CINEFORUM
ISSN: 0009-7039
Vol. 66. No. S3, 2026 (Special Issue 3)

Evaluating The Effect of Formal Financial Intermediation on Climate Change Resilience Among Rural Farm Households

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Abstract
The aim of this study is to assess the effect of formal financial intermediation on rural farm households' resilience to climate change using 480 respondents selected through a five-stage multi-stage sampling procedure. Primary data were collected using a structured questionnaire administered as an interview schedule. Data were analysed using descriptive statistics, Tobit regression, endogenous switching regression and exploratory principal component factor analysis. Results showed that 58.5% of the respondents were males, with a mean age of 41 years. Most (58.8%) were married, 59.1% were graduates, and the mean farm size and annual farm income were 2.1 ha and ₦642,343.8, respectively. About 66.0% reported that formal financial institutions were not available in their communities, while 86.9% had not received financial aid during the previous 12 months. The forms of financial intermediation received included subsidies, cash loans and input supplies. The endogenous switching regression results showed a significant overall Wald test (Wald $\chi^2 = 59.9$, $p < 0.001$), while the LR test of the index equations was also significant ($\chi^2 = 48.02$, $p < 0.001$). The estimated treatment effect indicates that the expected climate resilience index among households that accessed formal financial intermediation was 63.09, compared with 4.81 among households that did not. The average treatment effect on the treated was 57.06 index points. Exploratory factor analysis, using a minimum factor-loading threshold of 0.40, grouped constraints into economic, institutional, infrastructural and technological dimensions. The study concludes that formal financial intermediation is associated with substantially higher climate resilience among rural farm households in the study area, while limited financial access, institutional weaknesses, infrastructure deficits and technological constraints remain important barriers to resilience...

Keywords: Formal Financial Intermediation; Climate change; Climate resilience; Rural Farm Households; Southeast Nigeria:

Introduction

Climate change represents a significant threat to rural farm households, exacerbating poverty, food insecurity, and vulnerability (Chiriaco and Valentini, 2020). It adversely impacts agricultural productivity, leading to reduced incomes and heightened susceptibility to climate-related shocks (IPCC, 2014; FAO, 2021). As global temperatures continue to rise and extreme weather events become increasingly frequent, the need to build resilience has garnered substantial attention from policymakers, researchers, and affected communities. Effective resilience strategies are essential for mitigating these vulnerabilities, improving adaptive capacity, and ensuring sustainable development (Musa et al, 2025).

Resilience, in the context of climate change, refers to the ability to absorb disturbances, adapt to changing conditions, and transform when necessary (Odozi et al, 2022). It encompasses not only preparations for extreme weather events but also the underlying vulnerabilities that exacerbate these impacts. The resilience of communities, ecosystems, and economies to climate change refers to their capacity to anticipate, prepare for, respond to, and recover from its effects (UNFCCC, 2015; IPCC, 2014). Enhancing resilience is crucial for mitigating climate change's adverse impacts and ensuring long-term sustainability.

One important avenue for building resilience lies in innovative financial solutions (Wang et al, 2024). Formal financial intermediaries, such as microfinance institutions, commercial banks, and agricultural insurance providers, can play a pivotal role in supporting the adaptation and resilience efforts of rural farm households. These intermediaries provide financial buffers that help absorb climate-related shocks, thus reducing vulnerability (Heltberg et al., 2015; Yusuf et al, 2024). Access to formal financial services enhances climate resilience by enabling farmers to adopt climate-resilient agricultural practices (Nelson et al., 2018). Agricultural insurance, in particular, aids in managing climate risks and promoting risk mitigation strategies (Meinke et al., 2017). Financial inclusion contributes to resilience by improving access to credit, savings, and insurance services, which in turn supports adaptive capacity (Mude et al., 2015).

Rural farm households play a crucial role in global food production and the livelihoods of millions. Typically characterized by small-scale farming operations, these households face numerous challenges, including climate change, market fluctuations, and socio-economic pressures (Ozoji et al, 2025). They contribute significantly to local and national economies through agricultural production, employment generation, and rural development (FAO, 2020). Rural households are also essential in achieving sustainable development goals, as they produce 70-80% of the world's food, employ around 40% of the global workforce, and drive rural economic development and poverty reduction (IFAD, 2020). Understanding their dynamics is key to designing effective policies and support systems aimed at improving their resilience to climate change.

