SUB-NATIONAL ESTIMATES OF THE PERCENTAGE OF HEALTH FACILITY DELIVERIES IN THE PHILIPPINES[1]

by

Rosanno P. Dacanay[2]

ABSTRACT

The percentage of health facility deliveries in the Philippines was estimated at the sub-national level using small area estimation technique. Using the 2008 National Demographic and Health Survey (NDHS), direct estimation was employed to estimate the percentage. This technique only had 49 estimates with viable measure of MSE, 51 short of the target of 100 estimates. To improve the estimates, model-based technique such as the regression-synthetic procedure was used. The regression model using the said technique had three predictors: (1) proportion of households with water soiled toilets, (2) proportion of the number of doctors to the total number of health workers, and the (3) proportion of the number of health and social work establishment to the total number of establishments which were taken from the 2007 Field Health Service Information Systems, 2007 Countryside in Figures, and the 2006 Census of Philippine Businesses and Industries, respectively. The two sets of estimates were evaluated by the coefficient of variation, a measure of reliability, and the mean square error (MSE), a measure of both accuracy and precision. It was shown that the model-based procedure have more estimates that are reliable and are much precise and accurate. Thus, it can be concluded that the model-based estimates are much better estimates than the direct estimates. The small area with the lowest estimate is Zamboanga Sibugay with approximately 12% deliveries in a health facility while Quezon City has the highest with around 94%.

1. INTRODUCTION

When giving birth, it is crucial that the place of delivery is hygienic and has the necessary tools to, as much as possible, ensure safe delivery. Deliveries in health facilities, such as hospitals and clinics, have higher probability that both mother and child will avoid complications and infections. Henceforth, it is important to quantify the deliveries in health facilities.

National and regional estimates of the indicator proportion of deliveries in health facilities are available in the Philippines through the National Statistics Office (NSO); however, sub-national or small area estimates such as the provincial and municipal level are not. Getting these estimates are very important for the prompt action of the government and health sectors to the areas with very low percentage of deliveries in a health facility.

Valid estimates of the proportion of health facility deliveries will identify which provinces or cities or municipalities have low proportions and which among the estimates are extremely low. Thus, these values will guide the sectors where immediate attention should be posed to.

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[2] Instructor, Institute of Statistics, University of the Philippines Los Baños

The estimates of the indicator for the provincial, city and municipal levels may be obtained by conducting separate surveys to these areas. However, this process is tedious and costly. These problems are resolved through small area estimation, a set of statistical techniques wherein previous survey data are used for the estimation of indicators and are further improved by administrative data.

This paper will present estimates of the proportion of deliveries held in a health facility for the small areas in the Philippines. This intends to disseminate information to those involved and the public as well as to increase their awareness.

The general objective of this paper is to estimate the proportion of health facility deliveries for the provinces and some key cities in the Philippines. Specifically, this study intends to:

1. obtain the estimates through direct estimation and indirect estimation such as the regression-synthetic technique, a model-based technique; and
2. evaluate these sets of estimates by using appropriate statistical measures.

2. REVIEW OF LITERATURE

In the Philippines, the National Demographic and Health Surveys (NDHS) of the National Statistics Office (NSO) is the main survey that studies health facility deliveries, among others. The NDHS presents the indicator as the proportion delivered in a health facility among all births in the 5 years preceding the survey. The data needed for the said indicator's estimate was gathered from the Individual Women's Questionnaire. The interviewee was asked directly where her delivery took place.

According to the 2008 NDHS, the proportion of deliveries in a health facility among all births is 44.2% (National Statistics Office [NSO], 2009). In comparison with the previous surveys, the proportion went up from 34% in 1998 and 37.9% in 2003 (NSO, 2006). Regional estimates are also available. The region with the highest proportion of health facility deliveries is the National Capital Region with 69.3% while the region with the lowest is the Autonomous Region of Muslim Mindanao with 14.7%.

