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PROVINCIAL AND HIGHLY URBANIZED CITY LEVEL ESTIMATION OF AVERAGE HOUSEHOLD SAVING RATE USING SPATIALLY CORRELATED RANDOM AREA EFFECTS MODEL

by

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ABSTRACT

This paper uses a spatially correlated random area effects model in estimating the average saving rate of households in all provinces and highly urbanized cities (HUCs) in the Philippines. Specifically, an empirical best linear unbiased (EBLUP) estimates are combined with a spatial autoregressive (SAR) model-based estimates by relating the small area direct estimates to the area specific covariates and taking into account the information provided by neighboring areas. The SAR model suggests that the provincial or HUC level proportion of young dependents (aged 0 to 14 years), proportion of the elderly (aged 65 years and above), proportion of household heads having a college education, and the average family size determine the average household saving rate in a province or HUC. Moreover, neighboring provinces and HUCs within their 120 kilometer radius are captured to have spatial clustering and such is considered in having a statistically significant and optimal spatial autocorrelation. Based on the SEBLUP estimates, most of the provinces and HUCs (39 out of 112) have average household saving rate between 10% and 15% while less than half (46%) of the provinces and HUCs have average household saving rate below 10%. Specific financial programs could be identified to boost the household saving rates of these provinces and HUCs. Among all the provinces and HUCs, 103 (91.96%) of them have estimates which are said to be reliable.

Keywords: small area estimation, EBLUP, SAR, SEBLUP

I. INTRODUCTION

One of the major concern of a country is to promote rapid and sustained economic growth. The challenge for this development is to find and implement strategic plans that can enhance the economic condition of their citizens. One of the possible strategies is through the improvement of national savings knowing that different growth models link higher saving rate with more economic growth. However, these growth models and hypotheses or theories are insufficient to support the impact of savings in increasing the value of a country's output. Empirical evidences must also be given enough consideration to better understand the underlying characteristics of individuals and specially the households when it comes to savings. According to Attanasio and Szekely (2001), given the lack of efficient credit and insurance markets among developing countries, household savings is an essential factor in the welfare of the people since their ability to save is one of the driving forces of social mobility and development of the possibilities of earning in the future. Researches on saving patterns of households at the national and regional levels has been conducted but not for smaller domain such as provinces or cities. The national and regional estimates of household saving rates are not enough in assessing the amount of savings that is essential in designing policies to promote savings and investment. Analysis at provincial or city level is more relevant for the government and financial institutions whose primary objective is to encourage individuals to increase and to improve personal savings, consequently the household savings.

This study presents part of the results of a study where saving rate is defined as the ratio of household savings and total expenditure of household. Moreover, the operational definition of household savings is the difference between the household's total income and household's total

[1] Part of the ongoing master's thesis of the author in the University of the Philippines Los Baños

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expenditure. The general objective of the study is to generate estimates of the average household saving rate among provinces and highly urbanized cities (HUCs) in the Philippines and give a corresponding measure of precision and reliability by taking into account the spatial dimension of the data set used. An empirical best linear unbiased predictor (EBLUP) combined with a simultaneously autoregressive model (SAR) was used and this adapts an explicit linking model with spatially correlated random effects. It was Petrucci and Salvati (2004) who were the first to combine estimates based on SAR and EBLUP models. This procedure is known to generate reliable and precise estimates even the domain of interest have small number of observations.

II. METHODOLOGY

One of the major sources of data used is the 2012 Family Income and Expenditure Survey (FIES). This nationwide survey of households undertaken every three years is the main source of family income and expenditures data which include, among others, sources of income in cash and in kind and the levels of consumption by item of expenditure. In 2012 FIES, 17 administrative regions were used as domains. It adopted the sampling design of the 2003 Master Sample (MS) for household surveys. Also, the 2010 Census of Population and Housing (CPH) and some administrative data sources were also used in the study. The CPH is a complete enumeration of the population which provides information on the size and distribution of total population as well as characteristics of individuals and households in the Philippines while administrative data sets were obtained from local government units, government agencies, and other unit or agencies that collect data for other purposes. Moreover, the geographic information extracted from the Philippine map which shows the provincial or highly urbanized city boundaries was also utilized to generate thematic maps.

