## 1. Introduction

It is widely believed that improving productivity, profitability, and sustainability of smallholder agriculture in sub-Saharan Africa is the key for promoting inclusive economic growth and main pathway out of poverty and reducing rural welfare inequality. Agriculture remains the dominant economic activity in many countries, accounting for a large share of employment - over 60% of the total labor force and more than 75% of the poor in these regions depended on agriculture for their livelihoods (World Bank Development Indicators 2014). With such a large portion of the rural population in agriculture, improving agricultural productivity, through agricultural research and development interventions particularly promoting sustainable intensification and modernizing market channels is critical for enhancing rural income distribution and can lead to reduced poverty and inequality (Datt and Ravallion 1996; Ravallion and Datt 1998; Christiaensen et al. 2011; Thirtle et al. 2003).

Although many countries in sub-Saharan Africa are characterized by low level of per capita income and livelihood systems primarily linked to agriculture and the (informal) service sectors, income and asset inequality is higher in sub-Saharan Africa than in other regions (the only exception is Latin America and the Caribbean) (Sahn and Stiefl 2003; Okojie and Shimeles 2006). Surprisingly, welfare inequality has remained broadly unchanged for the last two decades (Ravallion 2014). The value of the Gini coefficient index increased from 0.52 in 1993 to 0.56 in 2008 (Beegle et al. 2016). Nevertheless, much of the policy attention has been on poverty alleviation although widening inequality can have implications on sustainable growth and poverty reduction (Dollar and Kraay 2002). Much less attention has been given to understanding how changes in agricultural productivity would affect welfare inequality.

The growing evidence however indicates that the more unequal the welfare distribution, the higher the negative effect on income growth and thus poverty reduction, the higher the chances that the bulk of the benefits of agricultural productivity accrue to the highest income households (Berg et al. 2012; Stiglitz 2012; Thirtle et al. 2003). Such growth in rural areas is not poverty reducing. Although improving agricultural productivity could play an important role in reducing poverty by generating higher incomes and creating employment for smallholder farmers and the rural poor and through its strong growth linkage effects on the growth in the other sectors (Datt and Ravallion 1998; Christiaensen et al. 2011; Mellor 2001; Irz and Tiffin 2006), its effects on welfare inequality are not well understood.

The literature presents a mixed picture of the effects of agricultural productivity on rural welfare inequality. Agricultural intensification that requires cash and initial capital may be difficult for the poor farmers to intensify production. The relatively rich households often have farms with good quality soils and access to capital markets or are situated in high potentials areas with good market access and tend to adopt higher return farm technology, and achieve higher aggregate output which could lead to falling and attractive output prices (Dercon and Gollin 2014). This suggests that, in the presence of imperfect capital and factor markets, agricultural productivity can lead non-adopting farmers to face lower returns (from low productivity and low output prices) and hence can tend to increase rural welfare inequality (Collier and Dercon 2014; Dercon and Gollin 2014).

Typically, poor small-scale farmers face several constraints that limit their productivity. Missing or incomplete capital markets, and lack of information about productivity enhancing inputs and market opportunities, often prohibit their ability to intensify agriculture and diversify into high-value commodities whose market demand is growing rapidly (Shiferaw et al. 2015; Dercon and Christiaensen 2011; Anderson and Feder 2007). High initial inequality in the distribution of productive assets, especially of land and heterogeneity of biophysical conditions (e.g. some households live in less-favored environments), poor infrastructure and lack of enabling policy environment can also be plausible candidates in explaining why some of the agricultural productivity change might be less effective in reducing rural inequality (Deininger et al. 2016; de Janvry and Sadoulet 2010; Jalan and Ravallion 2004; Galoro and Zeira 1993).

Therefore, despite its policy relevance the effect of agricultural productivity on rural welfare distribution and inequality is not well investigated and empirical evidence in sub-Saharan Africa remains very limited. More specifically, there is limited research on the differential effects of labor and land productivity on welfare inequality in rural areas. Therefore, there is a need for careful analyses of these linkages to elucidate appropriate and evidence-informed policymaking to support inclusive agricultural and rural transformation. This paper aims to bridge this gap by analyzing the distributional effects of agricultural productivity using newly-available and nationally representative comparable panel data from Nigeria and Uganda. This allows interesting cross-country analysis and insights on the resulting effects of productivity change on distributional outcomes. The paper measures welfare using both per capita aggregate consumption and asset metrics. In doing so, the paper contributes to and extends the existing literature in several respects. First, it examines differential impacts of agricultural productivity change on welfare distribution in terms of change in aggregate consumption and asset and identifies the policy relevant determinants of inequality. Second, the paper provides useful insights on the relationship between agricultural productivity and welfare distribution by decomposing the specific effects through changes in labor and land productivity that allows us to identify pro-poor patterns of agricultural production.

The remainder of the paper is organized as follows. Section 2 presents conceptual and measurement issues on household welfare, agricultural productivity and welfare distribution. Section 3 presents the empirical model and identification strategy. Section 4 presents the data and the key variables used for the analysis of effects on household welfare measured by both aggregate consumption and asset-wealth distribution. Section 5 presents empirical results before we conclude in the final section, highlighting the main findings and policy implications.

## 2. Welfare and agricultural productivity

To examine the agricultural productivity and welfare distribution linkages, we measure household welfare using both per capita aggregate annual consumption and asset-wealth. Measuring welfare using both consumption and asset-wealth measures[1] enables us to address the short run and long run effects of agricultural productivity change. Unlike short-term income indicator, asset-wealth accounts for a household's total productive resources beyond the current income level (Carter & Zimmerman 2001). It provides a more accurate description of a household's structural income which directly influences its welfare status irrespective of variability in transient income (Sahn & Stifel 2000). Households lacking sufficient assets are forced to face economic hardship and deprivation when changes in short-term income occur. Wealth therefore leads to increased economic security and assets buffer households against unexpected hardships and contribute to consumption smoothing (Carter & Zimmerman 2001). From a dynamic perspective, it is the accumulation of assets which over time enables households to earn enough income flows to move out of poverty (Cater and Barrett, 2006).

To construct the asset-wealth index from different units' assets such as as acres of land owned, years of education, or numbers of various types of livestock owned, we apply the livelihood regression model developed by Adato et al. (2006). Compared to alternative methods, such as

[1] Aggregate household expenditure form both food and non-food expenditure, income, asset and total value of crops is adjusted using regional CPI with 2005/06 as the base period.

principal component and factor analysis, the livelihood-based asset index facilitates a more intuitive interpretation of the results. The asset-wealth is constructed through a livelihood regression, which assigns weights on assets based on their marginal contribution to a household's livelihood which is specified as:

$$Y_{it} = \alpha + \sum_{j=1} \beta_j \left(K_{ijt}\right) + \sum_{j,k} \beta_{ij}\left(K_{ijk}\right)\left(K_{ikt}\right) + \lambda_{pt} + \gamma_i + \pi_{it} \quad (1)$$

Let $Y_{it}$ be defined as household i's measured income per capita. The literature suggests a wide range of human, social, physical, natural and geographic capital factors likely to shape a household's future well-being (Naschold 2012). Accordingly, we include various proxies for demographic variables, wealth variables, access to extension, access to infrastructure, financial institutions and information, and community variables. In this model, a vector of assets likely to shape a household's future wellbeing is utilized. $K_{ijt}$ is a vector of asset items $j$ including human, social, physical, and natural capital owned by household $(i)$ at time $t$. All items j are interacted with each other $(k)$ to allow the marginal return of assets to vary with the levels of other assets. $\beta$ represents a vector of coefficients of current household assets. $\gamma_i$ denotes household fixed effects, which control for a variety of fixed factors that shape household wellbeing.

