

Impact of household income diversification on household welfare in a developing rural economy

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Abstract

Purpose – The purpose of the study is to estimate the impact of household income diversification on household welfare in a developing rural Nigerian economy.

Design/methodology/approach – The study used a panel fractional probit correlated random-effects technique to achieve the 1st-stage and 2nd-stage regression estimations. Four waves of the Nigerian General Household Survey panel for the periods 2010/2011, 2012/2013, 2015/2016 and 2018/2019 were used. Income diversification measures used are the Simpson diversification index and the count index, while household welfare is proxied by dietary diversity score and household consumption spending per adult equivalent.

Findings – The empirical results of the instrumental variables estimation suggest that income diversification positively and significantly impacts rural household welfare. The study further tests whether income diversification has non-homogeneous effects on consumption using quantile regression and found that the positive connection between income diversification and household welfare is across all percentiles, and the magnitude of the impact is slightly higher for non-poor households than for poor households. One of the major findings is that the choice of income diversification proxy significantly influences the welfare effect on rural households.

Practical implications – The results emphasize the need for Nigerian policymakers to design and implement social protection programs targeted at households for income diversification.

Originality/value – The study becomes the curtain raiser in literature to employ four waves of the Nigerian General Household Survey panel data.

Keywords Panel models, Consumer economics, Income, Household welfare, Household survey

Paper type Research article

1. Introduction

There is an increasing high level of discussion in development economics literature on whether income diversification may be explored to improve rural household welfare, especially in sub-Saharan Africa (Riithi, 2015; Lanjouw & Lanjouw, 2001). This discussion is imperative in light of the rising rates of youth unemployment and food shortages in Africa, both of which contribute to rising rural poverty rates. For instance, Nigeria is one of the countries in sub-

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Saharan Africa with a substantial rural population of about 99.9 m in 2021 but is plagued with poverty (World Bank, 2021). About 80% of households with at least 20 persons in rural areas live below the poverty line as of 2019 (Sasu, 2022). Evidence from the World Poverty Clock (2020) corroborates this in Figure 1 which depicts the ten top African economies with extreme poverty rates. Despite massive agricultural labor participation, over 80%, Nigeria recorded an excess of 86 m people with extreme poverty (Chukwu, 2024a, b), out of which more than 70 m reside in rural areas.

Statistics above ranked Nigeria the highest among the top ten poor African countries, followed by Congo-Kinshasa (68.89 m living in extreme poverty) and Ethiopia (23.7 m people living in extreme poverty). Therefore, rural households in Nigeria tend to seek sustainable pathways to improve their welfare through income diversification strategies. At this point, one can argue that income diversification is crucial for reducing poverty, even though, its impact on improving the overall welfare of the household remains debatable.

Over the years, successive governments in Nigeria have implemented various programs and policies aimed at improving the general well-being of rural households. These include the Better Life Programme (BLP) in 1987, the National Directorate of Employment (NDE) in 1987, the Family Support Programme (FSP) in 1993, the Family Economic Advancement Programme in 1997, the Poverty Alleviation Programme (PAP) in 2000, the National Poverty Eradication Programme (NAPEP) in 2001 and the National Economic Empowerment and Development Strategy (NEEDS) in 2003. A recent addition to these strategies is the National Social Investment Programme, specifically N-Power, which was introduced in 2016. Despite all these efforts, Nigeria has not been able to achieve the expected objectives of reducing poverty and inequality (Chukwu, 2024a, b), ensuring food and nutritional security and improving the overall welfare of its citizens. Sadly, the nation is still known as the poverty capital of the world.

Most researchers only examined how income diversification affects well-being without looking at the factors that motivate households to diversify, whereas some only look at the latter (Senevirathna & Dharmadasa, 2021; Akaakohol & Aye, 2014). Hence, this study examines the factors that influence income diversification in Nigeria and its effects on household welfare. The welfare analysis is crucial for identifying the root causes of poverty as well as developing effective policy interventions. It is obvious that identifying the drivers of income diversification would help policymakers to design effective policies that increase households' diversification patterns, which would eventually result in improved living standards for households.

