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Alaine DC Amon and Zita V.J. Albacea, PhD

For additional information, please contact:

Author's name : Alaine DC Amon
Designation : Instructor
Affiliation : Institute of Statistics, U.P. Los Baños
Address : College, Los Baños, Laguna
Tel. no. : (049) 536-2381
E-mail : alaine_amon@yahoo.com; alaine_amon@hotmail.com

Co-author's name : Zita V.J. Albacea
Designation : Associate Professor
Affiliation : Institute of Statistics, U.P. Los Baños
Address : College, Los Baños, Laguna
Tel. no. : (049) 536-2381
E-mail : zvjalbacea@yahoo.com

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Alaine DC Amon and Zita V.J. Albacea, PhD ²

ABSTRACT

Food poverty is defined as the inability to access good quality, affordable and nutritious food. One of its measures is food poverty incidence or subsistence incidence which is defined as the proportion of households whose annual income is below the computed food threshold to the total number of households. In this paper, estimates of food poverty incidence at the municipality level obtained using three estimation techniques are being presented. One of the estimation techniques used is the direct estimation with the use of the 2000 Family Income and Expenditure Survey (FIES) data set. The other two indirect estimation techniques, specifically the regression-synthetic and the empirical best linear unbiased prediction (EBLUP), use the variables from 2000 Census on Population and Housing and other administrative data, in addition to the direct estimates in estimating the municipal food poverty incidence. The direct estimates of the municipality-level food poverty incidence range from 0 to 100%. On the average the municipality-level food poverty incidence in the Philippines is equal to 12.52%. There were 253 direct estimates equal to zero while there is only municipal estimate with 100% food poverty incidence 1 estimate equal to 100. The direct estimates were found to be unreliable since only 7 estimates have coefficients of variation of at most 10 percent. In the regression-synthetic estimation procedure, the resulting predicting model has 4 predictors, namely; municipal proportion of (1) households headed by male married person who is elementary undergraduate; (2) households with members aged between 1 and 6 years; (3) housing units with roof made of light materials; and (4) barangays with electricity. This model resulted reliable set of estimates. On the other hand, the EBLUP procedure resulted to estimates that are even less reliable than the direct estimates.

KEYWORDS: Food poverty incidence, direct estimation, regression-synthetic estimation, empirical best linear unbiased prediction

I. INTRODUCTION

Poverty, a form of deprivation, is one of the major problems of many countries and reducing them is a global concern. In fact, the first of the United Nation's Millennium Development Goals (MDG) is to eradicate extreme poverty and hunger, with specific target of halving the share of people whose income is less than one dollar a day and of people who suffer from hunger between the year 1990 and 2015. However, attempting to reduce poverty requires a sound understanding of which people are affected; particularly there is a need to identify who the poor are, where they are and how many they are.

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² Instructor and Associate Professor of Statistics, respectively, University of the Philippines Los Baños, College, Laguna, Philippines.

In the Philippines, poverty alleviation has been a major concern in developing policies and programs as reflected in the Philippine Medium Term Development Plan. Official poverty statistics in the country are released by the National Statistical Coordination Board (NSCB) and are estimated every three years after the results of the Family Income and Expenditure Survey (FIES) have been available except for food and poverty threshold, which are estimated annually.

One of the essential aspects in depicting poverty is food poverty. Food poverty is defined as the inability to access good quality, affordable and nutritious food. It is usually measured in terms of food poverty incidence or subsistence incidence, which is defined as the proportion of households whose income is below the computed food threshold to the total number of households. It indicates how much of the total number of households are food poor thus reflecting the economic, social and nutritional status of the country and affects the country's overall performance.

Food threshold, also known as subsistence threshold, is used to identify the households that cannot afford to buy the basic food requirements. Particularly, food threshold refers to the peso value of the minimum food requirements just enough to satisfy the nutritional requirements for economically necessary and socially desirable physical activities (Marquez and Virola, 1995). Further, for a person to be able to meet its minimum food needs, a person should have an income of at least the per capita food threshold. In the official poverty statistics released by NSCB, the per capita subsistence threshold in the national level is P7,810 in the year 2000. It was estimated that 16.7% of the households or 2.5 million households are below the subsistence threshold in the year 2000, which is an increase of 0.5% over the 16.2% estimate in 1997. The NSCB also produces estimates of food threshold and food poverty incidence at the regional level with urban-rural disaggregation. National Capital Region (NCR) has the highest regional food threshold in 2000. An individual in this region needs to have an annual income of at least P9,561 to meet his basic food requirements. Region IX or Zamboanga Peninsula Region has the lowest food threshold.

