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Variation in Educational Attainment Levels: Statistical Evidence from The Nigeria Demographic Health Surveys (2008, 2013 and 2018)

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ABSTRACT

This study focuses on the existent wide and varying disparities in the level of educational pursuit which cut across gender, geographic locations and economic divide globally. The understanding of this, contributes to the equitable distribution of educational amenities, and to the accurate measure of socio-economic, and human capital development. This study explores the Thiel's index and the geographically weighted regression, (which are veritable tools for assessing regional disparity indices), in describing the Nigerian context using data from the National surveys of 2008, 2013 and 2018. The study findings reveal a decline in educational attainment status in the Northern region compared to their southern counterpart especially in the North-West. It also reveals an increase in the number of uneducated persons and a growing number of "Out-of-school" children over the years 2008, 2013, and 2018.

1. Introduction

Education is an essential tool for societal and/or national advancement; but there seems to be a wide and varying disparity in the level of educational pursuit largely due to geographical positioning, limited resources, and socio-economic factors such as poverty, parental education level, and family income (Saima and Nasir, 2016; Abraham, 2019); as well as gender disparities with females having lower literacy rates compared to males - attributed to cultural practices, early marriage, and lack of access to education, especially in rural areas (UNESCO, 2019). Educational inequality is a global problem (Hart, 2019; Roza and Satrianto, 2021) often resulting in severe effects globally such as increased out-of-school children (Obasuyi et al., 2018), women trafficking, prostitution, and child labour (Adeoti, 2021); it also leads to generation of gaps and marginalization among groups (UNESCO, 2021). The World Bank (2018) report notes that the literacy rate for females in Nigeria is 48.8%, compared to 70.8% for males; The National Bureau of Statistics (NBS, 2019) also found that the percentage of people with tertiary education in Nigeria varies widely across different regions, with the southern region having a higher percentage of about 9.9%, compared to 2.6% in the northern region. Habibu et al., (2014), adopting the Theil's Index and a Decomposition Analysis, found that educational inequality was higher in the North than in the South, as 17 out of 19 states of northern Nigeria have higher Theil index than the national index. The study further revealed that within-regions inequality rather than between-regions inequality is the main source of education inequality in Nigeria. Habibu, et al., (2014), found evidence that equitable distribution of education has significant and positive effects on regional income level. Their results confirm the role of education inequality in accounting for regional income differences in Nigeria.

Michaela and Andrea (2017) assessed education attainment level across regions of the European Union (EU) with consideration of the spatial aspect. The findings from the spatial analysis proved the existence of positive spatial autocorrelation and persistence of disparities in education attainment level across EU regions during the analyzed period, while the econometric analysis confirmed the expected positive impact of economic growth on education attainment level as well as the necessity to incorporate the spatial dimension into the model. Abraham (2019) attempted to identify key factors, of both spatial and non-spatial forms, that affect primary education in Ethiopia. The study found that low teachers' qualification, motivation, limited teachers' building capacity, ineffective school leadership, low participation of parents, lack of adequate school facilities, overcrowded classes, low quality of

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classrooms, high pupil-teacher ratio, and lack of instructional materials were some of the non-spatial factors that affect lower education quality.

This paper assesses the outcome of the national surveys in 2008, 2013 and 2018 in an attempt to better understand coverage and trends of educational attainments in Nigeria and also compare the educational distribution between regions of the country

2. Methods

Data drawn from the Nigerian Demographic and Health Surveys (NDHS) for 2008, 2013, and 2018 were used. The NDHS is a national sample survey that provides up-to-date information on demographic and health indicators. The sample used was selected using a stratified, two-stage cluster design, with enumeration areas (EAs) as the sampling units for the first stage. The second stage was a complete listing of households carried out in each of the 1,400 selected EAs. A representative sample of approximately 42,000 households was selected for the survey. Specifically, information was collected on fertility levels, marriage, educational level, etc.

