AN EXPLORATORY SPATIAL ANALYSIS OF HOUSEHOLD SIZE FROM 2006 TO 2010 IN NIGERIA

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ABSTRACT
Large household size of more than 5 persons per household (POPFACT, 2017) can hinder the attainment of Sustainable Development Goals (SDGs) by creating an unnecessary burden on family and the nation. Existing studies on household size have focused more on its consequences with limited attention to its pattern and causes. In addition, the smaller spatial units have mostly been the focus of such analysis and where a national data was used, the set of predictors often identified were assumed to explain the variations in household size across the component units. Due to differences in socioeconomic characteristics of residents and government policies, one expects differential predictors of household size in a multi-ethnic and multicultural country like Nigeria. Using the 2011 household survey data from the National Demographic and Health Surveys (NDHS, 2011), Moran-I, spatial regression, and Pearson Product Moment Correlation were used to analyse the spatial dependency in household size with a view to identifying its spatiotemporal correlates and predictors. The Moran-I showed that states that are contiguous have similar or near similar household sizes. Polygamy ($r = 0.723$, $P<0.05$), food poverty ($r = 0.478$, $P<0.05$), absolute poverty ($r = 0.506$, $P<0.05$) and a dollar-per-day poverty ($r = 0.503$, $P<0.05$) had a positive relationship with household size. Conversely, percentage of people using family planning ($r = -0.687$, $P<0.05$), unemployment ($r = -0.434$, $P<0.05$), percentage of the literate ($r = -0.537$, $P<0.05$), and number of higher institutions ($r = -0.558$, $P<0.05$) had negative significant relationship with household size. Improved use of family planning, access to education and encouraging monogamy will help in reducing large family size in Nigeria.

1.0 INTRODUCTION
Attainment of the Millennium Development Goals (MDGs) by countries would require addressing the persistently large family size commonly found in some developing countries like Nigeria. Large family size has been attributed to a number of socio-economic and cultural factors that work either singly or in unison (Isiugo-Abanihe, 1994; Ajao *et al.,* 2011; Miller *et al*., 2011; Peichl *et al.,* 2012). Despite the rural-urban differentials in household size, there are similarities in some of the factors that precipitate large family size. Understanding the determinants of household size is particularly important in Nigeria because of the relatively higher household size, which most of the times is fuelled by a large number of children (Isiugo-Abanihe, 1994). A close relationship has been found between large household size and poverty (Peichl *et al.,* 2012; Anyanwu, 2014), water consumption (Chang 2008; Chang *et al.,* 2010; Arbués *et al.,* 2010; Mansur and Olmstead, 2012), food security (Ajao *et al.,* 2011; Miller *et al.,* 2011; Anyanwu, 2014) and household budget (Okunade *et al.,* 2010; Dunbar *et al.,* 2013). The multiplicity of factors accounting for large household size across different geographies over time is an indication of the need for studies that examine the roles of space and time on household size dynamics. Therefore, addressing the persistently high household size would require an understanding of the spatio-temporal trend in household size and their determinants. Nigeria's population was estimated at 54 million in 1963; it increased to 88 million in 1991, and to 133 million in 2010. It was estimated that the country's population would be around 178 million by 2015 (Owuamanam and Alowolodu, 2010). There have been various initiatives to address the persistently high household size in Nigeria. However, many of them have yielded little or no results because most of the policies are applied without incorporating the peculiarities of each state in terms of socio-economic and cultural dynamics.

Numerous factors contribute to the inherently large household size. These may be broadly grouped into economic, sociological, geographical, cultural and psychological factors. Previously identified predictors of large household size include women's age, husband's education, women currently not working, lack of consensus between husband and wife on the number of children, son preference, high fertility intention, contraceptive knowledge, contraceptive use and child mortality (Isiugo-Abanihe, 1994; Kamal and Pervaiz, 2011; Ajao *et al.,* 2011; Miller *et al.,* 2011; Peichl *et al.,* 2012). In addition, factors such as family background and income have also been identified as parts of the reasons for large family size (Owuamanam and Alowolodu, 2010). The higher the level of education of women is, the lower their family size will be, owing to the demand for workplaces.

Also, unemployed and underemployed women have large family sizes because of the less demand placed on their time (Cleland *et al.,* 1996; Jejeebhoy 1996; Wusu 2012). Thus, having more children may be a compensating factor for not working. Therefore, raising children may be viewed as a form of work with futuristic payment. An inverse relationship exists between family size and spouse education. Duration of marriage, the ideal number of children, age of women at last delivery, number of rooms and the crowding index have also been found to significantly affect family size (Hamadeh *et al.,* 2008; Wusu 2012). Similarly, male education, age at marriage, monogamy, inter-spousal communication and intention not to rely on children for old-age support have been identified as a significant motivational factor for smaller family size (Isiugo-Abanihe, 1994). Household size can also be positively related to the level of fertility and the mean age at marriage, and inversely associated with the level of marital disruption (Bongaarts, 2001). Economists have argued that rather than the absolute value placed on children, it is the relative value placed on children compared to other consumption-related activities that often determine the number of children in any family (Easterlin, 1978). In this regard, households seek to derive maximum benefits from the number of children they have. However, the demand for children may vary across cultures and geographical regions, as a result of available budget and difference in their preference for large household size (Easterlin, 1978).

Studies have shown that there are relationships between individuals' family size preferences and socio-demographic characteristics, such as attitudes, and values (Ezeh *et al.,* 1996; Hayford and Morgan, 2008). The number of surviving children could also be one of the most important predictors of the desired family size (McCarthy and Oni, 1987). Fuster (1986) observes that, while infant mortality explains most fertility variations, early marriage and first maternity often lead to increased family size. In addition, there is a linkage between the number of children and marital satisfaction even when compared to other variables, like wealth and education. However, this result is significantly different from what obtains in Western countries (Onyishi *et al.,* 2012). Men also gain socially and economically from having a large family size (Isiugo-Abanihe, 1994). Bankole *et al*. (1996) aver that women who are exposed to media messages are more likely to desire fewer children than those who are not exposed to such messages and that exposure to mass media messages is a significant predictor of contraceptive use. Large family size has also been linked with poverty, as poor people tend to have large family size (Owuamanam and Alowolodu, 2010).

Sample surveys of the population are usually employed in the identification of the predictors of large family size (Isiugo-Abanihe, 1994). Although, McClelland (1983) noted that most existing studies on household size are beset with the problem of small sample sizes. On the contrary, this study used a nationally available household survey data of thirty-six states in Nigeria to understand the pattern and predictors of large household size. Earlier studies were based on household survey or geographically aggregated data which do not give a national picture of the spatial complexity and trends in household size. Log-log Regression Model (Kamal and Pervaiz, 2011) and multiple stepwise regression analysis (Hamadeh *et al.,* 2008) have been used to identify the predictors of high family size. The results from such analysis tend to identify some generic factors that do not take cognisance of spatial variations in the geographic entity that constituted the study area. This study employed the Exploratory Spatial Data Analysis (ESDA) technique to investigate the spatio-temporal trend, as well as correlates and predictors of household size across states in Nigeria. Identifying patterns and factors affecting household size would assist in crafting policies aimed at addressing persistently large household size in the country.