Previous empirical studies focused mainly on the determinants of income diversification in Nigeria using a primary survey (Idris-Adeniyi, Busari, & Adedokun, 2020; Nmeregini, Nzeakor, & Ekweanya, 2019). Other empirical studies that link income diversification with

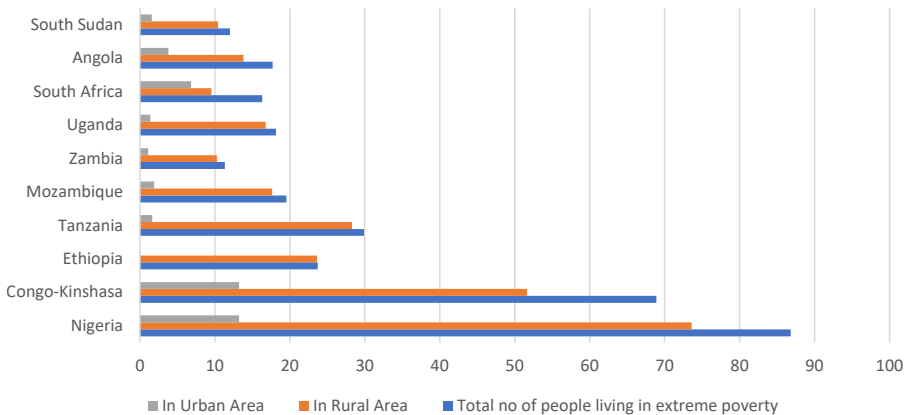


Figure 1. Level of extreme poverty in top ten African economies. Source: World poverty clock data (2020)

household welfare in Nigeria based on primary data with a narrow scope and estimates that are plagued by endogeneity exist (Daud, Awotide, Omotayo, Omotosho, & Adeniyi, 2018; Oyinbo & Olaleye, 2016; Adepoju & Obayelu, 2013; Awotide, Awoyemi, Diagne, Kinkingihoun, & Ojehomone, 2012). This current study utilizes four waves of panel survey data from Nigeria, capturing the income diversification dynamics and its implication on rural households' welfare. This study accounts for endogeneity and reverse causality problems by employing instrumental variables estimation techniques that rely on panel data analysis. The study further examines the mean effects of income diversification on household welfare; and further uses quantile regressions to estimate the heterogeneous effects.

The remaining sections of the article are organized thus: Section 2 surveys related literature; Section 3 explains the methodological framework employed and data used; Section 4 discusses the empirical results and findings; while Section 5 discusses the conclusion and policy implications.

2. Literature review

2.1 What does theory tell us?

Literature had analyzed or captured income diversification with different analytical measurements, such as the Herfindahl–Hirschman index, the Berry index, the entropy measure and the Simpson index (Batool, Babar, Nasir, & Iqbal, 2017). Other measures include the Herfindahl–Simpson index (Djido & Shiferaw, 2018) and the vector of income shares measurement (Alobo & Bignebat, 2017; Sharma, Pandit, White, & Polyakov, 2015). Nevertheless, empirical evidence reveals that all these indices can yield similar outcomes, as there is no clearly defined distinction (Iraoya, 2019; Zhao & Barry, 2014). Therefore, following Kakungulu *et al.* (2018), Iraoya and Isinika (2020) and Chukwu and Chukwu (2023), this study used the Simpson diversification index and count index as measures of income diversification. Greater access to essential services such as electricity, water, sewage or gas is often viewed as a significant improvement in the well-being of households (Hentschel & Lanjouw, 1996). However, the definition of household welfare based solely on access to essential services has been questioned in literature. Since it ignores other important components of household welfare, such as level of food intake, the consumption of non-food goods and services, housing services and so on (Hentschel & Lanjouw, 1996), therefore, welfare can be derived from either direct consumption of goods or the characteristics of the goods (Grootaert, 1981). Therefore, different approaches can be used to measure welfare, such as household consumption expenditure, the income approach and the composition of consumption and employment behaviors (Grootaert, 1981).

