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Drivers and Determinants of Multidimensional Poverty Among Nigerian Farming Households

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Abstract

Using data from 1,614 farming households across 26 Local Government Areas in 13 Nigerian states, a Multidimensional Poverty (MDP) index comprising seven dimensions, i.e., health, nutrition, education, water and sanitation, living standard, social security, employment and income; was computed as the dependent variable. A Beta regression model was applied to determine the influence of socio-economic, infrastructural, occupational, and household-level factors because MDPI is a bounded continuous variable between 0 and 1. The model explained 73.7% of the variation in MDP with significant State-level differences, particularly, Osun, Oyo, Kaduna states, and the FCT exhibited between 10% and 28% higher MDP in comparison to Benue state, the base. Human capital indicators, particularly tertiary education, was associated with up to 3.3% reduction in poverty, echoing findings that education is a pathway out of deprivation. All-season roads and respondents living in urban areas experienced lower poverty, consistent with studies on infrastructure and rural welfare. Energy access emerged as a critical factor: reliance on fuelwood exacerbated poverty, while access to gas, solar, and grid electricity significantly reduced it, supporting evidence on the welfare impacts of modern energy access. Occupational diversification into non-agricultural employment (e.g., civil/public service, forestry, healthcare) was associated with lower poverty, aligning with findings on livelihood diversification. Conversely, reliance on maternity homes and Traditional medicine practitioners was directly associated with deprivation, while access to hospitals mitigated it, reinforcing health–poverty linkages. Numerical variables revealed that higher income and asset values decreased poverty, whereas security shocks, unemployment, and underemployment strongly heightened vulnerability, consistent with recent Nigerian studies. The findings underscore that poverty is multidimensional, shaped by structural, household, and livelihood factors. Policies that expand educational access, improve rural infrastructure, enhance modern energy supply, and foster non-agricultural employment while mitigating security risks are essential pathways for poverty reduction. These results corroborate earlier empirical studies on the critical role of human capital, infrastructure, and livelihood diversification in addressing MDP in Sub-Saharan Africa.

Keywords: Beta regression, education, energy access, infrastructure, rural households, livelihood diversification

1. Introduction

Multidimensional poverty (MDP) remains one of the most persistent development challenges confronting sub-Saharan Africa, with Nigeria, Africa's most populous country, bearing a significant share of the burden. Regional disparities within Nigeria and livelihood vulnerabilities contributing to deprivation beyond income measures require

a clearer understanding of the drivers and determinants of MDP which is crucial for policy design against poverty reduction and economic empowerment (Etim & Odo, 2022). Despite periods of economic growth and vast natural resources, high poverty rates have been on the rise, with MDP affecting over 133 million people, representing approximately 63% of its population (National Bureau of Statistics [NBS], 2022). Unlike conventional income-based poverty measures, MDP captures the complex and overlapping deprivations that households experience across multiple domains such as health, education, living standards, energy access, and security (Alkire & Santos, 2014, 2010). This broader conceptualization is critical for determining the structural and systemic factors that perpetuate poverty for effective policy response.

The persistence of MDP is linked to a range of interdependent factors, including unemployment, underemployment, low educational attainment, inadequate infrastructure, poor energy access, insecure land tenure, and exposure to conflict and insecurity (World Bank, 2022). Moreover, spatial disparities in poverty dynamics reflect variations in governance, resource endowments, institutional capacity, and socio-economic conditions across regions and states (Ogunniyi *et al*., 2020). These complex drivers require a multidimensional analytical approach that goes beyond income metrics to examine how structural vulnerabilities, household-level characteristics, and contextual factors jointly shape poverty outcomes.

In recent years, Nigeria has experienced heightened security challenges ranging from insurgency and banditry to communal clashes and farmer–herder conflicts, which have disrupted livelihoods, displaced populations, and eroded household resilience (Akinyemi *et al*., 2021). Simultaneously, persistent labour market weaknesses, including high unemployment and widespread underemployment, continue to limit income generation and exacerbate poverty. The interplay of these factors with infrastructural deficits, unreliable energy supply, and low human capital formation highlights the nature of poverty in Nigeria and underscores the need for targeted, evidence-based interventions.

1.1 Statement of the Problem

Despite substantial investments in poverty reduction strategies and social protection initiatives, MDP remains pervasive in Nigeria. National assessments reveal that poverty is not only widespread but also deeply entrenched, with disparities across states, rural and urban areas, and socio-economic groups (NBS, 2022). Traditional poverty reduction efforts, which focus primarily on income enhancement, have achieved limited success because they overlook the multiple, overlapping deprivations that households face.

A major gap in existing research is that there is insufficient empirical evidence on how security shocks, employment status, educational attainment, asset ownership, energy access, and infrastructure jointly shape MDP outcomes at the subnational level. Moreover, the influence of spatial heterogeneity and context-specific factors is often underexplored, limiting the design of targeted interventions that address localized poverty dynamics. Addressing this gap is critical to inform policies that move beyond generic poverty alleviation programs toward integrated, context-sensitive strategies.

1.2 Objectives of the Study

The main objective of this study is to investigate the drivers and determinants of MDP across selected states in Nigeria. Accordingly, the objectives of this research are to:

Describe the socio-economic and cultural characteristics of the respondents

Examine the relationship between MDP status and socio-economic characteristics

Estimate the determinants of MDP among the respondents

By achieving the research objectives, this study aims to provide a clear description of the respondents' profiles, the correlations between poverty status and socio-economic factors and the key determinants of MDP among the respondents thereby contributing to a deeper understanding of MDP in selected states of Nigeria. The goal is to inform policies and interventions that can effectively address the critical factors contributing to MDP in Nigeria and similar developing economies, ultimately reducing poverty and improving the well-being of individuals and communities.

1.3 Research Questions

The study seeks to answer the following questions:

What are the socio-economic and cultural characteristics of the respondents?

What is the relationship between MDP status and socio-economic characteristics?

What are the determinants of MDP among the respondents?

The research questions are designed to understand the demographic, social, and economic profiles of the respondents, identify correlations between poverty status and socio-economic factors, and determine key determinants of MDP in Nigeria.

1.4 Significance of the Study

This study contributes to the growing body of knowledge on poverty by offering perspectives that captures the complex interplay of its structural, socio-economic, and contextual determinants. The findings provide evidence to inform the design of integrated poverty reduction strategies that go beyond income-based interventions. Policymakers can use the insights to prioritize investments in areas such as security, employment creation, education, energy infrastructure, and spatially targeted development programs. The study also provides a valuable reference for researchers and development practitioners seeking to understand and address poverty in developing economies.

1.5 Scope and Limitations of the Study

The study focuses on selected states in Nigeria, capturing both rural and urban contexts to reflect spatial diversity in poverty dynamics. The analysis centers on household-level determinants, including security shocks, employment, education, asset ownership, energy access, infrastructure, and location. While the study provides robust cross-sectional evidence, it does not capture temporal dynamics or causal pathways, and some variables may be subject to measurement errors or endogeneity. Future research could build on these findings using longitudinal data and quasi-experimental methods to strengthen causal inference.

1.6 Theoretical Framework

The study of MDP requires integrating perspectives from economic, social, and human development theories like Amartya Sen's Capability Approach (1999), which shifts poverty analysis beyond income deprivation to focus on the substantive freedoms and capabilities individuals must live the lives they value. According to Sen, poverty arises when people lack basic capabilities such as health, education, and social participation, even if their income levels are above the poverty line. This perspective underpins MDP measures that capture deprivations across multiple dimensions of well-being.

Sen's Capability Approach is complemented by basic needs theory, which was advanced by Streeten et al., (1981), emphasizing the fulfillment of essential human needs including food, shelter, health, and education as prerequisites for development. Poverty, in this sense, is the inability to meet these minimum standards. Furthermore, the social exclusion theory (Silver, 2007, 1994) explains poverty as the result of structural inequalities and exclusion from mainstream social, economic, and political processes, highlighting the role of institutional and cultural barriers.

Lastly, the sustainable livelihoods framework (Chambers & Conway, 1992) provides a holistic view of poverty by linking assets, vulnerability contexts, and livelihood strategies. It underscores how poverty drivers are embedded in broader socio-economic and environmental contexts. Together, these theories provide a lens for analyzing poverty dynamics and guide this study's approach to identifying its determinants and drivers in selected Nigerian states.

1.7 Conceptual Framework

The conceptual framework for this study is anchored on the multidimensional nature of poverty as conceptualized by the Alkire-Foster (AF) method (Alkire & Foster, 2011), which measures poverty across multiple dimensions and indicators. It posits that an individual is multidimensionally poor if they are deprived in a critical proportion of these indicators simultaneously. In this study, MDP is conceptualized as being influenced by a set of interrelated socio-economic, demographic, and cultural factors as well as spatial and environmental conditions as shown in Figure 1.

The framework illustrates that these variables interact to influence individuals' capabilities and functioning, which in turn determines their MDP status. Interventions aimed at reducing poverty must therefore address these determinants simultaneously rather than focusing solely on income or consumption measures.

