nonfarm economy over the study period, with significant differences between regions. So what is driving the observed changes in livelihood diversification? To what extent are the changes in livelihood diversification driven by changes in household welfare? Is livelihood diversification driven by distress or accumulation motives? We turn to econometric methods to answer these questions.

Household welfare (proxied by the asset wealth index) is the key explanatory variable of interest. As already described, it is constructed from a set of household assets using principal component analysis (PCA). The results from the first principal component explained 26.8% of the variance. Owning a television had the highest factor weighting, implying that it was the most important in explaining the asset wealth index (Table 4). This implies that all other assets being held equal, a household with a television would be ranked higher in terms of socio-economic status than a household without one (Martin and Lorenzen 2016). This was followed by having a telephone, block/brick house with iron roof and/or cement floor, kerosene stove, sewing machine, bicycle, land holdings and lastly livestock. The farm-related productive assets (land and livestock) turned out to be the least important in explaining asset wealth.

Table 4. Factor loadings from the first principal component of the asset wealth index

Asset variable	Factor loadings	Mean	Std. Dev	Min	Max
Telephone	0.6894	0.724	0.447	0	1
Television	0.7436	0.478	0.500	0	1
Bicycle	0.3411	0.608	0.489	0	1
Sewing machine	0.4134	0.140	0.347	0	1
Kerosene stove or other modern stove	0.5594	0.418	0.494	0	1
Number of livestock units	0.157	0.962	0.191	0	1
Land holdings (hectares)	0.263	1.487	1.512	0.01	14
Block/brick house, iron roof, cement floor	0.6496	0.530	0.500	0	1

Three fixed effects panel data models[10] are estimated using three different indicators of diversification, and compared with similar models by region (Appendix 1). The descriptive characteristics for all the variables in the econometric models are given in Appendix 2. The model results confirm that improvements in household welfare (in terms of asset wealth) is positively and significantly associated with increase in the level of diversification over time, *ceteris paribus* (Table 5). The relationship is positive and significant in all the models even at regional level, except for nonfarm income share in Nyeri. Hence, increase in asset wealth is significantly associated with an increase in all forms of diversification (the number and distribution of income sources, the nonfarm income share and high-return diversification). This indicates that wealthier households diversify their livelihoods to maximize returns on their assets and are likely to diversify more than poorer households. Thus "accumulation" is the primary motive for diversification in this context, and it is richer households with sufficient assets who have access to nonfarm income and high-return nonfarm opportunities. Nonfarm employment activities tend to be hindered by high entry barriers, and hence it is relatively richer households who are in a better position to participate.

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[10] We tested for fixed effects, and compared both fixed and random effects models using the hausman specification test (Wooldridge, 2010). The test results were all significant, hence the choice of fixed effects models. The models failed the test for heteroskedasticity. Hence we use robust standard errors to correct this problem in our estimations (Cameron & Trivedi 2005).

Our result is consistent with previous literature based on longitudinal data, that it is mainly pro-active wealthier households with assets who increase their level of diversification for accumulation (for Ethiopia: Bezu and Barrett 2012; Bezu, Barrett, Holden et al 2012; Block and Webb 2001; Prowse 2015; for Tanzania: Dimova and Sen 2010; for Mali: Abdulai and CroleRees 2001). The models also show that a higher initial level of diversification is positively and significantly associated with the subsequent increases in the level of diversification. At the regional level, the initial level of diversification is positively and significantly associated with the nonfarm income share in both regions. Whereas, in Nyeri, the initial level of diversification is positively and significantly associated with high-return diversification, as well as with the (the number and distribution of income sources. Our result however contradicts the findings of Lemi (2006), and Block and Webb (2001) in Ethiopia, perhaps because the contexts are different.

