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Title: The Moderating Role of Education on the Financial Inclusion-Food Poverty Nexus: The Case of Uganda.

Abstract

- Purpose

  This paper investigates the impact of financial inclusion on food poverty, focusing on the moderating role of education.

- Design/methodology/approach

  Using data from the Uganda National Household Survey 2019/2020, this study employs a binary Logit model to examine the impact of three dimensions of financial inclusion: ownership of a savings account, access to credit, and a financial inclusion index on food poverty, with emphasis on the interaction between education and financial inclusion.

- Findings

  The study finds that both financial inclusion and education significantly reduce food poverty, with education enhancing the effectiveness of financial inclusion in this regard. The interaction between financial inclusion measures and education is statistically significant, highlighting education's role in improving the utilisation of financial services to alleviate food poverty.

- Originality

  While financial inclusion's role in reducing poverty and improving economic well-being has been studied, the moderating role of education remains underexplored. This paper addresses this gap by analysing how education interacts with financial inclusion to jointly influence food poverty, focusing on education as a moderator in the financial inclusion- food poverty relationship.

Introduction

Food security remains a critical global challenge, particularly in poorer countries where vulnerable populations often struggle to access sufficient and nutritious food (Majumder et al., 2016; McMichael, 2009; Sila & Pellokila, 2007). While economic growth and poverty reduction efforts have made significant strides, disparities persist. One key factor that intersects with economic well-being and food security is financial inclusion.

If a household's average per-person food expenditure is less than the food poverty line, all individuals in the household are considered to be in food poverty. Everybody needs sufficient food to lead a healthy life. Thus, the Sustainable Development Goals (Zero Hunger (SDG 2) and Good Health and Wellbeing (SDG 3)) reinforce ending hunger, achieving food security and improved nutrition and promoting sustainable agriculture.

Omar & Inaba (2020) view financial inclusion as a means of making formal financial services accessible and affordable, especially for low-income people. Further, Baborska et al. (2020) argue that financial services represent tools that can potentially help manage the household income available for investments and consumption, which may ultimately improve economic welfare (Barugahara, 2021). Thus, several studies (Omar & Inaba, 2020;Park & Mercado, 2018;Mohammed et al., 2017) have examined the impact of financial inclusion on poverty and found empirical evidence that financial inclusion reduces poverty and brings about social inclusion. Focusing on food poverty, generally, researchers (Koomson & Ibrahim, 2018;Arshad, 2022; Gyasi et al., 2021; Baborska et al., 2020; Jabo et al., 2017) find that financial inclusion reduces food insecurity. However, Baborska et al. (2020) argue that the effect of financial inclusion on food poverty is ambiguous and depends on the type of financial services, with savings account use decreasing food insecurity, credit use increasing food insecurity, and formal payment services not affecting food insecurity.

Despite the substantial scholarly and policy attention garnered to the study of the significance of financial inclusion in addressing poverty and enhancing economic well-being, the role of education as a moderator in this context remains underexplored. This paper fills the gap by examining the interaction between education and financial inclusion and their joint effect on food poverty, i.e., we examine the moderating effect of education on the financial inclusion-food poverty nexus.

Specifically, we argue that the impact of financial inclusion on food security will depend on how efficiently the household uses the financial services, which depends on the financial education of the individual. Highly educated individuals are likely to make informed decisions concerning the use of financial services. This will ultimately positively affect their investment and consumption, reducing incidences of food insecurity compared to individuals with low financial education. Financial education refers to the knowledge and understanding of financial products and concepts and the ability and confidence to appreciate financial risks and opportunities and make informed decisions to improve one's financial well-being. Hence, apart from financial inclusion, individuals must be empowered through increased financial education to use financial resources efficiently. Therefore, we argue that education can enhance the effect of financial inclusion on food security by ensuring the efficient use of financial resources.

The paper uses data from the Uganda National Household Survey 2019/2020 and employs the binary Logit model. Uganda presents a compelling case study for assessing the moderating impact of education on financial inclusion in determining food security as it exhibits a diverse socioeconomic landscape characterised by significant disparities in education levels, financial inclusion, and food security outcomes across different regions and demographic groups. This diversity provides a rich context for examining how variations in educational attainment intersect with disparities in access to financial services and nutritional outcomes. Moreover, food poverty is a key problem in developing countries like Uganda, and according to Food and Agriculture Organization of the United Nations (FAO) (2023), global hunger affected 9.2% of the population in 2022. Specifically, based on the Uganda National Survey Report (2019/2020), about 3.5 million Ugandans (about 8.5%) were classified as food-poor (Uganda Bureau of Statistics (UBOS), 2021).

Uganda also faces challenges related to education access and quality, particularly in rural and underserved areas (Financial Inclusion Insights, 2018). Despite efforts to improve enrollment rates, disparities in educational attainment persist. Investigating how these disparities influence individuals' ability to leverage financial services for food security can offer valuable insights into the role of education as a moderator. Moreover, agriculture remains a primary source of livelihood for the majority of Ugandans, particularly in rural areas (Digital Frontiers Institute (DFI), 2019). However, FAO (2020) noted that the sector faces challenges such as limited access to credit, inadequate infrastructure, and climate variability, which affect agricultural

productivity and food security. Understanding how education influences farmers' ability to access financial resources, adopt modern agricultural practices, and mitigate risks associated with food production can shed light on the pathways through which education moderates the relationship between financial inclusion and food security.

The paper is outlined as follows: Section 1 presents the introduction, Section 2 provides a review of relevant literature, Section 3 gives the research methodology and data, Section 4 presents the empirical findings and discussion, and lastly, Section 5 presents the conclusion and implications.

Review of relevant literature

Literature exploring the intricate interplay between food security and financial inclusion is steadily expanding as scholars delve into understanding their complex relationship. The impact of financial inclusion on food security is multifaceted, with various channels through which it influences household well-being. Savings and credit mechanisms, integral to financial inclusion, play pivotal roles in bolstering food security by facilitating consumption smoothing and investment in income-generating ventures.

Bartfeld & Collins (2017) highlight the significance of savings and credit in mitigating economic hardships by enabling households to maintain stable food consumption patterns. Additionally, financial inclusion fosters entrepreneurship (Koomson & Ibrahim, 2018) thereby augmenting household incomes and subsequently enhancing food security (Sinyolo & Mudhara, 2018). Koomson et al. (2023) assert that inclusive finance facilitates investments in education and health, fostering human capital accumulation, which, in turn, boosts productivity and income, thus promoting sustainable food security.

However, there are potential drawbacks to financial inclusion. Koomson et al. (2023) cautioned that excessive access to credit could lead to over-indebtedness, potentially exacerbating food insecurity. Moreover, the utilisation of financial services may entail costs that some households find unsustainable, ultimately leading to food insecurity (Baborska et al., 2020). For instance, households might prioritise saving for potential shocks over profitable investments or resort to costly emergency loans after a shock has occurred, thereby diminishing incomes and exacerbating food poverty.

Empirical studies offer insights into the relationship between financial inclusion and food security across diverse contexts. Jabo et al. (2017) find that formal credit access improves food security among rural Nigerian farming households by facilitating productive activities and investments in agricultural inputs. Similarly, Gyasi et al. (2021) observe a significant reduction in food insecurity among older Ghanaians with increased access to financial services.

Further evidence supporting the positive impact of financial inclusion on food security is provided by Arshad (2022) and Koomson et al. (2023), particularly emphasising the role of entrepreneurship in mediating this relationship, especially in male-headed and rural households. Additionally, Lin et al. (2022) highlight the positive influence of digital inclusive finance on food security in China, attributing it to reduced financial constraints, increased credit accessibility, rural economic development, and promotion of agricultural industrialisation.

In contrast, Baborska et al. (2020) suggest that the impact of financial inclusion on food security varies depending on the type of financial service utilised. While savings accounts alleviate food insecurity, credit usage tends to exacerbate it. Furthermore, Nepal & Neupane (2022) find that while savings accounts mitigate food shortages, access to credit has no significant effect on food security in flood-prone regions of India.