2.2 Empirical literature

Results of previous studies in sub-Saharan Africa are mixed. For instance, whereas some empirical studies in SSA show that income diversification has a decreasing poverty effect (Salifu, 2019; Van den Berg & Kumbi, 2006), others found that income diversification widens income inequality (Salifu, 2019; Block & Webb, 2001; Canagarajah, Newman, & Bhattamishra, 2001; Reardon & Taylor, 1996).

Many empirical studies found a non-negative correlation between income diversification and household welfare (Danso-Abbeam, Dagunga, & Ehiakpor, 2020; Zakaria, Azumah, Akudugu, & Donkoh, 2019; Salifu, 2019; Asmah, 2011). In Ghana, Asmah (2011) used an endogenous switching model with repeated cross-sectional data, and found that welfare is positively correlated with income diversification. Zakaria *et al.* (2019) used the same methodological approach but with a micro-level data, and found that diversified households are better-off with respect to welfare than non-diversified households. Using the same analytical technique, Danso-Abbeam *et al.* (2020) used data from 400 farm households and found that non-farm diversification significantly produces welfare benefits. A related study in

Ghana by [Mahama and Nkegbe \(2021\)](#) examined welfare effects of livelihood diversification using instrumental variable approach to account for potential endogeneity and selection bias associated with the OLS estimation technique. Their study found that diversification has a wealth creation effect, which is consistent with [Salam, Bauer, and Palash \(2019\)](#) for Bangladesh and [Rahut, Mottaleb, and Ali \(2018\)](#) for rural Bhutan.

[Kakungulu et al. \(2018\)](#) employed two waves of Ugandan household panel survey data plus the fixed effect model and quantile regression model. Their study revealed that income diversification reduces vulnerability and aid income growth among poor rural households in Uganda.

Using a similar approach, [Khan and Morrissey \(2020\)](#) used a panel of 3,676 households obtained from three rounds of Tanzanian panel surveys and found that non-agricultural wage employment is welfare-improving irrespective of gender. It also found that non-agricultural self-employment diversification strategy is welfare increasing mostly in rural areas, and that females benefit more relative to males. The result contradicts [Khan & Morrissey \(2013\)](#) for Uganda but is consistent with [Asfaw, Scognamillo, Di Caprera, Sitko, and Ignaciuk \(2019\)](#) for Malawi, Niger and Zambia; [Kidane and Zegeye \(2019\)](#) for Ethiopia and [Zeeshan, Mohapatra, and Giri \(2019\)](#) for India.

However, [Gautam and Andersen \(2016\)](#) discovered a negative connection between income diversification and household welfare in Nepal. The study adopted multivariate regression analysis on data collected from a sample of 313 rural households. The result revealed that well-being is not correlated with income diversification but with households' engagement in high-return sectors such as trade and salaried jobs. The finding is consistent with [Dzanku and Sarpong \(2011\)](#). Still in the continent of Asia, [Senevirathna and Dharmadasa \(2021\)](#) investigated income diversification patterns and household welfare in Sri Lanka using a nationally representative sample of 21,756 households using the aggregate asset index as a proxy for household welfare and the OLS technique. The study found that income diversification significantly increases household welfare in Sri Lanka.

[Adepoju and Obayelu \(2013\)](#) used micro-level data obtained from 143 households involved in rural farming in Ondo State, Nigeria, to ascertain the welfare effect of income diversification. The multinomial logit regression adopted in the study revealed that income obtained from participating in non-farm activities significantly impacts on household welfare. A similar result was obtained by [Awotide et al. \(2012\)](#) for Nigeria using a random sample of 600 rice farmers. Their study found that farmers participating in other non-farm wage employment were better-off than those in farm-related employment.

[Iraoya \(2019\)](#) conducted an analysis of the impact of diversifying income sources on household welfare in Nigeria. The study used a panel of the second and third waves of the Nigerian general household survey, that is, 2012/2013 and 2015/2016. The result of the Foster-Greer-Thorbecke (FGT) model revealed that income diversification is a critical poverty-reducing factor among rural households in Nigeria. In the same vein, [Dedehouanou and Mcpeak \(2019\)](#) investigated the effect of income diversification on household resilience to food insecurity in Nigeria. The study used the 2010/2011 and 2012/2013 LSMS-ISA panel survey datasets and adopted a random effect model. The result of the random effect regression revealed that the diversifying of income significantly impacted household welfare.

