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Agricultural Economics Research, Policy and Practice in Southern Africa

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/ragr20

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To cite this article: Moses Kakungulu, Moses Isabirye, Kevin Teopista Akoyi, Kaat Van Hoyweghen, Liesbet Vranken & Miet Maertens (2021) Changing income portfolios and household welfare in rural Uganda, Agrekon, 60:3, 227-242, DOI: 10.1080/03031853.2021.1939743

To link to this article: https://doi.org/10.1080/03031853.2021.1939743

AGREKON
2021, VOL. 60, NO. 3, 227–242
https://doi.org/10.1080/03031853.2021.1939743

Changing income portfolios and household welfare in rural Uganda*

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ABSTRACT

This paper provides evidence on the heterogeneous welfare implications of rural income portfolios in eastern Uganda. We use household survey data from two-panel rounds, and fixed and random effects estimation and quantile regressions to estimate average and heterogeneous effects. While the literature mostly focuses on either income diversification or participation in non-farm activities, we distinguish between income diversification, using the Simpson Index, and off-farm income generation. We use ex-post income and poverty measures as well as an ex-ante vulnerability measure to analyse welfare effects. We find that income diversification and non-farm income generation improve household income, and reduce poverty and vulnerability. We find that it is most beneficial for poorer households with less land assets to diversify their income portfolio, while moving out of agriculture is equally beneficial at all income levels and most beneficial for households with more human capital. We find that income diversification reduces vulnerability most strongly at high levels of diversification and low levels of income while non-farm income generation reduces vulnerability at lower levels of non-farm income and increases vulnerability at higher levels of non-farm income. Our results lead to nuanced findings that bring additional insights in the literature on structural transformation and rural development.

ARTICLE HISTORY
Received 26 May 2020
Accepted 28 May 2021

KEYWORDS
Income diversification; non-farm income; poverty; vulnerability; rural development

1. Introduction

Structural rural transformation is widely discussed as an essential pathway towards upward rural income mobility and poverty reduction in developing countries (Anderson Djurfeldt, Dzanku, and Isinika 2018; Barrett, Carter, and Timmer 2010, 2017; Dzanku 2018; Estudillo, Sawada, and Otsuka 2008; Gautam and Anderson 2016; Kumanayake, Estudillo, and Otsuka 2014; Meert et al. 2005; Losch, Freguin-Gresh, and White 2012; Mccullough 2017; Perez, Bilsborrow, and Torres 2015; Van den Broeck and Maertens 2017). Structural transformation implies diversification of rural income portfolios and a shift in income generation from agricultural and low-return activities to non-agricultural and high-return activities (Ellis 2000; Barrett, Reardon, and Webb 2001). On the one hand, empirical studies largely point to income-enhancing and poverty-reducing effects of rural income diversification and participation in off- and non-farm activities (e.g., Dzanku 2018; Estudillo,

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Supplemental data for this article can be accessed at https://doi.org/10.1080/03031853.2021.1939743.
*This article is based on earlier work, published as working paper by Kakungulu and co-authors (2018).

Sawada, and Otsuka 2008; Kumanayake, Estudillo, and Otsuka 2014; Meert et al. 2005; Lanjouw and Lanjouw 2001; Loison 2019; Reardon et al. 2006; Van Hoyweghen, Van den Broeck, and Maertens 2020; Winters et al. 2010). Other studies claim that diversification leads to income smoothing rather than income growth (Barrett, Reardon, and Webb 2001; Rigg 2006; Davis et al. 2010; Haggblade, Hazell, and Reardon 2010). On the other hand, the available evidence points out that participation in the rural non-farm economy is biased towards relatively better-off households who can overcome risk, capital and skills barriers to enter and invest in non-farm activities – resulting in increased income inequality in rural areas (Babatunde and Qaim 2009; Bezu, Barrett, and Holden 2012). In a review article on income diversification, Alobo Loison (2015) concludes that the growth of the rural non-farm economy in Sub Saharan Africa (SSA) is neither inclusive nor redistributive.

In this paper, we empirically analyse the relation between income diversification and participation in the rural non-farm economy on the one hand and household welfare on the other hand. We use household survey data from two panel rounds in the Mount Elgon region in eastern Uganda, and fixed and random effects estimation and quantile regressions. Our study is innovative and relevant for several reasons. First, we focus on the welfare implications of (1) income diversification, defined as having a diversified portfolio of income-generating activities, as well as (2) off-farm income generation, defined as the importance of off-farm income in total household income. The literature largely treats income diversification and rural off-farm income generation as two sides of the same coin. Yet, income diversification and off-farm income generation are not necessarily highly or linearly correlated. Conceptually, income diversification might be a specific livelihood strategy of rural households, for example, to smooth income, but might also be a transition phase in the process of moving out of agriculture. Households can have a low level of income diversification if off-farm income generation is low (this is if they specialise in agriculture) but also if off-farm income generation is high (this is if they move out of agriculture and specialise in off- and non-farm activities). Empirical studies most often focus on either income diversification or participation in off-farm activities, and rarely investigate how these are related to each other. Studies focusing only on income diversification might underestimate the welfare effects of structural transformation while studies focusing only on off-farm income generation fail to capture that such income might be derived from multiple off- and non-farm sources. A recent study by Dzanku (2018) analyses the welfare implications of specialisation in staple food crop production, using income diversification and participation in the rural non-farm economy as alternative measures of not specialising in staple crops, but does not focus on interpreting differences in welfare effects of these different measures. By focusing on the different welfare implications of income diversification and of off-farm income generation, we bring additional insights in the literature on structural transformation and rural development in SSA.