2.0 METHODOLOGY

A household is defined as either a person or group of persons living together and maintaining unique eating arrangement (NBS, 2012). The data used in the analysis of the spatio-temporal trend in household size were obtained from Nigeria's National Bureau of Statistics, 2012. The report is a comprehensive compilation of socio-economic and allied data at the state level in Nigeria. The themes covered in the report include education, health, housing conditions, households, employment, public safety (road accidents and crime), population/vital registration, the legislature and communication, transportation, energy, as well as religion. The survey and sample design from which most of the data were collected emanated from the concerted efforts of the following departments of the Bureau: Demography and Social Statistics, Real Sector and Household Statistics, as well as Field Services and Methodology Departments. The data were aggregated to the state level data. The reported household size between 2006 and 2010 in each state was obtained from the NBS report. A number of previously identified variables that are most likely to affect household size such as data on marital status, types of building, percentage of the population using family planning, percentage of the population not employed, percentage of the population that are over 15 years who are literate, percentage of the state population that falls within the three poverty categories, namely food poverty, absolute poverty, dollar-per-day poverty, access to media and number of higher institutions were considered.

The relationships between household size and the selected explanatory variables were explored using the Pearson correlation. The observed correlation coefficients were a measure of the strength of the relationship between family size and those variables. It must be stated that correlation here does not imply causality. We analysed the relationship between household size and each of the variables to determine the direction and magnitude of correlation. Only those variables that are strongly associated with household size at $p \leq 0.05$ significant level were integrated into the regression models. Three regression models were explored in the identification of important predictors of household size: Ordinary Least Square (OLS) regression, Spatial Lag Regression Model (SLM) and Spatial Error Regression Model (SEM). The incorporation of the SLM and SEM was meant to address the challenge of spatial autocorrelation inherent in the household size data.

The independent variables together with household size (dependent variable) were used to develop multiple regression models. Ordinary Least Square (OLS) regression was first used to identify important predictors of household size from among the variables that showed a strong association with household size. The stepwise regression option of the OLS was used to select independent variables that were significant and which minimised redundancy in the model. Finally, SEM and SLM regressions were used to correct spatial bias in estimated household size. Compared to OLS regression models, spatial regression incorporates spatial dependency in the form of lag and error dependence (Ward and Gleditsch, 2008). In spatial error models, the error terms across different spatial units are correlated; while in spatial lag models, the dependent variable is affected by the independent variable in the adjacent neighbourhood (Chang *et al.,* 2010).

Both SLM and SEM remove any bias or trends in spatially dependent data, such as that of household data, as evident from the Moran-I. If there is no spatial correlation between the errors for connected observations *i* and *j*, the spatial error parameter λ will be *0*, and the model becomes a standard linear regression model where the individual observations are independent of one another. However, if the spatial error parameter $\lambda \neq 0$, then there is a pattern of spatial dependence between the errors for connected observations. The spatial error model was used to correct for the positive spatial correlation in household size and other independent variables. This correction reduced the estimated coefficient for the impact of household size. However, the spatial error estimates assume a model where the only spatial dependence between observations stems from the errors or excluded factors, not in the systematic component of the model. The comparison between OLS, SEM and SLM provided the basis for selecting a model that best predicts household size more accurately than others. Spatial autocorrelation and regression were performed using *GeoDa* software available at https://www.geoda.uiuc.edu/ (Anselin *et al.,* 2006).

One of the most widely used indices of spatial autocorrelation is Moran-I, a global measure of spatial autocorrelation. Moran-I index was used to develop a global estimate of autocorrelation in the household data, while Getis & Ord measure of Local Indicator of Spatial Autocorrelation (LISA) was used to estimate spatial dependency in household size among states over time. Given a set of features and associated attribute, it evaluates whether the pattern expressed is clustered, dispersed, or random. The z-score and p-value are used to evaluate the significance of the index. The p-value is a numerical approximation of the area under the curve for a known distribution, limited by the test statistics. Near things are expected to be more similar than distant things. Thus, the observed household size in neighbouring states is expected to be more similar than household size from distant states (Tobler, 1970). If space is of less importance, the distribution ordinarily is expected to assume a normal curve distribution function, however, the influence of space and humans often alter the expected randomness to either cluster or a regular pattern of distribution. When the distribution of objects and phenomena assume a clustered pattern, and near things become more similar than distant things, then we assume that such phenomena are spatially dependent (Keitt *et al.*, 2002).

The Moran-I provide information on the direction and strength of spatial autocorrelation in the dependent variable. We hypothesized that there is a spatial dependency in household size in Nigeria. Thus, adjacent states tend to exhibit similar family size pattern compared to distant states. The analysis of spatial dependency in family size was accomplished using Moran-I. For the Global Moran-I statistic, the null hypothesis states that the attribute being analysed is randomly distributed and, thus, the spatial processes promoting the observed pattern of values are random. The range of Moran's-I is between -1 and 1. A high positive value indicates a tendency towards clustering and the closer the value is to 1 the smaller the spatial differences in the values being measured. On the other hand, the low negative Moran's-I indicates a tendency toward disaggregation into smaller components. In addition, Moran's-I that is equal to zero implies that no spatial autocorrelation exists (Wang *et al.*, 2012). It should, however, be noted that, whereas Moran's-I is useful in detecting global spatial correlation, it does not show where high or low household sizes are clustered or dispersed among the states in Nigeria.

Local Index of Spatial Autocorrelation (LISA) analysis was used to calculate spatial autocorrelation value for each state by examining the extent to which a household size resembles its neighbouring groups. This provides an evaluation of where unusual interactions occur, isolating either "hot" spots (areas of high local autocorrelation) or "cold" spots (areas of low local autocorrelation) (Anselin, 1995). This technique provides additional information on the pattern of household size distribution. The hotspot analysis was based on the *Getis-Ord Gi** statistic. The resultant z-scores and p-values show where features with either high or low values cluster spatially. To be a statistically significant hot spot, a feature will have a high value and be surrounded by other features with high values as well. When the local sum is very different from the expected local sum, and when that difference is too large to be the result of random chance, a statistically significant z-score results. For statistically significant positive z-scores, the larger the z-score is, the more intense is the clustering of high values (hot spot).

3.0 RESULTS AND DISCUSSIONS

3.1 Change in Household Size in Nigeria between 2006 and 2010

Bongaarts (2001) notes that average household size varies only modestly among regions in developing countries, ranging between 4.8 and 5.6. However, the average household size in Nigeria in 2006 was 4.7. Ogun State had the lowest household size (2.6), while Kano State (6.6) had the highest household size. Seventeen out of thirty-six States had a household size in excess of the national average. Most states with the lowest household size were in the southwestern part, while those with the highest household size were located in the northcentral part of Nigeria. However, with the exception of Rivers State, all the states with more than the national average of family size were in the northern part of the country, while those with figures below the national average were in the southern part of the country, with the exception of FCT and Kogi State.