Despite growing evidence linking financial inclusion to food security, the literature remains inconclusive, especially regarding the role of specific financial services and user characteristics. Critically, no studies consider how education may enhance the effectiveness of financial inclusion. This study contributes by explicitly modelling education as a moderator in the financial inclusion–food poverty relationship using data from Uganda. The current body of literature has yet to explore the moderating influence of financial education on the dynamic interplay between financial inclusion and food security. This research seeks to address this notable gap by elucidating how education shapes the intricate relationship between financial inclusion and food security. The proposition posits that individuals with higher levels of education possess the cognitive tools and knowledge necessary to make informed financial decisions, thereby leveraging financial services to positively impact their food security status. Conversely, the uneducated may be prone to making suboptimal financial choices, potentially leading to adverse outcomes. Understanding this moderating effect could offer insights into the

contradictory findings observed, particularly concerning the impact of credit usage on food security. Further analysis is warranted to elucidate this relationship comprehensively.

Research Methodology and Data

The study's objective is to examine the moderating effect of education in the financial inclusion- food poverty nexus. It used data from the Uganda National Household Survey for FY 2019/20.

Model specification and estimation

$$y_i = \beta_0 + \beta_1 FI_i + \beta_2 Educ_i + \beta_3(FI_i \times Educ_i) + \delta\chi + \varepsilon_i \qquad (1)$$

Where FI_i represent financial inclusion, which is a dummy variable that takes on 1 if the individual is financially included and 0 if the individual is not financially included. $Educ_i$ is a measure of an individual's educational attainment, which is the number of completed years of schooling. We include an interaction term between financial education and education $(FI_i \times Educ_i)$ to examine the moderating effect of education on the impact of financial inclusion on food poverty. Also, χ is a set of other factors that influence individuals' likelihood of being food-poor, δ represents a set of beta coefficients and ε_i is the error term.

We applied a binary logit model to estimate the above model. Binary logistic regressions are particularly suitable for analysing cross-sectional data and explaining the outcome of a dichotomous (0/1) dependent variable of interest subject to a set of influencing covariates (Greene, 2008)and does not assume a linear relationship between the dependent and independent variables (Hosmer Jr et al., 2013). Moreover, the logistic regression model is widely used in poverty, health, and food security research where outcome variables are categorical or binary in nature (see: Jabo et al., 2017; Gyasi et al., 2021; Arshad, 2022). It offers a robust framework for assessing the marginal effects of predictors and accounts for heteroskedasticity in binary outcomes and avoids predicted probabilities falling outside the [0,1] interval—a common problem in linear probability models (Wooldridge, 2010). The study investigated the determinants of food poverty subject to a set of explanatory factors. This study's dependent variable, 'y', represents the individual's likelihood of being food-poor. (y = 1, if an individual's monthly food expenditure is below the national food poverty line; y = 0, otherwise); meanwhile, the explanatory variables can take any form (discrete, continuous).

The binary regression is specified as follows:

$$y_i^* = X'\beta + \epsilon \tag{2}$$

$$y_i = \begin{cases} 1 & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases} \tag{3}$$

Where y_i^* is a latent (unobserved) variable, y_i is the observed variable that takes on the value of 1 if an individual i is food-poor and zero otherwise. X is a vector of independent variables that determine an individual's likelihood of being food-poor, ϵ is the disturbance process (error term).

Note that the parameters of the logit model, since it is a nonlinear regression model, are not necessarily the marginal effects as in the linear models (Greene, 2008).

In a nonlinear model like a logit model, marginal effects are more informative than coefficients (Cameron & Trivedi, 2010). Average Marginal Effects were estimated and were used in the analysis. The logit model was estimated using the Maximum Likelihood estimator. The standard errors are adjusted for clustering on person id (pid) to account for heteroskedasticity across individuals and correct for the non-independence of observations. This adjustment yields robust standard error estimates, ensuring more reliable hypothesis testing and enhancing the overall validity of the model's inferences.

In nonlinear models, the evaluation of interaction effects extends beyond the straightforward inspection of the sign, magnitude, or statistical significance of the coefficient on the interaction term, as emphasised by(Ai & Norton, 2003). Norton et al. (2004) further elucidate that the statistical significance of the interaction effect cannot be assessed using a simple t-test on the interaction term coefficient β_3 in model 1. Instead, the appropriate test for the statistical significance of the interaction effect must rely on the estimated cross-partial derivative rather than the coefficient of the interaction term itself. In this paper, we employ graphical methods to illustrate the interaction effects and their statistical significance, thereby providing a more nuanced and accurate analysis.

To address potential endogeneity between financial inclusion and food poverty, we control for a rich set of household and regional characteristics. Where data limitations restrict the use of valid instruments, we interpret the results as indicative of associations rather than causal effects. We further conduct robustness checks including alternative model specifications.

Data

We used data from the Uganda National Household Survey (UNHS) of FY 2019/20, which was collected by the Uganda Bureau of Statistics (UBOS). The data consists of 34,192 randomly selected individuals throughout the country. We cleaned data to eliminate individuals without complete data, determining the observations to be used in the analysis. Only individuals aged 15 and above are considered in the study since the financial inclusion data was collected for individuals aged 15 and above. After data cleaning and restricting the age of individuals to 15 and above, the number of observations was reduced to 13,581. The data collected from the household survey included demographic and socioeconomic characteristics and information on individuals' use of financial services.

The dependent variable is whether the individual is food-poor, a dummy variable that takes on "1" if the individual's monthly food expenditure is below the national food poverty line and "0" otherwise.

The individuals' likelihood of being food-poor depends on many factors, both economic and non-economic, and these may include the following:

1) **Financial Inclusion**: There were three measures in this study. First, we measured financial inclusion as a dummy variable that takes on 1 if an individual has a savings account and zero otherwise; second, we measured financial inclusion as a dummy variable that takes on 1 if an individual used credit during the period of study and 0 otherwise. Lastly, we constructed a financial inclusion index for the two dummy variables (having a savings account and credit use), each component having a weight of 50%. An individual with a score less than 0.5 is considered not financially included and financially included if the score is 0.5 and above. Hence, the financial inclusion index is a dummy variable taking on zero if the individual does not have a savings account or did not use credit but taking on one if the individual has a savings account or uses credit or both. Hence, if the individual is financially included, the index takes on 1 and 0 if not financially included. A negative coefficient is expected since financially included individuals may have access to funds that can be used for investment in income-generating activities and human capital and for smoothing consumption in times of economic hardship, thereby reducing the likelihood of such individuals being food-poor.

2) **Education** is the number of years of schooling an individual has attained. A negative coefficient is expected since educated individuals are ==most== likely to have the skills and knowledge to engage in income-generating activities that will provide sufficient funds for food.

3) ==**Gender:**== It's a dummy variable taking on 1 for males and 0 for females. We expect a negative coefficient since males in Uganda are, on average, wealthier than females. Also, because of the gender inequality challenges that females face in Uganda, males are more likely to have the means to provide for food, hence having food security compared to females.

4) **Age of the individual:** The ==coefficient can be positive or negative. Since young people are more likely to be employed and older people may have no income due to retirement, being young may reduce the risk of food poverty.== However, the old may have accumulated savings from their longtime employment and hence may be more food secure.

5) **Urban**: This measures an individual's location, which takes on 1 if the individual lives in an urban area or 0 if one lives in a rural area. A negative coefficient is expected since, in Uganda, incomes for urban dwellers are, on average, higher than those of their rural counterparts, which means urban dwellers are less likely to be food-poor.

6) **Marital status**: This dummy variable takes 1 for married individuals and 0 for those who are not married (single, divorced, windowed). A negative coefficient is expected since being married can lead to a combined effort for providing food for the household, reducing the likelihood of an individual being food-poor compared to the unmarried.