Second, we use panel data and specifically analyse heterogeneous effects. Panel data allows of exploiting both the variation within households over time and the variation between households over space, in fixed and random effects models, to explore the relation between income diversification and off-farm income generation, and household welfare. We analyse heterogeneity to understand which households benefit most from income diversification and off-farm income generation. We reveal which factors condition the relation between income levels and income diversification through interaction terms in the regression models; and we explore heterogeneity along the income distribution using quantile regression techniques. Insights on possible heterogeneous welfare effects of rural income diversification and off-farm income generation are very scarce while understanding who benefits most is important from a policy perspective (Gautam and Anderson 2016; Losch, Freguin-Gresh, and White 2012; Winters et al. 2010). In addition, we use different monetary welfare measures as outcome variables in our analysis, including income and monetary poverty as static welfare measures, and vulnerability, defined as the probability that future household income falls below the poverty line, as a dynamic measure of welfare (Chaudhuri, Jalan, and Suryahadi 2002).

Third, this research was carried out in the context of a collaborative project (SureLive) on improving livelihoods in the Mount Elgon region in Eastern Uganda. This region has a very high population density and a large incidence of poverty. The region is severely threatened by land degradation, resulting in an increased occurrence and severity of recurrent landslides that have devastating consequences and even wash away complete villages. The agricultural frontier in this region is closed and agricultural landholdings are becoming smaller and increasingly fragmented (Mugagga and Buyinza 2013). Moving away from land-dependent income-generating activities is imperative for rural households in this context, and understanding the welfare consequences of this process is imperative for policy-makers seeking to accelerate or steer the process of structural rural transformation in this region. The insights from this study will directly inform these policymakers. While our case-study approach clearly has limitations in terms of generalising findings, lessons can be learnt that are relevant for other poverty-struck and densely populated areas in SSA that are prone to environmental degradation.

2. Literature review

2.1 Income diversification and off-farm income generation

On the one hand, income diversification can be a livelihood strategy of rural households. Households may allocate their productive assets and family labour among various economic activities – including self-employment and wage employment in different sectors, including agricultural and non-agricultural sectors, including food and cash crop production, including production for subsistence and for the market – and locations (Abdulai and CroleRess 2001; Alobo Loison 2015; Davis et al. 2010; Dzanku 2018; Gautam and Anderson 2016; Losch, Freguin-Gresh, and White 2012; Perez, Bilsborrow, and Torres 2015; von Braun and Kennedy 1995; Winters et al. 2010). Such a deliberate income diversification strategy might be related to risk management behaviour and serve income smoothing rather than (or in addition to) income growth (Barrett, Reardon, and Webb 2001; Dercon 2002; Ellis, 2000; Haggblade, Hazell, and Reardon 2010; Meert et al. 2005; Reardon et al. 2006). On the other hand, income diversification can be a transition phase in the process of moving out of agriculture (Anderson Djurfeldt, Dzanku, and Isinika 2018; Kumanayake, Estudillo, and Otsuka 2014; Van den Broeck and Maertens 2017). Rural households might enter off-farm employment and/or invest in non-farm businesses gradually by investing in productive assets, building up skills and relaxing liquidity constraints (Loison 2019; Cunguara, Langyintuo, and Darnhofer 2011; Ellis and Freeman 2004). This may result in a temporary situation of diversified income portfolios with farm and non-farm activities but ultimately lead to a situation of specialisation in higher return off-farm activities in the long run.

Whether income diversification is an intentional livelihood strategy to smooth and/or augment income, or a temporary phase in the process of moving out of agriculture, has potentially important implications. If diversification is a temporary result of households moving out of agriculture, there may only be a positive correlation between income diversification and off-farm income generation at low to medium levels of diversification. Existing studies focus on either income diversification, using the Simpson index or Herfindahl index as an indicator (e.g., Barrett, Reardon, and Webb 2001; Motsholapheko, Kgathi, and Vanderpost 2012; Naznin, Hossain, and Khairul 2015; Sahal and Baha 2010), off- and non-farm income generation in general (e.g., Babatunde and Qaim 2009; Barrett, Reardon, and Webb 2001; Bezu, Barrett, and Holden 2012; Davis et al. 2010; Lanjouw and Lanjouw 2001; Sharaunga and Mudhara 2016), or specifically on off-farm wage employment (e.g., Haggblade, Hazell, and Reardon 2010; Imai, Gaiha, and Thapa 2015; Van Hoyweghen, Van den Broeck, and Maertens 2020). A recent study (Dzanku 2018) includes both, income diversification and participation in the rural non-farm economy, but does not focus on potentially diverging welfare implications. To the best of our knowledge, there are no studies that distinguish between the welfare implications of income diversification and the welfare implications of off-farm income

generation, as we do in this paper. Moreover, the welfare implications of income diversification may differ depending on whether households are moving out of agriculture or deliberately diversifying their income portfolio. No study has looked at heterogeneity across households, as we do in this paper.

Rural income diversification and off-farm income generation have been studied in different contexts – including studies in Asia (Estudillo, Sawada, and Otsuka 2008; Imai, Gaiha, and Thapa 2015; Kijima and Lanjouw 2005; Kumanayake, Estudillo, and Otsuka 2014; Naznin, Hossain, and Khairul 2015) and SSA (Babatunde and Qaim 2009; Barrett, Reardon, and Webb 2001; Bezu, Barrett, and Holden 2012; Dzanku 2018; Ellis and Freeman 2004; Haggblade, Hazell, and Reardon 2010) – and using different methods. Studies have analysed the implications of income diversification and off-farm income generation for household income (Barrett, Reardon, and Webb 2001; Kijima and Lanjouw 2005), consumption (Cunguara, Langyintuo, and Darnhofer 2011; Naznin, Hossain, and Khairul 2015), poverty (Haggblade, Hazell, and Reardon 2010; Imai, Gaiha, and Thapa 2015), food security (Zereyesus et al. 2017) and vulnerability (Imai, Gaiha, and Thapa 2015) – and mostly point to positive welfare effects. While older studies mainly rely on cross-sectional data, more recent studies use panel data that allow to better identify the welfare implications of income diversification and to analyse dynamics over time (Babatunde and Qaim 2009; Bezu, Barrett, and Holden 2012; Dzanku 2018; Kijima and Lanjouw 2005; Lay et al. 2008).