With large portion of the national government spending responsibilities devolved to the local government since 1991 as a means of bringing government service closer to its user, provincial level estimates or even municipal level estimates need to be generated. These estimates will be used to determine which of the specific provinces or municipalities need the support of the government the most. Therefore there is a need to generate reliable statistics at this level.

In response to this need, the NSCB estimates the food poverty incidence at the provincial level. However it was observed that these provincial direct estimates produce high coefficients of variation. Sample sizes in the provincial level are rarely large enough such that direct estimates may not be considered reliable. In fact, sample sizes are zero for some provinces. Moreover, this problem will even get worse if municipal-level direct estimates are to be obtained. This problem is due to the limitation of the sampling design of FIES from which the income and expenditure data used for poverty estimation are gathered. This survey is designed to provide precise direct estimates up to the regional level. The 2000 FIES was conducted based from the revised master plan that was designed to provide estimates at the provincial level with an acceptable measure of reliability. However, using this survey, some provincial estimates still did not render sampling errors at tolerable level (Albacea, 2004).

An option to improve the local area level estimates is to increase the number of sample households for each local area. However, increasing the sample size would require additional cost. Furthermore, non-sampling errors may increase due to the increase in the sample size. Another alternative approach to obtain reliable estimates at the local area level without increasing the sample size and risk of non-sampling error is by the use of small area estimation techniques. These techniques make uses of administrative and/or census data, on top of the survey data to produce more accurate and precise estimates for smaller areas of disaggregation.

Applying the small area estimation techniques, this paper aims to estimate food poverty incidence at the municipality level. By estimating the municipality food poverty incidence, the local government can determine which the municipalities that need the support the most and thus, nutritional as well as basic assistance can be easily implemented.

II. METHODOLOGY

There were three major sources of data used and these are: the Family Income and Expenditure Survey (FIES) and Census on Population and Housing (CPH) and data from administrative records. The FIES is a nationwide survey of households conducted by the National Statistics Office (NSO) every three years since 1985. The survey collects information on family income, expenditures, consumptions and other related information affecting income and expenditure levels and patterns in the country.

The Census of Population and Housing is also conducted by NSO once every 10 years with Census of Population at 5-year interval. The 2000 Census of Population and Housing otherwise known as Census 2000 is the 11th census of population and the 5th census of housing to be undertaken in the Philippines and it was designed to take an inventory of the total population and housing units in the Philippines as well as collect information about their characteristics.

The data from 2000 Field Health Service Information System (FHSIS) of the Department of Health, 2000 enrolment information from the Department of Education and income class of the province and municipalities were also used. The FHSIS is a nationwide compilation of selected health indicators of the different programs of the Department of Health.

Using the 2000 FIES, food poor households were identified. A food poor household is defined as a household whose income is below the regional food threshold. The annual per capita income of the household was compared to the official regional food threshold released by NSCB. Those households whose annual per capita income is below the regional food threshold are classified as food poor. The direct estimator of the municipal food poverty incidence is defined as the ratio of the total number of food poor households to the total number of households in the municipality. The direct estimator is based on data obtained from sample units in the area of interest.

The indirect estimates of food poverty incidence at the municipal level of the Philippines are also generated. These indirect estimators use the model-based approach. One of techniques under the model-based approach is the regression-synthetic estimation. This method makes use of a weighted least squares estimator of b obtained using weights equal to the inverse of the total variability due to modeling and sampling processes.

The initial step in the regression synthetic technique is to identify a set of auxiliary variables that describe the characteristics of a household that may be related to municipality level food poverty incidence. These set of auxiliary variables should be available in the 2000 FIES, Census 2000, 2000 FHSIS and other administrative data and should be defined and measured in a consistent way in all data sources. To determine the possible auxiliary variables to be included in the model, variables from Census 2000, 2000 FHSIS and other administrative data were correlated with the direct estimates of food poverty incidence. The variables which are highly correlated with food poverty incidence were included as auxiliary variables. With these auxiliary variables, the regression synthetic estimates of the parameter

was determined. Estimates of the bias, mean square error and coefficient of variation were obtained to evaluate the regression synthetic estimates. Coefficient of determinations, R^2 and adjusted R^2 were also used to assess the overall adequacy of the model. Assumptions of the classical linear regression model were also evaluated.

