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Income diversification and household welfare in Uganda 1992–2012

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ABSTRACT

We use five waves of household surveys in Uganda, from 1992/3 to 2011/12, to study income diversification and its effect on the welfare of rural and urban households during a period of sustained economic growth and poverty reduction, comparing the 1990s to the 2000s, and disaggregating by gender of the household head. Diversification is measured in terms of access to incomes from agriculture (farming), agricultural wage, self-employment (informal), wage employment and remittances. The analysis shows substantial and evolving variation in the effects of diversification across rural/urban locations and gender of the household head. Diversification became increasingly beneficial for welfare over time in rural areas, particularly for male headed households, but not for female headed households that diversified into agricultural wage employment. Diversification was also important for the livelihoods of urban households, but with large differences across male and female headed households likely reflecting differentials in the returns to non-agricultural employment. Remittances were associated with increasing welfare in the 2000s for all households, although the proportion of households receiving remittances has been declining.

1. Introduction

Many studies show that there is a positive relationship between income diversification and household welfare in sub-Saharan Africa (SSA) (Alobo Loison, 2015) as diversification plays an important role in household livelihood strategies (Asfaw et al., 2019; Van den Broeck and Kilic, 2019). Much of the literature focusses on farming households engaging in nonfarm activities (Reardon et al., 1992; Ellis, 1998; Reardon et al., 2007; Davis et al., 2010). Davis et al. (2017) show that while agriculture remains the main source of income for rural African households, diversification into nonfarm employment is increasing. Van den Broeck and Kilic (2019) also consider diversification into nonfarm employment for five SSA countries (including Uganda), noting that women are less likely to participate in off-farm wage employment and when they do it is most likely to be casual wage work in agriculture. Their analysis is based on individual-level data, over a relatively short period (2010–14 in the case of Uganda), and does not relate diversification to a measure of household welfare. In contrast, for Uganda, we analyse diversification at the household level over a relatively long period (1992–2012) of sustained economic growth and relate this to household welfare, measured in terms of adult equivalent consumption expenditure (which can be consistently and comparably measured across the surveys).

To investigate household income diversification and welfare over two decades we use five Ugandan national household surveys, with panel data for the 1990s (the 1992/93 and 1999/00 surveys) and the 2000s (surveys in 2005/06, 2009/10 and 2011/12). Five sources of household income are considered: remittances, own account agriculture (farming), and off-farm employment disaggregated into agricultural wage, non-agricultural self-employment, and non-agricultural wage. The welfare effect of diversification is conceptualised and analysed in two ways, both addressing endogeneity arising from time-varying unobserved heterogeneity. Firstly, to estimate the overall effect of households diversifying into an additional income source, we use a panel instrumental variable (IV) procedure combining leave-out mean instruments (Townsend, 1994) with heteroscedasticity-based instruments (Lewbel, 2012). Secondly, the core analysis employs panel multinomial endogenous switching (PMES) regressions (Bourguignon et al., 2007; Khonje et al., 2018) to estimate the average treatment effect on the treated (ATT) for adopting different diversification strategies. We conduct separate analysis for rural and urban households and, when estimating the ATT of different diversification strategies, we also separate by the sex of the household head. We acknowledge that this is not a gender analysis, which requires addressing intra-household behaviour: 'Gender refers to relations between men and women, not an exclusive

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focus on women … [and a focus on the head being female] confounds gender issues with those of household structure' (Quisumbing and Doss, 2021, pp. 4482). Rather, we provide analysis distinguishing between households headed by males and females.

Our approach extends existing studies and addresses the limitations of studies that only demonstrate correlations given the difficulties of accounting for endogeneity and unobserved heterogeneity using cross-section data. Most studies are cross-sections or only cover a short period of time, hence are unable to capture the changing dynamics in employment opportunities and welfare, especially in the decades after 1990 when many SSA countries experienced sustained economic growth, and most only focus on rural households. In contrast, we include urban households and cover two decades with panel data. Uganda is an interesting country in this regard because in the two decades from 1990 it sustained economic growth, improvements in household welfare, and reductions in poverty, driven by increased production in agriculture in the 1990s (Appleton, 2001). Headcount poverty according to the national poverty line fell from 56% in 1992 to 31% in 2006 (Kakande, 2010, pp. 237-8).

Our analysis provides three key findings. First, the type of diversification and effects on welfare vary by the gender of the household head (although we consider income sources of all members aged over 14). Second, diversification plays an important role in the livelihoods of urban households, where welfare effects are different than in rural areas. In rural areas, off-farm diversification is welfare improving except for females in agricultural wage employment. In urban areas, off-farm employment provides the highest welfare improvement for male headed households whereas farming has the highest welfare improvements for female headed households. Third, the pattern of diversification and its welfare impact differs in the 2000s compared to the 1990s, notably remittances are associated with higher welfare only in the 2000s.

Section 2 provides a brief overview of related literature on diversification in Uganda. Section 3 presents the conceptual framework and empirical strategy. Section 4 discusses the data and how measures of income diversification are constructed, with descriptive statistics. Results of the combined IV and panel multinomial endogenous switching estimation are in Section 5. Section 6 concludes with directions for further research.

2. Background and literature

Existing literature on income diversification tends to focus on nonfarm activities in rural areas (e.g., Reardon et al., 2007) or the emergence of household enterprises in urban areas (e.g., Fox and Sohnesen, 2012). The literature on rural income diversification focuses on off-farm opportunities including agricultural wage and nonfarm employment (Reardon et al., 1992; Reardon, 1997; Ellis, 1998; Davis et al., 2010). Davis et al. (2017), examining many countries from SSA (including Uganda), conclude that off-farm diversification is likely to be welfare enhancing. However, their analysis focuses only on rural households, only considers the primary source of household income and does not consider household welfare, and uses only two rounds of data for Uganda, 2005/06 and 2009/10.

Van den Broeck and Kilic (2019) investigate off-farm employment from a gender perspective for five SSA countries, including Uganda (albeit for a much shorter period and not related to welfare). In the case of Uganda, they find that women are less likely to participate in off-farm wage employment; those that do are engaged mostly in less remunerative agricultural wage labour. Antonelli et al. (2022), analysing rural Ugandan farmers' welfare and exposure to climatic shocks, find that crop and income diversification can increase welfare by reducing climate risk.

Rural nonfarm employment may not reduce poverty as the low-skilled (especially females) cannot access high paying jobs, although such opportunities may prevent incomes declining further for the poor (Lanjouw, 2007). This justifies investigating the link between welfare and income diversification for types of households over an extended period. Analysis considering crop and income diversification for farming households in Malawi, Niger and Zambia (data for various years between 2010 and 2015) finds that 'income diversification is a welfare enhancing strategy in all the three countries' (Asfaw et al., 2019, pp. 286).