2.2 Poverty and vulnerability

Poverty can be temporary, with people moving in and out of poverty if their income and consumption levels fluctuate, or chronic, with people persistently at income and consumption levels below the poverty line. A static poverty measure does not distinguish between temporary and chronic poverty, while understanding this distinction is crucial for eradicating poverty in SSA (Cahyadi and Waibel 2015; Hohberg et al. 2018). Vulnerability, defined as the likelihood to be poor in the near future, can be a useful measure to capture the intertemporal nature of poverty (Chaudhuri, Jalan, and Suryahadi 2002). There is a growing body of literature on household vulnerability, including empirical studies in different regions and contexts, that documents the complementarity of a focus on a dynamic vulnerability measure (e.g., Bali Swain and Floro 2012; Bogale 2012; Cahyadi and Waibel 2015; Celidoni 2013, 2015; Dutta, Foster, and Mishra 2011; Günther and Harttgen 2009; Hohberg et al. 2018; Hoddinott and Quisumbing 2010; Hoogeveen 2005; Imai, Gaiha, and Kang 2011; Klasen and Waibel 2013, 2015; Ligon and Schechter 2003; Povel 2015; Ward 2016; Zereyesus et al. 2017). Some studies focus specifically on vulnerability and household income portfolios. For example, Zereyesus et al. (2017) and Imai, Gaiha, and Thapa (2015) find that participation in off-farm activities reduces vulnerability to (food) poverty in Ghana, and in Vietnam and India, respectively. We add to this evidence by examining the household vulnerability implications of income diversification and off-farm income generation in Uganda.

3. Data and methods

3.1 Study area and data collection

We conduct our research in the Mount Elgon region in Eastern Uganda, a region characterised by a high population density, increasing land pressure and fragmentation. Soil fertility is declining and cultivation on marginal lands, such as on steep slopes, is increasing, which makes the region extremely prone to landslides (Knapen et al. 2006). Households in the research area are traditionally farm-households, deriving the majority of their income from mixed cropping and livestock rearing in zero-grazing systems. The most commonly cultivated crops include coffee, bananas, maize and beans (Mugagga and Buyinza 2013). Due to increasing land scarcity, households are increasingly

complementing their farm income with wages earned off-farm and on-farm. Small business activities, such as petty trade, retail shops, carpentry, hairdressing and tailoring are emerging in the area.

We conducted fieldwork in the research area in the period 2014–2016 and collected data through two rounds of a quantitative household survey, with the first baseline survey implemented in May–July 2014 and the second follow-up round in August–October 2016. The baseline survey includes 600 households, selected in a multistage sampling design. In the first stage, we purposively selected five of the eight districts (Bududa, Manafwa, Sironko, Bulambuli and Kapchorwa) in the Mount Elgon region. The more urbanised district of Mbale and the less densely populated districts (Kween and Bukwo), close to the border with Kenya were excluded. In the second stage, villages in the five districts were stratified into three classes according to altitude and 20 villages were selected in each stratum. In the third stage, ten households in each of the 60 villages were randomly selected. For the second survey, 100 households were intentionally and randomly dropped from the initial sample – in order to sample an additional 200 households from the border districts (Kween and Bukwo) – and another 42 households unintentionally dropped out, either because they migrated or because they were not available during the survey period. The latter corresponds to an attrition rate of 8.4%. With this rather limited incidence of attrition, and because no significant differences could be detected in observed characteristics between dropout households (households only present in the first survey round) and panel households (households present in both the first and second survey round), attrition bias is likely limited.[1] For the analysis in this paper, we use data from a balanced panel of 458 households.

A quantitative questionnaire, structured in different topical modules, was used in both survey rounds. The questionnaire was slightly modified in between survey rounds but information on-farm and off-farm activities and income was asked in the same way. The survey data include information on household demographics, land ownership and management, agricultural production and marketing, forest interaction, non-land asset holdings, off-farm wage employment, self-employment and non-labour income. A team of trained enumerators, using tablets and computer-assisted personal interviewing software, implemented the survey. Income data refer to a 12-month-period prior to the survey. Household survey data are complemented with data from a quantitative village survey in all sampled villages, including information on institutions, infrastructure, accessibility and agro-ecology; and with qualitative information from semi-structured interviews with district agricultural officers, community development officers and sub-county chiefs on rural livelihood strategies, land management and population growth.

3.2 Indicators

3.2.1 Income diversification and off-farm income

We use the Simpson Index (SI) as a measure of income diversification. The SI is considered most suitable for measuring income diversification because it takes into account both the number of income sources and the distribution of income between different sources (Naznin, Hossain, and Khairul 2015). To calculate the SI, we distinguish between six broad income sources[2]: cropping, livestock, non-farm businesses (non-farm self-employment), wage employment (including off-farm wages earned in other agricultural enterprises as well as non-farm wages earned in the non-agricultural sector), collection of forest products and non-labour income (public and private transfers). The index is calculated as follows with S_i being the share of income source i in total household income:

$$SI = 1 - \sum_{i=1}^{6} S_i^2 \text{ with } 0 \leq SI < 1 \quad (1)$$

The minimum value of the SI is 0 if households derive all their income from one source, and it increases with the level of diversification. To present descriptive statistics, we classify households

into three income diversification categories based on terciles: households with slightly diversified income portfolios ($SI \leq 0.33$); households with moderately diversified income portfolios ($0.33 < SI \leq 0.66$) and households with highly diversified income portfolios ($0.66 < SI < 1$). In addition, we measure off-farm income generation by calculating the share of off-farm income (including income from non-farm businesses, wage employment, collection of forest products and non-labour income) in total household income.