7) **Employment status:** This is a dummy variable, taking on 1 if an individual is employed and 0 if an individual is unemployed. Being employed provides a stable and secure source of income that can be used for food, hence reducing the incidences of food poverty compared to unemployed individuals. A negative coefficient is expected.

8) **Household Size:** This is measured as the number of people in the household where the individual comes from. We expect a positive coefficient, as an individual from a large household may be more likely to experience food poverty. Food has to be shared among many people, and providing food for a large family can be challenging.

9) **Agriculture:** It is a dummy variable that takes on 1 for an individual who engaged in some form of agriculture and 0 otherwise. A negative coefficient is expected since agriculture is a source of food; hence, engagement in agriculture is expected to reduce food poverty.

Empirical Findings and Discussions

Summary Statistics and Correlations

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Food poor	13581	.199	.399	0	1
Saving Account	13581	.187	.39	0	1
Credit use	13581	.22	.415	0	1
Education	13581	5.766	4.242	0	17
Gender	13581	.428	.495	0	1
Age	13581	41.882	16.127	15	100
Urban	13581	.261	.439	0	1
Marital status	13581	.687	.464	0	1
Employment status	13581	.476	.499	0	1
Household size	13581	4.715	2.545	1	25
Agriculture	13581	.797	.403	0	1

Source: Authors own work

From Table 1 above, 19.9% of the individuals sampled were food-poor, i.e., their average food expenditure was less than the national food poverty line. A percentage of 19.9% of the food-poor individuals is high, indicating that food poverty is a real problem in Uganda. Only 18.7% of the individuals sampled had a savings account, and 22% of the individuals in the sample used credit; this is an indication of low levels of financial inclusion, which may have negative consequences for food poverty since researchers generally find that financial inclusion increases food security. The average education of individuals sampled is 5.8 years, indicating a low level of education in Uganda. It indicates that most individuals have less than a primary education level, as the completion of primary education is 7 years in Uganda. A low level of education may hinder the effective use of financial services in Uganda, hence leading to negative repercussions for food poverty. 42.8% of the individuals in the sample are males. The average age of the individuals in the sample was 41.9 years, indicating that the sampled individuals are mature enough to use financial services. Only 26.1% of the individuals lived in urban areas, whereas the majority, 73.9% of the sample, were rural-based. 68.7% of the individuals in the sample were married. Only 47.6% of the individuals were in employment, an indication of a high level of unemployment and a high dependency ratio in Uganda. This may have negative effects on food security. The average hold size was 4.7 individuals. 79.7% of the individuals in the sample engaged in agriculture, indicating that agriculture is the backbone of Uganda. Additionally, this may help reduce the incidence of food poverty in the country.

Table 2: Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) food poor	1.000										
(2) saving Account	-0.128	1.000									
(3) credit use	-0.110	0.236	1.000								
(4) Education	-0.198	0.252	0.077	1.000							
(5) Gender	-0.055	0.047	0.071	0.216	1.000						
(6) Age	0.055	0.007	-0.013	-0.294	0.025	1.000					
(7) urban	-0.016	0.087	-0.040	0.256	-0.062	-0.091	1.000				
(8) marital status	-0.182	0.052	0.027	0.111	0.194	-0.187	-0.088	1.000			
(9) employment status	-0.047	0.118	0.122	0.165	0.162	-0.150	0.101	0.025	1.000		
(10) Household size	-0.334	0.062	0.083	0.002	-0.023	-0.014	-0.112	0.348	-0.037	1.000	
(11) Agriculture	-0.094	-0.005	0.061	-0.181	0.044	0.103	-0.384	0.154	-0.106	0.257	1.000

Source: Authors own work

From Table 2, all the measures of financial inclusion (saving account and credit use) are negatively correlated with food-poor, implying that financial inclusion reduces food poverty. Education is negatively correlated with food poverty, suggesting that educated individuals are more likely to be employed or to use financial services effectively, thereby reducing the incidence of food poverty. Being male is associated with a lower likelihood of experiencing food poverty, possibly because males are more creative than females and can more easily initiate income-generating activities, which reduces the probability of food poverty among males compared to females. Age is positively associated with food poverty, suggesting that as individuals age and approach retirement, they may lose these sources of income, potentially leading to food poverty. Living in an urban area is associated with less food poverty, possibly because in Uganda, urban dwellers earn significantly higher incomes than rural individuals, thereby ensuring food security in urban areas more than in rural areas. Marriage is associated with a lower incidence of food poverty, possibly because of the combined efforts to provide for the family that marriage brings rather than being single. Being in employment reduces food poverty since employment is a source of income that can be used to ensure food security. Surprisingly, an increase in household size is associated with a reduction in food poverty. It may result from a combined effort by household members to provide food. Engagement in agriculture is negatively correlated with food poverty since agriculture is a source of food.

Figure 1 below shows the scatter plot of food poverty by the FI Index (Financial Inclusion Index). There is a negative relationship between food poverty and financial inclusion, suggesting that financial inclusion is negatively associated with food security.
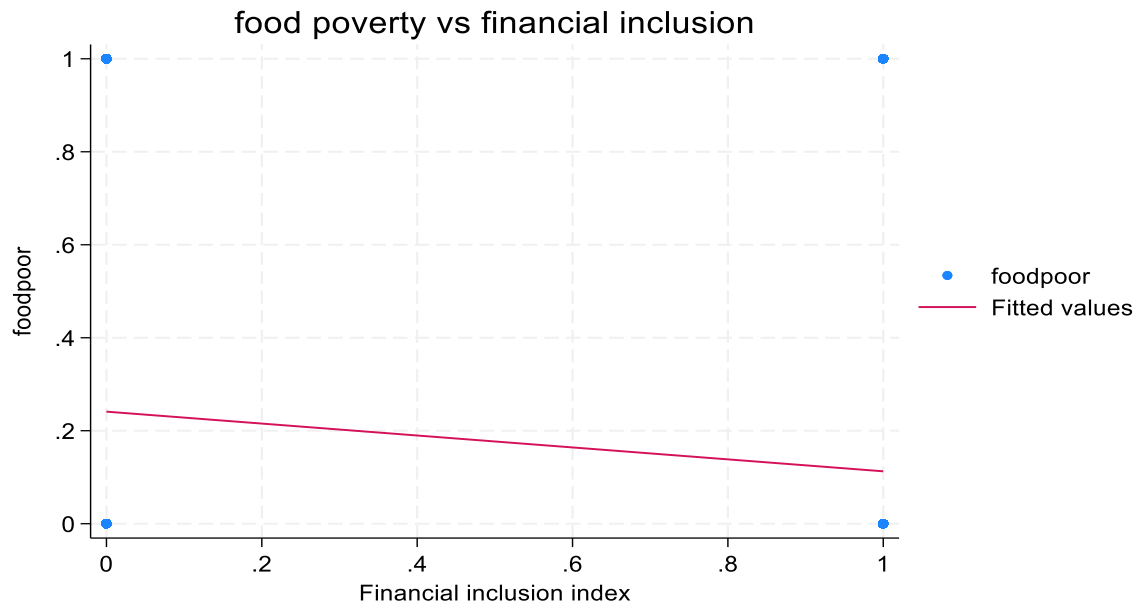
Figure 1: Food poverty by financial inclusion.

