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Spatial Analysis of Hotspots and Coldspots of Poverty in Nigeria

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Abstract

The study identified the hotspots and coldspots of poverty as well as the determinants of poverty of each identified group. Data were obtained from National Living Standard Survey and Core Welfare Indicators Questionnaire Survey conducted by National Bureau of Statistics. Spatial econometrics technique was used to analyze data. The result of the analysis identified the hotspots and coldspots of poverty with average poverty rates of 82.6% and 31.8% respectively. The positive significance of spatial dependence of hotspots (ρ = 0.34) and coldspots (ρ = 0.21) indicated that spillover of poverty existed in significant proportion among senatorial districts in the two groups. Percentage of people employed in agriculture, type of soil, annual rainfall, household membership of association and access to credit are found to be important determinants of poverty in hotspots of poverty in Nigeria. Incorporation of poverty spillover when designing poverty alleviation programme, increased productivity of people employed in agriculture and the need to bridge the infrastructural gap between the hotspot and coldspots could play a significant role in reducing poverty incidence significantly in Nigeria.

Keywords

Poverty, Spatial Contiguity, Senatorial District, Spillover of Poverty

1. Introduction

Poverty in Nigeria is particularly worrisome because of the country's available natural and human resources. The World Bank report [1] established that Nigeria with about 170 million population falls among countries with extreme poverty whose over 70% population live on $1.25 (N200) or even less per day. National Bureau of Statistics (NBS) put the poverty rate in Nigeria at 54.4% and 69.0% in 2005 and 2010 respectively, while [2]

and [3] reported 70.2% and 70% respectively. United Nations Habitat [4] put the poverty rate at 76%. With quantum of poor unemployed youth, poverty has been linked with the rising number of youth engaging in social vices such as robbery, 419 activities (including internet fraud), political thugs, campus cultism, drug and human trafficking, militancy and Boko haram insurgence in the northeast which has claimed many lives.

Over the years, a number of Poverty Reduction Strategy (PRS) has been initiated in Nigeria. This includes the recently designed National Economic Empowerment Development Strategies (NEEDS). Also, a special Federal Government institution to alleviate poverty in the country; the National Poverty Eradication Programmes (NAPEP) was created. These previously initiated PRS in the country appear only to have addressed the various manifestations of poverty, such as unemployment, lack of access to credit and functional rural and urban infrastructures, and gender inequality among others. While these PRS were well intentioned, none had any significant, lasting, or sustainable positive effects on the people they were planned for ([3], [5]). This may be attributed among others to the non-consideration of the heterogeneous nature of poverty and spatial contiguity of geographical units in the design of PRSPs. Virtually, all existing poverty studies ([6]-[16]) treated geographic unit, such as a local government area, a state, ora geographical zone, as an independent isolated entity rather than as an entity surrounded by other geographic units with which it interacts. In a village or urban community, many of the households may have similar sources of income, and all households affected by the same agro-climatic and geographic conditions. Households may also have other circumstances in common including road conditions, availability of public facilities such as health, water supply and education. Hence, it is reasonable to suppose that households living in the same area tend to act in similar ways and to influence one another ([17]). The poverty level of a community is not only determined by factors highlighted above but also by conditions in the neighbouring communities. For instance, if the poverty level of a specific geographical entity is low, the neighbouring communities will be affected by the spillover effects of low poverty. The same is also true if an area is prosperous, the spillover effect of the prosperity will lead to a reduction in poverty in the neighbouring areas. According to [18], if this bias (spatial dependence) is ignored, econometric results may be incorrect and produce policy recommendations that are counterproductive. We use spatial data analysis methods in this study to explore the spatial contiguity of senatorial districts based on poverty incidence, and spatial econometric methods to incorporate the spatial bias formally into the econometric models.

The focus of this study is on senatorial districts. In addition to legislative duties, senators also have tasks with the economic development of their respective senatorial district through lobby for sitting capital projects and judicious use of monthly constituency allowance meant for execution of projects that will enhance the well-being of the people. A thorough knowledge of the poverty situation and incidences at the senatorial levels will provide sufficient information to state governors to know how to intervene effectively. Furthermore, each senatorial district, on average is made up of 7 local government areas which also imply that knowledge of poverty situation in the senatorial district can guide local government chairmen and councilors on how to tackle poverty in their domains.

There is scarce information on spatial decomposition and spillover of poverty across the Senatorial Districts (SD) in Nigeria. The objective of the study is to determine the similarity (high-high, low-low) or dissimilarity in poverty incidence across the neighbouring senatorial districts. This will enable a senator to know whether his SD's performance is better or worse than the performance of neighbouring SDs in terms of poverty reduction. The study also identified the determinants of cold (low-low) and hot (high-high) spots of poverty. The paper is divided into four sections; namely introduction, theoretical framework, methodology, results and discussion and conclusion.

2. Theoretical Framework and Previous Literatures

The concepts and assumptions of spatial analysis measure geographic variables that exhibit properties of spatial dependency (the tendency of the same variables measured in locations in close proximity to be related). While traditional statistical techniques have treated this feature as nuisance, spatial statistics considers them explicitly. In the past, models that explicitly incorporated "space" (or geography) were primarily found in specialized fields such as regional science, urban and real estate economics and economic geography (examples are reviews in [19]-[22]). However, spatial econometric methods have increasingly been applied in a wide range of empirical investigations in more traditional fields of economics as well, including, among others, studies in agricultural

and environmental economics ([17] [18] [23]-[30]).

