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Spatial Analysis of Income Growth in the Philippines: Evidence from Intra-Country Data (1988 to 2009)

Dennis S. Mapa[1], Manuel Leonard F, Albis[2], Dorcas Mae P. Comandante[3], Josephine D. Cura[3] and Ma. Maureen P. Ladao[3]

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I. INTRODUCTION

The growth rates of provincial per capita income in the Philippines in the last 25 years have been generally diverse: there are provinces with average annual per capita income growth that can be considered as moderately high (more than 5%), while majority of the provinces have income growth that is comparable to the poorest countries in the world (around 1%). There are several reasons why the economic performance of the Philippines, in general, had been disappointing relative to its more successful East Asian neighbors. As noted by Balisacan and Hill (2003), "the Philippines economic performance looks deficient partly because it is most often compared with its neighbors … the world's fastest growing".[4] Several papers have come out in recent years, specifically explaining what went wrong in the case of the Philippines.[5]

The relatively moderate and inconsistent (compared to the country's East Asian neighbors) income growth over a longer period is one of the major reasons of the high poverty incidence in the country. The official statistics on headcount poverty compiled by the National Statistical Coordination Board (NSCB) showed that while the percentage of poor Filipinos increased to 26.5 percent in 2009 (the latest poverty data) from 24.9 in 2003. Moreover, the percentage of subsistence poor (or food poor)[6] did not change much during the same period, only slightly decreasing from 11.1 percent in 2003 to 10.8 percent in 2009. However, the number of food poor in the population has increased to about 9.44 million in 2009 from 8.8 million in 2003.

Empirical analysis using cross-country data during the period 1975 to 2000 (Mapa and Balisacan, 2004) points to the country's rapid population growth as one of the reasons why the country is not one of the high-performing Asian economies. The Philippines has the second largest population in Southeast Asia (about 92 million in 2010), next only to Indonesia, and

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[4] During the period 1976-2000, for example, the average growth rates (in US$ Purchasing Power Parity or PPP) for the Philippines, Thailand and Korea are 4.1%, 7.98%, and 9.90%, respectively.

[5] Balisacan and Hill (2003) and Balisacan and Hill (2007) provide a collection of such good papers.

[6] The prevalence of subsistence poor refers to the proportion of families or individuals with per capita income less than the per capita food threshold. The food threshold is determined using regional one-day menus priced at the provincial level. These menus are determined using low-cost nutritionally adequate food items satisfying basic food requirements of 2,000 calories which are 100% adequate for the recommended energy and nutrient intake (RENI) for energy and protein and 80% adequate for the RENI for vitamins, minerals and other nutrients (NSCB 2010).

ranks among the countries with the highest population growth rates in Asia.[7] The authors' econometric models showed that demographic factors have strong and significant effects on economic growth. Using simulation analysis to compare the income growth paths of the Philippines and Thailand, the authors showed that differences in the population growth rates between the two countries account for about 0.768 percentage point of forgone growth for the Philippines. It implies that had the Philippines followed Thailand population growth path during the period 1975 to 2000 the country's growth in the average income per person would have been 0.768 percentage point higher every year. Using the country's provincial data,

Using intra-country (provincial) data, Mapa, Balisacan and Briones (2006) identified the factors constraining the income growth in the Philippines provinces during the period 1985 to 2003. Using robustness procedures, the authors found that the high level of inequality and high percentage of young dependents (percentage of those aged 0 to 14 relative to the total population) are contributing negatively to the average provincial per capita income growth. The authors also showed the two variables to be robust determinants of provincial income growth. Moreover, the models also showed that the long running conflict in the provinces of the Autonomous Region of Muslim Mindanao (ARMM)[8] results to a lower average per capita income growth in these provinces relative to the other provinces in the Philippines.

Other studies notably, Balisacan (2005, 2007) and Balisacan and Fuwa (2002), showed the level of human stock capital (using child mortality rate as the proxy variable in the studies) as a statistically significant determinant of provincial income growth rate. In addition, these studies also showed the literacy rate and access to infrastructure as positive and significant determinants of provincial income growth rate. The authors also find that increment in land reform implementation (CARP) have a positive and significant effect on the average provincial income growth rate. To capture the effects of politics on provincial income growth, the Balisacan papers utilized the initial political conditions defined as the extent of dynasty within a province – empirically measured as the proportion of provincial officials related by blood or affinity. Using different econometric model specifications, Balisacan and Fuwa (2002) showed that the extent of dynasty has a negative and significant effect on income growth, while Balisacan (2007) showed the same dynasty variable, while negatively affecting income growth, is statistically insignificant.

