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Design-Based Estimation Of Provincial Poverty Incidence In The Philippines

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ABSTRACT

This study presents a procedure to estimate provincial or city-level poverty incidence of the Philippines using the sampling design of the 1994 Family Income Expenditure Survey (FIES). The properties of the design-based estimates like its mean, mean square error and coefficient of variation are also computed. The design-based estimates of provincial or city level poverty incidence are unbiased. However, the estimates have large mean square error and coefficients of variation. On the average, the mean square error of the estimates is 0.003649 while the average coefficient of variation of the estimates is 19.15%. the lowest computed coefficient of variation is 4.8% while the highest is 127.08%. Only 28 out of 105 provinces and cities have coefficients of variation at most 10%. These results indicate that computing provincial or city-level estimates of poverty incidence based on the design of FIES will not provide precise estimates. Alternative estimation procedure like small area estimation techniques can be used instead.

KEYWORDS: Poverty Incidence; Design-based Estimation; Complex Survey

1. INTRODUCTION

In the Philippines, official statistics are usually generated at the national and regional levels since most of the nationwide surveys, which are the main sources of these estimates, have regions as their domains. In particular, official poverty statistics are produced for national and regional levels with urban-rural disaggregation. This is because the methodology used by the government in determining poverty threshold allows for estimation at these levels only. This condition was brought about by the limitation of the needed data obtained from various nationwide surveys like the Food Consumption Survey (FCS), Retail Price Survey (RPS), Farm Prices Survey (FPS), Family Income and Expenditure Survey (FIES), and National Nutrition Survey (NNS). Estimates obtained from some of these surveys are said to be precise at the regional level only since regions are commonly used as domains of estimation in their sampling designs.

With the strengthening of the local government through the Local Government Code, there is a need to produce statistics at a disaggregation level smaller than a region with urban-rural disaggregation. Provincial or even municipality estimates especially poverty statistics are being recommended as well as demanded by both users and policy makers. Virola (1994) recommended that a study be made on the possibility of producing official provincial poverty figures so as to focus rightly the government programs to the proper beneficiaries. In an open forum during the Sixth National Convention on Statistics held on December 4-5, 1995, Virola also commented that regional estimates may no longer be relevant and that the more relevant statistics at this time would be those lower than regional level, e.g. provincial and city levels.

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Officials of the provinces need to use provincial and city level statistics to better improve implementing, monitoring and evaluating projects. The national government, on the other hand, may use provincial and city level statistics to determine those provinces that need more government support. One way of generating these statistics is to conduct surveys at the provincial and city levels. However, the conduct of such surveys will be very costly and time consuming. A possible alternative is to obtain direct estimates of provincial and city level statistics from the results of nationwide surveys. But such approach was reported (Ghosh and Rao, 1994) to be disadvantageous in the sense that it is unreliable. In this paper, this 'negative' characteristic of the design-based estimates will be investigated. In addition, the computation of the standard error of provincial poverty incidence estimates will be expounded using the 1994 FIES data set. The statistical Analysis System (SAS) software was used to implement all the computations.

2. METHODOLOGY

2.1 Overview

Poverty incidence is defined as the ratio of two counts, namely; total number of poor households and total number of households. Both counts are estimated at a given level of aggregation. The income statistics that are used to determine the poor households can be obtained from the Family Income and Expenditure Surveys (FIES). The 1994 FIES used a stratified two-stage cluster sampling design. The urban and rural areas of each province and major cities serve as principal domains for the survey. Barangays, which are classified as either urban or rural, are the primary sampling units (PSUs) and the households within each sample barangay comprise the secondary sampling units (SSUs). It is also from this survey where expenditure statistics used in the computation of regional poverty thresholds are obtained.

Let the subscript i denote a province or a city in one of the regions in the Philippines. Let the variable Yi-(htk) for the kth household in the tth barangay of the hth stratum be equal to one if the income of the household is below the regional poverty threshold; and zero, otherwise. Similarly, let xi-(htk) be an indicator variable defined as one if the (htk)th household belongs to the ith province or city; zero, otherwise. Also, the basic sampling weight attached to the $(htk)^{th}$ element, denoted by $w_{(htk)}$, is taken as the inverse of the probability of inclusion of the element in the sample.