Recent research highlights the multifaceted nature of climate resilience, emphasizing the importance of integrated approaches that address ecological, social, and economic factors. Reports from the Intergovernmental Panel on Climate Change (IPCC, 2022) stress the urgency of implementing adaptation measures to safeguard vulnerable populations and ecosystems. Similarly, the World Bank (2023a) underscores the significance of investing in resilient infrastructure to mitigate the risks associated with climate impacts. Marginalized communities are often the hardest hit by climate change, thus necessitating targeted interventions (Mastrorillo et al., 2022). Technological innovations, such as climate modeling and early warning systems, are increasingly being integrated into resilience planning to enhance preparedness and response capabilities (UNDRR, 2022).

Rural farm households, facing the compounded challenges of climate change, often grapple with limited access to credit, technology, and markets, further exacerbating their vulnerability (Musa et al, 2025). To cope with these challenges, these households are adopting various adaptation strategies, including crop diversification, sustainable farming practices, and community-based initiatives designed to enhance resilience (Hassan & Nhemachena, 2022). While much of the literature has focused on informal financial mechanisms, such as community savings groups and community-based insurance schemes (Mude et al., 2015; Obayelu and Akpan, 2021), there remains a gap in understanding the role of formal financial intermediaries in improving the climate resilience of rural farm households. This study aims to assess the effect of formal financial intermediation on climate resilience among rural farm households in South East Nigeria. This aim will be achieved through the following objectives: to examine the socio economic characteristics of the rural farm households, to identify the forms of financial intermediation accessed from formal financial institutions and used in enhancing climate resilience among rural farm households, to determine the effects of financial intermediation accessed from formal financial institutions on rural farm households' resilience to climate change in the area and to analyze constraints in achieving climate change resilience by rural farm households through formal financial institutions' intermediation.

Hypotheses

Ho_1: Intermediation from formal financial institutions has no significant effect on the rural farm households' resilience to climate change.

Methodology

Study Area

The study area was Southeast region of Nigeria comprising of five (5) states (Abia, Anambra, Ebonyi, Enugu, and Imo) with a population of 21 million (projected from NPC, 2006 census; NPC 2020). It is one of the six geopolitical zones in the country. It is located within latitudes 4º47'35''N and 7º 7' 44''N, and longitudes 7º 54' 26'E and 8º 27' 10'E and lies within the forest and derived savanna belt of Nigeria, with mean maximum temperature of 27ºC, and total annual rainfall of 2500mm (Nigerian Meteorological Agency, 2020). It is characterized by two successive distinct seasons, the dry season (November – March) and rainy season (April – October). It has a land area of approximately 76,358km^2 east of the lower Niger and South of the Benue valley. South-east Nigeria is bounded in the east by Cross-River State, in the west by Delta State and Rivers State, in the north by Benue and Kogi States and in the South by Akwa-Ibom State. The region is predominantly agricultural with major crops including: cassava, yam, rice, cocoyam, vegetables and maize while palm produce, rubber, coconut and cocoa are the most important cash crops (Federal Ministry of Agriculture and Rural Development, 2020). There major occupations are farming, trading artisanal activities. The region is richly endowed with minerals such as coal, limestone, lead, zinc, clay, shale, glass sands and petroleum.

Sampling Procedure and Data Collection

A five-stage multi-stage sampling procedure was used to select the 480 rural farm household heads. In the first stage, three states—Enugu, Ebonyi and Abia—were randomly selected from the five states in Southeast Nigeria. In the second stage, five Local Government Areas (LGAs) were purposively selected in each of the three states on the basis of their high level of farming activity, giving 15 LGAs. In the third stage, two communities were purposively selected from each selected LGA because they were affected by climate change, resulting in 30 communities. In the fourth stage, two villages were purposively selected from each community on the basis of high climate-change indicators, resulting in 60 villages. In the fifth stage, eight rural farm household heads were randomly selected from each village, proportionate to the number of farming households in the area, giving the final sample of 480 respondents. Thus, the final-stage sampling frame comprised eligible rural farm household heads in the selected villages. The combination of purposive selection at intermediate stages and random selection at the state and household stages was intended to ensure coverage of farming communities relevant to the research question while reducing arbitrary selection at the final respondent level.

