



HAL
open science

Patterns and determinants of household income diversification in rural Senegal and Kenya

Sarah Alobo, Celine Bignebat

► **To cite this version:**

Sarah Alobo, Celine Bignebat. Patterns and determinants of household income diversification in rural Senegal and Kenya. *Journal of Poverty Alleviation and International Development*, 2017, 8 (1), pp.93-126. hal-01608295

HAL Id: hal-01608295

<https://hal.science/hal-01608295v1>

Submitted on 25 May 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

Patterns and Determinants of Household Income Diversification in Rural Senegal and Kenya*

Sarah ALOBO LOISON & Céline BIGNEBAT**

Abstract: Income diversification is considered one of the important household strategies for securing rural livelihoods. We investigate its patterns and determinants using data on 1,747 farm households collected in 2007-2008 from six regions in rural Senegal and

* This is an open-access article distributed under the terms of the Creative Commons license Attribution-Noncommercial-NoDerivs 3.0 Unported. Distribution and reproduction are permitted, provided that the original authors and JPAID as the source are credited. Acknowledgement: This work is funded through a collaborative effort by the Centre de Co-opération Internationale en Recherche Agronomique et Développement (CIRAD), UMR MOISA, France and Department of Human Geography (AFRINT Project), Lund University, Sweden. The qualitative fieldwork was supported and facilitated by different partners: Initiative Prospective Agricole et Rurale (IPAR) in Senegal (We are especially grateful to Ibrahima Hathie, Cheikh Oumar Ba and Madické Niang), and AFRINT Project in Kenya (Special thanks to Willis Oluoch-Kosura, Department of Agricultural Economics, University of Nairobi and Stephen K. Wambugu, Department of Agribusiness/Geography, Chuka University, Chuka, Kenya). We are very grateful for the critical comments and improvements on different versions of this article by Magnus Jirstrom, Agnes Andersson Djurfeldt, Göran Djurfeldt and Mikael Hammarskjöld of Department of Human Geography, Lund University, Sweden. We also acknowledge the enriching contributions from Pierre-Marie Bosc, Bruno Losch, Michel Benoit-Cattin, Jean-Michel Sourriseau, Jean-François Bélières, and Sandrine Dury of CIRAD/Montpellier. The authors are also grateful to the JPAID reviewers for their insightful comments that improved this article. Different versions of this article were presented at “The 6èmes Journées recherches en sciences sociales” – INRA/SFER/CIRAD/Toulouse School of Economics, France in December 13-14, 2012; The “5th European Association of Agricultural Economics (EAAE) Ph.D. Workshop,” Leuven, Belgium in May 29-31, 2013 and at “The Development Research Day,” School of Economics and Management, Lund University in October 23, 2014. The views expressed and any errors are those of the authors.

** Sarah Aloblo Loison (corresponding author) is a Ph.D. candidate (co-tutelle) in *Social & Economic Geography* at the Department of Human Geography, Lund University; Geocentrum 1, Solvegatan 10, SE-223 62 Lund, Sweden and, in *Economics* at Montpellier SupAgro/Ecole Doctorale Economie et Gestion de Montpellier (EDEG) in conjunction with UMR MOISA, CIRAD, 73 Rue Jean François Breton, 34398 Montpellier cedex 5, France. Email: sarah.alobo@keg.lu.se; sarah.alobo@cirad.fr;

Céline Bignebat is a researcher based at the National Institute for Agricultural Research, INRA UMR MOISA & DIAL, Paris, France. Email: Celine.Bignebat@inra.fr

Kenya. The empirical investigation shows that the regional variation in income diversification does not follow any clear patterns, with push and pull determinants acting concurrently within and between regions. Therefore, policies on income diversification need to be tailored to meet the development needs of specific regions. More generally, income diversification is significantly associated with household asset endowments, demographic factors, accessibility to rural towns, migration opportunities, and perceptions on food security.

Keywords: Rural livelihoods, Income diversification, Push and pull determinants, Senegal, Kenya

Rural households in Sub-Saharan Africa (SSA) generally construct their livelihoods from multiple income sources, contrasting the traditional image that they are mainly peasants who obtain their income only from farming. Income diversification is a strategy whereby households allocate their productive assets among different income generating activities (Abdulai & CroleRees 2001). Households may diversify their farm activities by growing different crops, rearing different kinds of livestock, working on other farms or engaging in natural resource related activities (Losch, Freguin-Gresh, & White 2012). They may also diversify into nonfarm activities by engaging in waged labor, self-employment or labor migration (Haggblade, Hazell, & Reardon 2007). Some households may even straddle between farm and nonfarm activities over time depending on the opportunities and constraints they face (Djurfeldt & Djurfeldt 2013). Income diversification may be a deliberate household strategy to secure survival, minimize risk, finance farm inputs, reduce income variability, or simply an involuntary response to cope with crises or shocks (Ellis, 2000b; Reardon, Berdegúe, Barrett & Stamoulis 2006). Diversification is becoming an increasingly important livelihood strategy among rural households in SSA (Barrett, Reardon, & Webb 2001; Haggblade et al.

2007; World Bank 2007). Empirical studies from SSA show that diversification has positive impacts on household incomes, wealth, consumption and nutrition (Barrett, Reardon, et al. 2001). Therefore, household diversification is of interest to policy makers because of its potential to contribute to poverty reduction and economic growth.

There is a wide empirical literature on rural livelihood diversification in SSA as reviewed in Aloba Loison (2015). However, most of the literature is based on cross-sectional data, and only a few studies use longitudinal or panel data to study the dynamics. Moreover, the cross-sectional patterns and determinants are mixed, depending on the specific geographical region, country, or rural context. In the absence of longitudinal or panel data, some studies have simultaneously analyzed different rural contexts based on cross-sectional data, and this provided a powerful tool to identify key determinants, patterns, similarities and differences between situations, in terms of household diversification (Barrett, Bezuneh, & Aboud 2001; Dercon & Krishnan 1996; Losch et al. 2012).

This paper analyses household income diversification in six regions of rural Senegal and Kenya. Specifically, what are the geographical patterns and determinants of income diversification among rural farm households? How do the patterns and determinants differ between dynamic and less dynamic agricultural regions? Senegal and Kenya are selected for the study as examples of growth in SSA economies, with the selected regions reflecting the diversity of rural situations, and at the same time capturing different patterns and levels of regional development (Losch et al. 2012). Access to such household level data from rural SSA is very rare. Hence, it is interesting use this type of data to study the regional variations in access to high income diversification opportunities in different parts of SSA. We are aware of the big differences between Senegal and Kenya; however, the regional dynamics captured by the data offer interesting perspectives to enhance our understanding of the different contexts in which diversification takes place. Nevertheless, there is need for better methodological approaches

to improve the understanding of what factors can be of a more general character in determining income diversification, and how they interplay with local/regional contexts. Our econometric results derived by using the household model approach indicate that the regional variation in income diversification does not seem to follow any clear patterns, with push and pull determinants acting concurrently within and between regions. The results illustrate the limitations of using household models in investigating the determinants of economic behavior such as income diversification in rural Africa, since the determinants of decisions made within the household context vary according to an individual's place in the family structure. Therefore, the household model which focusses on the household head, inevitably leaves out other possible determinants and motivations for diversification such as the structural, social or cultural constraints on other adult members in the household who are not household heads.

The rest of the paper is organized as follows: the next section explains the conceptual and analytical framework. This is followed by a detailed methodological section. Thereafter, the results are presented and discussed, and conclusions given in the final section.

Conceptual and analytical framework

Income diversification generally refers to income strategies of rural households involving an increase in their number of economic activities, regardless of the sector or location (Start 2001). The income strategies may involve diversification of farm activities only, combining both farm and nonfarm activities, or completely diversifying out of farming. Rural households generally diversify their activities based on their capacity, as determined by access to different types of assets (Reardon et al. 2006). The incentives for diversification are categorized into "push" and "pull" determinants (Barrett, Reardon et al. 2001; Haggblade et al. 2007). The push-pull theory of diversification is based on principles of neoclassical economics of utility maximization, rational choice, factor-price

differentials between regions and countries, and labor mobility (Singh, Squire, & Strauss 1986; Taylor & Adelman 2003). Given an asset base, the farm household makes choices by comparing between the returns from farm labor time and time spent on nonfarm income generating activities (Singh et al. 1986). The assumption is that increases in nonfarm incomes provide incentives for farm households to diversify their income sources (Reardon et al. 2006).