A number of studies outside the country were conducted to look for different factors that may affect women's choice in the place of delivery. Usually, the common determinants to health facility deliveries are antenatal care and school attendance.

In Nairobi, Kenya, results showed that having advises during antenatal care, pregnancy wantedness, and parity are main factors of place of delivery of women (Fotso, Ezeh, Madise, Ziraba, & Ogollah, 2009). Also, Out of 70% who went to health facilities for their delivery, only 48% were attended by trained professionals. Similarly, Fotso, Ezeh, and Essendi (2009) stated that higher odds of delivery in a health facility is higher in women with at least secondary education, if pregnancy was wanted, and with higher number of antenatal visits. On the other hand, it is lower in women aged less than 25 years old.

In their study in Southern Tanzania, Mrisho et al. (2007) observed in a survey that lack of money, transport, sudden onset of labor, short labor, staff attitudes, lack of privacy, tradition and cultures affect the place of delivery. Additionally, belonging to an ethnic group effects the variation in choosing the place of delivery. Also, women living in female-headed households are more likely to deliver in health facilities than those who live in male-headed households.

A study in the urban Uttar Pradesh India by Bloom, Lippeveld and Wypij (1991) also found that antenatal care is also a factor in the choice of place of delivery. In addition, it was

found that women with their first delivery is more likely to be in health facility. On the other hand, the effects of the first delivery and problems experienced during birth play an important role in health facility delivery.

Satoko, Sophal, and Susumu (2006) found that antenatal care and length of school attendance are factors in place of delivery in rural Cambodia. In addition to his findings, prolonged labour was found to affect the choice of place. In rural Burkina Faso, the use of delivery care was found to be determined by the distance of the health facility, education, and asset ownership (Hounton et al, 2008).

3. METHODOLOGY

3.1. Data Sources

The sources of data used in this study were the 2008 National Demographic and Health Surveys (NDHS), 2007 Field Health Service Information Systems (FHSIS), 2007 Countryside in Figures (CIF), and the 2006 Census of Philippine Business and Industry (CPBI). Direct and indirect estimates were derived from these four datasets.

As part of the global Demographic and Health surveys, the NDHS is conducted by the National Statistics Office (NSO) every five years with the goal of gathering information on maternal and child health, fertility and family planning. Its survey design is three-staged where the first stage are the provinces and regions; second are the primary sampling units which included a barangay or groups of contiguous barangays with at least 500 households; and third are the enumeration areas. Directly, the estimate will be obtained by employing the design and by using a ratio estimator.

Indirect estimation, specifically the regression-synthetic, needs auxiliary variables or predictors. These variables should only be administrative and/or census data. Among other datasets used, three were included. These are 2006 CPBI, 2007 FHSIS, and the 2007 CIF.

The CPBI (formerly the Census of Establishments) is nationwide census that covers the economic activities such as agriculture, fishing, construction, mining, health and other establishments. The CPBI serves as the fundamental source of information for the different sectors of businesses in the Philippines. FHSIS is an annual report presented by the Department of Health or DOH. These data include some information on health status and diseases of Filipinos. The facts on health on this report came from health offices, both regional and provincial. The CIF is a collection of vital statistics in the provincial level integrated by the National Statistical Coordination Board (NSCB).

3.2. Estimation

The small areas which were identified for the estimation of the proportion are the 17 cities/municipalities in the National Capital Region (NCR), Tacloban City in Leyte, General Santos City in South Cotabato, and the 81 provinces; which total to 100 small areas. The direct estimation employs the design of the survey. The direct estimates of proportion of health facility deliveries in a certain small area is obtained by a ratio estimator: the number of deliveries done in a health facility divided by the number of all deliveries, where government and private hospitals or clinics are considered as health facility deliveries.

Direct estimates sometimes are unreliable. Thus, indirect estimation was employed to come up with possibly much reliable estimates. The regression-synthetic estimation procedure was used in this study. This procedure uses auxiliary variables from the three

datasets discussed earlier. The auxiliary variables are those variables which are correlated to the indicator.