In summary, the extant literature on the welfare and income diversification nexus in Nigeria is narrow and based on micro-level data with specific areas of concentration ([Daud et al., 2018](#); [Oyinbo & Olaleye, 2016](#); [Etim & Edet, 2016](#); [Adepoju & Obayelu, 2013](#)) despite problems of endogeneity and self-selection bias associated with such method. However, [Iraoya \(2019\)](#) and [Dedehouanou and Mcpeak \(2019\)](#) utilized panel data and recognized that income diversification is endogenous, as such, accounted for possible endogeneity and reverse causality problems. Nonetheless, like many others unable to show the difference in welfare among households of different livelihood strategies. Unlike existing studies for Nigeria, current research exposition analyzes the impact of income diversification on the welfare of rural Nigerian households with the application of competing measures of household welfare and the income diversification index using the four waves of NGHS panel data, namely 2010/2011, 2012/2013, 2015/2016 and 2018/2019, which cut across all six geopolitical zones of Nigeria.

3. Methodology and data

3.1 Theoretical framework

Barnum and Squire (1979) and later Singh, Squire, and Strauss (1986) assumed the household as both producer and consumer (Loison, 2015). Their thesis was originally developed for agricultural household modeling but can as well be employed for non-agricultural household analysis (Cohen, Chen, & Dunn, 1996). The theory posits that households distribute their resources, including labor, between diversified livelihood compositions involving farm and non-farm activities to improve their welfare optimally (Etuk, Udofe, & Okon, 2018). According to theory, livelihood diversification choices of the household with respect to the amount of labor to allocate to either farm or non-farm are jointly considered within the family (Mackenzie, 2017). The theory assumes that all household resources are pooled, and the underlying goal of a household's participation is to maximize their utility (Mattila-Wiro, 1999). Reardon, Berdegue, Barret, and Stamoilis (2006) modified the farm household theory by assuming household diversification decisions as a function of many factors referred to as incentives and capacity variables. They defined incentive as a return that could "pull" and "push" the households into the farm or non-farm activities, which include the extent of variability of prices and wages (Chukwu & Chukwu, 2023). The price variability may differ meaningfully among households due to heterogeneous asset endowments, access to markets and human capital (Atamanov & van den Berg, 2011). According to Reardon *et al.* (2006), capacity variables are the vector of household characteristics that equipped them to respond to the incentive, namely education, age, household assets, access to credit facilities, gender and household size, among others. The reduced-form equation that capture the theoretical framework is thus:

$$D_{ij} = f(s; wfa, wofa, wk, wh, wpa, wg) \quad (1)$$

where D_{ij} is the net farm and off-farm income shares, s represents the vector of input and output prices, w -vectors represent several fixed assets available to the household and specifically wfa stands for farm assets, $wofa$ for off-farm assets, wk for key financial assets, wh for human capital assets, wpa for public assets and wg represents other important assets of the area.

3.2 Model specification

Following Tesfaye and Tirivayi (2020), the study intends to estimate the impact of income diversification on household welfare as follows:

$$Y_{it} = x_{it}\beta + \bar{x}\lambda + ID_{it}\varphi + \alpha_i + v_{it} \quad (2)$$

where Y_{it} is a welfare measure (log of household consumption expenditure per adult equivalent and dietary diversity score), ID_{it} is income diversification and x_{it} is a vector of additional covariates (household demographic and socioeconomic characteristics and institutional factors).

The study used the two-stage residual inclusion (2SRI) technique as a robustness check. The 2SRI technique takes into account any possible endogeneity and reverse causation between income diversification and household welfare. Income diversification is regressed on the instrumental factors and extra covariates in the 1st stage of the 2SRI framework. In this study, a panel fractional probit correlated random-effects technique as specified in Equation (2) is used to achieve this 1st stage. The residual needed for the 2nd stage is retrieved from the 1st-stage regression.

The correlated random effect (CRE) technique is also used to implement the 2nd-stage estimation. The endogenous variable (ID_{it}) is kept in the primary outcome equation in the 2nd stage, and the 1st stage regression residuals are added to the equation to replace the unobserved confounders.