Province-year dummies $\lambda_{pt}$ were added to control for shocks common to the entire zones and regions. The squared terms of several variables were also included to account for potential diminishing returns on assets and lifecycle effects. We also include interaction effects between all basic assets to allow the *marginal* return of assets to vary with the level of other assets. We therefore estimate a livelihood regression model in equation (1) using household-level FEs[2]. A complete list and definitions of variables are provided in Table 1. We calculate asset-wealth from the fitted values of the model. The estimation results using household random effects are reported in Table 2. The asset-wealth is constructed from the fitted values of the livelihood regression equation (1):

[2]Community variables (e.g. soil quality, political rule, shocks at village level) might influence returns to capital as well. Their omission might lead to biased estimates. As a robustness test we also do estimate the asset wealth with community and community-time fixed effects. We find that the pattern of asset wealth does not substantively vary across the two methods of constructing the asset wealth. The results are available on request.

$$A_{it} = \hat{Y}_{it} = \alpha + \sum_{j=1} \hat{\beta}_j \left(K_{ijt}\right) + \sum_{j,k} \hat{\beta}_{jk} \left(K_{ijk}\right) \left(K_{ikt}\right) \tag{2}$$

We measure agricultural productivity in terms of land and labor productivity. Land productivity is computed as the total net-value of crop output per hectare, while labor productivity is measured as the ratio of the total net-value of crop output to person days worked in the farm.

## 3. Empirical Strategies

### 3.1. Agricultural productivity and welfare linkages

Building on the previous section, we estimate the effect of agricultural productivity measured using both land and labor productivity on household adjusted per capita aggregate consumption ($C_{it}$ ) and asset-wealth($A_{it}$) constructed by using the following function:

$$C_{it} \left(A_{it}\right) = \gamma_1 \mathrm{P}_{it} + \gamma_2 \mathrm{H}_{it} + \gamma_3 W_{it} + \gamma_4 L_{it} + \gamma_5 V_{vt} + \varsigma + \lambda_{pt} + \eta_{it} \tag{3}$$

The dependent variable used in the regression-based decomposition analysis is the consumption and asset-wealth. The effect of interest is captured by the coefficients on $\mathrm{P}_{it}$, which is productivity of land (total net-value of crop output per hectare) and productivity of labor (total net-value of crop output per person days on the farm). $\mathrm{H}_{it}$ represents a vector of household demographic characteristics and $W_{it}$ captures household wealth indicators. To explore the effect of extension service and plot characteristics ($L_{it}$) on aggregate consumption and asset-wealth, we include information on the frequency of contact with extension agent, the plot slope and potential wetness index. We also include community characteristic assets ($V_{vt}$) such as weather indicators (temperatures and precipitation), agricultural potential and access to market and road.

Community variables are included in the equation because they represent the availability of productive economic infrastructure due to infrastructure investments by service providers which is closely associated with non-farm and other income-generating activities in the local environment. Because similar intrinsic demographic characteristics can lead to different asset distribution patterns, a household fixed effect $\varsigma$ is included to control for time-invariant unobserved demographic characteristics. Furthermore, a region-year fixed effect ($\lambda_{pt}$) is included to control for further geographic diversity in land quality, weather conditions, and distance to markets, local leadership, and paths of development and for covariate shocks affecting all provinces uniformly in each year. $\eta_{it}$ is the error term for which strict exogeneity condition is summed to hold, are independently and normally distributed with zero mean and constant variance.

It is likely that agricultural productivity is correlated with household level of information, level of human capital and physical assets and unobserved heterogeneities (unobserved variation in plot characteristics, managerial skill or ability). This correlation between the unobserved individual effect in the error term $\eta_{it}$ and agricultural productivity would cause a bias in ordinary least squares (OLS) estimators (Hausman and Taylor 1981). The problem in estimating the drivers of agricultural productivity is that unobserved characteristics (e.g., information about inputs, managerial skill, ability, and additional dimensions of soil quality) are likely to be correlated with productivity and the variables of interest. While the fixed effects model addresses bias caused time invariant factors that are endogenous (dimensions of soil quality and geographic variables), it does not actually identify the effect of time invariant variables that may be correlated with welfare and also correlated with agricultural productivity. As an alternative, we employ the Correlated Random Effects (CRE) model which, enables us to mitigate the impact of time invariant unobserved household characteristics and still recover the coefficients on time invariant variables (Mundlak 1978; Chamberlain 1982). The CRE estimation procedure involves adding the mean of time-varying variables as an extra set of explanatory variables in hopes that they are able to mostly capture the effects of unobserved time-invariant characteristics (Wooldridge 2010).

### 3.2. Regression-Based Decomposition

After identifying the linkage between agricultural productivity on household welfare, we employ regression-based decomposition analysis to explore the relationship between agricultural productivity and welfare inequality measured using both per capita consumption and asset-wealth. More specifically, we investigate the factors that contribute to increasing in aggregate consumption and asset-wealth inequality at a given point in time and over time for both Uganda and Nigeria.

The conventional approach which decompose the total inequality either by population groups or factor components provides limited information on the determinants of welfare inequality. Moreover, these approaches are unable to control for other factors when trying to identify and measure the contribution of a particular variable (Shorrocks 1999; Bourguignon et al. 2001; Fields 2003). Recent applied work has reawakened interest in inequality decomposition using regression-based approaches to avoid some of the restrictions of the traditional methods (Oaxaca 1973; Blinder 1973; Juhn et al. 1993; Bourguignon, et al. 2001). We use the regression-based decomposition, first to investigate the factors that contribute to increasing in aggregate consumption and asset-wealth inequality at a given point in time: 2009, 2010 and 2011. Second, we use regression-based decomposition to examine the relative contribution of agricultural productivity change to change in welfare distribution inequality, by which we can identify the effect of productivity change on aggregate consumption and asset-wealth inequality.

The regression-based inequality decomposition methods also allow to quantify the effects of variables in welfare inequality and enable inclusion of factors that may drive the observed inequality, such as demographic, wealth indicators, and community variables. More specifically, we adopt the Fields' decomposition method to identify the relative contribution of agricultural productivity change and other factors to adjusted per capita aggregate consumption and asset-wealth inequality (Fields, 2003). We combine Fields' and regression-based method to quantify the effects of our main interest variables and a set of other factors variables in explaining household welfare inequality. Nevertheless, the Fields' method has some limitations like the functional form for the income generating function must be log-linear; given that our model is log-linear, we do not consider this to be a major limitation.

Using the Fields' method, we begin with determinant welfare function, which, in linear form can be written as:

$$A_i = \gamma_1 z_1 + \gamma_2 z_2 + \gamma_3 z_3 + \gamma_4 z_4 + \gamma_5 z_5 + \eta_i \quad (4)$$

where $A$ measures welfare indicators, measured using adjusted aggregate consumption and asset-wealth. The explanatory variables include agricultural productivity, demographic and wealth indicators, and access to infrastructure and community variables as explained in the previous model. $\gamma_1$ is the coefficient of the $i^{th}$ explanatory factor estimated from an OLS regression of the transformed variables. $\eta_i$ is the error term for which strict exogeneity condition is assumed to hold, are independently and normally distributed with zero mean and constant variance. The results of the estimation of the determinants of aggregate consumption and asset-wealth function are then used to disentangle the contribution of different factors to household welfare inequality.