Source: Authors own work

Figure 2 below illustrates that education level is negatively correlated with food poverty, indicating that education is associated with improved food security.
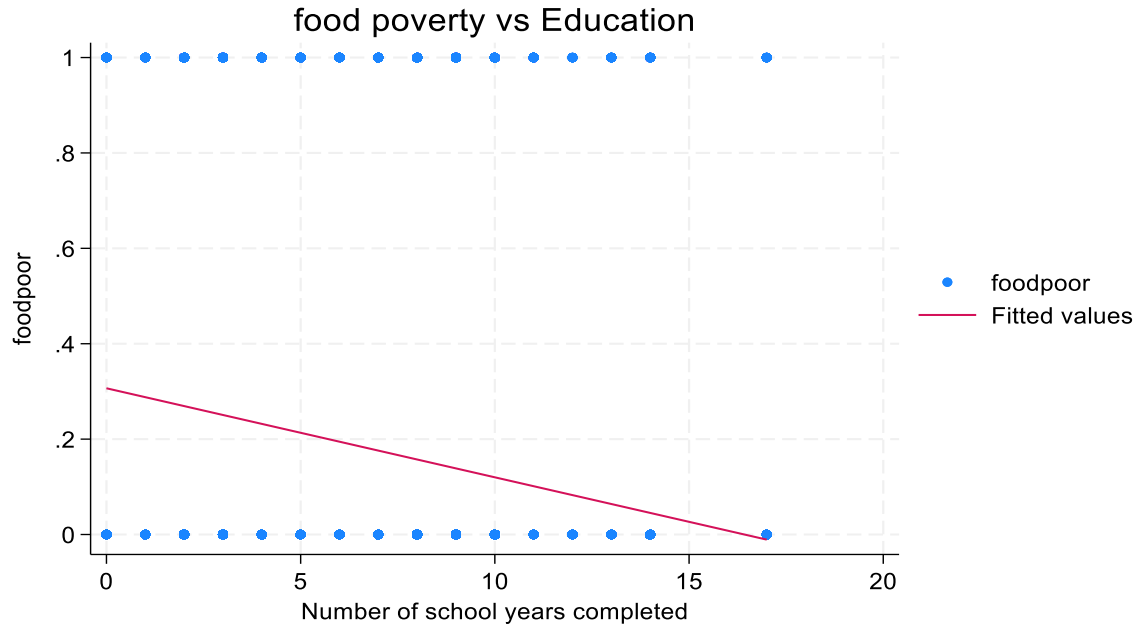

Figure 2: Education by Food Poverty

Source: Authors own work

Figure 3 below displays a scatter plot between financial inclusion and education, indicating a positive correlation between the two variables. This suggests that education may enhance the use of financial services.
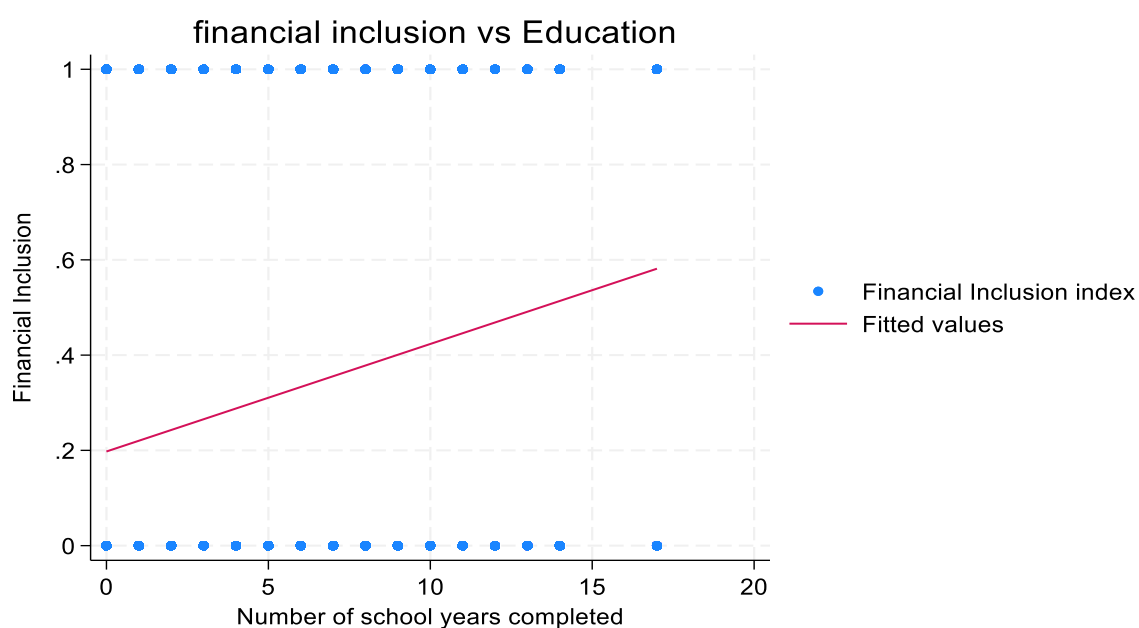

Figure 3: Financial inclusion by education
Source: Authors own work

Empirical Results

Table 3: The moderating effect of education on the financial inclusion- food poverty nexus

	(1) dy/dx	(2) dy/dx	(3) dy/dx	(4) dy/dx	(5) dy/dx	(6) dy/dx
Saving A/C	-0.0797*** (0.0039)			-0.1068*** (0.0134)		
Credit use		-0.0715*** (0.0078)			-0.0906*** (0.0162)	
FI index			-0.0780*** (0.0087)			-0.0973*** (0.0179)
Education	-0.0179*** (0.0005)	-0.0189*** (0.0003)	-0.0179*** (0.0004)	-0.0186*** (0.0002)	-0.0195*** (0.0002)	-0.0188*** (0.0003)
Gender	-0.0196 (0.0270)	-0.0154 (0.0264)	-0.0164 (0.0271)	-0.0197 (0.0266)	-0.0155 (0.0263)	-0.0163 (0.0266)
Age	-0.0012*** (0.0001)	-0.0013*** (0.0001)	-0.0012*** (0.0001)	-0.0012*** (0.0000)	-0.0013*** (0.0000)	-0.0013*** (0.0001)
Urban	-0.0161***	-0.0203***	-0.0181***	-0.0164***	-0.0203***	-0.0185***

	(1)	(2)	(3)	(4)	(5)	(6)
	(0.0027)	(0.0035)	(0.0029)	(0.0029)	(0.0036)	(0.0032)
Marital	-0.0030	-0.0060	-0.0056	-0.0033	-0.0062	-0.0062
	(0.0208)	(0.0205)	(0.0202)	(0.0205)	(0.0205)	(0.0198)
Employ	-0.0250***	-0.0233***	-0.0207***	-0.0253***	-0.0235***	-0.0213***
	(0.0077)	(0.0073)	(0.0076)	(0.0077)	(0.0073)	(0.0077)
Hsize	-0.0622***	-0.0618***	-0.0614***	-0.0621***	-0.0617***	-0.0613***
	(0.0054)	(0.0053)	(0.0054)	(0.0053)	(0.0053)	(0.0053)
Agriculture	-0.0321***	-0.0327***	-0.0311***	-0.0315***	-0.0327***	-0.0306***
	(0.0098)	(0.0102)	(0.0101)	(0.0102)	(0.0103)	(0.0105)
savingeduc				0.0044***		
				(0.0015)		
cerditeduc					0.0038**	
					(0.0017)	
FIeduc						0.0036**
						(0.0018)
N	13581	13581	13581	13581	13581	13581
Pseudo-R^2	0.1933	0.1937	0.1883	0.1936	0.1939	0.1833

Saving A/C is a dummy variable for having a savings account, FI index is the financial inclusion index, marital is marital status, employ is the dummy for employment status, hsize is household size, agriculture is a dummy for engagement in agriculture, savingeduc is the interaction term between having a savings account and education, crediteduc is the interaction term between credit use and education, and FIeduc is the interaction term between financial inclusion index and education. Figures in parentheses stand for standard errors, ***, **, * stand for statistical significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

Source: Authors own work

Table 3 presents results from logit models 1, 2, and 3, which do not incorporate interaction effects between financial inclusion proxies and education. In contrast, models 4, 5, and 6 in Table 3 introduce these interactions, offering insights into the potential enhancement of financial inclusion's impact on food poverty by education. Average marginal effects are reported in Table 3, with standard errors adjusted for clustering on person ID (PID), leading to robust standard error estimates and valid hypothesis testing.

According to Table 3, Model 1, our analysis suggests that having a savings account reduces the probability of food poverty by 8%. This reduction may be attributed to individuals' ability to accumulate funds, which can cushion them during times of food insecurity or be used for investments in income-generating activities, thereby enhancing their income levels and safeguarding them from food poverty. These findings align with the research of Baborska et al. (2020) and Nepal and Neupane (2022), who also concluded that saving reduces food insecurity.