Table 5. Determinants of changes in livelihood diversification

	Model 1:			Model 2:			Model 3:		
	Inverse Herfindahl index			Nonfarm income share			High-return diversification		
Explanatory variables	*Coef.*	*SE*	*Pvalue*	*Coef.*	*SE*	*Pvalue*	*Coef.*	*SE*	*Pvalue*
Asset wealth index	0.238	0.072	***	0.065	0.023	***	0.074	0.029	***
Initial diversification	0.332	0.080	***	0.670	0.069	***	0.436	0.091	***
No.of active males (16-60 years)	-0.035	0.041		-0.008	0.015		0.042	0.015	***
No.of active females (16-60 years)	-0.091	0.038	**	-0.025	0.012	**	-0.041	0.012	***
No. of young children (< 15 years)	-0.007	0.027		0.009	0.009		-0.002	0.007	
No. of old people (> 61 years)	0.053	0.069		0.004	0.023		-0.019	0.027	
Membership of group (1=yes, 0=no)	0.183	0.124		0.073	0.035	**	0.095	0.045	**
Use of hired labor (1=yes, 0=no)	0.334	0.119	***	0.145	0.041	***	0.096	0.045	**
Agricultural input credit (1=yes, 0=no)	-0.099	0.135		-0.137	0.042	***	-0.169	0.049	***
Land title (1=yes, 0=no)	-0.030	0.137		-0.089	0.038	**	-0.084	0.045	*
Number of meals in lean season	-0.099	0.092		0.020	0.032		0.047	0.032	
Borrow to cover needs (1=yes, 0=no)	-0.212	0.090	**	-0.079	0.032	***	-0.058	0.037	
Constant	1.762	0.290	***	0.173	0.094	**	0.054	0.100	
No. of households	498			475			498		
R	0.25			0.29			0.22		

Note: All models control for household fixed effects. The models are corrected for heteroscedasticity using robust Huber/white standard errors. ***, **, * represent statistical signficance at 1%, 5% and 10% respectively.

The household composition variables such as the number of active males in the household is positive and significant for engagement in high-return diversification, and this is the same result for the Kakamega model. Whereas, the number of females is negative and significant for all the models. We get the same result for engagement in high-return diversification in both regions. This shows that most females are mostly engaged in low-return nonfarm activities as opposed to high-return ones. Furthermore, for Kakamega, the number of females

in the household is also negatively and significantly associated with the number and distribution of income sources. These results contradict those of Andersson Djurfeldt, Djurfeldt, & Bergman Lodin, (2013) using the global *Afrint* data. Moreover, their study finds a negative gender gap in terms of income for Kenya, although it was not significant. Our results however contradict those of Lay et al 2008 for Kakamega who found that females had higher levels of diversification compared to males.

The gender differences in diversification in our study are probably because generally men in Kenya have better access to productive resources, in terms of skills or capital, that are necessary for diversification. But for Kakamega, cultural factors tend to limit women's ownership or control over productive resources like land. During the qualitative fieldwork in Western Kenya it was reported that many farm laborers tend to be women because they do not own land for farming. The women can mainly access farmland through their husbands or family. However, some better-off women with access to wage or self-employment opportunities are able to privately rent land for farming. On the other hand, households with more young children and old people in Kakamega are more likely to increase their level of diversification, suggesting a distress diversification.

The use of hired labor was a positive and significant driver of livelihood diversification, as shown by all three models. This result was consistent at the regional level – households who employed hired labor significantly increased the number and distribution of their income sources. While in Kakamega, the increased use of hired labor is a significant determinant of changes in nonfarm income share. This result is also depicted by the stories in Boxes 1 and 2.

The results show that over the study period, livelihood diversification in some regions was also driven by distress motives, characterised by survival strategies such as borrowing to cover subsistence needs. In Kakamega, poorer households who borrowed to meet their subsistence needs had significantly less diversified income sources and could not access high-return nonfarm diversification opportunities. The results corroborate other author's (Andersson Djurfeldt, 2012), who find that in Western Kenya, nonfarm income sources are important for coping with seasonality and food insecurity. The poorer and richer households coped with seasonality in agricultural production differently. While the poor with few nonfarm income sources were forced to reduce their consumption burdens during the dry season, the rich on the other hand could profit from seasonality using trade-based or barter exchanges for agricultural produce.