Household-based business activities have become an important source of non-agricultural income diversification in urban areas. Fox and Sohnesen (2012) define household enterprises (HEs) as own-account enterprises in non-agricultural sectors that may employ family members as distinct from microenterprises defined as employing at least one non-family member; in broad terms HE 'owners' correspond to individuals recorded as self-employed without employees in labour force surveys (although the two categories can differ). Household enterprises generated most new jobs outside agriculture, and in Uganda had a greater marginal effect on household consumption than private wage employment, but a lower effect than public wage or microenterprises (Fox and Sohnesen, 2012: Table 3, pp. 26). However, this is a finding for a particular year (2005/06) and may not reflect trends over a longer period.

3. Conceptual framework and empirical strategy

The sustainable rural-livelihoods framework (Ellis, 1998) emphasises the role of assets/capital (physical, human, natural, social, and financial) and households' access to different employment opportunities in determining their earning activities. It emphasises households' dual objectives of maximising welfare and coping with risks related to agricultural production and market shocks. This framework can be extended to risks faced by urban households, especially those associated with informal employment. To assess the relationship between income diversification and welfare we use a standard reduced form model of household consumption (Glewwe, 1991; Appleton, 1996):

$$lCons_{it} = \alpha_i + X_{it}\varpi + H_{rt} + \xi_{it} \quad (1)$$

where welfare of household i at time t is measured using log of adult equivalent consumption ($lCons_{it}$); α_i captures unobserved heterogeneity arising from productivity or innate ability of members, their risk attitudes, social networks, and other time invariant factors; and X_{it} is a vector of household characteristics including household size, log of household assets, region, urban or rural location, and characteristics of the head (age, gender, years of education, and marital status). As consumption is measured in current survey year prices, we include H_{rt}, a dummy interaction term between region and year to account for regional differences in inflation across survey years.

Equation (1) is used to assess the effects of diversification on welfare, where diversification is measured in two different ways (see Section 4). Firstly, ID is a count of the total number of the five different income sources households reported. Including ID in (1) shows the welfare effect of households diversifying into an additional income source. Secondly, as the nature of income sources and their welfare effects may vary and change over time, we assess the welfare effects of different diversification strategies by categorising households into mutually exclusive diversification strategies, with different categorisations for rural and urban households.

Many forms of capital affecting diversification choice are captured in X_{it} (e.g. household assets, education level) and α_i controls for time invariant forms of social capital and access. However, estimating the welfare effects of diversification using either measure is difficult due to the presence of unobserved time-varying factors, such as liquidity constraints and expenditure shocks, which affect both welfare outcomes and diversification choices. We resolve this issue in different ways for each measure.

For ID, we estimate the local average treatment effect of diversifying into an additional income source using an instrumental variables (IV)

procedure that combines external instruments using the leave-out mean approach (Townsend, 1994; Asfaw et al., 2019) with generated instruments using Lewbel's (2012) heteroskedasticity-based method. The generated instruments are used to increase efficiency and provide overidentifying information as the leave-out mean instrument is exactly identified. For analysing different diversification strategies, we use panel multinomial endogenous switching (PMES) estimation to calculate the average treatment effect on the treated (ATT) for adopting a specific strategy. The details of each estimation procedure are given below.

3.1. Combined IV estimation procedure

To estimate the local average treatment effect (LATE) of increasing the number of income sources on household welfare, we utilise a combined panel IV procedure to estimate the following model of household welfare:

$$lCons_{it} = \alpha_i + ID_{it}\mathrm{B} + M_{it}\Gamma + X_{it}\Omega + H_{rt}\Phi + u_{it} \quad (2)$$

where $lCons_{it}$ measures welfare of household i at time t; ID_{it} the count of household income sources; and M_{it} is a vector of dummy variables capturing the main labour activity of the household head (included as the head's main activity may affect access to additional income sources); X_{it}, α_i, and H_{rt} are as before.

Finding valid external instruments to address time-varying unobserved heterogeneity is difficult given they need to be relevant for both farm and off-farm income sources and across survey waves with varying questionnaires. The IV procedure uses the leave-out mean approach where the mean *ID* score of other households in the enumeration area is used as an instrument for a household's own *ID* score. The leave-out mean of the local area will be correlated with the household's own *ID* as it captures local employment/earning conditions but is not expected to be directly related to household welfare. However, because most of the variation is at the community level, there may be concerns regarding efficiency and potentially weak correlation if supply factors are more important than local demand in determining employment. Measurement error may also be a concern as data are available only for 10–15 neighbouring households in an enumeration area. Hence, we supplement the leave-out mean instrument with heteroskedasticity-based instruments (HI) following Lewbel (2012). Lewbel's approach achieves identification when there are some exogenous variables in the structural equation (for our model this includes predetermined variables such as age, gender, and region) and errors in the first-stage regression are heteroskedastic. Instruments are generated by multiplying the exogenous variables that have been centred at their respective means with the residuals from the first-stage regression. The greater the degree of heteroskedasticity in the first stage regression the stronger the correlation between the instruments and endogenous variable. Lewbel (2018) shows that the HI approach is also valid for discrete endogenous variables like *ID*.

While HI can be used on their own, they are less efficient and reliable than conventional instruments as they are generated using higher moments. However, they can supplement external instruments, particularly when such instruments are weak, as this improves efficiency and allows testing overidentifying restrictions for exactly identified models such as ours (Lewbel, 2012). The test statistics are reported for our results (Table 2 below) and bootstrapped standard errors are used as the combined IV procedure utilises generated instruments.

3.2. PMES estimation

The first step of the PMES conceptualises the decision of the ith household at time t to adopt specific diversification strategy j as one that maximises the household's expected utility over all other alternative strategies $m \neq j$. Therefore, the probability that household i at time t chooses diversification strategy j is equal to:

$$Prob\left(D_{it}^{j}=j|X_{it},L_{it},\bar{x}_i,H_{rt}\right) = \frac{exp\left(\alpha_j + X_{it}\beta_j + L_{it}\gamma_j + \bar{x}_i\delta_j + H_{rt}\pi_j\right)}{\sum_{k\neq j} exp(\alpha_k + X_{it}\beta_k + L_{it}\gamma_k + \bar{x}_i\delta_k + H_{rt}\pi_k)} \forall\, j = 1,2,\cdots,5 \quad (3)$$

where X_{it} is again the vector of household characteristics, L_{it} is the vector of selection instruments that accounts for local demand for different types of employment and availability of income sources, $\bar{x}_i$ is the Chamberlain-Mundlak device (Mundlak, 1978) containing means of time-varying covariates in X_{it} to account for unobserved heterogeneity, and H_{rt} is a vector of region-time dummies accounting for spatial and temporal differences. Parameters β_j, γ_j, δ_j, and π_j are estimated using a multinomial logit model.