Unlike in the developed countries, there are few literatures on the application of spatial econometrics to poverty studies in sub-Saharan Africa. It is generally new in Nigeria. According to [26], the landscape of poverty is a result of many forces acting independently and in interaction with other social and structural forces to produce a set of opportunities and constraints. These are manifested in the economic realities of wealth and poverty. Poverty is a highly heterogeneous phenomenon showing a wide spatial variability. A large difference in the standard of living of the populations in different geographical locations is common. Spatial heterogeneity between areas can be introduced in a model for a variety of reasons, including differences in agroclimatic conditions, geographic conditions (particularly access to main urban centres and markets), the presence of natural resources (particularly water for irrigation), other non-physical conditions (especially, historical and ethnic) and facets of public policy ([31]).

In a study on poverty and inequality in Vietnam: spatial patterns and geographic determinants, [27] findings revealed that 10 percent point increase in the poverty rate in a district results in 8 percent increase in the poverty rate in a neighbouring district. In a similar study on spatial approach to social and political forces as a determinant of poverty in US, [18] indicate that a 10 percentage point increase in the poverty rate in a county results in a 2% increase in the poverty rate in a neighbouring county. This is strong evidence that spillover effects exist between counties with respect to poverty. Neighbourhood effects on poverty as a result of similarities in socioeconomic and environmental factor are well documented in studies ([32] [33]) carried out in Kenya and Uganda respectively. This finding is corroborated by [24]. They reasoned that poverty of a neighbourhood is tied to the fortunes of neighbouring areas: there are geographic spillovers in poverty reduction. Reducing poverty in particular neighbourhoods affects the poverty of neighbouring tracts. A study on the topography of poverty in US, [26] findings showed that 51.9% of the total counties belong to similar spatial concentration (low-low and high-high), whereas only 7.8% were categorized as being spatial outliers (high-low and low-high).

Writers in the sociological, political science, and regional science literatures point out that certain community attributes are empirical correlates of successful communities ([34]-[40]). These and other studies suggest that many factors influence the level of community and economic development of a place [41]. For example, view poverty as a condition of the local social structure. Numerous studies have found a positive association between economic development and social capital [18]-[42]. investigated the independent effects of social capital on family poverty rate; their result revealed that counties/local government areas rich in social capital have lower family poverty rates.

According to [43], the intrinsic value of education in raising individual capabilities and freedoms and consequently contributing to higher incomes cannot be over-emphasised. It has been severally documented (example is [44]) that labour is the main asset of the poor. One of the important ways of enhancing and preserving this asset is through education. Indeed, the [45] showed that investment in education and other forms of human capital particularly health is an important element of a poverty reduction strategy.

3. Methodology

The study covered the 109 Senatorial Districts (SD) of Nigeria. Each Senatorial district is composed of Federal constituencies (360 Federal constituencies) while Federal constituency is made up of Local Government Areas. **Figure 1** shows the senatorial districts map of Nigeria. The study utilized secondary data obtained from 2006 Core Welfare Indicator Questionnaire Survey (NLSS) and 2003/2004 National Living Standard Survey data by National Bureau of Statistics (NBS). The only NBS data disaggregated into senatorial districts. Other sources were the Nigerian Institute of Meteorological Services (NIMET) for agro-climatic and environmental data and Food and Agricultural Organisation for the fertility soil map of Nigeria.

Although the 2006 Core Welfare Indicator Survey data were collected two years after the National Living Standard Survey (NLSS), the 2004-2006 periods was one of relatively slow growth and low inflation in Nigeria, so it was reasonable to assume that there was relatively insignificant change. Similar studies carried out with lagged data are:

1) [17] in Ecuador combined Census of population and households conducted in 1990 and the World Bank's Living Standard Measurement Surveys (LSMS) conducted in 1995.

2) [32] in Uganda utilized two household data sets collected by the Uganda Bureau of Statistics (UBOS):