To generate reliable estimates at provincial or city level, estimates of average household saving rate were derived using a spatial empirical best linear and unbiased prediction (SEBLUP) model which generated empirical best linear unbiased prediction estimates with spatially correlated random area effects. This procedure accounts the information provided by neighboring areas using a spatial autoregressive (SAR) model which was first introduced by Anselin (1988). The SAR model used in this study is a special case of a general linear mixed model where the spatial dependence is incorporated in the error structure. Prior to developing a SAR model, a classical regression model of the provincial or HUC level direct estimates of average household saving rate was identified. Several functional forms were tried such as one identified by the stepwise regression procedure. However, predictors retained in the model were those with practical and statistical significance; were consistent with the economic theory; and were able to meet the assumptions of the regression model. Also, the spatial autocorrelation of the average household saving rate was identified. In particular, the study examined different distance thresholds to find a spatial weight matrix that would give the optimal autocorrelation in the model. To implement a SAR estimator, a spatial weight matrix was defined and incorporated in the error structure of the classical regression model. Using the predicting model, SAR model-based estimates of the average household saving rate were computed. The SEBLUP estimates of the average household saving rate were then obtained as a weighted sum of the direct estimates and predicted average household saving rate generated using the SAR process.

III. RESULTS AND DISCUSSION

Figure 1 displays the choropleth map of the provincial or HUC level direct estimates of the average household saving rate. The choropleth map is a specific method of thematic mapping in which areas within the map were colored depending on the characteristic of interest being displayed. The characteristic of interest is the household average saving rate among different provinces or HUCs in the Philippines. Choropleth mapping is one way of visualizing the spatial distribution of the data set wherein the estimates of the average saving rate were grouped into classes which correspond to a specific range of values. Areas such as provinces or HUCs in the map were colored depending on its class. Based on the choropleth map in Figure 1, it can

be observed that colors green and yellow dominates. This implies that there were quite a number of provinces or HUCs with average saving rate ranging from 5 to 15%. In fact, majority (63%) of the provinces or HUCs have direct estimates of average saving rate ranging from 5 to 15%. It can also be observed that most of the provinces or HUCs belong to the categories where their nearby provinces or HUCs also belong. Such spatial pattern might be an indicator that the average saving rate of a province or HUC could be affected by the average saving rate of its nearby areas.

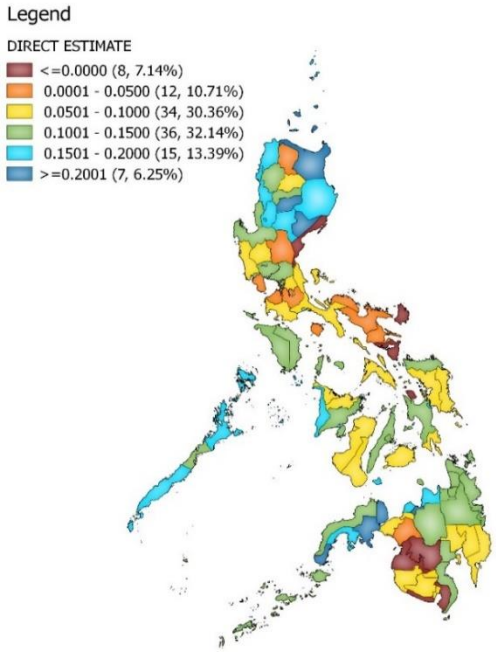

Figure 1. Choropleth map of the provincial or HUC level design-based estimates of the average household saving rate.