The second stage of the PMES involves estimating separate OLS models of the welfare outcome for each of the five diversification strategies. The welfare outcome equations for the five regimes are given as:

$$\begin{cases} lCons_{it}^{1} = \alpha_1 + X_{it}^{1}\varphi_1 + \bar{x}_i^{1}\theta_1 + H_{rt}^{1}\zeta_1 + \widehat{\lambda}_{it}^{1}\sigma_1 + \varepsilon_{it}^{1} \\ \qquad\qquad \vdots \quad \vdots \\ lCons_{it}^{5} = \alpha_5 + X_{it}^{5}\varphi_5 + \bar{x}_i^{5}\theta_5 + H_{rt}^{5}\zeta_5 + \widehat{\lambda}_{it}^{5}\sigma_5 + \varepsilon_{it}^{5} \end{cases} \quad (4)$$

where $lCons_{it}^{j}$ is the welfare outcome of household i at time t with diversification strategy j, $\widehat{\lambda}_{it}^{j}$ are the inverse Mills ratios computed from the estimated probabilities in (3) that are included to control for selection bias from time-varying unobserved heterogeneity. X_{it}, $\bar{x}_i$, and H_{rt} are as before.[1] ε_{it}^{j} are normally distributed error terms but are likely to be heteroskedastic due to generated regressors used in the two-step procedure, hence bootstrapped standard errors are required, for which we use 1000 replications.

For the models in (4) to be identified, selection instruments are required in the first stage in (3) in addition to those automatically generated by the nonlinearity of the selection model (Di Falco, 2014; Khonje et al., 2018). Hence, L_{it} is only included in (3) to meet this exclusion restriction. The selection instruments used are all leave-out mean instruments that account for local access to different income sources and employment. For rural households we use four instruments: the proportion of households in the enumeration area with access to remittances excluding the reporting household (LOM Remittances, to capture household members' access to migration opportunities), and three variables based on the average proportion of adults of working age in the enumeration area, excluding those from the reporting household, employed in non-agricultural self-employment (LOM NAS, captures local economic conditions for self-employment), non-agricultural wage (LOM NAW), and agricultural wage employment (LOM AW) - the latter two capture local demand for wage labour. For urban households, we use all four instruments and include a variable for the proportion of households in the enumeration area engaged in own account agriculture excluding the reporting households (LOM Farm). Shackleton et al. (2020) highlight the importance of urban farming in SSA, with practices such as buying/renting of arable land or animal husbandry being common, meaning such activities can be selected into even without prerequisite endowments.

As the selection instruments capture local access to the different income sources, they are unlikely to directly influence household welfare except through the adoption decision. We run a simple falsification test (Di Falco et al, 2011; Khonje et al., 2018) to assess the validity of these instruments. Results confirm the validity of these instruments in all the models we estimate, with the instruments jointly affecting the

[1] The main labour activity of the head (M_{it}) included in (2) is excluded in the PMES due to collinearity with diversification strategies.

selection decision (see Appendix Tables A6-A11) but not household welfare (see Appendix Tables A12a – A12c).[2]

3.2.1. Estimation of ATT

The PMES procedure estimates ATT by allowing for counterfactual outcomes. As the base diversification category ($j = 1$) is that of specialisation in one income source (farming for rural households, off-farm employment for urban), we can estimate the ATT of diversifying into an additional income source. ATT are calculated as the difference between the expected actual outcomes and the counterfactual of adopting a different strategy. The actual outcomes for mean welfare are computed as:

$$\begin{cases} E\left[lCons_{it}^{2}|j=2\right] = \alpha_2 + X_{it}^{2}\varphi_2 + \bar{x}_i^{2}\theta_2 + H_{rt}^{2}\zeta_2 + \hat{\lambda}_{it}^{2}\sigma_2 \\ \qquad\qquad \vdots \quad \vdots \\ E\left[lCons_{it}^{5}|j=5\right] = \alpha_5 + X_{it}^{5}\varphi_5 + \bar{x}_i^{5}\theta_5 + H_{rt}^{5}\zeta_5 + \hat{\lambda}_{it}^{5}\sigma_5 \end{cases} \tag{5}$$

The counterfactual outcomes of non-specialised households (j greater than 1) if they had specialised in the base income source are:

$$\begin{cases} E\left[lCons_{it}^{1}|j=2\right] = \alpha_1 + X_{it}^{2}\varphi_1 + \bar{x}_i^{2}\theta_1 + H_{rt}^{2}\zeta_1 + \hat{\lambda}_{it}^{2}\sigma_1 \\ \qquad\qquad \vdots \quad \vdots \\ E\left[lCons_{it}^{1}|j=5\right] = \alpha_1 + X_{it}^{5}\varphi_1 + \bar{x}_i^{5}\theta_1 + H_{rt}^{5}\zeta_1 + \hat{\lambda}_{it}^{5}\sigma_1 \end{cases} \tag{6}$$

The ATT, shown in (7), can be interpreted as the average percentage change in welfare for diversifying households that decide not to be specialised. A final diversification strategy ($j = 5$) is included for completeness to capture households without any income from the base income source; as such, it is likely to be set by initial endowments and may not be a viable diversification strategy for specialised households. Nevertheless, comparisons with such households give insights into the opportunities and their associated welfare outcomes.

$$E\left[lCons_{it}^{j}|j=J\right] - E\left[lCons_{it}^{1}|j=J\right] \tag{7}$$

4. Measuring diversification and summary statistics

The analysis combines five surveys collected by the Uganda Bureau of Statistics (UBoS): the 1992/93 Integrated Household Survey (IHS), the 1999/00 Uganda National Household Survey (UNHS), and three waves of the Ugandan National Panel Survey (UNPS) using data for 2005/06, 2009/10, and 2011/12. This allows coverage of the twenty years from 1992 to 2012, which we roughly split into the 1990s (1992–2000) and 2000s (2005–12). Although the different waves have similar sampling designs and coverage, the phrasing of some questions varies, so we use information on labour activities common to all surveys. The 1992/93 IHS and 1999/00 UNHS comprise a panel of 1,398 households, from which 1,095 have the required data in both waves. The three waves of UNPS contain 2,344 (2005/06), 2,376 (2009/10), 2,152 (2011/12) households with the requisite data, with more than three quarters of those sampled being observed in all three periods. Attrition is modest at 5–10 per cent except for urban households in the 2000s; allowing for replenishment using split-off households, attrition is around five per cent or less for the rural samples (see Appendix Table A1).