2.2 Design-based estimator of provincial poverty incidence.

A design-based estimator of poverty incidence of the i^{th} province or city, denoted by $\hat{P}_i$, is given by:

$$\hat{P}_i = \frac{\hat{NP}_i}{\hat{N}_i} \qquad (1)$$

where $\hat{NP}_i$ is an estimate of the total number of poor households and $\hat{N}_i$ is an estimate of the total number of households residing in the i^{th} province or city.

The design-based estimator of the total number of households in the i^{th} province or city is

$$\hat{N}_i = \sum_{h=1}^{L}\sum_{l=1}^{b_h}\sum_{k=1}^{c_{hl}} w_{(hlk)} x_{i-(hlk)} \qquad (2)$$

while an estimator of the total number of poor households in the i^{th} province or city is defined as

$$\hat{NP}_i = \sum_{h=1}^{L}\sum_{l=1}^{b_h}\sum_{k=1}^{c_{hl}} w_{(hlk)} Y_{i-(hlk)} \qquad (3)$$

The estimator, $\hat{p}_i$, is a combined ratio estimator. Cochran (1977) showed such estimator is consistent but biased except in some special types of population. However, the bias is negligible in large samples. An expression for the bias of the estimator is given by:

$$\left| BIAS \ in \ \hat{p}_i \right| = \sigma_{\hat{p}_i} \frac{\rho_{\hat{p}_i \hat{N}_i} \cdot \sigma_{\hat{N}_i}}{N_i} \leq cv \ of \ \hat{N}_i$$

where $\sigma_{\hat{p}_i}, \sigma_{\hat{N}_i}, \rho_{\hat{p}_i \hat{N}_i}$ and N_i, are the standard error of $\hat{p}_i$, standard error of $\hat{N}_i$, correlation coefficient of $\hat{p}_i$ and $\hat{N}_i$, and the true total number of households in i^{th} province or city, respectively. Also, cv of $\hat{N}_i$ refers to the coefficient of variation of $\hat{N}_i$. Cochran (1977) also stated that the bias is negligible relative to its standard error, provided only that the cv of $\hat{N}_i$ is less than 0.10.

Usually, a nonlinear estimator, like $\hat{p}_i$, has no exact expression for the sampling variances nor simple and unbiased estimators of its variability. According to Wolter (1985), a useful method of estimating the variability of nonlinear estimators is to approximate the estimator by a linear function of the observations. Then, variance formulae appropriate to the specific design can be applied to the linear approximation. One such method makes use of Taylor series or binomial series expansion.

To derive estimates of bias and mean square error of $\hat{p}_i$, model $\hat{NP}_i$ as $NP_i + e_{1i}$ and $\hat{N}_i$ as $N_i + e_{2i}$ where e_{1i} and e_{2i} are correlated error terms since both estimates are taken from the same survey. Thus,

$$\hat{p}_i = \frac{\hat{NP}_i}{\hat{N}_i} = \frac{NP_i\left(1 + \frac{e_{1i}}{NP_i}\right)}{N_i\left(1 + \frac{e_{2i}}{N_i}\right)} = p_i \frac{\left(1 + \frac{e_{1i}}{NP_i}\right)}{\left(1 + \frac{e_{2i}}{N_i}\right)} \qquad (4)$$

can be written using Taylor series expansion as

$$\hat{p}_i = p_i\left(1+\frac{e_{1i}}{NP_i}\right)\left(1-\frac{e_{2i}}{N_i}+\frac{e_{2i}^2}{N_i^2}-\text{K}\right)$$

$$= p_i\left(1+\frac{e_{1i}}{NP_i}-\frac{e_{2i}}{N_i}-\frac{e_{1i}e_{2i}}{NP_iN_i}+\frac{e_{2i}^2}{N_i^2}+\text{K}\right)$$

and

$$\hat{p}_i - p_i = p_i\left(\frac{e_{1i}}{NP_i}-\frac{e_{2i}}{N_i}-\frac{e_{1i}e_{2i}}{NP_iN_i}+\frac{e_{2i}^2}{N_i^2}+\text{K}\right). \tag{5}$$

Retaining terms up to and including degree two and taking the expectations term by term, a first order approximation to the bias is given by:

$$BIAS\ \ in\ \ \hat{p}_i = E[\hat{p}_i]-p_i$$

$$= p_i\left(\frac{E[e_{1i}]}{NP_i}-\frac{E[e_{2i}]}{N_i}-\frac{E[e_{1i}e_{2i}]}{NP_iN_i}+\frac{E[e_{2i}^2]}{N_i^2}\right).$$