Prior to developing a model for the spatial empirical best linear unbiased prediction (SEBLUP) estimation procedure, the spatial autocorrelation of the average household saving rate was examined using Moran's I autocorrelation coefficient. In particular, this study used different distance thresholds to examine the distance that could give the optimal correlation. Considering 100 kilometers, the spatial autocorrelation is 0.3227. Increasing the threshold by 10 kilometers, the spatial autocorrelation further increased to 0.3634. To obtain the optimal correlation, the distance was further increase from 110 to 120 kilometers and the spatial autocorrelation also increase from 0.3634 to 0.3898. Since the spatial autocorrelation still increases using the 110 to 120 kilometers as distance threshold, further increased from 120 to 130 kilometers was examined. However, at this range of distance threshold, gradual decrease of spatial autocorrelation coefficient was observed. Therefore, neighboring provinces or HUCs within their 120 kilometer radius was captured to have spatial clustering and considered in having the optimal autocorrelation. It also shows that the spatial autocorrelation are all positive where high values of average household saving rate at one province or HUC are associated with high values of average household saving rate at neighboring provinces or HUCs. Figure 2 shows the spatial correlation of average household saving rate using different distance threshold.

Moreover, Moran's I scatter plot is a graphical tool used for detecting local spatial association. Figure 3 shows positive association between the average household saving rate of a province or HUC to its neighboring provinces or HUCs. It can be observed that most of the values are within the first and third quadrants implying high-high or low-low association while only few of the values are within the second and fourth quadrants implying negative association.

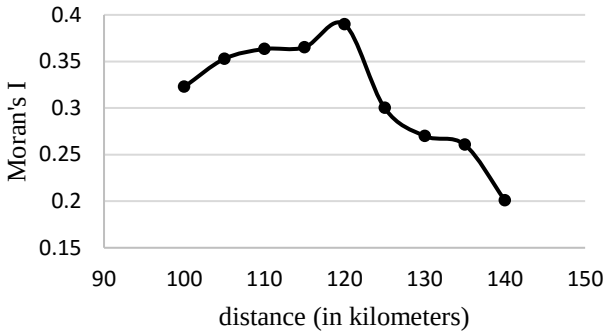

Figure 2. Spatial autocorrelation of average household saving rate using different distance threshold.

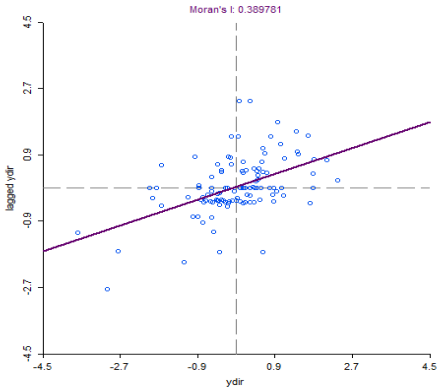

Figure 3. Moran's I scatter plot.

Table 1 shows the parameter estimates of the simultaneously autoregressive (SAR) model for provincial or city average household saving rate. Results show that all predictors significantly differ from zero. Having these predictors, the percentage of young dependents (aged 0 to 14 years) and average family size has indirect relationship with the average household saving rate. A one-percentage point increase in the percentage of young dependents contribute to a 0.18 percentage point decrease in the average household saving rate. Also, additional increase in the average family size contributes to a decrease in the average household saving rate. On the other hand, the positive coefficient means that an additional percentage point increase in the percentage of the elderly (aged 65 years and above), or percentage of household heads having a college education, or percentage of household heads who are OFWs in the province or city contribute to an increase in the average household saving rate.

The resulting model used a proximity distance weight matrix incorporated in the error structure of the regression model. It also have a coefficient of determination (R^2) of 78.38%. Given the identified model, the assumptions of the model were found to be satisfied using residual analysis. Using the predicting model, SAR model-based estimates of the average household saving rate were computed. The SEBLUP estimates of the average household saving rate were then obtained as a weighted sum of the direct estimates and predicted average household rate generated using the SAR process.