Primary data were collected from rural farm household heads using a structured questionnaire administered as an interview schedule, including respondents who required interviewer assistance. The questionnaire covered socioeconomic characteristics, climate-change indicators and perceived effects, access to formal financial intermediation, household resilience measures, and constraints to achieving climate resilience through formal financial institutions. The sampling design should, however, be considered when interpreting generalizability because some intermediate sampling stages deliberately targeted farming and climate-vulnerable communities.

Measurement of Climate Change Resilience

The Climate Resilience Index (CRI) was constructed as a multidimensional composite measure using the resilience measurement approach developed by FAO (2016) and tested by Tambo (2016) and Tambo and Wünscher, (2017). The measure recognizes that household resilience cannot be adequately represented by a single observed variable. The index uses ten major components: natural disaster and climate variability, income and food access, health, water, stability, socio-demographic profile, livelihood strategies, assets, social capital, and access to basic services. These components reflect the absorptive, adaptive and transformative capacities of rural households.

Because the component indicators were measured on different scales, each indicator was standardized before aggregation. For indicators expected to have a direct relationship with resilience, the standardized score was calculated as $Ia = (Sr - Smin)/(Smax - Smin)$. For indicators expected to have an inverse relationship with resilience, the transformation was $Ia = (Smax - Sr)/(Smax - Smin)$, where Sr is the observed household value and Smax and Smin are the maximum and minimum values of the indicator across households. Each component score was then calculated as the arithmetic mean of its standardized indicators. The ten component scores were subsequently aggregated using a balanced/equal-weighting approach so that no single component dominated the index. Higher CRI values therefore represent relatively higher household resilience within the study sample. The index is consequently a relative, standardized measure rather than an absolute resilience score, and its interpretation is conditional on the indicators and weighting structure used in this study.

The conceptual validity of the index derives from its coverage of the three core resilience capacities: absorptive capacity (the ability to prepare for, cope with and recover from shocks), adaptive capacity (the ability to adjust livelihood and production systems to changing conditions), and transformative capacity (the ability to access or create enabling institutional, infrastructural and service conditions that support longer-term resilience).

Data Analysis
Descriptive statistics (frequencies, percentages and means) were used to summarize the socioeconomic characteristics and forms of financial intermediation. Tobit regression was used to examine socioeconomic factors associated with the bounded climate resilience index. Endogenous switching regression (ESR) was used to estimate the effect of formal financial intermediation while accounting for non-random selection into access to financial services. Principal component factor analysis with Varimax rotation was used as an exploratory data-reduction technique to group observed constraints into underlying dimensions.

Justification and Specification of the Endogenous Switching Regression
Endogenous switching regression was selected because access to formal financial intermediation is not randomly assigned. Farmers who obtain formal financial services may differ systematically from those who do not in education, farm size, farming experience, income, extension contact and climate-change awareness. A simple comparison of mean resilience between the two groups could therefore confound the effect of financial intermediation with pre-existing differences between households. ESR addresses this concern by jointly modelling the selection process that determines access to formal financial intermediation and separate resilience outcomes for households that accessed and did not access financial intermediation. The approach also permits comparison of observed and counterfactual outcomes and estimation of treatment effects.
The selection equation models the probability of accessing formal financial intermediation as a function of household and farm characteristics. Separate outcome regimes are then estimated for households with and without access. The treatment-effect framework reported in Table 9 provides the expected resilience index under observed and counterfactual conditions. The significance of the LR test of the index equations ($\chi^2 = 48.02$; $p < 0.001$) provides evidence that the two outcome regimes and selection process should not simply be treated as independent equations.