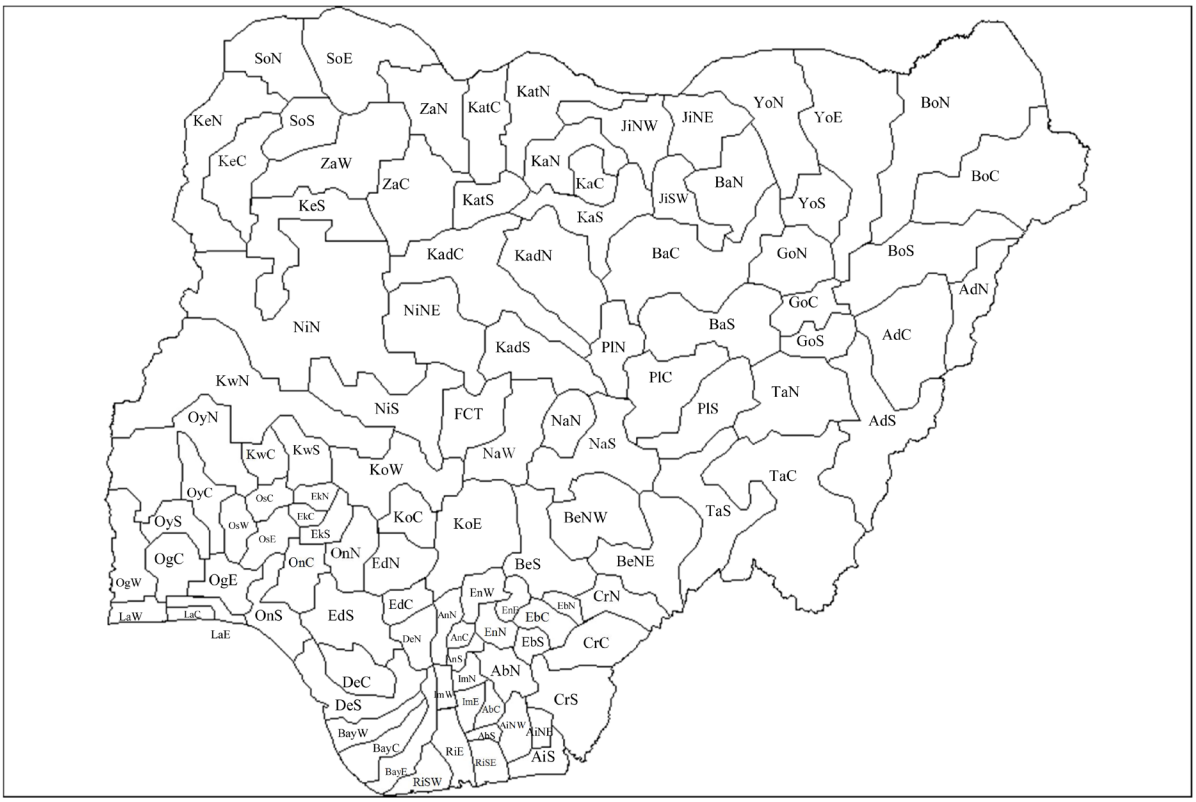

Figure 1. Senatorial district map of Nigeria. Source: adapted from [49]. Note: See the meaning of the abbreviations in **Table 1**.

census data for 1991 and sample survey data from 1992 (IHS) to derive welfare estimates and maps.

3) [18] in the United States of America utilized family poverty rate from the 2000 Census while the explanatory variables were measured in 1990.

The study provided answers to the following research questions, using senatorial district as the reference geographical location:

1) Is the poverty incidence of a senatorial district significantly influenced by poverty incidence of neighbouring senatorial district(s)?

2) What are the factors influencing poverty levels in senatorial districts with similar spatial patterns of poverty?

The detail of the variables (dependent and independent) used in the analysis, the *a priori* expectations and the literatures supporting the *a priori* expectations are presented in **Table 2**.

Soil Classification (SOC)

The soil classification per senatorial district data were obtained from the Food and Agricultural Organization (FAO) soil map of Nigeria based on natural fertility and traditional agricultural practices. FAO classified Nigerian soil into very low productivity, no productivity, high productivity, medium productivity and low productivity. For this study, a dummy variable was used to capture the soil classification. The soil of very low productivity and no productivity were classified as bad soil (bad soil = 0) while soils of high productivity, medium productivity and low productivity were classified as good soil (good soil = 1). Good soil (soils of high productivity, medium productivity and low productivity) was expected to bring about reduction in poverty rate ([32] [33]).

Data were analyzed using descriptive and spatial regression analyses. A diagnostic ordinary least squares regression analysis was carried out by expressing the prevalence of poverty per SD as a function of selected spatial variables. This was to ascertain the presence of spatial dependence. The OLS regression model was estimated as:

Table 1. Senatorial districts codes and meaning of abbreviations.

Senatorial District	ID	Senatorial District	ID	Senatorial District	ID	Senatorial District	ID	Senatorial District	ID
Abia Central	AbC	Borno North	BoN	Gombe South	GoS	Kwara Central	KwC	Oyo North	OyN
Abia North	AbN	Borno South	BoS	Imo East	ImE	Kwara North	KwN	Oyo South	OyS
Abia South	AbS	Cross River Central	CrC	Imo North	ImN	Kwara South	KwS	Plateau Central	PlC
Adamawa Central	AdC	Cross River North	CrN	Imo West	ImW	Lagos central	LaC	Plateau North	PlN
Adamawa North	And	Cross River South	CrS	Jigawa North-east	JiNE	Lagos East	LaE	Plateau South	PlS
Adamawa South	AdS	Delta Central	DeC	Jigawa North-west	JiNW	Lagos West	LaW	Rivers East	RiE
Akwa Ibom North-west	AiNW	Delta North	DeN	Jigawa South-west	JiSW	Nasarawa North	NaN	Rivers South-east	RiSE
Akwa Ibom North-east	AiNE	Delta South	DeS	Kaduna Central	KadC	Nasarawa South	NaS	Rivers South-west	RiSW
Akwa Ibom South	AiS	Ebonyi Central	EbC	Kaduna North	KadN	Nasarawa Central	NaC	Sokoto East	SoE
Anambra Central	AnC	Ebonyi North	EbN	Kaduna South	KadS	Niger East	NiE	Sokoto North	SoN
Anambra North	AnN	Ebonyi South	EbS	Kano Central	KaC	Niger North	NiN	Sokoto South	SoS
Anambra South	AnS	Edo Central	EdC	Kano North	KaN	Niger South	NiS	Taraba Central	TaC
Bauchi Central	BaC	Edo North	EdN	Kano South	KaS	Ogun Central	OgC	Taraba North	TaN
Bauchi North	BaN	Edo South	EdS	Katsina Central	KatC	Ogun East	OgE	Taraba South	TaS
Bauchi South	BaS	Ekiti Central	EkC	Katsina North	KatN	Ogun West	OgW	Yobe East	YoE
Bayelsa Central	BayC	Ekiti North	EkN	Katsina South	KatS	Ondo Central	OnC	Yobe North	YoN
Bayelsa East	BayE	Ekiti South	EkS	Kebbi Cental	KeC	Ondo West	OnW	Yobe South	YoS
Bayelsa West	BayW	Enugu East	EnE	Kebbi North	KeN	Ondo East	OnE	Zamfara Central	ZaC
Benue North-east	BeNE	Enugu North	EnN	Kebbi South	KeS	Osun Central	OsC	Zamfara North	ZaN
Benue North-west	BeNW	Enugu West	EnW	Kogi West	KoW	Osun East	OsE	Zamfara West	ZaW
Benue South	BeS	Gombe Central	GoC	Kogi Central	KoC	Osun West	OsW	FCT	AbJ
Borno Central	BoC	Gombe North	GoN	Kogi East	KoE	Oyo Central	OyC		