3.2.2 Welfare indicators

We use three different welfare indicators: income, poverty and vulnerability. We calculate per capita income (in per adult equivalent terms) for both survey rounds as the ratio of total household income over the adult equivalent household size. We use the modified OECD adult equivalence scale with a weight of 1 for the household head, 0.5 for each additional adult member and 0.3 for household members aged 14 or below. We define a household as all members who were living, sleeping and eating together in the same compound for at least six months in the 12-month-period prior to the survey. We define total income as the income a household earned during the 12-month-period prior to the survey, including net income from crop and livestock production (including crops and products consumed by the household), net income from non-farm businesses, wages and salaries, income from forest products, and income from private and public transfers. Crop and livestock income is calculated as the value of crop and livestock production, including non-marketed output valued at current market prices, minus variable production costs, including purchased inputs, hired labour and land rent. We use real income data to compare household income in 2014 and 2016. We compound 2014 income data to 2016 price levels, using the consumer price indices derived from IMF data (IMF 2018). Poverty is measured with a dummy variable indicating whether the annual per capita income falls below the international poverty line of $3.10 a day (measured in 2011 PPP prices), which is equivalent to UGX3,552 a day (measured in real 2016 terms).

Vulnerability is measured using the method proposed by Chaudhuri, Jalan, and Suryahadi (2002) and is defined as the probability that the future income $Y_{i,t+1}$ of household i in period $t+1$ will fall below the poverty lineλ. This is expressed as follows:

$$V_{it} = \Pr\left(Y_{i,t+1} \leq \lambda\right) = \Phi\left(\frac{\lambda - \hat{Y}_{i,t}}{\sqrt{\hat{\mu}_{i,t}^2}}\right) \tag{2}$$

Since future income $Y_{i,t+1}$ is unobserved, vulnerability is derived from the expected income $\hat{Y}_{i,t}$ and the variance of income $\hat{\mu}_{i,t}$ using the cumulative density function of the standard normal distribution, Φ. The expected income $\hat{Y}_{i,t}$ and the variance of income $\hat{\mu}_{i,t}$ are estimated separately for 2014 and 2016 to maximise the explanatory power of the regressions:

$$Y_{i,t} = \alpha X_{i,t} + \beta Z_j + \mu_{i,t} \tag{3}$$

where $X_{i,t}$ is a vector of household characteristics and Z_j is a vector of village characteristics to control for covariate shocks. We estimate the income equation and obtain the residuals $\hat{\mu}_{i,t}$. The squared residuals $\hat{\mu}_{i,t}^2$ are the variance of the idiosyncratic component of income. As proposed by Chaudhuri, Jalan, and Suryahadi (2002), since the error term is assumed to be heteroscedastic, we apply a three-step feasible generalised least squares (FGLS) technique to estimate Equation (3) and obtain consistent and efficient estimates of the error term. The results of the FGLS models are reported in Table A1 in Appendix. The resulting vulnerability measure V_{it} is a continuous variable ranging from 0 to 1, with higher values indicating higher vulnerability levels. For the descriptive analysis, we use 0.5 as a threshold, as is most common in the literature (Chaudhuri, Jalan, and Suryahadi 2002). This implies that households are considered to be vulnerable if their probability to fall below the poverty line is 0.5 or above. Highly vulnerable households maybe those who are currently poor

and are likely to remain poor as well as households who are currently not poor but are very likely to fall into poverty.

3.3 Econometric approach

To analyse the relation between income diversification or off-farm income generation and household welfare, we use three different sets of models and techniques. First, we estimate the average welfare implications using models of the following generic form:

$$Y_{ijt} = \alpha + \beta I_{ijt} + \gamma X_{ijt} + \delta Z_j + d_t + u_i + \varepsilon_{i,t} \quad (4)$$

We estimate different models for three different outcome variables $Y_{ijt} < sub > < /sub >$ expressing the welfare of household *i* in village *j* at time *t:* that is income (specified in per capita and logarithm terms), poverty and vulnerability as defined in Section 3.2. The key explanatory variable I_{ijt} is either a measure of income diversification (SI) or off-farm income generation (share of off-farm income) for household *i* in village j at time *t* as defined in Section 3.2. Control variables include a vector of observable household characteristics, X_{ijt} (gender, age and education of the household head, number of adults and children, and land and livestock holdings), a vector of village characteristics, Z_j (altitude, distances to the road, market and forest), and a time fixed effect variable d_t to capture all the temporal variation in the region between 2014 and 2016 such as weather shocks and price variation. The vectors of control variables X_{ijt} and Z_j are not included in the regressions on vulnerability as the same variables are used to estimate the indicator. The error term includes a time-invariant component u_i and a time-variant component $\varepsilon_{i,t}$. Our main interest is in the coefficient βmeasuring the relation between income diversification and or off-farm income generation and household welfare. We explore possible non-linear relations by estimating Equation (4) with and without a quadratic term of I_{ijt}. To exploit both variability within and between households, we estimate the models using both fixed effects (FE) and random effects (RE) regression techniques. We use linear regression models; for the binary outcome indicator poverty this implies a linear probability model. We cluster the standard errors at village level and report robust errors. While in the FE model time-invariant unobserved heterogeneity is controlled for, the models might still suffer from reverse causality. We, therefore, interpret findings as associations rather than causal effects.

Second, we analyse heterogeneous welfare implications by including interaction terms between $I_{i,t}$ and $X_{i,t}$ in Equation (4). We include in separate models interaction terms between the SI or the share of off-farm income on the one hand, and gender, education and age of the household head, the number of adults in the household, and the household landholdings on the other hand. These models (Equation (5)) are estimated using RE regressions. The results allow to reveal whether the welfare effects of income diversification vary with certain characteristics of the household.

$$Y_{ijt} = \alpha' + \beta' I_{ijt} + \gamma' X_{ijt} + \delta' Z_j + \eta I_{ijt} X_{ijt} + d_t + u_i + \varepsilon'_{i,t} \quad (5)$$

Third, we analyse the heterogeneous welfare implications of income diversification and or off-farm income generation and we estimate the treatment coefficients at different quantiles of the welfare distribution. We use a fixed-effects panel quantile regressions to analyse the association between income diversification and off-farm income generation on income and vulnerability at different quantiles of the income and vulnerability distribution (Equation (6)).

$$q_\tau(Y_{ijt}|I_{ijt}X_{ijt}Z_j) = \beta_\tau I_{ijt} + \gamma_\tau X_{ijt} + \delta_\tau Z_j + d_t + u_i + \varepsilon_{i,t} \quad (6)$$

The term $q_\tau(Y_{ijt}|I_{ijt}X_{ijt}Z_j)$ is the τ^{th} conditional quantile of the outcome variable and τ ranges between zero and one. The coefficient β_τ represents the estimated change in the outcome variable of a change in the measure of income diversification and or off-farm income generation overtime at

the τ_{th} quantile of the outcome distribution. We apply 100 bootstrap replications on the estimation to correct the standard errors. This analysis is done only for continuous outcome variables, income and vulnerability.