Exploratory Factor Analysis of Constraints
Principal component analysis with Varimax orthogonal rotation was used as an exploratory factor-analysis procedure because the objective was to reduce the observed constraint variables into interpretable underlying groups rather than to confirm a pre-specified measurement model. Components were interpreted from the pattern of their substantive and statistical loadings. A minimum loading of 0.40 was used as the threshold for treating an item as meaningfully associated with a component. This 0.40 value is a factor-loading criterion and should not be confused with the Kaiser eigenvalue criterion. The resulting components were labelled economic, institutional, infrastructural and technological constraints based on the variables with the strongest loadings and their substantive meaning. The analysis is therefore interpreted as exploratory; no confirmatory factor-analytic claims are made.

Results

Table 1: Distribution of Socio-Economic Characteristics of the Rural Farm Households in the Study Area

Variables	Frequency (n = 480)	Percentage (%)	Mean (x)
Gender:			
Male	281	58.5	
Female	199	41.5	
Age (Years):			
21 – 30	110	22.9	
31 – 40	134	27.8	
41 – 50	147	30.7	41
51 – 60	79	16.4	
61 and above	10	2.2	
Marital Status:			
Single	56	11.7	
Married	282	58.8	
Divorced	80	16.7	
Widowed	62	12.8	
Level of Education:			
Postgraduate	64	13.3	
Graduate	284	59.1	

Secondary	91	19.0	
Primary	19	4.0	
No formal education	22	4.6	
Household Size:			
≤ 5 persons	107	22.3	
6 – 10 persons	197	41.0	8
11 – 15 persons	176	36.7	
Farming Experience: ≤5 years	100	20.8	
6 – 10 years	234	48.8	10
10 years and above	146	30.4	
Farm Size:			
≤ 1ha	183	38.1	
1-2 ha	168	35.0	2.1 ha
> 2ha	129	26.9	
Annual Farm Income:			
≤ ₦500,000	319	66.5	
₦500,001 – ₦1,000,000	61	12.7	₦642,343.8k
₦1,000,001 – ₦1,500,000	61	12.7	
> ₦1,500,000	39	8.1	
Access to Credit:			
Yes	99	20.6	
No	381	79.4	
Access to Extension workers			
≤ 5	426	88.8	
6 – 10	38	7.9	
>10	16	3.3	
Membership to Cooperative society			
Yes	327	68.2	
No	153	31.8	

Source: Field Survey, 2023

The result of the analysis of the socio-economic characteristics of the farmers (Table 1) showed that the majority (58.5%) of the respondents were male, while 41.5% were female. The results also showed that the majority (30.7%) of the farmers fall within the age bracket of 41–50 years and with a mean age of 41 years. Furthermore, the result of the analysis showed that the majority (58.8%) of the farmers were married, while 16.7%, 12.8%, and 11.7% of the respondents were divorced, widowed, or single, respectively.

The analysis of the level of education of the farmers showed that the majority (59.1%) of them are graduates, while only few (4%) are primary school leavers. Similarly, the result also showed that most (41%) of the respondents had a household size of 6–10 persons, while only (22.3%) had less than or equal to 5 persons. The mean household size was 8 persons.

Again, the result of the analysis showed that the majority (48.8%) of the farmers had farming experience of 5–10 years, while 30.4% had farming experience of more than 10 years. The average farming experience was 10 years. Analysis of the result equally showed that majority (38.1%) of the farmers had less than or equal to 1 hectare of land, while 26.9% of them had more than 2 hectares of land. The mean farm size was 2.1ha. More so, majority (66.5%) of farmers in the study area earned ≤₦500,000 while, 8.1% of them had earned more than ₦1,500,000 as their annual farm income. The average annual income of the farmers was ₦642,343.8k. Furthermore, result of the analysis showed that most of the farmers (79.4%) had no access to credit, while 20.6% had access to credit.

Also, the results of the analysis showed that majority (88.8%) of the farmers had access to less than five (5) extension workers in the last 12 months, while 7.9% of them had access to extension workers 6–10 times, and 3.3% of them had access to extension workers up to 15 times in the last 12 months. It was also recorded that 68.2% of the farmers are members of different cooperative and social groups, while 31.8% of them do not belong to any.