Table 1. Parameter estimates of the simultaneously autoregressive (SAR) model for provincial or city average household saving rate.

Predictor	*Estimated Coefficient*	*Standard Error*
Proportion of young dependents (aged 0 to 14 years) in the province or city	-0.1817*	0.0437
Proportion of the elderly (aged 65 years and above) in the province or city	0.4851*	0.1773
Proportion of household heads having a college education in the province or city	0.2642*	0.0694
Proportion of household heads who are OFWs in the province or city	0.6757*	0.1368
Average family size in the province or city	-0.0170*	0.0052
Autoregressive coefficient	0.7160*	0.1020
Constant	0.1294*	0.0361

*significant at 5% level of significance

The complete list of SEBLUP estimates of the provincial or HUC average household saving rate, including the mean square error and coefficient of variation can be found in Appendix Tables 1A and 2A. Based on the results, the average value of the estimates is 10.76%. The SEBLUP estimates' range is 30.05 percentage points. Moreover, based on the set of estimates, Maguindanao has the lowest average household saving rate (-2.44%) while Quirino has the highest average household saving rate (27.61%) among all provinces and HUCs. The distribution of the SEBLUP estimates of average household saving rate is shown in Table 2. Most of the provinces or HUCs (39 out of 112) have average household saving rate between 10% and 15% while 52 out of 112 provinces or HUCs have average household saving rate less than 10%.

Table 2. Distribution of SEBLUP estimates of the average saving rate of different provinces or HUC in the Philippines.

SEBLUP Estimate of Average Household Saving Rate	*Count*	*Percentage*
<0.000	2	1.79
0.001 - 0.050	13	11.61
0.051 - 0.100	37	33.04
0.101 - 0.150	39	34.82
0.151 - 0.200	11	9.82
>0.200	10	8.93

To further assess the statistical properties of the SEBLUP estimates, some measures of precision were generated. The values of the estimated MSE ranged from 1.2300×10^{-6} to 0.00006 which means that all MSE values are less than 0.0001. Mandaluyong City and General Santos City have the lowest and highest estimated MSE of its corresponding SEBLUP estimates, respectively.

Another way of assessing the statistical properties of SEBLUP estimates is using the coefficient of variation (CV) in measuring their reliability. Presented in Table 3 and Figure 5 are the distribution of the estimated CV of estimates of the average household saving rate for different provinces or HUCs in the Philippines. Among the 112 provinces or HUCs, 103 (91.96%) of them have estimates which are said to be reliable. Only 8 percent of the provinces or HUCs have CV greater than 10%.

Table 3. Distribution of the coefficient of variation of SEBLUP estimates of the average household saving rate of different provinces or HUCs in the Philippines.

CV (%)	*Counts*	*Percentage*
< 10.00	103	91.96
10.01-20.00	6	5.36
20.01-30.00	0	0.00
> 30.01	3	2.68

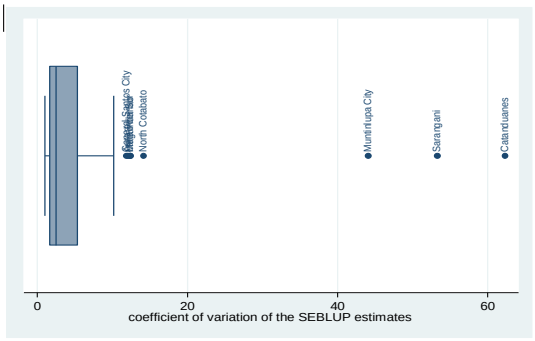

Figure 5. Box plot of the distribution of the computed CV of the SEBLUP estimates.