Our results further indicate that having a land title has a significant negative effect on pursuing both nonfarm income sources and high-return nonfarm employment. A similar result was obtained at the regional level for Nyeri - having a land title was negatively and significantly associated with increasing nonfarm income share. This corroborates what was concluded by Lay et al 2008, that more secure land rights seem to provide an incentive for people to engage more heavily in farming, rather than to diversify into nonfarm employment. Their study in Western Kenya found that not having a land title deed was a significant determinant of low-return nonfarm employment when compared to agricultural employment.

Membership to farmer groups was important in increasing nonfarm income share and high-return diversification. Membership to farmer groups was positive and significant for increasing the number of income sources for both regions. It was also important for increasing nonfarm income share in Kakamega. Joining groups are important for smoothing income and consumption by saving in the face of positive shocks to income, and dis-saving (or borrowing) in the face of negative shocks to income (Dimova and Sen 2010). Our qualitative fieldwork interviews from Kenya revealed that a number of households were involved in high income farm and/or nonfarm activities mostly through joining farmer groups[11] which accessed capital and start-up skills from government, donors, NGOs or banking institutions (this is also illustrated in Box 1). Some households were able to access land, capital and inputs for farming through such farmer groups, which were involved in livestock production, horticulture and other high value farm and nonfarm enterprises (such as production of ornamental Arabica flowers in Icuga village in Nyeri; silkworm and mulberry farming in Gatagati village in Nyeri; building energy stoves in Ekero village in Kakamega).

Change in agricultural input credit was negatively and significantly associated with changes in nonfarm income share and high-return diversification. At the regional level, the results were similar, indicating that increased agricultural input credit promotes the intensification of farming, especially in the high potential area (Nyeri). The *Afrint* authors have already indicated that, although farm sizes are declining rapidly (Andersson Djurfeldt & Jirström, 2013), intensification of production especially of grains has been happening already in Kenya and this is linked to increased input use (Djurfeldt et al., 2005; Djurfeldt et al., 2011). However, according to (Mathenge et al., 2015), there is no organised credit system for maize

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[11] Some of the groups reported in the fieldwork interviews were SACCOs (Savings and Credit Associations), ROSCAs (Rotating Savings and Credit Associations), table banking groups, which mobilize savings and give credit to members.

(which is the major crop produced in Kenya), hence some rural households may be driven to seek off-farm income sources to finance farm inputs.

4.0 Conclusions

Generally, the livelihoods of rural households in the regions of Western and Central Kenya that have been examined in this study are highly diverse, with the households engaged in a wide range of farm and nonfarm income activities, as well as obtaining non-labor incomes (remittances, pensions and rent/interest). There was a mix of dynamism and stagnation, in terms of livelihood diversification, with significant differences between regions and across groups of households. There were structural changes characterised by a significant drop in farm income share, while the nonfarm income share in household incomes increased significantly over the study period. This was especially the case in the region with poor agro-ecology and market access (Kakamega).

Furthermore, the dynamics and motivations for livelihood diversification, as well as its association with rural household welfare, are investigated through the theories of survival/distress/push-driven motives (risk minimisation and coping strategies) and accumulation motives (leading to progressive wealth). The overall finding from the econometric work is that when we control for household fixed effects and other determinants of diversification identified in previous literature, there is a positive and significant relationship between changes in household welfare in terms of asset wealth and changes in livelihood diversification. Over the study period, households who increased their asset wealth in both regions, were more likely to increase diversification into both farm and nonfarm income sources, as well as high-return nonfarm opportunities. Thus relatively wealthier pro-active households with greater assets employ livelihood diversification as an accumulation strategy. Moreover, poor households had less diversified income sources and could not access high return nonfarm diversification opportunities. While some of them adopted survival strategies in the face of declining farm incomes, which included borrowing to cover their subsistence needs, especially in Kakamega.

Other important determinants of positive changes in livelihood diversification include initial level of diversification, household composition in terms of age, gender and structure, membership to farmer groups and the use of hired labor. On the other hand, increased access to farm-related assets such as input credit and more secure land rights, promoted specialisation in farming rather than diversification.

The results may have important implications for development policy in rural Kenya – highlighting the importance of recognising and harnessing the positive aspects of rural household livelihood diversification for poverty reduction. While at the same time mitigating the negative aspects through policy initiatives that focus on increasing access to assets and reducing entry barriers for the poor into more remunerative farm and nonfarm activities.