The regression-synthetic technique employs a linear regression model. The auxiliary variables are the predictors of the model. The predictors are fitted against the computed direct estimates. Tests on the assumptions on regression analysis were done to confirm whether or not the model was appropriate for the data. Those tests include residual analysis and multicollinearity. Residual analysis consists of tests on normality, independence, zero mean, non-serial correlation, and homoscedasticity of the errors. Aside from the assumptions of a linear regression model, the model with a relatively high coefficient of determination with logical predictors was selected.

3.3. Evaluation of Estimates

Accuracy, precision, and reliability of each of the estimates were the statistical properties used to evaluate the estimates. These properties were also used to determine which sets of estimates of the proportion of health facility deliveries are the "best".

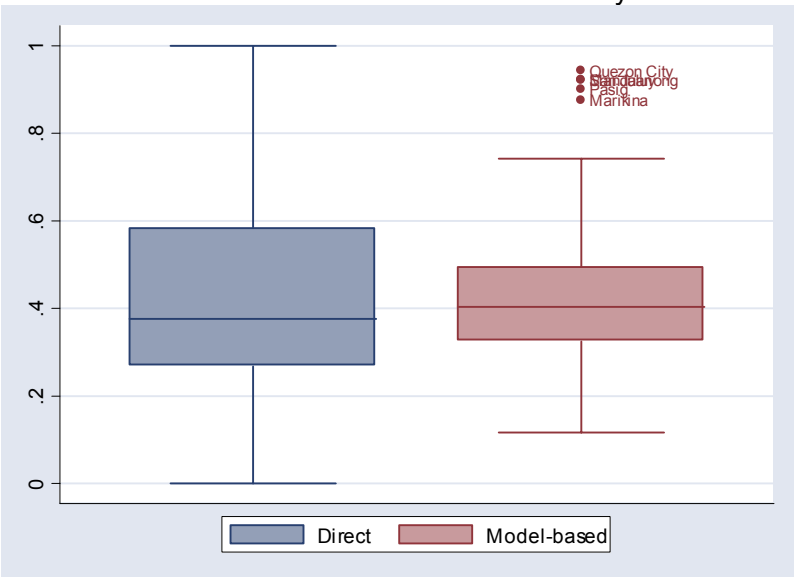
The estimates were said to be precise and accurate if the mean square error (MSE) was the smallest among the three sets. The coefficient of variation of an estimate with value of at most 10% was said to be reliable. The "best" estimation procedure for this study is the procedure with the most number of low MSE and the most number of reliable estimates.

4. RESULTS AND DISCUSSION

Out of 100 estimates for the proportion of deliveries in a health facility computed using the direct estimation procedure, only 49 have viable measures of accuracy and precision. The other 51 estimates either had negative variance, zero value of the variance, or missing variance. The 100 estimates had a mean of 0.43 and standard deviation of 0.23.

The regression-synthetic procedure produced estimates with all of them having viable estimates of the MSE and CV. Similarly with the direct estimates, the mean is also 0.43. On the other hand, the standard deviation is smaller, with a value of 0.17.

Below is the boxplot of the two sets of estimates. It can be seen that the two sets have different distributions with the model-based with a smaller dispersion. Both the sets of estimates illustrate that the center is approximately in the 0.40 mark. This means that around half of the identified small areas have at most 40% health facility deliveries.



In the National Capital Region, the direct estimates of the proportion of health facility deliveries for Pateros and San Juan in NCR both have 100%. The model-based estimates showed different results for the city with the highest proportion (Quezon City with (94.29%). Nonetheless, the two procedures both showed that Caloocan has the least value of the estimate. Note that the model-based estimates are all reliable (in terms of CV) unlike the direct estimates, where not all of them have a measure of reliability. In comparison with the direct and model-based estimates, the reported proportion of health facility deliveries from FHSIS were also included in the table. It can be seen that the FHSIS results are different from the estimates of this paper. See below.