With $E[e_{1i}] = E[e_{2i}] = 0$, the expression becomes

$$BIAS\ \ in\ \ \hat{p}_i = p_i\left(-\frac{E[e_{1i}e_{2i}]}{NP_iN_i}+\frac{E[e_{2i}^2]}{N_i^2}\right)$$

$$= p_i\left(\frac{Var[\hat{N}_i]}{N_i^2}-\frac{Cov\left[\hat{NP}_i,\hat{N}_i\right]}{NP_iN_i}\right). \tag{6}$$

Using estimates of p_i, N_i and its variance estimator, NP_i, and its corresponding covariance estimator with N_i, a natural estimator of the approximate bias in $\hat{p}_i$ is then given by

$$bi\hat{a}s\ \ in\ \ \hat{p}_i = \hat{p}_i\left(\frac{v\hat{a}r[\hat{N}_i]}{\hat{N}_i^2}-\frac{c\hat{o}v\left[\hat{NP}_i,\hat{N}_i\right]}{\hat{NP}_i\hat{N}_i}\right). \tag{7}$$

Likewise, a first order approximation of the total variance or the mean square error (MSE) of $\hat{p}_i$ can be obtained. Squaring both sides of Equation 5 and taking its expectation lead to the following expression:

$$E\left[(\hat{p}_i-p_i)^2\right] = E\left[p_i^2\left(\frac{e_{1i}^2}{NP_i^2}+\frac{e_{2i}^2}{N_i^2}-\frac{2e_{1i}e_{2i}}{NP_iN_i}+\frac{e_{1i}^2e_{2i}^2}{NP_i^2N_i^2}+\text{K}\right)\right]. \tag{8}$$

Using a similar technique employed in obtaining an approximate bias, the resulting expression is:

$$E\left[(\hat{p}_i - p_i)^2\right] = p_i^2\left(\frac{E\left[e_{1i}^2\right]}{NP_i^2} + \frac{E\left[e_{2i}^2\right]}{N_i^2} - \frac{2E\left[e_{1i}e_{2i}\right]}{NP_iN_i}\right)$$

which can be simplified to:

$$MSE\left[\hat{p}_i\right] = p_i^2\left(\frac{Var\left[\hat{NP}_i\right]}{NP_i^2} + \frac{Var\left[\hat{N}_i\right]}{N_i^2} - \frac{2Cov\left[\hat{NP}_i, \hat{N}_i\right]}{NP_iN_i}\right). \qquad (9)$$

Substituting estimates of p_i, N_i, and NP_i, and their corresponding variance and covariance estimators in Equation 9 leads to an estimator of the mean square error of $\hat{p}_i$ which is given by:

$$m\hat{s}e\left[\hat{p}_i\right] = \hat{p}_i^2\left(\frac{v\hat{a}r\left[\hat{NP}_i\right]}{\hat{NP}_i^2} + \frac{v\hat{a}r\left[\hat{N}_i\right]}{\hat{N}_i^2} - \frac{2c\hat{o}v\left[\hat{NP}_i, \hat{N}_i\right]}{\hat{NP}_i\hat{N}_i}\right). \qquad (10)$$

This expression is similar to those given in several textbooks like Cochran (1977), Sukatme, et. al. (1984) and Wolter (1985).

The variance and covariance estimators of $\hat{NP}_i$ and $\hat{N}_i$, are computed according to the sampling design of FIES, that is,

$$v\hat{a}r\left(\hat{NP}_i\right) = \sum_h^L \frac{b_h}{b_h - 1}\sum_l^{b_h}\left(\hat{NP}_{i-hl} - \overline{NP}_{i-h}\right)^2,$$

$$v\hat{a}r\left(\hat{N}_i\right) = \sum_h^L \frac{b_h}{b_h - 1}\sum_l^{b_h}\left(\hat{N}_{i-hl} - \overline{N}_{i-h}\right)^2, \quad \text{and} \qquad (11)$$

$$c\hat{o}v\left(\hat{NP}_i, \hat{N}_i\right) = \sum_h^L \frac{b_h}{b_h - 1}\sum_l^{b_h}\left(\hat{NP}_{i-hl} - \overline{NP}_{i-h}\right)\left(\hat{N}_{i-hl} - \overline{N}_{i-h}\right);$$

