Efficiency Of Proportional Allocation Procedure Over Other Allocation Procedures In Stratified Random Sampling

Fayose Taiwo Stephen, Adebara Lanre

The Federal Polytechnic, School of Science and Computer Studies, Department of Mathematics and Statistics, Nigeria, PH +2348165264106
fayose_ts@fedpolyado.edu.ng

The Federal Polytechnic, School of Science and Computer Studies, Department of Mathematics and Statistics, Nigeria, PH +2347030538802
lanreadebara@gmail.com

ABSTRACT: The study is designed to examine the efficiency of Proportional allocation procedure over equal and Neyman allocations. The data used for this study were secondary data collected from the National Bureau of Statistics in Ondo State, Nigeria on the income of Household Heads. A stratified random sampling scheme was used in selecting 5 income categories (stratum) in the study. A 10% sample was randomly selected from each category and the mean, variance and standard errors of incomes were obtained. Having analyzed the data collected using Equal Allocation, Proportional Allocation and Neyman Allocation procedures, the variance and standard error of proportional allocation procedure were smaller than that of Neyman Allocation and equal allocation procedures. Hence, Proportional allocation procedure is the best and hence the most efficient. The mean and variance of Optimum Allocation were not considered because the cost of sampling was not available. Finally, the least income was ₦10,000 and highest income was ₦1,650,000. This indicated that incomes were unevenly distributed.

KEYWORDS: Efficiency, Stratified Random Sampling, Proportional Allocation, Neyman Allocation.

1.0 Introduction.
Sampling methods are designed to provide valid, scientific and economical tools for research problems. According to Kish (1965) and Hunt and Tyrell (2004), sampling plays a vital role in research design involving human population and commands increasing attention from social scientists, chemists, engineers, accountants, biologists and medical practitioners. Sampling problems are in general to practitioners engaged in marketing, commerce, industry, public health, biostatistics, education, public administration, economics, sociology, anthropology, psychology, political Science and even social workers (Olayiwola *et al*, 2013). Income refers to as money or other gain or return resulting from goods or services produced in a given period of time, usually measured annually. Income may be received by an individual or by an entity, such as a corporation or a government. Income is usually measured in money terms. The various types of income are usually described within the private or the public sector of economic activity. In the private sector the four major types of incomes are wages, the return for use of land; interest, the return for the use of capital; and profit, the return to the business owner. Income is referred to as National Income in the public sector. National Income refers to as the money measure of the annual flow of goods and services in an economy. Income is the consumption and savings opportunity gained by an entity within a specified time frame which is generally expressed in monetary terms. Wealth is the amount that households have accumulated out of the past income through saving or inheritance. In General Household's Survey, Income is defined as the sum of all the wages, salaries, profits, interest, payments, rents and other forms of earnings received in a given period of time usually in a year. The amount that any household gets depends on its income and wealth. In Public Sector Economics, Total Income Consumption, Savings and Investments.

MATERIALS AND METHODS
The methodologies include Stratified Random Sampling, method of Proportional allocation, Neyman allocation procedures.

STRATIFIED RANDOM SAMPLING
Stratified Random Sampling is a method of sampling from a population. Stratified Random Sampling is one obtained by separating the population elements into non overlapping group, called strata and selecting a simple random sample from each. It ensures that at least one observation is picked from each of the strata, even if probability of it being selected is far less than 1.

PROPORTIONAL ALLOCATION
Proportional allocation method is a procedure for providing a sample among the strata in stratified sample survey. It is also an allocation procedure in stratified ransom sampling that partitions the sample size among the strata proportional to the size of the strata. A stratified sample selects separate samples from subgroups of the population, which are called "strata" and can often increase the accuracy of survey results. There is need to decide how to allocate the resources for data gathering to the strata. Three factors typically affect the distribution of resources to the strata include: The population size, The variability of values, The data collection per unit cost in the strata. Proportional allocation uses a sampling fraction in each strata that is proportional to that of the total population. The stratifies estimator of the proportion p is

$$\sum_{i=1}^{m} W_i P_i \qquad (1)$$

Where the weights Wi, are defined as in the case of sampling for the population:

$$W_i = \frac{N_i}{N} \qquad (2)$$

The following is an approximate expression for the variance of the estimator of the population proportion P, for use with large samples. The appropriate variance of $\widehat{P}$ is

$$V(P_{st}) = \sum_{i=1}^{m} W_i^2 \frac{P_i Q_i}{n_i} \qquad (3)$$

Where $Q_i = 1 - \widehat{P_1}$

When finite – population correction factors f_i must be considered, the following expression is appropriate for the variance of P_{st}:

$$V(P_{st}) = \frac{1}{N} \sum_{i=1}^{m} N_i (N_i - n_i) \frac{P_i Q_i}{(N_i - 1) n_i} \qquad (4)$$

When the proportional allocation is used, an approximate expression is

$$V(P_{st}) = \frac{1-f}{n} \sum_{i=1}^{m} W_i^2 P_i Q_i \qquad (5)$$

NEYMAN ALLOCATION
Neyman allocation method was proposed by A.A. Tschuprow in 1923 but named after J. Neyman. It is a method used to allocate samples to strata based on the strata-variances and similar sampling costs in the strata. A Neyman allocation scheme provides the most precision for estimating populations mean given a fixed total sample size for stratified random sampling, the population is divided into H mutually exclusive strata. Neyman allocation is a sample allocation method that may be used with stratified samples. The purpose of the method is to maximize survey precision given a fixed sample size. The variance of the Neyman allocation is

$$V[X_{n,opt}^*] = \frac{1}{n} \left(\sum_{k=1}^{i} w_k \sigma_k \right) \qquad (6)$$

Neyman allocation method is better than proportional allocation but if the variances of the strata are all the same, then proportional allocation is as efficient as Neyman allocations.

DATA PRESENTATION AND ANALYSIS

TABLE 1: TABLE SHOWING NO OF HOUSEHOLD HEADS SELECTED RANDOMLY ON EACH STRATUM

| INCOME CATEGORY IN NAIRA	NUMBER OF HOUSEHOLD HEADS
0-24,999	500
25,000-39,999	600
40,000-59,999	500
60,000-99,999	300
100,000 AND ABOVE	100
TOTAL	**2000**

TABLE 2: TABLE SHOWING NO OF HOUSEHOLD HEADS SELECTED RANDOMLY IN EACH STRATUM AFTER 10% SAMPLING IN EACH STRATUM

INCOME CATEGORY IN NAIRA	NUMBER OF HOUSEHOLD HEADS
0-24,999	50
25,000-39,999	60
40,000-59,999	50
60,000-99,999	30
100,000 AND ABOVE	10
TOTAL	**200**

A 10% sample was randomly selected from each stratum so as to obtain the stratified mean.

RESULTS AND DISCUSSIONS

Figure 1: Bar Chart showing the frequency of Household Heads and Income category
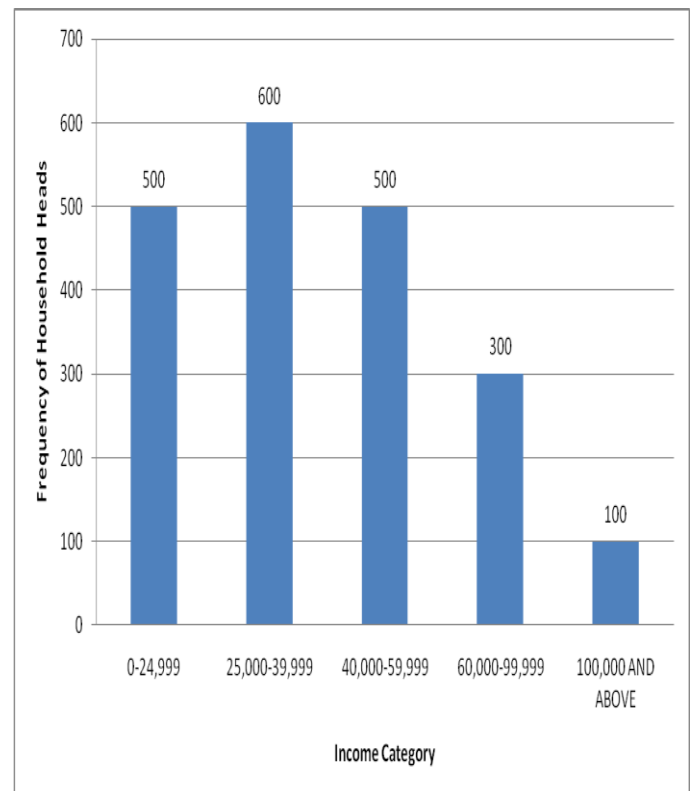
Considering the analysis and estimates obtained, the variance and standard error under Neyman allocation procedure were 15.294 and 3.911 respectively. For proportional allocation, the variance 0.2491 and standard