Push determinants are negative factors that may force farm households to seek additional livelihood activities within and/or outside farming. They include factors such as risk, seasonality, land constraints driven by population pressure and fragmented land holdings, missing or incomplete factor markets (land, capital, labor), and market access problems due to poor infrastructure and high transaction costs, asset strategies and coping behavior (Barrett, Reardon et al. 2001; Ellis 2000b). Such factors tend to dominate in high-risk and low-potential agricultural environments, subject to drought, flooding and environmental degradation (Haggblade, Hazell & Reardon 2010). They are associated with survival-led type of diversification, whereby poorer rural farm households are pushed to engage in low-return nonfarm activities to ensure survival, to reduce vulnerability or to avoid falling deeper into poverty (Haggblade et al. 2007).

On the other hand, pull determinants are positive factors which provide incentives for people to expand their livelihood activities within and/or outside farming. Examples include commercialization of agriculture, improved infrastructure, proximity to an urban area, improvements in market access, growth of rural towns, development of labor markets, improvements in education and technology (Barrett, Reardon et al. 2001; Haggblade et al. 2007; Losch et al. 2012). Such pull factors tend to dominate in less risky, more dynamic agricultural environments (Haggblade et al. 2010). They are associated with opportunity-led type of diversification which occurs when wealthier rural households engage in high-return nonfarm activities, with accumulation objectives, in order to increase their incomes and

maximize returns from their assets (Haggblade et al. 2007). Moreover, securing better living standards through diversification is a cumulative process that requires the ability to generate cash, invest in assets and diversify across activities (Ellis & Freeman 2004).

Following the push-pull theory, we hypothesize that the observed levels of income diversification among farm households in a given region are mainly associated with push or pull factors. We expect farm households in relatively stagnant agricultural regions where push factors are more prevalent (such as poor market access, difficult farming conditions and lack of nonfarm opportunities) (Haggblade et al. 2007, 2010), to engage in low income diversification activities as a means of survival. In contrast, in relatively dynamic agricultural regions, pull factors are more prevalent (such as better infrastructure and market access, productive agriculture, more nonfarm opportunities), therefore households have opportunities to engage in attractive high income diversification activities (Haggblade et al. 2007; 2010).

Diversification is commonly measured using income because of its clear interpretation as a welfare outcome (Barrett & Reardon 2000). Income diversification is analyzed by examining the composition of household incomes in terms of different income generating activities (Abdulai & CroleRees 2001). It is also analyzed using the vector of income shares associated with different income sources (Davis et al. 2010; Escobal 2001; Lay, Mahmoud & M'Mukaria 2008), most especially nonfarm income (Barrett, Reardon et al. 2001; Barrett & Reardon 2000; Ellis 2000a, 2000b; Escobal 2001; Lay et al. 2008; Reardon et al. 2006). The share of household income from nonfarm activities is used to highlight the importance of nonfarm income in a household's livelihood. There are also alternative measures of diversification based on a wide range of indices as measures of diversity (Patil & Taillie 1982). The most common in finance, economics, and social science literature is the Herfindahl-Hirshman index, which is equal to the sum of squared shares across each possible income source (Anderson & Deshingkar 2005; Barrett & Reardon 2000; Bradshaw,

Dolan & Smit 2004; Zhao & Barry 2013). The Herfindahl index is useful for disaggregating diversification data because it is sensitive to the range of income sources available and hence provides a multidimensional perspective on diversification behavior (Barrett & Reardon 2000). The index estimates the increasing mix of activities used to generate household income, taking into account the number and distribution of income sources (Zhao & Barry 2013).

In this paper, to measure income diversification, we use the nonfarm income share in total household income, together with a transformation of the Herfindahl index referred to as the Inverse Herfindahl Index (IHI). The IHI has the advantage of estimating both the number of household income sources and the contribution of each income source to total household income (Aihonsu, Olubanjo & Shittu 2011; Ersado 2006; Patil & Taillie 1982; Zhao & Barry 2013). The IHI ranges from one (where a household is highly specialized with complete dependence on a single income source) to the maximum possible diversity of income sources (highly diversified). It rises with increasing number of income sources and its value is maximized for a given number of income sources when all income sources are equally distributed. The index measures income diversification as an increasing mix of income sources away from complete dependence on a single source (own crop farming). The index is given by the formula below:

$$IHI = \frac{1}{\text{Herfindahl index}} = \frac{1}{\sum_{i=1}^n S_i^2}$$

where S_i represents the share of income source i in total income, while n is the total number of income sources. We disaggregate household income into 10 categories: (1) crops, (2) livestock, (3) HFG (hunting, fishing and gathering), (4) onfarm processing, (5) farm wage, (6) nonfarm wage, (7) nonfarm self-employment, (8) remittances, (9) transfers and (10) rents. These components of household income may be further classified into the farm or nonfarm categories (Barrett, Reardon et al. 2001). Farm income is obtained from the production or gathering of

unprocessed crops or livestock or forest or fish products from natural resources (categories 1 through 5). Nonfarm income is derived from all non-agricultural sources (categories 6 through 10). Nonfarm wage refers to wages or salaries obtained in exchange for labor services to an employer. While nonfarm self-employment refers to income earned through activities operated directly by the owner. We classify onfarm processing as farm income because, in our data, it mainly consists of small-scale transformation of raw products to add value to farm outputs, mainly groundnuts into oil. The category remittances are incomes received from household members, relatives or friends living elsewhere, while transfers are incomes received from other households (donations), or from public (pensions) or non-governmental bodies (subsidies or social grants). Rents are incomes generated by rental revenues from physical assets or securities.

Data and Sources

Quantitative survey

The data for this study come from a cross-sectional survey of rural households collected between November 2007 and May 2008 by the RuralStruc program (2007-2010), which was a joint initiative of the World Bank, the French Cooperation (French Development Agency, Ministry of Agriculture and Fisheries, Ministry of Foreign and European Affairs, Agricultural Research Centre for International Development (CIRAD), and the International Fund for Agricultural Development (Losch et al. 2012). It was aimed at understanding the dynamics and the processes of rural change in countries at different stages of structural transformation. The data was collected from rural households in different types of regions in seven countries, including Senegal and Kenya, using a common methodology (Losch et al. 2012).

The regions were purposively selected based on criteria related to

market access (infrastructures and proximity to cities), the presence of integrated value chains, the level of public investments and public goods, and the situation regarding natural resources. Three types of regions were a priori identified: (i) *winning regions* (WR) are relatively more dynamic agricultural regions where the on-going dynamics of integration to markets (whether related to specific value chains, the proximity of urban centers or good infrastructure) provide market-related opportunities and are strong drivers of change; (ii) *losing regions* (LR) are relatively more stagnant agricultural regions that are characterized by trends toward marginalization due to local constraints (low factors endowment, lack of public goods, poor connection to markets); (iii) *intermediary regions* (IR) are agricultural regions where the trends appear to be more imprecise (Losch et al., 2012). The final sample of surveyed rural households was stratified at the country level according to the regional categories. Within each type of region (WR, IR and LR), specific villages were purposively selected based on regional characteristics (Losch et al., 2012). Thereafter the surveyed households were randomly selected from census lists to allow representativeness at the local level. The total sample from Senegal and Kenya consists of 1,747 rural households, after excluding 23 non-farming households.