4. Results

4.1 Household characteristics

In Table 1, we present descriptive statistics for the pooled sample of households and a mean comparison for households with slightly, moderately and highly diversified income portfolios. Nine percent of households in the sample are female-headed; the average education of the household head is 8.3 years and the average age 51 years. Households are rather large with on average of 4 members above the age of 14 and 2.6 members below the age of 14. Households with highly and moderately diversified income portfolios are less likely to be female headed and are larger. Land and livestock holdings are rather low with on average 1.76 ha of land and 2.2 tropical livestock units but are larger for households with moderately and highly diversified income portfolios. In addition, households with highly and moderately diversified income portfolios are located at lower altitude and further away from the forest.

4.2 Household welfare

Figure 1 depicts the correlation between income or vulnerability on the one hand and income diversification or the share of off-farm income on the other hand. There is some positive correlation between per capita income and the Simpson index of diversification or the share of off-farm income. There is no, or only a weak negative correlation between vulnerability and the Simpson index of diversification or the share off-farm income.

Figure 2 depicts an inverted u-shaped relationship between income diversification and the share of off-farm income. This relation results from how income diversification and off-farm income generation are defined. Yet, the figure clearly shows that, in our sample, a low level of income diversification might be associated with a small share of off-farm income (i.e., households specialising in agriculture) or with a large share of off-farm income (i.e., households moving out of agriculture and specialising in off-farm activities). This justifies our approach to differentiate between income diversification and off-farm income generation.

Table 1. Household characteristics across income diversification categories.

	Pooled sample	Slightly diversified	Moderately diversified	Highly diversified
Number of observations	916	363	509	44
Female HH head (%)	9.0	11.3	7.9*	2.3*
Education of HH head (years)	8.3 (0.15)	8.0 (0.24)	8.5 (0.21)	8.3 (0.75)
Age of HH head (years)	51.2 (0.48)	51.9 (0.76)	51.1 (0.64)	47.1** (1.98)
Number of adults	4.0 (0.07)	3.8 (0.10)	4.1** (0.10)	4.5** (0.36)
Number of children	2.6 (0.06)	2.4 (0.10)	2.6 (0.08)	3.1** (0.27)
Land size (ha)	1.76 (0.08)	1.4 (0.09)	1.9*** (0.12)	2.6*** (0.54)
Livestock units (TLU)	2.2 (0.07)	1.8 (0.12)	2.4*** (0.09)	3.2*** (0.35)
Altitude (ft.)	983.1 (16.6)	1060.2 (26.3)	945.4*** (22.0)	782.8*** (68.7)
Distance to forest (km)	4.3 (0.08)	3.9 (0.29)	4.1*** (0.10)	4.6*** (0.13)
Distance to market (km)	4.4 (0.10)	4.3 (0.16)	4.5 (0.14)	3.9 (0.41)
Distance to main road (km)	2.5 (0.06)	2.6 (0.09)	2.5 (0.08)	2.3 (0.24)

Notes: We use *t*-tests to compare households with moderately and highly diversified income portfolios with households with slightly diversified income portfolios. Significant differences are indicated with ***$p < .01$, **$p < .05$ or *$p < .1$. Standard errors of the mean are reported between parentheses. Adults refer to household members above the age of 14; children refer to household members aged 14 or below. One tropical livestock unit (TLU) equals 1 cow/horse, 0.8 donkey, and 0.2 sheep/goat.

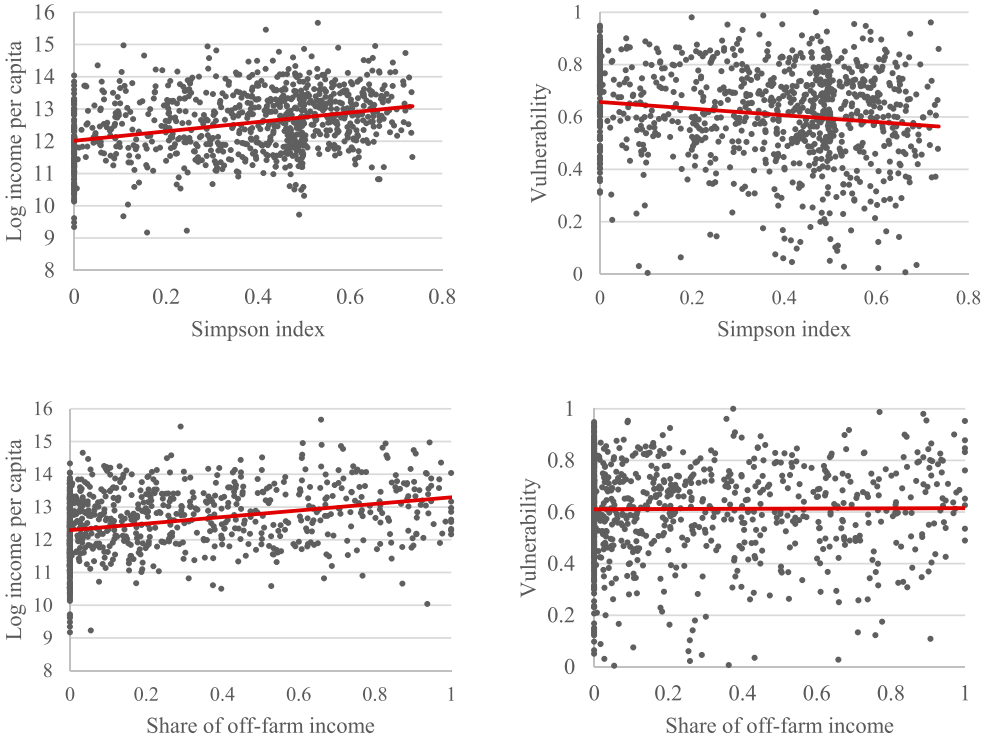

Figure 1. Correlation between income, vulnerability, income diversification (Simpson index) and the share of off-farm income.