In 2007, the average household size reduced to 4.6. Ogun State still had the lowest household size (3.0), although with a slight increase of 15.4% compared to the previous year. Bauchi State had the highest household size of 7.9. The increase in household size in Bauchi between 2006 and 2007 was 36.2%, whereas the increase in household size for Kano was 3.1% within the same period. It is understandable that Kano had a higher household size because the state often reports the highest population figure compared to other states in Nigeria. The highest household size reported for Bauchi is quite surprising, as the state is typically not among states with higher population figure in Nigeria. Sixteen states had a household size in excess of the national average, while others had figures below the national average in 2007. Between 2006 and 2007, Bauchi (36.2%), Delta (28.1%), Ebonyi (22.0%) and Borno (19.6%) States had the highest percentage increase in household size, while the highest reductions were in states such as Nassarawa (-42.9%), Rivers (-24.5%), Bayelsa (-23.3%), and Oyo State (-16.3%). The household size in Yobe State remained unchanged in the two periods under consideration (Figure 2A).

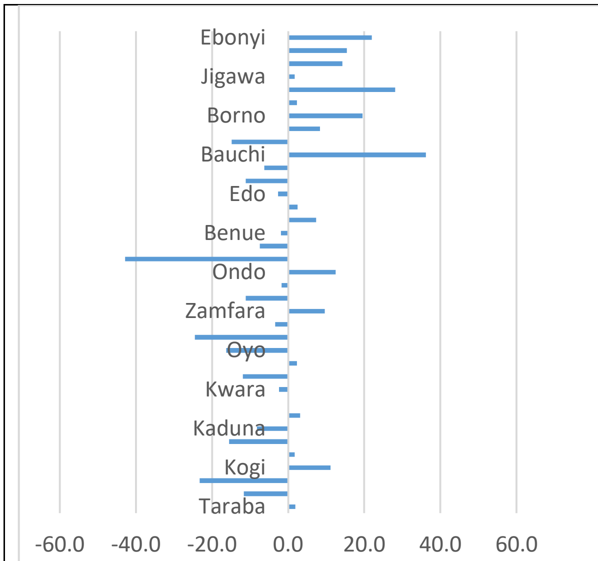

Figure 2A: Change in Household Size between 2006 and 2007

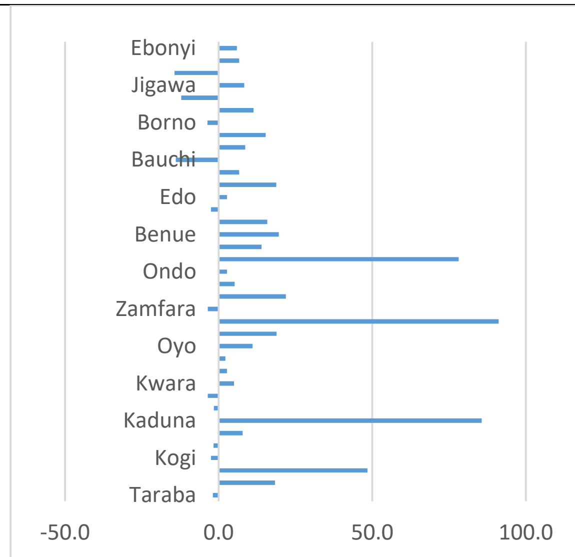

Figure 2B: Change in Household Size between 2007 and 2008

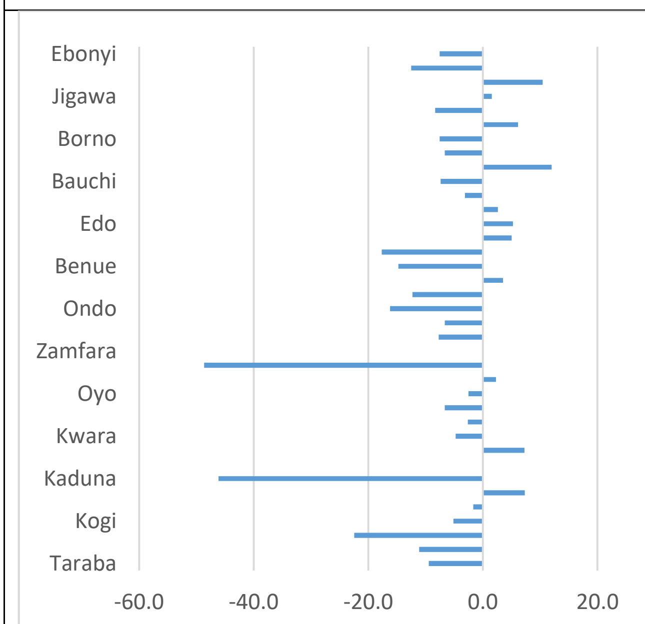

Figure 2C: Change in household size between 2008 and 2009

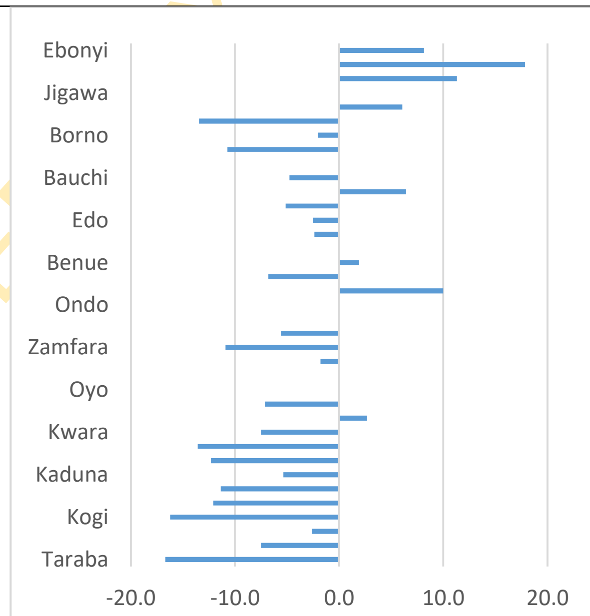

Figure 2D: Change in household size between 2009 and 2010

Figure 2: Change in household size between 2006 and 2010 across states in Nigeria

In 2008, the average household size in Nigeria increased to 5.2 from 4.8 in 2007. This represents an 8.3% increase in the national household size. Ogun State and Ekiti State in the southwestern part of the country recorded the lowest household size of 3.2. Thus, there was a slight increase in household size between the two periods under consideration. Similarly, Kebbi State recorded the highest household size of 10.9 and followed by Kaduna State (10.2). These two states are located in the northern part of the country. Sixteen states recorded household size above the national average, while the remaining states had figures below the national average. Within the same period, eleven states witnessed household size reduction, while the remaining experienced increased household size (Figure 2B). The highest percentage reduction in household size were noticed in Niger (-14.3%), Bauchi (-13.9%), and Delta (-12.2%) States, while the highest percentage increase were in Kebbi (91.2%), Kaduna (85.7%) and Nassarawa (78.1%) States. All the states that witnessed increased household size were confined to the northern part of Nigeria. While Ogun State consistently recorded the lowest household size, no consistent pattern has been established for the states with the highest household size, as this changed from Kaduna to Bauchi and then to the Kebbi States over the years under consideration.

In 2009, the average household size dropped to 4.7 from 5.2 in the previous year. Ogun State recorded the lowest household size (2.8), while Jigawa State recorded the highest household size (6.6). The household size for 2009 was quite lower than what obtained in 2008. Nineteen (19) states recorded household size higher than the national average size. Twenty-four (24) states recorded a reduction in their household size from the previous year, two (2) states (Zamfara and Kano states) remained unchanged, while eleven (11) states experienced increased household size from the previous year (Figure 2C). Kebbi (-48.6%), Kaduna (-46.2%), and Bayelsa (-22.4%) States recorded the highest reduction percentage in household size, while Sokoto (12.0%), Niger (10.4%), and Cross River (7.3%) State recorded the highest increase in household size in 2009. Generally, there was a considerable reduction in household size for the year 2009 compared to the year 2008.