Given the changing nature of the survey questionnaires, especially regarding incomes and labour market activities, we focus on income sources that can be consistently tracked across the surveys and are comparable across both urban and rural households for the national level analysis. This gives five separate household income sources: labour activities are classified into agriculture (farming), agricultural wage (AW), non-agricultural self-employment (NAS)[3]and non-agricultural wage (NAW). We also distinguish between off-farm employment (comprising AW, NAS and NAW) and non-agricultural employment (only NAS and NAW) when exploring different diversification strategies. Research on income diversification in rural areas has shown the importance of migrant remittances for livelihoods (Wouterse and Taylor, 2008), so remittances are included as a fifth source of income.

Income diversification can be measured in various ways. With only two income sources, shares are appropriate and a common approach for rural households is to use the nonfarm share in total income (Reardon et al., 1992; Davis et al., 2010). With more than two sources of income, two approaches are common – count or weighted shares. We construct discrete indicator variables based on counts of number of income sources to create our overall measure of household income diversification (Dercon and Krishnan, 1996; Abdulai and CroleRees, 2001). The alternative Herfindahl index measure based on earnings shares from multiple sources (Asfaw et al., 2019) is not feasible given insufficient data on earnings from the different income sources.

Creating a measure of diversification at the individual level is difficult; depending on the survey, individuals can list up to two, three or four different activities of varying recall periods, implying that the measure of individual diversification depends on the survey design. The type of employment (wage/self-employment or agricultural/non-agricultural) for each worker can be calculated more reliably, so we classify each worker in each type of employment as a different source of income. We use only the first two reported activities to be consistent across waves. Although two workers in wage jobs can be seen as two distinct income sources, this separation is harder to justify for household activities – employment on household plots or in a household enterprise is treated as one (family labour) income source. Even for agricultural wage employment, incomes of different workers may be linked due to local conditions such as employment on the same neighbouring farms (thus the work may be temporary and short-term, one reason why earnings are low).

The simplicity of the count measure ensures consistency across waves, but at a cost of missing individuals' multiple activities. We then explore the specific diversification strategies that households commonly employ by categorising them into one of five mutually exclusive diversification strategies, differentiating between the strategies of urban and rural households. For rural households, the base category is only engaging in farming, then three other categories are included for households that farm and have either off-farm income (NAS, NAW, or AW), or remittance income, or both. The fifth category is households that do not receive any farm income but can have any combination of the other sources. For urban households, the base category is only engaging in off-farm employment, with a further three categories for those who also engage in farming, or receive remittances, or both. The fifth category are households without off-farm employment. Throughout the analysis we only consider the employment of household members aged 14 or above.

Table 1 shows the income sources and diversification strategies of households, disaggregated by rural/urban locations, gender of the household head, and across time (1990s for 1992/93 and 1999/2000 waves, and 2000s for 2005/06, 2009/10, and 2011/12 waves). For some analysis, particularly for urban households, sample sizes become too small when disaggregating by both gender and time, so we classify households by either the head's gender or the time period but not both (see Appendix Table A2).

Panel A in Table 1 shows the prevalence of the five income sources for sampled households. More than 90% of both male and female headed rural households engaged in own account agriculture, even into the 2000s, as found in other SSA countries (Davis et al. 2017). Even amongst

[2] When estimating for urban households in the 2000s sample we exclude LOM Farm Income from the set of instruments because it significantly affects household welfare.

[3] This includes owners of informal businesses (small if not microenterprises) although the majority are own account workers.

urban households farming rates are quite high (51% in 1990s and 44% in 2000s), reflecting the importance of urban agriculture (Shackleton et al. 2020). Female headed households (henceforth FHH) are more than twice as likely to receive remittances compared to male headed (58% compared to 28%), with similar levels of prevalence in both urban and rural areas. However, prevalence rates have been declining over time with the proportion of male headed households (MHH) receiving remittances halving between the 1990s and 2000s and falling by around a quarter for FHH. In the 1990s, about half of all rural households were engaged in off-farm employment and this rose to two-thirds by the 2000s, although this is still below the levels for urban households at around 90%.

Rural growth in off-farm employment has largely come from NAS and AW. Off-farm employment is more prevalent for MHH in both urban and rural areas, although the gap has declined over time. The gap is largely due to lower engagement in NAW for FHH, particularly in urban areas. This reflects a general trend across SSA where women are less able to access wage employment in higher productivity sectors and those offering full-year/full-time contracts (Van den Broeck and Kilic, 2019). In contrast, engagement in AW (which is generally casual, informal, and less remunerative, see Davis et al., 2017; Van den Broeck and Kilic, 2019)) is higher amongst FHH and NAS engagement is similar to that of MHH.

Panel B shows how the prevalence of these income sources translates to the aggregate count measure of income diversification (*ID*). In general, nearly all types of households have on average at least two of the five sources of income. FHH are more diversified than MHH in both urban and rural locations. However, this is due to FHH being more likely to receive remittances. If remittances are excluded from the count (*ID-R* measure) or if only the three off-farm sources are counted (*ID Off-farm*) then MHH are more diversified. The overall *ID* count has been stable over time for most households as the decline in remittances has been offset by increased off-farm participation, except for urban MHH where diversification decreased.

Panel C shows the five mutually exclusive diversification strategies that households can be categorised into, which differ for urban and rural households. The data corroborates *ID* in finding MHH are more specialised. In rural areas 25% of MHH have farming as their sole income source compared to 16% for FHH, whereas in urban areas 42% of MHH have off-farm employment as their sole income source compared to 20% for FHH. In urban areas specialisation in only off-farm employment has increased over time. During the 1990s both urban and rural MHH were quite evenly distributed over the first four categories ($j = 1$ to $j = 4$), but due to declining remittances in the 2000s three-quarters were in the first two ($j = 1$ and $j = 2$). In rural areas the largest category for MHH is farm plus off-farm ($j = 2$) in the 2000s, while in urban areas the largest was off-farm specialisation ($j = 1$). For rural FHH, in the 1990s the largest category was farm plus remittances ($j = 3$); in the 2000s, as remittances declined, farm plus off-farm employment ($j = 2$) became more common along with having all three income types ($j = 4$). For urban FHH, off-farm plus remittances (j = 3) declined somewhat in the 2000s but continued to be the most common category, although there were large increases in the first two categories.

The data highlight that diversification is as evident for urban households as it is for rural. In the 1990s, urban households had higher average *ID* for both FHH and MHH and there were similar distributions for rural and urban households over the first four categories ($j = 1$ to $j = 4$). In the 2000s, urban households became more specialised, particularly MHH where the large reduction in remittances could not be offset by already high levels of off-farm employment. Nonetheless, the level of diversification was largely similar to that of rural households.