1.8 Empirical and Literature Review

Poverty research has evolved from a unidimensional, income-based approach to a multidimensional perspective that captures deprivations in multiple domains of life. Townsend (1979) first conceptualized poverty as the inability to participate fully in society due to lack of resources. This view laid the foundation for Sen's Capability Approach (1999), which redefined poverty as the deprivation of basic capabilities rather than merely low income.

The development of the MDPI by Alkire & Foster (2011) and Alkire et al., (2013) which was expanded by Sallawu et al. (2025) marked a shift in poverty measurement. MPI incorporates indicators across market, education, and living standards, revealing deprivations that income measures alone cannot capture. Studies applying the MPI in Nigeria (e.g., Oyekale, 2015; Ogunniyi et al., 2021) show persistent MDP, particularly in rural areas, driven by poor access to education, healthcare, and infrastructure.

Empirical studies across sub-Saharan Africa and Nigeria provide evidence of the nature of poverty and its determinants. Alkire & Santos (2014, 2010) demonstrated that MDP varies widely across countries and is often driven by deprivations in education and health. In Nigeria, Auta et al., (2019) found that household size, education, and employment influenced poverty status, while Oyekale (2015) identified rural residence and low asset ownership as strong predictors of multidimensional deprivation. Socio-economic and demographic factors consistently emerge as major determinants. Adewumi and Adebayo (2020) found that education was inversely associated with poverty likelihood, while larger household size exacerbated vulnerability. Nwosu and Ndubueze (2019) showed that female-headed households and those with high dependency ratios are more prone to MDP. Cultural and institutional factors

also play critical roles as Osabohien et al., (2022) demonstrated that social exclusion and weak governance exacerbate poverty.

Olowa and Olowa (2015) reported that spatial disparities exacerbate MDP incidence in northern Nigeria, driven by poor access to education and health services. Conversely, Akinbode and Salami (2018) linked urban poverty reduction to improved employment and social safety nets. Rural households face higher deprivation levels due to limited infrastructure, poor service delivery, and restricted livelihood opportunities (Olowa & Olowa, 2015). Urban poverty, though lower in intensity, is driven by informal employment and inadequate housing (Akinbode & Salami, 2018). Furthermore, dynamic analyses reveal that households may transition in and out of poverty depending on shocks, social interventions, and livelihood diversification (Abdu & Delarue, 2020).

Recent studies (Sallawu et al., 2025; Ogunniyi et al., 2021; Abdu & Delarue, 2020) highlights the dynamic nature of poverty and observed that changes in employment opportunities and access to social services can shift households in and out of poverty, emphasizing the role of structural transformation. Also, education, gender of household head, and access to infrastructure were key drivers of poverty transitions in Nigeria. These findings underscore the importance of contextual factors in shaping poverty outcomes, supporting the present study's focus on selected states to capture spatial and socio-economic heterogeneity.

Despite substantial progress, gaps remain in how these determinants interact across regions and socio-economic circumstances. This study addresses this gap by examining the drivers and determinants of MDP in selected states of Nigeria, thereby contributing valuable insights that can inform and enhance poverty reduction policies and practices, ultimately contributing to more effective strategies for addressing MDP in developing economies.

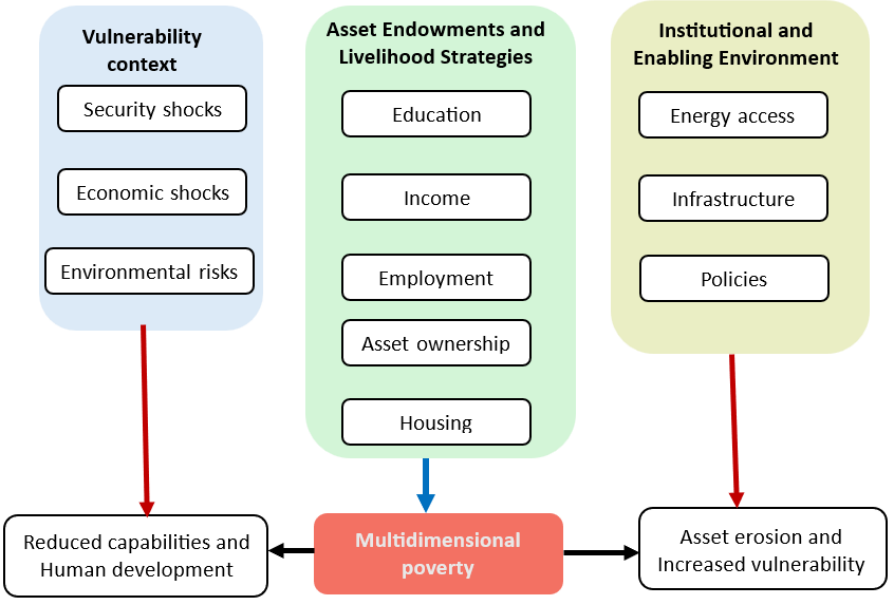


Figure 1. Conceptual framework of determinants of MDP

2. Materials and Methods

The data utilized were collected from 1614 farming community households from 26 Local Government Areas (LGAs) of 13 selected states of Nigeria in North Central, North West, South West, North East, South East and South South zones.

The details of the computation of MDPI, the dependent variable in this study, are reported by Sallawu et al., (2025). The MDPI comprises seven dimensions, i.e., health, nutrition, education, water and sanitation, living standard, social security, employment and income. The data on socio-economic characteristics, housing ownership, occupation, education, type of energy in use and other factors critical to the achievement of the objectives were collected directly from 1614 respondents sampled. The data were collected using structured questionnaire administered via the KoboToolbox application (www.kobotoolbox.org, 2024) by trained enumerators between May and October 2024. The data were analyzed using beta regression with no intercept, Poisson and stepwise Poisson regressions for the purpose of robustness check. However, beta regression model was chosen because the dependent variable (MDPI) is a continuous proportion bounded between 0 and 1 and it produced considerable number of significant variables as well

as the conformity of the variables with the *a priori* expectation. The Explicit form of the model is specified in equation (1):

$$MDP\ Index_i = \beta_0 + \sum_{j=1}^{29} \beta_j X_{ji} + \epsilon_i$$

where:

MDP Index$_i$ = Multidimensional Poverty index of the i-th respondent,

β_0 = intercept term,

β_j = coefficient of the j-th explanatory variable,

X_j = j-th explanatory variable $j = 1,2,\ldots,29$,

ϵ = error term.

The explanatory variables are: X_1 = State, X_2 = Gender, X_3 = Religion, X_4 = Marital status, X_5 = Status in the family, X_6 = Access Road, X_7 = Development level, X_8 = Highest educational level attained, X_9 = Membership of association, X_{10} = Ownership of dwelling, X_{11} = Energy supply, X_{12} = Primary occupation, X_{13} = First medical facility, X_{14} = Local government, X_{15} = Region, X_{16} = Income, X_{17} = Total value of land held, X_{18} = Value of assets, X_{19} = Farm size, X_{20} = Age of the respondents, X_{21} = Security shocks, X_{22} = Unemployment, X_{23} = Underemployment, X_{24} = Tropical livestock unit, X_{25} = Family size, X_{26} = Children under the same roof, X_{27} = Years in formal education, X_{28} = Constraints, X_{29} = Number of associations.

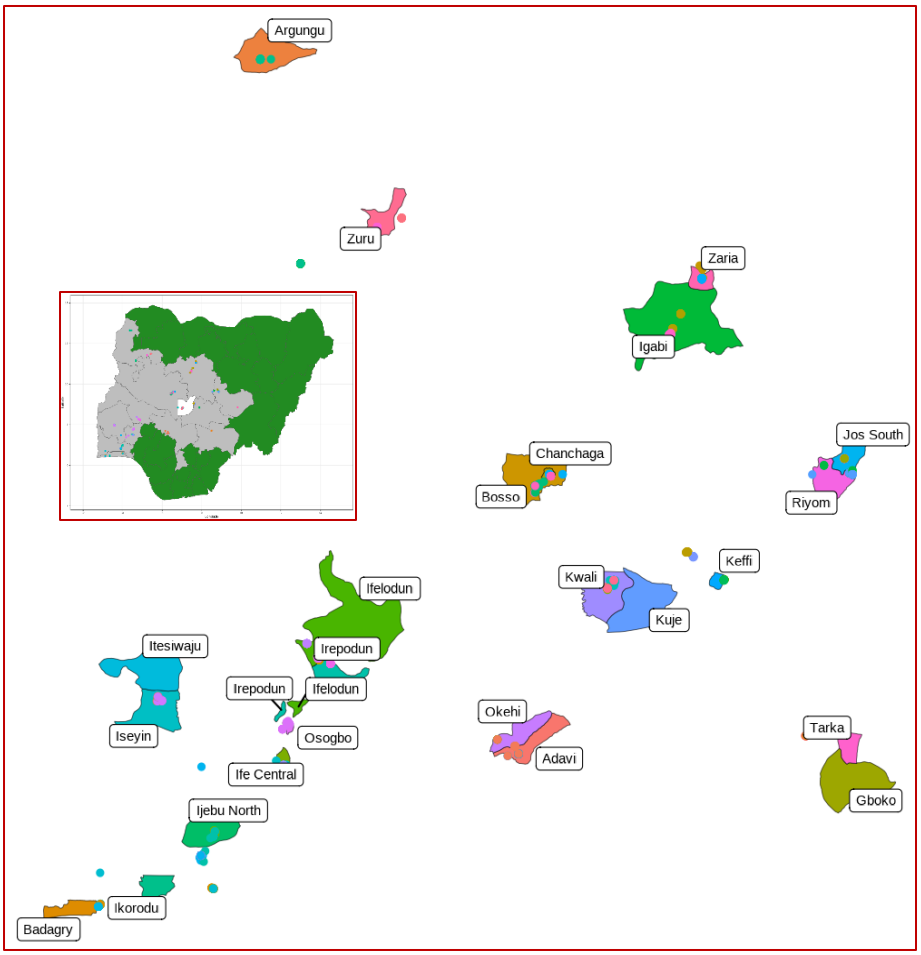


Figure 2. Map of Nigeria showing the study areas.