where

$$\hat{NP}_{i-hl} = \sum_{k=1}^{c_{hl}} w_{(hlk)}y_{i-(hlk)},$$

$$\overline{NP}_{i-h} = \sum_{l=1}^{b_h}\hat{NP}_{i-hl} \Big/ b_h,$$

$$\hat{N}_{i-hl} = \sum_{k=1}^{c_{hl}} w_{(hlk)}x_{i-(hlk)},$$

$$\overline{N}_{i-h} = \sum_{l=1}^{b_h}\hat{N}_{i-hl} \Big/ b_h,$$

b_h is the total number of primary sampling units (barangays) in the h^{th} stratum of the i^{th} province or city; and c_{hl} is the total number of secondary sampling units (households) in the t^{th} primary sampling unit of the h^{th} stratum in the i^{th} province or city.

Using the mean square error, another measure of variability of the estimator can be computed. This measure which is commonly referred to as the coefficient of variation or $cv[\hat{p}_i]$ is computed as:

$$cv[\hat{p}_i] = \frac{\sqrt{m\hat{s}e[\hat{p}_i]}}{\hat{p}_i}. \tag{12}$$

3. RESULTS AND DISCUSSION

Poverty incidence was estimated following the sampling design of the 1994 FIES, which is stratified two-stage cluster sampling. The estimates of the counts: total number of poor households $\left(\hat{NP}_i\right)$ and total number of households $\left(\hat{N}_i\right)$, are unbiased. Table 1 shows the estimates and their corresponding coefficients of variation for provinces and cities that were defined as separate domains in FIES.

On the average, there are an estimated 121,476 households per province or city with an estimated 43,671 poor households. The minimum estimated number of households is 2,977 in the province of Batanes, which has also the minimum estimated number of poor households equal to 376. On the other hand, the highest estimated number of households is 420,918 in the province of Negros Occidental excluding Bacolod City. Pangasinan has the highest estimated number of poor households, which is equal to 191,092.

Table 1. Design-based estimates of the total number of poor households and total number of households by region, province and city and their corresponding coefficients of variation (CV). 1994 FIES.

REGION	PROVINCE/CITY	$\left(\hat{NP}_i\right)$	CV OF $\left(\hat{NP}_i\right)$	$\left(\hat{N}_i\right)$	CV OF $\left(\hat{N}_i\right)$
NCR	Manila	27141	26.19	382027	1.54
NCR	Pasig	5803	34.55	91884	1.61
NCR	Quezon City	22949	17.38	352462	0.89
NCR	Caloocan City	17663	13.76	134912	1.71
NCR	Makati	5730	39.66	105459	8.90
NCR	Pasay City	5845	33.45	75985	3.04
NCR	Other Metro	35592	19.15	378165	0.96
NCR	Marikina	4728	36.51	69502	1.52
NCR	Valenzuela	13471	26.57	97226	2.69
NCR	Parañaque	4458	41.94	78022	3.14
1	Ilocos Norte	40500	10.54	99823	3.28
1	Ilocos Sur	55571	9.02	111541	1.43
1	La Union	53663	16.54	115743	8.51
1	Pangasinan	191092	6.54	379156	3.94
2	Batanes	376	127.66	2977	3.16
2	Cagayan	81843	10.01	184922	3.76
2	Isabela	78253	11.77	238550	1.62
2	Nueva Viscaya	16286	34.96	70148	5.04
2	Quirino	15873	9.66	26502	8.77

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Table 1. continued ....