Among provinces or HUCs with less than 10% CV, Sorsogon has the lowest estimated average household saving rate of 2.14%. This implies that provinces or HUCs with negative average household saving rate are not reliable. Meanwhile, Quirino province is at the top position with the highest SEBLUP estimate. Those in the top 10 provinces with the highest saving rate among all provinces or HUCs are considered reliable. Tables 4 and 5 show the top ten reliable SEBLUP estimates of the provinces or HUCs with the lowest and highest reliable average household saving rate, respectively.

Table 4. Top ten provinces with the lowest reliable SEBLUP estimates of the average household saving rate of different provinces or HUCs in the Philippines.

Rank	*Province*	*SEBLUP Estimate (%)*	*CV %*
1	Sorsogon	2.14	8.76
2	Western Samar	2.94	6.49
3	Masbate	3.15	5.36
4	Marinduque	3.44	8.46
5	Basilan	4.24	8.77
6	Davao Oriental	4.50	9.70
7	Compostela Valley	4.62	3.84
8	Biliran	4.66	4.33
9	Occidental Mindoro	5.26	5.41
10	Camarines Norte	5.30	5.57

Table 5. Top ten provinces with the highest reliable SEBLUP estimates of the average household saving rate of different provinces or HUCs in the Philippines.

Rank	*Province*	*SEBLUP Estimate (%)*	*CV (%)*
1	Quirino	27.61	2.50
2	Ifugao	25.69	1.13
3	Cagayan De Oro City	24.49	1.14
4	Zamboanga del Sur	23.88	1.26
5	Zamboanga City	23.65	1.21
6	Misamis Occidental	22.57	1.12
7	Ilocos Norte	22.44	1.00
8	Ilocos Sur	22.36	1.01
9	Cagayan	20.86	1.76
10	Iloilo City	20.26	1.20

Meanwhile, a choropleth map was constructed for the SEBLUP estimates. Based on the choropleth map in Figure 6, it can be observed that colors green and yellow still dominates similar to the map generated for the direct estimates. This implies that there were quite a number of provinces or HUCs with average household saving rate ranging from 5 to 15 percent. Still, majority (67%) of the provinces or HUCs have SEBLUP estimates of average household saving rate ranging from 5 to 15%.

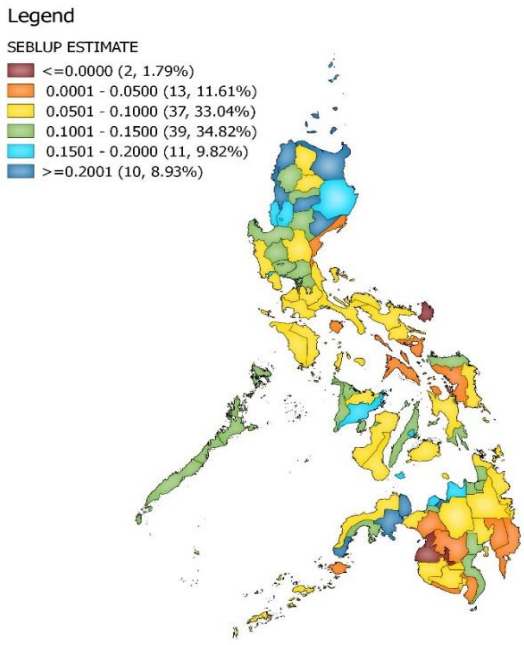

Figure 6. Choropleth map of the provincial or HUC level SEBLUP estimates of the average household saving rate.

IV. SUMMARY AND CONCLUSION

The SEBLUP estimates reveal that majority (67%) of the provinces or HUCs have average household saving rate ranging from 5 to 15 percent. However, given the values of the SEBLUP estimates, less than half (46%) of the provinces or HUCs still have an average household saving rate below 10%. In this regard, efforts in improving the saving rate of households in those areas with minimal or no savings at all should be prioritized. Moreover, the identified SAR model found that when a province or HUC has the following demographic characteristics: a younger population, lower educational attainment of household heads, fewer household heads which are working overseas, and larger family size; the saving rate of households, on the average, in the province or HUC tends to decrease. Therefore, to boost the household saving rates for the whole country, proper and unremitting monitoring of those demographic characteristics for all the provinces and HUCs in the country should be done. Also, suitable programs must formulate for those areas where indicators of lower household saving rate are present. Lastly, financial institutions could use those indicators of the average household saving rate in identifying areas for potential investment and operation.