The rest of the paper is presented as follows. Section II gives an overview of the spatial dependence, particularly in the context of the econometric growth models. This section also

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[7] The country's annual population growth rate from 1975 to 2000 is 2.36%, although this has gone down to 1.90% for 2000-2010 based on the results of the 2010 Census of Population. In May 1, 2010 the population of the Philippines is at 92.34 million. Moreover, data shows that the total fertility rate (TFR) is highest among the poorest households, where the TFR is 5.20 for the poorest 20 percent of households against the national average of 3.30 (as of 2008).

[8] The Autonomous Region in Muslim Mindanao is the region of the Philippines that is composed of all the Philippines' predominantly Muslim provinces, namely: Basilan (except Isabela City), Lanao del Sur, Maguindanao, Sulu and Tawi-Tawi, and the Philippines' only predominantly Muslim city, the Islamic City of Marawi. The regional capital is at Cotabato City, although this city is outside of its jurisdiction. The poverty incidence (percent of population) in the region is 45.9% in 2009 and three of its provinces are among the poorest provinces in the Philippines in 2009, namely: Sulu (poverty incidence: 44.1%), Maguindanao (53.7%) and Lanao del Sur (44.8%).

explains the process of computing the Spatial Weight Matrix and the concepts of the Moran's Index, the Moran's Scatterplot. Section III provides the empirical analysis of the spatial dependence of the provincial income growth of the provinces while section IV discusses the results of the econometric models. Lastly, section V concludes.

II. SPATIAL AUTOCORRELATION IN THE ECONOMETRIC GROWTH MODEL

Spatial autocorrelation is defined as the coincidence of value similarity with location similarity (Anselin and Bera; 1998). Spatial dependence occurs when the observations of one location depends on the values of the other locations. The presence of spatial structure in the quantitative data provides the information about the similarity of the characteristics (e.g. income growth of neighboring provinces) vis-à-vis the distance between the locations (provinces) and the spatial autocorrelation of the variable (e.g. income growth) explains how this variation is affected by the distance (Fortin and Dale; 2009). Positive spatial autocorrelation happens when similar values of the variable of interest (e.g. income growth) cluster together, while negative spatial autocorrelation appears when dissimilar values are clustered in space. In the economic growth literature, the possibility that space is a determinant of income growth has been studied widely in the context of geographical variables such as climate and location (Gallup, Sachs, Mellinger; 1999). The area of spatial-econometrics, a sub-field of econometrics, looks at the possibility of spatial interaction and spatial structure and has recently been incorporated into the study of empirical growth (Durlauf and Quah; 1999). The applications of spatial econometric has been traditionally carried out in the regional science applications (Abreu, De Groot and Florax; 2004), where politically unstable regions/countries may have negative externalities or spillover effects on the other regions/countries. Since the publication of the book on Spatial Econometrics: Methods and Models by Luc Anselin (Anselin; 1988), numerous studies on spatial econometric analysis of geographical spillovers and growth have been made. The basic premise of spatial econometrics in regional/provincial economic growth studies is that regional/provincial data can be spatially ordered since similar regions tend to cluster and that econometric models must take into account the fact that economic phenomenon may not be randomly distributed on an economically integrated regional space (Baumont, Ertur, Le Gallo; 2001).

To capture potential spatial/spillover effects which indicates how the average growth rate of per capita income in the Philippine provinces is affected by its neighboring provinces, after controlling for other factors affecting income growth, Mapa, Balisacan and Briones (2006) introduced a measure of neighborhood effect in their intra-country growth regression models. This variable is computed as the average growth rate of the neighboring provinces, where the neighbors (of a specific home province) are identified using a contiguity-nearest distance based measure.[9] The inclusion of this spatial variable, the neighborhood effect, into the growth regression model, conforms to the spatial auto-regressive model discussed by Anselin (1988, 2009). By introducing a spatial variable, the dynamics of how the provinces' economic performance interacts with each other can be better understood. The empirical analysis of the authors showed a negative and significant influence of the neighborhood effect in the growth

