ICASTOR Journal of Mathematical Sciences
Vol. 10, No. 1 (2016) 5 - 16

POVERTY INCIDENCE IN NIGERIA: AN APPLICATION OF THE BINOMIAL TEST

O. I. Osowole,
Department of Statistics,
University of Ibadan,
Nigeria

Rita N. Nwaka,
Department of Mathematics,
College of Education,
Agbor, Delta State
Nigeria

J. Kayode,
Department of Mathematics and Statistics,
Bowen University,
Iwo, Osun State,
Nigeria

F.O. kazeem,
National Bureau of Statistics
South-West Zonal Office,
Ikolaba, Ibadan, Oyo State,
Nigeria

ABSTRACT

This study considers an alternative estimation of the incidence of poverty based on the binomial test. The core objective is to explore an available alternative in the presence of limitations posed by consumption measurement problems, inadequate technical capacity and paucity of funds to conduct reliable household surveys. It is believed that the alternative approach considered will be less demanding and cost effective. This is the Nigerian situation with dwindling resources for the collection of necessary household survey data. The incidence of poverty is estimated from the binomial test using a recent general household survey panel data with per capita expenditure as the proxy for poverty. The estimate of the incidence of poverty from the binomial test compared well with the estimate expected conventionally. The alternative estimation procedure from the binomial test may therefore be adopted by socio and economic researchers especially in less developed nations because it gives an indication of the increase or decrease in poverty incidence. This will indeed aid assessment of poverty intervention programmes.

Keywords: Incidence of poverty, Binomial test, Index of poverty, Poverty measurement, Multidimensional poverty, Socio and Economic researchers

INTRODUCTION

Poverty in Nigeria as noted by Anyawu (2012) is on the increase. He observed that the main reason for this is bad implementation of policies by government. These policies, according to him failed to concentrate on those who are poor. The level of poverty incidence in Nigeria in 2010 was 69% (Kale, 2012). He noted again that both the North East and North West geopolitical zones had the highest poverty incidences of 76.3% and 77.7%, respectively, while the South West zone had the lowest incidence of 59.1%. Furthermore,

Correspondence: **O.I. OSOWOLE,** DEPARTMENT OF STATISTICS, UNIVERSITY OF IBADAN, IBADAN, OYO-STATE, NIGERIA . E-mail: dosowole@yahoo.com

according to Kale (2012), the Sokoto state had the highest incidence of 86.4%, while Niger state had the least incidence of 43.6%.

Choosing an appropriate index of poverty from available options is cardinal in the course of poverty measurement and this is dependent on an appropriate identification of the poor in a given population (Fajardo-Duka, 1992)

The definition of who the poor are is not an easy matter. This is because poverty is seen from different angles by different people. This perhaps confirms the multi-dimensional nature of poverty. A household might be income poor, consumption poor, assest poor or it might be derived in its access to basic social amenities. All these represent different shades of poverty that a given household might be experiencing at one time or the other. The uni-dimensional approach to poverty is when only income or expenditure is used as a proxy for household poverty. Several authors in Nigeria (Aigbokhan (1997); Canagarajah & Thomas (2001); Ajakaiye & Adeyeye (2001); Akintola & Yusuf (2001); Osinubi (2003); Oyekale et al (2004); Olaniyan & Awoyemi (2006); Adesanoye & Okunmadewa (2007); Olubanjo et al (2007); Omonona et al (2008); Ibrahim & Umar (2008); Oshewolo (2010); Obayelu & Awoyemi (2010); Anyanwu (2011, 2013); Adawo (2011); Olorunsanya & Omotesho (2011); Asogwa et al (2012); Akerele et al (2012); and Okoroafor & Nwaeze (2013)) have adopted this approach in their respective studies on poverty in Nigeria including its various subdivisions. The global adoption of this approach may not be unconnected with its computational appeal as introduced by Foster et al (1984). The approach generally includes the estimation of poverty incidence, depth and severity; the three basic dimensions of poverty.