Region	Province/City/Municipality	Administrative Values	Direct Estimation			Model-based Estimation		
			Estimate	MSE	CV	Estimate	MSE	CV
14	Manila	84.6	95.11			69.3	0.001156	4.91
14	Mandaluyong	61.8	79.86			92.21	0.002285	5.18
14	Marikina	43.4	71.58			87.55	0.002432	5.63
14	Pasig	54.1	74.02			90.05	0.002308	5.34
14	Quezon City	42.1	63.16	0.000701	4.19	94.29	0.002338	5.13
14	San Juan	45.9	100			92.14	0.002285	5.19
14	Caloocan	27.6	58.52	0.004997	12.08	52.65	0.00225	9.01
14	Malabon	28.5	70.98			67.47	0.001397	5.54
14	Navotas	0	54.34	0.028469	31.05	61.73	0.001289	5.82
14	Valenzuela	50	75.26			59.04	0.001429	6.4
14	Las Piñas	53.5	64.42	0.033597	28.45	71.99	0.001415	5.23
14	Makati	55.9	82.79	0.007275	10.3	71.57	0.001379	5.19
14	Muntinlupa	39.5	63.82			74.27	0.001667	5.5
14	Parañaque	33.1	63.51			60.93	0.001434	6.22
14	Pasay City	64.2	76.39			66.36	0.001168	5.15
14	Pateros	0	100			69.08	0.001221	5.06
14	Taguig	2.8	79.11			63.56	0.001243	5.55

The estimates for some of the key provinces are shown on the next table. Direct estimation showed that Basilan had no health facility deliveries; while the regression-synthetic technique showed that around 16 out of 100 deliveries are held in health facility. Importantly, the regression-synthetic estimation showed that there is an improvement in the estimation in most of the provinces except for the provinces in Region 16.

Region	Province/City/Municipality	Administrative Values	Direct Estimation			Model-based Estimation		
			Estimate	MSE	CV	Estimate	MSE	CV
5	Masbate	16.2	12.28	0.002605	41.55	20	0.000989	15.72
8	Eastern Samar	17.2	12.95			29.34	0.000373	6.58
8	Leyte_Tacloban City	62.2	53.85			40.08	0.000825	7.17
12	Cotobato(North)	13.4	21.36	0.001494	18.09	32.42	0.000409	6.24
12	Sultan Kudarat	15	15.31			38.82	0.000251	4.08
12	Sarangani	13.4	13.79	0.002832	38.58	23.17	0.000821	12.37
12	Cotobato City	31.7	22.23			38.74	0.001271	9.2
12	General Santos City	23.9	34.26			41.29	0.000318	4.32
13	Surigao Del Norte	23.2	37.59	0.001136	8.97	37.46	0.000324	4.81
15	Ifugao	29.5	47.26	0.005877	16.22	37.82	0.000495	5.88
16	Basilan	7	0			15.92	0.002495	31.38

Region	Province/City/Municipality	Administrative Values	Direct Estimation			Model-based Estimation		
			Estimate	MSE	CV	Estimate	MSE	CV
16	Lanao Del Sur	12.9	34.76	0.002918	15.54	15.04	0.003112	37.08
16	Maguindanao	8.4	7.88	0.00016	16.05	16.18	0.001183	21.26

Seen on the next table are the estimates for the proportion of health facility deliveries for the other 71 provinces. The provinces with the lowest and highest proportion of health facility deliveries using direct estimation are Sulu (1.48%) and Pampanga (82.01%), respectively, while for the regression-synthetic are Zamboanga Sibugay (11.64%) and Nueva Vizcaya (61.08%), respectively.