$$y_i = \beta_i X_i + \varepsilon_i \tag{1}$$

where:

y_i is a vector average poverty rates;

X_i is a matrix of independent variables,

β_i is a vector of coefficients,

ε is a vector of random errors.

The geo-referenced independent variables data were grouped under demographic, agro-ecological and environmental, infrastructural, sociopolitical and economic characteristics (see **Table 2**). The data under each grouping were based on senatorial district.

Through the diagnostic, the presence of spatial autocorrelation is revealed as well as the cause (spatial lag or spatial error) for necessary correction. Either of the models below corrects the defect (the presence of spatial dependence):

1) Spatial-error model:

$$y = x_i\beta_i + \left(1 - \lambda W_{(e)}\right)^{-1} \varepsilon \tag{2}$$

Table 2. Variables used for empirical analysis (dependent variable: poverty rate).

SN	Explanatory Variables	Symbol	*A Priori* Expectation	Data Source(s)	Literature
1.	***Agro-climatic and Environmental Characteristics* (*GAC*)**				
	▪ Average annual rainfall per senatorial district (mm)	AvRa	-	NIMET & CBN statistical bulletin	[27]
	▪ Percentage of people employed in agriculture	PEA	+/−	CWIS (2006)	[46]-[48]
	▪ International land bordered SD (Yes = 1, No= 0)	ILBSD	-	NBS senatorial District map	[49]
	▪ Coastal bordered SD (Yes = 1, No = 0)	CBSD	-	NBS senatorial District map	[49]
	▪ Soil classification (good soil = 1, bad soil = 0)	SoC	-	FAO soil map (see **Appendix 3**)	[33] [50]
2.	***Demographic Characteristics* (*DEC*)**				
	▪ Male headed household per senatorial district (%)	MaH	+/−	CWIS (2006)	[42] [51]
	▪ Female headed household per ▪ senatorial district (%)	FeH	+/−	CWIS (2006)	[13] [52]
	▪ Average household size per senatorial district	HS	-	CWIS (2006)	[47] [53]
	▪ Literate adult (%)	LA	-	CWIS (2006)	[11] [18]
3.	***Sociopolitical and Economic Characteristics* (*SPC*)**				
	▪ Households membership of association (social capital index)	HMA	-	NLSS (2004)	[9] [18] [24] [54] [55]
	▪ Access to credit facilities (%)	ACF	-	CWIS (2006)	[56]-[58]
4.	***Infrastructural Characteristics* (*INC*)**				
	▪ Access to safe water sources (%) per SD	SwS	-	CWIS (2006)	[49] [59]
	▪ Access to safe sanitation (%) per SD	SaS	-	CWIS (2006)	[49] [60]-[62]
	▪ Access to health facilities (%) per SD	AHF	-	CWIS (2006)	[32] [49]
	▪ Connection to public electricity (%)	Cpelect	-	CWIS (2006)	[60] [61]

Note: Nigerian Institute of Meteorological Services (NIMET), Central Bank of Nigeria (CBN), National Bureau of Statistics (NBS), Core Welfare Indicator Survey Data (CWIS), National Living Standard Survey Data (NLSS) & Food and Agriculture Organization. The detailed information on soil classification is given below.

2) Spatial-lag model:

$$y = \left(1 - \rho W_{(l)}\right)^{-1} x_i \beta_i + \left(1 - \rho W_{(l)}\right)^{-1} \varepsilon \tag{3}$$

where:

y is an $n \times 1$ vector of dependent variable (average poverty rate),

x_i an $n \times k$ matrix of covariates (independent variables),

β_i is the regression coefficient for the independent variables,

ε is a zero-mean error term,

$W_{(l)}$ and $W_{(e)}$ are $n \times n$ spatial lag and error weights matrices, respectively.

$\{\rho, \lambda\}$ the associated scalar spatial parameters (measures the extent of spillover).