3. Results and Discussion

This section contains the results of the comprehensive analysis of the data carried out.

3.1 Results

The age structure and household statistics of the respondents are found on Table 1 and Table 2 respectively, while Table 3 shows the Socio-cultural distribution of the respondents, and Table 4 shows of the critical economic variables and how they are related to MDP status. Table 5 shows the coefficients estimates of the determinants of MDP of all the models implemented. All computations, estimations and visualizations were carried out with packages in R Programming {vers. 4.5.1} (R Core Team, 2025; Nmadu, 2025; Cribari-Neto & Zeileis, 2010; Wickham, 2016).

The study surveyed a total of 1614 households across selected states of Nigeria, capturing a diverse socio-economic and demographic profile like multiple religions, and varied marital statuses, reflecting the socio-cultural heterogeneity of the sampled population. Although small- and medium-sized households dominated, household sizes ranged widely. Households with better housing quality, reliable energy sources, and higher education levels tended to exhibit lower levels of MDP. Larger family size slightly increased poverty while higher income and asset value was inversely associated with poverty as expected.

The results further reveals that higher education (tertiary) strongly mitigated poverty, showing the transformative effect of human capital on welfare. Additionally, reliable and diverse energy sources like gas cooker, grid electricity, solar, generator and generator/grid electricity hybrid systems lower MDP, while dependence on fuelwood played a pivotal role in exacerbating it, demonstrating a strong link between energy poverty and multidimensional deprivation. Also, traditional medical practitioners and those unemployed were more likely to face higher poverty. Notably, using maternity homes or traditional medicine practitioners for healthcare is a confirmation of MDP status and possess greater risk, while reliance on hospitals (general/private) is a reverse case of MDP, suggesting a strong health poverty nexus. Finally, more of the respondents with access to all-season roads are in the poverty trap, consistent with the role of rural infrastructure in market integration and livelihood opportunities.

Table 1. Age structure of the respondents

Lower class	Upper class	Freq	%
0.9	11	6	0.37
11.2	21	181	11.21
21.4	32	518	32.09
31.6	42	394	24.41
41.8	52	289	17.91
52	62	158	9.79
62.2	72	51	3.16
72.4	83	10	0.62
82.6	93	6	0.37
92.8	103	1	0.06
Total		1614	100

Table 2. Household size of the respondents

Lower class	Upper class	Freq	%
0.98	3.3	746	46.31
3.3	5.6	261	16.20
5.6	7.9	256	15.89
7.9	10.2	201	12.48
10.2	12.5	58	3.60
12.5	14.8	35	2.17
14.8	17.1	35	2.17
17.1	19.4	5	0.31
19.4	21.7	8	0.50
21.7	24	6	0.37
Total		1611	100

Table 3. Socio-cultural distribution of the respondents

Gender	Marital status	Religion	Family Status					Total
			Breadwinner only	Housewife	Household head and breadwinner	Household head only	Member	
Female	Co-habiting	Christianity	0	0	0	2	6	8
		Islam	0	0	0	1	0	1
	Divorced	Christianity	3	1	2	1	3	10
		Islam	0	0	0	4	2	6
	In a relationship	Christianity	0	0	0	0	3	3
	Married	Christianity	1	8	6	8	60	83
		Islam	2	10	3	1	34	50
	Separated	Christianity	0	0	1	1	0	2
		Islam	0	0	0	0	4	4
	Single	Christianity	5	0	1	10	95	111
		Idol worshipper	0	0	1	1	1	3
		Islam	1	0	1	6	50	58
		None	0	0	0	0	1	1
	Widow(er)	African traditional religion	1	0	0	0	0	1
		Christianity	3	0	14	4	2	23
		Islam	1	0	0	2	2	5
Male	Co-habiting	Atheist	1	0	0	1	0	2
		Christianity	0	0	1	0	1	2
		Other Eastern religion	0	0	0	1	0	1
	Divorced	African traditional religion	0	0	0	1	0	1
		Christianity	0	0	3	8	1	12
		Islam	0	0	3	2	1	6
	In a relationship	African traditional religion	0	0	0	0	1	1
		Christianity	0	0	1	1	5	7
		Islam	0	0	2	0	3	5
	Married	African traditional religion	0	0	3	5	0	8
		Christianity	18	0	174	77	11	280
		Idol worshipper	0	0	3	4	1	8
		Islam	25	0	356	41	22	444
	Separated	Christianity	0	0	3	0	0	3
		Islam	0	0	3	4	0	7
	Single	African traditional religion	0	0	0	0	4	4
		Christianity	7	0	16	46	180	249
		Idol worshipper	0	0	0	0	2	2
		Islam	7	0	11	17	145	180
		None	1	0	0	0	0	1
	Widow(er)	African traditional religion	0	0	0	1	0	1
		Christianity	0	0	7	2	0	9
		Idol worshipper	0	0	0	1	0	1
		Islam	0	0	3	0	0	3
Non-binary/third gender	In a relationship	Christianity	0	0	0	0	1	1
	Married	Christianity	0	0	0	1	0	1
	Single	Christianity	1	0	0	1	1	3
	Widow(er)	Other Eastern religion	0	0	0	0	1	1
Prefer not to say	Married	Christianity	0	0	0	0	1	1
	Single	Islam	0	0	0	0	1	1

The model fit (Table 5) was strong and robust ($R^2 = 0.737$), indicating that **73.7%** of the variations in MDP were explained by the included covariates. Security shocks, unemployment, and underemployment emerged as the most significant positive predictors of MDP respectively ($p < 0.001$). Specifically, the results indicates that security shocks

(30.6%), unemployment (29.7%), and underemployment (10.8%) are associated with higher poverty percentage rates, stressing the vulnerability of rural livelihoods and their role in driving poverty. Conversely, several variables exhibited strong negative relationships with MDP, indicating their protective effects. Education, particularly tertiary attainment (28.2%), emerged as a negative predictor of MDP ($p < 0.05$). Consistent with this, access to reliable and cleaner energy sources is another critical determinant indicating that households relying on gas cookers (24.9%), grid electricity (24.6%), or hybrid systems combining generators and solar power (up to 35.9%) recorded lower levels of MDP. Also, formal sector employment in the civil service (11.5%), public sector (10.1%), and private enterprises (6.6%) are associated with lower MDP, confirming the protective role of stable means of livelihood. Similarly, housing ownership, particularly purchased dwellings (6.4%) in the stepwise model, was linked to lower levels of poverty, emphasizing the role of secure tenure and housing assets in poverty reduction.

Furthermore, infrastructure and spatial factors also matter. Households with access to all-season roads exhibited lower MDP, highlighting the importance of infrastructure in enhancing market access, service delivery, and livelihood opportunities. Also, geographic heterogeneity was evident: states such as Osun and Oyo, and the southern region more broadly, displayed significant coefficients, suggesting spatial disparities in poverty dynamics that warrant region-specific interventions. Specifically, households in Osun (28.3%), Oyo (11.3%), Kaduna (10.2%), and the FCT (10.8%) exhibited higher MDP than the base state (Benue), while Lagos (6.7%), Niger (1.8%), and Nasarawa (3.1%) showed relatively lower risks than Benue, though not significant all through.