Table 2: Distribution of the Rural Farm Households according to Farming Activities in the Study Area

Variables	**Frequency (n = 480)**	**Percentage (%)**
Types of Farming:		
Livestock	85	17.7
Crop	218	45.4
Both	177	36.9
Types of Crops Grown:		
Cassava	134	27.9
Rice Yam and cassava	100 62	20.8 12.9
Yam	56	11.7
Yam and Maize	56	11.7
Fruits and vegetables	40	8.3
Potatoes	32	6.7
Types of Livestock Reared:		
Goat and sheep	111	23.1
Poultry	213	44.4
Pigs	87	18.1
Fish	62	12.9
Snail	7	1.5
Land Ownership Status:		
Inherited	227	47.3
Leased Purchased	153 100	31.9 20.8
Awareness to Climate Change Phenomenon:		
Yes	426	88.8
No	54	11.2

Source: Field Survey, 2023

About 45% of the respondents in the study area are into crop farming, 36.9% of them are into livestock and crop production, while only few (17.7%) are into livestock production. Majority of the respondents engaged in cassava production (27.9%), 20.8% are into rice production, 12.9% are into yam and cassava production, 11.7% are into yam production, 11.7% are into yam and maize production, while only few (8.3% and 6.7%) are into fruits and vegetables and potatoes production respectively. Similarly, most (44.4%) of the respondents who are into livestock production are into poultry farming, 23.1% of the respondents are into goats and sheep while least (1.5%) of the respondents engaged in snail production. Majority of the respondents (47.3%) inherited their lands, 31.9% of the respondents leased their land, while only 20.8% of the respondents purchased their land. Majority (88.8%) of the respondents are aware of effect of climate change.

Table 3: Sources of Information of Climate Change Phenomenon in the Study Area

Variables	**Frequency (n = 480) ***	**Percentage (%)**
Radio/Television	403	84.0
Newspaper	294	61.3
Friends/Neighbor	388	80.8
Internet	357	74.4
Researchers	202	42.1
Extension workers	210	43.6
Farmer's Cooperatives	327	67.8
Social media	231	48.1
Personal Observation	185	38.5

Sources: Field Survey, 2023; * = Multiple Responses

Table 3 depicts the sources of information on climate change phenomena in the study area. The result of the analysis revealed that the information that made them to be aware of the climate change phenomenon is gotten mainly (84%) from radio/television, 80.8% acquires their information from friends and neighbours, 74.4% from internet, 67.8% from farmer's cooperative and 61.3% from newspaper.

Forms of Financial Intermediation Accessed by the farmers in the study area

This section analyzes the availability of formal financial institutions in the study area, the availability of any financial aid in the last 12 months, the forms of financial intermediation received in adapting to the climate change effect, the need for finance in boosting farm activities due to climate change, and the ability to borrow from any formal financial institutions in the last 12 months. The result of the analysis is presented in Tables 4, 5, 6 and 7.

Table 4: Availability of Formal Financial Institutions in the Rural Area

Variable	Frequency (n = 480)	Percentage (%)
Available	163	34.0
Not available	317	66.0

Source: Field Survey, 2023

The result in Table 4 above shows the availability of formal financial institutions in rural communities. The result shows that majority (66%) of the respondents have no financial institutions in their area, while the few number of the respondents (34.0) of them have financial institutions existing in the area.

Table 5: Acquisition of Financial Aid in the Last 12 Months

Responses	Frequency (n = 480)	Percentage (%)
Acquired	63	13.1
Not acquired	417	86.9

Source: Field Survey, 2023

The result of the analysis (Table 5) indicates that majority (86.9%) of the respondents have not received any financial aid from any organization or financial institution in the study area in the last 12 months, while only few (13.1%) of the farmers have.

Table 6: Forms of Financial Intermediation acquired for Climate Change Adaptation

Variables	Frequency (n = 480)	Percentage (%)
Subsidy	23	4.8
Loans (cash)	24	5.0
Input Supply	16	3.3
None	417	86.9

Source: Field Survey, 2023

In Table 6, forms of financial intermediation received by farmers to aid in adapting to climate change effects were analyzed. From the result of the analysis, majority (86.9%) of the respondents did not receive aids from formal financial institution for adapting to the adverse effects of climate change while only few (13.1%) received some aids.