In Table 2, we present descriptive statistics for income, poverty, vulnerability and the share of income from different sources for the pooled sample and subsamples. We report results of a mean comparison between 2014 and 2016, and between households with slightly, moderately and highly diversified income portfolios. Over the panel period, the average per capita income increased by 26%, income poverty reduced from 61% of sampled households to 54%, and the share of vulnerable households reduced from 64% to 59%. The share of income derived from cropping, the most important income source, decreased while the share of income derived from livestock and from non-labour transfers increased. Households with moderately and highly diversified income portfolios have on average significantly higher total and per capita incomes, are less likely to be poor and vulnerable, and derive a smaller share of income from cropping but a higher share from

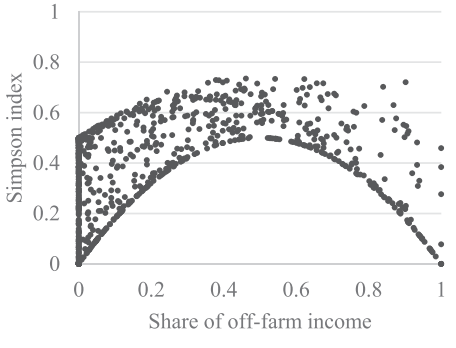

Figure 2. Relationship between income diversification (Simpson index) and the share of off-farm income in total household income.

Table 2. Income, poverty and vulnerability over time (2014–2016) and across income diversification categories.

	Pooled sample	2014 sample	2016 sample	Slightly diversified	Moderately diversified	Highly diversified
Number of observations	916	458	458	363	509	44
Household income (1,000 UGX)	2536 (2452)	2453 (2198)	2,618 (2683)	1860 (2029)	2860*** (2494)	4357*** (3364)
Per capita income (1,000 UGX)	442 (508)	391 (375)	494*** (609)	344 (417)	596*** (552)	629*** (515)
Poor households (%)	47.4	61.4	54.1***	62.5	39.3***	15.9***
Vulnerable households (%)	61.2	63.6	58.7***	64.4	59.3***	56.5***
Share of income from (%)						
Cropping	51.9 (33.1)	56.5 (30.0)	47.4*** (35.3)	68.2 (40.2)	42.6*** (21.6)	25.5*** (11.4)
Livestock	23.2 (27.1)	20.1 (25.1)	26.3*** (28.7)	14.2 (29.3)	29.4*** (24.5)	25.4*** (14.4)
Non-farm business	6.1 (15.4)	6.5 (14.3)	5.7 (16.4)	2.0 (12.2)	7.7*** (16.3)	20.9*** (15.3)
Wage employment	4.9 (17.9)	5.0 (18.0)	4.8 (17.8)	4.6 (19.7)	4.8 (16.8)	7.3 (13.9)
Forest products	1.1 (6.3)	1.2 (6.8)	1.1 (5.8)	0.3 (1.6)	1.7*** (8.1)	2.3*** (5.7)
Non-labor transfers	12.7 (22.7)	10.8 (17.4)	14.7*** (26.8)	10.6 (26.1)	13.8** (20.5)	18.4* (13.1)

Notes: We use *t*-tests to compare household in 2014 and 2016; and to compare households with moderately or highly diversified income portfolios with households with slightly diversified income portfolios. Significant differences are indicated with * $p < .1$, ** $p < .05$ or *** $p < .01$. Standard deviations are reported between parentheses.

livestock, non-farm businesses, forest products and transfers than households with a slightly diversified income portfolio.

4.3 Welfare implications

In Table 3, we present a summary of the estimated coefficients on income diversification and off-farm income generation from FE and RE estimations. The full regression results are reported in Tables A2–A5 in the Appendix. The FE and RE estimations are very consistent; implying that within household variation drives the results. The results reveal that income diversification and off-farm income generation are associated with a higher household per capita income, and a lower probability to be poor or vulnerable to poverty – with the latter result only being significant for the SI and not for the share of off-farm income. The estimated coefficients are quite strong. We find that, on average, a 10-percentage point (pp) higher SI of diversification is associated with a 13% higher per capita income and a 5 pp lower likelihood to be poor on average. Likewise, a 10 pp higher share of off-farm income is, on average, associated with a 12–15% higher per capita income and a 4.2–4.9 pp lower likelihood to be poor.

We find an indication of a quadratic relation for the share of off-farm income and per capita income (only significant in the RE estimation). We find significant coefficients for the quadratic terms for vulnerability, for both the SI and the share of off-farm income and in both the FE and RE models. The results imply that vulnerability decreases with an increasing SI but at a decreasing rate; and that vulnerability reduces with an increasing share of off-farm income up to a certain point (about 0.4 in the vulnerability distribution), after which the relation reverses and vulnerability increases with further increases in the share of off-farm income.

In Table 4, we present a summary of the estimated heterogeneous association between income diversification and or off-farm income generation and per capita income or income poverty from RE estimations with interaction terms. The full regression results are reported in Tables A6–A10 in the Appendix. The results show that per capita income is significantly larger and poverty significantly less likely for smaller households with more land and a better--educated household head. The interaction terms reveal that the positive association between income diversification and the level of income is less strong for households with more land and an older household head. Also, the negative

Table 3. Summary of fixed (FE) and random effects (RE) regression results estimating the average and quadratic relations between income diversification or off-farm income generation and per capita income, poverty or vulnerability.