Region	Province/City/Municipality	Administrative Values	Direct Estimation			Model-based Estimation		
			Estimate	MSE	CV	Estimate	MSE	CV
1	Ilocos Norte	27.5	56.32	0.002332	8.57	40.99	0.000654	6.24
1	Ilocos Sur	21.8	46.67			44.66	0.000405	4.51
1	La Union	47.1	74.78	0.015974	16.9	42.71	0.000492	5.2
1	Pangasinan	20.2	32.5	0.000382	6.01	42.4	0.000566	5.61
2	Batanes	42.5	33.33			47.85	0.001217	7.29
2	Cagayan	22.5	34.31	0.001126	9.78	41.37	0.000518	5.5
2	Isabela	16.2	22.66	0.000464	9.5	39.47	0.000379	4.93
2	Nueva Vizcaya	26.4	32.05			61.08	0.003479	9.66
2	Quirino	24.5	31.77	0.013241	36.22	32.27	0.000521	7.08
3	Bataan	62.2	76.18	0.027562	21.79	46.85	0.000745	5.83
3	Bulacan	28.8	49.32	0.003157	11.39	55.21	0.000729	4.89
3	Nueva Ecija	24.4	46.65			46.84	0.000301	3.7
3	Pampanga	57	82.01			54.39	0.001235	6.46
3	Tarlac	33.7	51.57			45.3	0.000324	3.97
3	Zambales	36.7	52.39			51.22	0.000539	4.53
3	Aurora	19.1	28.57			34.33	0.000336	5.34
5	Albay	18.3	27.06	0.000482	8.11	37.84	0.000556	6.23
5	Camarines Norte	18.7	50.62			34.81	0.000291	4.9
5	Camarines Sur	13.2	35.8	0.0005	6.25	37.67	0.000313	4.69
5	Catanduanes	32.6	31.81			35.32	0.000337	5.2
5	Sorsogon	34.9	46.66	0.005686	16.16	29.87	0.000364	6.38
6	Aklan	28.9	26.51			40.67	0.000428	5.09
6	Antique	32.3	28.59			42.08	0.000377	4.61
6	Capiz	47.9	50.1	0.004175	12.9	37.79	0.000385	5.19
6	Iloilo	50.3	58.19	0.000243	2.68	53.56	0.001178	6.41
6	Negros Occidental	53.5	42.22			46.73	0.00044	4.49
6	Guimaras	45	66.67			43.95	0.000473	4.95
7	Bohol	26.8	25.89	0.001908	16.87	39.46	0.000511	5.73
7	Cebu	35.4	54.31	0.000776	5.13	46	0.000489	4.81
7	Negros Oriental	30.9	35.74			24.91	0.00053	9.24
7	Siquijor	11.8	25			32.4	0.001084	10.16
8	Leyte	25.6	34.11			33.8	0.000339	5.45
8	Northern Samar	16.9	46.7			25.5	0.000488	8.66