Table 4. Economic distribution of the respondents based on the MDP status

Housing	Education	Energy	MDPI				Total
			explosive	high	moderate	low	
Family	Adult/In service	Fuel wood/charcoal	0	1	0	0	1
		Generator/personal power plant	0	0	1	0	1
		Generator/personal power plant None	0	1	0	0	1
	None	Fuel wood/charcoal	1	11	4	0	16
		Fuel wood/charcoal Gas cooker	0	4	0	0	4
		Solar system power supply	0	0	2	0	2
	Primary	Fuel wood/charcoal	3	9	6	0	18
		Fuel wood/charcoal Gas cooker	0	1	5	0	11
		Local kerosene stove/lantern	0	1	5	2	7
		Grid electricity	0	0	5	1	6
	Qur'anic	Fuel wood/charcoal	0	4	3	0	7
		Fuel wood/charcoal Local kerosene stove/lantern Gas cooker/grid electricity	0	1	1	0	25
	Secondary	Fuel wood/charcoal	15	33	28	0	76
		Generator/personal power plant Gas cooker	0	0	43	0	43
		Local kerosene stove/lantern /grid electricity	1	0	26	2	31
		Fuel wood/charcoal Local kerosene stove/lantern Gas cooker	1	1	24	2	26
		Grid electricity	0	3	12	0	17
		Fuel wood/charcoal Generator/personal power plant Local kerosene stove/lantern /grid electricity	0	1	8	0	15
		Fuel wood/charcoal Gas cooker	0	7	4	0	11
		Fuel wood/charcoal/grid electricity	0	7	3	0	6
	Tertiary	None	0	0	21	3	31
		Fuel wood/charcoal	1	14	15	0	30
		Generator/personal power plant Local kerosene stove/lantern Gas cooker /grid electricity	0	0	28	1	29
		Fuel wood/charcoal Local kerosene stove/lantern /grid electricity	0	0	10	16	26
		Fuel wood/charcoal Solar system power supply Local kerosene stove/lantern Gas cooker /grid electricity	0	0	9	0	10
		Fuel wood/charcoal Gas cooker /grid electricity	0	5	3	0	8

Housing	Education	Energy	MDPI				Total
			explosive	high	moderate	low	
		Grid electricity	0	7	3	0	7
		Fuel wood/charcoal Generator/personal power plant /grid electricity	0	0	6	0	7
		Fuel wood/charcoal /grid electricity	1	0	6	0	7
							25
	Vocational/Skills acquisition	Fuel wood/charcoal	0	0	1	0	1
		Grid electricity	0	0	1	0	1
		Solar system power supply	0	1	0	0	1
Free	None	Fuel wood/charcoal	1	0	0	0	1
	Secondary	Fuel wood/charcoal	0	0	1	0	1
Husband	None	Fuel wood/charcoal Gas cooker	0	3	0	0	3
	Primary	Fuel wood/charcoal Gas cooker	0	1	0	0	1
	Secondary	Fuel wood/charcoal Gas cooker	0	1	0	0	1
	Tertiary	Fuel wood/charcoal Gas cooker	0	1	0	0	1
		Fuel wood/charcoal Gas cooker /grid electricity	0	2	1	0	3
Inheritance	Adult/In service	Fuel wood/charcoal	1	0	0	0	1
	None	Fuel wood/charcoal	0	1	1	0	2
		Fuel wood/charcoal Local kerosene stove/lantern	0	1	0	0	1
	Primary	Fuel wood/charcoal	0	8	30	0	38
		Gas cooker	0	0	3	1	4
	Qur'anic	Fuel wood/charcoal	1	2	0	0	3
		Fuel wood/charcoal /grid electricity	0	0	1	0	2
	Secondary	Fuel wood/charcoal	4	21	9	0	34
		Fuel wood/charcoal Generator/personal power plant Local kerosene stove/lantern /grid electricity	0	0	21	0	21
		Generator/personal power plant	0	0	10	0	19
		None	0	1	2	0	16
		Generator/personal power plant /grid electricity	0	1	7	0	7
	Tertiary	Fuel wood/charcoal Local kerosene stove/lantern Gas cooker /grid electricity	0	1	10	0	23
		Generator/personal power plant	0	1	2	20	22
		Fuel wood/charcoal /grid electricity	1	12	11	0	21
		Generator/personal power plant Others	1	0	6	2	11
		Fuel wood/charcoal Gas cooker /grid electricity	0	4	6	0	10
		Grid electricity	0	3	3	0	5
	Vocational/Skills acquisition	Fuel wood/charcoal	0	1	1	0	2
		Fuel wood/charcoal Local kerosene stove/lantern /grid electricity	0	1	0	0	1
		Grid electricity	0	0	1	0	1
Leased	None	Fuel wood/charcoal	1	1	0	0	2
		Gas cooker	0	1	0	0	1
	Primary	Fuel wood/charcoal /grid electricity	0	0	1	0	1
		Local kerosene stove/lantern	0	1	0	0	1
	Qur'anic	Fuel wood/charcoal Solar system power supply Others	0	1	0	0	1
	Secondary	Fuel wood/charcoal	0	2	3	0	5
		Grid electricity	0	0	1	0	1
	Tertiary	Fuel wood/charcoal	2	3	2	0	7
Owned	Adult/In service	Fuel wood/charcoal /grid electricity/Others	0	1	0	0	1
		Gas cooker	0	1	0	0	1
	None	Fuel wood/charcoal	0	9	3	0	12
		Fuel wood/charcoal Gas cooker	0	3	0	0	3
	Primary	Fuel wood/charcoal Gas cooker	0	4	3	1	8

Housing	Education	Energy	MDPI				Total
			explosive	high	moderate	low	
		Solar system power supply /grid electricity	0	1	5	0	7
		Fuel wood/charcoal Local kerosene stove/lantern	0	5	3	0	6
		Fuel wood/charcoal /grid electricity	0	2	4	0	5
		Fuel wood/charcoal Gas cooker /grid electricity	0	1	0	0	5
	Qur'anic	Fuel wood/charcoal	0	2	3	0	5
		Grid electricity	0	1	2	0	4
	Secondary	Fuel wood/charcoal	8	24	8	0	5 40
		Fuel wood/charcoal Gas cooker	0	12	13	0	25
		Grid electricity	0	0	13	2	15
		None	0	1	9	0	11
		Fuel wood/charcoal Others	0	0	8	0	9
		Fuel wood/charcoal Gas cooker /grid electricity	0	1	4	0	5
	Tertiary	Solar system power supply Generator/personal power plant Gas cooker /grid electricity	0	1	17	8	27
		Fuel wood/charcoal Gas cooker	0	5	19	0	24
		Local kerosene stove/lantern /grid electricity	0	0	12	3	17
		Fuel wood/charcoal Gas cooker /grid electricity	0	3	12	0	15
		Fuel wood/charcoal	0	6	6	0	12
		Fuel wood/charcoal Generator/personal power plant Gas cooker	0	0	10	1	11
		Fuel wood/charcoal Solar system power supply /grid electricity	0	1	6	0	9
		Generator/personal power plant	0	0	1	5	6
	Vocational/Skills acquisition	Grid electricity	0	1	3	0	3
		Fuel wood/charcoal Local kerosene stove/lantern /grid electricity	0	0	1	0	2
		Fuel wood/charcoal /grid electricity	0	1	1	0	1
		Fuel wood/charcoal	0	0	1	0	1
		Fuel wood/charcoal Gas cooker	0	0	0	0	1
Purchased	Primary	Fuel wood/charcoal	0	0	1	0	1
	Secondary	Fuel wood/charcoal	0	0	2	0	2
		Fuel wood/charcoal /grid electricity	0	1	1	0	1
		Fuel wood/charcoal Gas cooker	0	0	0	0	1
		Generator/personal power plant /grid electricity	0	0	1	0	1
		/grid electricity	0	0	1	0	1
	Tertiary	Fuel wood/charcoal /grid electricity	0	1	8	0	9
		Generator/personal power plant	0	0	3	0	4
	Vocational/Skills acquisition	Fuel wood/charcoal /grid electricity	0	0	1	0	1
	None	Fuel wood/charcoal	0	2	1	0	3
		Fuel wood/charcoal /grid electricity	0	2	2	0	4
		Grid electricity	0	1	1	0	2
Rented	Primary	Fuel wood/charcoal	0	3	9	0	12
		Gas cooker	1	1	8	0	11
		Fuel wood/charcoal /grid electricity	0	3	4	0	5
	Qur'anic	Gas cooker /grid electricity	0	0	1	0	1
		Grid electricity	0	1	0	0	1
	Secondary	Fuel wood/charcoal Gas cooker	0	21	24	0	47
		Fuel wood/charcoal	3	20	17	0	38

Housing	Education	Energy	MDPI				Total
			explosive	high	moderate	low	
		Gas cooker	0	1	11	0	22
		Local kerosene stove/lantern	0	0	13	2	19
		Human waste/Animal wate/Bio-gas	0	1	14	1	16
		Fuel wood/charcoal /grid electricity	0	11	2	0	9
		Fuel wood/charcoal Generator/personal power plant	1	0	3	0	5
	Tertiary	Local kerosene stove/lantern	0	0	28	2	31
		Generator/personal power plant /grid electricity	0	1	19	8	30
		Grid electricity	0	1	11	0	14
		Fuel wood/charcoal /grid electricity	0	3	4	1	13
		Fuel wood/charcoal Gas cooker	0	8	7	0	8
		Generator/personal power plant	1	0	7	0	8
		Solar system power supply Generator/personal power plant Gas cooker /grid electricity	0	1	3	1	5
	Vocational/Skills acquisition	Fuel wood/charcoal	0	3	2	0	5
		Fuel wood/charcoal Gas cooker	0	0	1	0	1
Total			55	496	968	95	1614