In Model 2 of Table 3, we find that credit use reduces the probability of food poverty by 7.2%. This result supports the evidence presented by Jabo et al. (2017), Gyasi et al. (2021), and Lin et al. (2022), who found that credit use enhances food security. The mechanism behind this effect may be that credit allows households to smooth food consumption during economic hardship or engage in more productive activities, thereby increasing their income and improving food security. However, our findings contrast with those of Baborska et al. (2020), who found that credit use increases food poverty, and with Nepal and Neupane (2022), who found no effect of credit use on food poverty.

Focusing on Model 3 of Table 3, we utilise the financial inclusion index, constructed from measures of savings account ownership and credit use, as our metric for financial inclusion. Our results indicate that financially included individuals have a 7.8% lower likelihood of being food-poor compared to those who are not financially included. These findings corroborate the results of Arshad (2022) and Koomson et al. (2023), who also used the financial inclusion index in their studies and found that financial inclusion reduces food poverty.

Our findings on the effect of financial inclusion on food poverty are robust across different measures of financial inclusion, including savings, credit use, and the financial inclusion index. This implies that financial inclusion significantly reduces the probability of being food-poor.

Across all models, our analysis reveals that education reduces the probability of food poverty by approximately 2%. This suggests that educated individuals are more likely to possess the skills and capacity to engage in productive activities, thereby enhancing their income and achieving food security. These findings are consistent with those of Eigbiremolen and Ogbuabor (2018), who reported that low education levels contribute to food poverty in Nigeria.

Age is positively associated with food security, potentially because older individuals are more likely to engage in productive activities that generate income, thereby reducing food poverty. Additionally, residing in an urban area decreases the likelihood of food poverty, possibly due to higher average incomes among urban dwellers compared to their rural counterparts in Uganda.

Employment significantly reduces the likelihood of experiencing food poverty, with the variable being statistically significant at the 1% level, indicating that stable income from employment is crucial for alleviating food poverty. Household size statistically reduces the

probability of food poverty, which may be attributed to the combined efforts of larger households in providing food, thereby enhancing food security.

Engagement in agricultural activities is associated with a 3% probability of reduction in food poverty, likely because agriculture provides a direct source of food. Interestingly, gender does not appear to affect food poverty, contrary to the expectation that males, who generally earn more than females in Uganda, would be more food secure. Similarly, marital status does not have a significant impact on food poverty in Uganda.

Overall, these findings underscore the multifaceted nature of food security determinants and highlight the critical role of financial inclusion, education, age, employment, urbanisation and agriculture in mitigating food poverty.

To ensure robustness and facilitate comparison, the models examining the moderating effect of education on the relationship between financial inclusion and food poverty were re-estimated using a Probit model. The results, presented in Table 4 in the appendix, closely align with those obtained from the Logit model, both in terms of the marginal effects and statistical significance.

To further assess the robustness of our findings, we disaggregated the full sample into urban and rural subgroups to account for potential heterogeneity between the two populations. The results, presented in Table 5 of the appendix, indicate that all measures of financial inclusion remain negative and statistically significant across both subgroups. This suggests that financial inclusion consistently reduces the probability of food poverty in both urban and rural areas. Notably, the magnitude of the effect is stronger in rural areas, implying that financial inclusion plays a more pronounced role in alleviating food poverty in less urbanised settings. Furthermore, education also exhibits a negative and statistically significant relationship with food poverty in both subgroups, indicating that higher levels of education are associated with a reduced likelihood of food insecurity.

Additionally, we examined gender-based heterogeneity by dividing the full sample into male and female subgroups; the results are presented in Table 6 of the appendix. The results reveal that financial inclusion continues to have a negative and statistically significant effect on food poverty for both males and females. However, the effect is more substantial among females, suggesting that financial inclusion has a relatively greater impact in reducing food poverty for women. Similarly, education maintains a negative and statistically significant association with food poverty in both gender subgroups. The effect is again stronger among females,

Interaction Effects

Focusing on the interaction terms in models 4, 5, and 6, we find that all measures of financial inclusion—having a savings account, credit use, and the financial inclusion index—remain statistically significant, as anticipated. This underscores the role of financial inclusion in reducing food poverty. The marginal effects of all proxies for financial inclusion on food poverty are now substantially larger, ranging from 9% to 11%, suggesting that education significantly enhances the impact of financial inclusion on food poverty.

Examining the interaction terms between the financial inclusion proxies in models 4, 5, and 6, we observe that these terms are positive and significant at the 1% to 5% level, further indicating that education amplifies the effect of financial inclusion on poverty reduction. However, it is important to note that in nonlinear models, such as the logit model, the interaction effect cannot be adequately assessed by merely examining the sign, magnitude, or statistical significance of the coefficient on the interaction term, as is possible in linear models (Ai & Norton, 2003). Instead, the interaction effect necessitates the computation of the cross-partial derivative. Consequently, we proceed to graphically represent the interaction effects to provide a more comprehensive analysis.

Focusing on Figures 4 and 5, which illustrate the interaction effects between having a savings account and education, the interaction effects are predominantly positive and statistically significant for a substantial number of observations. This indicates that education enhances the impact of savings on reducing food poverty. Furthermore, it suggests that educated individuals are more likely to utilise their savings productively and efficiently than their uneducated counterparts, thereby amplifying the effect of savings in reducing food poverty.
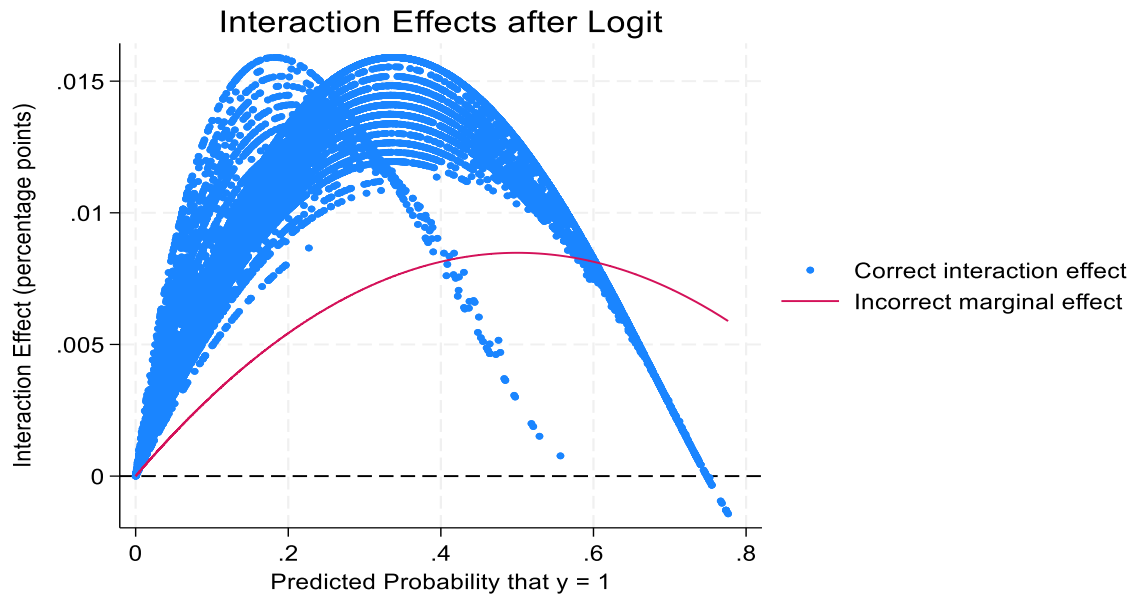
Figure 4: Interaction Effects Between Savings and Education
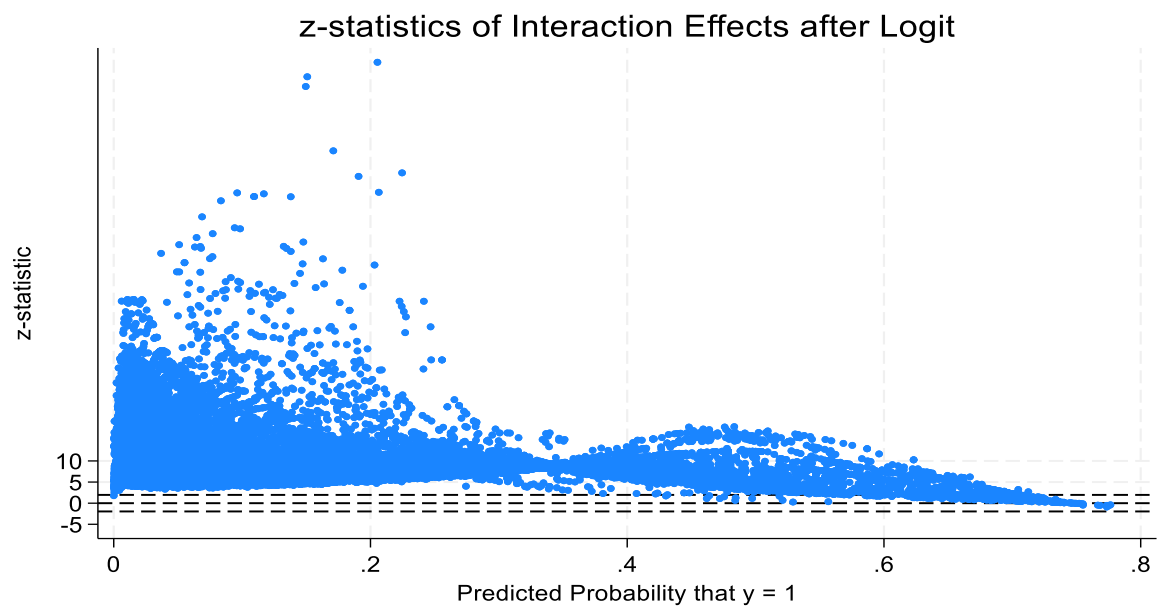
Source: Authors own work