Table A3 of the Appendix contains further summary statistics for consumption (the outcome variable), the main covariates from our analysis, as well as the leave-out mean instruments used for the econometric modelling. We also include relative consumption, which compares the consumption of the household to the national average for that survey wave. Welfare (consumption) is similar on average for MHH and FHH. Average welfare in rural areas was around 25% below the national average in the 1990s and 2000s, while welfare of urban households was about 80% higher than the average. Table A4 shows how relative consumption varies across *ID* and different diversification strategies (with further discussion provided in the Appendix).

5. Results

5.1. ID and household welfare

Table 2 presents the results from estimating (2) using our combined panel IV estimation procedure. The estimates compare the effect of *ID* on household welfare across rural/urban locations and over time. After accounting for time-varying and time-invariant unobserved heterogeneity, *ID* only had a significant impact for rural households in the 2000s, where having an additional income source increased welfare by 3%. The results indicate that even though average *ID* was similar in the 1990s and 2000s, it is only in the latter period that diversification has been welfare-enhancing or what Alobo Loison (2015) classifies as 'opportunity-led'. In contrast, rural diversification in the 1990s was more welfare-maintaining or 'survival-led', where additional income sources did not significantly improve welfare but helped offset consumption shortfalls. As *ID* only captures off-farm diversification, its limited impact on household welfare in the 1990s is consistent with evidence that income growth over the 1990s mainly came from crop production (Appleton, 2001).

Table 2 highlights that diversification has not significantly impacted the welfare of urban households in either period. This may reflect differing prevalence and welfare effects of the diversification strategies adopted by rural and urban households. Further, Table 1 showed that diversification strategies changed over time, with remittances declining and off-farm employment becoming more prevalent, even though overall *ID* remained largely unchanged. We assess the effect of this in the next section.

5.2. ATT of diversification strategy adoption for rural households

The first stage of the PMES (reported in Tables A6 and A7) shows the determinants of adoption of diversification strategies, indicating that in rural areas all four leave-out mean instruments (that account for local availability of income sources) significantly affect the adoption decision, although for FHH the availability of NAS and AW is generally not significant. Other than household size and age of the head, none of the other variables are significant (this is not surprising as the Chamberlain-Mundlak device factors out time invariant heterogeneity). Our focus is on the welfare effects of diversification.

Table 3 shows the average treatment effect on the treated (ATT) in terms of a percentage change in welfare for rural households changing their diversification strategy from the base category of only farming. The highest ATT was for rural households without farming incomes ($j = 5$), accounting for 3% and 7% of the total sample in 1990s and 2000s respectively (but too few to be included for FHH in the 1990s), suggesting these are households with access to high return off-farm employment rather than the landless poor. This is unlikely to be a viable strategy for most farming households but highlights important trends as ATT, hence welfare, are the largest and increased over time.

Focussing on feasible diversification strategies, for MHH the ATT was largest for the most diversified households ($j = 4$, all income sources, increasing welfare by 12% in the 2000s) in both periods and diversifying out of only farming became increasingly beneficial over time for all strategies – adding only remittances ($j = 3$) was only beneficial in the 2000s. For FHH in the 1990s, adding only remittances also had no significant effect but moving into off-farm employment ($j = 2$) was associated with a large increase in welfare, even larger than off-farm income plus remittances ($j = 4$). In the 2000s, the patterns for FHH and MHH are

Table 1
Distribution of Households Income Sources and Diversification.

	Rural Households				Urban Households			
	Male Headed		Female Headed		Male Headed		Female Headed	
	1990s	2000s	1990s	2000s	1990s	2000s	1990s	2000s
N	1,449	3,852	413	1,425	209	1,119	119	476
				Panel A: Percentage of Households with each income source				
Farm income	97	93	96	91	52	44	49	44
Remittances	46	21	69	53	44	23	71	57
Off-farm Work	53	68	44	60	90	94	82	88
– NA Self	27	41	25	37	57	60	51	59
– NA Wage	21	23	13	18	53	59	42	45
– Agri Wage	11	19	11	20	7	5	3	6
				Panel B: Average Income Diversification Count Score				
ID	2.02	1.98	2.15	2.18	2.13	1.90	2.16	2.12
ID - R	1.56	1.76	1.46	1.65	1.69	1.68	1.45	1.55
ID Off-farm	0.58	0.83	0.50	0.74	1.17	1.24	0.97	1.11
				Panel C: Percentage Diversification Strategies (*j*)				
1 = Rural: Only farm = Urban: Only off-farm	24	26	16	16	27	45	14	22
2 = Farm + off-farm work	30	48	14	26	24	29	13	19
3 = Rural: Farm + remit = Urban: Off-farm + remit	23	6	40	22	20	11	34	31
4 = All three	21	13	27	26	19	10	22	17
5 = Rural: No farming = Urban: No off-farm	3	7	4	9	10	6	17	11

Notes: Agri is agricultural; NA is non-agricultural; *ID* is the count measure of income diversification *(-R* excludes remittances); and *ID Off-farm* is a count of how many of the three types of off-farm employment the household engages in. '1990s' refers to data from the 1992/93 and 1999/2000 waves, '2000s' refers to data from the 2005/06, 2009/10, and 2011/12 waves. In Panel C, the base income sources used to categorise households differ for rural and urban households (only farming being the base for rural, only off-farm the base for urban). 'All three' refers to households that have farm, off-farm, and remittance incomes.

Table 2
Income Diversification and Household Consumption.

	Rural 1990s	Rural 2000s	Urban 1990s	Urban 2000s
lcons	FE + Heteroskedasticity IV			
ID	0.024	0.030**	−0.073	0.004
	(0.106)	(0.014)	(0.134)	(0.051)
Observations	1,862	5,237	327	1,579
Households	931	1,889	164	596
KP rK F-stat	526	343	19	32
Hansen J-stat	4.83	3.42	0.058	3.30
J-stat p-value	0.437	0.636	0.971	0.192

Notes: *Households* refers to number of distinct households in the panel sample. Bootstrapped standard errors in parentheses based on 1000 replications (*** p < 0.01, ** p < 0.05, * p < 0.1). Estimation is conducted using leave-out means IV combined with heteroskedasticity-based IV. All regressions are weighted using household weights. A full set of controls are included, with their results reported in Appendix Table A5. *KP rK F-stat* refers to the Kleibergen-Paap Wald rk F-statistic used to test the relevance of the instruments, in all cases the statistic is large enough to reject the null of weak instruments. Hansen J-statistic and its corresponding p-value are reported for the overidentification test, all models fail to reject the null that all instruments are exogenous.