In Senegal, the WR is located in the *Senegal River Delta* in the North. The region has a semi-arid climate (200 to 400 mm of rain), alluvial humid and clay soils in depressions which favor irrigated rice production, and sandy soils in rain-fed areas. The region has a good level of market integration, with proximity to the major cities of St. Louis and Dakar. Major agricultural activities include production of rice, sugarcane, horticulture (mainly industrial tomato and onion), livestock (cattle, sheep, goats) and fisheries. Family farms coexist with large commercial farms or agribusinesses involved in tomato processing, sugarcane and horticulture. Several agribusinesses are integrating local producers mainly into contract production of tomato and sugarcane. Many nonfarm job opportunities are found in trade, services and agro-industries due to good accessibility to major cities and other smaller

rural towns. The IR is located in the central *groundnut basin* (Mékhe and Nioro). Mékhe has very good accessibility to the cities of St Louis, Thiès, and Dakar, while Nioro has good to medium accessibility to the city of Kaolack and the Gambia border (Losch et al. 2012). The groundnut basin has areas with semi-arid and North-Sudanian climate, with rainfall ranging between 300-900 mm, concentrated from June to September. The region is the major area of production of groundnuts, which is one of Senegal's main exports (Maertens 2009). It is densely populated, the majority of family farms are semi-subsistence, with limited irrigation possibilities (Ba, Diagana, Dièye, Hathie & Niang 2009). The main agricultural activities include crop production (cassava, cowpeas, millet, sorghum, rice and maize), livestock and fishing. Nonfarm job opportunities consist of mainly low-return self-employment activities. The LR is *Casamance*, which is located in the South (bordering Gambia). The region has difficult connection to the rest of the country because of poor infrastructure. It has Sudano-Guinean climate, receiving about 1000 mm of rain, with clay to sandy or silty tropical soils, offering a high potential for agriculture. Farming is mostly rain fed and households mainly produce staples (maize, sorghum, millet), as well as rice, cotton, groundnut, cattle and fish. Nonfarm job opportunities are very limited.

In Kenya, the WR is *Nakuru North*, which is located along the main transportation corridor between Mombasa and Kampala (Uganda). There is good access to Nakuru town, which is the fourth largest town in Kenya. The region has a high potential for agriculture and livestock, with annual rainfall between 950 and 1500 mm. Households cultivate a large variety of crops including wheat, maize, millet, beans, pyrethrum, tea, coffee, potatoes and vegetables. Cattle ranching, poultry farming and bee-keeping are also well developed. There are several agribusinesses integrating local producers on contract for tea and coffee production. Several nonfarm opportunities especially businesses and industries exist in nearby towns, and tourism is very active in the region. The IR is *Bungoma*, which is among the fastest growing densely populated regions in western Kenya. The region has a poor road network which is largely

impassable during the rainy season. However, the region has good soils and well distributed rainfall, making it agriculturally productive. Households mainly produce staples (maize, beans, potatoes, sorghum) for subsistence, and sugarcane, tobacco, cotton and coffee as cash crops, in addition to livestock. Some agro-industries are providing employment opportunities in paper milling and other small-scale manufacturing. The LR is *Nyando*, which is located on the large plains of Awach and Nyando rivers, and faces perennial flooding and erosion. It has series of hills and scarps to the South, and the fertile Kano Plains going down to Lake Victoria in the Northwest. Households produce staples (maize, groundnuts, beans, sorghum, cassava, sweet potatoes) mainly for subsistence. The main cash crop is sugarcane, produced by individual households and estates. Dairy farming and coffee production are suitable in the higher altitudes. Sugarcane mills and cotton ginneries in some areas have closed down. Nonfarm job opportunities are very limited.

Qualitative fieldwork

Given the limitations of our quantitative data which were collected to facilitate analysis using a household model, the first author collected qualitative data from rural Senegal and Kenya during fieldwork periods between November 2012 and October 2013. This was used to enrich the quantitative analysis in order to give a deeper qualitative understanding of the rural contexts and the patterns of household diversification.

The regions, villages and respondents for the qualitative work were all purposively selected, with characteristics similar to those of the quantitative data, but without the aim of being statistically representative. The regions and villages were selected based on differences in agro-ecological potential and market access. While respondents were selected based on certain criteria (such as location, gender, wealth) to ensure variety and to obtain detailed information. The qualitative data were collected using in-depth interviews with 150 household heads and key informants (government officials, extension

agents, leaders of farmer groups and village chiefs), complemented with personal observation.

For Kenya, qualitative data was collected in January and February 2013 from the central (Nyeri district) and western (Kakamega district) part of the country. A total of four villages were chosen (Ichuga and Gatagati villages from Nyeri district; Ekeru and Mukuyu villages from Kakamega district). For Senegal, fieldwork was carried out in the groundnut basin (Mekhe and Fass Diaksao villages in Mekhe region) between November and December 2012, and in the Delta region (Mboundoum and Bokhol villages in the upper and lower Senegal Delta, respectively) between September and October 2013. The qualitative data collected was analyzed using content analysis, synthesis and interpretation, in order to complement and explain the quantitative results.

Results and Discussion

Regional patterns of household income diversification

Household income patterns

The annual total household incomes (in \$PPP¹ per capita) from different farm and nonfarm activities of rural households in the study are shown in Table 1. The income patterns show that households in the WR in both countries obtain significantly higher total incomes compared to those in the IR and LR. They have significantly higher incomes from both farm and nonfarm sources. Only households in the WR of both

¹ PPP (purchasing power parity) exchange rates allow for comparison of relative price levels across countries. We convert household incomes per capita aggregated at the regional level from local currency units into \$PPPs (international dollars) for the year 2007, which is the year of reference of the RuralStruc survey. We use conversion rates of 1 Senegal CFA Franc = \$258.6 PPP and 1 Kenya Shilling = \$34 PPP, following Losch et al. (2012).

countries have incomes above the relative poverty line (\$2 per day per capita). In contrast, total household incomes in the LR and IR of Senegal fall significantly below the absolute poverty line² (\$1.25 per day per

Table 1.

Composition of Household Incomes (Per Capita \$PPP)

Income source	Senegal			Kenya		
	LR	IR	WR	LR	IR	WR
1. Crops	163.4 (235)	160.2 (428)	306.5 (163)	208.2 (272)	213.7 (288)	365.5 (268)
2. Livestock	89.7 (116)	22.1 (202)	84.2 (43)	29.5 (112)	57.1 (168)	328 (235)
3. HFG	5 (14)	2.8 (21)	7.6 (6)	19.5 (24)	3.8 (17)	0 (0)
4. Onfarm processing	0 (0)	2.8 (17)	0.2 (1)	0 (0)	0 (0)	0 (0)
5. Farm wage	0.3 (1)	2.9 (8)	9.9 (9)	25.4 (49)	11.7 (24)	18.1 (28)
6. Nonfarm wage	10.6 (5)	31.8 (74)	93.5 (37)	183.3 (160)	143.3 (101)	306.1 (98)
7. Self-employment	69.5 (128)	183.5 (393)	261.8 (128)	115.4 (77)	101.2 (114)	929.5 (219)
8. Public transfers	0 (0)	0 (0)	0 (0)	0.1 (2)	0.2 (2)	0.9 (3)
9. Remittances	20 (55)	38.1 (167)	17.5 (30)	3 (70)	2.2 (44)	11.6 (95)
10. Rents	2 (33)	1.1 (35)	50 (39)	12.4 (144)	6.6 (76)	25.3 (122)
Farm income (1-5)	258.4 (238)	190.8 (449)	408.4 (171)	282.6 (276)	286.3 (295)	711.6 (284)
Nonfarm income (6-10)	102.1 (171)	254.5 (422)	422.8 (153)	314.2 (260)	253.5 (205)	1,273.4 (273)
Total income (1-10)*	360.5b	445.3b	831.2a	596.8b	539.8b	1,985.0a
N (households)	239	461	176	283	299	289

Notes: Figures in parentheses are the number of households receiving income from a given source. *a, b show the differences in means for total income between regions in each country, using Tukey-Kramer pairwise comparison tests at 1% level of significance. Similar letters indicate no significant difference between regions.

² \$1.25 per day was the international poverty line in 2005, but has been raised to \$1.90 in 2015 (World Bank, 2015).

capita). This indicates the prevalence of high levels of poverty among rural households in the IR and LR of both countries.

Nonfarm income diversification

Nonfarm income shares as a per cent of total household incomes range between 29.9 in the LR of Senegal (lowest) and 54.1 in the IR of Senegal (highest), indicating significant regional differences (Table 2). The figures are consistent with the literature (Haggblade et al. 2010; Reardon 1997), indicating that nonfarm income shares among rural African households are ranging between 35-50 per cent of total household incomes. However, at the same time, about 15 per cent of the rural households in our study for each country do not have any nonfarm

Table 2.