Figure 5: Z-statistics of Interaction Effects Between Savings and Education

Source: Authors own work

Additionally, Figures 6 and 7 depict the interaction effects between credit use and education. The findings reveal that these interaction effects are predominantly positive and statistically significant for a significant number of observations. The results suggest that the utilisation of credit in conjunction with education has a more substantial impact on reducing food poverty

than credit use alone. This implies that education enhances the effectiveness of credit use, thereby amplifying the positive effect of credit use on reducing food poverty.
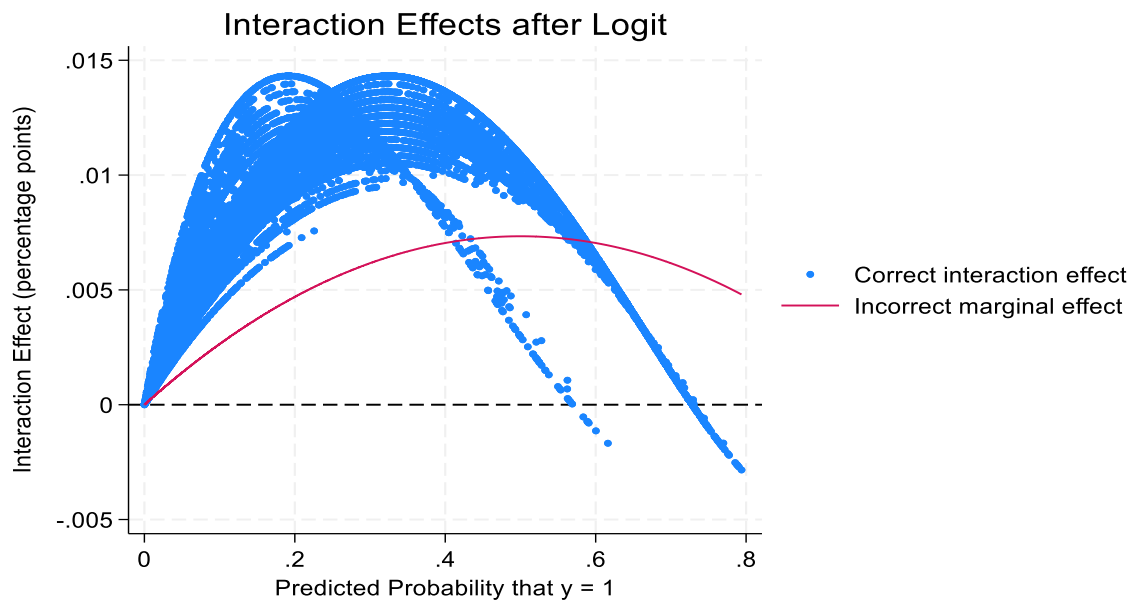

Figure 6: Interaction Effects Between Credit Use and Education

Source: Authors own work
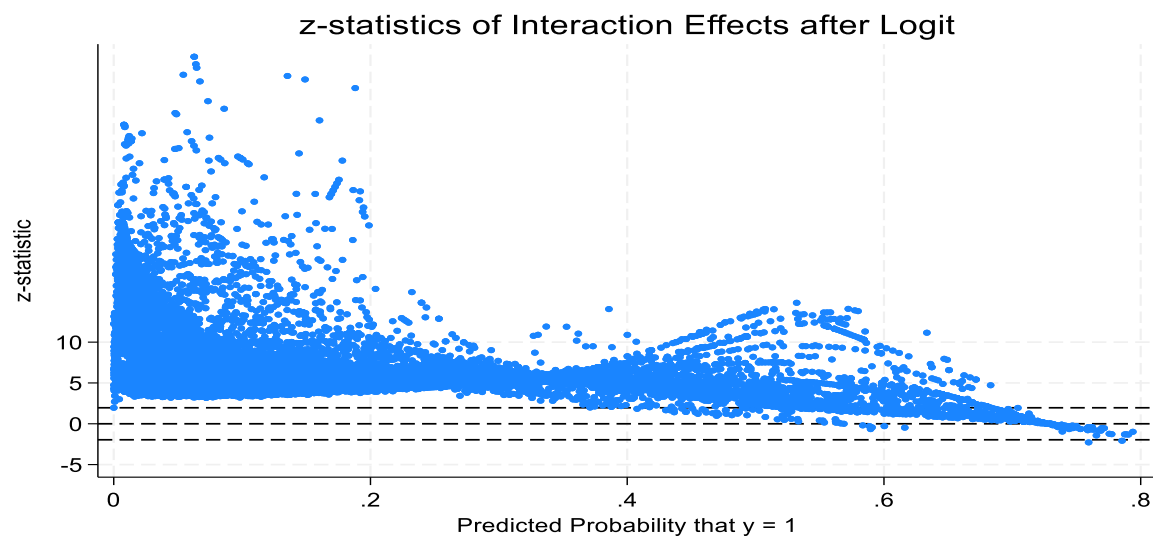
Figure 7: Z-statistics of Interaction Effects between Credit Use and Education

Source: Authors own work

Furthermore, Figures 8 and 9 illustrate the interaction effects between the financial inclusion index and education. The results indicate that these interaction effects are predominantly positive and statistically significant for a substantial number of observations. This suggests that the combination of financial inclusion and education leads to a greater reduction in food

poverty compared to financial inclusion alone. Specifically, the data imply that education enhances the efficacy of financial service utilisation, thereby amplifying the positive impact of financial inclusion on reducing food poverty.