REGION	PROVINCE/CITY	$\left(\hat{NP}_i\right)$	CV OF $\left(\hat{NP}_i\right)$	$\left(\hat{N}_i\right)$	CV OF $\left(\hat{N}_i\right)$
3	Bataan	31230	19.08	98878	10.36
3	Bulacan	41929	17.20	308259	5.54
3	Other Nueva Ecija	82107	9.90	241174	1.30
3	Other Pampanga	30051	20.24	213312	2.60
3	Other Tarlac	51616	14.15	123297	6.61
3	Other Zambales	34426	11.82	80059	5.52
3	Angeles City	9847	31.05	53264	2.11
3	Olongapo City	13964	29.80	49595	2.17
3	Cabanatuan City	7339	30.27	36148	11.06
3	San Fernando	1616	57.74	28273	2.86
3	Tarlac	15994	25.88	42388	7.77
4	Other Batangas	50285	16.70	227991	0.99
4	Cavite	21563	21.94	246572	4.93
4	Other Laguna	48125	11.41	257093	3.45
4	Marinduque	24522	29.92	44836	13.87
4	Occidental Mindoro	20463	14.47	62897	4.30
4	Oriental Mindoro	52351	11.54	121397	1.16
4	Palawan	66609	9.96	109622	6.37
4	Other Quezon	128782	7.36	272833	2.47
4	Rizal	24291	14.84	173985	3.27
4	Romblon	38928	6.32	45863	2.73
4	Aurora	17054	12.04	33296	7.03
4	Batangas City	7037	26.67	37348	5.83
4	Lipa City	7315	37.64	30158	4.71
4	San Pablo City	4303	53.99	35720	3.69
4	Lucena City	3814	27.96	31785	1.33
5	Albay	88435	9.94	198788	3.08
5	Camarines Norte	39144	18.05	80521	1.89
5	Camarines Sur	140477	6.93	272831	2.19
5	Catanduanes	15135	29.03	41860	16.60
5	Masbate	124802	8.31	153430	4.30
5	Sorsogon	78841	8.44	130465	3.60
6	Aklan	32253	15.42	81243	3.07
6	Antique	53256	7.77	91295	2.79
6	Capiz	70326	7.72	125715	4.56
6	Other Iloilo	133429	8.40	289321	1.38
6	Other Negros Occidental	177447	6.52	420918	3.04
6	Iloilo City	5954	38.30	57947	1.85
6	Bacolod City	15610	26.04	66960	2.21
7	Bohol	84341	12.30	186580	5.56
7	Other Cebu	113894	9.71	363309	2.53
7	Negros Oriental	80002	10.69	213388	2.83
7	Siquijor	7774	29.37	18412	17.91
7	Cebu City	15837	23.06	130053	2.80
7	Mandaue City	7469	25.20	40612	2.20
8	Eastern Samar	22542	26.93	82008	9.45
8	Leyte	121194	9.39	321595	2.29
8	Northern Samar	49276	11.63	103205	1.79
8	Samar (Western)	42993	13.28	105918	2.11
8	Southern Leyte	28112	10.96	80953	9.69

Table 1. continued ....

REGION	PROVINCE/CITY	$\left(\hat{NP_i}\right)$	CV OF $\left(\hat{NP_i}\right)$	$\left(\hat{N}_i\right)$	CV OF $\left(\hat{N}_i\right)$
9	Basilan	20055	18.14	52595	7.56
9	Zamboanga Del Norte	88118	8.22	146824	3.35
9	Other Zamboanga Del Sur	103558	10.53	218977	2.97
9	Zamboanga City	18801	40.91	90372	20.94
10	Other Agusan Del Norte	29227	13.46	50552	8.68
10	Agusan Del Sur	48156	10.25	71499	2.19
10	Bukidnon	98250	18.01	165538	12.21
10	Camiguin	8106	15.10	12365	8.52
10	Misamis Occidental	48720	15.57	97646	4.45
10	Other Misamis Oriental	56053	14.33	118986	10.01
10	Surigao Del Norte	57730	11.01	98180	4.33
10	Butuan City	20506	14.25	44293	2.07
10	Cagayan De Oro City	21750	13.07	75136	15.60
11	Davao	80627	9.60	183250	5.93
11	Other Davao Del Sur	83444	8.32	135540	1.33
11	Other South Cotabato	65154	12.59	162695	3.13
11	Surigao Del Sur	42894	14.90	97795	6.42
11	Davao City	24591	32.13	179747	2.35
11	Davao Oriental	53717	11.57	86544	2.13
11	General Santos City	8909	32.43	41574	2.92
12	Other Lanao Del Norte	49354	6.95	74290	3.91
12	Cotobato	91397	10.29	155093	3.76
12	Sultan Kudarat	45218	17.87	86876	3.18
12	Iligan City	24719	35.36	48306	15.39
12	Marawi City	3536	36.00	10609	7.86
12	Cotobato City	2913	42.55	20069	5.59
CAR	Abra	30449	26.47	39133	21.62
CAR	Other Benguet	25432	17.17	65262	5.78
CAR	Ifugao	23159	35.87	27746	30.98
CAR	Kalinga-Apayao	29491	15.30	48042	3.01
CAR	Mountain Province	16894	31.98	25013	24.61
CAR	Baguio City	5540	27.08	36009	4.16
ARMM	Other Lanao Del Sur	36843	10.44	77715	4.11
ARMM	Other Maguindanao	77860	7.69	118534	3.30
ARMM	Sulu	60473	10.91	84588	3.64
ARMM	Tawi-Tawi	22905	18.76	49179	3.50