In 2010, the average household size further reduced to 4.5 from 4.7 in 2009. The reduction in household size may be attributed to policy shift as well as the efforts of the various national and international governmental and non-governmental organizations. Ondo (3.1) and Kogi (3.1) States had the lowest household size in 2010, while Jigawa State (6.6) had the highest household size. Since 2009, Jigawa State has remained the state with the highest household size. Sixteen states had a household size greater than the national average, while the remaining had figures below the national average. Taraba (-16.7%), Kogi (-16.2%), and Yobe (-13.6%) States experienced household size reduction, while Ogun (17.9%), Niger (11.3%), and Nassarawa (10.0%) State experienced increased household size between 2009 and 2010 despite the reduction in the national average household size. Household size between 2009 and 2010 remained unchanged in Oyo, Akwa Ibom, Rivers, Katsina, Sokoto and Jigawa states (Figure 2D). In general, between 2006 and 2010, Taraba (-24.5%), Imo (-14.0%) and Bayelsa (-14.0%) and Kogi (-13.9%) States recorded the highest reduction in household size, while Ebonyi (29.3%), Ogun (26.9%), and Niger (20.4%) States recorded the highest increase in household size.

Despite the increase in the national average household size in 2008, some states witnessed a reduction in the household size; and despite the downward trend observed between 2009 and 2010, some states still continue to witness an increase in their household size. It is obvious that temporal and spatial variations exist in household size among states in Nigeria. Therefore, efforts at addressing the persistently high household size should be focused on states with exceptionally higher household size.

4.2 Pattern of Household Size between 2006 and 2010 in Nigeria

Figure 3 shows the spatial pattern of household size among states between 2006 and 2010. As shown in Figure 3(A-E), states with similar household size were clustered together. States with high household size were clustered in the northern part, while most states in the south-western region were characterised with moderately low household size. There was a comparatively higher positive spatial autocorrelation in household size (Moran's I= 0.359-0.815), suggesting that the pattern of household size was not randomly distributed from 2006 to 2010 among states in Nigeria (Table 1). The pattern of household size between 2006 and 2010 was clustered. Adjacent states tended to have similar or near similar household size compared to non-adjacent or non-contiguous states. The intensity of clustering decreased from 2006 through 2008 and increased in 2009 and subsequently decreased in 2010. The existence of spatial autocorrelation provided the basis for the use of spatial regression to better understand household size pattern in Nigeria. Furthermore, temporal autocorrelation was also observed in household size over time. The Moran's-I between previous and succeeding years showed a very high Moran's-I. The Moran's-I between the household size in 2009 and 2010 was the highest (0.743); this was followed by the household size between 2006 and 2007 (0.724). However, Moran's-I of household size between 2007 and 2008 was the lowest (0.550) followed by that of 2008 and 2009 (0.606). Thus, temporal autocorrelation also existed in household size despite the variations in household size over time.

Table 1: Indices of Spatial Autocorrelation in Household Size in Nigeria

Year	Moran-Index	R Square Change	Expected Index	Variance	Z-Score	P-Value	Interpretation
2006	0.729183	0.639	-0.02778	0.009925	7.604622	0.0000	Clustered
2007	0.700119	0.651	-0.02778	0.009672	7.237593	0.0000	Clustered
2008	0.359059	0.205	-0.02778	0.008386	4.398071	0.0050	Clustered
2009	0.814548	0.802	-0.02778	0.009957	7.959253	0.0000	Clustered
2010	0.641739	0.585	-0.02778	0.009989	6.34789	0.0000	Clustered