To obtain the EBLUP estimate of municipality level food poverty incidence, the regression synthetic estimate was combined with the direct estimates with the ratio of the variance due to modeling process to the total variance as weights. For the municipalities with no direct estimates, the EBLUP estimates were considered to be the same as the regression-synthetic estimates. Estimates of the mean square error and coefficient of variation were obtained to evaluate the EBLUP estimates.

Furthermore, the municipal food poverty incidence estimates using the direct, regression-synthetic and EBLUP techniques were compared based on the mean square error and coefficient of variation of the estimates. All results were generated using the Statistical Analysis System (SAS) and STATA software.

III. RESULTS AND DISCUSSION

The 2000 FIES have 1,237 municipalities considered for estimation. Based on the 2000 FIES, the municipality-level food poverty incidence ranges from 0 to 100 percent. On the average, the municipality food poverty incidence in the Philippines is equal to 18.13% with a standard deviation of 18.75%. Thirty-two percent (512 out of 1,237) of the municipalities have an estimated food poverty incidence of at most 10% while only 4 municipalities have an estimated food poverty incidence greater than 90%. From the 1,237 municipalities, 253 municipalities (20.45%) yielded an estimate of food poverty incidence equal to 0% which implies that in these 253 municipalities no households were identified as food poor. While only the municipality of Bacungan (Leon B. Postigo) from the province of Zamboanga del Norte has an estimated food poverty incidence equal to 1 which implies that all households in this municipality are food poor.

Ranking the municipalities in descending order of the direct estimates of food poverty incidence shows that among the top 10 food poor municipalities, 8 municipalities are from Mindanao. The top 10 food poor municipalities are: Bacungan (Zamboanga del Norte), Barira (Maguindanao), Siayab (Zamboanga del Norte), Sapad (Lanao del Norte), Tigbao (Zamboanga del Sur), Banisilan (Cotabato), Tinglayan (Kalinga), San Francisco (Quezon), Old Panamao (Sulu) and Maimbung (Sulu).

Since 253 municipalities have zero estimates for the food poverty incidence and 1 municipality have an estimate of food poverty incidence equal to 1, only 983 municipalities have a valid estimate of mean square error and coefficient of variation of the estimates. Of these 983 municipalities with valid estimates, only 7 municipalities have reliable estimates with coefficients of variation of at most 10%. These municipalities are: Sapad (Lanao del Norte), Datu Odin Sinsuat, Sultan Kudarat, Barira (Maguindanao), Alabel (Sarangani), Siayan (Zamboanga del Norte), and Tigbao (Zamboanga del Sur). Of these municipalities, the municipality of Barira from Maguindao obtain the most reliable estimates of food poverty incidence with a coefficient of variation equal to 2.53 percent. On the average, the coefficient of variation of municipality food poverty incidence is equal to 54.70% with a standard deviation of 27.31 percent. Most of the municipalities (196 out of 983 or 19.94%) have estimates with coefficients of variation greater than 90%, which indicates that the direct estimates are unreliable.

Generally, most of the direct estimates of food poverty incidence at the municipality level have small distances from their true values as reflected by their mean square errors. The small values of the mean square errors imply that the direct estimates are accurate and precise. The mean square error ranges from 7.26×10^{-7} to 0.0248 with Baguio City having the most precise and most accurate estimate of food poverty incidence. On the average, the mean square error of the estimates is equal to 0.0093 with a standard deviation of 0.0070. Most of the municipalities (173 out of 983 or 17.60%) have a mean square error of at most 0.002.

In modeling the municipality food poverty incidence, auxiliary variables were first identified. The possible auxiliary variables used in the study were obtained from 2000 Census of Population and Housing, 2000 FHSIS and other administrative data sources. In this study, of the 983 municipalities with valid direct estimates 7 municipalities were excluded in the modeling process since these estimates are found to be outliers. Therefore, only 976 municipalities were considered in modeling municipality food poverty incidence.