	Per capita income (log)		Poverty (binary)		Vulnerability	
	FE	RE	FE	RE	FE	RE
Simpson index	1.323*** (0.160)	1.364*** (0.129)	−0.507*** (0.088)	−0.496*** (0.070)	−0.073*** (0.025)	−0.099*** (0.022)
Simpson index	0.996* (0.551)	1.493*** (0.432)	−0.324 (0.302)	−0.351 (0.235)	−0.197** (0.088)	−0.197** (0.076)
Simpson index^2	0.509 (0.820)	−0.201 (0.645)	−0.285 (0.449)	−0.227 (0.351)	−0.193** (0.131)	−0.153** (0.113)
Share of off-farm income	1.576*** (0.123)	1.232*** (0.091)	−0.491*** (0.072)	−0.424*** (0.050)	−0.013 (0.022)	−0.001 (0.017)
Share of off-farm income	1.885*** (0.350)	1.997*** (0.289)	−0.487** (0.206)	−0.590*** (0.163)	−0.109* (0.061)	−0.125** (0.053)
Share of off-farm income^2	−0.411 (0.436)	−0.974*** (0.349)	−0.005 (0.257)	0.210 (0.196)	0.127* (0.077)	0.162** (0.065)

Full regression results are reported in Appendix Tables A2–A5. Bootstrapped standard errors clustered at village level are reported in parentheses. Significant coefficients are indicated with *$p < .1$, **$p < .05$ or ***$p < .01$.

Table 4: Summary of random effects regression results estimating the heterogeneous relation between income diversification or off-farm income generation and per capita income or poverty.

	Per capita income (log)		Poverty (binary)	
	I = Simpson index	I = share off-farm income	I = Simpson index	I = share off-farm income
Diversification (I)	1.199*** (0.248)	1.019*** (0.181)	−0.480*** (0.135)	−0.337*** (0.100)
$I \times$ Education HH head	0.021 (0.027)	0.045*** (0.017)	0.002 (0.014)	−0.013* (0.007)
Education HH head	0.021* (0.012)	0.019** (0.009)	−0.015** (0.006)	−0.012** (0.005)
Diversification (I)	1.605*** (0.161)	1.290*** (0.108)	−0.610*** (0.087)	−0.473*** (0.060)
$I \times$ Land size	−0.148** (0.059)	−0.038 (0.037)	0.070** (0.032)	0.032 (0.021)
Land size	0.084*** (0.030)	0.031** (0.015)	−0.040** (0.016)	−0.019** (0.008)
Diversification (I)	1.379*** (0.135)	1.235*** (0.094)	−0.496*** (0.073)	−0.427*** (0.052)
$I \times$ Female HH head	−0.163 (0.442)	−0.037 (0.344)	0.0002 (0.241)	0.048 (0.190)
Female HH head	−0.031 (0.182)	- 0.036 (0.136)	0.112 (0.099)	0.088 (0.072)
Diversification (I)	2.438*** (0.457)	1.623*** (0.324)	−0.688*** (0.249)	−0.638*** (0.180)
$I \times$ Age HH head	−0.021** (0.009)	−0.008 (0.006)	0.004 (0.005)	0.004 (0.003)
Age HH head	0.005 (0.004)	−0.001 (0.003)	0.001 (0.002)	0.001 (0.002)
Diversification (I)	1.295*** (0.265)	1.489*** (0.169)	−0.495*** (0.144)	−0.545*** (0.095)
$I \times$ Number of adults	0.017 (0.058)	0.065* (0.036)	−0.0002 (0.032)	0.031 (0.020)
Number of adults	−0.113*** (0.027)	−0.081*** (0.018)	0.044*** (0.015)	0.032*** (0.010)

Notes: Full regression results are reported in Appendix Tables A7–A11. Bootstrapped standard errors clustered at village level are reported in parentheses. Significant coefficients are indicated with * $p < .1$, ** $p < .05$ or *** $p < .01$.

Table 5. Summary of quantile fixed effects regression results estimating the relation between income diversification or off-farm income generation and per capita income or vulnerability at different quantiles.

	Q10	Q25	Q50	Q75	Q90
Per capita income (log)					
Simpson index	2.081*** (0.117)	1.320*** (0.182)	1.307*** (0.205)	1.153*** (0.151)	0.961*** (0.227)
Share of off-farm income	1.406*** (0.104)	1.394*** (0.212)	1.371*** (0.170)	1.215*** (0.126)	1.174*** (0.154)
Vulnerability					
Simpson index	−0.104* (0.058)	−0.096*** (0.033)	−0.085*** (0.027)	−0.071** (0.035)	−0.050** (0.025)
Share of off-farm income	−0.064** (0.026)	−0.058** (0.025)	−0.055** (0.027)	−0.028 (0.019)	−0.028 (0.072)

Notes: Full regression results are reported in Appendix Tables A12–A15. Bootstrapped standard errors clustered at village level are reported in parentheses. Significant effects are indicated with * $p < .1$, ** $p < .05$ or *** $p < .01$.

correlation between income diversification and the likelihood to be poor is less strong for households with more land. Off-farm income generation is positively correlated with per capita income and negatively with the likelihood to be poor, and these correlations are stronger for better-educated households.

In Table 5, we report the results of the quantile fixed effects regressions estimating the relation between income diversification or off-farm income generation and per capita income or vulnerability at different quantiles of the income and vulnerability distribution. The full regression results are reported in Tables A11–A14 in the appendix. We find that both the SI and the share of off-farm income are positively associated with per capita income at all quantiles of the income distribution, and significant negatively correlated with vulnerability at almost all quantiles of the vulnerability distribution. Income diversification and off-farm income generation have the strongest positive correlation with per capita income at the lowest income quantile and the strength of the association decreases along with the income distribution. This implies that households at the lower end of the income distribution benefit relatively more from diversifying away from agriculture than households at the upper end of the income distribution. The coefficients for SI vary more strongly along with the income distribution than the coefficients for the share of off-farm income. The estimated coefficients on income diversification for the lower-income quantile is more than double the estimated coefficient for the upper-income quantile while the estimated coefficient on a share of off-farm income for the lower-income quantile is only 23% higher than the estimated coefficient for the upper-income quantile. The negative correlation of SI and off-farm income generation with vulnerability is strongest for the lowest vulnerability quantile and becomes weaker along with the vulnerability distribution, which implies that the most vulnerable households benefit least from income diversification and off-farm income generation.