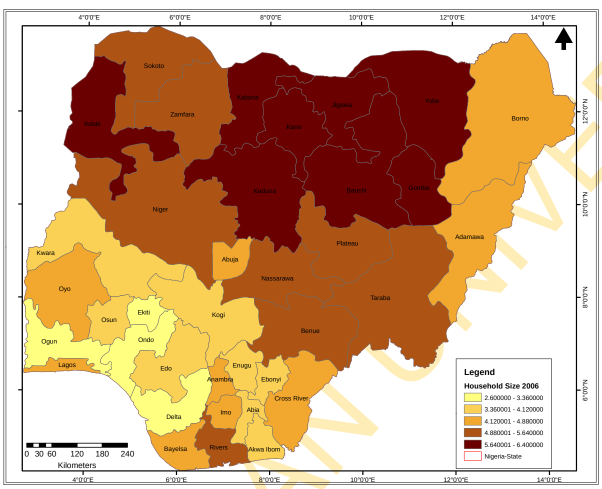

Fig 3A: Distribution of Household Size in 2006

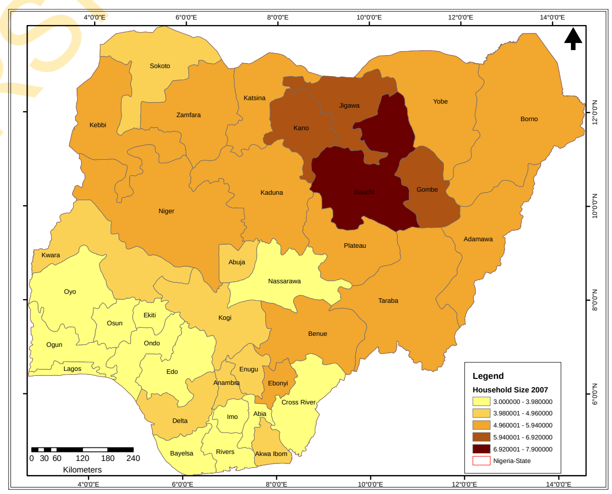

Fig 3B: Distribution of Household Size in 2007

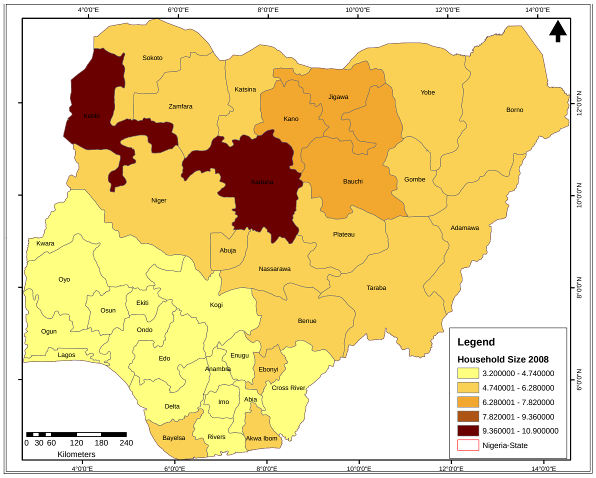

Fig 3C: Distribution of Household Size in 2008

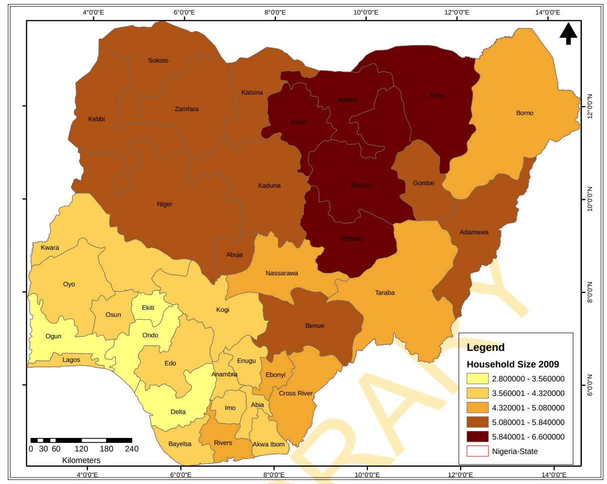

Fig 3D: Distribution of Household Size in 2009

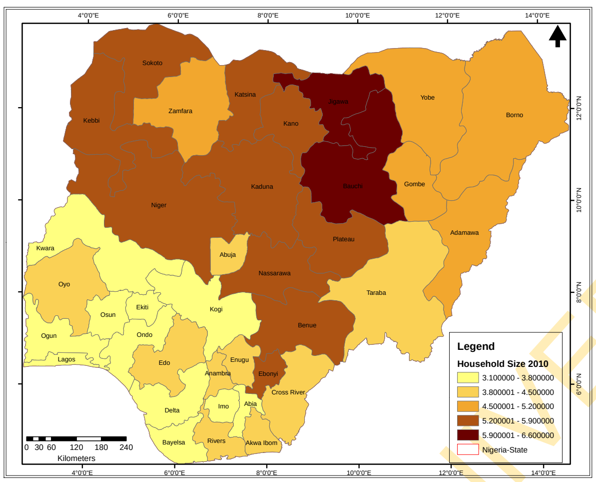

Fig 3E: Distribution of Household Size in 2010

Figure 4 (A-E) displays time-series LISA maps of household size in Nigeria. These LISA maps indicate hotspot (dark) and coldspot (blue) of household size. The dark colour represents states with higher household size and which are also surrounded by states with correspondingly higher household size. The blue shades represent states with lower household size and are surrounded by states with lower household size. In 2007, seven (7) states were categorised as the hotspot of high household size; these states were in the northern part of Nigeria, while cold spots occurred in six states in the south-western part of Nigeria. The household size in 2007 displayed hot spot pattern similar to what obtained in 2006. However, states characterised as cold spots reduced to four. States exhibiting cold spot of household size further reduced to three in 2008 (Ogun, Ondo and Ekiti), while states exhibiting hot spot also reduced to three (3). This result is in tandem with the result of the Global Moran-I index value. Household size pattern was similar between 2009 and 2010, as the same number of states exhibited hot spot and cold spots. The results from LISA maps further confirmed the existence of spatial autocorrelation in household size data. The observed clustering provides justification for the use of spatial lag and spatial error regression model to unearth unbiased predictors of household size.

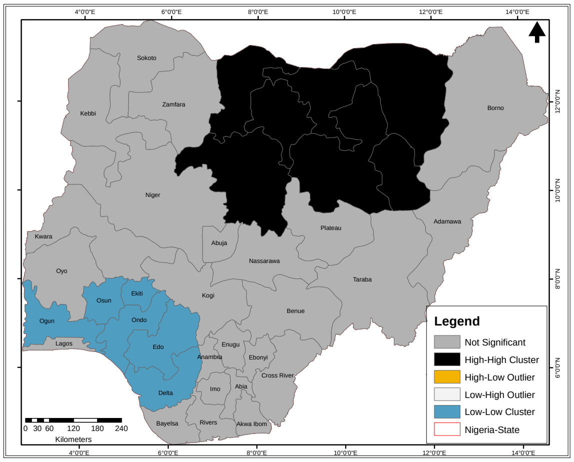

Figure 4A: LISA Map of Household size in 2006

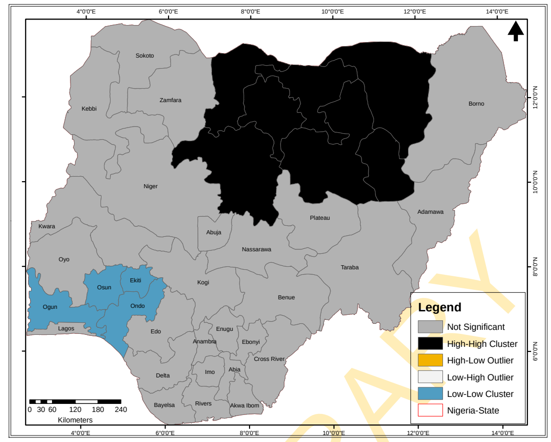

Figure 4B: LISA Map of Household size in 2007

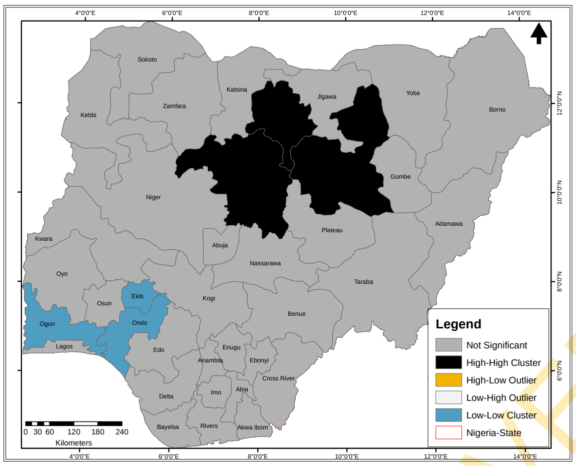

Figure 4C: LISA Map of Household size in 2008

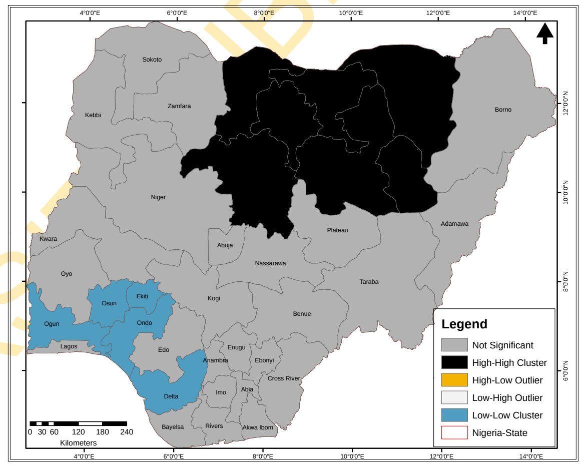

Figure 4D: LISA Map of Household size in 2009

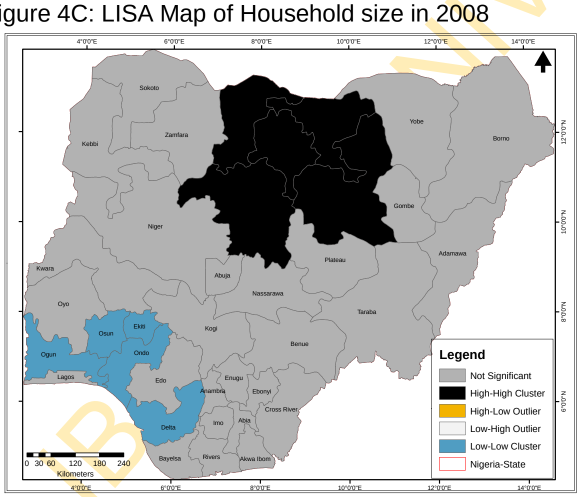

Figure 4E: LISA Map of Household size in 2010

Figure 4(A-E) shows Households Size Local Indicators of Spatial Autocorrelation Maps

4.3 Correlates of Household Size

The percentage of the population that engaged in monogamy was negatively correlated (r =-0.561) with household size while the percentage that engaged in polygamy showed a positive correlation (r= 0.723) with household size. Monogamy promotes lower household size, while polygamy has the potential to increase the household size (Isiugo-Abanihe, 1994). In addition, the percentage of the population using family planning also displayed a negatively significant correlation (r=-0.687) with household size. Thus, the higher the percentage of the population in each state using one form of family planning or others, the lower the household size.