Likewise, the coefficient of variation of $\hat{N}_i$ is presented. On the average, the coefficient of variation of $\hat{N}_i$ is 5.44%, which is less than 10% (the limit suggested by Cochran (1977) for bias to be considered negligible). The minimum coefficient of variation is 0.89% that of Quezon City with 814 sampled households while the maximum is 30.98% that of the province of Ifugao with 77 sampled households. The distribution of the values of the coefficient of variation of $\hat{N}_i$ is given in Table 2. At least 87% (92 out of 105) of the small areas have coefficient of variation less than 10%. Those small areas with coefficient of variation at least 10% include Bataan, Cabanatuan City, Marinduque, Catanduanes, Siquijor, Zamboanga City, Bukidnon, Misamis Oriental excluding Cagayan de Oro City, Cagayan de Oro City, Iligan City, Abra, Ifugao and Mountain Province.

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Table 2. Distribution of the coefficient of variation of $\hat{N}_i$ ($m = 105$ provinces and cities).

COEFFICIENT OF VARIATION (%)	FREQUENCY	PERCENTAGE
At most 10.00	92	87
10.01 – 20.00	9	9
20.01 – 30.00	3	3
Greater than 30.00	1	1

Using the estimated counts, the design-based estimates of poverty incidence was computed. Table 3 shows the estimates and their approximate characteristics like bias, variance, mean square error and coefficient of variation.

On the average, the poverty incidence of a small area is equal to 38.05%. The lowest estimated poverty incidence is 5.43% that of Makati City while the highest estimated poverty incidence is 84.88% that of the province of Romblon. The approximate bias of the estimates ranges from -0.009705 to 0.005144 where at least 40% (43 out of 105) are less than zero. The average bias is -0.000123 which indicates that the estimates slightly underestimate the true value. In terms of total variability (mean square error), the average approximate variability is 0.003649. The lowest approximate mean square error is 0.00130 of Quezon City and the highest is that of Batanes with an approximate mean square error equal to 0.25723. Note that Quezon City has the lowest coefficient of variation of $\hat{N}_i$ and with 814 sample households compared to Batanes with 69 sample households included in the survey. Because of this high approximate mean square error, Batanes has a high coefficient of variation of $\hat{p}_i$ equal to 127.08%. The lowest coefficient of variation is 4.80% of Lanao del Norte excluding Iligan City.

Table 3. Design-based estimates of provincial and city level poverty incidence. 1994 FIES.

REGION	PROVINCE/CITY	*No. of sampled households*	$\hat{p}_i$	BIAS	MSE	CV OF $\hat{p}_i$
NCR	Manila	746	0.0711	-0.000004	0.000345	26.14
NCR	Pasig	190	0.0632	0.000127	0.000491	35.08
NCR	Quezon City	814	0.0651	0.000015	0.000130	17.51
NCR	Caloocan City	359	0.1309	0.000028	0.000327	13.81
NCR	Makati	292	0.0543	0.000098	0.000452	39.13
NCR	Pasay City	182	0.0769	-0.000271	0.000615	32.24
NCR	Other Metro	850	0.0941	0.000036	0.000331	19.33
NCR	Marikina	147	0.0680	0.000093	0.000629	36.87
NCR	Valenzuela	166	0.1386	-0.000287	0.001261	25.63
NCR	Parañaque	140	0.0571	-0.000182	0.000550	41.04

Table 3 continued....