5. Discussion

We find that income diversification as well as off-farm income generation are associated with improved rural incomes and reduced poverty. The associations we find are quite strong with a 10-percentage point higher Simpson index or share of off-farm income, associated with, on average, a 13% higher per capita income and a 5-percentage point lower probability to be poor. These quite strong welfare implications are in line with findings from other studies (e.g., Bezu, Barrett, and Holden 2012; Dzanku 2018; Kumanayake, Estudillo, and Otsuka 2014; Loison 2019; Lanjouw and Lanjouw 2001; Perez, Bilsborrow, and Torres 2015; Reardon et al. 2006) but contradict findings from studies pointing out that income diversification is not associated with higher income or reduced poverty (e.g., Bryceson 2002; Dercon 2002; Ellis, 2000; Reardon et al. 2006). Our findings imply that in the Mount Elgon region in Eastern Uganda, diversifying income portfolios away from crop and livestock production on the own household farm, is in general associated with income growth, and that the ongoing rural structural transformation process is pro-poor.

Moreover, we find that relations between income, income diversification and off-farm income generation are heterogeneous across households. First, we find that it is particularly more beneficial for households at the lower end of the income distribution to diversify their income portfolio, and for younger households and household with less land. Second, we find that it is more beneficial for larger and more educated households to move out of agriculture, and that the correlation between off-farm income generation and income levels varies less strongly along with the income distribution. These heterogeneous results indicate that income diversification and off-farm income generation indeed have slightly different welfare implications. Our findings contradict previous conclusions in the literature that only relatively wealthier households are able to gain from rural income diversification (Bezu, Barrett, and Holden 2012; Canagarajah et al., 2001; Ruben and Van den Berg, 2001) and that specifically resource-poor households with low farm profit potential should move out of agriculture (Gautam and Anderson 2016; Perez, Bilsborrow, and Torres 2015; Rigg 2006; Van den Broeck and Maertens 2017). Our findings imply that especially low-income households with less assets (land) can gain from diversifying their income portfolio with agricultural and non-agricultural activities while households with human capital (labour as well as education), irrespective of their income level, can gain from moving out of agriculture. This more nuanced conclusion results from distinguishing explicitly between income diversification and off-farm income generation in this study.

We find that both income diversification and off-farm income are associated with reduced vulnerability of rural households. This is in line with previous studies indicating a negative effect of off-farm income generation on vulnerability (Imai, Gaiha, and Thapa 2015; Zereyesus et al. 2017) but our findings also add nuances. We find that income diversification correlates with higher per capita income and lower vulnerability at all income levels. Off-farm income generation is associated with higher per capita income at all income levels, but is only associated with reduced vulnerability for households at the lower 50% of the income distribution and not for households at the upper 50% of the income distribution. In addition, we find that income diversification is negatively correlated with vulnerability and that this correlation is stronger at higher levels of income diversification. Off-farm income generation is only associated with lower vulnerability at low levels of off-farm income and is associated with higher vulnerability at higher levels of off-farm income. These quadratic and heterogeneous relations imply that income diversification serves both income growth and income smoothing while off-farm income generation mainly serves income growth. In rural societies where agriculture is the main income source, moving out of agriculture at first may result in income diversification but ultimately may lead to specialisation in off-farm activities. Income diversification and off-farm income shares are correlated only at lower levels of off-farm income generation and ultimately have different welfare implications, as observed in our research area. By including ex-post income and poverty measures and ex-ante vulnerability measures in the analysis, we are able to disentangle the diverse implications of income diversification and off-farm income generation.

6. Conclusion

In this study, we empirically analyse the relation between household welfare on the one hand and income diversification and off-farm income on the other hand. We use household survey data from two-panel rounds in the Mount Elgon region in rural Uganda and fixed and random effects estimation and quantile regressions. While the literature mostly focuses on either income diversification or participation in off-farm activities, we specifically include and distinguish between income diversification and off-farm income generation. We use income and poverty as well as vulnerability to analyse the welfare implications of income diversification and off-farm income generation. Our results lead to nuanced findings that complement existing insights. We find that on average income diversification and off-farm income generation are associated with improved rural incomes, reduced poverty and reduced vulnerability of rural households. We find that it is most

beneficial for poorer households with less land assets to diversify their income portfolio while moving out of agriculture is more equally beneficial at all income levels and most beneficial for households with more human capital. In addition, we find that income diversification is most strongly related to reduced vulnerability at high levels of diversification and low levels of income while off-farm income generation is associated with reduced vulnerability only at low levels of income and is even associated with higher vulnerability at higher levels of off-farm income generation. We conclude that income diversification serves both income growth and income smoothing while off-farm income generation mainly serves income growth.

We need to acknowledge that our results are case study specific and derived from a region with increasing pressure on land. The focus on income diversification in the Mount Elgon region is justified by the pressing need to divert to less land-dependent income-generating activities. To better understand rural income portfolios, studies should distinguish better between income diversification and off-farm income generation, and move beyond the estimation of average welfare effects. Also, the combination of static income and poverty measures with a dynamic vulnerability measure in an empirical welfare analysis, is a particularly interesting avenue to better understand income portfolios and their welfare implications.

Notes

1. With *t*-tests for continuous variables and *z*-tests for binary variables no significant differences (at the 10% level) in observed characteristics could be detected between dropout households and panel households.
2. We only distinguish six rather broad income sources because our focus is on diversification towards non-farm income, which does not require more detail, and because the coffee-banana intercropping system that is the dominant farming system in the research area does not allow to easily attribute input costs to different crops to calculate crop income separately for different food or cash crops.

Acknowledgement

The authors thank Alice Nakiyemba Were and John Sekajugo for support with data collection.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Flemish Interuniversity Council – University Development Cooperation (VLIR-UOS) (grant number ZEIN2013PR398 UGANDA), and the KU Leuven Research Fund (grant number OT/13/055).

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