Table 3
ATT of Diversification for Rural Households.

		Male headed HHs		Female headed HHs	
		1990s N = 1,449	2000s N = 3,843	1990s N = 396	2000s N = 1,421
j = 2	Farm + off-farm work	0.035***	0.063***	0.316***	0.072***
		(0.009)	(0.003)	(0.074)	(0.010)
j = 3	Farm + remittances	−0.020	0.094***	0.016	0.091***
		(0.012)	(0.012)	(0.030)	(0.013)
j = 4	Farm + off-farm + remittances	0.056***	0.123***	0.111***	0.106***
		(0.011)	(0.007)	(0.038)	(0.012)
j = 5	No farming	0.169***	0.226***	–	0.260***
		(0.061)	(0.016)		(0.028)

Notes: The base category (j = 1) is for households whose sole income source is own account agriculture (farming). Female headed HHs in 1990s had too few observations to include nonfarming households in the analysis (17 households or about 4% of the sample). Standard errors in parentheses (*** p < 0.01, ** p < 0.05, * p < 0.1).

similar: the effect of moving into just off-farm is lower than for adding remittances (now significant) and the largest effect is for both additional incomes (j = 4, increasing welfare by 11%).

Interestingly, the time trends in the ATT for farming households diversifying into off-farm (j = 2) were very different for MHH and FHH, even though both experienced substantial increases in the proportion of such households (going from 30% to 48% for MHH and 14% to 26% for FHH). For MHH the ATT doubled over time while for FHH it fell by over three-quarters – while MHH have been able to access off-farm employment of similar or higher relative returns in the 2000s, for FHH off-farm has become more prevalent but offering lower returns relative to the 1990s.

A potential explanation is the growth in AW, which is generally informal, casual, and offers low returns. Although growth of AW has been similar for both MHH and FHH, the highly informal and casual nature of such work means the effect on welfare may be different. We explore this by separating off-farm employment into AW and non-agricultural employment (NA = NAS and NAW), categorising households into one of nine categories, as shown in Table 4, along with the proportion of households in each category. Due to low sample size we only carry out this analysis for the 2000s. For MHH, the most common diversification is farming plus NA (35% of the sample, specialising in just farming is 26%). For FHH diversification strategies are more dispersed, with the most common strategy being farming and

Table 4
Frequency and ATT with Off-farm Disaggregation.

Type	Definition	Frequency (%)		ATT from second stage PMSR	
		Male N = 3,843	Female N = 1,421	Male N = 3,843	Female N = 1,421
j = 1	Only farming	25.53	16.3	–	–
j = 2	Farm + agri wage	8.6	6.1	−0.053***	−0.098***
				(0.010)	(0.026)
j = 3	Farm + non-agri employment	34.53	16.8	0.077***	0.157***
				(0.004)	(0.017)
j = 4	Farm + remittances	6.4	21.8	0.090***	0.091***
				(0.013)	(0.013)
j = 5	Farm + agri wage + non-agri employment	4.9	3.6	0.052***	−0.034
				(0.017)	(0.055)
j = 6	Farm + agri wage + remittances	2.2	6.4	0.071*	0.021
				(0.040)	(0.033)
j = 7	Farm + non-agri + remittances	9.2	17.45	0.119***	0.130***
				(0.009)	(0.016)
j = 8	Farm + agri wage + non-agri + remittances	2.0	2.6	0.108**	0.155***
				(0.042)	(0.066)
j = 9	No farming	6.6	9.0	0.175***	0.251***
				(0.017)	(0.026)

Notes: Standard errors in parentheses (*** p < 0.01, ** p < 0.05, * p < 0.1).

remittances (22%), followed by farming, remittances and NA (17%) and farming plus NA (17%). FHH are also more likely to have higher levels of diversification, with 30% of farming households having at least two other income types (j = 5 to j = 8) while for MHH it is 18%.

The final two columns of Table 4 show the ATT from the second stage of the panel multinomial switching regression for this new categorisation.[4] The findings for rural households are clear: diversification into only AW reduces welfare; for MHH, any other diversification is beneficial, especially non-agricultural or remittances; for FHH, in contrast, only diversification with non-agricultural or remittances is beneficial. It is noteworthy that any strategy including AW has a lower ATT than the corresponding strategy without AW, for example it is better to add remittances only than AW plus remittances. It is also notable that adding NA, alone or with another source, has a higher ATT for FHH than for MHH, as does not engaging in farming. Overall, adding AW has a greater detrimental effect on FHH welfare than for MHH whereas adding NA is a greater benefit for FHH welfare than for MHH.

5.3. ATT of diversification strategy adoption for urban households

Table 5 reports the ATT for urban areas; in contrast to the rural analysis we either separate by time or gender of the head and not both due to sample size constraints. The first stage estimates for the determinants of diversification strategy (see Tables A10 and A11) show that local availability of income sources captured by the leave-out means are significant but few of the other covariates are (occasionally household size and age of the head), similar to the results for rural areas.

In the 1990s, there were no better diversification strategies for urban households than specialising in off-farm employment (j = 1). Households with off-farm plus remittances (j = 3) were 16% worse off, while those with off-farm plus remittances and farm income (j = 4) were 15% worse off, suggesting households were pushed into such diversification to maintain welfare. In the 2000s, remittances played a beneficial role in improving household welfare like in rural areas; households with both off-farm and remittances (j = 3) had 8% higher welfare than those just with off-farm, while those with additional remittance and farm incomes

[4] The first-stage estimates are shown in Tables A8 and A9 of the Appendix and are similar to the results in Tables A6 and A7 for when five diversification strategies were used.

Table 5
ATT for Urban Households.

		1990s N = 327	2000s N = 1,591	Male headed N = 1,327	Female headed N = 591
j = 2	Off-farm + farm	−0.070	−0.100***	0.004	0.224***
		(0.056)	(0.014)	(0.017)	(0.056)
j = 3	Off-farm + remittances	−0.158***	0.078***	0.068***	0.002
		(0.053)	(0.012)	(0.022)	(0.034)
j = 4	Off-farm + farm + remittances	−0.148*	−0.075***	−0.006	0.306***
		(0.074)	(0.023)	(0.030)	(0.064)
j = 5	No off-farm income	−0.281***	−0.104***	−0.091	0.323***
		(0.100)	(0.037)	(0.055)	(0.104)

Notes: The base category ($j = 1$) is for households whose sole income source is off-farm employment. Standard errors in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

($j = 4$) had 8% lower welfare levels. In both periods, additional farm incomes ($j = 2$) had a negative effect on welfare but only significant in the 2000s. Households without any off-farm income ($j = 5$) were also significantly worse off in both periods, with negative ATTs being much larger in size in the 1990s (28% vs 10%).