REGION	PROVINCE/CITY	*No. of sampled households*	$\hat{p}_i$	BIAS	MSE	CV OF $\hat{p}_i$
1	Ilocos Norte	182	0.4057	0.000733	0.002245	11.68
1	Ilocos Sur	194	0.4982	0.000421	0.002388	9.81
1	La Union	210	0.4636	-0.000426	0.003927	13.52
1	Pangasinan	760	0.5040	-0.000017	0.000675	5.16
2	Batanes	69	0.1262	-0.000873	0.025723	127.08
2	Cagayan	302	0.4426	0.000390	0.002032	10.19
2	Isabela	405	0.3280	0.000163	0.001568	12.07
2	Nueva Viscaya	114	0.2322	0.001319	0.007064	36.20
2	Quirino	76	0.5990	0.000663	0.001385	6.21
3	Bataan	189	0.3159	0.000043	0.002588	16.11
3	Bulacan	678	0.1360	-0.000246	0.000424	15.14
3	Other Nueva Ecija	430	0.3405	-0.000023	0.001100	9.74
3	Other Pampanga	424	0.1409	0.000064	0.000818	20.30
3	Other Tarlac	265	0.4186	0.000178	0.002892	12.85
3	Other Zambales	150	0.4300	0.000803	0.002711	12.11
3	Angeles City	119	0.1849	-0.000529	0.003084	30.04
3	Olongapo City	103	0.2816	0.000761	0.007429	30.61
3	Cabanatuan City	128	0.2030	0.001414	0.003846	30.55
3	San Fernando	70	0.0571	0.000183	0.001107	58.23
3	Tarlac	77	0.3773	-0.001076	0.007864	23.50
4	Other Batangas	422	0.2206	-0.000006	0.001350	16.66
4	Cavite	503	0.0875	0.000456	0.000429	23.68
4	Other Laguna	552	0.1872	0.000299	0.000526	12.25
4	Marinduque	109	0.5469	-0.005730	0.014755	22.21
4	Occidental Mindoro	117	0.3253	0.000328	0.002234	14.53
4	Oriental Mindoro	198	0.4312	0.000228	0.002648	11.93
4	Palawan	204	0.6076	-0.000332	0.001762	6.91
4	Other Quezon	463	0.4720	0.000365	0.001416	7.97
4	Rizal	463	0.1396	0.000134	0.000446	15.13
4	Romblon	97	0.8488	0.000152	0.002602	6.01
4	Aurora	63	0.5122	0.002432	0.004999	13.80
4	Batangas City	102	0.1884	0.002606	0.003387	30.88
4	Lipa City	85	0.2426	-0.001244	0.007600	35.94
4	San Pablo City	75	0.1205	-0.000579	0.004071	52.96
4	Lucena City	75	0.1200	0.000436	0.001228	29.20
5	Albay	322	0.4449	0.000221	0.001965	9.96
5	Camarines Norte	142	0.4861	0.000857	0.008449	18.91
5	Camarines Sur	457	0.5149	0.000272	0.001425	7.33
5	Catanduanes	102	0.3616	-0.004166	0.004401	18.35
5	Masbate	211	0.8134	-0.000223	0.002978	6.71
5	Sorsogon	186	0.6043	0.001123	0.003483	9.77
6	Aklan	140	0.3970	0.000660	0.004123	16.17
6	Antique	156	0.5833	0.000510	0.002386	8.37
6	Capiz	209	0.5594	0.001315	0.002686	9.26
6	Other Iloilo	506	0.4612	0.000044	0.001501	8.40
6	Other Negros Occidental	702	0.4216	0.000237	0.000791	6.67
6	Iloilo City	146	0.1027	-0.000105	0.001523	37.98
6	Bacolod City	163	0.2331	0.000679	0.003976	27.05

Table 3. continued ...