None of the housing indicators (percentage living in a single room, flat, and whole buildings) correlated with household size. In addition, their coefficients, apart from showing negative relations, were also relatively low (Table 2). This implies that, at the national level, housing-related factors might not be significantly influencing household size. The percentage of the population that is unemployed, the percentage of the population above 15 years that are literate, and the number of higher institutions also were significantly related to household size. However, while unemployment showed a positive significant relationship, percentage of the literate population above 15 years and number of higher institutions showed a negative relationship (Cleland *et al.,* 1996; Jejeebhoy 1996; Wusu 2012). In addition, the three measures of poverty were also positively related to household size. Thus, the higher the poverty index is, the higher the household size is; this may also imply that the poor tend to have a larger household size compared to the rich (Owuamanam and Alowolodu, 2010). Access to media measured in terms of radio and television ownership were also significantly related to household size (Bankole *et al*., 1996). Although, while radio ownership showed a significantly positive relationship, television ownership displayed a significantly negative relationship with household size (Table 2).

Table 2: Correlation Coefficients between Household Size in 2010 and other Variables

Variables	Correlation Coefficients	Significant Level	Status
Married Monogamy	-0.561	0.000	Significant
Married Polygamy	0.723	0.000	Significant
Percentage Using Family Planning	-0.687	0.000	Significant
Single Room	0.136	0.211	Not significant
Flat	-0.205	0.112	Not Significant
Whole Building	-0.41	0.404	Not Significant
Unemployment in 2011	0.625	0.000	Significant
Percentage Literate 15 years and above	-0.537	0.000	Significant
Number of Higher Institutions	-0.558	0.000	Significant
Food poverty	0.478	0.001	Significant
Absolute Poverty	0.506	0.001	Significant
Dollar Per Day Poor	0.503	0.001	Significant
Radio Ownership 2008	0.781	0.000	Significant
Television Ownership 2008	-0.543	0.000	Significant

Furthermore, the spatial autocorrelation among the selected variables ranges between 0.761 and 0.12. Radio ownership (0.761), polygamous marriage (0.682), and percentage using family planning (0.675) recorded the highest spatial autocorrelation; while monogamous marriage (0.121), dollar-per-day poverty (0.299), absolute poverty (0.299), and food poverty (0.317) recorded the lowest spatial autocorrelation. In addition, the inter-variable autocorrelation between household size and these selected variables showed that, while monogamous marriage (-0.159), percentage using family planning (-0.652), percentage unemployed (-0.273), percentage literate (-0.503), television ownership (-0.453) and number of higher institution recorded a negatively significant spatial autocorrelation, monogamous marriage (0.556), food poverty (0.407), absolute poverty (0.462), dollar-per-day poverty (0.459), and radio ownership (0.687) were significant and positively auto-correlated with household size.

4.4 Modelling the Predictors of Household Size

Table 3 summarises the results from the Ordinary Least Square (OLS) regression, Spatial Error Model (SEM) and Spatial Lag Model (SLM). Despite some differences in the coefficients obtained for variables, the sign of the correlation coefficients remained the same in all the models although the magnitude differed. Amazingly, the percentage explanation offered by both OLS and SLM was similar, while that of SEM was substantially different. The lambda value of -0.882 in the SEM was statistically significant ($p \leq 0.05$), while that of SLM was not significant (t= 0.029, $p \geq 0.05$). This implies that spatial errors are not randomly distributed among the states and that there exists a clear spatial autocorrelation between household size and the independent variables.

Generally, the standard errors of SEM were much lower than the standard errors in SLM and OLS models. The relationship between household size and the percentage using family planning (-2.604), although negatively significant, was relatively weaker than the one between household size and monogamy (-4.945), as indicated by a lower statistical test value on the OLS model. The percentage of the population that engaged in polygamy became less important in OLS and SLM than SEM but were statistically significant. The test statistics for the SEM were generally higher than those of SLM and OLS in most cases, with the exception of percentage unemployed. This would lead to the overestimation of the OLS standard error unless the spatial dependency inherent in the data is addressed. Similarly, the percentage of the population using family planning became less important in both the OLS and SLM and was significant in SEM, as demonstrated by the lower Z-value.

The percentage explanation provided by the OLS and SLM was the lowest (84.3%), followed by the SEM (88.5%). As shown in Table 3, the SEM provided an additional 4.1% explanation of variation in the model compared to the OLS and SLM. Thus, the SEM provided a better model than others. Furthermore, the SEM regression model had a better fit than the OLS and SLM regression models, as indicated by a lower Akaike Information Criterion (AIC). This result showed that SEM increased the model's ability to explain the variations in household size across states in Nigeria. SEM had the least AIC compared to other models. Thus, the spatial error regression provided a much better model than the OLS model although the difference in the coefficient of the two models was small (5.4576). Similarly, the log-likelihood factor was the lowest in the SEM (13.13), but highest in the OLS (15.86). Two variables were significant in the OLS and SLM, namely percentage of the population that engage in monogamy, and percentage of the population using family planning. In addition to these two variables, the SEM identified percentage of the population that engage in polygamy, percentage of the population that are literate above 15 years, percentage of the population experiencing food poverty, percentage of the population that owns radio, and percentage of the population that owns television. Thus, while OLS and SLM identified two variables, SEM identified four variables, and SLM identified seven (7) variables as explanatory factors for the observed patterns of household size in Nigeria.