Consequently, 2SRI specification is thus:

$$Y_{it} = x_{it}\beta + \bar{x}\lambda + ID_{it}\varphi + \check{ID}_{it}\delta + \alpha_i + w\bar{V}_i + \varepsilon_{it}^{2SRI} \dots \dots \dots (3)$$

where Y_{it} is a welfare measure, ID_{it} is income diversification. \check{ID}_{it} captures the residuals from income diversification model, which takes care of endogeneity problem. x_{it} is vector of additional covariates and \bar{V}_i is the mean of all time-varying covariates (Tesfaye & Tirivayi, 2020). Standard errors are bootstrapped because the 2nd-stage outcome equation incorporates estimates from the 1st stage reduced form equation (residuals).

The quantile model is specified thus:

$$Y_{it,\tau} = \beta_{\tau}id_{it} + \delta_{\tau}x_{it} + e_{\tau it} (4)$$

with

$$Q_{\tau}(Y_{it}/id_{it}, x_{it}) = \beta_{\tau}id_{it} + \delta_{\tau}x_{it} (5)$$

where Y is a welfare measure captured with consumption expenditure, id is income diversification, x is a vector that captures other covariates and e is an idiosyncratic error vector.

Potential endogeneity resulting from the bidirectional cause-and-effect relationship between the household welfare indicator and the income diversification makes it more difficult to analyze the distributional effects of diversifying income on household consumption expenditure (Xu, 2017). The second-stage residual inclusion (2SRI) method, which has been used in comparable investigations, is used in this study to address this issue (Michler, Baylis, Arends-Kuenning, & Mazvimavi, 2018). The study uses the panel fractional probit correlated random effects model to first regress income diversification on a set of covariates. The 2nd stage equation in reduced form is specified as follows:

$$Y_{\tau,it} = \beta_{\tau}id_{\tau,it} + \varphi_{\tau}\check{id}_{\tau,it} + \delta_{\tau}x_{\tau,it} + \omega_{\tau}\bar{V}_i + \varepsilon_{\tau,it}^{2SRI} (6)$$

Adapting Tesfaye and Tirivayi (2020), the study used pooled quantile regression with Mundlak (1978) transformation for the endogeneity of income diversification in order to test for robustness (Asfaw et al., 2019). Note that \check{id}_{it} captures the residuals from the 1st-stage income diversification equation to account for the potential endogeneity between household income diversification and household welfare and \bar{V}_i is the mean of the time-varying control variables (Tesfaye & Tirivayi, 2020).

3.3 Data and their features

Data for the study were drawn from four rounds of the Nigeria General Household Survey Panel (NGHS-Panel), namely 2010/2011, 2012/2013, 2015/2016 and 2018/2019. The datasets are nationally representative surveys and provide a unique opportunity to study household income diversification patterns across diverse perspectives. This survey is the outcome of a collaboration that has been established between the Nigeria National Bureau of Statistics, the Federal Ministry of Agriculture and Rural Development (FMA&RD), the National Food Reserve Agency (NFRA), the Bill and Melinda Gates Foundation (BMGF) and the World Bank (WB). The NGHS-Panel survey is conducted biennially. The NGHS-Panel has a sample of about 5,000 households. The project covered both the rural and urban areas in Nigeria, but in this study, the interest is on the rural households. Each round of the NGHS panel was conducted in two separate visits, the first during post-planting and the second during post-harvest. The survey conducted for the NGHS waves recognized three major instruments,

namely household, community and agriculture. The econometrics software employed for analyses is the STATA version 16.

4. Results and discussion

4.1 Descriptive statistics

Table 1 presents the descriptive statistics for the covariate variables, which indicate that 12% of households head were females, and the mean age of household head was 49 years. The average year of formal education of head of households is about five years and that of household members is above two years. Table 1 below indicates that the average family size of household is about six members and about 1.83% of household members were between the age of dependency. On average, households' assets value was about ₦95.733 and less than 2% of the households had access to formal financial credit.