Share of Farm and Nonfarm Income Sources (Per Cent of Total Household Income)

Income source	Senegal			Kenya		
	LR	IR	WR	LR	IR	WR
1. Crops	51.4	38.4	44.1	34.3	50.9	24.3
2. Livestock	16.2	5.7	6.8	8.2	10.3	21.0
3. HFG	2.4	0.9	1.3	2.6	1.5	0.0
4. Onfarm processing	0.0	0.5	0.1	0.0	0.0	0.0
5. Farm wage	0.1	0.4	0.9	7.1	3.2	3.0
6. Nonfarm wage	1.3	5.4	8.9	30.2	17.3	15.3
7. Self-employment	22.7	40.4	30.4	11.4	14.8	33.6
8. Public transfers	0.0	0.0	0.0	0.01	0.04	0.02
9. Remittances	5.1	8.0	3.6	1.6	0.7	1.6
10. Rents	0.7	0.3	3.9	4.6	1.3	1.1
Farm income share (1-5)	70.1	45.9	53.2	52.2	65.9	48.3
Nonfarm income share (6-10)*	29.9	54.1	46.8	47.8	34.1	51.7
	b	a	a	a	b	a
N (households)	239	461	176	283	299	289

Notes: * a, b show the differences in means for nonfarm income between regions in each country, using Tukey-Kramer pairwise comparison tests at 1% level of significance. Similar letters indicate no significant difference between regions.

incomes. This indicates that some farm households are unable to diversify into nonfarm income sources, and therefore rely only on farming to sustain their livelihoods. As shown by other studies in rural SSA (Jirström, Andersson, & Djurfeldt 2011; Jirström, Archila, & Aloba Loison 2018), there is a considerable share of such rural households that are not engaged in any nonfarm income diversification, simply because such opportunities do not exist.

In discussing the regional differences, it is important to note that the specific context of each region matters, because it influences the type of diversification pursued by different farm households. Moreover, household income levels may reflect the type of diversification pursued. For Kenya, our results show, as expected, that rural households in the WR have significantly more nonfarm incomes than those in the IR (Table 2). As already shown, households in the WR had significantly higher total incomes than those in the IR and LR. At the same time, households in the WR have more access to relatively high-return nonfarm opportunities (mainly self-employment and nonfarm wage). This supports our hypothesis that in the WR of Kenya, diversification could be mainly associated with pull factors. The pull factors prevalent in the WR of Kenya include regional endowment of natural resources such as the rift valley and Nakuru national park which offer opportunities for diversification linked to tourism, plus better market access opportunities due to good road network, and good connections to major cities (Losch et al. 2012).

However, surprisingly, there is no significant difference in nonfarm income share between households in the WR and LR of Kenya. And yet as already shown, farm households in the LR had significantly lower total incomes than those in the WR. Therefore, the low incomes albeit with high levels of diversification, gives credit to our hypothesis that in the LR of Kenya, diversification could be mainly associated with push factors. In this region, such push factors include poor agricultural conditions because of perennial flooding and erosion, coupled with poor road infrastructure and poor market access opportunities (Losch et al.

2012).

For Senegal, as expected, the households in the LR have significantly lower nonfarm income share (compared to the IR and WR). Moreover, as already shown, households in the LR had significantly lower total incomes (compared to the IR and WR). This supports our hypothesis that the observed levels of income diversification among the farm households in the LR of Senegal is mainly associated with push factors. Such push factors prevalent in the LR of Senegal include poor road infrastructure and difficult market access, because the region is very remote and cut off from the rest of the country by the Gambia (Losch et al. 2012).

Contrary to what we expected, there is no significant difference in nonfarm income share between the IR and WR of Senegal. And yet, as already shown, households in the IR earn significantly lower total incomes than those in the WR. In the IR, households have high levels of nonfarm income share yet significantly low total incomes, indicating that diversification is mainly a means of survival. This can be attributed to prevalence of push factors such as long and recurrent drought seasons. The qualitative fieldwork in the IR (Mekhe region) supports this interpretation, because it revealed a common pattern where farm households participate mainly in low-return nonfarm activities (especially basketry and crafts), and there is predominantly the migration of youthful family members (to the capital, the Delta, and other urban areas) in order to manage long drought seasons annually, when crop farming is not possible because of lack of irrigation.

On the other hand, high income diversification in the WR of Senegal could be attributed to pull factors such as availability of commercialized farming opportunities, better market access due to good road infrastructure, good accessibility to the capital Dakar and other major towns, which facilitate high-return nonfarm opportunities. In addition, the farming system in the WR of Senegal has benefitted from heavy government and private investment in irrigation infrastructure and mechanized cultivation, as well as development of contract farming

through large agribusinesses (Ba et al. 2009).

Determinants of income diversification

We now turn to econometric regression techniques to estimate the determinants of income diversification (Table 4). Income diversification is proxied by the *Inverse Herfindahl Index* (IHI), which is used as the dependent variable. The explanatory variables include household assets and push/pull variables, which are described and summarized in Appendix 1 and 2, respectively. We noted that a major weakness of the IHI is that it is two dimensional and provides limited information concerning the overall structure of household diversification. However, Zhao and Barry (2013) showed that using two-dimensional indices in empirical analyzes of rural income diversification produces strong consistency of quantile patterns between income and diversification, compared to one-dimensional indices (such as the nonfarm income share).

Our data has a large number of observations with values of one for the IHI, because some households rely on only one income source. Estimating such censored variables using OLS would yield biased and inconsistent estimates (Long 1997). Therefore, we use a Tobit model (Wooldridge 2010), which is a censored regression model to provide a more accurate estimation given the nature of our dependent variable. The Tobit technique assumes that the dependent variable has a number of its values clustered at a limiting value. Hence it estimates a regression line using all observations, both those at the limit and those above it (McDonald & Moffitt 1980). Other studies on income diversification have also used Tobit models to overcome such limitations (Babatunde & Qaim 2009; Janvry & Sadoulet 2001; Woldenhanna & Oskam 2001).

The results of the IHI (Table 3) are somewhat consistent with our results from the nonfarm income share, in estimating the regional differences in household income diversification. The IHI is significantly higher in certain regions (the IR in Senegal, and the WR in Kenya—when

compared to the LR in each respective country). This indicates that household income diversification has significant importance in these regions. However, the push/pull incentives for diversification seem to be associated with the specific regional contexts.

Table 3.

Income Diversification by Region

Country	Region	IHI	SD	Min	Max	N
Senegal	LR	1.80 b	0.56	1.00	3.85	239
	IR	1.96 a	0.65	1.00	4.00	461
	WR	1.85 ab	0.63	1.00	4.12	176
Kenya	LR	1.91 b	0.69	1.00	4.53	283
	IR	1.83 b	0.73	1.00	4.25	299
	WR	2.25 a	0.70	1.00	4.45	289

Notes: a, b show the differences in means for IHI between regions in each country, using Tukey-Kramer pairwise comparison tests at 1% level of significance. Similar letters indicate no significant difference between regions.

Accessibility to rural towns

In each context, accessibility to rural towns or urban centers (proxied by the variable *distance to nearest big town*) has different effects on household income diversification (Table 4). The variable is negatively correlated with IHI in the LR of Senegal, indicating that households further from the nearest big town are relatively less diversified, as expected. In contrast, the variable is positively correlated with IHI in the WR of both countries, suggesting that even households who are located relatively far away from the big town in the WR are able to diversify their income sources. This indicates that accessibility to rural towns is a pull factor in the WR which enables households to easily exploit the services, opportunities and other advantages of rural towns to increase their farm and nonfarm incomes.