Table 5. Coefficients estimates of the determinants of MDP of the respondents

	Beta	Beta no intercept	Poisson	Stepwise Poisson
(Intercept)	-0.192		1.930***	1.962***
	(0.238)		(0.268)	(0.045)
State				
FCT	0.261***	0.069	0.103	
	(0.059)	(0.230)	(0.078)	
Kaduna	0.244***	0.052	0.097	
	(0.066)	(0.239)	(0.084)	
Kebbi	0.132*	-0.059	0.055	
	(0.062)	(0.235)	(0.082)	
Kogi	0.074	-0.118	0.026	
	(0.078)	(0.237)	(0.111)	
Kwara	0.041	-0.151	0.082	
	(0.071)	(0.230)	(0.091)	
Lagos	-0.023	-0.215	0.065	
	(0.063)	(0.228)	(0.088)	
Nasarawa	-0.038	-0.230	-0.032	
	(0.065)	(0.228)	(0.087)	
Niger	-0.038	-0.230	0.018	
	(0.059)	(0.233)	(0.083)	
Ogun	0.007	-0.185	0.047	
	(0.065)	(0.236)	(0.090)	
Osun	0.321***	0.129	0.249*	
	(0.063)	(0.240)	(0.097)	
Oyo	0.273***	0.081	0.107	
	(0.080)	(0.238)	(0.107)	
Plateau	-0.062	-0.254	0.053	
	(0.058)	(0.235)	(0.082)	
Benue		-0.192		
		(0.238)		
Gender				
Male	-0.009	-0.009	-0.021	
	(0.022)	(0.022)	(0.027)	
Non-binary/third gender	-0.120	-0.120	-0.113	
	(0.160)	(0.160)	(0.196)	
Prefer not to say	0.063	0.063	0.094	
	(0.214)	(0.214)	(0.273)	
Religious affiliation				

	Beta	Beta no intercept	Poisson	Stepwise Poisson
Atheist	-0.164	-0.164	-0.048	
	(0.273)	(0.273)	(0.356)	
Christianity	0.165+	0.165+	0.084	
	(0.091)	(0.091)	(0.116)	
Idol worshipper	0.167	0.167	0.067	
	(0.123)	(0.123)	(0.148)	
Islam	0.195*	0.195*	0.096	
	(0.092)	(0.092)	(0.117)	
None	-0.099	-0.099	-0.035	
	(0.252)	(0.252)	(0.317)	
Other Eastern religion	-0.042	-0.042	-0.088	
	(0.370)	(0.370)	(0.535)	
Marital status				
Divorced	0.015	0.015	0.067	
	(0.114)	(0.114)	(0.142)	
In a relationship	0.188	0.188	0.160	
	(0.125)	(0.125)	(0.156)	
Married	-0.002	-0.002	0.051	
	(0.103)	(0.103)	(0.131)	
Separated	0.168	0.168	0.118	
	(0.125)	(0.125)	(0.155)	
Single	0.049	0.049	0.068	
	(0.103)	(0.103)	(0.131)	
Widow(er)	-0.073	-0.073	0.002	
	(0.114)	(0.114)	(0.144)	
Status in the family				
Housewife	-0.022	-0.022	-0.018	
	(0.088)	(0.088)	(0.105)	
Household head and breadwinner	-0.168***	-0.168***	-0.069	
	(0.040)	(0.040)	(0.047)	
Household head ONLY	-0.133**	-0.133**	-0.059	
	(0.043)	(0.043)	(0.050)	
Member	-0.155***	-0.155***	-0.061	
	(0.040)	(0.040)	(0.047)	
Access road				
Seasonal	0.024	0.024	0.042	0.080*
	(0.034)	(0.034)	(0.041)	(0.032)
All-season	-0.087**	-0.087**	0.000	0.034
	(0.032)	(0.032)	(0.042)	(0.029)
Tarred	-0.036	-0.036	0.008	0.034
	(0.035)	(0.035)	(0.043)	(0.026)
Development level				
Rural	0.047+	0.047+	0.017	
	(0.025)	(0.025)	(0.031)	
Urban	-0.036	-0.036	-0.007	
	(0.029)	(0.029)	(0.038)	
Highest educational level attained				
None	-0.015	-0.015	-0.028	
	(0.166)	(0.166)	(0.186)	
Primary	-0.177	-0.177	-0.107	
	(0.157)	(0.157)	(0.176)	
Qur'anic	-0.138	-0.138	-0.077	
	(0.166)	(0.166)	(0.186)	
Secondary	-0.220	-0.220	-0.127	
	(0.156)	(0.156)	(0.174)	
Tertiary	-0.331*	-0.331*	-0.173	
	(0.158)	(0.158)	(0.177)	
Vocational/Skills acquisition	-0.250	-0.250	-0.143	
	(0.173)	(0.173)	(0.195)	
Membership of Associations				
Yes	0.014	0.014	0.005	

	Beta	Beta no intercept	Poisson	Stepwise Poisson
	(0.028)	(0.028)	(0.033)	
Ownership of dwelling				
Free	-0.017	-0.017	-0.043	
	(0.215)	(0.215)	(0.222)	
Husband	0.067	0.067	0.068	
	(0.114)	(0.114)	(0.129)	
Inheritance	0.049+	0.049+	0.032	
	(0.026)	(0.026)	(0.031)	
Leased	0.010	0.010	0.028	
	(0.074)	(0.074)	(0.079)	
Owned	-0.013	-0.013	-0.017	
	(0.024)	(0.024)	(0.029)	
Purchased	-0.120*	-0.120*	-0.066	
	(0.058)	(0.058)	(0.070)	
Rented	0.024	0.024	0.017	
	(0.023)	(0.023)	(0.028)	
Energy supply				
Fuel wood/charcoal Gas cooker	-0.120***	-0.120***	-0.066+	-0.096**
	(0.032)	(0.032)	(0.038)	(0.033)
Fuel wood/charcoal Gas cooker Others	-0.396*	-0.396*	-0.245	-0.358
	(0.199)	(0.199)	(0.268)	(0.260)
Fuel wood/charcoal Gas cooker/grid electricity	-0.188***	-0.188***	-0.074	-0.160***
	(0.047)	(0.047)	(0.057)	(0.047)
Fuel wood/charcoal Generator/personal power plant	-0.169+	-0.169+	-0.073	-0.148
	(0.095)	(0.095)	(0.108)	(0.103)
Fuel wood/charcoal Generator/personal power plant Gas cooker	-0.478***	-0.478***	-0.252	-0.325+
	(0.135)	(0.135)	(0.174)	(0.168)
Fuel wood/charcoal Generator/personal power plant Gas cooker/grid electricity	-0.831**	-0.831**	-0.423	-0.375
	(0.308)	(0.308)	(0.388)	(0.379)
Fuel wood/charcoal Generator/personal power plant Local kerosene stove/lantern Gas cooker/grid electricity	-0.203	-0.203	-0.072	-0.151
	(0.139)	(0.139)	(0.165)	(0.155)
Fuel wood/charcoal Generator/personal power plant Local kerosene stove/lantern/grid electricity	0.094	0.094	0.026	-0.008
	(0.204)	(0.204)	(0.239)	(0.231)
Fuel wood/charcoal Generator/personal power plant/grid electricity	-0.273	-0.273	-0.197	-0.258
	(0.210)	(0.210)	(0.265)	(0.259)
Fuel wood/charcoal/Local kerosene stove/lantern	-0.028	-0.028	-0.027	-0.052
	(0.054)	(0.054)	(0.065)	(0.056)
Fuel wood/charcoal/Local kerosene stove/lantern Gas cooker	0.068	0.068	0.021	-0.029
	(0.125)	(0.125)	(0.134)	(0.127)
Fuel wood/charcoal/Local kerosene stove/lantern Gas cooker/grid electricity	-0.292***	-0.292***	-0.135	-0.239**
	(0.083)	(0.083)	(0.101)	(0.086)
Fuel wood/charcoal/Local kerosene stove/lantern/grid electricity	-0.223*	-0.223*	-0.088	-0.160
	(0.090)	(0.090)	(0.107)	(0.098)
Fuel wood/charcoal only	-0.084	-0.084	0.014	-0.032
	(0.205)	(0.205)	(0.221)	(0.215)
Fuel wood/charcoal and others	-0.359	-0.359	-0.087	-0.148
	(0.326)	(0.326)	(0.418)	(0.409)
Fuel wood/charcoal/grid electricity	-0.138***	-0.138***	-0.067+	-0.125***
	(0.032)	(0.032)	(0.037)	(0.031)
Fuel wood/charcoal/grid electricity/Others	0.513	0.513	0.259	0.015
	(0.519)	(0.519)	(0.657)	(0.281)
Fuel wood/charcoal Solar system power supply	0.305	0.305	0.105	0.050
	(0.296)	(0.296)	(0.306)	(0.291)