[9] Using the contiguity measure, two provinces are neighbors if they share a common border. To mitigate the problem associated with some island provinces (e.g. Province of Cebu) in the country, the authors used the nearest neighbor method for this group of provinces.

regression model. The results showed a negative spatial correlation among the neighboring provinces, as the average growth rate of per capita income of the home province increases, the average growth rate of per capita income of the neighboring provinces decrease, showing some sort of negative growth externalities.[10]

This paper incorporates the provincial spatial dependence in the intra-country growth regression model (Barro-type) by utilizing the commonly used spatial lag model to capture this location dependency.[11] Substantive spatial dependence is incorporated into the unconditional growth regression specification through a spatially lagged dependent variable,

$$g_{y^o} = \underline{X}\,\underline{\beta} - \alpha \log(y^{o}_{T_1}) + \theta(YD/P) + \rho W g_{y^o} + \varepsilon \qquad (1)$$

where g_{y^o} is the growth rate of per capita income, y^0_{T1} is the initial per capita income, *YD/P* is the proportion of young dependents (aged 0 to 14) in the population and X is the vector of economic and political variables (or the Barro's core) that may have impact on the steady state growth.

The matrix W is the spatial weights matrix with elements w_{ij} corresponding to the province (*i*,*j*). The spatial weight matrix is an (n x n) positive matrix (W) that provides "neighborhood sets" for each observation (Anselin, 2002). Its elements are non-stochastic, non-negative, finite, and exogenous to the model. An observation is not a neighbor to itself; hence the diagonal elements, denoted by $\boldsymbol{w_{ii}}$, are set to zero. The element $\boldsymbol{w_{ij}}$ $(\boldsymbol{i \neq j})$, indicates the spatial connection between region i to region j (Baumont, Ertur, & Le Gallo, 2001). To facilitate comparison among different models, the weight matrix shall be standardized so that the sum of the elements in a row equals unity. The choice on the kind of matrix to be used depends on the researcher. An example is the simple binary contiguity matrix, which is a matrix with values of elements equal to 1, when regions i and j share a border; and 0, otherwise. The use of the contiguity measure is not appropriate if there is a relatively high degree of heterogeneity in the spatial distribution of points or in the areas of regions (Anselin, 2002). For locations with high degree of heterogeneity, a spatial weight matrix with a distance-based critical cut-off is preferred. This paper employs the distance-based spatial weight, using the inverse of the distance, defined as:

$$w_{ij} = \begin{Bmatrix} 0 & if \;\; i = j \\ 1/d_{ij} & if \;\; d_{ij} < D \\ 0 & if \;\; d_{ij} \geq D \end{Bmatrix}$$

where $\boldsymbol{d_{ij}}$ is the distance between provinces i and j, using the provincial capital city/municipality as the point of reference and D is the cut-off distance, usually equal but not restricted to the first quartile of the distances (Baumont, Ertur, & Le Gallo, 2001). For the purposes of this study, the 35th percentile, a distance of about 655 kilometers, was used to ensure the existence of at least one neighbor for each province. Our interest is the parameter ρ in the econometric model in (1),

[10] Similar studies using European regions (Baumont, Ertur and Le Gallo (2001)) and US States/Counties show that the neighborhood effect is positive.

[11] The two other methods of capturing spatial dependence are the spatial error model and the spatial cross-regressive model.

which provides information on the spatial relationship of the per capita income growth of the home provinces and their neighbors, controlling for other factors.

Moran's Index

Existence of spatial autocorrelation indicates that the values of variables in one location are affected by values of the variables in neighboring locations. This is one of the problems faced by researchers in executing regression analysis on spatial relationships. Several measures of spatial autocorrelation, like the Geary's C (Geary, 1954), have already been proposed. The most popular of which is the Moran's Index (Moran, 1950), which will be the focal measure of spatial dependence that will be used in this paper. The Moran's I have shown to be consistently more powerful than Geary's C (Cliff and Ord, 1975; 1981), tests for global spatial autocorrelation for continuous data. The statistic is expressed as,

$$\boldsymbol{I} = \left[\frac{\boldsymbol{n}}{\boldsymbol{S_o}}\right] \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} \boldsymbol{w_{ij} x_i x_j}}{\sum_{j=1}^{n} \boldsymbol{x_i}^2}$$