Household asset endowments

The number of *tropical livestock units*³ owned by the household is strongly positive and significantly correlated with the IHI in the IR and LR for Kenya, and in the IR for Senegal. This suggests that livestock is an important financial and productive asset used for engaging in multiple activities. Our qualitative fieldwork found that in IR of Senegal, livestock is mainly used for building savings, purchasing food, providing capital for migration, hiring labor for farming and engaging in nonfarm activities (mainly petty trade). In the drought prone IR of Senegal, livestock income in addition to crop income is a very important safety net when there is crop failure (Reardon 1997). Whereas, our qualitative fieldwork in Kenya found that dairy livestock is used as collateral to obtain credit from formal lenders, hence it is an important financial asset. It was reported that credit is mainly obtained from co-operatives and farmer groups through which farmers sell milk on contract to large processors. Livestock incomes are also used for accumulating savings in table banking groups, purchasing food, farm inputs, paying school fees, solving pressing cash needs and engaging in nonfarm activities. In western Kenya, oxen are used for draught power in farming and sometimes leased out to earn extra income. In addition, livestock are an important part of cultural ceremonies like circumcision.

Credit availability is negative and significantly associated with IHI in the IR of Senegal. This suggests that households who received credit⁴

³ Having livestock does not necessarily translate into revenues. Moreover, the number of households with livestock but with no livestock revenue is large in Senegal (about 46 per cent) compared to Kenya (6.5 per cent). Hence for Kenya, the effect of livestock on income diversification may be overestimated, because the livestock variable—through sales of milk or animals—may influence the livestock revenues and hence the results of the IHI.

⁴ Only 36 per cent of the households in the study from Senegal received credit, mainly from informal sources.

had relatively less diversified income sources, implying that they concentrate on farming. Credit is important for purchasing farm inputs and assets, mobilizing savings, and may provide the necessary working capital to set up farm enterprises (Reardon 1997; Schwarze et al. 2005). Furthermore, it was reported during the qualitative fieldwork in Mekhe region, that credit is used to buy farm inputs and hire farm labor. However, many respondents indicated that they mainly access credit for farming informally from friends or family members, rather than formally from banks or micro-finance institutions. This is probably because formal land market transactions in Senegal are limited, as land cannot be used as collateral for formal credit (Ba et al. 2009). However, from the qualitative findings in rural Senegal, it seems that an active informal market for selling and leasing land exists.

Table 4.

Tobit Estimates of the Determinants of Income Diversification in Rural Senegal and Kenya

Dependent variable: IHI	Senegal			Kenya		
Explanatory variables	LR	IR	WR	LR	IR	WR
Distance to nearest big town (km)	-0.003** (0.001)	-0.003 (0.004)	0.008* (0.003)	0.000 (0.003)	0.006 (0.003)	0.012* (0.006)
Farm equipment index	0.205** (0.067)	0.126** (0.047)	-0.031 (0.073)	0.144 (0.077)	0.127 (0.106)	-0.020 (0.074)
Facility index	-0.238 (0.133)	-0.037 (0.069)	0.212 (0.118)	0.065 (0.117)	-0.373** (0.117)	-0.130 (0.067)
Housing quality index	-0.022 (0.086)	0.073 (0.064)	-0.444*** (0.136)	-0.287* (0.136)	0.066 (0.163)	0.039 (0.065)
Age of household head	-0.032 (0.018)	0.010 (0.013)	0.052 (0.034)	0.002 (0.033)	-0.030 (0.021)	-0.006 (0.020)
Age of household head squared	0.000 (0.000)	0.000 (0.000)	-0.001 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Gender of household head	-0.313 (0.191)	-0.253 (0.237)	-0.214 (0.286)	-0.099 (0.122)	-0.197 (0.150)	-0.157 (0.131)
Education level of household head	0.18 (0.098)	-0.129 (0.081)	-0.131 (0.112)	-0.144 (0.157)	0.088 (0.118)	-0.096 (0.112)
Number of potentially active members in the household	0.023* (0.011)	-0.011 (0.009)	0.011 (0.013)	0.023 (0.025)	0.056 (0.029)	0.019 (0.020)

Credit availability	-0.132 (0.087)	-0.138* (0.067)	-0.079 (0.102)	0.161 (0.120)	0.087 (0.129)	0.111 (0.121)
Tropical livestock units	0.002 (0.002)	0.023*** (0.006)	-0.006 (0.004)	0.014 (0.011)	0.137*** (0.030)	0.044** (0.015)
Farm size per adult equivalent (hectares)	0.021 (0.043)	-0.022 (0.040)	0.042 (0.055)	0.213* (0.094)	-0.453* (0.200)	0.043 (0.110)
Social networks of household head	-0.041 (0.067)	0.142* (0.066)	-0.016 (0.099)	0.002 (0.112)	0.028 (0.095)	0.150 (0.087)
Household has migrant(s) abroad	0.276** (0.090)	0.222** (0.080)	0.426* (0.175)	0.070 (0.239)	0.154 (0.460)	-0.264 (0.233)
Household has migrant(s) in capital/main cities	0.378*** (0.114)	0.411*** (0.079)	0.094 (0.139)	0.294* (0.138)	0.317 (0.189)	0.000 (0.102)
Food security situation of the household	0.081 (0.077)	-0.120* (0.060)	0.140 (0.098)	-0.251 (0.182)	0.046 (0.163)	0.221* (0.111)
Constant	3.231*** (0.622)	1.603*** (0.455)	1.166 (1.052)	1.650* (0.719)	2.129*** (0.517)	2.005** (0.575)
<i>N (households)</i>	230	422	170	281	295	285
<i>uncensored households</i>	215	403	156	269	261	280
<i>left censored households at IHI ≤ 1</i>	15	19	14	12	34	5
<i>Akaike's information criteria (AIC)</i>	387			623		

Notes: ***, **, * indicate statistical significance at 0.1%, 1% and 5% levels, respectively. Figures in parentheses are robust standard errors using Huber/White estimators to control for heteroskedasticity

Access to facilities (facility index) such as running water, electricity in the house, and private toilet was negatively and significantly correlated with IHI in the IR of Kenya. Such basic facilities can be viewed as important productive and non-productive assets for engaging in farm and nonfarm activities, a lack of which may act as entry barriers to income diversification. Whereas, *access to farm equipment (farm equipment index)* is significantly and positively correlated with IHI in the LR and IR of Senegal. This implies that rural households who accessed farm equipment (such as animal traction, mechanical/motorized traction, sprayer, micro-irrigation system, irrigation pump, silo, tractor) were able to diversify their income sources. Some farm equipment, especially for animal traction, are important assets for exploiting farmland in rural

Senegal, and for generating additional income, thereby relaxing constraints on other income sources. During the fieldwork, it was reported that animal ploughs drawn by horses or donkeys, and tractors are used to generate extra cash by leasing them to other farm households during agricultural seasons. On the other hand, *housing quality index* (type of roof, floor and walls) is significant and negatively correlated with diversification in the WR of Senegal and LR of Kenya. This suggests that the relatively better-off households in these regions are more likely to specialize in farming, rather than diversifying out of farming.

For Kenya, *farm size per adult equivalent* was significant with mixed effects: in the IR, the larger the farm size per adult equivalent, the more intensive the specialization in agriculture. This suggests that there is no push factor of land scarcity in this region. However, in the LR, the larger the farm size per adult equivalent, the more households engaged in diversified activities. This can be attributed to poor agro-ecological conditions that lead to low revenues from agriculture, hence better-off households with more land seek better opportunities by diversifying away from farming. Also, probably due to low endowment of physical capital assets other than land, some households may fail to engage efficiently in farming. Land assets seem to play a key role in explaining both survival-led and opportunity-led diversification strategies in Kenya (Lay et al. 2008).

The variable on *social networks of the household head* was positive and significant in the IR of Senegal. The variable was constructed as a composite indicator of the number of groups and associations the head belongs to, in order to show the importance of social capital. Social groups and networks are known to relax credit constraints of their members, provide a form of social insurance, and are a source of capital for engaging in various activities. Bernard, Collion, de Janvry, Rondot and Sadoulet (2008) find that community organizations are important for risk sharing, especially in the IR of Senegal, which is more vulnerable to environmental risks because of relatively poor soils, low rainfall, and almost non-existent irrigation facilities. It was reported during our

qualitative fieldwork that farmer groups are very important for accessing mutual farm labor and accessing subsidized fertilizers from government. While most female respondents reported being members of tontines (mutual groups) where funds generated are mainly used to cover expenditures on food, household items and religious or family ceremonies.