The concept of multidimensional poverty derived its root from the pioneering work of Amartya Sen (Sen (1979, 1985, 1987). Authors who have also contributed to the growth of the concept include Tsui (2002), Atkinson (2003), Bourguignon and Chakravarty (2003), Alkire and Foster (2007, 2011), Batana (2008), Alkire and Santos (2010), Oyekale (2011), and Levine et al (2014). The main difference between this concept and unidimensional method is its ability to view poverty over a wider spectrum. Thus, it offers a broader scope than the uni-dimensional method.

The motivation for this study is hinged on Sahn and Stifel (2003) who noted that problems of measurement generally limit the use of expenditure measures in less developed nations. They also observed that the quality of expenditure and consumption surveys from these nations are low, coupled with lack of adequate 'technical capacity' on the part of parastatals of government saddled with the responsibility for conducting the surveys; as well as the reduction in foreign aids from international donor agencies to reduce the financial burden of conducting such surveys. It is in the light of this that this present study is being undertaken. This study is an attempt to estimate the poverty incidence from the binomial test in line with the suggestion of Sahn and Stifel (2003, p.465) who opined that ''more rapid, less costly, and less demanding approaches for measuring poverty'' should be sought. This study is limited to the head count index because it measures the incidence of poverty and

according to Fajardo-Duka (1992, p.162) ‘‘it is the most commonly used and easiest to compute’’

1. Methodology

1.1 Traditional Unidimensional Approach

The conventional approach following the uni-dimensional ground breaking work of Foster et al (1984) is the estimation of the three basic dimensions of poverty. These dimensions are poverty incidence, depth and severity. These dimensions are summarized by Foster-Greer-Thorbecke (FGT) generalized poverty index

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{z-y_i}{z}\right)^\alpha I(y \leq z) \quad (1)$$

where α is the aversion index assuming values 0, 1 and 2. The generalized index becomes head count, poverty gap and square poverty gap indices when α = 0,1 and 2 in that order. N is the total number of households, z is the poverty line, y_i is the per capita household expenditure for the i^{th} household and I($y \leq z$) is an indication function assuming value of 0 when y > z and value of 1 when $y \leq z$. The poverty line is a predetermined threshold for classifying any household into poor and non poor. Poor households are those whose per capita expenditure are less than or equal to the poverty line, while non poor households are those whose per capita expenditure are greater than the poverty line. The poverty line is generally defined as

$$z_1 = \frac{2}{3}\ mean\ per\ capita\ expenditure \quad (2)$$

This is the traditional poverty line. This poverty line will be considered in this study with its selected variants

$$z_2 = mean\ per\ capita\ expenditure \quad (3)$$

$$z_3 = median\ per\ capita\ expenditure \quad (4)$$

The reason for choosing these poverty lines is based on the comment of Srinivasan (2000) who observed that measures of poverty are sensitive to the poverty lines used in their computations. Additional objective of this study is to see how the hypotheses of the binomial test will be affected by these poverty lines.

As earlier said, this present study is limited to the computation of the incidence of poverty via the head count index. The head count index is defined as

$$P_0 = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{z-y_i}{z}\right)^0 I(y \leq z) = \frac{q}{N} \quad (5)$$

where q is the number of poor households in the study population.

1.2 The Binomial Test

The test consists of the outcomes of n independent trials where each outcome falls into two distinct classes; but not both. The classes are generally represented as class1 and class 2 respectively. We shall let the number of observations in the two classes be O_1 and O_2 respectively with n (total number of observations) equal to the sum of O_1 and O_2; that is n = O_1 + O_2. The two basic assumptions of the test are that each trial has probability 'p' of belonging to any of the two classes and that the trials are mutually independent. It should be noted that 'p' is constant over all the trials. The total number of independent trials is generally denoted as n. This test is a Non Parametric test and specifically suitable for the present study. This is because the household data to be used for analytical considerations allow the use of ordinal scale of measurement. This is true since households are classified as 'poor' and 'non poor' respectively. Furthermore this test will be considered appropriate since no distribution function is assumed for the per capita expenditure data; a proxy for poverty.