where $\boldsymbol{n}$ is the number of observations, $\boldsymbol{w_{ij}}$ is the element of the spatial weight matrix $\boldsymbol{W}$ corresponding to the ith row and the jth column, $\boldsymbol{x_i}$ and $\boldsymbol{x_j}$ are deviations from the mean of a variable for regions i and j, respectively, and $\boldsymbol{S_o}$ is a normalizing factor equal to the sum of the elements of the weights matrix $\boldsymbol{W}$, that is, $\boldsymbol{S_o} = \sum_{i=1}^{n}\sum_{j=1}^{n} \boldsymbol{w_{ij}}$. If the rows of the weight matrix are standardized, the Moran's Index reduces to,

$$\boldsymbol{I} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} \boldsymbol{w_{ij} x_i x_j}}{\sum_{j=1}^{n} \boldsymbol{x_i}^2}$$

In matrix notation, this is,

$$\boldsymbol{I} = \frac{\boldsymbol{x'Wx}}{\boldsymbol{x'x}}$$

where $\boldsymbol{W}$ is a spatial weights matrix and $\boldsymbol{x}$ is a vector of observed values $\boldsymbol{x_i}$, in deviations from the mean (Lim, 2003). Based on the cross-products of the deviations from the mean, the Moran's Index is similar but not equivalent to a correlation coefficient between $\boldsymbol{x}$ at one location and the weighted average of the values of $\boldsymbol{x}$ of its neighbors. Its range of possible values is from -1 to 1, where a positive value indicates that across all geographic units, similar values are more likely than dissimilar values between neighbors, and vice versa. Under the assumption of no autocorrelation, the expected value of the Moran's Index is $-\frac{\boldsymbol{1}}{\boldsymbol{n-1}}$, regardless of the specified weight matrix. The expected value approaches to zero as $\boldsymbol{n}$ approaches infinity. In addition, the Moran's Index is equivalent to the slope coefficient in the linear regression of the spatial $\boldsymbol{Wx}$ on $\boldsymbol{x}$.

Moran's Scatterplot

The Moran's I statistic gives us a single global result for the whole data set. However, it does not provide information on the characteristics of spatial clustering. To provide graphical analysis of local spatial dependence, one may use the Moran's scatterplot. The scatterplot is helpful in identifying outlying provinces. The Moran's scatterplot has four main parts and providing four different kinds of spatial association between the home province and its neighboring provinces. For this paper, the four parts correspond the following classifications: (a) high per capita income growth rate for the home province with high per capita income growth rate for neighboring provinces (HH - Quadrant I), (b) low per capita income growth rate for the home province with high per capita income growth rate for neighboring provinces (LH - Quadrant II), (c) low per capita income growth rate for the home province with low per capita income growth rate for neighboring provinces (LL - Quadrant III), (d) high per capita income growth rate for the home province with low per capita income growth rate for neighboring provinces (HL - Quadrant IV). One can think of it as "the spatial lag of the variable on the vertical axis and the original variable on the horizontal axis (Anselin, 2002)." A more comprehensive presentation of the spatial dependence of the average per capita income growth rate can be done using scatter plot maps.

III. EMPIRICAL ANALYSIS OF THE PROVINCIAL DATA (1988-2009)

The dataset used in this study consist of information collected from the 74 provinces in the Philippines. The provinces are those defined in 1985 for data consistency. Currently, there are 80 existing provinces. The provinces are listed in Table 1 below. Data on average per capita income were sourced from the Family Income and Expenditure Surveys (FIES), data on road density were sourced from the Department of Public Works and Highways (DPWH). Information on the proportion of governors and mayors affiliated to the President comes from the Commission on Elections (COMELEC). The Philippine Statistical Yearbook (PSY) provides the data on the land type of all the provinces in the Philippines. The data on the percentage of municipalities classified according to the degree of slope is taken from GIS maps. The data on the annual amount of rainfall (in millimeter) for each province was taken from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). The variables and the data sources used in the econometric models are provided in Table 2.