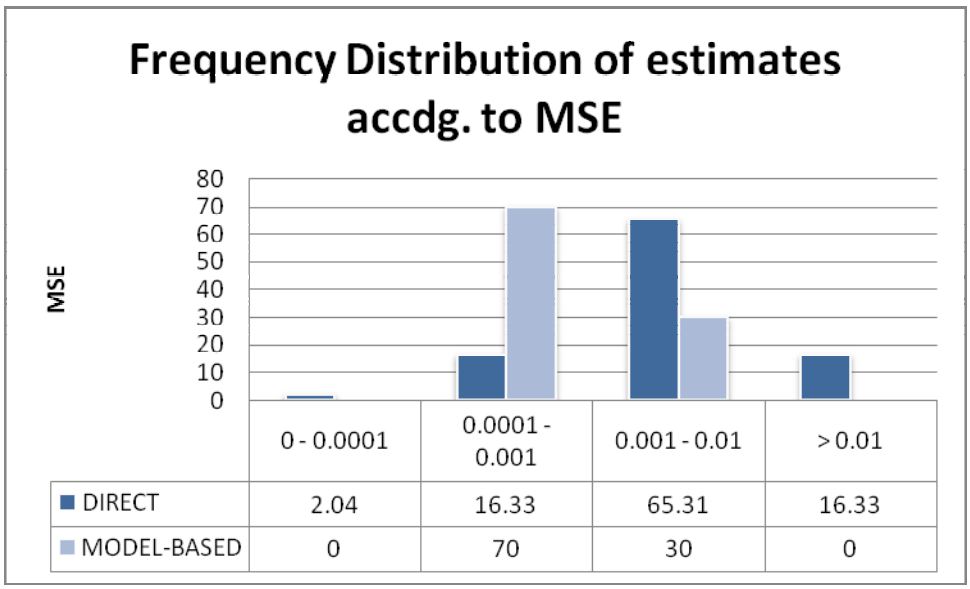
Region	Province/City/Municipality	Administrative Values	Direct Estimation			Model-based Estimation		
			Estimate	MSE	CV	Estimate	MSE	CV
8	Western Samar	8.2	11.85			22.16	0.00098	14.12
8	Southern Leyte	47.4	51.51	0.00954	18.96	35.83	0.000521	6.37
8	Biliran	78.8	66.67	0.02269	22.59	34.09	0.000311	5.17
9	Zamboanga Del Norte	19.2	31.41	0.007374	27.34	38.37	0.000857	7.63
9	Zamboanga Del Sur	18.9	32.5			33.32	0.000339	5.52
9	Zamboanga Sibugay	5.9	11.62	0.001706	35.55	11.64	0.001814	36.57
9	Isabela City	11.7	55.56			38.56	0.001003	8.21
10	Bukidnon	23.1	15.83	0.001547	24.86	32.23	0.000336	5.69
10	Camiguin	34.2	73.33			31.67	0.000691	8.3
10	Lanao Del Norte	29.6	34.61	0.003316	16.64	46.66	0.000866	6.31
10	Misamis Occidental	31.6	37.62			37.55	0.000345	4.95
10	Misamis Oriental	40.1	50.21			47.87	0.000571	4.99
11	Davao del Norte	40.8	37.2	0.004649	18.33	40.98	0.000428	5.05
11	Davao Del Sur	49.5	55.2			45.87	0.000427	4.5
11	Davao Oriental	26.6	19.9	0.001254	17.79	44.37	0.001303	8.14
11	Compostela Valley	25.5	29.87			28.63	0.000487	7.71
12	South Cotabato exc Gen San	23.9	34.26			41.29	0.000318	4.32
13	Agusan Del Norte	24	27.36	0.001146	12.37	42.33	0.000399	4.72
13	Agusan Del Sur	14.4	20.43			28.54	0.000593	8.53
13	Surigao Del Sur	25.6	43.55	0.00683	18.98	31.55	0.000545	7.4
15	Abra	41.6	56.04	0.017667	23.72	42.13	0.000432	4.93
15	Benguet	56.2	64.91	0.01157	16.57	55.01	0.000954	5.62
15	Kalinga	28.6	23.55			36.69	0.000799	7.71
15	Mountain Province	77.9	25.05			39.84	0.000576	6.02
15	Apayao	24.8	13.33			36.02	0.000335	5.08
16	Sulu	7.9	1.48	0.000065	54.54	15.64	0.00322	36.29
16	Tawi-Tawi	3	4.19	0.001166	81.54	22.69	0.000815	12.58
41	Batangas	33.3	52.41	0.003255	10.89	51.44	0.000903	5.84
41	Cavite	33.4	59.87			50.66	0.000597	4.82
41	Laguna	28.2	60.73	0.004189	10.66	48.25	0.000302	3.6
41	Quezon	28.4	33.91	0.002804	15.61	31.53	0.000353	5.96
41	Rizal	30.6	50.32	0.003984	12.54	42.8	0.000613	5.78
42	Marinduque	14.5	29.43	0.007379	29.19	32.15	0.000405	6.26
42	Occidental Mindoro	13.9	11.32	0.001266	31.42	23.38	0.000619	10.64
42	Oriental Mindoro	14.1	37.04	0.00239	13.2	39.67	0.000442	5.3
42	Palawan	13.6	25.23			26.68	0.000563	8.9
42	Romblon	28.6	23.85	0.0033	24.08	26.57	0.00051	8.5