1.3 Hypotheses under the Binomial Test

There are basically three forms of hypotheses. These are

i. $H_0 : p = p^*$
$H_1 : p \neq p^*$ (two tailed test)

ii. $H_0 : p = p^*$
$H_1 : p > p^*$ (one tailed test)

iii. $H_0 : p = p^*$
$H_1 : p < p^*$ (one tailed test)

Where p* is some specified constant such that $0 \leq p^* \leq 1$. For (i) H_0 will be rejected if $T > t_2$ or $T \leq t_1$. Also H_0 will be rejected if T > t and T ≤ t for (ii) and (iii) respectively. T is the test statistic which refers to the number of observations belonging to class1(O_1) = number of poor households. This implies that $T = O_1$. This is so because the binomial test is concerned only with the probability of the outcome ''class1''. More specifically, we note the following for the tests above. For (i) the level of significance α corresponds to the two tails of the

binomial distribution with parameters n and p^*, where the size of the upper tail is α_2 and that of the lower tail is α_1 so that $\alpha_1 + \alpha_2 = \alpha$. The implication here is that, t_1 and t_2 are obtained from the binomial distribution table such that $P(Y \leq t_1) = \alpha_1$ and $P(Y > t_2) = \alpha_2$ where Y follows the binomial distribution with parameters n and p^*. For (ii) $P(Y > t) = \alpha$ or $P(Y \leq t) = 1-\alpha$ and for (iii) $P(Y \leq t) = \alpha$. The attaractiveness of the binomial test is that it allows us to test hypothesis on whether the poverty incidence has increased or decreased. As earlier noted by Kale (2012), our interest shall be to confirm whether the incidence of poverty has decreased or increased from 69%. In line with the three forms of the binomial test's hypotheses, the following hypotheses shall be of interest:

$$\begin{matrix} a. & H_0 : p = 0.69 \\ & H_0 : p < 0.69 \\ b. & H_0 : p = 0.69 \\ & H_0 : p > 0.69 \end{matrix} \qquad (6)$$

1.4 Large Sample Approximation for the Binomial Test

When n is large ($n \geq 30$), the large sample approximation is given below. Let

$$Z^* = \frac{T - E_0(T)}{[Var_0(T)]^{\frac{1}{2}}} = \frac{T - np_0}{\sqrt{np_0q_0}} \sim N(0,1) \qquad (7)$$

where np_0 and np_0q_0 are the expectation and variance of T under the null hypothesis. From (5), the number of poor households (q) is determined from the binomial test by noting that the test statistic T is also the number of poor households. The implication of this is that the estimate of the head count index from the binomial test is

$$P_0 = \frac{T}{N} \qquad (8)$$

This is not very different from the estimate of the head count index given by Kakwani (1993). The decision rules for Z^* in (7) for the hypotheses mentioned in (6) are to reject the null hypotheses when $Z^* < Z_\alpha$ (or $-Z^* > -Z_\alpha$) and $Z^* > Z_\alpha$ (or $-Z^* < -Z_\alpha$) respectively.

2. Empirical Illustration

2.1 Description of Data

The methods presented in this study will be applied to the 2012/2013 Nigeria General Household Survey Panel data. The General Household Panel Survey (GHPS) was conducted by the National Bureau of Statistics(NBS) of Nigeria in 2012 in partnership with the Federal Ministry of Agriculture and Rural Development, the National Food Reserve Agency, the Bill and Melinda Gates Foundation and the World Bank. The 2012/2013 GHPS was the first of its kind in Nigeria. The GHPS was a cross sectional survey of 22,000 households carried out periodically throughout the country. The survey involved the selection of a sub-sample of 5,000 households which became the sample for the GHPS. The information collected on these households included information on agricultural, household income, expenditure and consumption activities. The sample design used in the GHPS was a two stage probability proportional to size sampling scheme. The first stage was the selection of the primary sampling units(PSUs). These were the enumeration areas(EAs). A total of five hundred (500) EAs were selected as PSUs. The second stage was the selection of households. The systematic sampling selection method was used for the selection of ten (10) households from each EA. The selection of ten households per EA was informed from previous general household surveys (GHSs) where ten households per EA were considered adequate. Five hundred (500) EAs were canvassed and 5,000 households were interviewed such that different states had different sample sizes. However, the households considered were not selected with replacement and this made the total number of households interviewed lower than the expected 5, 000 households. The choice of the GHPS for a study of this type is ideal since it provides a framework to monitor similar households over time. It should be noted again for emphasis, that the adopted proxy of poverty in this study, is the per capita household expenditure. This is the ratio of total expenditure to the household size for a given household. The poverty lines used are defined in (2), (3) and (4) respectively.