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Appendix 1. Determinants of changes in diversification by region

Explanatory variables	Inverse Herfindahl Index						Nonfarm income share						High-return diversification					
	Kakamega			Nyeri			Kakamega			Nyeri			Kakamega			Nyeri		
	Coef.	SE	Pvalue	Coef.	SE	Pvalue	Coef.	SE	Pvalue	Coef.	SE	Pvalue	Coef.	SE	Pvalue	Coef.	SE	Pvalue
Asset wealth index	0.202	0.117	*	0.218	0.095	**	0.092	0.045	**	0.039	0.025		0.081	0.043	*	0.071	0.038	*
Initial diversification	0.111	0.187		0.406	0.089	***	0.782	0.133	***	0.663	0.077	***	0.092	0.096		0.731	0.117	***
No.of active males (16-60 years)	0.021	0.052		-0.096	0.073		-0.005	0.023		-0.014	0.016		0.046	0.016	***	0.032	0.027	
No.of active females (16-60 years)	-0.116	0.046	***	-0.023	0.057		-0.025	0.018		-0.022	0.017		-0.030	0.012	***	-0.048	0.019	***
No. of young children (< 15 years)	0.014	0.041		-0.049	0.043		0.023	0.013	*	0.001	0.010		-0.001	0.007		-0.005	0.015	
No. of old people (> 61 years)	0.177	0.103	*	0.004	0.101		0.031	0.052		0.001	0.023		0.036	0.038		-0.058	0.034	*
Membership of group (1=yes, 0=no)	0.299	0.190		0.027	0.166		0.135	0.077	*	0.050	0.038		0.149	0.070	**	0.050	0.062	
Use of hired labor (1=yes, 0=no)	0.282	0.150	*	0.453	0.189	**	0.250	0.064	***	0.053	0.044		0.078	0.046	*	0.111	0.078	
Agricultural input credit (1=yes, 0=no)	-0.211	0.290		-0.107	0.157		-0.263	0.092	***	-0.096	0.043	**	-0.330	0.090	***	-0.108	0.055	**
Land title (1=yes, 0=no)	0.041	0.163		-0.096	0.216		-0.043	0.057		-0.140	0.053	***	-0.055	0.039		-0.140	0.085	
Number of meals in lean season (1=yes, 0=n)	-0.177	0.111		0.080	0.158		0.019	0.042		0.011	0.043		0.051	0.040		0.013	0.051	
Borrow to cover needs (1=yes, 0=no)	-0.323	0.125	***	0.006	0.138		-0.116	0.051	**	-0.008	0.039		-0.047	0.031		0.022	0.068	
Constant	2.059	0.379	***	1.164	0.453	***	0.137	0.162		0.221	0.137		-0.018	0.113		0.192	0.174	
No. of households	251			247			229			246			251			247		
R	0.18			0.21			0.28			0.50			0.12			0.35		

Note: All models control for household fixed effects. The models are corrected for heteroscedasticity using robust Huber/white standard errors. ***, **, * represent statistical signficance at 1%, 5% and 10% respectively.

Appendix 2. Descriptive Statistics for variables in the econometric models

Explanatory variables	Mean	Std. Dev	Min	Max
Inverse Herfindahl Index	1.832	0.819	1	5
Nonfarm income share	0.214	0.318	0	1
High return diversification	0.148	0.355	0	1
Asset wealth index	-8.82e 10	1.000	-2	2
No.of active males (16-60 years)	1.946	1.387	0	7
No.of active females (16-60 years)	2.074	1.506	0	10
No. of young children (< 15 years)	2.132	2.013	0	13
No. of old people (> 61 years)	0.624	0.815	0	6
Membership of farmer group (1=yes, 0=no)	1.396	0.490	0	1
Use of hired labor (1=yes, 0=no)	1.626	0.484	0	1
Agricultural input credit (1=yes, 0=no)	1.274	0.446	0	1
Land title (1=yes, 0=no)	1.778	0.416	0	1
Number of meals in lean season	2.574	0.588	1	3
Borrow to cover needs (1=yes, 0=no)	2.476	0.500	0	1