The model-based estimates were predicted by three variables: proportion of households with water soiled toilets, proportion of the number of doctors to the total number of health workers, and the proportion of the number of health and social work establishment to the total number of establishments. These three predictors came from the 2007 FHSIS, 2007 CIF, and the 2006 CPBI, respectively. The three variables maybe considered as

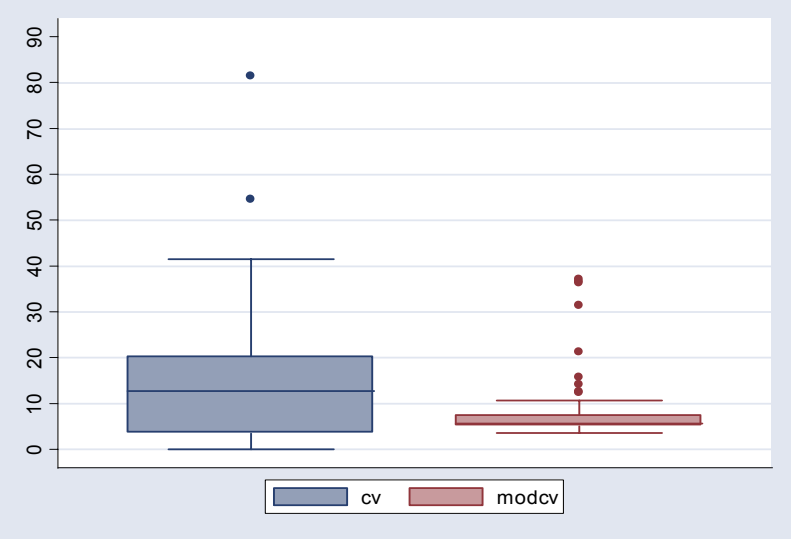
economic predictors for the indicator. It can be seen that all the coefficients are positive, meaning an increase in the membership to the characteristic of interest of the predictor will increase indicator, holding other predictors constant. For example, an additional household with a water sealed toiled will increase the delivery in a health facility. In terms of fit of the model, the coefficient of determination is 58% and its adjusted value is around 57%. This means that around 57% of the variation of the three predictors can explain the variation of the proportion of health facility deliveries.

Predictors	Regression Coefficient	Standard Error
Proportion of households with water sealed toilets	0.3266053	0.0947734
Proportion of the number of doctors to the total number of health workers	3.250028	0.7356934
Proportion of the number of health and social work establishments to the total number of establishments	5.461816	1.193163
Constant	-0.0593556	0.0691532

The model-based procedure was found to have more precise and accurate estimates. Seventy percent have MSE's between 0.0001and 0.001, a large percentage compared to 16.33% of the direct estimation technique. See figure below.



The next figure shows the boxplots of the CV's of the two sets of estimates. The CV boxplot of the model-based procedure clearly show that the CV's are lower compared to that of the direct estimates'. Particularly, the model-based CV's center around 5% while the direct CV's center above 10%, 5 points higher than that of the model-based.



5. CONCLUSION

Using the 2008 National Demographic Survey, direct estimates of the proportion of health facility deliveries were obtained for all provinces and some key cities in the Philippines. The procedure gave 49 estimates out of 100 without valid MSE. On the average, the estimates deviate by as much as 0.23 from the mean of 0.43.

The model-based estimates were obtained by regressing auxiliary variables that were taken from the 2006 Census of Philippine Businesses and Industries, 2007 Field Health Service Information Systems, and the 2007 Countryside in Figures. The regression-synthetic model had adjusted R^2 equal to 57% with predictors proportion of households with water soiled toilets, proportion of the number of doctors to the total number of health workers, and the proportion of the number of health and social work establishment to the total number of establishments. The model-based estimates have a mean of 0.43 with a standard deviation 0.17.

Basing on precision, accuracy, and reliability, estimates computed using the model-based procedure was found to be better in comparison with direct estimation. Thus, the model-based estimates are more appropriate to use in inference.

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