Table 1. List of 74 Philippine Provinces Included in the Study

Region I	**Region IV**[12]	**Region VI**	**Region X**	**Region XIII**
Ilocos Norte	Aurora	Aklan	Bukidnon	Metro Manila
Ilocos Sur	Batangas	Antique	Camiguin	XIV
La Union	Cavite	Capiz	Misamis Occidental	Abra
Pangasinan	Laguna	Iloilo[13]	Misamis Oriental	Benguet
Region II	Marinduque	Negros Occidental	**Region XI**	Ifugao
Batanes	Mindoro Oriental	**Region VII**	Davao[14]	Kalinga Apayao[15]
Cagayan	Quezon	Bohol	Davao del Sur	Mt. Province
Isabela	Rizal	Cebu	Davao Oriental	**Region XV**
Nueva Vizcaya	Romblon	Negros Oriental	South Cotabato[16]	Lanao del Sur
Quirino	Mindoro Occidental	Siquijor	**Region XII**	Maguindanao[17]
Region III	Palawan	**Region VIII**	Cotabato	Sulu
Bataan	**Region V**	Eastern Samar	Lanao del Norte	Tawi-Tawi
Bulacan	Albay	Leyte[18]	Sultan Kudarat	**Region XVI**
Nueva Ecija	Camarines Norte	Northern Samar		Agusan del Norte
Pampanga	Camarines Sur	Samar		Agusan del Sur
Tarlac	Catanduanes	Southern Leyte		Surigao del Norte[19]
Zambales	Masbate	**Region IX**		Surigao del Sur
	Sorsogon	Baslian[20]		
		Zamboanga del Sur[21]		
		Zamboanga del Norte		

[12] Region IV is now divided into CALABARZON or Region IV-A and MIMAROPA or Region IV-B.
[13] Guimaras is now separated from Iloilo.
[14] Compostela Valley is now separated from Davao. The name of Davao changed back to Davao del Norte.
[15] Kalinga Apayao is now two different provinces: Kalinga and Apayao.
[16] Sarangani is now separated from South Cotabato.
[17] Shariff Kabunsuan is now separated from Maguindanao.
[18] Biliran is now separated from Leyte.
[19] Dinagat Islands was separated from Surigao del Norte in 2006.
[20] Basilan now belongs to Region XV (ARMM), and Aurora in Region III.
[21] Zamboanga Sibugay is now separated from Zamboanga del Sur.

Table 2. Variables and Data Sources in the Econometric Models

Variables	Description	Data Source
GROWTH	Average Annual Growth Rate of Nominal Per Capita Income	Authors Computation from FIES data of NSO
LOGINIINC	Initial per capita income (in natural logarithm); for 1988, 1994 and 2000	FIES, NSO
POP014_INIT	percentage of young dependents	Authors Computation from FIES, NSO
AVERAIN	Average Rainfall	PAGASA
AVEGOVMAY	Percentage of Mayor and Gov with the President's Party	COMELEC
AVEEGINI	Gini Coefficient (income)	Authors Computation from FIES, NSO
AVEEGINI_SQ	Square of Gini (income)	Authors Computation from FIES, NSO
GRELECTSH	Growth Rate - HHs with Electricity	Authors Computation from FIES, NSO
GRROADNAT	Growth Rate - National Road	Department of Public Works and Highways
GEOGRAPHY	Dummy Variable for Geography (Landlock)	Philippine Statistical Yearbook
SLOPE	Slope of the Land	Geographical Information System
MINERAL	Province with Mineral	DENR, Mines and Geosciences Bureau

Using the data set, the authors created three (3) pseudo-panel data, for years: (a) 1988-1994, (b) 1994-2000 and (c) 2000-2009. One of the objectives of the paper is to look the changes (if there any) of spatial correlation or spatial dependence of the growth rates of income in the Philippine provinces through the years. Another reason for the creation of the pseudo-panel data is to increase the sample size to minimize the error in the estimation of the econometric models.

The average per capita income growth for the provinces during the three (3) pseudo-panel periods are provided in table 3. The figures show that the average income growth per person has been erratic and inconsistent, growing at just about 0.51 percent during the period 1988 to 1994, increasing at a relatively impressive rate of 3.45 percent in 1994 to 2000, but dropped again to 0.36 for 2000 to 2009. The overall per capita income growth during the period 1988 to 2009, a period of 21 years, is just about 1.24 percent.