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APPENDIX

Table 1A. SEBLUP estimates of the average household saving rate of different provinces in the Philippines.

PROVINCE	*MEAN*	*MSE*	*CV (%)*
REGION I (Ilocos Region)			
ILOCOS NORTE	22.44	0.00000501	1.00
ILOCOS SUR	22.36	0.00000512	1.01
LA UNION	16.35	0.00000623	1.53
PANGASINAN	11.91	0.00000211	1.22
REGION II (Cagayan Valley)			
BATANES	17.96	0.00000477	1.22
CAGAYAN	20.86	0.00001354	1.76
ISABELA	16.00	0.00000608	1.54
NUEVA VIZCAYA	13.49	0.00000416	1.51
QUIRINO	27.61	0.00004765	2.50
CAR - Cordillera Administrative Region			
ABRA	14.04	0.00000659	1.83
BENGUET	18.22	0.00002799	2.90
IFUGAO	25.69	0.00000838	1.13
KALINGA	5.72	0.00000374	3.38
MOUNTAIN PROVINCE	14.51	0.00000330	1.25
APAYAO	6.90	0.00000223	2.16
REGION III (Central Luzon)			
BATAAN	5.68	0.00000240	2.73
BULACAN	10.81	0.00002524	4.65
NUEVA ECIJA	7.77	0.00000374	2.49
PAMPANGA	13.65	0.00000338	1.35
TARLAC	10.20	0.00000311	1.73
ZAMBALES	9.82	0.00000349	1.90
AURORA	1.38	0.00000277	12.07
REGION IV-A (CALABARZON)			
BATANGAS	6.17	0.00002528	8.15
CAVITE	6.53	0.00001804	6.51
LAGUNA	9.16	0.00000366	2.09
QUEZON	8.33	0.00000431	2.49
RIZAL	10.14	0.00003171	5.55
REGION IV-B (MIMAROPA)			
MARINDUQUE	3.44	0.00000844	8.46
OCCIDENTAL MINDORO	5.26	0.00000809	5.41
ORIENTAL MINDORO	9.76	0.00000177	1.36
PALAWAN	11.63	0.00000750	2.36
ROMBLON	9.27	0.00000656	2.76
REGION V (Bicol Region)			
ALBAY	5.36	0.00000850	5.44
CAMARINES NORTE	5.30	0.00000871	5.57
CAMARINES SUR	5.65	0.00001379	6.57
CATANDUANES	-0.96	0.00003599	62.34
MASBATE	3.15	0.00000285	5.36
SORSOGON	2.14	0.00000351	8.76