2.1 Thiels Index

This is a member of the Generalized entropy family of spatial methods; having the advantage of being additively decomposable. It can be exploited to investigate the extent to which a country's education can be attributed to between and within regional groupings. The Theil index measures an entropic "distance" the population is away from the egalitarian state of everyone having the same outcome. The numerical result is in terms of negative entropy so that a higher number indicates more order that is further away from the complete equality.
Given $x_i\ (i = 1,2, \dots N)$ *where* x_i is the relative share of education indicator in geographical area "i" in population N; the Thiel's T index is thus given as:

$$T_i = \frac{1}{N}\sum_{i=1}^{N}\frac{x_i}{\mu}\ln\left(\frac{x_i}{\mu}\right)$$

where $\mu = \frac{1}{N}\sum_{i=1}^{N} x_i$
The "education share" refers to each location's education share divided by the country's total education attainment. If the population is divided into "m" subgroups, where: s_i *is the education share of group* i; N *is the total population, and* N_i *is the population of group* i, T_i *is the Theil index for subgroup* i, $\bar{x}_i$ *is the mean education share of group* i, *and* μ *is the mean education share of the entire population*
Then Theil's index becomes:

$$T_T = \sum_{i=1}^{m} s_i T_i + \sum_{i=1}^{m} s_i \ln\left(\frac{\bar{x}_i}{\mu}\right) \quad where\ s_i = \frac{N_i}{N}\frac{\bar{x}_i}{\mu}$$

If everyone has the same education share, then T_T equals 0. If one area has all the educational share, then TT gives the result ln N, which is maximum inequality. Dividing T_T by ln N can normalize the equation to range from 0 to 1, but then the independence axiom is violated.

2.2. Geographically Weighted Regression (GWR)

Belongs to a class of models with variable coefficients. The regression coefficients of the explanatory parameters form continuous surfaces that are assessed at certain points in space. The general GWR model is given by:

$$y_i = \beta_0(u_i, v_i) + \sum_{k}^{p}\beta_k(u_i, v_i)\,X_{ij} + \varepsilon_i$$

where (u_i, v_i) represents the geographical coordinates. GWR constructs a separate equation for every spatial unit (i) of the area that is being studied, incorporating the dependent and explanatory variables.
The coefficients of the model can be expressed in matrix from as $\beta = \begin{bmatrix} \beta_0(u_1, v_1) & \dots & \beta_p(u_1, v_1) \\ \beta_0(u_j, v_j) & \dots & \beta_p(u_j, v_j) \\ \beta_0(u_n, v_n) & \dots & \beta_p(u_n, v_n) \end{bmatrix}$
In order to give a weight to observations decreasing with their distance to the point of interest, an estimate is performed using the weighted least squares given a weighing matrix $W_{(u_i v_i)}$. Thus, the coefficients $\hat{\beta}(u_i, v_i) =$

$\left(X^T W_{(u_i,v_i)} X\right)^{-1} X^T W_{(u_i,v_i)} Y$. This is achieved using the STATA version 15 software.

3. Results and Discussion

First, we present the results from the estimation of the Thiel's indices:

Table 1: Thiel's Inequality indices across geopolitical zones by level of educational attainment

Region	None	Primary	Secondary	Higher
NC	0.28115	0.18952	0.09829	0.16486
NE	0.18773	0.27150	0.20214	0.24035
NW	0.20778	0.35462	0.43793	0.58740
SE	0.70892	0.27399	0.13201	0.15173
SS	0.24935	0.18694	0.07441	0.08758
SW	0.24818	0.13755	0.10333	0.18733

Table 2: Educational Distribution by Educational Attainment Levels Across Years.

Theil's Index	Educational attainment levels			
Year	None	Primary	Secondary	Higher
2008	0.43918	0.10755	0.18845	0.27986
2013	0.56992	0.11254	0.16430	0.18997
2018	0.53565	0.10113	0.12377	0.16733

Table 1 presents the Thiel's Inequality Index by Geopolitical Zones. The North central zone has inequality indices of 0.28115, 0.18952, 0.09829 and 0.16486 for No education, primary, secondary and higher education respectively. The disparity is highest among those with "No education", and least among those with Secondary education. This suggests that there are more uneducated persons, while those who seek education are more likely to stop at the secondary level, although a few attain higher educational levels. The North East zone shows disparities of 20.2% to 27.15% among those with primary to higher education. The North-West zone has the lowest educational attainment tendencies with greater disparity of 35.46%, 43.79% and 58.74% for primary, secondary and Higher education respectively. This shows that the likelihood of attaining higher levels of education widens progressively. North-West indices suggest possibility of more out-of-school case or lack of interest in Western and/or formal education.