Table 3. Average per Capita Income Growth of the Philippine Provinces

Variable	Mean	Std. Dev.	Min	Max
Annual Growth Per Capita Income (1988-1994)	0.47	3.41	-8.96	10.63
Annual Growth Per Capita Income (1994-2000)	3.45	3.28	-3.19	13.05
Annual Growth Per Capita Income (2000-2009)	0.36	1.73	-4.20	5.26
Annual Growth Per Capita Income (1988-2009)	1.24	1.35	-2.49	4.25

The existence of spatial autocorrelation in income growth is examined using the Moran's index and the results are given in table 4. The estimated Moran's indices are all positive for the three panels and for the overall period 1988 to 2009, implying positive spatial correlation on the provincial per capita income growth. This means that the average income growth of the home and neighboring provinces are more likely to be similar (increasing together or decreasing together), rather than being dissimilar (one is increasing while the other is decreasing). All these values, although small, mean that a positive autocorrelation is present in the data indicating the clustering of provinces with similar average per capita income growth rates.

Testing the significance of the Moran's indices, however, shows that only the values for 1988 to 1994 and the overall period 1988 to 2009 are significantly different from zero. The indices for the periods 1994 to 2000 and 2000 to 2009 are not significantly different from zero.

Table 4. Moran's Indices for the Average per Capita Income Growth

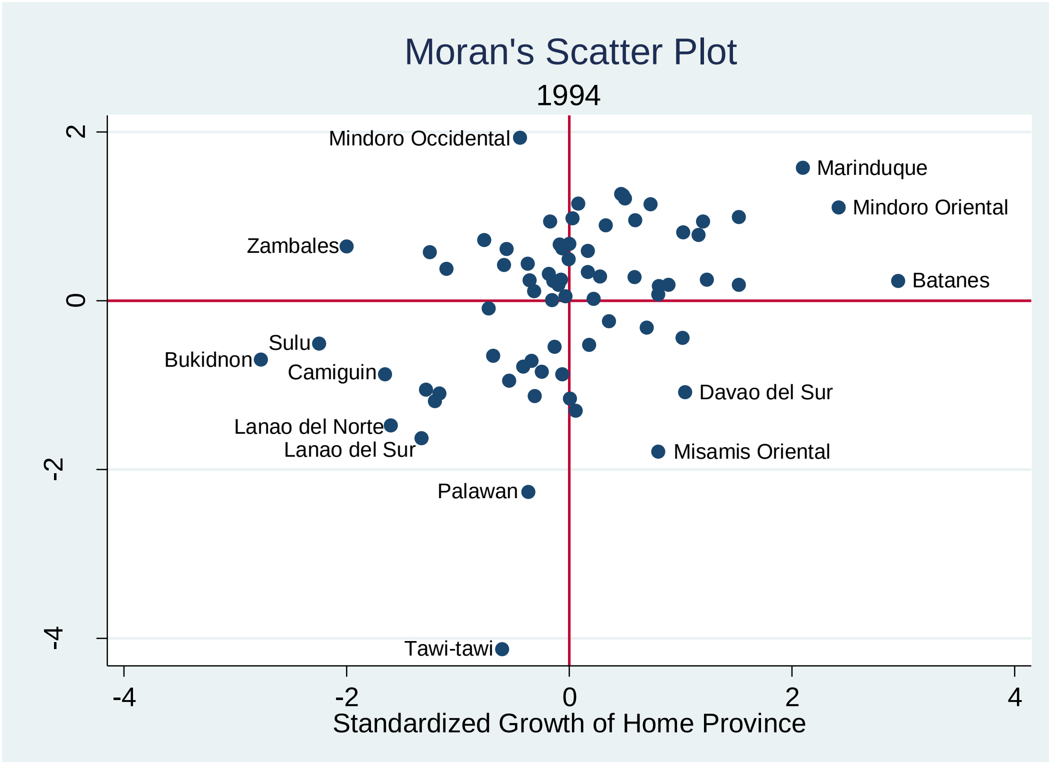
Year	Moran's Index	SD	z-stat	p-value*
1988-1994	0.194	0.052	4.037	0.0000
1994-2000	0.036	0.052	0.963	0.1680
2000-2009	0.030	0.050	0.891	0.1860
1988-2009	0.120	0.049	2.725	0.0030

* one-sided p-value

The figures below present the Moran's scatter plots and the corresponding Philippine maps that will be used to describe the movement of the average income growth rate of the provinces through time. The Moran's scatterplots in figures 1 to 4 display the distribution of all the 74 provinces on the four quadrants, based on the home provinces' relation to the average income growth rate of the neighboring provinces. The provinces in quadrants 1 (High-High or HH) and 3 (low-Low or LL) represent the home provinces that experienced similar income growth rates to the neighboring provinces, whereas those included in quadrants 2 (Low-High or LH) and 4 (High-Low or HL) represent the home provinces with contrasting income growth rates to the neighboring provinces.