Following [18] [26]-[29] [63], we calculated local Moran's I and obtain Local Indicator of Spatial Association (LISA) map (this identifies the hotspots and coldspots of poverty).

4. Results and Discussion

4.1. Exploratory Spatial Data Analysis

The average poverty rates in coldspots (low-low) of poverty were 31.81per cent while the average poverty rate was 82.6 per cent (see **Appendix 1** and **Appendix 2**). The minimum and maximum poverty rates in coldspots were 17.2 per cent and 49.6 per cent for Oyo central and Delta south respectively; while in the hotspots of poverty, the maximum and minimum poverty rates were 58.2 per cent and 97.7 per centfor Sokoto north and Jigawa north-east respectively. The result showed that few SDs in the coldspots of poverty (low-low) have poverty rate higher than the average poverty rate. Conversely, most SDs in the hotspots (high-high) have their poverty rates higher than the average poverty rate (see **Appendix 1** and **Appendix 2**).

Moreover, the result of the analysis revealed that there was positive spatial autocorrelation (0.665) in poverty incidence across Nigeria (see **Figure 2**). The diagnostics test confirmed the presence of spatial dependence insignificant proportion ($p < 0.001$). **Figure 2** shows the Moran scatter plot of poverty rates for the senatorial districts in Nigeria. The figure shows that most senatorial districts are found in the high-high (47) and low-low (43) neighbourhoods in the country.

Apart from affirming the significant presence of spatial dependence, the test also identified the type of spatial dependence responsible, (see also [62] [64]) (see **Appendix 3**). From this result, it means that poverty incidence in one SD is not only influenced by factors within a SD but also by the poverty incidence of the neighbouring SDs. This may be attributed to significant spillover of poverty among contiguous SDs. Hence, it is imperative that spatial dimension is considered as one of the important factors influencing poverty. According to [18], studies that ignore spatial autocorrelation (dependence) can produce biased results (coefficient estimates) and lead to ineffective and possibly counterproductive-recommendations for policies targeted at poverty alleviation.

Moreover, the result obtained from Local Indicator of Spatial Association (LISA) identified the hotspots (high-high) and coldspots (low-low) of poverty in Nigeria. **Table 3** shows that out of 90 senatorial districts that have similar spatial pattern of poverty incidence (high-high and low-low), 51 SDs have similar spatial patterns that are statistically significant. LISA indices ($p < 0.05$). The hotspots (high-high SDs) constitute the senatorial districts with high poverty incidence as well as their neighbours. The red colour in **Figure 3** shows the high poverty rate SDs that are bordered by high poverty SDs (hotspots). These SDs are found in the northern part of the country. The dark-blue colour shows the low poverty rate SDs that are neighboured by low poverty rate SDs (coldspots). The light-blue colour depicts low poverty rates SDs that are bordered by high poverty rate SDs (low-high). Out of 19 outlier (dissimilar patterns: high-low and low-high), 4 SDs have significant LISA indices ($p < 0.05$). The part of **Figure 3** with white colour shows the SDs that their LISA indices are not statistically significant ($p > 0.05$).

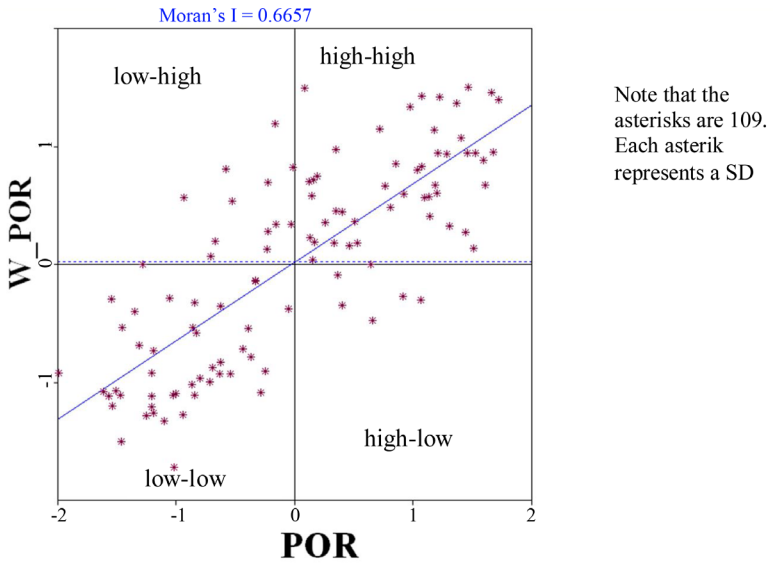

Figure 2. Scatter plot of poverty incidence for 109 SDs.