Figure 8: Interaction Effects Between Financial Inclusion Index and Education

Source: Authors own work

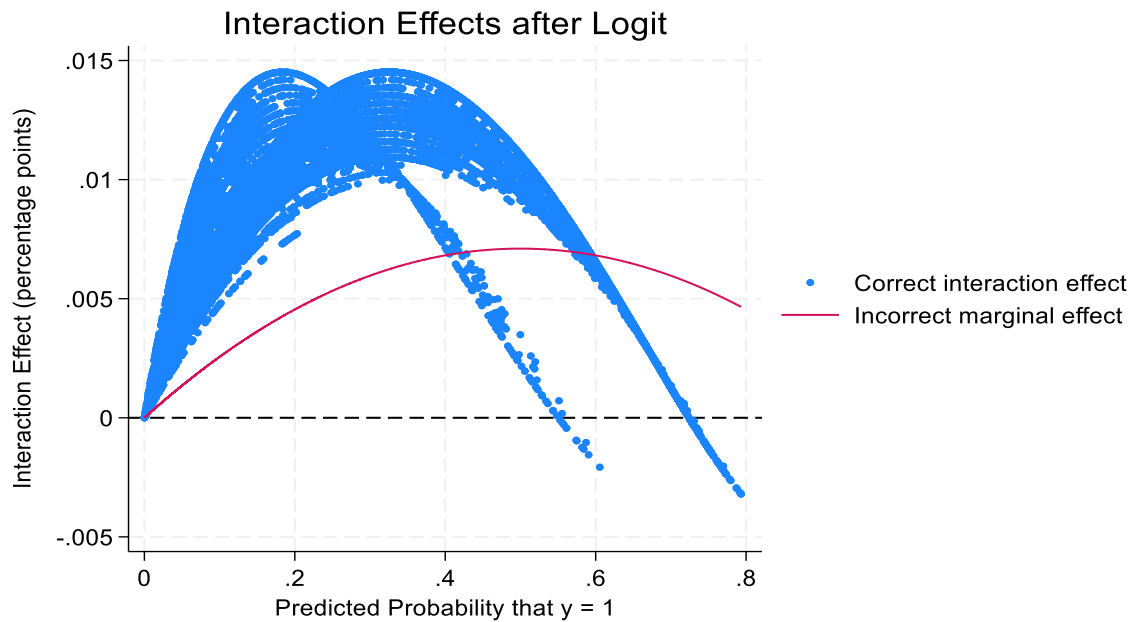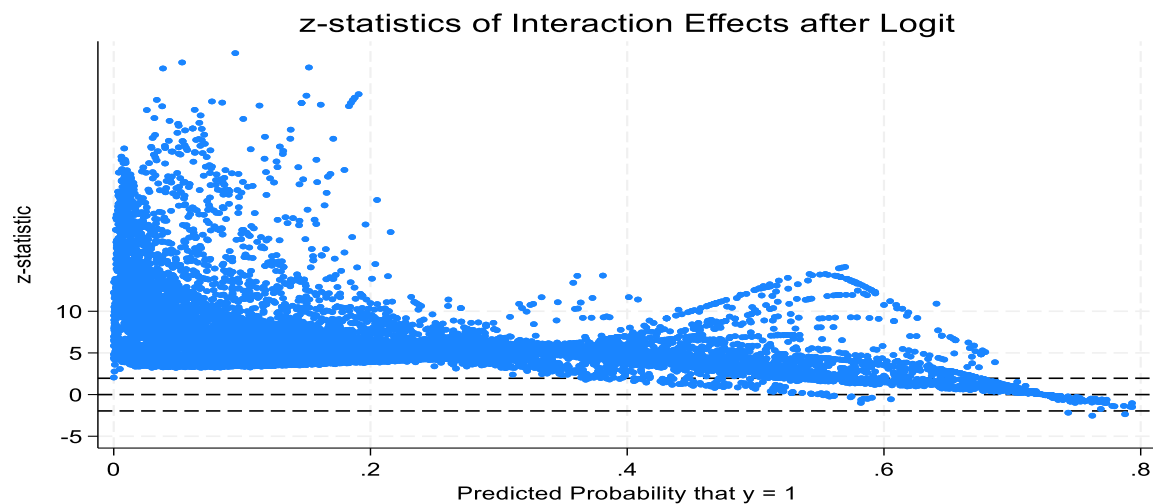**Figure 9: Z-statistics of Interaction Effects Between Financial Inclusion Index and Education**

Source: Authors own work

Our findings demonstrate robustness across various measures of financial inclusion, including savings, credits, and the financial inclusion index. Generally, the interaction effects between education and financial inclusion proxies are predominantly positive and statistically significant for most observations. This indicates that individuals with higher levels of education are more likely to utilise financial services effectively—by investing in income-generating activities, human development, health, and consumption smoothing—thereby mitigating the risk of food poverty relative to their less-educated counterparts. Consequently, we conclude that education amplifies the beneficial impact of financial inclusion on reducing food poverty.

Conclusion and Implications

This study aimed to empirically investigate the impact of financial inclusion on food poverty, with a focus on the moderating role of education. Utilising data from the Uganda National Household Survey 2019/2020 and employing a binary Logit model, we found that not only does financial inclusion and education play a crucial role in reducing the likelihood of food poverty; but that education improves the effectiveness of financial service utilisation, thereby enhancing the positive effects of financial inclusion on reducing food poverty. Specifically, the study showed that for the government to tackle food poverty, it is important to ensure that people participate in the financial sector by having a savings account and access to credit.

This study has significant policy implications not only for Uganda but also for other developing countries with similar contexts. The findings underscore the pivotal role of education in fostering financial inclusion. A lack of knowledge about the features and conditions of financial products results in low confidence and trust in these products, thereby creating a barrier to accessing financial services. Consequently, governments and policymakers should organise seminars on financial literacy to equip people with the necessary knowledge about financial services, thereby boosting their confidence in accessing the funds they need. Additionally, increased financial education leads to better savings and budget management among individuals and households, thereby enhancing savings, stimulating investment, and reducing food poverty. Moreover, access to credit should be improved, enabling individuals to secure bank loans to finance businesses and address food insecurity issues.

Policies aimed at supporting agriculture also play a crucial role in addressing food poverty. Government and policymakers can create schemes that offer agricultural insurance grants and

credits to small farmers, helping them overcome uncertainty and financial challenges. Additionally, insurance companies can provide life and health protection through micro-insurance, reducing the vulnerability of low-income farmers and households to food poverty caused by accidents or illness. To enhance financial access in rural areas, policymakers should prioritise basic financial services, expand branch networks and ATM availability, and develop flexible savings deposit packages tailored to farmers' income streams. Addressing barriers to financial inclusion is crucial for the effective implementation of policies.

Limitations of the Study

One of the key limitations of this study is the potential issue of endogeneity, particularly the reverse causality between education, financial inclusion, and food poverty. While the analysis assumes that education and financial inclusion influence food poverty, it is also possible that food poverty itself affects educational attainment and financial inclusion. For instance, households experiencing severe food poverty may have limited resources to invest in education or participate in financial systems, creating a bidirectional relationship that is not fully accounted for in the estimations.

Ideally, addressing endogeneity would require the use of instrumental variables (IV) to isolate the exogenous variation in education and financial inclusion that is not directly influenced by food poverty. However, due to data constraints, this study lacks a suitable instrument to effectively correct for this issue. The absence of a valid instrument limits the ability to make strong causal inferences from the estimated logit model.

Despite this limitation, the findings still provide valuable insights into the relationship between education, financial inclusion, and food poverty. Future research should explore the use of more robust econometric techniques or seek alternative datasets that include potential instrumental variables to better address endogeneity concerns.