The contribution of the independent variables to distributional change is then expressed as a function of the magnitude of the coefficients of the consumption and asset-wealth equation and the magnitude of the change in the variable relative to the variation in consumption and asset-wealth. This allows us to estimate the percentage contribution of the flow of consumption and asset-wealth accounted by explanatory variables ($z_k$) to household welfare inequality using the following relative factor inequality weight (k) identity:

$$\sigma_A^2 = \sum_{k=1}^{k-1} \sigma_{\gamma_k z_k, A} + \sigma_{\eta, A} \quad (5)$$

where $\sigma_{\gamma_k z_k, A}$ and $\sigma_{\eta, A}$ are the variance of log-welfare indicators, the covariance of $\gamma_k z_k$ and $A$, and the covariance of the residuals (η) and $A$. Empirically the relative factor inequality weight for factor $k$ using the OLS estimate of the coefficient of the determinants of aggregate consumption and asset-wealth function is given as:

$$s_k = \frac{\sigma_{\gamma_k z_k, A}}{\sigma_A^2} = \frac{\gamma_k \cdot \sigma_{xk} \cdot \sigma_{xk,A}}{\sigma_y} \quad (6)$$

The term $s_k$ is also known as the "factor inequality weight". The sign of $s_k$ indicates whether the income flow from $z_k$ is inequality increasing or decreasing. If $s_k = 0$, the distribution of welfare from factor $k$ is as equal or as unequal as the distribution of total welfare. As a result, factor $k$ has no impact on total inequality. The regression error shows how much of total welfare inequality remains unaccounted for by the income flows from endowments denoted by the explanatory variables. Fields' (2003) noted that the relative contribution of a factor to overall inequality is invariant to the choice of inequality measure under six axioms proposed by Shorrocks (1982). Hence, the contribution of an individual factor to welfare inequality is simply $s_k \cdot A$. The residuals are also treated as another factor whose coefficient is one ($\gamma_k = 1$). Factors are composed of residuals ($K$-th factor) and ($K - 1$) exogenous variables excluding the constant in equation (4).

Accordingly, given that our third objective of the paper is to investigate the relative contribution of agricultural productivity change to change in welfare distribution inequality, we use Fields' (2003) to calculate the contribution of $z_k$ to the total change in welfare inequality between time periods. Using variance of log of per capita aggregate consumption and asset-wealth, $\sigma_y$ to measure inequality, the contribution of $z_k$ to the change in welfare inequality between two periods, $T_0$ and $T_1$, is expressed as:

$$\pi_k = \frac{s_{kT_1}\sigma_{AT_1}^2 - s_{kT_0}\sigma_{AT_0}^2}{\sigma_{AT_1}^2 - \sigma_{AT_0}^2} \quad (7)$$

## 4. Data sources and summary statistics of key variables

### 4.1. Data sources

The study uses high quality panel datasets from the Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) from Nigeria (for a two waves) and Uganda (three waves). The LSMS-ISA datasets are nationally representative and the significant uniformity in the survey instruments used across countries offers a unique opportunity for cross-country comparison. These nationally representative datasets include detailed information on demographic and household characteristics, household shocks, assets, agricultural production, non-farm income, and other sources of income, allocation of family labor, hiring of labor, access to services, and detailed data on aggregate annual consumption. The agriculture module, among others, contains information on agricultural and livestock production, farm technology, use of modern inputs, and productivity of crops and livestock. The community-level instrument contains information on local level infrastructure, basic public goods, nature of agricultural land, precipitation and other factors that could potentially affect the agricultural production and productivity.

### 4.2. Description of key variables

This section presents descriptive statistics for selected variables used in the analysis. Net income is computed from net agricultural returns to land and family labor, income from non-farm income both non-farm wage and non-farm self-employment and remittances. Using a balanced sample of 2406 households for two rounds of panel data in Nigeria and 1787 households[3] for the three rounds of panel data in Uganda. Table 1 reports the mean values for welfare and productivity measures, demographic characteristics (household size, education, age, gender, exposure to economic and agricultural shocks); wealth indicators which include land, livestock, both total and agricultural assets. The table also indicates the average income per capita is about 284.70 thousand Naira in Nigeria and 1106.27 thousand USh in Uganda. The average land productivity is about 405.99 thousand Naira per hectare in Nigeria and 1119.46 thousand USh per hectare in Uganda. Similarly, the average labor productivity is about 2.96 thousand Naira in Nigeria and 28.55 thousand USh in Uganda. Besides, Table 1 reports descriptive results of access to extension and community characteristic and access to infrastructure, financial institutions and information.

[3]The final balanced sample of households with farmland resulted in a balanced panel of 2406 households in Nigeria in two years and 1846 households in three years in Uganda.

### 4.3. Overview of rural household welfare distribution

This section presents an overview of the inequality in adjusted aggregate consumption and asset-wealth for both countries. Table 3 and 4 set out changes in mean consumption and asset-wealth per quintile of aggregate consumption and asset-wealth distribution for each survey year as percentage changes for Nigeria and Uganda, respectively. The results (Table 3) indicate that mean consumption in Nigeria grew significantly for the bottom quintiles and the top quintiles. But variations in the rates of consumption growth between quintiles are marked, with average consumption in the higher quintiles growing faster than those in the lower quintiles. Moreover, the results on asset-wealth indicate that mean asset-wealth in Nigeria declined significantly for the first four quintiles, while the top most quintile experienced a substantially higher mean asset-wealth growth rate of 27 %. Similarly, for Uganda the results (Table 4) indicate that mean consumption declined significantly for the bottom quintiles, while mean consumption grew significantly the top quintiles. Similar, trend is observed for mean asset-wealth although they are not statistically significant. In general, the aggregate consumption and asset-wealth of the poor and the middle class decline, while they increase significantly much more for the top quintiles, which explains the rising aggregate consumption and asset-wealth inequality observed in those countries.

We summarize the estimates of the inequality measures over the period in Table 5 for Nigeria and 6 for Uganda. To provide a complete ordering of distributions and to assess the robustness of the trend to different inequality measures, we report consumption and asset-wealth inequality measured by several indices including: The Gini coefficient, the mean log deviation, two Generalized Entropy Indices including the Theil index, and the Atkinson index. The results indicate that asset-wealth inequality measures are higher than consumption inequality measures in both countries although the difference is smaller for Uganda. For example, the average the asset-wealth Gini coefficient for the survey period is 0.50 which is 0.09 higher than consumption Gini coefficients for Nigeria. This may be because asset inequality is more a reflection of "permanent income" compared to consumption which is transient. This is consistent with earlier findings that asset-wealth inequality in Africa are considerably high (Sahn and Stiefl 2003). Possible explanations for the higher asset-wealth Gini coefficients include barriers to participate in high return activities, which makes it difficult for middle-and lower income quintiles to accumulate assets.

The results also show that, both aggregate consumption and asset-wealth inequality in Nigeria have grew significantly between 2010 and 2012. The Gini-index in consumption inequality increases from 0.45 to 0.54 while asset-wealth increased from 0.51 to 0.62 or by 23.5%. For Uganda, only aggregate consumption inequality has grown significantly between 2009 and 2011. The Gini-index in asset-wealth increased from 0.44 to 0.48 or by 10 %. The rising of consumption and asset-wealth inequality over the reference period can be seen in the movements in the Lorenz curve[4] in Figure 1. Similarly, the results also show that consumption inequality has grown significantly between 2009 and 2011, while asset-wealth inequality almost remains the same over three periods as it can be seen in the movements in the Lorenz curve in Figure 2. In the next section the paper investigates the factors that contributes in increasing in consumption and asset-wealth inequality over the period using Fields' method regression-based decomposition techniques.

## 5. Results and discussions

### 5.1. The linkages between agricultural productivity and household welfare

The estimation results for aggregate consumption and asset-wealth function using the Correlated Random Effects (CRE) model are reported in Table 6 for Nigeria and Uganda. Several regression coefficients are statistically significant and the signs of the estimated coefficients are in line with the theoretical expectations. Robust standard errors are computed in order to correct for potential heteroscedasticity. In general, the estimates confirm that agricultural productivity measured in both land and labor productivity have significant correlation with households' aggregate consumption and asset-wealth for both countries. These results support the hypothesis that improving agricultural productivity by stimulating productivity enhancing investments by smallholders in higher-return activities is a key to improve welfare in rural areas.