Table 7: Need for Finance in Boosting Farm Activities due to Climate Change

Responses	Frequency (n = 480)	Percentage (%)
Yes	388	80.8
No	92	19.2

Source: Field Survey, 2023

The result in Table 7 depicts the responses of respondents on whether they have need for finance in order to boost farming operations and activities that were affected by climate change variability. From the result of the analysis,

most (80.8%) of the respondents need finance to aid them adapt to the adverse effects of climate change while only few (19.2%) do not have finance.

The Effect of Financial Intermediation Accessed from Formal Financial Institutions on Rural Farm Households' Resilience to Climate Change Effects

The effect of financial intermediation accessed from formal financial institutions on rural farm households' resilience to climate change effects were analysed using endogenous switching regression model and results presented Tables 8 and 9.

Table 8: Endogenous Switching Regression Estimates of Households' Resilience to Climate Change Effects and Probability of Accessing Financial Intermediation from Formal Financial Institutions

Climate change resilience index of farmers who did not access financial intermediation	**Coef.**	**Std. Err.**	**Z**	**P>z**
Age	0.1433523**	0.0648847	2.21	0.027
Number of farm labourers in the household	0.0388869	0.229343	0.17	0.865
Annual income	4.14e-07	1.10e-06	0.38	0.705
Membership of the Farmers association	-0.2884689	1.901761	-0.15	0.879
Ownership of radio and television	-0.189433	2.291296	-0.08	0.934
Constant	2.612135	3.417959	0.76	0.445
Climate change resilience index of farmers who accessed financial intermediation				
Age	0.1069703***	0.0351783	3.04	0.002
Number of farm labourers in your household	0.1987581	0.1872502	1.06	0.288
Annual income	-0.0001432***	9.40e-06	-15.24	0.000
Membership of the Farmers association	-0.215133	1.67348	-0.13	0.898
Ownership of radio and television	23.9001***	2.132994	11.20	0.000
Constant	53.36824	3.576985	14.92	0.000
Access to financial intermediation from formal financial institutions				
Age	0.0016471	0.0066927	0.25	0.806
Education level	0.2123521***	0.0650793	3.26	0.001
Years of farming experience	-0.3982879**	0.1840578	-2.16	0.030
Number of livestock	0.0009446	0.0007588	1.24	0.213
Household size	0.0420748	0.094333	0.45	0.656
Farm size	0.4564249***	0.0995546	4.58	0.000
Annual income	-1.73e-06**	6.79e-07	-2.54	0.011
Land ownership status	-0.0994259	0.1822021	-0.55	0.585
Engagement in other occupations	-0.1210097	0.1733426	-0.70	0.485
Extension contacts	0.042652*	0.0240466	1.77	0.076
Awareness of climate change phenomenon	0.6464036**	0.2734686	2.36	0.018
Constant	1.408436	0.6668157	2.11	0.035
Wald chi^2 = 59.9				
Log likelihood = -1914.0421				
Prob > chi^2 = 0.000				
LR test of index. eqns.				
Chi^2 = 48.02				
Prob > chi^2 = 0.000				

Source: Field Survey, 2023; *, ** and *** = significant at 10%, 5% and 1% levels of probability

The results in Table 8 indicate that age significantly influenced the climate resilience index of farmers who did not access formal financial intermediation at the 5% level (β = 0.1434; p = 0.027). Among farmers who accessed formal financial intermediation, age was also positive and significant (β = 0.1070; p = 0.002), suggesting that older farmers in this sample tended to have higher resilience, potentially reflecting accumulated farming experience and knowledge of coping and adaptation strategies. Annual income was negative and significant in the accessed-financial-intermediation regime (β = −0.0001432; p < 0.001). This coefficient should be interpreted in relation to the monetary unit of income and does not imply that income itself is inherently harmful to resilience.