error 0.4991 while equal allocation gave variance of 0.261 and Standard error of 0.5109. Proportional allocation procedure gave the least variance. This was followed by Equal allocation and Neyman allocation procedures. Proportional allocation procedure is the best selection procedure for this study. Hence, for estimating the mean, variance and the standard error of the income of Household heads in Ondo State, of all the three sample allocation procedures considered in this study, Proportional allocation procedure is the best and hence the most efficient.

CONCLUSION

The principle of stratification has been applied to income distribution of household heads in Ondo State. It is necessary as income vary from individual to individual. Finally, for estimating the variance and standard error of the income of household heads in Ondo State, out of all the three sample allocation procedures considered in this study, Proportional allocation procedure is the best and hence the most efficient.

REFERENCES

[1] D. R. Anderson, D. J. Sweeney, T. A. Williams, J. Freeman and E. Shoesmith , "Statistics for Business and Economics".9th edition. Thomson. ISBN-13-978-1-84480-313-2. 2007.

[2] P. David, Doane and Lorie, Seward, "Journal of Statistics Education". Volume 19, No 2. 2011.

[3] S. P. Ghosh, "A Note on Stratified Random Sampling with Multiple Characters." Col. Stat. Bull, 8, 81 – 89. 1958.

[4] N. Hunt and S. Tyrell. "Stratified Sampling." Coventry University Press. 2004. http://www.coventry.ac.uk/ec/~nhunt/meths/strati.html (accessed February 28, 2011).

[5] L. Kish, "Survey Sampling." New York. Wiley. 1965.

[6] P. S. Mann, "Introductory Statistics –International Student Version." 7th edition. Wiley Plus Inc. ISBN: 978-0-470-50583-0. 2009.

[7] J. Neyman, "On the Two Different Aspects of the Representative Methods. The Method Stratified Sampling and The Method of Purposive Selection" Journal of Royal Statistical Society, 97, 558-606. 1934.

[8] O. M. Olayiwola, F. S. Apantaku, H. O. Bisira and A. A. A. Adewara, "Efficiency of Neyman Allocation Procedure over other allocation procedures in Stratified Random Sampling" American Journal of Theoretical and Applied Statistics, 2 (5): 122-127. Doi: 10.116/ajtas.20130205.12. 2013.

[9] S. C. Gupta, "Fundamentals of Statistics" 6th edition. ISBN: 978-93-5024-595-8. 2010.

[10] P. V. Sukhatme, B. V. Sukhatme, S. Sukhatme and C. Asok, "Sampling Theory of Survey with Applications." 3rd edition. Ames, Iowa: Iowa State University Press. 1984.

[11] O. A. Adedayo "Understanding Statistics".

Author Profile

Fayose Taiwo Stephen obtained HND in Statistics from The Federal Polytechnic, Ado Ekiti, Ekiti State, Nigeria in 2007. He also obtained PGD in Statistics from The Federal University of Technology Akure, Ondo State, Nigeria in 2014. He further obtained BSc degree in Statistics from Joseph Ayo Babalola University, Ara-Ikeji, Osun State, Nigeria in 2015. He also obtained MBA degree in Financial Management from Ladoke Akintola University of Technology, Oyo State in 2013. He recently completed his M.Tech degree in Statistics from the Federal University of Technology, Akure, Ondo State, Nigeria in 2018. He began his lecturing career in 2013 at The Federal Polytechnic, Ado Ekiti, Ekiti State, Nigeria. He belongs to different professional and academic bodies both in Nigeria and overseas. He is happily married.