Demographic factors

In Senegal, the *number of potentially active members in the household* is positively correlated with IHI in the LR. In this region, diversification is used as a more permanent strategy to deal with seasonality and risks, and household activities are characterized by multiple production and consumption strategies (Ba et al. 2009). Households are engaged in a mix of *ex ante* risk management and coping strategies. Household consumption is organized within the family in such a way as to regulate consumption over the year between the short rainy season and the long dry season. Different household members are engaged in different livelihood strategies—some are seasonal, others temporary and others more permanent (Losch et al. 2012). According to our qualitative fieldwork, consumption is regulated between productive and non-productive members of the family. In many households, during the dry season some productive family members migrate to other areas to look for work. Some migrants send remittances to support the family left behind. Migration remittances are used by the remaining household members to buy food and farm inputs. Household members who migrate seasonally usually return to the village during the rainy season to provide additional labor for farm activities.

Other demographic variables such as *age, gender and level of education of the household head*, whilst found important as determinants of income diversification in other African studies (Abdulai & CroleRees 2001; Lay et al. 2008; Woldenhanna & Oskam 2001), are not significant at regional level, for both countries.

The role of migration

The variables *households with migrants in the capital or main cities, and households with migrants abroad* (both compared to *households with migrants in other rural areas*) have a strongly positive and significant correlation with IHI in every region of Senegal. For Senegal, migration abroad is a significant income diversification strategy in every region, while migration to the capital/main cities is significant only in the IR and LR. For Kenya, migration to the capital is significant in the LR. The variables concerning migrants in the household were included in the regression analysis as proxies for the level of social capital of the household, in the view that it promotes income diversification. Moreover, having migrants in the household does not imply having remittances. Households with migrants but no revenues from migration are quite numerous in our sample, making up about 71 per cent in Senegal and 76 per cent in Kenya. This confirms our interpretation of the presence of migrants in the household as mainly social assets for networks and co-operation.

Migration abroad or to the capital/main cities is mainly in search of better economic opportunities, the pull factor being higher wages in the migration destination, which gives households incentives to diversify their income sources. However, households in risky areas may be pushed to migrate for risk reduction and to minimize income variability (Barrett, Reardon et al. 2001). The importance of migration greatly depends on the destination of the migrant (Wouterse & Taylor 2008). Migrants abroad or to capital/main cities are more likely to engage in nonfarm activities because the returns are higher (Reardon et al. 2006), but may also engage in farm activities (Wouterse & Taylor 2008). Migration abroad is an accumulation strategy only accessible for households that have a certain level of wealth at their disposal (Sakho-Jimbira & Bignebat 2007). However, migration transfers can also stimulate nonfarm activities by reducing liquidity constraints, to increase capital needed for migration (Bignebat & Sakho-Jimbira 2013). Income diversification and migration

in the Sahelian regions are mainly used to compensate for shortfalls in cropping income, since households are constrained by the single and short cropping season, low rainfall, poor soils and general lack of irrigation (Reardon, Delgado & Matlon 1992).

An important perception from our qualitative fieldwork in Senegal is that migration to different destinations is a strategy to increase household income sources outside the farming season, especially in the drought prone LR and IR where access to irrigation facilities is very limited. While in the WR where irrigation is more prevalent, migration abroad seems to be an important strategy for high income diversification. In the drought prone regions, crop farming is mainly carried out during one rainy season between June to September, with a long dry period afterwards where many rural households are unable to farm. As a result, many are pushed to supplement farm income with mainly low income nonfarm activities during the year, including seasonal migration of productive household members. It was reported that seasonal migrants travel especially to coastal areas for fishing in order to get incomes to support their families in the rural areas. Some of the migrants who find better job opportunities tend to migrate more permanently mainly to the capital Dakar, and a few to neighboring countries or abroad. Migrants to the capital Dakar tend to engage in nonfarm activities such as petty trade, commerce, transport, masonry, tailoring, and carpentry. As Reardon (1997) indicates, households with migrants usually maintain social ties with the resident household and remittances are an important safety net especially in areas where agricultural incomes are insufficient due to low agricultural potential. Some households are pushed to depend on income from migration because nonfarm activities are covariant with farming (Reardon et al. 2006).

In Kenya, on the other hand, the qualitative fieldwork revealed that migrants to the capital (Nairobi) and other major towns are mainly young people below 40 years old, for education purposes (university or other tertiary institutions) or in search of employment opportunities. The young people who migrate to urban areas for education purposes tend to

stay temporarily, some with relatives in the urban areas, while others return to the village during school holidays. Those who find jobs in the capital or other cities tend to settle more permanently and only return to the village during festive seasons or religious holidays. Some migrants occasionally send remittances to their families in the villages using MPESA (mobile money transfer services).

Perceptions on food security

The variable *food security situation of the household* is negative and significant in the IR of Senegal. In contrast, it is positive and significant in the WR of Kenya. It is a qualitative and subjective variable which was self-reported to reflect the evolution of household food security, and therefore should be interpreted cautiously. In the questionnaire, respondents were asked how their food security has changed in the last ten years from 2008 (whether it got better or remained unchanged or worsened). In the WR of Kenya, perceived improvement in household food security in the last decade is positively correlated with income diversification. While on the contrary, in the IR of Senegal, perceived food security concerns seem to have been an entry barrier against income diversification. From the qualitative fieldwork in the IR of Senegal (Mekhe), it was reported that most households do not farm during the dry season because of lack of irrigation facilities. However, in some villages where soils are suitable, cassava is an important source of income and food security during the dry season, as it can be harvested from 6 months up to one year, depending on the food and cash needs of the family. A common opinion was that relatively poor households with limited incomes tend to harvest their cassava quicker, thereby reducing their food security, and are forced into precarious alternative sources of income.

Whereas for Kenya, the WR was reported to be relatively food secure. Crop production is mainly conducted during two rainy seasons in the year. In general households are involved in production of high value

horticultural crops (fruits and vegetables), plantation crops (tea, coffee), trees, in addition to food crops, and zero-grazed dairy cattle for milk (with cultivation of grasses and fodder crops). Farmers have good connections to markets for their produce due to good road infrastructure and proximity to large cities.

Conclusions

Household income patterns from our study show that it is rural farm households in the WR in both countries that obtain significantly higher total incomes compared to those in the IR and LR. Moreover, an analysis of household income composition shows significant regional differences in terms of income diversification, but no clear patterns. In Senegal, there is no significant difference in the level of income diversification between the IR and WR, unexpectedly, —yet households in the IR earn significantly lower total incomes than those in the WR. While in Kenya, there is no significant difference in the level of income diversification between the WR and LR, surprisingly —although farm households in the LR earn significantly lower total incomes than those in the WR. These patterns rendered support to our hypothesis that the observed levels of income diversification among farm households in a given region are mainly associated with push or pull factors. We noted however that although geographical location of the region matters, the specific context of each region (such as the type of infrastructure, the level of public investments and public goods, and the situation regarding the use of natural resources) matters even more, because it influences the type of diversification pursued by different farm households.

The empirical investigation into the regional determinants of income diversification in rural Senegal and Kenya reveals that push and pull factors tend to act concurrently within and between regions, although with no clear patterns. This implies that policies on income diversification need to be tailored to meet the development needs of specific regional contexts in order to have beneficial impacts. In general,

the significant determinants of income diversification include accessibility to rural towns, household assets, demographic factors, migration opportunities, as well as perceptions on food security. At the regional level, accessibility to rural towns is significant in the WR of both countries. While assets such as livestock are significant in certain regions (the IR of Senegal, and the WR and IR of Kenya). Migration is an important diversification strategy across all regions of Senegal, while credit and social networks are mainly important in the IR of Senegal. Finally, perceptions on food security emerge as important determinants in certain regions (the WR of Kenya and IR of Senegal).

In conclusion, our econometric results have highlighted the limitations of using the household economic approach in modelling the determinants of economic behavior in rural Africa, because of its inherent focus on the household head as the decision maker. As a result, analyzing the determinants of decisions made by the household head may fail to capture other factors that may influence behavior of the household, since data from other adult members who are not household heads is excluded. Therefore, there is a need for better methodological approaches that go beyond the commonly used household models, in order to improve the understanding of income diversification, its determinants, and how they interplay with local/regional contexts.