Households with large family sizes experience a significantly lower aggregate consumption. Controlling for other factors, we find that male-headed households exhibit higher aggregate consumption than their female-headed counterparts – indicating the existence of some underlying factors that lead to unequal access to productive inputs and services. More importantly, we find that wealth variables and access to extension services and public infrastructure play a significant role in improving aggregate consumption for both countries. In general, these results indicate asset-wealth at the household level is significantly higher in more accessible areas

[4]The Lorenz curve represents the functional relationship between the cumulative proportion of expenditure and the cumulative proportion of expenditure units, assuming that expenditure units are arranged in ascending order of expenditure

compared to less-favored areas with poor biophysical conditions and poor market access for both countries. Moreover, households in villages with higher precipitation are more likely to have higher aggregate consumption.

### 5.2. Welfare distribution inequality effect of agricultural productivity

We use aggregate consumption and asset-wealth function regression results to calculate inequality weights using the Fields' method decomposition procedures in order to decompose the level of inequality and show the contribution of land and labor productivity and other factors. The Fields method decomposition[5] results also contain the contribution of the estimated variance of consumption and asset-wealth from the aggregate consumption and asset-wealth function (or the model that includes all explanatory variables in its calculation of predicted aggregate consumption and asset-wealth) to total inequality calculated using the original aggregate consumption and asset-wealth data. Recall that inequality is decomposed into key components including agricultural productivity, demographic, wealth indicators, and access to infrastructure and community variables. In the next sub-section, we investigate the factors that contribute to increasing in aggregate consumption and asset-wealth inequality at a given point in time and over time for Uganda and Nigeria.

#### *Factors that contribute for increases inequality at a given point in time*

The results from the decomposition procedures for aggregate consumption and asset-wealth, in terms of the percentage share of total inequality explained by each factor and year are presented in Table 8 for Nigeria and in Table 9 for Uganda. The results indicate that for both Nigeria and Uganda, aggregate consumption and asset-wealth inequality increases with land and labor productivity, albeit at different levels. Land productivity contribution to annual consumption inequality increased over the years from 11 % in 2009 to 34 % of inequality in 2011 in Uganda, while labor productivity contribution decrease over given period. This may be because either bottom or middle income farmers have limited access to improved farm technology and are

[5] We also apply the Shapley value decomposition but the results are similar, in terms of both magnitude and direction. The results are available on request.

liquidity constrained to access farm technology. This also indicate that policies may increase agricultural productivity for wealthier farmers before making an equal push for improving markets and access to farm technologies for the resource poor and small-scale producers. When we look at the contribution of land and labor productivity, we find labor and land productivity contribute less than one percent for consumption and asset inequality.

While income flows from agricultural productivity measures appear to contribute positively to increase aggregate consumption inequality, demographic characteristics and wealth variables account for the largest share of total inequality for both countries. Their contribution to annual consumption inequality increased over the periods in Nigeria (see Table 8). For Uganda, the contribution of demographic characteristics and wealth variables to annual consumption decreases over time. For example, demographic characteristics decrease from 66% in 2009 to 17% in 2011, while demographic characteristics contribution to asset-wealth inequality increases over the same period (see Table 9).

Comparing the access to infrastructure and community variables contribution to both aggregate consumption and asset-wealth inequality between Nigeria and Uganda, their contribution to asset-wealth inequality is higher for Uganda than Nigeria. This may suggest that spatial inequality is higher in Uganda than Nigeria and that high initial inequality in the distribution of biophysical and socioeconomic conditions, including poor infrastructure and policy environment can explain why some of the agricultural productivity might be less effective in reducing rural inequality.

Land holding contribution to total asset-wealth inequality increased over the period for both countries. It increased from 1 % in 2010 to about 3% 2012 in Nigeria, while it increases from 3% in 2009 to 14% in 2011 in Uganda. This is in line with the literature, for example Anderson and McKay (2004) find that around 50% of Africa's high inequality could be attributed to high ratios in key factor endowments, such as land and asset holdings (see Table 8 and 9). The results may suggest that in the presence of incomplete or missing capital markets farm households make production and investment decisions based on the assets they hold, thus poorer households are limited in their capacity to adopt farm technology that enhances agricultural productivity, which leads resource-poor household into chronic poverty and vulnerability.

***Factors that contribute to increase to the change of welfare inequality (over time)***

Results in Table 10 shows the of decomposing the differences in aggregate consumption and asset-wealth inequality between the two years[6] using the factor inequality weights produced by the Fields' decomposition methods. The change in inequality decomposed here is the change in the variance of log of aggregate consumption and asset-wealth calculated using original expenditure and asset-wealth. The agricultural productivity variables contributed to annual consumption inequality change in both countries. Agricultural productivity measured by land productivity increased annual consumption inequality change by about 3% in Nigeria and 12% in Uganda. Agricultural productivity measured by labor productivity increased aggregate consumption inequality change by the same percentage in Nigeria and 23% in Uganda. Land and labor productivity increased total asset-wealth inequality change by about 2 and 6% in Nigeria and Uganda, respectively, while land productivity decreased total asset-wealth inequality change although the parentage is too small. Agricultural productivity had higher contribution to total welfare inequality change in Uganda than in Nigeria. This could be because the pre-existing conditions e.g. access to farm technology, infrastructure, credit and the asset inequality between the poor and better off households could be higher in Uganda. This means that poor households are not benefitting as much from the agricultural productivity change and this would increase the gap and income inequality (Collier and Dercon 2014; Dercon and Gollin 2014).

Family education played a major role in increasing asset-wealth inequality in Nigeria, while it played a major role in increasing aggregate consumption inequality in Uganda. Similarly, land holding and physical asset contributed to increasing asset-wealth inequality in both countries, but its contribution is higher in Uganda than Nigeria. In general wealth variables contributed to increasing asset-wealth inequality in both countries. Wealth indicators increased asset-wealth inequality change by about 92 % in Uganda and 23 % in Nigeria. Access to infrastructure and community variables contributed to increasing asset-wealth inequality in Nigeria and increasing in aggregate consumption inequality in Uganda.

## 6. Conclusions and policy implications

Whereas the relationship between agricultural productivity and welfare distribution has been a subject of long-standing interest, it is perhaps surprising that much less is known about the welfare

[6]The change in the variance of log of consumption and asset between 2010 and 2012 for Nigeria, and 2009-2011 for Uganda.

outcomes and distributional effects of agricultural productivity change in many countries in sub-Saharan Africa. Using nationally representative panel data for Nigeria and Uganda, we assess agricultural productivity and welfare distribution linkages. We address three important objectives in the process of investigating these relationships. First, the paper examines differential effects of agricultural productivity on welfare and welfare distribution. Second, the paper investigates the specific policy-relevant factors that contribute to changes in aggregate annual consumption and asset-wealth inequality for both countries. Third, the paper provides some insights on the relationship between agricultural productivity and welfare distribution by separately measuring the effects of agricultural productivity change in terms of both land and labor productivity.

The study examines the correlation between agricultural productivity and rural household welfare using the Correlated Random Effects (CRE) model. The results show that agricultural productivity measured in both land and labor productivity have significant correlation with households' aggregate consumption and asset-wealth for both countries. These results support the hypothesis that improving agricultural productivity by stimulating productivity enhancing investments by smallholders in higher-return activities is a key to improve welfare in rural areas.

We use a regression-based inequality decomposition approach to estimate the effect of agricultural productivity and other variables on welfare inequality at a given time and change of welfare inequality (overtime). First, we addressed factors that contribute to increasing inequality at **a given point in time** for both countries. The results show that the contribution of land productivity to annual consumption inequality increased over the years from 11 % in 2009 to 34 % of inequality in 2011 in Uganda, while contribution of labor productivity decreased over the same period. When we look at the contribution of land and labor productivity in Nigeria, we find labor and land productivity contribute less than 1 % for consumption and asset inequality in 2010 and 2012.