Disaggregating by gender of the head shows that the beneficial effect of receiving remittances ($j = 3$) was only experienced by MHH. Otherwise, no other diversification strategy offered higher levels of welfare for MHH than specialising in off-farm employment ($j = 1$). The results are the opposite for FHH, where households also receiving remittances ($j = 3$) were no better off than the base group but all other diversification strategies significantly improved welfare – adding farm income ($j = 2$) or farm and remittances ($j = 4$) increased welfare by 22% and 31% respectively. FHH without any off-farm employment ($j = 5$) had the largest ATT at 32%, hence off-farm employment does not appear to be highly remunerative. This is in stark contrast to MHH where off-farm specialisation is one of the best strategies. The ATT for diversifying into remittance income (which were significantly positive for MHH and insignificant for FHH) further supports this, as the remittances received are generally from migrant household members engaged in off-farm employment within Uganda. Further, the difference is not due to FHH having greater access to agricultural incomes, as farming prevalence was higher amongst MHH.

6. Concluding remarks

This paper investigates the role of income diversification and different diversification strategies on household welfare, distinguished by gender of the head, urban and rural households, and changes over the medium to long run. Using data from five Ugandan national household panel surveys over 1992 to 2012, household welfare is measured in terms of adult equivalent consumption expenditure and income diversification strategies are captured by the number and types of sources of income of household members. The analysis considers five sources of household income: remittances, own account agriculture (farming), and off-farm employment which consists of agricultural wage employment, non-agricultural self-employment and non-agricultural wage. Diversification strategies cover the various combinations of these sources.

The data show that livelihoods of female headed households (FHH) are more diversified than their male headed (MHH) counterparts in both rural and urban areas as well as across time. FHH on average engage in a greater variety of income sources, although this is largely due to receiving remittances than members engaging in off-farm employment. MHH are also more likely to be specialised in one activity. In rural areas, overall (count) diversification has barely changed, although strategies have changed over time as declines in remittances were offset by increased off-farm employment. In urban areas, diversification has declined over time, largely due to fewer households reporting remittances particularly for MHH. Diversification is equally prevalent in urban and rural areas and plays an important role in household livelihoods.

The initial analysis uses a panel IV approach that combines the leave-out mean instruments with heteroskedasticity-based instruments to assess the effects of an additional income source on household welfare. The results indicate that in rural areas it was only during the 2000s (more accurately for 2005–2012) that there was a significant improvement in household welfare from diversifying into an additional income source, with welfare improving by 3% on average. In rural areas during the 1990s (1992–2000), increasing the number of income sources had no significant effect on welfare, consistent with Appleton (2001) who indicates income growth in Uganda during the 1990s largely arose from crop production. In urban areas, simply increasing the number of income sources also did not significantly affect welfare in either period.

While this provides an overall assessment of the effects of increasing the number of income sources, it disregards the differing returns and welfare effects from different income sources. Thus, we apply panel multinomial endogenous switching estimation to investigate the effects of households moving into specific diversification strategies compared to being fully specialised in the predominant income source (farming for rural households, off-farm employment for urban). When assessing the effects of moving into different diversification strategies in this way, large welfare effects become evident with substantial variation across the gender of the household head, urban/rural locations, and over time.

In rural areas for MHH, the benefits of farming households diversifying into off-farm, remittances, or both increased in the 2000s compared to the 1990s with the largest effect for households with both additional income sources. As MHH are 75% of the rural sample, this largely accounts for the average effect of having an additional income source only being significant in the 2000s. For rural FHH, by the 2000s the effect of farm households diversifying into off-farm, remittances, or both were largely similar to that of MHH, although the proportions utilising each strategy were different. However, there were large declines in the benefits of female headed farming households moving into just off-farm employment over time, with treatment effects falling from 32% in the 1990s to 7% in the 2000s. For rural households in the 2000s, diversification into only agricultural wage employment reduced welfare and any strategy including AW had a lower ATT than the corresponding strategy without AW. For MHH, any other diversification is beneficial, whereas for FHH only diversification without AW is beneficial except that having all income sources gives the highest benefit (increasing welfare by 11%). Adding non-agricultural employment, alone or with another source, is a greater benefit for FHH welfare than for MHH, whereas AW has a greater detrimental effect for FHH. This is concerning as engagement in agricultural wage labour has been one of the fastest growing sources of employment for rural females and is more prevalent than non-agricultural wage employment. This suggests that diversification into these low earning activities occurs mainly to maintain consumption. While these results hold only for FHH it is consistent with

evidence that agricultural wage earnings are lower for rural females.[5]

In urban areas there were much larger differences in the welfare effects of different diversification strategies between MHH and FHH. For MHH, specialising in off-farm employment generally offers greater returns, while FHH that did not specialise in off-farm activities (specifically by adding farm income) increased their welfare by 20–30%. FHH who had no off-farm income were 32% better off than those specialising in it, indicating that returns to off-farm employment for FHH are much lower than for MHH.

As our analysis is limited to the number and types of activities, the results are only for the extensive margin. Further work on the intensive margin, such as hours worked in particular activities, would be a useful area for future research. This could substantiate the indications from our analysis regarding the association of agriculture wage with lower welfare, especially for FHH, and that the failure of off-farm employment to improve the welfare of urban FHH may be due to the casual and temporary nature of these activities. Further research is needed on the determinants and constraints to entry into non-agricultural employment in rural areas, particularly for the households pushed into agricultural wage employment. While for urban areas, constraints to accessing higher return non-agricultural activities particularly by FFH needs more investigation. The roles of access to credit, social networks, as well as covariate and idiosyncratic shocks need to be included to better inform policy decisions.

Our findings also indicate additional research on remittances is required as they have become one of the most important welfare-enhancing diversification strategies in both urban and rural areas, even if the proportion of households receiving them has declined. It is unclear whether this is due to changing opportunities and circumstances of migrant members or due to the linkages between outmigrants and origin households weakening over time. The example of remittances illustrates the evolving nature of household diversification strategies and their welfare effects in general, thus continued and updated research using more recent data is needed for policy relevance.

To summarise, diversification into off-farm employment by household members and remittances from migrant members have become increasingly beneficial to the welfare of rural Ugandan households over time. However, the growth in agricultural wage employment raises concerns particularly for FHH. If distress prompts farming households to diversify into agricultural wage, with such households having 5–10% lower welfare than those who did not diversify, such diversification may be welfare-reducing. In contrast, diversifying into non-agricultural employment was associated with large welfare gains particularly for FHH. In urban areas, there appears to be a lack of high return non-agricultural employment for FHH for whom there are welfare gains to diversifying into urban farming, in contrast to MHH for whom off-farm specialisation is one of the best strategies. Thus, improving access to non-agricultural employment for rural FHH and increasing returns to non-agricultural employment for urban FHH are important policy concerns.