The result for South-South, with 0.07441 and 0.08758 indices for secondary and Higher education respectively; these are closest to zero, implying that the residents of the zone have nearly equal tendencies to rise up to these educational levels. With a 70.89% inequality index at "No education" level, the study found that there are more educated South-South residents. This pattern is not too far from that evident in the other two zones in Southern Nigeria. The result on Table 2 presents the inequality indices by year of survey. The study findings reveals that the inequality indices rose by 13% within the 5-year survey interval from 2008 to the 2013, and then declined slightly in 2018 survey. This suggests more uneducated persons in the country currently going by the last national survey results. Despite this outcome, the 2018 national survey gives evidence of improved secondary and tertiary level education within the population compared to the outcome of previous surveys. The decline of about 6.6% and 11.3% in secondary and tertiary education respectively between 2008 and 2018, supports this claim. Next, from the Geographically Weighted Regression, we test for the significance of the bandwidth, and also of the non-stationarity condition for each of the predictor variables as shown in Tables 3 and 4.

Table 3: Significance Test for Bandwidth

Sn	Educational Attainment	Band width	p-value
1	No Education	1.8135	<0.001
2	Primary	1.4416	<0.001
3	Secondary	1.8135	<0.001
4	Tertiary	8.257	0.310

Table 4: Significance Test for Non-Stationarity across levels of Educational Attainment

	No Education		Primary		Secondary		Higher	
Variable	Si	p-value	Si	p-value	Si	p-value	Si	p-value
Constant	889.7559	0.010	97.3237	0.620	92.4138	0.850	1.7406	0.970
NC	299.7719	0.850	172.9497	0.310	64.2262	1.000	2.3345	0.890
NE	404.7186	0.790	117.2751	0.980	97.9428	0.940	0.9141	0.990
NW	677.5157	0.640	136.6286	0.940	199.2713	0.260	2.7599	0.920
SE	169.4731	1.000	243.4034	0.460	80.833	0.990	1.1939	0.990
SS	52.6817	1.000	55.6434	1.000	71.5709	0.990	1.473	0.970
2013	1.3E+03	<0.001	173.5357	0.420	149.4889	0.070	4.3395	0.240
2018	1.3E+03	<0.001	145.4389	0.540	185.7112	0.010	4.7835	0.330

Table 3 presents the bandwidth for the geographically weighted regression (GWR) model. This test whether or not, the geographically weighted regression model is better suited for modeling the data than the global linear regression model; while Table 4 presents the significance tests for non-stationarity of the parameter estimates which show that the relationship between the outcome variable (in this case, number of persons with specific educational attainment) It can be observed from Table 3, that the geographically weighted regression models for No Education, Primary and Secondary have statistically significant p-values (0.000 <0.05) hence suggesting the geographically weighted regression model is a better option than the global linear regression model in describing frequency educational attainment levels in Nigeria. But the case differs for Higher education which has a non-significant p-value of 0.310 (>0.05). Table 4 shows that the relationship between the number of persons with No education and year of survey varies significantly over the study area. A similar scenario plays out for Secondary education (at 10% significant level for Year 2013). The maps in Figures 1 – 3, depicts these findings. The three Spatial Maps on Educational Attainment levels are presented in Figures 1 – 3 for 2008, 2013, and 2018 national surveys. It describes the distribution of educational attainment in Nigeria across all the states. This shows clearly that the Northern regions are worst hit with lower tendencies to further their education beyond primary school.