Second, we examined factors that contribute to changes in welfare inequality **(over time)** for both countries. We find that agricultural productivity changes increased annual consumption and asset wealth inequality in both countries, while agricultural productivity contributed to a greater welfare inequality change in both Nigeria and Uganda. This could be because the pre-existing conditions e.g. access to farm technology, infrastructure, credit and the asset inequality between the poor and better off households could be higher in Uganda. This means that poor households are not benefitting as much from the agricultural productivity change and this would increase the gap and income inequality.

We also find that the contribution of wealth variables and access to infrastructure are more important compared with other variables in terms of amplifying the welfare inequality effects in both countries. This supports the hypothesis that high initial inequality in the distribution of productive assets such as land and the salient heterogeneity of biophysical and socioeconomic conditions, including poor infrastructure and policy environment can explain why agricultural productivity growth might be less effective in reducing rural inequality. As such, measures are needed to increase land and labor productivity using new farm technologies and improved access to markets and services that will reduce inequality. Measures to increase smallholder productivity could include increased access to credit and new agricultural technologies and risk management strategies as well as information and education on new production methods and marketing services.

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**Table 1:** Descriptive statistics of variables used in the econometric analysis by country

| Variables | **Nigeria**=4,806 | | **Uganda**=5361 | |
|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. |
| **Welfare and agricultural productivity measures** | | | | |
| Total per capita aggregate consumption (local unit=LCU, 1000) | 98.87 | 103.64 | 595.65 | 7333.79 |
| Total income per capita (LCU, 1000) | 284.70 | 1036.24 | 1106.27 | 1390.34 |
| Total value of harvested crops (LCU, 1000) | 250.46 | 510.08 | 3578.15 | 26560.31 |
| Work force (person days) | 381.66 | 712.14 | 342.49 | 678.42 |
| Total value harvested per area planted (LCU, 1000) | 405.99 | 776.00 | 1119.46 | 1118.59 |
| Total value harvested per person days (LCU, 1000) | 2.96 | 62.87 | 28.55 | 358.32 |
| **Demographic characteristics** | | | | |
| Family size (number) | 6.10 | 3.05 | 6.33 | 3.21 |
| Dependent (<15, >64 years old) | 2.58 | 2.03 | 3.44 | 2.24 |
| Gender (Gender of the household head, Male=1) | 0.88 | 0.32 | 0.71 | 0.46 |
| Educ. HH head (years) | 4.63 | 4.77 | 2.32 | 4.33 |
| Mean Education (years) | 4.34 | 3.16 | 6.65 | 4.78 |
| Age HH head (years) | 50.71 | 16.15 | 46.42 | 15.15 |
| Demographic shocks (HH shocks experience yes=1) | 0.18 | 0.39 | 0.12 | 0.32 |
| Economic shocks (HH shocks experience yes=1) | 0.10 | 0.30 | 0.02 | 0.15 |
| Agricultural shocks (HH shocks experience yes=1) | 0.17 | 0.37 | 0.38 | 0.48 |
| **Wealth Variables** | | | | |
| Farm size (in hectare) | 0.58 | 1.30 | 3.68 | 11.84 |
| Area planted (in hectare) | 0.77 | 0.69 | 4.16 | 12.90 |
| Livestock (tropical livestock unit) | 74.14 | 1051.41 | 1.66 | 7.91 |
| Value of total assets (LCU, 1000) | 938.50 | 2686.42 | 12100.97 | 58294.38 |
| Value of agricultural assets (LCU, 1000) | 26.14 | 837.66 | 442.15 | 2036.76 |
| **Access to extension and plot characteristics** | | | | |
| Ext contract (Frequency of contact with extension agent, no.) | 0.44 | 1.94 | 0.38 | 2.04 |
| Slope of the plot (percent) | 2.79 | 2.76 | 7.08 | 6.68 |
| Potential Wetness Index | 13.92 | 4.23 | 1225.76 | 239.26 |
| **Community characteristics** | | | | |
| Average total rainfall in wettest quarter (mm) | 666.55 | 147.87 | 435.87 | 67.49 |
| Precipitation of wettest quarter (mm) | 706.42 | 180.12 | 452.48 | 75.31 |
| Annual precipitation (mm) | 1361.07 | 589.12 | 1220.85 | 192.08 |
| Percent agriculture land within approx. 1 km buffer (%) | 35.12 | 28.44 | 44.84 | 19.32 |
| Distance to the main road (km) | 12.27 | 14.58 | 7.25 | 7.58 |
| Distance to the market (km) | 70.46 | 38.87 | 29.72 | 19.95 |
| Distance to the state capital (km) | 74.55 | 52.84 | 20.18 | 17.43 |
| **Access financial institution & information** | | | | |
| Access to bank (Yes=1) | 0.18 | 0.42 | 0.13 | 0.20 |
| Member of cooperative (Yes=1) | 0.06 | 0.24 | na | |
| Owns or has access to a radio (Yes=1) | 0.94 | 0.25 | na | |
| Owns or has access to television (Yes=1) | 0.40 | 0.49 | na | |
| Owns or has access to a mobile phone (Yes=1) | 0.06 | 0.23 | na | |
| Access to internet (Yes=1) | 0.04 | 0.20 | na | |

**Source:** Based on LSMS-ISA surveys in Nigeria and Uganda.

**Note:** Household welfare measures are computed in local currency units (LCU) and purchasing power parity (PPP) adjusted using the retail and national CPI, with 2010 for Nigeria and 2006 for Uganda as the base period. Because of differences in local currencies, the means are not directly comparable for income, per capita aggregate consumption and productivity measures.

**Table 2:** FE estimates of livelihood regression model to construct the asset-wealth index

| | **Dependent variable**: Net adjusted total income per capita | | | |
|---|---|---|---|---|
| | **Nigeria** | | **Uganda** | |
| **Variables** | **coef** | **se** | **coef** | **se** |
| Family size | -0.550*** | 0.081 | -0.348*** | 0.061 |
| Dependent | -0.058 | 0.062 | -0.185*** | 0.052 |
| Gender | 0.252*** | 0.071 | 0.065** | 0.031 |
| Mean Education | -0.706*** | 0.212 | 0.559*** | 0.172 |
| Age HH Head | 0.248* | 0.133 | -0.105* | 0.063 |
| Age HH Educ | 0.013 | 0.041 | 0.066*** | 0.021 |
| Farm Size | 0.237 | 0.214 | 1.355*** | 0.101 |
| Livestock | 0.067 | 0.061 | 1.136*** | 0.272 |
| Value of total assets | 0.086 | 0.062 | 0.733*** | 0.111 |
| Value of agricultural assets | 0.126 | 0.111 | -1.008*** | 0.181 |
| Ext contact | 0.098* | 0.062 | 0.119*** | 0.032 |
| Self-employment | 1.144*** | 0.063 | 0.534*** | 0.031 |
| Non-farm employment | 2.089*** | 0.081 | 0.420*** | 0.031 |
| Receiving remittances | 0.618*** | 0.071 | 0.096*** | 0.032 |
| Hhage^2 | -0.054** | 0.031 | 0.087*** | 0.021 |
| Total Asset^2 | -0.005 | 0.012 | -0.100*** | 0.032 |
| Agricultural Asset ^2 | 0.036** | 0.021 | -0.199*** | 0.051 |
| Livestock ^2 | 0.012 | 0.012 | -0.194*** | 0.062 |
| Mean Education^2 | 0.220*** | 0.073 | -0.113*** | 0.021 |
| Farm Size^2 | -0.079 | 0.061 | -0.127*** | 0.013 |
| Farm Size *Agricultural Assets | -0.139* | 0.081 | 0.214*** | 0.031 |
| Farm Size * Total Asset | 0.039 | 0.041 | -0.205*** | 0.032 |
| Farm Size *Livestock | 0.071 | 0.041 | -0.032 | 0.042 |
| Agricultural Asset * Livestock | -0.031 | 0.031 | 0.033 | 0.101 |
| Total Asset * Livestock | -0.022** | 0.013 | -0.067 | 0.081 |
| Total Asset * Agricultural Assets | 0.003 | 0.022 | 0.314*** | 0.082 |
| Distance to nearest major road | 0.034 | 0.023 | -0.000 | 0.041 |
| Distance to nearest market | -0.027 | 0.041 | -0.113** | 0.061 |
| Distance to state capital | 0.009 | 0.042 | -0.024 | 0.052 |
| Access to bank(Yes=1) | 0.271*** | 0.061 | 0.215*** | 0.061 |
| Access to cooperative | 0.016 | 0.092 | na | |
| Access to a radio | 0.011 | 0.094 | na | |
| Access to television | 0.216*** | 0.051 | na | |
| Access to a mobile phone | 0.120 | 0.112 | na | |
| Access to internet | 0.148 | 0.133 | na | |
| Number of observations | 2,403 | | 1787 | |
| $R^2$ | 0.67 | | 0.59 | |