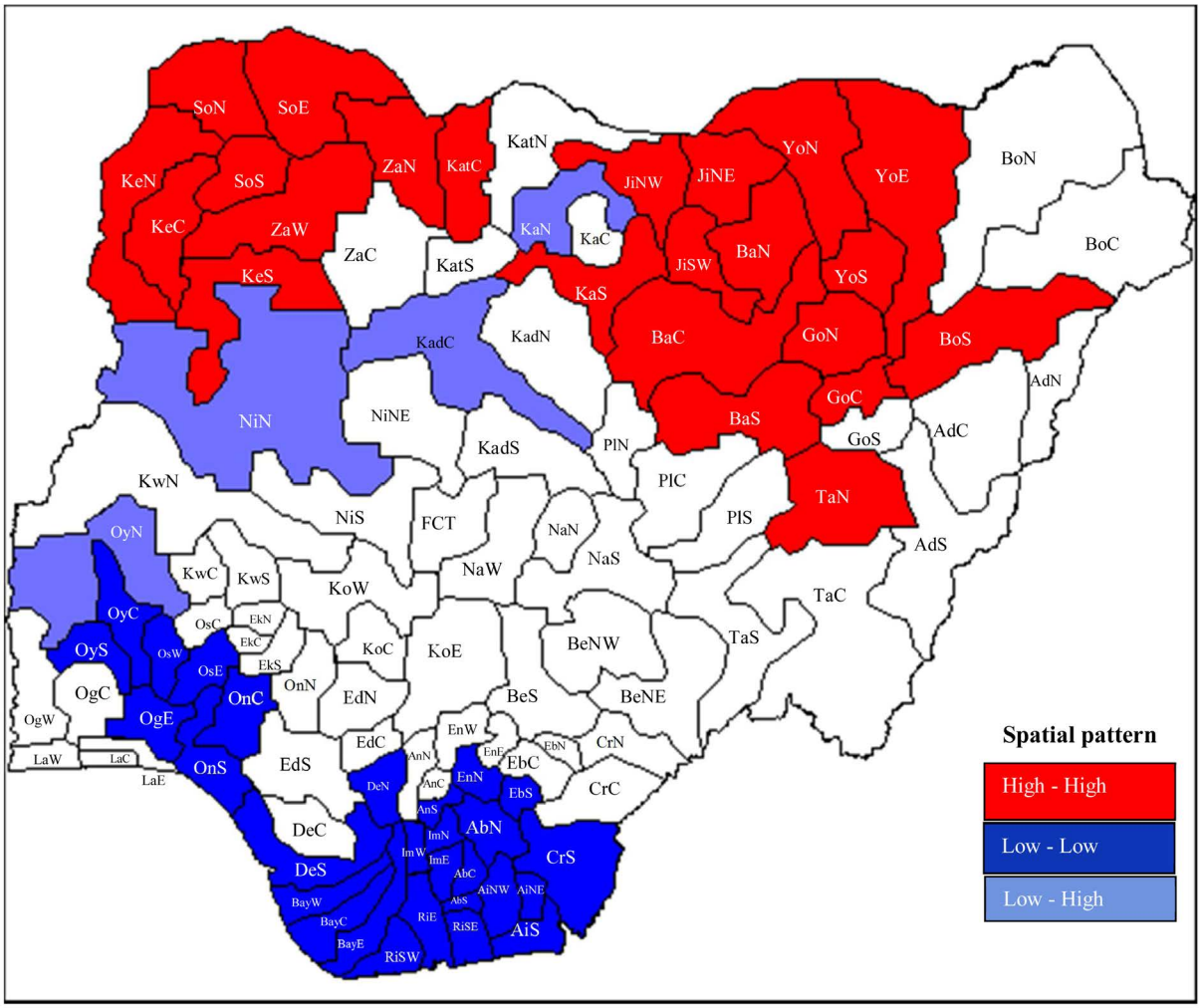

Figure 3. LISA map for significant spatial pattern (coloured) of poverty incidence.

Table 3. LISA groupings of senatorial districts.

LISA Grouping	Total	Sig. (at most 0.05)	Not Sig.
Low-Low	43	28 (65%)	15
High-High	47	23 (49%)	24
Low-High	13	4	9
High-Low	6	NA	6

Source: the results of data analyses (2010). NA means Not Available.

The choice of spatial-lag model for estimating the determinants of hotspots and cold spots of poverty was based on the significance of robust Lagrange Multiplier (lag) (see **Appendix 3**).

4.2. Determinants of Hotspots (High-High) and Coldspots (Low-Low) of Poverty

The spatial-lag estimation for hotspots and coldspots of poverty is shown in **Table 4**. From the result, the spatial autocorrelation coefficient (*rho*) for hotspots and coldspots of poverty are 0.34 and 0.21 respectively. This means that 10% decrease (increase) in poverty rate of SDs in the hotspotsis expected to bring about 3.4% decrease (increases) in the poverty rate of the neighbouring SDs. While in coldspots of poverty, 10% decrease (increase) in poverty rate in SDs is expected to bring about 2.1% decreases (increase) in the poverty rates of the

Table 4. Determinants of poverty incidence in coldspots and hotspots SDs using spatial-lag techniques.