	Beta	Beta no intercept	Poisson	Stepwise Poisson
Fuel wood/charcoal Solar system power supply Generator/personal power plant	-0.084	-0.084	-0.005	-0.075
	(0.290)	(0.290)	(0.342)	(0.334)
Fuel wood/charcoal Solar system power supply Generator/personal power plant Gas cooker/grid electricity	-0.087	-0.087	-0.057	-0.250
	(0.302)	(0.302)	(0.372)	(0.356)
Fuel wood/charcoal Solar system power supply Human waste/Animal wate/Bio-gas	0.372	0.372	0.270	0.169
	(0.336)	(0.336)	(0.359)	(0.291)
Fuel wood/charcoal Solar system power supply Local kerosene stove/lantern Gas cooker/grid electricity	-0.259	-0.259	-0.167	-0.210
	(0.293)	(0.293)	(0.365)	(0.355)
Fuel wood/charcoal Solar system power supply Others	0.136	0.136	0.109	0.066
	(0.337)	(0.337)	(0.365)	(0.291)
Fuel wood/charcoal Solar system power supply/grid electricity	0.030	0.030	0.045	-0.123
	(0.300)	(0.300)	(0.313)	(0.290)
Gas cooker	-0.422***	-0.422***	-0.273***	-0.287***
	(0.038)	(0.038)	(0.049)	(0.039)
Gas cooker/grid electricity	-0.308***	-0.308***	-0.180**	-0.254***
	(0.048)	(0.048)	(0.060)	(0.054)
Generator/personal power plant	-0.225***	-0.225***	-0.168*	-0.250***
	(0.064)	(0.064)	(0.081)	(0.072)
Generator/personal power plant Gas cooker	-0.114	-0.114	-0.122	-0.279
	(0.141)	(0.141)	(0.203)	(0.173)
Generator/personal power plant Gas cooker/grid electricity	-0.458***	-0.458***	-0.293+	-0.374**
	(0.116)	(0.116)	(0.150)	(0.141)
Generator/personal power plant Local kerosene stove/lantern	-0.355	-0.355	-0.204	-0.254
	(0.219)	(0.219)	(0.271)	(0.261)
Generator/personal power plant Local kerosene stove/lantern Gas cooker/grid electricity	-0.529*	-0.529*	-0.326	-0.367
	(0.217)	(0.217)	(0.275)	(0.260)
Generator/personal power plant Local kerosene stove/lantern/grid electricity	-1.172**	-1.172**	-1.102	-1.224+
	(0.451)	(0.451)	(0.715)	(0.708)
Generator/personal power plant only	-0.467	-0.467	-0.265	-0.292
	(0.328)	(0.328)	(0.371)	(0.319)
Generator/personal power plant and others	0.392+	0.392+	0.101	0.105
	(0.236)	(0.236)	(0.247)	(0.207)
Generator/personal power plant/grid electricity	-0.502***	-0.502***	-0.333***	-0.445***
	(0.049)	(0.049)	(0.061)	(0.047)
Human waste/Animal waste/Bio-gas	-0.033	-0.033	-0.012	-0.031
	(0.158)	(0.158)	(0.184)	(0.162)
Local kerosene stove/lantern	-0.297***	-0.297***	-0.166+	-0.211*
	(0.077)	(0.077)	(0.096)	(0.088)
Local kerosene stove/lantern Gas cooker	-0.566+	-0.566+	-0.369	-0.360
	(0.306)	(0.306)	(0.392)	(0.379)
Local kerosene stove/lantern Gas cooker/grid electricity	-0.328+	-0.328+	-0.192	-0.272
	(0.169)	(0.169)	(0.201)	(0.194)
Local kerosene stove/lantern/grid electricity	0.141	0.141	0.038	-0.020
	(0.123)	(0.123)	(0.137)	(0.132)
None	-0.096	-0.096	-0.032	-0.049
	(0.093)	(0.093)	(0.110)	(0.105)
Grid electricity	-0.324***	-0.324***	-0.209***	-0.283***
	(0.031)	(0.031)	(0.038)	(0.032)
Solar system power supply	-0.194*	-0.194*	-0.109	-0.230*
	(0.081)	(0.081)	(0.102)	(0.091)
Solar system power supply Gas cooker	-0.253	-0.253	-0.109	-0.195
	(0.288)	(0.288)	(0.345)	(0.335)
Solar system power supply Gas cooker/grid electricity	-0.467*	-0.467*	-0.320	-0.321
	(0.217)	(0.217)	(0.276)	(0.269)
Solar system power supply Generator/personal power plant	-0.139	-0.139	-0.121	-0.193

	Beta	Beta no intercept	Poisson	Stepwise Poisson
	(0.178)	(0.178)	(0.231)	(0.226)
Solar system power supply Generator/personal power plant Gas cooker	-0.587**	-0.587**	-0.386	-0.497+
	(0.227)	(0.227)	(0.299)	(0.290)
Solar system power supply Generator/personal power plant Gas cooker/grid electricity	-0.173	-0.173	-0.145	-0.259+
	(0.128)	(0.128)	(0.161)	(0.155)
Solar system power supply Generator/personal power plant/grid electricity	-0.462**	-0.462**	-0.422*	-0.519**
	(0.157)	(0.157)	(0.208)	(0.196)
Solar system power supply Local kerosene stove/lantern	-0.684*	-0.684*	-0.239	-0.425
	(0.305)	(0.305)	(0.359)	(0.336)
Solar system power supply/grid electricity	-0.212	-0.212	-0.098	-0.254
	(0.144)	(0.144)	(0.182)	(0.171)
Primary occupation				
Agricultural Trading business	-0.087	-0.087	-0.050	
	(0.055)	(0.055)	(0.062)	
Artisan (e.g. mechanic, electrician, repairer of electronic equipment/GSM, vulcanizer, blacksmith etc.)	-0.085	-0.085	-0.055	
	(0.058)	(0.058)	(0.066)	
Civil/Public servant	-0.187***	-0.187***	-0.122+	
	(0.055)	(0.055)	(0.063)	
Commercial motor vehicle/motorcycle/ tricycle driver	-0.035	-0.035	-0.031	
	(0.061)	(0.061)	(0.071)	
Commercial motor vehicle/motorcycle/ tricycle transport owner	-0.135+	-0.135+	-0.095	
	(0.081)	(0.081)	(0.097)	
Construction, Mining/quarrying	0.059	0.059	0.043	
	(0.110)	(0.110)	(0.126)	
Crop farming	-0.065	-0.065	-0.036	
	(0.049)	(0.049)	(0.055)	
Domestic duties	-0.061	-0.061	-0.033	
	(0.109)	(0.109)	(0.126)	
Fashion and Tailoring service	-0.063	-0.063	-0.067	
	(0.066)	(0.066)	(0.076)	
Fisheries/Aquaculture production	-0.073	-0.073	-0.055	
	(0.070)	(0.070)	(0.081)	
Forest production and/or harvesting	-0.371**	-0.371**	-0.138	
	(0.137)	(0.137)	(0.154)	
Formal Private employment	-0.184	-0.184	-0.087	
	(0.149)	(0.149)	(0.179)	
Handcraft	-0.043	-0.043	-0.035	
	(0.056)	(0.056)	(0.063)	
Health care service provider (Nurses, paramedics, itinerants etc.)	-0.263*	-0.263*	-0.211	
	(0.125)	(0.125)	(0.158)	
Housewife	-0.112	-0.112	-0.025	
	(0.095)	(0.095)	(0.108)	
Leasing out of property/equipment	-0.119	-0.119	-0.065	
	(0.108)	(0.108)	(0.124)	
Livestock farming	-0.085	-0.085	-0.052	
	(0.056)	(0.056)	(0.064)	
Medical doctor	-0.428*	-0.428*	-0.348	
	(0.199)	(0.199)	(0.279)	
Non-Agricultural Trading business	-0.075	-0.075	-0.058	
	(0.060)	(0.060)	(0.068)	
None/Unemployed	-0.135+	-0.135+	-0.016	
	(0.069)	(0.069)	(0.078)	
Private sector worker	-0.117*	-0.117*	-0.068	
	(0.054)	(0.054)	(0.062)	
Public sector employment	-0.213**	-0.213**	-0.107	