Several functional relationships were tried however only the model which satisfies the assumptions of the classical regression model and most parsimonious model was to be selected. The predicting model for municipality food poverty incidence consist of four predictors, namely: proportion of household headed by male married person who is elementary undergraduate, proportion of barangays with electricity, proportion of households with members aged between 1 to 6 years, and proportion of housing units with roof made of light materials. The model was fitted using weighted least square (WLS) estimation

procedure with weights equal to the reciprocal of the estimated total variance both due to sampling and modeling processes. The estimated coefficients of the weighted regression model are shown in the table below together with their standard errors. The resulting model has a coefficient of determination, R^2 , of 22.26% and an adjusted R^2 of 21.94 percent. This means that about 22% of the total variation of the municipality food poverty incidence are explained by the predictors in the model. The model is significant at 1% level of significance while the auxiliary variables are significant at 2% level of significance.

Table 1 Estimated regression coefficients of the model of food poverty incidence at the municipality level using the weighted least squares procedure.

PREDICTOR	ESTIMATED COEFFICIENT	STANDARD ERROR
Municipality level proportion of households headed by male married person who is elementary undergraduate	0.427	0.066
Municipality level proportion households with members aged between 1 and 6 years	0.223	0.099
Municipality level proportion of housing units with roof made of light materials	0.135	0.025
Municipal proportion of barangays with electric power	-0.091	0.022
Constant	0.031	0.055

Using the WLS estimates of the coefficients, the predicted values from the model serve as the regression-synthetic estimates of municipality food poverty incidence. For the municipality included in the sample, the estimates of municipality food poverty incidences range from 2.3 to 41.83%. On the average, the estimate of municipality food poverty incidence in the Philippines is 19.91% with a standard deviation of 7.71 percent. Majority of the municipalities have an estimate of food poverty incidence between 10 to 30%. On the other hand, no municipality has estimates greater than 50 percent. All municipalities have accurate and precise regression synthetic estimate as indicated by their mean square error with values of at most 0.0008. In terms of reliability, the coefficients of variation of the estimates range from 2.35% to 60.25% of which almost 91% have coefficients of variation at most 10 percent. Generally, the regression synthetic estimation technique generated accurate, precise and reliable estimates of municipality food poverty incidence in the Philippines as reflected by their mean square error and coefficients of variation.

Combining the direct estimates and the regression-synthetic estimates with appropriate weight, the empirical best linear unbiased predictor (EBLUP) estimates of the municipality food poverty incidence were obtained. The weight used in EBLUP estimation is determined by the ratio of the model variance to the total variance. Therefore, for those

municipalities with small variance in the regression-synthetic estimation compared to the direct estimation, the regression-synthetic have larger contribution in determining the EBLUP estimates than the direct estimate.

The EBLUP estimates range from 0.0085 to 61.56% which is wider compared to the regression-synthetic estimates but narrower compared to the direct estimates. On the average, the EBLUP estimate of the municipal food poverty incidence is 19.91% with a standard deviation of 12.06%. Almost 34% of the estimates range from 10 to 20 percent. In terms of accuracy and precision, the mean square error ranges from 0 to 0.0093. More than 87% of the estimates have mean square error greater than 0.0012. In terms of reliability of these estimates, the coefficient of variation ranges from 7.95% to 99.83% of which only 2 municipalities have coefficients of variation of at most 10 percent. The distribution of the coefficient of variation is said to concentrate between 20 to 40%. These estimates did not show any improvement in terms of reliability as compared from the direct estimates.

IV. CONCLUSION

Food poverty incidence reflects the economic, social and nutritional status of the country. It indicates how much of the total number of households are food poor. In this paper, food poverty incidence was estimated at the municipality level. Particularly, this study showed the application of regression-synthetic and empirical best linear unbiased prediction techniques as small area estimation techniques in determining the municipality food poverty incidence.

The results show that the “best” set of estimates were obtained using the regression-synthetic estimator since the mean square errors of the estimates obtained are the smallest compared to the two other estimation techniques. Moreover, the regression-synthetic estimator gave almost 91% of the municipalities with estimates having coefficients of variation at most 10%.

Thus, this paper shows that model-based estimation techniques, specifically the regression-synthetic does provide an alternative set of estimates to the direct estimation technique for estimating municipal food poverty incidence.

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