Table 3: Regression Coefficients, Standard Errors, Test Statistics and Probability for an Ordinary Least Square Regression (OLS), Standard Error Model (SEM), and Spatial Lag Model (SLM) of Household Size in Nigeria

Variables	Coefficient			Standard Error			T-Statistic			Probability		
	OLS	SEM	SLM	OLS	SEM	SLM	OLS	SEM	SLM	OLS	SEM	SLM
CONSTANT	6.234	5.479	6.163	1.853	1.496	1.591	3.365	3.662	3.874	0.002	0.000	0.000
Married Monogamy	-0.115	-0.124	-0.115	0.023	0.014	0.019	-4.945	-8.748	-5.946	0.000	0.000	0.000
Married Polygamy	-0.027	-0.065	-0.026	0.037	0.023	0.030	-0.732	-2.791	-0.868	0.471	0.005	0.386
Percent Using Family Planning	-0.092	-0.099	-0.090	0.035	0.027	0.030	-2.604	-3.617	-2.999	0.015	0.000	0.003
Percent Unemployment	-0.001	0.000	-0.001	0.012	0.008	0.010	-0.103	-0.042	-0.114	0.919	0.966	0.909
Percent Literate Above 15 Years	-0.006	-0.014	-0.006	0.008	0.007	0.007	-0.795	-2.058	-0.912	0.434	0.040	0.362
Food Poverty	-0.017	-0.017	-0.017	0.013	0.008	0.011	-1.331	-1.961	-1.578	0.195	0.050	0.115
Absolute Poverty	-0.508	-0.428	-0.499	0.387	0.305	0.323	-1.313	-1.404	-1.543	0.201	0.160	0.123
Dollar Per Day Poor	0.527	0.454	0.517	0.383	0.302	0.321	1.376	1.502	1.613	0.181	0.133	0.107
Radio Ownership	0.052	0.073	0.050	0.031	0.025	0.026	1.691	2.878	1.879	0.103	0.004	0.060
Television Ownership	0.025	0.046	0.024	0.034	0.023	0.029	0.752	1.986	0.824	0.459	0.047	0.410
No of Higher Institution	-0.021	0.040	-0.019	0.058	0.043	0.050	-0.367	0.933	-0.386	0.717	0.351	0.699
Lambda		-0.882	0.029		0.212	0.171		-4.154	0.172		0.000	0.864

N = 37, R^2 = 0.843 (OLS), 0.885 (SEM), 0.843 (SLM); Log likelihood = -15.8556 (OLS), -13.126780 (SEM), 15.8422 (SLM); Akaike Information Criterion = 55.7112 (OLS), 50.2536 (SEM), 57.6845 (SLM)

5.0 Discussion

The foregoing analysis showed that there were spatio-temporal variations in household size among states in Nigeria. In addition, clear regional patterns were evident, most especially in northern and southwestern parts of the country. The oscillating nature of the household size across states might be an indication of the various programmes and policies aimed at addressing the persistently high household size in some of the states. Consistently for three years, Ogun State had the lowest household size; the same was not true for states with the highest household size. At the national level, household size decreased from 2006 to 2007 and increased between 2007 and 2008, when it reached its peak and declined from 2008 to 2010 (Figure 5). The decrease could be as a result of increased public awareness of the consequences of large family size and perhaps because of increasing adoption of various family planning methods. Ogun, Ekiti, Ondo, and the Kogi States had lower household size, while Kano, Kaduna, Bauchi and Jigawa States consistently featured as states with high household size in the country.

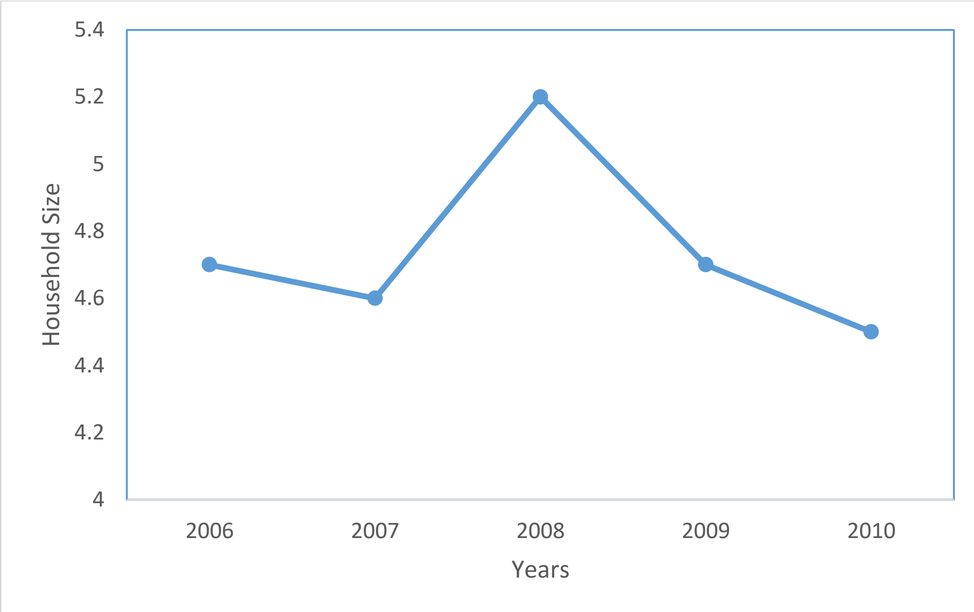

Figure 5: Trend in Average Household Size in Nigeria between 2006 and 2010

States with similar or near similar household size were more contiguous in 2006 and 2009 and were less contiguous in 2008 and 2010. Adjacent or contiguous states had similar or near similar household size, compared to non-contiguous states. This is the basis of the spatial autocorrelation that characterized the household size data. The lowest clustering, though significant ($p \leq 0.05$), was in 2008. This corresponds to the year with the highest recorded average household size. The year 2007 and 2009, had relatively low household size, following a period of higher household size, and had relatively higher Moran-I. This is an indication that there could be greater clustering of household size with a reduction in household size than the isolated and elevated household size that characterized few states currently. The correlation between average household size and Moran-I showed a significantly negative relationship ($r = -0.76465$, $p \leq 0.05$), which is an indication that the higher the household size is, the lower the intensity of household clustering among states; and the lower the household size is, the higher the intensity of clustering among states is. Thus, the observed clustering would reduce with the reduction in household size across states.

Furthermore, a clear regional pattern in the distribution of household size is also evident from the analysis. This is because significantly higher hotspot of household size was mainly visible among some of the states in the northern part of Nigeria, while a significantly lower hot spot of household size characterized states in the south-western part of the country. States such as Katsina, Kano, Kaduna, Jigawa, Bauchi, Yobe and Gombe were hotspots of household size. However, Kano, Kaduna, and the Bauchi States had a comparatively higher frequency than the other states. Cold spots of household size were observed in Ogun, Osun, Ondo, Ekiti, and occasionally, Edo and Delta States.

Some of the correlates of household size included marriage type, percentage of the population using at least one family planning method, literacy, unemployment, poverty, and access to media. None of the housing-related indicators was significantly related to household size. It should be emphasized that the reported correlation coefficients do not necessarily imply causality, they are indicators of a possible association with household size. Studies abound on the relationship between household size and some of the variables in this analysis (Isiugo-

Abanihe, 1994; Hamadeh *et al.*, 2008; Owuamanam and Alowolodu, 2010; Kamal and Pervaiz, 2011). The study supports existing analysis, though conducted at the national level. Thus, irrespective of the scale of data collection, some of the observed relationships still hold.

The spatial error regression model provided a more robust approach to modelling household size distribution in Nigeria than the most often used ordinary least square regression. This is because SEM takes cognizance of the challenge of spatial autocorrelation in household size data and the associated explanatory variables. Thus, rather than using two variables for predicting the household size, seven variables were identified as important predictors of household size. The incorporation of the variables identified by the SEM, such as the percentage of the population that engage in monogamy, the percentage of the population that engage in polygamy, the percentage of the population using family planning, the percentage of the population that are literate above 15 years, the percentage of the population experiencing food poverty, the percentage of the population that own radio and the percentage of the population that own television, would help in developing a broad-based model that can help in predicting household size.