	Beta	Beta no intercept	Poisson	Stepwise Poisson
	(0.080)	(0.080)	(0.096)	
Retired Civil/Public Servant	-0.176*	-0.176*	-0.105	
	(0.073)	(0.073)	(0.085)	
Student in School (any type)	-0.078	-0.078	-0.019	
	(0.060)	(0.060)	(0.070)	
Traditional medical practice	-0.453**	-0.453**	-0.286	
	(0.147)	(0.147)	(0.197)	
FIRST medical facility				
Clinic	-0.008	-0.008	-0.006	
	(0.028)	(0.028)	(0.034)	
General Hospital	-0.069*	-0.069*	-0.037	
	(0.028)	(0.028)	(0.035)	
Maternity	0.443**	0.443**	0.149	
	(0.164)	(0.164)	(0.175)	
Traditional medicine practitioner	0.248**	0.248**	0.131	
	(0.083)	(0.083)	(0.097)	
Nurse	-0.159	-0.159	-0.064	
	(0.116)	(0.116)	(0.141)	
Pharmacy	-0.043	-0.043	-0.018	
	(0.027)	(0.027)	(0.032)	
Private Hospital	-0.100*	-0.100*	-0.065	
	(0.040)	(0.040)	(0.051)	
Self-medication	0.031	0.031	0.013	
	(0.032)	(0.032)	(0.039)	
LGA				
Argungu			0.073	
			(0.072)	
Badagry			0.010	
			(0.077)	
Bosso			-0.033	
			(0.077)	
Gboko			0.041	
			(0.061)	
Ife Central			-0.126	
			(0.087)	
Ifelodun			-0.011	
			(0.069)	
Igabi			-0.006	
			(0.061)	
Ijebu North			-0.006	
			(0.075)	
Iseyin			0.028	
			(0.067)	
Jos South			-0.099	
			(0.082)	
Keffi			0.022	
			(0.078)	
Kuje			0.057	
			(0.062)	
Okehi			0.002	
			(0.085)	
Region				
South				0.067**
				(0.024)
Numeric variables				
Income	-0.019***	-0.019***	-0.000	
	(0.004)	(0.004)	(0.000)	
Total Value of land held	-0.000	-0.000	0.000	
	(0.004)	(0.004)	(0.000)	
Value of assets	-0.012**	-0.012**	-0.000	
	(0.004)	(0.004)	(0.000)	

	Beta	Beta no intercept	Poisson	Stepwise Poisson
Farm Size in ha	-0.000	-0.000	-0.000	
	(0.000)	(0.000)	(0.000)	
Age of the respondent in years	-0.000	-0.000	-0.001	
	(0.001)	(0.001)	(0.001)	
Security shock	0.443***	0.443***	0.282***	0.267***
	(0.025)	(0.025)	(0.032)	(0.026)
Unemployment	0.503***	0.503***	0.242***	0.260***
	(0.024)	(0.024)	(0.027)	(0.023)
Underemployment	0.134***	0.134***	0.081***	0.103***
	(0.019)	(0.019)	(0.022)	(0.019)
Tropical livestock unit	0.000	0.000	0.000	
	(0.000)	(0.000)	(0.000)	
Family Size	0.004*	0.004*	0.001	
	(0.002)	(0.002)	(0.002)	
Children under same roof	-0.000	-0.000	0.000	
	(0.000)	(0.000)	(0.000)	
Years in formal educational	0.003	0.003	-0.000	-0.008***
	(0.004)	(0.004)	(0.005)	(0.002)
Constraints latent variable (MR1)	0.008	0.008	0.002	
	(0.006)	(0.006)	(0.007)	
Constraints latent variable (MR2)	0.004	0.004	0.002	0.004*
	(0.004)	(0.004)	(0.005)	(0.002)
Constraints latent variable (MR3)	-0.007	-0.007	0.012	
	(0.020)	(0.020)	(0.024)	
Constraints latent variable (MR4)	-0.018	-0.018	-0.006	
	(0.028)	(0.028)	(0.033)	
No of Association	0.016	0.016	0.009	
	(0.013)	(0.013)	(0.015)	
Num.Obs.	1614	1614	1614	1614
R^2	0.737	0.737		
AIC	-3856.5	-3856.5	7011.3	6875.7
BIC	-3032.4	-3032.4	7900.1	7204.3
Log.Lik.			-3340.660	-3376.838
F				14.936
RMSE	0.07	0.07	1.26	1.40

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.2 Discussion of results

The findings regarding households exposed to security shocks suggests that they are more likely to experience higher levels of deprivation, reflecting the disruptive impact of conflict and insecurity on livelihoods, productive assets, income-generating activities, and access to essential social services which corresponds with the findings by Huluka (2025) and World Bank (2025), also Mitul et. al. (2023). They reiterated that conflict-induced displacement increases MDP, as affected households often lose access to employment opportunities, education, healthcare, and infrastructure. For example, in Ethiopia, 96% of conflict-displaced households were multidimensionally poor compared to 45% of non-displaced households, demonstrating the severe welfare consequences of insecurity and forced displacement (Huluka, 2025). Furthermore, the World Bank reports that fragile and conflict-affected economies have become the global epicenter of poverty and food insecurity, with conflict contributing to declining incomes, weakened institutions, and reduced access to basic services (World Bank, 2025).

Similarly, a lower household income and paltry asset values is correlated with lower MDP, highlighting the importance of wealth accumulation and income stability in mitigating poverty which goes in line with Fan *et al., (*2005) and Wagstaff, 2002. They asserted that asset ownership and income diversification are key pathways out of multidimensional deprivation. These findings also align with global evidence that formal employment and asset accumulation contribute substantially to multidimensional well-being (World Bank, 2022).

The findings on labour market variables (unemployment and underemployment) reinforces the link between labour exclusion and deprivation which is a critical path in tuning up or down the likelihood of MDP. These results are in line Akinyemi *et al., (*2023), also, Fan *et. al.*, 2005; World Bank, 2022 in which they found that job creation and active

labour market policies remain central to poverty reduction strategies. Additionally, the findings by showed how conflict and joblessness exacerbate deprivation thus undermining household resilience and economic stability. The occupation and sectoral effects mirror World Bank (2022) findings that diversification into non-agricultural jobs reduces vulnerability in rural households.

The linkage between education and poverty echoes findings by Ogunniyi *et al., (*2020) and Alkire & Santos (2014, 2010), which show human capital as a pathway out of MDP. Households with higher educational levels (Ahmed, 2018) are less likely to experience multiple deprivations, reflecting the transformative role of human capital (UNDP, 2010, 2019, 2020) in enhancing access to better employment, income, and services (Alkire & Santos, 2014). Sustained investments in education as a structural poverty reduction strategy is the implication of this result.

The findings on energy poverty are consistent with Barnes *et al., (*2011), who linked modern energy access to improvements in health, productivity, and poverty reduction. They highlighted the welfare gains associated with improved energy access, including enhanced health, education, and productivity outcomes. The significance of hybrid energy solutions further suggests that diversified energy systems offer greater resilience and welfare benefits than reliance on a single source (Ogunniyi *et al*., 2020). Furthermore, the link of MDP to healthcare utilization patterns are supported by Wagstaff (2002), who found that poor households often rely on lower-quality facilities which tends to reinforce poverty traps. The infrastructure effect aligns with Fan *et. al*. (2005), who demonstrated that poor road access reduces rural poverty in Sub-Saharan Africa.

3.3 Policy Implications

The results provide robust evidence that MDP is driven by a combination of structural, socio-economic, infrastructural, and security-related factors. Security shocks are among the strongest predictors, underscoring the necessity of integrating sensitive conflict approaches into poverty reduction strategies. Interventions that restore livelihoods and rebuild community resilience in areas affected by conflict can mitigate poverty intensity considerably.

Beyond direct security interventions, structural labour market reform is equally vital to ensuring the sustainability of poverty reduction efforts. The roles of unemployment and underemployment highlight the need for policies that promote job creation, vocational training, and inclusive labour markets. Enhancing employment opportunities, particularly for youth and women, will directly reduce deprivations and promote family cohesion.

Investments in human capital and asset accumulation remain fundamental. Expanding access to quality tertiary education and supporting household asset building can help break intergenerational cycles of poverty. Similarly, housing policies that promote secure tenure and affordable home ownership can strengthen household resilience.

The strong correlation between energy access and poverty reduction, as shown in Table 4, suggests that expanding reliable and clean energy access through grid extension, mini-grids, and incentives for hybrid systems will not only improve welfare but also unlock new economic opportunities. Infrastructure development, particularly road construction, further enhances these gains by connecting households to markets, services, and opportunities.

Finally, the evidence of geographic heterogeneity underscores the importance of spatially differentiated policies. Poverty reduction strategies should be tailored to state- and region-specific contexts, accounting for local drivers, vulnerabilities, and opportunities. To adequately tackle the policy environment regarding MDP architecture, integrated multidimensional strategies are required. Therefore, over a short-term, it is recommended that security-responsive interventions, livelihood restoration, employment programmes, vocational training, asset support, targeting households and states with higher MDP should be implemented. In the medium-term, energy expansion, employment diversification, infrastructure development, affordable housing and land tenure reforms are required, and higher education expansion, structural labour market reforms, human capital development, institutionalized regional poverty reduction policies should be targeted.

4. Conclusion and Recommendations

This study demonstrates that MDP in Nigeria is shaped by a constellation of interlinked factors. Addressing security challenges, expanding employment opportunities, investing in education, improving energy access, and enhancing infrastructure are central to reducing poverty. Interventions informed by local conditions will yield the greatest impact. While the findings provide valuable insights, they should be interpreted in light of certain limitations, including constraints in data availability, potential measurement challenges associated with selected indicators, and the exclusion of some regional, cultural, and institutional variables that were beyond the scope of this study. Future research could address these limitations by incorporating more granular datasets, additional factors, and longitudinal analyses to better capture regional heterogeneity and evolving poverty dynamics. Nevertheless, the findings contribute to the growing evidence base on MDP reduction and provide actionable insights for policymakers committed to fostering inclusive and sustainable development.