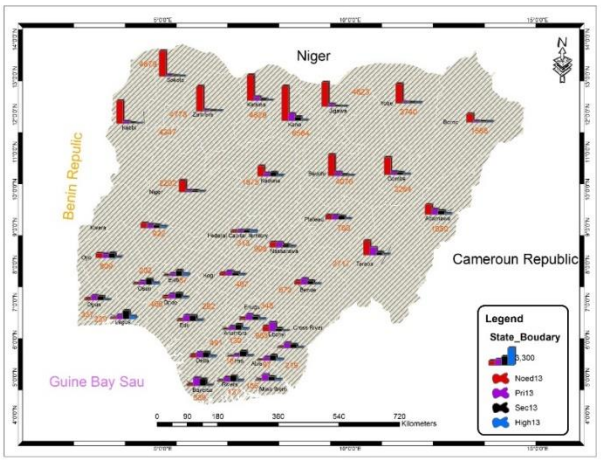

Fig.1- Education attainment, 2008

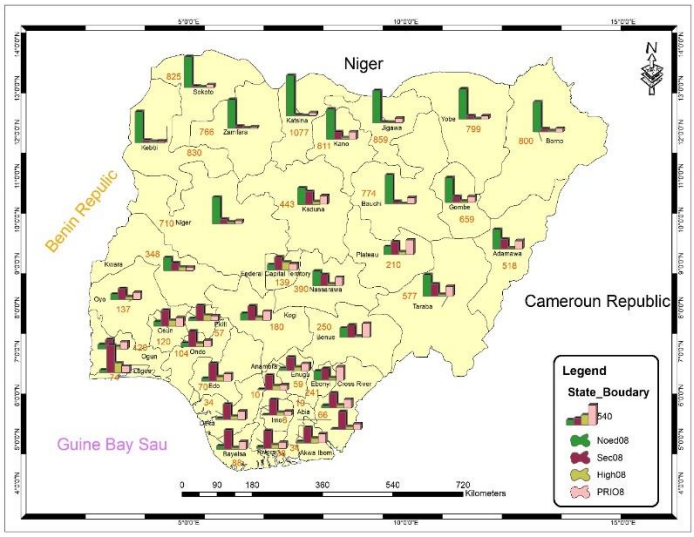

Figure 2- Education attainment, 2013

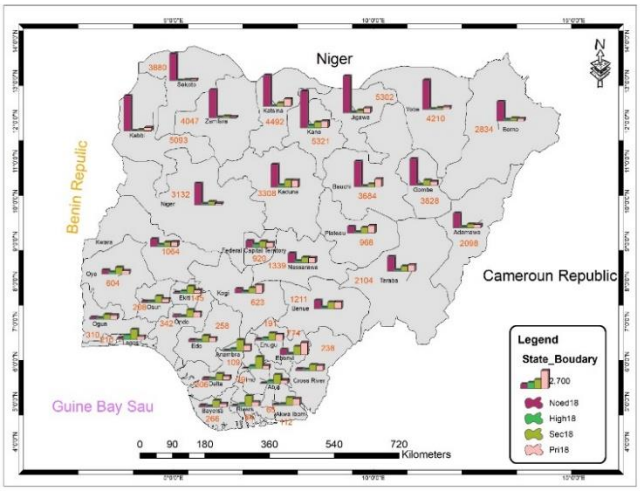

Figure 3- Education attainment, 2018

Next, we explore the outcome of the global linear regression models.

Table 5a ANOVA on "No Education"

Source	SS	df	MS	Number of obs	=	111
Model	206425606	7	29489372.2	F(7, 103)	=	38.10
Residual	79729369.1	103	774071.545	Prob > F	=	<0.001
Total	286154975	110	2601408.86	R-squared	=	0.721
				Adj R-squared	=	0.7024
				Root MSE	=	879.81

Table 5b Coef. of the GWR Representing No Education

No_edu	Coef.	Std. Err.	t	P>t	[95% Conf.Interval]	
NC	595.0556	282.6031	2.11	0.038	34.57892	1155.532
NE	1978.167	293.2711	6.75	<0.001	1396.533	2559.801
NW	3038.389	282.6031	10.75	<0.001	2477.912	3598.866
SE	-46.34444	307.5853	-0.15	0.881	-656.367	563.6785
SS	-72.94444	293.2711	-0.25	0.804	-654.579	508.6897
Yr2013	1284.757	204.5525	6.28	<0.001	879.0752	1690.438
Yr2018	1363.703	204.5525	6.67	<0.001	958.0212	1769.384
_cons	-632.2087	238.6445	-2.65	0.009	-1105.5	-158.914

Table 5a reveals that the model fits the data well with p-value of 0.000<0.05. Also, the predictor variables account for about 72.1% of the variations in the number of persons with no education. Table 5b reveals that the prevalence of "No education" is most prominent in the northern zones compared to the south-west zone given that their p-values are below 0.05. North-West is most critical with a coefficient of about 3038.389. the mean number of persons without education is also critical in 2013 and 2018 surveys compared to 2008.

Table 6a ANOVA Representing Primary Education.

Source	SS	df	MS	Number of obs	=	111
Model	8011037.7	7	1144433.96	F(7, 103)	=	14.93
Residual	7893449.37	103	76635.4308	Prob > F	=	<0.001
Total	15904487.1	110	144586.246	R-squared	=	0.5037
				Adj R-squared	=	0.4700
				Root MSE	=	276.83