References

- Abdulai, A., & CroleRees, A. (2001). Determinants of income diversification amongst rural households in Southern Mali. *Food Policy*, 26(4), 437–452. [http://doi.org/10.1016/S0306-9192\(01\)00013-6](http://doi.org/10.1016/S0306-9192(01)00013-6)
- Aihonsu, J. O., Olubanjo, O. O., & Shittu, A. M. (2011). Determinants of income diversification amongst rural farm households in Southwest Nigeria.
- Alobo Loison, S. (2015). Rural Livelihood Diversification in Sub-Saharan Africa: A Literature Review. *The Journal of Development Studies*, 51(9), 1125–1138. <http://doi.org/10.1080/00220388.2015.1046445>
- Anderson, E., & Deshingkar, P. (2005). *Livelihood diversification in rural*

- Andhra Pradesh, India.* (F. Ellis, H. A. Freeman, & Others, Eds.), *Rural livelihoods and poverty reduction policies*. Routledge.
- Andersson Djurfeldt, A., & Djurfeldt, G. (2013). Structural Transformation and African Smallholders: Drivers of Mobility within and between the Farm and Non-farm Sectors for Eight Countries. *Oxford Development Studies*, 41(3), 281–306.
<http://doi.org/10.1080/13600818.2013.817550>
- Ba, C. O., Diagana, B., Dièye, P. N., Hathie, I., & Niang, M. (2009). Changements structurels des économies rurales dans la mondialisation. *Programme RuralStruc Sénégal--Phase II, IPAR/ASPRODEB*.
- Babatunde, R. O., & Qaim, M. (2009). Patterns of income diversification in rural Nigeria: determinants and impacts. *Quarterly Journal of International Agriculture*, 48(4), 305–320.
- Barrett, C. B., Reardon, T., & Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food Policy*, 26(4), 315–331. [http://doi.org/10.1016/S0306-9192\(01\)00014-8](http://doi.org/10.1016/S0306-9192(01)00014-8)
- Barrett, C. B., Bezuneh, M., & Aboud, A. (2001). Income diversification, poverty traps and policy shocks in Côte d'Ivoire and Kenya. *Food Policy*, 26(4), 367–384.
[http://doi.org/10.1016/S0306-9192\(01\)00017-3](http://doi.org/10.1016/S0306-9192(01)00017-3)
- Barrett, C. B., & Reardon, T. A. (2000). Asset, Activity, and Income Diversification Among African Agriculturalists: Some Practical Issues. *SSRN Electronic Journal*. <http://doi.org/10.2139/ssrn.257344>
- Bernard, T., Collion, M.-H., de Janvry, A., Rondot, P., & Sadoulet, E. (2008). Do Village Organizations Make a Difference in African Rural Development? A Study for Senegal and Burkina Faso. *World Development*, 36(11), 2188–2204.
<http://doi.org/10.1016/j.worlddev.2007.10.010>
- Bignebat, C., & Sakho-Jimbira, M. S. (2013). Migrations et diversification des activités économiques locales : étude du Bassin arachidier du Sénégal. *Mondes En Développement*, 164(4), 93.
<http://doi.org/10.3917/med.164.0093>
- Bradshaw, B., Dolan, H., & Smit, B. (2004). Farm-Level Adaptation to Climatic Variability and Change: Crop Diversification in the Canadian Prairies. *Climatic Change*, 67(1), 119–141.

- <http://doi.org/10.1007/s10584-004-0710-z>
- Davis, B., Winters, P., Carletto, G., Covarrubias, K., Quiñones, E. J., Zezza, A., ... DiGiuseppe, S. (2010). A Cross-Country Comparison of Rural Income Generating Activities. *World Development*, 38(1), 48–63. <http://doi.org/10.1016/j.worlddev.2009.01.003>
- Dercon, S., & Krishnan, P. (1996). Income portfolios in rural Ethiopia and Tanzania: Choices and constraints. *Journal of Development Studies*, 32(6), 850–875. <http://doi.org/10.1080/00220389608422443>
- Ellis, F. (2000a). *Rural livelihoods and diversity in developing countries*. Oxford university press.
- Ellis, F. (2000b). The Determinants of Rural Livelihood Diversification in Developing Countries. *Journal of Agricultural Economics*, 51(2), 289–302. <http://doi.org/10.1111/j.1477-9552.2000.tb01229.x>
- Ellis, F., & Freeman, H. A. (2004). Rural Livelihoods and Poverty Reduction Strategies in Four African Countries. *Journal of Development Studies*, 40(4), 1–30. <http://doi.org/10.1080/00220380410001673175>
- Ersado, L. (2006). *Income Diversification In Zimbabwe : Welfare Implications From Urban And Rural Areas*. The World Bank. <http://doi.org/10.1596/1813-9450-3964>
- Escobal, J. (2001). The Determinants of Nonfarm Income Diversification in Rural Peru. *World Development*, 29(3), 497–508. [http://doi.org/10.1016/S0305-750X\(00\)00104-2](http://doi.org/10.1016/S0305-750X(00)00104-2)
- Haggblade, S., Hazell, P. B. R., & Reardon, T. (2007). *Transforming the Rural Nonfarm Economy: Opportunities and Threats in the Developing World*. Intl Food Policy Res Inst. Retrieved from <http://books.google.se/books?id=5QNHAwAAQBAJ>
- Haggblade, S., Hazell, P., & Reardon, T. (2010). The Rural Non-farm Economy: Prospects for Growth and Poverty Reduction. *World Development*, 38(10), 1429–1441. <http://doi.org/10.1016/j.worlddev.2009.06.008>
- Janvry, A. de, & Sadoulet, E. (2001). Income Strategies Among Rural Households in Mexico: The Role of Off-farm Activities. *World Development*, 29(3), 467–480. [http://doi.org/10.1016/S0305-750X\(00\)00113-3](http://doi.org/10.1016/S0305-750X(00)00113-3)
- Jirström, M., Andersson, A., & Djurfeldt, G. (2011). Smallholders caught in poverty - flickering signs of agricultural dynamism. In G. Djurfeldt, E.

- Aryeetey, & A. C. Isinika (Eds.), *African smallholders. Food crops, markets and policy* (pp. 74–106). Wallingford: CABI.
<http://doi.org/10.1079/9781845937164.0074>
- Jirstrom, M., Archila, M. F. B., & Aloba Loison, S. (2018). African smallholder farmers on the move: Farm and nonfarm trends for six sub-Saharan African countries, 2002-2015. In Andersson Djurfeldt, A., F. M. Dzanku and A. Isinika (Eds.), *Agriculture, Diversification and Gender in Rural Africa: Longitudinal Perspectives from Six Countries*. Oxford: Oxford University Press.
- Lay, J., Mahmoud, T. O., & M'Mukaria, G. M. (2008). Few Opportunities, Much Desperation: The Dichotomy of Non-Agricultural Activities and Inequality in Western Kenya. *World Development*, 36(12), 2713–2732. <http://doi.org/10.1016/j.worlddev.2007.12.003>
- Long, J. S. (1997). *Regression models for categorical and limited dependent variables*. Sage Publications.
- Losch, B., Freguin-Gresh, S., & White, E. T. (2012). *Structural Transformation and Rural Change Revisited: Challenges for Late Developing Countries in a Globalizing World*. World Bank Publications. Retrieved from
<http://books.google.se/books?id=GfvAwfTenE0COvensen>
- Maertens, M. (2009). Horticulture exports, agro-industrialization, and farm-nonfarm linkages with the smallholder farm sector: evidence from Senegal. *Agricultural Economics*, 40(2), 219–229.
<http://doi.org/10.1111/j.1574-0862.2009.00371.x>
- McDonald, J. F., & Moffitt, R. A. (1980). The Uses of Tobit Analysis. *The Review of Economics and Statistics*, 62(2), 318.
<http://doi.org/10.2307/1924766>
- Patil, G. P., & Taillie, C. (1982). Diversity as a Concept and its Measurement. *Journal of the American Statistical Association*, 77(379), 548–561.
<http://doi.org/10.1080/01621459.1982.10477845>
- Reardon, T. (1997). Using evidence of household income diversification to inform study of the rural nonfarm labor market in Africa. *World Development*, 25(5), 735–747.
[http://doi.org/10.1016/S0305-750X\(96\)00137-4](http://doi.org/10.1016/S0305-750X(96)00137-4)
- Reardon, T., Berdegue, J., Barrett, C. B., & Stamoulis, K. (2006). Household income diversification into rural nonfarm activities. In *Transforming*