Key limitations include potential endogeneity (income and assets may be endogenous to MDP) and contemporaneous measurement of shocks. To strengthen causal inference, future work should use panel data or

instrumental variable approaches and explore lagged shock measures. Additional subgroup (urban/rural, gender, state) and interaction analyses (e.g., education × energy; unemployment × security exposure) would elucidate compounding vulnerabilities and refine targeting.

References:

1. Adam, H., & Osbahr, H. (2019). Factors influencing rural livelihood diversification activities among women in Northern Region of Ghana. International Journal of Agricultural Science, Research and Technology in Extension and Education System, 9(3), 115–123. Retrieved from https://sanad.iau.ir/Journal/ijasrt/Article/1033581
2. Abdu, M., & Delarue, J. (2020). Dynamics of poverty in Nigeria: Evidence from panel data. World Development, 130, 104944. https://doi.org/10.1016/j.worlddev.2020.104944
3. Adeoti, A. I. (2014). Trend and determinants of multidimensional poverty in rural Nigeria. African Journal of Agricultural Research, 9(2), 198–211. https://doi.org/10.5897/AJAR2013.7545
4. Adeoti, A. I., & Oni, O. A. (2019). Multidimensional poverty in rural Nigeria: Insights from demographic and health survey. Journal of Poverty, 23(6), 456–472. https://doi.org/10.1080/10875549.2019.1572157
5. Adewumi, B., & Adebayo, O. (2020). Education and multidimensional poverty reduction in Nigeria. African Development Review, 32(4), 623–638. https://doi.org/10.1111/1467-8268.12467
6. Ahmed, J. (2018). Analysis Gender Role and Factors Affecting Soil and Water Conservation Adoption in Kersa Districts of Eastern Hararghe Zone, Ethiopia: The Case of Fanya Juu, Soil and Stone Bund Measure. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems, 8(1), 49-58.
7. Akinbode, S. O., & Salami, A. (2018). Urban poverty dynamics and livelihood strategies in Nigeria. Social Indicators Research, 137(1), 225–243. https://doi.org/10.1007/s11205-017-1586-7
8. Akinyemi, B. E., Fowowe, B., & Afolabi, A. (2023). Insecurity, unemployment and multidimensional poverty in Nigeria. Journal of African Development, 25(2), 45–63.
9. Akinyemi, J. O., Odimegwu, C. O., & Adebowale, A. S. (2021). Household decision-making and multidimensional poverty among women in Nigeria. Journal of International Women's Studies, 22(5), 120–136.
10. Alkire, S., & Foster, J. (2011). Counting and multidimensional poverty measurement. Journal of Public Economics, 95(7–8), 476–487. https://doi.org/10.1016/j.jpubeco.2010.11.006
11. Alkire, S., & Santos, M. E. (2010). Acute multidimensional poverty: A new index for developing countries. Oxford Poverty & Human Development Initiative Working Paper, 38.
12. Alkire, S., & Santos, M. E. (2014). Measuring acute poverty in the developing world: Robustness and scope of the multidimensional poverty index. World Development, 59, 251–274. https://doi.org/10.1016/j.worlddev.2014.01.026
13. Alkire, S., Roche, J. M., & Seth, S. (2013). Multidimensional poverty index: Robustness and scope. World Development, 59, 251–274. https://doi.org/10.1016/j.worlddev.2013.01.013
14. Barnes, D. F., Khandker, S. R., & Samad, H. A. (2011). Energy access, efficiency, and poverty: How many households are energy poor in Bangladesh? Policy Research Working Paper No. 5332. World Bank. https://doi.org/10.1596/1813-9450-5332
15. Chambers, R., & Conway, G. (1992). Sustainable rural livelihoods: Practical concepts for the 21st century (IDS Discussion Paper No. 296). Institute of Development Studies.
16. Cribari-Neto F. & A. Zeileis. (2010). Beta Regression in R. Journal of Statistical Software 34(2):1-24. doi:10.18637/jss.v034.i02.
17. Etim, N. A., & Odo, E. J. (2022). Determinants of multidimensional poverty among rural households in Nigeria. African Development Review, 34(3), 355–367. https://doi.org/10.1111/1467-8268.12600
18. Fan, S., Nyange, D., & Rao, N. (2005). Public investment and poverty reduction in Tanzania: Evidence from household survey data. Development Policy Review, 23(4), 483–503. https://doi.org/10.1111/j.1467-7679.2005.00293.x
19. Huluka, A. T. (2025). Conflict as a driver of multidimensional poverty in rural and urban areas of the East Wollega Zone of Ethiopia. Discover Global Society, 3(168). https://doi.org/10.1007/s44282-025-00311-4
20. Mitul, S., Huda, F., Asaduzzaman, M. (2023). Understanding Livelihood Status of Fishing Communities to the Impact of Climate Change in The Coastal Areas of Bangladesh. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems, 13(1), 1-9.
21. Mulangu, F., Benlamine, M., Keller, M., & Nganou, J.-P. (2024). Disaggregated impacts of growth on multidimensional poverty: Does the source of growth matter? World Bank Policy Research Working Paper. https://doi.org/10.60572/y30h-qv31
22. National Bureau of Statistics (NBS). (2022). Nigeria Multidimensional Poverty Index (MPI) Report 2022. Abuja: NBS.

23. Nmadu, J. (2025). Multidimensional poverty evaluation at national, sub-national and factor levels. _Dyn4cast: Dynamic Modeling and Machine Learning Environment_. R package version 11.11.26, https://github.com/JobNmadu/Dyn4cast.

24. Nwosu, E., & Ndubueze, P. (2019). Demographic characteristics and multidimensional poverty in Nigeria. Journal of Poverty Studies, 5(2), 88–105.

25. Ogunniyi, A., Olagunju, K. O., Fadare, O., & Adedoyin, R. (2021). Determinants of poverty transitions in rural Nigeria. World Development Perspectives, 22, 100307. https://doi.org/10.1016/j.wdp.2021.100307

26. Ogunniyi, A., Olagunju, K., Kabir, S. K., & Philips, F. (2020). Scaling up agricultural innovation for inclusive livelihood and productivity outcomes in sub-Saharan Africa: The case of Nigeria. Technological Forecasting and Social Change, 161, 120247. https://doi.org/10.1016/j.techfore.2020.120247

27. Osabohien, R., Afolabi, A., & Olanrewaju, G. (2022). Governance, social exclusion and poverty in Sub-Saharan Africa. Development Policy Review, 40(3), e12537. https://doi.org/10.1111/dpr.12537

28. Oyekale, A. S. (2015). Measurement and determinants of multidimensional poverty in rural Nigeria. Journal of Poverty, 19(4), 345–367. https://doi.org/10.1080/10875549.2014.999975

29. Sen, A. (1999). Development as freedom. Oxford University Press.

30. Silver, H. (1994). Social exclusion and social solidarity: Three paradigms. International Labour Review, 133(5–6), 531–578.

31. Silver, H. (2007). The process of social exclusion: The dynamics of an evolving concept. Chronic Poverty Research Centre Working Paper, 95.

32. Streeten, P., Burki, S. J., Haq, M. U., Hicks, N., & Stewart, F. (1981). First things first: Meeting basic human needs in developing countries. Oxford University Press.

33. Townsend, P. (1979). Poverty in the United Kingdom: A survey of household resources and standards of living. Penguin Books.

34. UNDP. (2010). Human Development Report 2010: The real wealth of nations. Palgrave Macmillan.

35. UNDP. (2019). Human Development Report 2019: Beyond income, beyond averages, beyond today. UNDP.

36. UNDP. (2020). Human Development Report 2020: The next frontier—human development and the Anthropocene. New York: UNDP.

37. UNESCO. (2018). Global education monitoring report 2018: Education for sustainable development. Paris: UNESCO.

38. Wagstaff, A. (2002). Poverty and health sector inequalities. Bulletin of the World Health Organization, 80(2), 97–105. https://www.scielosp.org/article/bwho/2002.v80n2/97-105/

39. Wickham, H. (2016). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag, New York.

40. Woldemichael, A., Terefe, D., & colleagues. (2025). Targeting rural poverty: A generalized ordered logit model analysis of multidimensional deprivation in Ethiopia's Bilate River Basin. Economies, 13(7), 181. https://doi.org/10.3390/economies13070181

41. World Bank. (2022). Nigeria poverty assessment 2022: A better future for all Nigerians. Washington, DC: World Bank. https://doi.org/10.1596/978-1-4648-1841-0

42. World Bank. (2025). Fragile and conflict-affected economies have become the epicenter of global poverty and food insecurity. Reported by Reuters, June 27, 2025. https://www.reuters.com/.