Variables Agro-ecological and environmental characteristics	Spatial-lag model-maximum likelihood estimation (coldspots)	Spatial-lag model-maximum likelihood estimation (hotspots)
People employed in agriculture (PEA)	0.2653*** (0.0870)	0.3521*** (0.0525)
Average annual rainfall (AVRA)	−0.0151*** (0.0039)	−0.0175*** (0.0071)
Soil classification (SOC)	1.2311 ns (4.17198)	−5.20147*** (1.48753)
Coastal bordered or international land bordered senatorial districts (CBSD/ILBSD)	−15.7029*** (4.9570)	−13.3856*** (2.9374)
Demographic characteristics		
Female headed households (FEH)	−1.0374*** (0.2074)	−0.2028*** (0.0176)
Male headed households (MAH)	0.7734*** (0.2231)	0.3851*** (0.0495)
Literate adult (LA)	−0.3143* (0.1863)	−1.1444*** (0.1102)
Household size (HS)	3.8706** (1.7456)	5.4767*** (3.8574)
Infrastructural characteristics		
Connection to public electricity (CPELECT)	0.1391** (0.0644)	−0.2683ns (0.1955)
Access to safe sanitation (SAS)	−0.09585* (0.0516)	−0.4082*** (0.0367)
Access to safe water source (SWS)	−0.1364* (0.0728)	−0.3325*** (0.0300)
Access to health facility (AHF)	−0.3441*** (0.1081)	−0.2740*** (0.0827)
Sociopolitical and economic characteristics		
Household membership of association (HMA)	−1.3944** (0.3418)	−0.8860*** (0.1679)
Access to credit facility (ACF)	−0.5731*** (0.2664)	−0.8510*** (0.1855)
Constant	225.833*** (34.4887)	228.5118*** (42.5780)
Pseudo R^2	0.8765	0.8944
Lag parameter (rho)	0.2114	0.3420
Log likelihood	−72.7904	−30.9423
Akaike info criterion	189.581	105.885
Schwarz criterion	218.889	130.866

Note that each variable under spatial lag and spatial error contains the reported coefficient estimates, the corresponding parentheses contain estimated standard errors; its hypothesis tests assume asymptotic normality of calculated *t*-statistics. Source: The results of data analyses (2010). Note: ***p-value < 0.01, **p-value < 0.05, *p-value < 0.10, ns means not significant.

neighbouring SDs.

The result from **Table 4** shows that the coefficients of number of people employed in agriculture and household size are significant and positively influenced poverty incidence in coldspots and hotspots of poverty. Spe-

cifically, the positive causal relationship between number of people employed in agriculture and poverty incidence is in agreement with [5] who noted that the high percentages of people employed in agriculture do not translate to a reduction in poverty incidence; rather, farming is seen as a harbinger of poverty for most of the participants, particularly the small-scale farmers who barely make enough income to cater for their daily needs. This assertion was corroborated by [65] that more than 80 percent of output growth since 1980 has come from the expansion of cropped areas, rather than from greater productivity of areas already cultivated. This means that poverty reduction in Nigeria most especially in the hotspots of poverty goes beyond increasing the number of people employed in agriculture. The need for increased productivity of farmers through improved technology, provision of basic infrastructure and investment in human capital is imperative. Moreover, the positive coefficient of household size agrees with [47] [53] [62] that larger households tend to be poorer, particularly those with many young children. Overall, each additional child under six years old lowers total consumption by 23% (higher in rural areas than urban); each additional member from age 7 - 24 lowers total consumption by 17%. The high-high poverty SDs is characterized by high household size (7.6) which is higher than the national average household size (5.0). The magnitude of this value suggests that increased awareness and use of family planning methods could have a significant effect on poverty reduction.

However, the coefficient of access to health facilities, sanitation and safe water sources are significant and negatively influenced poverty incidence in coldspots and hotspots of poverty. These results showed that households having access to safe sanitation, safe water sources and health facilities are less likely to be poor. These findings agree with [52] that the slower growth in Nigeria; most especially the northern zone of may not be unconnected with long-standing lags in provision of health, education and other social services which resulted in proportionately more poor in the north.

Furthermore, the coefficient of the average annual rainfall is also negative and significant with different magnitudes in coldspots and hotspots of poverty. However, coefficient of soil classification is significant in only hotspots of poverty. Rain as a source of water is required for farming activities, household uses and replenishment of water in dams for irrigation of crops and fish-rearing during the dry season. Since agriculture is the main source of livelihood in rural areas in Nigeria, the importance of irrigation farming in high-high senatorial districts cannot be overemphasized because of the short rainy season. It is expected that with good soil management practices, appropriate technology and availability of water through irrigation; farmers (most especially in hotspots of poverty) will be able to produce all year round. According to [66], irrigation benefits the poor though higher production, higher yields, lower risk of crop failure, and higher and year-round farm and nonfarm employment. Irrigation enables smallholders to adopt more diversified cropping patterns, and to switch from low-value subsistence production to high-value market-oriented production.

The result also shows that households' access to credit and membership of association have negative relationship with poverty incidence in coldspots and hotspots of poverty. This finding agrees with [40] [41] [67] that social capital has a significant positive effect on the rate of per capita income growth which is a precursor to reduction in poverty incidence. Average household membership of associations in hotspots of poverty was 67.6% compared to 94.3% in coldspots of poverty (see **Appendix 1** and **Appendix 2**).

Furthermore, the result supports the initial postulate that as the percentage of household access to credit facilities increases, poverty rate is likely to reduce; all things being equal. The study reveals a small access to credit among households in hotspots of poverty (6.79%) compared to 12.03% in coldspots of poverty (see **Appendix 1** and **Appendix 2**). According to [56]; unless the poor can borrow, they are likely to remain trapped in poverty. Access to micro-credit is a compelling anti-poverty and development strategy because of its ability to stimulate savings and promote asset accumulation among the poor people.

With the average poverty rate of 82.6% in hotspots of poverty, a consistent reduction in poverty based on the aforementioned significant factors will go a long way in reducing the national average poverty rate in Nigeria.