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Appendix

Table 4: Probit model: The moderating effect of education on the financial inclusion- food poverty nexus

	(1) dy/dx	(2) dy/dx	(3) dy/dx	(4) dy/dx	(5) dy/dx	(6) dy/dx
Saving A/C	-0.0752*** (0.0043)			-0.1088*** (0.0148)		
Credit use		-0.0710*** (0.0092)			-0.0968*** (0.0182)	
FI index			-0.0765*** (0.0097)			-0.1017*** (0.0196)
Education	-0.0179*** (0.0004)	-0.0189*** (0.0003)	-0.0179*** (0.0004)	-0.0188*** (0.0002)	-0.0197*** (0.0003)	-0.0191*** (0.0004)
Gender	-0.0168 (0.0278)	-0.0129 (0.0270)	-0.0140 (0.0277)	-0.0168 (0.0273)	-0.0130 (0.0268)	-0.0138 (0.0270)
Age	-0.0012*** (0.0001)	-0.0013*** (0.0001)	-0.0012*** (0.0001)	-0.0012*** (0.0001)	-0.0013*** (0.0001)	-0.0012*** (0.0001)
Urban	-0.0156*** (0.0037)	-0.0199*** (0.0048)	-0.0176*** (0.0039)	-0.0160*** (0.0039)	-0.0198*** (0.0049)	-0.0180*** (0.0043)
Marital	-0.0061 (0.0217)	-0.0088 (0.0214)	-0.0085 (0.0211)	-0.0066 (0.0213)	-0.0091 (0.0213)	-0.0091 (0.0206)
Employ	-0.0241*** (0.0080)	-0.0220*** (0.0074)	-0.0196** (0.0076)	-0.0246*** (0.0080)	-0.0224*** (0.0074)	-0.0204*** (0.0078)
Hsize	-0.0600*** (0.0057)	-0.0597*** (0.0057)	-0.0593*** (0.0057)	-0.0599*** (0.0056)	-0.0596*** (0.0056)	-0.0591*** (0.0055)
Agriculture	-0.0328*** (0.0098)	-0.0329*** (0.0101)	-0.0313*** (0.0100)	-0.0318*** (0.0102)	-0.0329*** (0.0102)	-0.0307*** (0.0105)
Savingeduc				0.0052*** (0.0016)		
Cerditeduc					0.0048*** (0.0017)	
FIeduc						0.0045** (0.0018)
Pseudo R2	0.11916	0.1923	0.1952	0.1921	0.1927	0.1957
N	13581	13581	13581	13581	13581	1358

Saving A/C is a dummy variable for having a savings account, FI index is the financial inclusion index, marital is marital status, employ is the dummy for employment status, hsize is household size, agriculture is a dummy for engagement in agriculture, savingeduc is the interaction term between having a savings account and education, crediteduc is the interaction term between credit use and education, and FIeduc is the interaction term between financial inclusion index and education. Figures in parentheses stand for standard errors, ***, **, * stand for statistical significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

Source: Authors own work

Table 5: Uban and Rural Subgroups: The moderating effect of education on the financial inclusion- food poverty nexus

	Urban Subgroup			Rural Subgroup		
	(1) dy/dx	(2) dy/dx	(3) dy/dx	(1) dy/dx	(2) dy/dx	(3) dy/dx
Saving A/C	-0.0423** (0.0207)			-0.1008*** (0.0154)		
Credit use		-0.0457*** (0.0061)			-0.0927*** (0.0160)	
FI index			-0.0518*** (0.0072)			-0.0945*** (0.0160)
Education	-0.1124*** (0.0050)	-0.1358*** (0.0029)	-0.1129*** (0.0033)	-0.0908*** (0.0107)	-0.1095*** (0.0057)	-0.0941*** (0.0083)
Age	-0.0003** (0.0002)	-0.0006*** (0.0002)	-0.0004*** (0.0001)	-0.0004*** (0.0001)	-0.0005*** (0.0002)	-0.0005*** (0.0002)
Gender	-0.0366*** (0.0131)	-0.0383*** (0.0124)	-0.0362*** (0.0137)	-0.0464 (0.0397)	-0.0418 (0.0392)	-0.0418 (0.0393)
Marital	-0.0144* (0.0079)	-0.0189** (0.0084)	-0.0174** (0.0083)	-0.0031 (0.0291)	-0.0075 (0.0285)	-0.0066 (0.0278)
Employ	-0.0231*** (0.0080)	-0.0251*** (0.0074)	-0.0189** (0.0075)	-0.0239** (0.0109)	-0.0214** (0.0106)	-0.0188* (0.0109)
Hsize	-0.0650*** (0.0049)	-0.0654*** (0.0047)	-0.0647*** (0.0050)	-0.0631*** (0.0061)	-0.0624*** (0.0061)	-0.0620*** (0.0060)
Agriculture	0.0297* (0.0166)	0.0297* (0.0172)	0.0303* (0.0169)	-0.0678*** (0.0082)	-0.0689*** (0.0078)	-0.0664*** (0.0080)
Savingeduc	-0.0768*** (0.0250)			-0.0161 (0.0141)		
Cerditeduc		-0.0195** (0.0080)			0.0384** (0.0163)	
FIeduc			-0.0499*** (0.0074)			-0.0033 (0.0112)
Pseudo R2	0.1712	0.1657	0.1719	0.1832	0.1831	0.1874

Saving A/C is a dummy variable for having a savings account, FI index is the financial inclusion index, marital is marital status, employ is the dummy for employment status, hsize is household size, agriculture is a dummy for engagement in agriculture, savingeduc is the interaction term between having a savings account and education, crediteduc is the interaction term between credit use and education, and FIeduc is the interaction term between financial inclusion index and education. Figures in parentheses stand for standard errors, ***, **, * stand for statistical significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

Source: Authors own work

Table 6: Subgroups by Gender: The moderating effect of education on the financial inclusion- food poverty nexus

	Male Subgroup			Female Subgroup		
	(1) dy/dx	(2) dy/dx	(3) dy/dx	(1) dy/dx	(2) dy/dx	(3) dy/dx
Saving A/C	-0.0840*** (0.0036)			-0.0922*** (0.0075)		
Credit use		-0.0605*** (0.0052)			-0.1030*** (0.0267)	
FI index			-0.0637*** (0.0034)			-0.1030*** (0.0236)
Education	-0.0586*** (0.0117)	-0.0712*** (0.0104)	-0.0569*** (0.0122)	-0.1512*** (0.0230)	-0.1790*** (0.0346)	-0.1551*** (0.0278)
Age	-0.0001 (0.0001)	-0.0002* (0.0001)	-0.0002* (0.0001)	-0.0007*** (0.0001)	-0.0008*** (0.0001)	-0.0007*** (0.0001)
Urban	-0.0236*** (0.0048)	-0.0320*** (0.0045)	-0.0275*** (0.0047)	-0.0282*** (0.0046)	-0.0328*** (0.0058)	-0.0299*** (0.0051)
Marital	-0.0101 (0.0109)	-0.0126 (0.0122)	-0.0090 (0.0125)	-0.0053 (0.0451)	-0.0116 (0.0445)	-0.0116 (0.0427)
Employ	-0.0546*** (0.0030)	-0.0550*** (0.0041)	-0.0518*** (0.0037)	-0.0003 (0.0022)	0.0024 (0.0022)	0.0061*** (0.0017)
Hsize	-0.0587*** (0.0015)	-0.0591*** (0.0015)	-0.0589*** (0.0016)	-0.0671*** (0.0077)	-0.0662*** (0.0072)	-0.0655*** (0.0073)
Agriculture	-0.0189*** (0.0030)	-0.0179*** (0.0030)	-0.0181*** (0.0030)	-0.0406*** (0.0141)	-0.0424*** (0.0138)	-0.0394*** (0.0142)
Savingeduc	-0.0118* (0.0066)			-0.0643*** (0.0155)		
Cerditeduc		0.0029 (0.0034)			0.0438 (0.0462)	
FIeduc			-0.0216**			-0.0228

			(0.0084)			(0.0252)
Pseudo R2	0.1872	0.1840	0.1884	0.1715	0.1711	0.1765
N	5812	5812	5812	7769	7769	7769

Saving A/C is a dummy variable for having a savings account, FI index is the financial inclusion index, marital is marital status, employ is the dummy for employment status, hsize is household size, agriculture is a dummy for engagement in agriculture, savingeduc is the interaction term between having a savings account and education, crediteduc is the interaction term between credit use and education, and FIeduc is the interaction term between financial inclusion index and education. Figures in parentheses stand for standard errors, ***, **, * stand for statistical significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

Source: Authors own work