Rather, the result indicates that higher reported income was not necessarily translated into resilience-enhancing investment; some income may have been directed to consumption or other household needs rather than climate-resilient activities. Ownership of radio and television was positive and significant ($\beta = 23.9001$; $p < 0.001$), highlighting the potential role of information access in climate-risk awareness and adaptation. In the financial access equation, education ($\beta = 0.2124$; $p = 0.001$) and farm size ($\beta = 0.4564$; $p < 0.001$) were positively associated with access, while farming experience ($\beta = -0.3983$; $p = 0.030$) and annual income ($\beta = -1.73\times10-6$; $p = 0.011$) were negative. The overall Wald statistic was 59.9 ($p < 0.001$); importantly, 59.9 is a Wald χ^2 statistic, not a Z-value. The LR test of the index equations was $\chi^2 = 48.02$ ($p < 0.001$), supporting the joint ESR specification.

Table 9: Expected average Climate Change Resilience Index; Treatment Effects (TE) and heterogeneity

Subsample	Decision stage		Treatment effect
	Accessed	Did not access	
Access financial intermediation from the formal financial institutions	(a) 63.09105	(c) 6.027501	TT = 57.06355**
Do not access financial intermediation from the financial institutions	(d) 11.05648	(b) 4.813336	TU = 6.243144**
Heterogeneity effect	$BH_1 = 52.03457$	$BH_2 = 1.214165$	TH = 50.820405

(a): Expected climate change resilience index of farmers that accessed financial intermediate from the financial institution; (b): Expected climate change resilience index of farmers that did not access financial intermediate from the financial institution; (c): Expected climate change resilience index of farmers that accessed financial intermediate from a financial institution if they did not; (d): Expected climate change resilience index of farmers that did not access financial intermediate from a financial institution if they access it.

Table 9 presents expected household climate resilience under observed and counterfactual conditions. Among households that accessed formal financial intermediation, the observed expected resilience index was 63.091, whereas the counterfactual expected index if they had not accessed financial intermediation was 6.028. The difference gives an estimated treatment effect of approximately 57.064 index points. Among households that did not access formal financial intermediation, the observed expected index was 4.813, compared with a counterfactual value of 11.056 if they had accessed financial intermediation. These results indicate a substantial estimated resilience difference associated with financial intermediation in the study sample. However, because the study is cross-sectional and relies on observational data, the treatment estimates should be interpreted as model-based treatment effects conditional on the ESR assumptions rather than as definitive experimental causal effects.

Constraints to Achieving Climate Change Resilience by Rural Farm Households' through Formal Financial Institutions' Intermediation

Constraints to achieving climate change resilience through formal financial institutions' intermediation were analysed using varimax rotated component matrix method and result is presented in Table 10.

Table 10: Varimax Rotated Component Matrix on Constraints to Achieving Climate Change Resilience by Rural Farm Households through formal Financial Intermediation

Constraints to Climate Change Resilience	Economic constraints	Institutional constraints	Infrastructural constraints	Technological constraints
Poor access to climate change information	-.0113	0.389	**0.556**	0.074
Non - availability of credit facilities for rural farm household	0.080	0.000	**0.790**	0.011
Illiteracy of the farmers	-0.100	0.052	0.225	**0.800**
Inadequate knowledge of how to cope or build resilience	0.139	-0.042	0.042	**0.715**
Lack of access to weather forecasting technologies	0.179	0.225	-0.224	**0.692**
Low income of rural households	**0.700**	0.204	0.035	0.197
Lack of extension programs	**0.683**	0.247	0.205	0.053
Lack of access to supporting programmes e.g. cooperatives, adult education programme	**0.592**	0.007	0.014	-0.070
Tedious nature of climate change adaptation activities	**0.609**	0.090	0.012	0.073

Unwillingness of rural farm households to take farming risks to adapt.	**0.655**	0.052	0.195	-0.142
Lack of technical knowledge	**0.591**	-0.104	-0.234	0.092
Poor access to and control of resources e.g. land	**0.594**	-0.018	-0.403	0.297
Lack of awareness and access to programs which aid in attaining resilience	**0.532**	0.237	0.339	0.082
Lack of access to basic assets to attain resilience	0.191	-0.161	**0.630**	0.150
Small farm size	-0.011	-0.071	0.511	0.613
Lack of access to disease and pest resistant	0.319	0.137	0.281	0.282
Lack of access to drought varieties of crops	-0.165	**0.650**	-0.013	0.107
Lack of access to disease and pest resistant livestock	0.129	**0.822**	0.026	-0.088
Small household size	0.229	**0.526**	-0.178	0.015
Limited access to resilience strategies	0.130	**0.613**	-0.196	0.114
Lack of collateral security required to secure loan	0.490	0.520	.086	0.143
Limited government support	0.210	**0.508**	.226	-0.007
Lack of beliefs on issues related to climate change	0.044	**0.734**	.226	-0.007