- the rural nonfarm economy. Opportunities and threads in the developing world* (pp. 115–140).
- Reardon, T., Delgado, C., & Matlon, P. (1992). Determinants and effects of income diversification amongst farm households in Burkina Faso. *Journal of Development Studies*, 28(2), 264–296. <http://doi.org/10.1080/00220389208422232>
- Sakho-Jimbira, M. S., & Bignebat, C. (2007). Local diversification of income sources versus migration: Complements or Substitutes? Evidence from rural families of the Senegalese Groundnut Basin.
- Schwarze, S., Zeller, M., Berdegué, J. A., Abruzzese Aguirre, R. A., Abanikanda, J., Hamzat, R. A., ... others. (2005). Income diversification of rural households in Central Sulawesi, Indonesia. *Quarterly Journal of International Agriculture*, 44(1), 61–73.
- Singh, I., Squire, L., & Strauss, J. (1986). *Agricultural household models: Extensions, applications, and policy*. The World Bank.
- Start, D. (2001). The Rise and Fall of the Rural Non-farm Economy: Poverty Impacts and Policy Options. *Development Policy Review*, 19(4), 491–505. <http://doi.org/10.1111/1467-7679.00147>
- Taylor, J. E., & Adelman, I. (2003). Agricultural Household Models: Genesis, Evolution, and Extensions. *Review of Economics of the Household*, 1(1/2), 33–58. <http://doi.org/10.1023/A:1021847430758>
- Woldenhanna, T., & Oskam, A. (2001). Income diversification and entry barriers: evidence from the Tigray region of northern Ethiopia. *Food Policy*, 26(4), 351–365. [http://doi.org/10.1016/S0306-9192\(01\)00009-4](http://doi.org/10.1016/S0306-9192(01)00009-4)
- Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT Press.
- World Bank. (2007). *World Development Report 2008: Agriculture for Development*. Washington DC: World Bank. Retrieved from <https://openknowledge.worldbank.org/handle/10986/5990>
- Wouterse, F., & Taylor, J. E. (2008). Migration and Income Diversification: Evidence from Burkina Faso. *World Development*, 36(4), 625–640. <http://doi.org/10.1016/j.worlddev.2007.03.009>
- Zhao, J., & Barry, P. (2013). Implications of different income diversification indexes: the case of rural China. *Economics and Business Letters*, 2(1), 13. <http://doi.org/10.17811/ebl.2.1.2013.13-20>

Appendix A

Description of Variables Used in the Econometric Models

Variables	Description
<i>Dependent variables</i>	
Inverse Herfindahl Index (IHI)	Sum of squared shares of each source of household income per capita (SPPP).
Nonfarm income share (NFS)	Share of non-farm income in total household income per capita (SPPP)
<i>Explanatory variables</i>	
<i>Physical assets</i>	
Winning region (WR)	(1=winning region, 0=losing region)
Intermediary region (IR)	(1= Intermediary region, 0=losing region)
Distance to nearest big town (km)	The big towns include Nakuru, Bungoma and Kisumu towns for Kenya; Dakar, Tivaouane, St. Louis, Dagana, Niore, Kolda and Sedhiou for Senegal
Farm equipment index (EQh)	EQh = sum of EQih (1-Pi), where Pi=ni/n and where EQih=1 if the household h can access agricultural equipment i (animal traction, mechanical/motorized traction, sprayer, micro-irrigation system, irrigation pump, silo, tractor), Pi = the probability of accessing the agricultural equipment i, ni=number of households which access agricultural equipment i, n= total number of households
Facility index (Fh)	Fh = sum of Fih (1-Pi) with Pi=ni/n and where Fih=1 if the household h has access to facility i (piped/running water, electricity in the house and private toilets in the house), Pi is the probability of accessing the facility i, ni= number of households which can access facility i, n= total number of households
Housing quality index (Qh)	Qh = sum of Qih (1-Pi) with Pi=ni/n and where Qih=1 if the quality of the housing i of the household h is (cement or concrete floor, roof made of iron or tile, wall made of stones or wood), Pi is the probability of having housing quality i, ni= number of households which have housing quality i, n= total number of households
Farm size per adult equivalent	Measured in hectares
<i>Human assets</i>	
Age	Age of the household (HH) head (years)
Gender	Sex of the household head (1=male, 0=female)
Active household members	Number of potentially active members in the household aged between 15 and 64 years
Education dummy	Level of education of the household head (1=Some formal education (primary, secondary or tertiary), 0= No formal education)
<i>Financial assets</i>	
Credit availability dummy	(1= Household has credit, 0= Household has no credit)
Tropical livestock units (TLU)	Calculated based on the energy needs of a 250kg ruminant. [camel (1), cattle (0.7), sheep (0.1), goats (0.1), horses (0.8), donkeys (0.5), pigs (0.2) chicken (0.01)] (see Makeham and Malcolm 1986)
<i>Social capital</i>	
Index of networks of household head	Is the sum of memberships to groups & associations, including agricultural mutual aid groups for Senegal. While for Kenya it is a dummy for membership to groups, associations or organisations (1=yes, 0=no)
Migration abroad	1= HH has migrant(s) abroad, 0= HH has migrant(s) in other rural areas
Migration to the capital or main cities	1=HH has migrant(s) in capital/main cities 0=HH has migrant(s) in other rural areas
<i>Food security situation of the household</i>	Evolution of household food security in the last 10 years from 2008 (1=improved/better, 0= remained unchanged or worsened)

Appendix B

Descriptive Statistics for Variables Used in the Econometric Models

Variables	Senegal (N= 822)				Kenya (N=861)			
	Mean	Std. Dev.	Mi n	Max	Mean	Std. Dev.	Mi n	Max
Nonfarm income share	0.45	0.31	0	1.0	0.44	0.34	0	1.0
Inverse Herfindahl Index (IHI)	1.91	0.63	1	4.1	2.00	0.73	1	4.5
Winning region	0.21	0.41	0	1	0.33	0.47	0	1
Intermediary region	0.51	0.50	0	1	0.34	0.47	0	1
Losing region	0.28	0.45	0	1	0.33	0.47	0	1
Distance to nearest big town (km)	31.72	29.30	6.0	125.0	30.39	13.43	8.9	60.3
Farm equipment index	1.34	0.77	0	4.1	0.60	0.57	0	3.7
Facility index	2.24	0.49	1	3.0	0.27	0.52	0	2.7
Housing quality index	2.28	0.57	0.5	3.0	0.41	0.59	0	1.7
Age of household head (years)	51.78	13.01	18	98	49.13	13.79	17	90
Age of head squared	2,850	1,394	324	9,604	2,604	1,443	289	8,100
Gender of head	0.97	0.17	0	1	0.81	0.39	0	1
Education level of head	0.212	0.41	0	1	0.995	0.07	0	1
Number of potentially active members in the household	6.80	3.88	1	30	3.69	2.16	0	12
Credit availability	0.36	0.48	0	1	0.11	0.32	0	1
Tropical livestock units	5.72	13.06	0	117.8	2.44	3.06	0	27.1
Farm size per adult equivalent (hectares)	0.97	0.87	0	6.4	0.29	0.35	0	3.6
Social networks of head	1.41	0.55	1	3	0.50	0.50	0	1
HH has migrant(s) in capital or main cities	0.20	0.40	0	1	0.14	0.35	0	1
HH has migrant(s) abroad	0.18	0.38	0	1	0.02	0.15	0	1
HH has migrant(s) in other rural areas	0.23	0.42	0	1	0.37	0.48	0	1
Food security situation of the household	0.47	0.50	0	1	0.10	0.30	0	1

Source: RuralStruc Quantitative Survey, data analysis by authors.