REGION	PROVINCE/CITY	*No. of sampled households*	$\hat{p}_i$	BIAS	MSE	CV OF $\hat{p}_i$
7	Bohol	343	0.4520	-0.000535	0.001976	9.83
7	Other Cebu	738	0.3135	-0.000133	0.000780	8.91
7	Negros Oriental	343	0.3749	-0.000025	0.001476	10.25
7	Siquijor	63	0.4222	-0.002085	0.007891	21.04
7	Cebu City	271	0.1218	0.000182	0.000821	23.53
7	Mandaue City	47	0.1839	0.000133	0.002181	25.39
8	Eastern Samar	121	0.2749	-0.000407	0.004583	24.63
8	Leyte	576	0.3769	0.000086	0.001244	9.36
8	Northern Samar	136	0.4775	0.000316	0.003313	12.06
8	Samar (Western)	195	0.4059	0.000347	0.003114	13.75
8	Southern Leyte	129	0.3473	0.000964	0.000987	9.05
9	Basilan	99	0.3813	0.001577	0.005156	18.83
9	Zamboanga Del Norte	246	0.6002	0.000787	0.002973	9.09
9	Other Zamboanga Del Sur	403	0.4729	-0.000294	0.002004	9.47
9	Zamboanga City	190	0.2080	0.002147	0.006238	37.97
10	Other Agusan Del Norte	87	0.5782	-0.001140	0.002222	8.15
10	Agusan Del Sur	150	0.6735	-0.000308	0.004133	9.55
10	Bukidnon	304	0.5935	-0.002079	0.003703	10.25
10	Camiguin	66	0.6556	-0.001487	0.004727	10.49
10	Misamis Occidental	166	0.4990	0.000498	0.006041	15.58
10	Other Misamis Oriental	200	0.4711	0.001053	0.003323	12.24
10	Surigao Del Norte	159	0.5880	0.001966	0.005858	13.02
10	Butuan City	103	0.4630	-0.000402	0.003888	13.47
10	Cagayan De Oro City	180	0.2895	0.004997	0.002285	16.51
11	Davao	399	0.4400	0.000300	0.001366	8.40
11	Other Davao Del Sur	233	0.6156	0.000020	0.002581	8.25
11	Davao Oriental	148	0.6207	-0.000243	0.004681	11.02
11	Other South Cotabato	317	0.4005	0.000072	0.002443	12.34
11	Surigao Del Sur	163	0.4386	0.001154	0.004492	15.28
11	Davao City	366	0.1368	-0.000446	0.001799	31.00
11	General Santos City	46	0.2143	0.000395	0.004961	32.87
12	Other Lanao Del Norte	135	0.6644	-0.000334	0.001015	4.80
12	Cotobato	267	0.5893	-0.000806	0.002234	8.02
12	Sultan Kudarat	164	0.5205	0.000450	0.008845	18.07
12	Iligan City	88	0.5117	-0.007217	0.019142	27.04
12	Marawi City	36	0.3333	0.005144	0.017147	39.28
12	Cotobato City	62	0.1452	0.001320	0.004133	44.29
CAR	Abra	76	0.7781	-0.005103	0.006188	10.11
CAR	Other Benguet	111	0.3897	-0.000836	0.003316	14.78
CAR	Ifugao	77	0.8347	-0.007903	0.009582	11.73
CAR	Kalinga-Apayao	87	0.6139	-0.000424	0.007960	14.53
CAR	Mountain Province	62	0.6754	-0.009705	0.005924	11.40
CAR	Baguio City	91	0.1539	-0.000458	0.001553	25.61
ARMM	Other Lanao Del Sur	169	0.4741	0.000781	0.002813	11.19
ARMM	Other Maguindanao	223	0.6569	-0.000085	0.001967	6.75
ARMM	Sulu	167	0.7149	-0.000119	0.005241	10.13
ARMM	Tawi-Tawi	88	0.4658	0.000370	0.007710	18.85

On the average, the computed coefficient of variation of $\hat{p}_i$ is equal to 19.15% with most of the values (43 out of 105) in the range from 10.01% to 20.00% (see Table 4). Only 28 small areas out of 105 (27%) have computed coefficient of variation of $\hat{p}_i$

less than 10%. The extremely high and quite variable coefficients of variation of $\hat{p}_i$ indicate the inappropriateness of using design-based estimators for computing poverty incidence.

Table 4. Distribution of the coefficient of variation of $\hat{p}_i$ (m = 105 provinces and cities).

COEFFICIENT OF VARIATION (%)	FREQUENCY	PERCENTAGE
At most 10.00	28	27
10.01 – 20.00	43	41
20.01 – 30.00	14	13
30.01 – 40.00	15	14
40.01 – 50.00	2	2
50.01 – 60.00	2	2
Greater than 60.00	1	1

4. CONCLUSION

Using the official methodology of computing poverty statistics, estimates of poverty incidence at the provincial or city level can be obtained using data from the Family Income and Expenditure Survey (FIES) and other nation-wide surveys. A design-based estimator of poverty incidence is a combined ratio estimator. Such an estimator is non-linear and has no closed-form expression for its mean square error (MSE). Approximate measures are obtained using the Taylor series expansion.

Using the 1994 FIES, design-based poverty estimates at the provincial or city level are found to have negligible bias but large mean square errors and coefficients of variation. On the average, the mean square error of provincial or city level poverty incidence estimator is equal to 0.003649 while the coefficient of variation of has an average value of 19.15%. Only 27% of the estimates have coefficients of variation at most 10% with the highest value equal to 127.08%.

The results of this study illustrate the 'unreliability' characteristic of using design-based estimates for provincial or city level poverty incidence. Alternative estimation procedures like small area estimation techniques (Part II of this paper) can be studied to obtain better estimates.

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