**Source:** Based on LSMS-ISA surveys in Nigeria and Uganda.

**Note**: Further control variables included the squared terms of several variables interaction effects between all basic assets.

The regression included a dummy for (zone X time) dummy for Nigeria and (regions X time dummy) for Uganda *** p<0.01. ** p<0.05. * p<0.10.

**Table 3:** Mean adjusted consumption and asset-wealth in Nigeria, 2010–2012 (Naira)

| Quintile of aggregate consumption distribution | Total N=4806 | 2010 N=2,403 | 2012 N=2,403 | Percentage changes in mean (2010-2012) |
|---|---|---|---|---|
| 1 | 39.84 | 39.38 | 40.39 | 2.49* |
| 2 | 61.37 | 61.27 | 61.48 | 0.34 |
| 3 | 81.75 | 81.87 | 81.63 | -0.29 |
| 4 | 110.71 | 109.98 | 111.39 | 1.27 |
| 5 | 200.75 | 184.91 | 212.39 | 12.94** |
| **Quintile of asset distribution** | **Total** | **2010** | **2012** | **Percentage changes in mean (2010-2012)** |
| 1 | 48.35 | 52.82 | 47.69 | -9.71** |
| 2 | 71.22 | 72.85 | 70.38 | -3.39* |
| 3 | 106.96 | 109.56 | 103.68 | -5.37* |
| 4 | 219.03 | 220.74 | 209.08 | -5.28* |
| 5 | 787.27 | 714.72 | 906.26 | 26.80*** |

**Source:** Based on LSMS-ISA surveys in Nigeria.
**Note**: *** p<0.01. ** p<0.05. * p<0.10.

**Table 4:** Mean adjusted consumption and asset-wealth in Uganda, 2009–2011 (USh)

| Quintile of aggregate consumption distribution | Total N=5361 | 2009 N=1787 | 2010 N=1787 | 2011 N=1787 | Percentage changes in mean (2009-11) |
|---|---|---|---|---|---|
| 1 | 131.08 | 141.10 | 124.75 | 132.71 | -5.95** |
| 2 | 237.2 | 239.44 | 236.63 | 235.95 | -1.46 |
| 3 | 345.20 | 347.66 | 343.04 | 344.60 | -0.88 |
| 4 | 515.47 | 518.77 | 513.51 | 513.12 | -1.09 |
| 5 | 1750.09 | 1330.11 | 1355.35 | 2751.35 | 71.41*** |
| **Quintile of asset-wealth distribution** | **Total** | **2009** | **2010** | **2011** | **Percentage changes in mean (2009-11)** |
| 1 | 273.84 | 273.84 | 275.34 | 272.13 | -0.63 |
| 2 | 487.87 | 487.88 | 487.76 | 483.43 | -0.91 |
| 3 | 724.92 | 724.92 | 737.59 | 743.65 | 2.58** |
| 4 | 1124.08 | 1124.09 | 1131.40 | 1134.74 | 0.95 |
| 5 | 2831.62 | 2858.71 | 2777.43 | 2857.04 | -0.06 |

**Source:** Based on LSMS-ISA surveys in Uganda.
**Note**: *** p<0.01. ** p<0.05. * p<0.10.

**Table 5:** Consumption and asset-wealth per capita inequality measures for Nigeria

| Inequality measures | Consumption | | | | Asset-wealth | | | |
|---|---|---|---|---|---|---|---|---|
| | **Total** | **2010** | **2012** | **Diff** | **Total** | **2010** | **2012** | **Diff** |
| Gini coefficient | 0.50 | 0.45 | 0.54 | *** | 0.59 | 0.51 | 0.63 | ** |
| Kakwani measure | 0.21 | 0.19 | 0.23 | ** | 0.29 | 0.22 | 0.35 | ** |
| Theil index (GE(a), a = 1) | 0.31 | 0.25 | 0.37 | *** | 0.74 | 0.58 | 0.92 | ** |
| Mean Log Deviation (GE(a), a = 0) | 0.28 | 0.25 | 0.31 | ** | 0.60 | 0.44 | 0.72 | *** |
| Entropy index (GE(a), a = -1) | 0.30 | 0.27 | 0.33 | ** | 0.78 | 0.53 | 0.88 | *** |
| N | 4806 | 2,403 | 2,403 | | 4806 | 2,403 | 2,403 | |

**Source:** Based on LSMS-ISA surveys in Nigeria.
**Note**: *** p<0.01. ** p<0.05. * p<0.10.

**Table 6:** Consumption and Asset-wealth per capita inequality measures for Uganda

| Inequality measures | Consumption | | | | | Asset-wealth | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Total** | **2009** | **2010** | **2011** | **Diff** | **Total** | **2009** | **2010** | **2011** | **Diff** |
| Gini coefficient | 0.47 | 0.44 | 0.48 | 0.48 | ** | 0.48 | 0.49 | 0.48 | 0.48 | |
| Kakwani measure | 0.19 | 0.17 | 0.20 | 0.20 | * | 0.19 | 0.2 | 0.19 | 0.19 | |
| Theil index (GE(a), a = 1) | 0.49 | 0.39 | 0.46 | 0.63 | ** | 0.42 | 0.43 | 0.41 | 0.41 | |
| Mean Log Deviation (GE(a), a = 0) | 0.37 | 0.32 | 0.38 | 0.40 | *** | 0.38 | 0.39 | 0.39 | 0.37 | |
| Entropy index (GE(a), a = -1) | 0.44 | 0.38 | 0.48 | 0.46 | *** | 0.50 | 0.5 | 0.49 | 0.51 | |
| N | 5361 | 1787 | 1787 | 1787 | | 5361 | 1787 | 1787 | 1787 | |