2.2 Results and Discussion

The traditional poverty line and its varints as defined in (2), (3) and (4) respectively are shown in Table (1). z_2 is the highest followed by z_3 and z_2. The corresponding number of the poor(q) from the poverty lines are shown in Table (2). The highest number of the poor came from z_2 followed by the numbers of the poor from z_3 and z_1. The estimates of the number of the proof based on the binomial test statistic for z_2, z_3 and z_1 in Table (3) are 3000, 2269 and 1867 respectively.

z_1 (traditional poverty line)	z_2	z_3
₦73989.9	₦110984.9	₦85906.95

Table 1: Estimates of the Poverty Lines

z_1 (traditional poverty line)	z_2	z_3
1867	3000	2269

Table 2: Estimates of the number of the poor

As discussed under (1.3), the test statistic T of the binomial test is the number of the poor also. From Table (2), it is obvious that the test statistic,T, is as shown in Table (3) for the poverty lines z_1, z_2 and z_3 respectively.

	T
z_1	1867
z_2	3000
z_3	2269

Table 3: Estimates of the binomial test statistic for the poverty lines

The large sample approximation to the binomial test as noted in (1.4) was used since the size (4536) of the data is indeed large. The mean, standard deviation and the test statistic values under the binomial test hypotheses are shown in Table (4). The means and standard deviations are the same for the three poverty lines used in this study. The reason for this similarity is because the sample size (n) and the hypothesized propotion of the poor (p^*) are fixed. Varying the values of these binomial test parameters might be a suggestion for future research. The test statistic values for the large sample approximation reveal that the highest value came from z_2 while the least came from z_1. The last column of Table (3.4) gives the critical value of the test statistic when $\alpha = 0.05$. The implication of this critical value is that the null hypothesis formulated in (2.6a) cannot be rejected since $- Z^* < - Z_\alpha$. For the hypothesis (2.6b), the null hypothesis will be rejected since $- Z^* < - Z_\alpha$. The implication of accepting and rejecting the null hypotheses in (2.6a) and (2.6b) is that $p^* \geq 0.69$ and this validates the claim by Kale (2012). The results here further implies that poverty is on the increase in Nigeria and this corroborates Ajakaiye et al (2016, p.218) who noted that '' Nigeria, no doubt, typifies a country that has had rapid economic growth but worsening poverty''. This study, by this finding, correlates with IndexMundi's (http://goo.gl/bmKYvS) estimate of the number of people living below the poverty line which was estimated as 70%.

	Mean $E_o(T)$	**Standard Deviation $\sqrt{Var_o(T)}$**	**Z^***	
z_1	**3129.84**	**31.1488**	**-40.542**	**$Z_\alpha = Z_{0.05} = 1.645$**
z_2	**3129.84**	**31.1488**	**-4.168**	
z_3	**3129.84**	**31.1488**	**-27.636**	

Table 4: Estimates of the mean, variance, standard deviation and Z^* under the null hypotheses of the binomial test for the poverty lines

Conclusion

This study has attempted an approach of estimating the poverty incidence in Nigeria via the binomial test. The appeal of this approach is that it allows us to determine, statistically, whether the incidence of poverty has increased or decreased. This is needful because it allows the government to access the impact of poverty interventions. It is worthy of note that the binomial test is robust to different poverty lines and the finding of this study suggests that poverty incidence in Nigeria is on the rise in line with past studies. There is therefore the need for the government to accelerate sincere efforts in reducing the burden of poverty in the country.