5. Conclusions and Recommendation

The study examined the determinant of hotspots and coldspots of poverty in Nigeria using spatial econometrics technique. The study revealed that the individual geographic units that made up the country were not independent and isolated entities; but individual entity was surrounded by other geographical units which interacted significantly with one another. The result affirmed that spillover of poverty from one senatorial district to the other was present in significant proportion. The study also identified the senatorial districts with low-low and

high-high poverty incidence. People employed in agriculture and household size have positive influence on poverty incidence while annual rainfall, literate adult and households' access to basic infrastructure have negative influence on poverty incidence in coldspots and hotspots of poverty

Based on the findings of this study, it is recommended that possible spillover of poverty from neighbouring geographical area should be incorporated while designing poverty reduction programmes. The need for increased productivity of farmers through adoption and availability of modern farm inputs rather than increase in the number of farmers is recommended by the study. This will not only bring about genuine contribution of agriculture to country's GDP but also the increase. General increase in the accessibility of populace to basic infrastructure (safe water, public electricity and health) and education by government, most especially in the high-high senatorial districts is important in order to achieve a sustainable poverty reduction in Nigeria.

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Appendices

Appendix 1: Descriptive Analysis Result for Low-Low Senatorial Districts

Variable	N	Range	Minimum	Maximum	Sum	Mean		Std. deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. error	Statistic
Coastal bordered Senatorial districts	28	1	0	1	9	0.32	8.99E−02	0.48
Poverty rate	28	32	17.2	49.2	890.8	31.814	1.717	9.083
Safe water source	28	84.8	10.7	95.5	1392.5	49.732	3.942	20.858
Household access to health facilities	28	73.6	12	85.6	1294.6	46.236	3.709	19.625
Male headed household	28	50.8	41.7	92.5	1870.7	66.811	2.547	13.48
Female headed household	28	53.4	42.3	95.7	2016.1	72.004	2.768	14.645
Household connection to public electricity	28	63	28	91	1743	62.26	3.01	15.93
SAS	28	89.4	2.9	92.3	1305.9	46.639	5.146	27.228
AVRA	28	1774	1315	3089	55,099	1967.82	102.62	543.02
HMA	28	19.5	80.5	100	2639	94.25	1.048	5.547
LOGS	28	143	200	343	7471	266.84	8.93	47.23
ACF	28	29.5	1.7	31.2	339.4	12.121	1.41	7.463
Soil fertility classification	28	1	0	1	14	0.5	9.62E−02	0.51
People employed in agriculture	28	64.8	10.4	75.2	1220.1	43.575	2.7	14.287
Household size	28	2.8	4	6.8	154.1	5.504	0.166	0.879
Literate adult	28	36	50.2	86.2	2039.1	72.825	1.563	8.273

Appendix 2: Descriptive Analysis Result for High-High Senatorial Districts

	N	Range	Minimum	Maximum	Sum	Mean		Std. deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. error	Statistic	Statistic	Std. error
PCOM	23	106,274	4969.67	111243.67	1436402.37	62452.28	6543.16	31379.90	−0.387	0.481
SDIC	23	1	0	1	9	0.39	0.1	0.5	0.477	0.481
LLSD	23	1	0	1	13	0.57	0.11	0.51	−0.282	0.481
ILBSD	23	1	0	1	10	0.43	1.10E−01	0.51	0.282	0.481
POR	23	39.5	58.2	97.7	1899.8	82.6	2.557	12.263	−0.885	0.481
SWS	23	69.4	12.1	81.5	951.2	41.357	3.856	18.493	−0.006	0.481
AHF	23	37.6	27.9	65.5	1080.8	46.991	2.217	10.63	−0.025	0.481
MAH	23	72.8	18.6	91.4	1325.1	57.613	4.411	21.153	−0.337	0.481
FEH	23	00:00.0	0	100	1244.8	54.122	6.01	28.824	−0.152	0.481
CPELECT	23	33.4	12.7	46.1	654.5	28.457	2.443	11.715	0.206	0.481
SAS	23	90.9	0.2	91.1	876	38.087	5.389	25.846	−0.027	0.481
AVRA	23	576	345	921	16,369	711.7	31.73	152.17	−0.672	0.481
HMA	23	43	53	95	1556	67.63	2.82	13.54	0.999	0.481
LOGS	23	108	92	200	2676	116.35	4.92	23.58	2.082	0.481
ACF	23	26.5	1.3	27.8	156.2	6.791	1.326	6.358	2.259	0.481
SOC	23	1	0	1	16	0.7	9.81E−02	0.47	−0.911	0.481
PEA	23	42.5	22	64.5	976.1	42.439	2.272	10.894	0.21	0.481
HS	23	4.6	5.3	9.9	174.5	7.587	2.49E−01	1.194	0.312	0.481
LA	23	29.3	9.2	38.5	400.8	17.426	1.704	8.173	1.327	0.481

Source: the results of data analyses (2010).

Appendix 3: Diagnostics for Spatial Dependence

Test	MI/DF	Value	Prob
Moran's I (error)	0.128670	3.3520293	0.0008023
Lagrange multiplier (lag)	1	14.056404	0.0001774
Robust LM (lag)	1	9.8452994	0.0017027
Lagrange multiplier (error)	1	4.2297725	0.0397208
Robust LM (error)	1	0.0186675	0.8913241