PROVINCE	*MEAN*	*MSE*	*CV (%)*
REGION VII (Central Visayas)			
BOHOL	8.63	0.00004178	7.49
CEBU	14.15	0.00001563	2.79
NEGROS ORIENTAL	7.78	0.00001816	5.48
SIQUIJOR	15.82	0.00000610	1.56
REGION VIII (Eastern Visayas)			
EASTERN SAMAR	7.56	0.00000406	2.67
LEYTE	8.68	0.00000190	1.59
NORTHERN SAMAR	11.34	0.00000364	1.68
WESTERN SAMAR	2.94	0.00000363	6.49
SOUTHERN LEYTE	11.00	0.00000496	2.03
BILIRAN	4.66	0.00000407	4.33
REGION IX (Zamboanga Peninsula)			
ZAMBOANGA DEL NORTE	9.97	0.00002721	5.23
ZAMBOANGA DEL SUR	23.88	0.00000901	1.26
ZAMBOANGA SIBUGAY	11.97	0.00001215	2.91
REGION X (Northern Mindanao)			
BUKIDNON	9.80	0.00003613	6.13
CAMIGUIN	7.90	0.00002872	6.78
LANAO DEL NORTE	8.78	0.00001133	3.83
MISAMIS OCCIDENTAL	22.57	0.00000645	1.12
MISAMIS ORIENTAL	18.05	0.00000715	1.48
REGION XI (Davao Region)			
DAVAO DEL NORTE	9.15	0.00001449	4.16
DAVAO DEL SUR	12.89	0.00002684	4.02
DAVAO ORIENTAL	4.50	0.00001906	9.70
COMPOSTELA VALLEY	4.62	0.00000314	3.84
REGION XII (Soccsksargen)			
NORTH COTABATO	1.37	0.00000377	14.18
SOUTH COTABATO	7.10	0.00000151	1.73
SULTAN KUDARAT	5.62	0.00003256	10.16
SARANGANI	0.45	0.00000568	53.29
ARMM - Autonomous Region in Muslim Mindanao			
BASILAN	4.24	0.00001384	8.77
LANAO DEL SUR	2.39	0.00000872	12.36
MAGUINDANAO	-2.44	0.00000915	12.40
SULU	7.94	0.00003959	7.93
TAWI-TAWI	7.84	0.00001049	4.13
REGION XIII (Caraga)			
AGUSAN DEL NORTE	11.07	0.00000412	1.83
AGUSAN DEL SUR	6.06	0.00000323	2.96
SURIGAO DEL NORTE	7.94	0.00000195	1.76
SURIGAO DEL SUR	9.35	0.00000631	2.69

Table 2A. SEBLUP estimates of the average household saving rate of HUCs in the Philippines.

REGION	*HUC*	*MEAN (%)*	*MSE*	*CV (%)*
REGION III	ANGELES CITY	14.71	0.0000196	3.01
	OLONGAPO CITY	16.05	0.0000103	2.00
NCR	MANILA CITY	10.65	0.0000145	3.57
	MANDALUYONG CITY	8.89	0.0000012	1.25
	MARIKINA CITY	13.02	0.0000069	2.02
	PASIG CITY	11.02	0.0000035	1.71
	QUEZON CITY	12.95	0.0000181	3.29
	SAN JUAN CITY	11.77	0.0000200	3.80
	CALOOCAN CITY	11.67	0.0000015	1.06
	MALABON CITY	9.10	0.0000110	3.65
	NAVOTAS CITY	9.16	0.0000125	3.85
	VALENZUELA CITY	11.14	0.0000014	1.06
	LAS PIÑAS CITY	14.30	0.0000165	2.84
	MAKATI CITY	17.25	0.0000062	1.44
	MUNTINLUPA CITY	0.45	0.0000039	44.08
	PARAÑAQUE CITY	11.13	0.0000030	1.56
	PASAY CITY	10.00	0.0000031	1.75
	TAGUIG CITY	12.03	0.0000027	1.36
REGION IV-A	LUCENA CITY	8.68	0.0000019	1.59
REGION IV-B	PUERTO PRINCESA CITY	13.89	0.0000064	1.82
REGION VI	ILOILO CITY	15.53	0.0000035	1.20
	BACOLOD CITY	10.75	0.0000013	1.05
REGION VII	CEBU CITY	15.34	0.0000090	1.96
	LAPU-LAPU CITY	2.39	0.0000087	12.36
	MANDAUE CITY	12.53	0.0000048	1.75
REGION VIII	TACLOBAN CITY	9.35	0.0000063	2.69
REGION IX	ZAMBOANGA CITY	23.65	0.0000082	1.21
REGION X	ILIGAN CITY	11.26	0.0000067	2.29
	CAGAYAN DE ORO CITY	24.49	0.0000079	1.14
REGION XI	DAVAO CITY	11.23	0.0000047	1.92