REFERENCE

1. Adawo, M. A. Poverty Reduction in Nigeria: A Necessary Agenda.*Current Research Journal of Economic Theory*, *3*(1), (2011).pp. 14-19
2. Adesanoye, A. O., and Okunmadewa, F. Y. Households' vulnerability to poverty in Ibadan metropolis, Oyo State, Nigeria. *Pakistan Journal of Social Sciences*, *4*(1), (2007). Pp. 120-128
3. Aigbokhan, B. E. Poverty alleviation in Nigeria: Some macroeconomic issues. In *NES Annual Conference Proceedings* (1997). (pp. 181-209)
4. Ajakaiye, D. O., and Adeyeye, V. A. Concepts, measurement and causes of poverty. *Central Bank of Nigeria Economic and Financial Review*, *39*(4), (2001). Pp. 8-44
5. Ajakaiye, O., Jerome, A. T., Olaniyan, O., Mahrt, K., & Alaba, O. A. 'Spatial and temporal multidimensional poverty in Nigeria', *Growth and Poverty in Sub-Saharan Africa*, (2016): p. 218.
6. Akerele, D., Momoh, S., Adewuyi, S. A., Phillip, B. B., and Ashaolu, O. F. Socioeconomic determinants of poverty among urban households in South-West Nigeria. *International Journal of Social Economics*, *39*(3), (2012). Pp. 168-181
7. Akintola, J. O., and Yusuf, J. Socio–economic analysis of poverty levels among rural dwellers in kwara state, Nigeria. *International Journal of Environment and Development*, *5*(2), (2001). Pp. *42-48*

8. Alkire, S., & Foster, J. *Counting and multidimensional poverty. Counting and multidimensional poverty measures.* OPHI working paper Series: (2007). 7

9. Alkire, S., & Foster, J. Counting and multidimensional poverty measurement. *Journal of Public Economics*, *95*(7), (2011). Pp. *476-487*

10. Alkire, S., & Santos, M. E. Acute multidimensional poverty: A new index for developing countries. *United Nations development programme human development report office background paper*, (2010). (2010/11)

11. Anyanwu, J. C. Towards reducing poverty in Nigeria: the case of Igboland. *J Econ Int Finance*, *2*, (2011). Pp. *513-528*

12. Anyanwu, J. C. *Accounting for Poverty in Africa: Illustrations with Survey Data from Nigeria.* African Developent Bank. (2012).

13. Anyanwu, J. C. The correlates of poverty in Nigeria and policy implications. *African Journal of Economic and Sustainable Development*, *2*(1), (2013). Pp. *23-52*

14. Asogwa, B. C., Okwoche, V. A., and Umeh, J. C. Analysing the determinants of poverty severity among rural farmers in Nigeria: a censored regression model approach. *American International Journal of Contemporary Research, 2(5),* (2012). Pp. *166-176*

15. Atkinson, A. B. Multidimensional deprivation: contrasting social welfare and counting approaches. *The Journal of Economic Inequality*, *1*(1): (2003). Pp. *51-65*

16. Batana, Y. M. Multidimensional measurement of poverty in Sub-Saharan Africa. *OPHI Working*, (13) (2008).

17. Bourguignon, F., & Chakravarty, S. R :The measurement of multidimensional poverty. *The Journal of Economic Inequality*, *1*(1), (2003). Pp. *25-49*

18. Canagarajah, S., and Thomas, S. Poverty in a wealthy economy: the case of Nigeria. *Journal of African Economies*, *10*(2), (2001). pp. *143-173*

19. *Fajardo-Duka, M. Poverty measurement and decomposition of aggregate poverty change in the Philippines. Philippine Review of Economics, 29(2) (1992).*