The average distance to the major tarred road and the nearest market was approximately 10km and 70km, respectively. As for shocks, 13% of households experienced price shock and idiosyncratic shock, while 14% experienced natural shock.

The minimum and maximum values highlight the variability across households in terms of characteristics, wealth, access to resources and exposure to shocks. The data suggests significant diversity in household size, age, education and financial access, which may impact overall well-being and resilience. The maximum household size of 35 illustrates extreme variability, indicating that some households are significantly larger, which may potentially impact resource allocation and social dynamics. Also, the household asset minimum and maximum values highlight significant wealth disparity, raising concerns about inequality.

4.2 Income diversification patterns and welfare measures

Table 2 presents the summary statistics of the rural households' income diversification patterns. The count index indicates that the mean value of income portfolios of the sampled rural households was around two, with a little variation during the periods of the panel survey. The averages of the Simpson index show slight differences between the survey periods, with the least value in 2010/2011.

Welfare is measured with household consumption per adult equivalent expenditure and dietary diversity score, which, respectively, capture a flow and a stock welfare measurement indicator (Upton, Cissé, & Barrett, 2016). Table 2 indicates that household's consumption expenditure per adult equivalent maintained an increasing trend all through the panel periods with a significant difference between 2015/2016 and 2018/2019. The number of different food group categories consumed by household seven days before the survey, referred to as the dietary diversity score, slightly declined between 2010/2011 and 2012/2013, but a higher score was recorded in 2018/2019.

4.3 Welfare effect of income diversification

4.3.1 *Income diversification and consumption.* The estimated coefficients of the FE-IV regression are non-negative as well as statistically significant for the count index equation only. This suggests that income diversification exerts a positive impact on rural household welfare. On average, an increase in the number of income portfolios by one unit results in about an 8% rise in consumption expenditure per adult equivalent. The diagnostic test results indicate that the instruments for income diversification are valid. The test of weak identification (the Kleibergen–Paap F-statistic) is statistically different from zero in all the estimated models, which rationalizes the relevance and strength of the selected instruments. More so, the test of overidentification (Sargan–Hansen statistic) is not significant. This indicates that there is no sufficient evidence to reject the conjecture (H_0) that the instruments used in the model can be exempted in the 2nd-stage estimation.

Table 1. Descriptive statistics

Variable	Description	Mean	Min.	Max.	Standard dev.
<i>Household characteristics</i>					
fhh	Gender of household head (female = 1, 0 otherwise)	0.1242993	0	1	0.3299374
hh_size	The total number of household members irrespective of age.	6.646054	1	35	3.460684
hh_size^2	Household size squared	56.1453	1	4,225	62.33843
hoh_age	Age of household head (years)	49.15856	15	130	14.8158
hoh_age^2	Age of household head (years) squared	2636.052	400	12,100	1579.739
hoh_edu	Education of household head (years)	4.521043	0	12	4.85692
hoh_edu^2	Education of household head (years) squared	44.0274	0	144	57.33382
aved_hhmem	Mean years of schooling of household members (years)	2.417675	0	12	2.668728
dep_ratio	Dependency ratio (age <14 > 64) to active working age	1.826571	0.078129	5.8	1.266848
<i>Wealth indicators</i>					
hh_asset	Value of household assets (Naira) per capita	95733.01	0	1.51e+07	359470.4
loghh_asset^2	Natural log of value of household assets (Naira) per capita squared	110.5471	0	1.96e+14	29.56705
<i>Community characteristics</i>					
dist_mkt	Distance from household location to nearest major market (km)/100	0.6990446	0.0028	2.27	0.4132075
dist_rd	Distance from household location to nearest tarred road (km)/100	0.0969623	0	1.152	0.1314087
<i>Shock variables</i>					
idio_shock	Household affected by idiosyncratic shocks: death of a family member, illness or loss of job = 1; 0 otherwise	0.1320402	0	1	0.3385495
price_shock	Household affected by price shocks: unanticipated changes of food prices, input and output prices = 1; 0 otherwise	0.1339977	0	1	0.340665
nat_shock	Household affected by demographic shocks: natural disasters, like floods, pests or drought = 1; 0 otherwise	0.1443189	0	1	0.3514284
<i>Financial access variables</i>					
credit_access	Household access to formal financial service credit = 1; 0 otherwise	0.0162826	0	1	0.1265658