Conclusion

The study has shown that, apart from the temporal variations in household size, there are spatial variations in household size among states in Nigeria. Variation in household size across states is a product of differences in the use of family planning methods and the percentage of people involved in monogamy and polygamy. In addition, food poverty is synonymous with high household size. Access to the media, in terms of radio and television ownership, can also help in reducing large household size. It should be stated that constraints to increasing adoption of family planning and programmes aimed at reducing the percentage of people involved in polygamy should be addressed by the government and allied agencies working in this area. A cluster of high household size exists in the northern part of Nigeria; this is currently confined to seven states. Government and various international and local non-governmental organisations should vigorously pursue programmes aimed at reducing household size in the identified hot spots and the current downward trend in the national household size should be vigorously sustained. The integration of spatial regression helped in addressing regression bias inherent in the OLS, as indicated by the relatively higher Moran-I. The SEM, thus, provided a better model of household size than other types of predictive models. Proper diagnosis of spatial autocorrelation would help in addressing the inherent bias in regression coefficients.

REFERENCES

Ajao, K. O., Ojofeitimi, E. O., Adebayo, A. A., Fatusi, A. O., & Afolabi, O. T. (2011). Influence of family size, household food security status, and child care practices on the nutritional status of under-five children in Ile-Ife, Nigeria. *African Journal of Reproductive health*, *14*(4).

Anselin, L. (1995). Local indicators of spatial association-LISA. *Geographical Analysis*, Vol. 27, 93–116.

Anselin, L. (1995). Local indicators of spatial association –LISA. *Geographical Analysis*, Vol. 27, 93-116

Anselin, L., Syabri, I., and Kho, Y. (2006). GeoDa: An introduction to spatial data analysis. *Geographical Analysis*, Vol. 38, 5-22

Anyanwu, J. C. (2014). Marital status, household size and poverty in Nigeria: evidence from the 2009/2010 survey data. *African Development Review*, 26(1), 118-137.

Arbués, F., Villanúa, I., & Barberán, R. (2010). Household size and residential water demand: an empirical approach. *Australian Journal of Agricultural and Resource Economics*, 54(1), 61-80.

Bankole, A., Rodriguez, G., & Westoff, C. F. (1996). Mass media messages and reproductive behaviour in Nigeria. *Journal of Biosocial Science*, *28*(2), 227-39.

Bongaarts, J. (2001). Household size and composition in the developing world in the 1990s. *Population Studies: A Journal of Demography*, 55(3), 263-279.

Chang, H., (2008). Spatial analysis of water quality trends in the Han River Basin, South Korea. *Water Research*, Vol 42, 3285-3304.

Chang, H., Parandvash, G. H., & Shandas, V. (2010). Spatial variations of single-family residential water consumption in Portland, Oregon. *Urban geography*, 31(7), 953-972.

Cleland John, Jejeebhoy S. I. (1996). Schooling and fertility: evidence from census and survey. In: Roger Jeffry, Alaka M Basu (Eds): *Girls schooling, women autonomy and fertility change in South Africa*. New Dehli: Sage Publications.

Dunbar, G. R., Lewbel, A., & Pendakur, K. (2013). Children's resources in collective households: identification, estimation, and an application to child poverty in Malawi. *The American Economic Review*, *103*(1), 438-471.

Easterlin, R. (1978). The economic and sociology of fertility: A synthesis. In C. Tilly, ed., *Historical studies of changing fertility*. Princeton, N.J.: Princeton University Press.

Ezeh, A. C., Seroussi, M., & Raggers, H. (1996). *Men's fertility, contraceptive use, and reproductive preferences* (Demographic and Health Survey Comparative Studies No. 18). Calverton, MD: Macro International Inc.

Fuster V. (1986) Determinants of family size in rural Glacia (Spain). *International Journal of Anthropology*, 1 (2) 129-134.

Hamadeh, R. R., Al-Roomi, K., & Masuadi, E. (2008). Determinants of family size in a Gulf Arab state: a comparison between two areas. *The journal of the Royal Society for the Promotion of Health*, *128*(5), 226-232.

Hayford, S. R., & Morgan, S. P. (2008). The quality of retrospective data on cohabitation. *Demography*, 45, 129–141.

Isiugo-Abanihe, U. C. (1994). Reproductive motivation and family-size preferences among Nigerian men. *Studies in Family Planning*, Vol 23(3)149-161.

Jejeebhoy S.J. 1995. ***Women's education, autonomy and reproduction behaviour:** experience from developing countries*. Oxford: Clarendon Press.

Kamal, A., & Pervaiz, M. K. (2011). Factors affecting the family size in Pakistan: Clog-log Regression Model Analysis. *Journal of Statistics*, *18*(1) 29-53.

Keitt, T. H., Bjørnstad, O. N., Dixon, P. M., and Citron-Pousty, S. (2002). Accounting for spatial pattern when modelling organism environment interactions," *Ecography*, vol. 25, no. 5, pp. 616–625.

Kpakpor M. 2005, Nigeria to eradicate poverty by 2010.*Nigerian Tribune*, October 16, 2005, P. 7

Mansur, E. T., & Olmstead, S. M. (2012). The value of scarce water: Measuring the inefficiency of municipal regulations. *Journal of Urban Economics*, *71*(3), 332-346.

McCarthy, J., & Oni, G. A. (1987). Desired family size and its determinants among urban Nigerian women: A two-stage analysis. *Demography*, *24*(2), 279-290.

McClelland, G. H. (1983). Family-size desires as measures of demand. *Determinants of fertility in developing countries: a summary of knowledge*, *1*, 288-343.

Miller, C. M., Tsoka, M., & Reichert, K. (2011). The impact of the social cash transfer scheme on food security in Malawi. *Food Policy*, *36*(2), 230-238.

Okunade, A. A., Suraratdecha, C., & Benson, D. A. (2010). Determinants of Thailand household healthcare expenditure: the relevance of permanent resources and other correlates. *Health Economics*, *19*(3), 365-376.

Onyishi, E. I., Sorokowski, P., Sorokowska, A., & Pipitone, R. N. (2012). Children and marital satisfaction in a non-Western sample: having more children increases marital satisfaction among the Igbo people of Nigeria. *Evolution and Human Behaviour*, *33*(6), 771-774.

Owuamanam, T. O., & Alowolodu, O. (2010). Educational pursuit and income as correlates of family size in Ondo State, Nigeria. *Journal of Social Sciences*, *23*(2), 123-127.

Peichl, A., Pestel, N., & Schneider, H. (2012). Does size matter? The impact of changes in household structure on income distribution in Germany. *Review of Income and Wealth*, 58(1), 118-141.

Tobler, W. (1970) A computer movie simulating urban growth in the Detroit Region," *Economic Geography*, vol. 46, pp. 234–240.

Wang, X. C., Kockelman, K. M., & Lemp, J. D. (2012). The dynamic spatial multinomial probit model: analysis of land use change using parcel-level data. *Journal of Transport Geography*, *24*, 77-88.

Ward, M.D and Gleditsch, K.S. (2008). *Spatial Regression Model*. Thousand Oaks, CA: sage.

Wusu, O. (2012). European Demographic Data Sheet 2012-online. *Vienna Yearbook of Population Research*, vol.10, 31-48.