**Source:** Based on LSMS-ISA surveys in Uganda.
**Note**: *** p<0.01. ** p<0.05. * p<0.10.

**Table 7:** CRE estimation of effect of agricultural productivity on household welfare

| | **Dependent Variable:** Adjusted aggregate consumption and asset-wealth per capita | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Nigeria** | | | | **Uganda** | | | |
| | **Consumption** | | **Asset-wealth** | | **Consumption** | | **Asset-wealth** | |
| | **Coef** | **Se** | **Coef** | **Se** | **Coef** | **Se** | **Coef** | **Se** |
| Land productivity | 1.059* | 0.57 | 0.024*** | 0.00 | 0.004** | 0.01 | 0.020*** | 0.00 |
| Labor productivity | 1.569 | 2.20 | 0.021*** | 0.00 | 0.031** | 0.01 | 0.022*** | 0.00 |
| Family size | -9.361*** | 1.19 | -0.382*** | 0.03 | -1.617*** | 0.08 | -0.319*** | 0.02 |
| Dependent | 3.864 | 6.08 | -0.111*** | 0.01 | 0.095* | 0.05 | -0.207*** | 0.02 |
| Gender | 2.600 | 5.36 | 0.240*** | 0.01 | 0.127*** | 0.02 | 0.081*** | 0.01 |
| Age of head | -4.389* | 2.59 | 0.004 | 0.01 | -0.094*** | 0.03 | -0.075*** | 0.01 |
| Mean education | 5.584 | 4.47 | 0.017** | 0.01 | -0.000 | 0.01 | 0.072*** | 0.00 |
| Farm size | 1.792 | 5.96 | 0.183*** | 0.01 | 0.037** | 0.02 | 0.307*** | 0.01 |
| Livestock | 1.190 | 1.27 | 0.032*** | 0.00 | 0.128*** | 0.04 | 0.407*** | 0.01 |
| Value of total asset | 6.812*** | 0.99 | 0.058*** | 0.00 | 0.321*** | 0.02 | 0.165*** | 0.01 |
| Value of agricultural assets | 2.951 | 3.43 | 0.148*** | 0.01 | -0.254*** | 0.03 | 0.022** | 0.01 |
| Contact extension | -3.160 | 5.51 | 0.113*** | 0.01 | -0.036 | 0.02 | 0.099*** | 0.01 |
| Access self-employ income | 7.285** | 3.60 | 1.133*** | 0.01 | 0.098*** | 0.02 | 0.539*** | 0.01 |
| Access wage employ income | 16.632*** | 5.36 | 2.162*** | 0.01 | 0.161*** | 0.02 | 0.443*** | 0.01 |
| Access remittances income | 15.184*** | 4.88 | 0.643*** | 0.01 | 0.066*** | 0.02 | 0.069*** | 0.01 |
| Distance to nearest road | -0.729** | 1.47 | 0.027*** | 0.00 | -0.039*** | 0.01 | -0.014* | 0.01 |
| Distance to nearest market | -7.013*** | 2.41 | -0.040*** | 0.01 | -0.015 | 0.02 | -0.155*** | 0.01 |
| Distance to capital of State | -4.498* | 2.32 | -0.034*** | 0.01 | -0.010 | 0.02 | -0.011 | 0.01 |
| Percent agric. | 0.159** | 0.07 | 0.000** | 0.00 | 0.003*** | 0.00 | 0.001*** | 0.00 |
| Precipitation (mm) | 0.011* | 0.01 | 0.000*** | 0.00 | 0.000** | 0.00 | 0.001*** | 0.00 |
| Annual mean temperature | -0.182 | 0.26 | 0.000 | 0.00 | 0.003*** | 0.00 | 0.001*** | 0.00 |
| Potential wetness index | 0.105 | 0.37 | 0.002* | 0.00 | 0.001 | 0.00 | 0.001 | 0.00 |
| Plot elevation | -0.002 | 0.01 | 0.000 | 0.00 | -0.001 | 0.00 | -0.000 | 0.00 |
| Demographic shocks | 3.391 | 2.01 | -0.116** | 0.05 | 0.131 | 0.11 | 0.085 | 0.07 |
| Economic shocks | -1.371 | 2.78 | -0.116** | 0.06 | -0.169*** | 0.06 | -0.715*** | 0.04 |
| Agricultural shocks | -7.502** | 3.53 | -0.292*** | 0.07 | 0.112 | 0.23 | 1.729*** | 0.14 |
| Cons | 22.412*** | 7.06 | 2.347*** | 0.17 | 5.670*** | 0.24 | 5.179*** | 0.12 |
| N | 2,403 | | 2,403 | | 1787 | | 1787 | |

**Source:** Based on LSMS-ISA surveys in Nigeria.

**Note:** The mean of time-varying variables, dummy for year and state/regions and are included as additional regressors in this Correlated Random Effect (CRE) model, but they are not reported for brevity. *** p<0.01. ** p<0.05. * p<0.10.

**Table 8:** Factor contribution (%) to inequality level using Fields' decomposition method for Nigeria

| | Consumption inequality | | Asset-wealth inequality | |
|---|---|---|---|---|
| | **2010** | **2012** | **2010** | **2012** |
| **Land productivity** | 0.39 | 1.54 | 0.93 | -0.01 |
| **Labor productivity** | 0.51 | 1.41 | 0.04 | 1.41 |
| **Demographic characteristics** | | | | |
| Family size | 37.38 | 39.96 | 9.87 | 12.04 |
| Dependent | 12.73 | 17.45 | 16.18 | 15.21 |
| Gender | 0.71 | 0.06 | 4.02 | 0.89 |
| Age of head | -0.15 | 0.25 | -0.29 | -0.35 |
| Mean education | 19.79 | 15.03 | 12.63 | 40.72 |
| **Total** | **70.46** | **72.75** | **42.41** | **68.51** |
| **Wealth Variables** | | | | |
| Farm size | -1.01 | -1.20 | 1.12 | 2.90 |
| Livestock | -0.14 | -0.02 | 0.09 | -0.05 |
| Total asset | 15.69 | 21.14 | 28.67 | 12.61 |
| Agricultural assets | 5.13 | 5.12 | 18.04 | 9.83 |
| **Total** | **19.67** | **25.04** | **47.92** | **25.29** |
| **Access to infrastructure and community variables** | | | | |
| Contact extension | 1.46 | 0.01 | 4.31 | 0.51 |
| Dist. to road | 1.53 | -0.28 | -0.15 | 0.25 |
| Dist. to market | 1.70 | 1.38 | -0.11 | 0.04 |
| Dist. to capital state | 5.70 | 1.06 | 2.35 | 3.03 |
| Percent agric | -0.87 | -1.40 | 0.15 | -0.47 |
| Precipitation | 0.29 | 2.65 | 0.07 | 5.78 |
| Temperature | 1.73 | -0.48 | 0.07 | -0.79 |
| Potential wetness | -1.20 | -0.80 | -0.05 | 0.04 |
| Elevation | -2.03 | -2.26 | 2.09 | -2.17 |
| **Total** | **8.31** | **-0.12** | **8.73** | **6.22** |

**Source:** Based on LSMS-ISA surveys in Nigeria

**Table 9:** Factor contribution (%) to inequality level using Fields' decomposition method for Uganda

| | Consumption inequality | | | Asset-wealth inequality | | |
|---|---|---|---|---|---|---|
| | **2009** | **2010** | **2011** | **2009** | **2010** | **2011** |
| **Land productivity** | 11.33 | 12.34 | 34.19 | 0.50 | 2.14 | 0.58 |
| **Labor productivity** | 3.16 | 3.40 | -0.78 | 2.28 | 2.69 | 1.00 |
| **Demographic characteristics** | | | | | | |
| Family size | 29.44 | 31.93 | 11.12 | -1.61 | -0.36 | -0.10 |
| Dependent | 9.45 | 10.64 | -0.31 | 12.22 | 11.81 | 8.33 |
| Gender | -0.25 | -0.22 | 0.30 | 1.76 | 2.23 | 2.04 |
| Age of head | 0.07 | -0.07 | 1.76 | 0.09 | 0.27 | 0.06 |
| Mean education | 17.12 | 10.01 | 13.58 | 3.43 | -0.01 | 14.08 |
| **Total** | **55.83** | **52.29** | **26.45** | **15.89** | **13.94** | **24.41** |
| **Wealth Variables** | | | | | | |
| Farm size | 1.89 | 5.20 | -2.70 | 2.74 | 9.76 | 14.11 |
| Livestock | 0.00 | 0.06 | 1.98 | 3.85 | 5.46 | 2.50 |
| Total asset | 0.82 | -7.41 | -4.71 | 62.54 | 56.01 | 64.12 |
| Agricultural assets | 14.07 | 22.50 | 17.84 | -7.95 | -7.86 | -21.38 |
| **Total** | **16.78** | **20.35** | **12.41** | **61.18** | **63.37** | **59.35** |
| **Access to infrastructure and community variables** | | | | | | |
| Contact extension | 5.00 | 5.17 | 10.00 | 3.75 | 2.35 | 0.00 |
| Dist. to road | 3.78 | 3.72 | -0.21 | 1.45 | 0.89 | 0.94 |
| Dist. to market | 6.94 | 4.20 | 5.68 | 3.96 | 3.00 | 3.65 |
| Dist.to capital state | -1.25 | 0.54 | -0.89 | -0.16 | -0.05 | -0.30 |
| Percent agric | -0.27 | -0.13 | 3.02 | 0.29 | 0.88 | 1.02 |
| Precipitation | -0.15 | -0.27 | -0.31 | -0.73 | -0.49 | -0.40 |
| Temperature of | 1.82 | 2.11 | 6.76 | -1.59 | 1.22 | -2.08 |
| Potential wetness | 0.50 | -0.19 | -52.48 | 10.77 | 4.22 | 4.76 |
| Elevation | -0.32 | 0.24 | 55.40 | 4.69 | 8.54 | 8.06 |
| **Total** | **16.05** | **15.39** | **26.97** | **22.43** | **20.56** | **15.65** |