Source(s): Authors' calculation using STATA 16

Table 2. Income diversification pattern and summary statistics for outcome variables over the study period

	2010/11	2012/13	2015/16	2018/19	Pooled
<i>A. Income diversity indices</i>					
Simpson diversification index (SID)	0.16 (0.207)	0.20 (0.208)	0.21 (0.210)	0.18 (0.208)	0.19 (0.209)
Count index	1.48 (0.629)	1.78 (0.610)	1.77 (0.604)	2.04 (0.712)	1.76 (0.669)
<i>B. Welfare variables</i>					
Consumption per adult equiv. (Naira)	100,471.6 (76470.06)	129,294.2 (288859.6)	136,965.5 (146009.6)	188,261.3 (153627.4)	137,517.5 (186833)
Dietary diversity score	8.148 (2.064)	7.775 (1.884)	8.493 (1.787)	9.082 (1.753)	8.355 (1.942)
Observations	3,000	2,927	2,619	2,693	11,231
Note(s): Reported mean values and values in parentheses are the standard deviations					
Source(s): Authors' calculation using STATA 16					

The fixed-effect instrumental variable estimates are slightly different from the estimates of the two-stage residual inclusion (2SRI) approach. The two-stage residual inclusion results suggest that income diversification statistically impacted household welfare for the Simpson diversification index and count index equations, while fixed-effect estimates in the Simpson diversification index equation are statistically insignificant. However, the generalized residuals coefficients are statistically significant for only the Simpson diversification index equation, which justified rejection of the exogeneity of income diversification in the consumption expenditure equations.

According to the study, the effect of income diversification on consumption was significant across the 2SRI and CRE methods, with coefficients indicating a positive relationship (see Table 3). The results of the 2SRI conformed with results obtained from correlated random-effects and pooled ordinary least squares where income diversification is treated as exogenous, thereby confirming that income diversification exerts a non-negative and significant effect on rural household welfare, as in Khan and Morrissey (2020) for Tanzania.

4.3.2 Income diversification and aggregate household dietary diversity. Table 4 show that income diversification has a negative and insignificant effect on rural household welfare (dietary diversity score). However, the FE-IV estimates contrasted with the estimates from the 2SRI method. The 2SRI estimates reveal that income diversification has a positive and statistically significant impact on rural household's welfare (dietary diversity score) at the 1% significance level. This suggests that on average, an increase in the income portfolio by 1% leads to a rise in rural household dietary diversity by 0.53 (Simpson diversification index) and 0.13 (count index). The statistical significance of the generalized residuals in 2SRI estimation validate the rejection of income diversification as exogenous.

Table 3. Effect of income diversification on consumption

	Simpson diversification index		Count index	
	Coefficients	Robust standard errors	Coefficients	Robust standard errors
(1) FE-IV	0.469	0.370	0.081*	0.050
(2) 2SRI	0.093***	0.032	0.055***	0.011
(3) CRE	0.097***	0.032	0.055***	0.011
(4) Pooled OLS	0.099***	0.036	0.059***	0.008
Note(s): ***, ** and * indicate statistical significance at 1, 5 and 10% levels, respectively				
Source(s): Authors' calculation using STATA 16				

Table 4. Impact of income diversification on rural household's dietary diversity

	Simpson diversification index		Count index	
	Coefficients	Robust standard errors	Coefficients	Robust standard errors
(1) FE-IV	-0.416	1.126	-0.093	0.152
(2) 2SRI	0.530***	0.103	0.134***	0.033
(3) FE-Poisson	0.058 ***	0.012	0.015***	0.003
(4) Pooled OLS	0.529***	0.121	0.163***	0.025

Note(s): ***, ** and * indicate statistical significance at 1, 5 and 10% levels

Source(s): Authors' calculation using STATA 16

The estimates from the 2SRI model are consistent with the estimates obtained from the pooled OLS and fixed-effects Poisson model where income diversification was treated as exogenous. The results suggest that income diversification has a non-negative and significant impact on household welfare at the 1% level of significance for both the Simpson diversification index and the count index. These findings are consistent with the findings of [Dedehouanou and Mcpeak \(2019\)](#), [Dev, Sultana, and Hossain \(2016\)](#) and [Block and Webb \(2001\)](#).