20. Foster, J., Greer, J., and Thorbecke, E. A class of decomposable poverty measures. *Econometrica: Journal of the Econometric Society*, (1984). Pp. *761-766*

21. Ibrahim, H., and Umar, H. S. Determinants of poverty among farming households in Nasarawa State, Nigeria. *PAT*, *4*(1), (2008). Pp. *11-21*

22. Kakwani, N. Poverty and economic growth with application to Côte d'Ivoire. Review of Income and Wealth, *39(2),* (1993). Pp. *121-139*

23. Kale, Y. The Nigeria poverty profile 2010 report. In *Press Briefing By The Statistician-General Of The Federation/Chief Executive Officer, National Bureau Of Statistics, Dr. Yemi Kale Held At The Conference Room, 5th Floor, NBS Headquarters, Central Business District, Abuja* (2012).

24. Levine, S., Muwonge, J., & Batana, Y. M. A Robust Multi-Dimensional Poverty Profile for Uganda. *Journal of Human Development and Capabilities*, *15*(4), (2014). pp. *369-390*

25. Obayelu, O. A., & Awoyemi, T. T. Spatial dimension of poverty in rura Nigeria. *Journal of Development and Agricultural Economics, 2(6),* (2010). Pp. *231-244*

26. Okoroafor, M. O., and Nwaeze, C. Poverty and Economic Growth in Nigeria 1990-2011. *The MacrothemeReview*, *2*(6) (2013).

27. Olaniyan, O., and Awoyemi, T. T. Inequality in the Distribution of Household Expenditure in Rural Nigeria: A decomposition analysis (2006).

28. Olorunsanya, E. O., and Omotesho, O. A. A Gender Analysis of Poverty Profile of Rural Farming Households in North Central, Nigeria. *International Journal of Agricultural Economics and Rural Development*, *4*(2), (2011). Pp. *11-27*

29. Olubanjo, O. O., Akinleye, S. O., & Soremekun, W. A. Poverty determinants among farmers in Ogun State, Nigeria. *Medwell Agric. J*, *2*(2), (2007). Pp. *275-280*

30. Omonona,B.T.,E.J. Udoh and A.A. Adeniran Poverty and its Determinants among Nigerian Farming Households: Evidence from Akinyele LGA of Oyo State, Nigeria. *European Journal of Social Sciences, Volume 6, Number 3* (2008). *pp 402-413*

31. Oshewolo, S. Galloping poverty in Nigeria: an appraisal of government interventionist policies. *Journal of Sustainable Development in Africa*, *12*(6), (2010). Pp. *264-274*

32. Osinubi, T. S. Urban poverty in Nigeria: A case study of Agege area of Lagos state, Nigeria. August, GDNnet (2003).

33. Oyekale, A. S., Adeoti, A. I., and Ogunnupe, T. O. Sources of income inequality and poverty in rural and urban Nigeria. In *3rd Annual Workshop of Poverty and Economic Policy (PEP) Network Dakar, Senegal, 11th-20th June* (2004).

34. Oyekale, T. O. Impact of poverty reduction programs on multidimensional poverty in rural Nigeria. *Jnl. of Sustainable Development in Africa, 13*(6) (2011).

35. Sahn, D. E., & Stifel, D. Exploring alternative measures of welfare in the absence of expenditure data. *Review of income and wealth*, *49*(4), (2003). Pp. *463-489*

36. Sen, A. Issues in the Measurement of Poverty. *The Scandinavian Journal of Economics*, (1979). Pp. *285-307*

37. Sen, A. Well-being, agency and freedom: the Dewey lectures 1984. *The Journal of Philosophy*, (1985). Pp. *169-221*

38. Sen, A. The standard of living: lecture I, concepts and critiques. *The Standard of Living*, (1987). 1-19

39. Srinivasan, T. N. Poverty and undernutrition in South Asia. *Food Policy, 25*(3): (2000).pp. *269-282*.

40. Tsui, K. Y. Multidimensional poverty indices. *Social Choice and Welfare, 19(1):* (2002). Pp. *69-93*