**Source:** Based on LSMS-ISA surveys in Uganda.

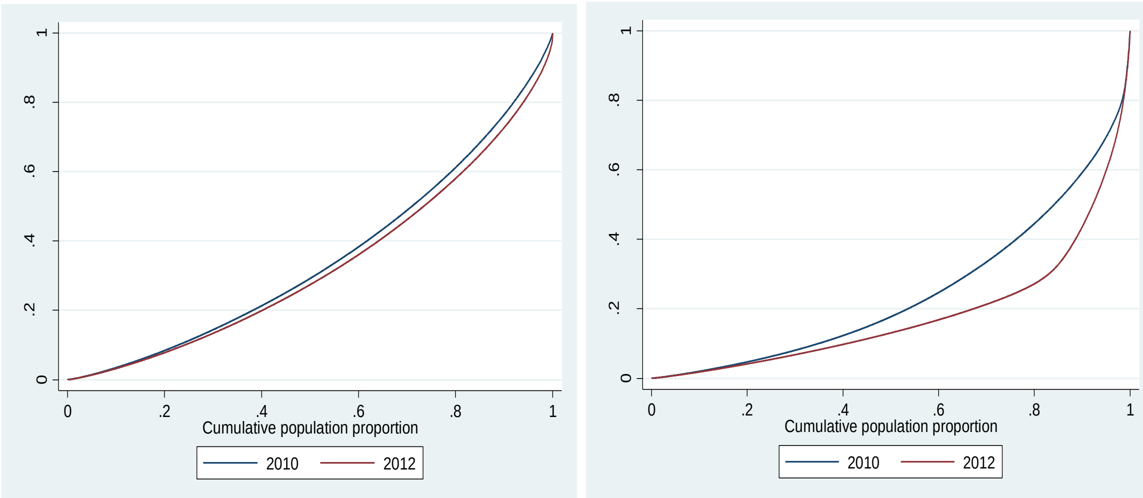
**Table 10:** Decomposition of inequality changes using Fields' decomposition method (%)

| | Nigeria | | Uganda | |
|---|---|---|---|---|
| | **Consumption inequality** | **Asset-wealth inequality** | **Consumption inequality** | **Asset-wealth inequality** |
| **Land productivity** | **2.82** | **-0.60** | **11.92** | **6.10** |
| **Labor productivity** | **2.84** | **0.08** | **23.08** | **1.82** |
| **Demographic characteristics** | | | | |
| Family size | 24.81 | -0.86 | 12.21 | -0.44 |
| Dependent | 34.90 | 17.31 | 6.40 | 0.01 |
| Gender | -1.30 | 1.04 | 0.41 | 0.09 |
| Age of head | 2.02 | 0.23 | 11.05 | -0.13 |
| Mean education | 0.71 | 33.89 | 24.94 | 2.59 |
| **Total** | **61.14** | **51.61** | **55.01** | **2.12** |
| **Wealth Variables** | | | | |
| Farm size | -0.27 | 11.19 | 3.10 | 20.43 |
| Livestock | 0.24 | 2.18 | 0.44 | 2.13 |
| Total asset | 14.40 | 3.81 | 5.39 | 56.44 |
| Agricultural assets | 8.06 | 5.04 | 5.68 | 3.52 |
| **Total** | **22.43** | **22.22** | **14.61** | **82.52** |
| **Access to infrastructure and community variables** | | | | |
| Contact extension | 4.87 | -0.10 | 0.01 | 4.00 |
| Dist. to road | 0.22 | 1.89 | 6.22 | 8.26 |
| Dist. to market | 0.24 | -0.01 | 0.47 | -0.86 |
| Dist.to capital state | 2.60 | -0.07 | 2.83 | -0.04 |
| Percent agric | -0.62 | 2.59 | 8.29 | -0.06 |
| Precipitation | 5.01 | 8.81 | -0.10 | -0.02 |
| Temperature of | 0.21 | -0.09 | -0.19 | -0.16 |
| Potential wetness | 2.09 | -1.47 | -2.98 | -8.50 |
| Elevation | -1.02 | 15.21 | 7.29 | 8.63 |
| **Total** | **13.6** | **26.76** | **21.84** | **11.25** |

**Source:** Based on LSMS-ISA surveys in Nigeria

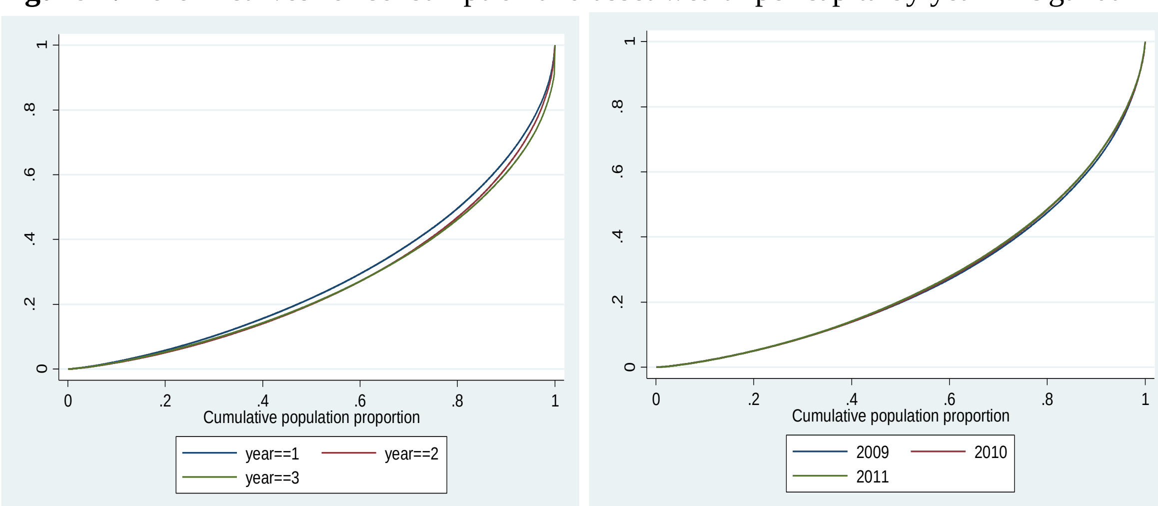
**Note**: The change in inequality decomposed here is the change in the variance of log of expenditure and asset wealth calculated using original expenditure and asset-wealth.

**Figure 1:** Lorenz curves for consumption and asset wealth per capita in Nigeria by year




**Source:** Based on LSMS-ISA surveys in Nigeria.

**Figure 2:** Lorenz curves for consumption and asset wealth per capita by year in Uganda




**Source:** Based on LSMS-ISA surveys in Uganda