4.3.3 Heterogeneous effects of income diversification on consumption. The impact of income diversification on disaggregated household consumption was estimated using quantile regression to ascertain whether diversifying income has different impacts on consumption across high-consuming (non-poor) and low-consuming (poor) rural households. The quantile regression coefficient estimates are summarized in [Table 5](#). The results of the 2SRI, where income diversification is treated as endogenous variable, reveal that income has a positive and significant impact on rural household consumption across all quantiles for both income diversification measures. This suggests that diversifying income has a positive influence on rural household's welfare, with slightly higher effects among higher-consuming households. This result is consistent with [Khan and Morrissey \(2020\)](#) for Tanzania.

As a robustness check, the study estimates a pooled quantile model with the Mundlak effect to account for unobserved heterogeneity ([Tesfaye & Tirivayi, 2020](#)), where income diversification is regarded as an exogenous variable. The robustness check results suggest that income diversification generates slightly greater welfare effects, even when the study did not account for the endogeneity of income diversification. The positive association of income diversification and welfare can be found across the various quantiles, and the magnitude of the effect is slightly different.

5. Conclusion and policy implications

The empirical findings imply that diversifying income sources improves the welfare of households in the rural sector through its favorable and significant effects on consumption spending and dietary diversity. The results of the FE-IV regression indicate that income diversification has a positive impact on rural household welfare. The estimated coefficients for the count index equation are non-negative and statistically significant, which suggests that income diversification has a beneficial effect on the well-being of rural households. The estimates obtained from the 2SRI model reveal that income diversification has a significant and positive impact on the dietary diversity score of rural households. The estimates obtained from the 2SRI model are consistent with those obtained from the pooled OLS and fixed-effects Poisson model, where income diversification was treated as exogenous. The results suggest that income diversification has a non-negative and significant impact on household welfare, at a 1% level of significance, for both the Simpson diversification index and the count index.

Table 5. Welfare effects of income diversification: *quantile regression estimates*

	Endogenous income diversification				Exogenous income diversification			
	20%	40%	60%	80%	20%	40%	60%	80%
Simpson index	0.077* (0.044)	0.117** (0.052)	0.098** (0.049)	0.085* (0.050)	0.077* (0.046)	0.128*** (0.047)	0.102** (0.047)	0.099* (0.054)
Count index	0.043*** (0.020)	0.055*** (0.009)	0.064*** (0.012)	0.051*** (0.015)	0.045*** (0.018)	0.056*** (0.010)	0.064*** (0.010)	0.049*** (0.016)

Note(s): ***, ** and * indicate statistical significance at 1, 5 and 10% levels
Source(s): Authors' calculation using STATA 16

Additionally, compared to impoverished and low-consuming households, households at the higher percentile of the consumption distribution exhibit the consumption effect of income diversification more clearly. Since income diversification has positive and significant effects on rural household welfare, developing policies for rural welfare improvement needs to be targeted at programs and policies encouraging income diversification.

Among others, some of the public policy measures to ensure improvement in rural households income diversification strategy include the following: (i) governments' provision of income-generating opportunities in rural areas to support households' involvements in the non-farm and off-farm sectors; (ii) creation of public awareness by the government on the effective strategies to raise public understanding of the importance of gender equality in all developmental endeavors as well as encourage women entrepreneurial and empowerment activities and (iii) governments' provision of rural infrastructure such as good road network for faster access to markets in order to ensure sustainable rural livelihoods.

Despite the interesting findings and contribution of this study, this study is affected by the data attrition problem. The data attrition problem further made it impossible for the study to examine the effect of income diversification transitions on household welfare using the four waves of the NGHS.

Compliance with ethical standards

Authors have no competing interests to declare on the content of this manuscript; hence, authors hereby ethically declare that they have no conflict of interest. The study used public data obtained freely from the World Bank website. The article is an original unpublished work and not under consideration elsewhere.

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