Table 6b Coef. of the GWR Representing Primary Education

Primary	Coef.	Std. Err.	T	P>t	[95% Conf.Interval]	
NC	90.6746	88.92036	1.02	0.310	-85.678	267.0272
NE	4.444444	92.27702	0.05	0.962	-178.565	187.4541
NW	-40.3254	88.92036	-0.45	0.651	-216.678	136.0272
SE	165.7222	96.78095	1.71	0.090	-26.22	357.6644
SS	155.6667	92.27702	1.69	0.095	-27.343	338.6764
Yr2013	577.1351	64.36191	8.97	<0.001	449.4885	704.7818
Yr2018	505.9459	64.36191	7.86	<0.001	378.2993	633.5926
_cons	120.2508	75.0889	1.6	0.112	-28.6704	269.1719

From Table 6a it can be seen that the model fits the data well with p-value of 0.001(<0.05). Also, only about 50.37% of the variations in the number of persons with at most "primary education" is explained by the predictor variables. Table 6b reveals that the prevalence of "Primary" is most explained by the year of survey (2008, 2013

and 2018)

Table 7a ANOVA Representing Secondary Education.

Source	SS	df	MS		
Model	11918980	7	1702711.43	Number of obs	= 111
Residual	5354609.81	103	51986.503	F(7, 103)	= 32.75
Total	17273589.9	110	157032.635	Prob > F	= <0.001
				R-squared	= 0.6900
				Adj R-squared	= 0.6689
				Root MSE	= 228.01

Table 7b Coef. of the GWR Representing Secondary Education

Sec. Sch	Coef.	Std. Err.	T	P>t	[95% Conf.Interval]	
NC	-319.9762	73.2372	-4.37	<0.001	-465.225	-174.728
NE	-489.5	76.00183	-6.44	<0.001	-640.232	-338.768
NW	-541.119	73.2372	-7.39	<0.001	-686.368	-395.87
SE	52.9	79.71139	0.66	0.5080	-105.189	210.9887
SS	-18.44444	76.00183	-0.24	0.8090	-169.176	132.2873
Yr2013	364.4054	53.0102	6.87	<0.001	259.2722	469.5386
Yr2018	536.5135	53.0102	10.12	<0.001	431.3803	641.6467
_cons	532.8604	61.84523	8.62	<0.001	410.2049	655.5158

From Table 7a it can be seen that the model fits the data well with p-value of 0.000(<0.05). Also, only about 69% of the variations in the number of persons with at most "secondary education" is explained by the predictor variables. Table 7b reveals that the prevalence of "Secondary" is most influenced all the predictor variables. The result shows a variation in count of persons with up to Secondary level education. The Northern zones seem to be way lower than the south with an inverse form of relation; while the impact in 2018 is most critical with an absolute T-score of 10.12

Table 8a ANOVA Representing Higher Education.

Source	SS	df	MS		
Model	735999.856	7	105142.837	Number of obs	= 111
Residual	704709.712	103	6841.84186	F(7, 103)	= 15.37
Total	1440709.57	110	13097.3597	Prob > F	= <0.001
				R-squared	= 0.5109
				Adj R-squared	= 0.4776
				Root MSE	= 82.71

Table 8b Coef. of the GWR Representing Higher Education

Higher	Coef.	Std. Err.	T	P>t	[95% Conf.Interval]	
NC	-63.49206	26.5689	-2.39	0.0190	-116.19	-10.799
NE	-144.5	27.5718	-5.24	<0.001	-199.18	-89.818
NW	-163.3968	26.5689	-6.15	<0.001	-216.09	-110.7
SE	-42.57778	28.9176	-1.47	0.1440	-99.929	14.7734
SS	-81.44444	27.5718	-2.95	0.0040	-136.13	-26.762
Yr2103	98.05405	19.231	5.1	<0.001	59.914	136.194
Yr2018	138.7027	19.231	7.21	<0.001	100.563	176.843
_cons	156.8589	22.4361	6.99	<0.001	112.362	201.356

From Table 8a it can be seen that the model fits the data well with p-value of 0.000(<0.05). Also, only about 51.1% of the variations in the number of persons with at most "Higher education" are explained by the predictor variables. Table 8b reveals that the prevalence of tertiary education is most influenced all the predictor variables. The result shows a variation in count of persons with up to Tertiary level education. The South-east and the South-west zones seem to be more likely to pursue tertiary education than others. The outcome, given the year of survey, is also significant.

4. Conclusion

In this paper, we carried out the spatial analysis of educational attainment level across geopolitical zones in Nigeria during the period 2008, 2013 and 2018. The study found out that there are clear variations across regions; between the North and the South, and clearly across the years of national survey, there have been both improvements and declines in the status quo. While secondary and higher education have improved, there has also been an increase in the number of persons with no education in Nigeria.

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