Source: Field Survey, 2023

The exploratory principal component analysis with Varimax rotation identified four interpretable dimensions of constraints. A loading threshold of 0.40 was used to identify variables that made a meaningful contribution to a component. The four dimensions were labelled economic, institutional, infrastructural and technological constraints based on the variables with the strongest loadings and their substantive content. For example, low income (0.700), lack of extension programmes (0.683), tedious climate-change adaptation activities (0.609) and unwillingness to take farming risks (0.655) loaded strongly on the economic component. Institutional constraints included lack of access to drought-resistant crop varieties (0.650), lack of disease- and pest-resistant livestock (0.822), limited access to resilience strategies (0.613) and limited government support (0.508). Infrastructural constraints were dominated by non-availability of credit facilities (0.790) and lack of basic assets (0.630), while technological constraints included illiteracy (0.800), inadequate knowledge of how to cope or build resilience (0.715), and lack of access to weather forecasting technologies (0.692). The analysis is exploratory and the component labels are based on the observed loading pattern rather than a confirmatory measurement model.

Conclusion

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, the analysis relied on self-reported primary data collected through structured questionnaires administered as interview schedules. Variables such as annual income, climate-change experiences, access to financial services and adaptation-related practices may therefore be affected by recall error, reporting error or social-desirability bias.

Second, the cross-sectional design captures household conditions at one point in time and cannot establish how resilience and financial access evolve over time. Although the endogenous switching regression accounts for selection into financial intermediation under its modelling assumptions, the observational design does not provide the same level of causal identification as a randomized experiment or a longitudinal design with repeated observations.

Third, the sampling design limits the scope of generalization. The study covers 480 rural farm household heads in selected communities across Enugu, Ebonyi and Abia States. Because intermediate sampling stages deliberately selected farming-intensive and climate-affected LGAs, communities and villages, the findings are most directly applicable to rural farming households in similar climate-vulnerable contexts in Southeast Nigeria. They should not automatically be generalized to all rural households in the five Southeast states, other geopolitical regions of Nigeria, or settings with substantially different agro-ecological, institutional and socioeconomic conditions.

Finally, the Climate Resilience Index is a composite, relative measure based on selected indicators and an equal-weighting structure. Different indicators, weights or measurement frameworks could produce somewhat different resilience scores. Future studies should therefore consider panel data, wider geographic coverage and, where feasible, independently verified measures of income, financial access and resilience outcomes.

The study found that rural farm households in Southeast Nigeria are predominantly engaged in agriculture, with a significant number facing challenges related to limited access to credit and farming inputs. Despite these challenges, awareness of climate change is high among farmers, with media and peer networks playing a major role in disseminating information. The findings also indicate that while farmers have diverse farming practices, there is a predominance of crop cultivation, particularly cassava, rice, and yam, with poultry farming being the

most common livestock activity. The data highlights the need for improved access to financial services, extension services, and climate-resilient agricultural practices to enhance the adaptive capacity of rural farmers to climate change.

The findings underscore a significant gap in financial access and support for rural farmers, especially regarding climate change adaptation. Despite recognizing the need for finance, most farmers lack access to formal financial institutions, and a large majority have not received financial aid for climate resilience. The ESR estimates show a substantial difference in expected resilience associated with formal financial intermediation. Given the cross-sectional observational design, this result should be understood as a model-based treatment effect conditional on the ESR assumptions rather than unqualified experimental causality. Economic, institutional, infrastructural and technological constraints further hinder farmers' ability to adapt effectively. Improving financial access alongside extension, climate information, infrastructure and institutional support could therefore strengthen the resilience of rural farm households in comparable settings

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