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CRediT authorship contribution statement

Rumman Khan: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Oliver Morrissey:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodpol.2023.102421.

References

Abdulai, A., CroleRees, A., 2001. Determinants of income diversification amongst rural households in Southern Mali. Food Policy 26, 437–452.
Alobo Loison, S., 2015. Rural Livelihood Diversification in Sub-Saharan Africa: A Literature Review. J. Develop. Studies 51 (9), 1125–1138.
Antonelli, C., Coromaldi, M., Pallante, G., 2022. Crop and income diversification for rural adaptation: Insights from Ugandan panel data. Ecol. Econ. 195, 107390.
Appleton, S., 1996. Women-headed households and household welfare: An empirical deconstruction for Uganda. World Dev. 24 (12), 1811–1827.
Appleton, S., 2001. Changes in Poverty and Inequality, Chapter 4. In: Collier, P., Reinikka, R. (Eds.), Uganda's Recovery: The Role of Farms, Firms and Government. The World Bank, Washington, DC, pp. 83–122.
Asfaw, S., Scognamillo, A., Di Caprera, G., Sitko, N., Ignaciuk, A., 2019. Heterogeneous impact of livelihood diversification on household welfare: Cross-country evidence from Sub-Saharan Africa. World Dev. 117, 278–295.
Bourguignon, F., Fournier, M., Gurgand, M., 2007. Selection bias corrections based on the multinomial logit model: Monte Carlo comparisons. J. Econ. Surv. 21 (1), 174–205.
Davis, B., Winters, P., Carletto, G., Coarrubias, K., Quinones, W., Zezza, A., Stamoulis, K., Azzarri, C., Di Guiseppe, S., 2010. A Cross-country Comparison of Rural Income Generating Activities. World Dev. 38 (1), 48–63.
Davis, B., Di Guiseppe, S., Zezza, A., 2017. Are African households (not) leaving agriculture? Patterns of households' income sources in rural Sub-Saharan Africa. Food Policy 67, 153–174.
Dercon, S., Krishnan, P., 1996. Income Portfolios in Rural Ethiopia and Tanzania: Choices and Constraints. J. Dev. Stud. 32, 850–875.
Di Falco, S., 2014. Adaptation to climate change in Sub-Saharan agriculture: assessing the evidence and rethinking the drivers. Eur. Rev. Agric. Econ. 41 (3), 405–430.
Di Falco, S., Veronesi, M., Yesuf, M., 2011. Does adaptation to climate change provide food security? A micro-perspective from Ethiopia. Am. J. Agric. Econ. 93 (3), 829–846.
Ellis, F., 1998. Household strategies and rural livelihood diversification. J. Dev. Stud. 35 (1), 1–38.
Fox, L., Sohnesen, T.P., 2012, Household Enterprises in Sub-Saharan Africa - Why they matter for growth, jobs, and livelihoods, The World Bank, Policy Research Working Paper WPS6184.
Glewwe, P., 1991. Investigating the Determinants of Household Welfare in the Côte d'Ivoire. J. Dev. Econ. 35, 307–337.
Kakande, M., 2010. Poverty Monitoring, Chapter 10 in F. In: Kuteesa, E., Tumusiime-Mutebile, A.W., Williamson, T. (Eds.), Uganda's Economic Reforms: Insider Accounts. Oxford University Press, Oxford, pp. 226–245.
Khan, R., Morrissey, O., 2019. Income Diversification and Household Welfare in Uganda 1992–2012, *CREDIT Research Paper 19/05*. University of Nottingham, School of Economics, Nottingham.
Khonje, M.G., Manda, J., Mkandawire, P., Tufa, A.H., Alene, A.D., 2018. Adoption and welfare impacts of multiple agricultural technologies: evidence from eastern Zambia. Agric. Econ. 49 (5), 599–609.
Lanjouw, P. (2007), Does the Rural Nonfarm Economy Contribute to Poverty Reduction?, Chapter 3 (pp 55-81) in P. Hazel, S. Haggblade & T. Reardon (Eds), Transforming the Rural Nonfarm Economy, Baltimore: Johns Hopkins University Press.
Lewbel, A., 2012. Using heteroscedasticity to identify and estimate mismeasured and endogenous regressor models. J. Bus. Econ. Stat. 30 (1), 67–80.

[5] Khan and Morrissey (2019) provide analysis for male and female household members and find that while there is a stronger positive association between household welfare for female than male members in NAW, females are more likely to engage in AW which has a much higher negative association with household welfare, suggesting lower earnings, than for males. The finding that labour diversification opportunities and outcomes differ between males and females is consistent with evidence in Quisumbing and Doss (2021) that gender relations within the household affect the behaviour of individuals.

Lewbel, A., 2018. Identification and estimation using heteroscedasticity without instruments: The binary endogenous regressor case. Econ. Lett. 165, 10–12.
Mundlak, Y., 1978. On the pooling of time series and cross section data. Econometrica 46 (1), 69–85.
Quisumbing, A.R., Doss, C.R., 2021. Gender in agriculture and food systems, Chapter 82. In: Barrett, C.B., Just, D.R. (Eds.), Handbook of Agricultural Economics, Volume 5. Elsevier, Amsterdam, pp. 4481–4549.
Reardon, T., 1997. Using evidence of household income diversification to inform study of the rural non-farm labour market in Africa. World Dev. 25 (5), 735–748.
Reardon, T., Delgado, C., Matlon, P., 1992. Determinants and Effects of Income Diversification amongst Farm Households in Burkina Faso. J. Dev. Stud. 28, 264–296.
Reardon, T., J. Berdegué, C. Barrett & K. Stamoulis (2007), Household Income Diversification into Rural Nonfarm Activities, Chapter 6 (pp 115-140) in P. Hazel, S. Haggblade & T. Reardon (Eds), Transforming the Rural Nonfarm Economy, Baltimore: Johns Hopkins University Press.
Shackleton, C.M., Drescher, A., Schlesinger, J., 2020. Urbanisation reshapes gendered engagement in land-based livelihood activities in mid-sized African towns. World Dev. 130, 104946.
Townsend, R.M., 1994. Risk and insurance in village India. Econometrica 62 (3), 539–591.
Van den Broeck, G., Kilic, T., 2019. Dynamics of off-farm employment in Sub-Saharan Africa: A gender perspective. World Dev. 119, 81–99.
Wouterse, F., Taylor, J.E., 2008. Migration and income diversification: Evidence from Burkina Faso. World Dev. 36 (4), 625–640.