The provinces included in quadrant 1 (HH) are the provinces where the both the home province and the neighboring provinces (using the distance measure) had average per capita growth rates higher than the national average, while the provinces in quadrant 3 (LL) are the are the provinces where the both the home province and the neighboring provinces had average per capita growth rates lower than the national average. The provinces in quadrant 2 (LH) are the provinces where the home province had lower average income growth compared to the national average, while the neighboring provinces experienced higher income growth compared to the national average. The provinces in quadrant 4 (LH) are the provinces where the home province had higher average income growth rate than the national average whereas the neighboring provinces had lower average income growth compared to the national average.

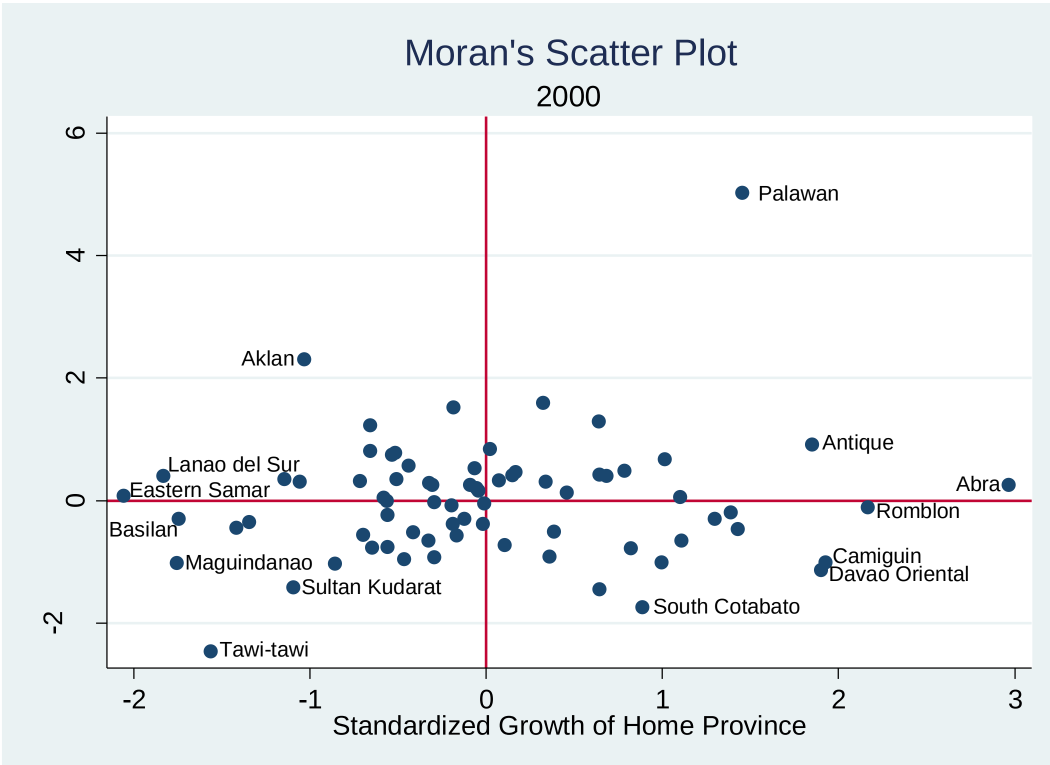
Figure 1. Moran's Scatter Plot (1988-1994)



The scatter plot corresponding to the period 1988 to 1994 indicates that about 60% of all the home provinces have similar income growth rates (higher or lower than the national average) with the neighboring provinces. About 34% of the provinces are in the High-High quadrant (quadrant 1), while 26% of the provinces are in the Low-Low quadrant (quadrant 1).

The rest of the provinces, about 40%, showed contrasting (or dissimilar) income growth rates with the neighboring provinces, with 29% in the Low-High quadrant (quadrant 2) and the remaining 11% in the High-Low quadrant (quadrant 4).

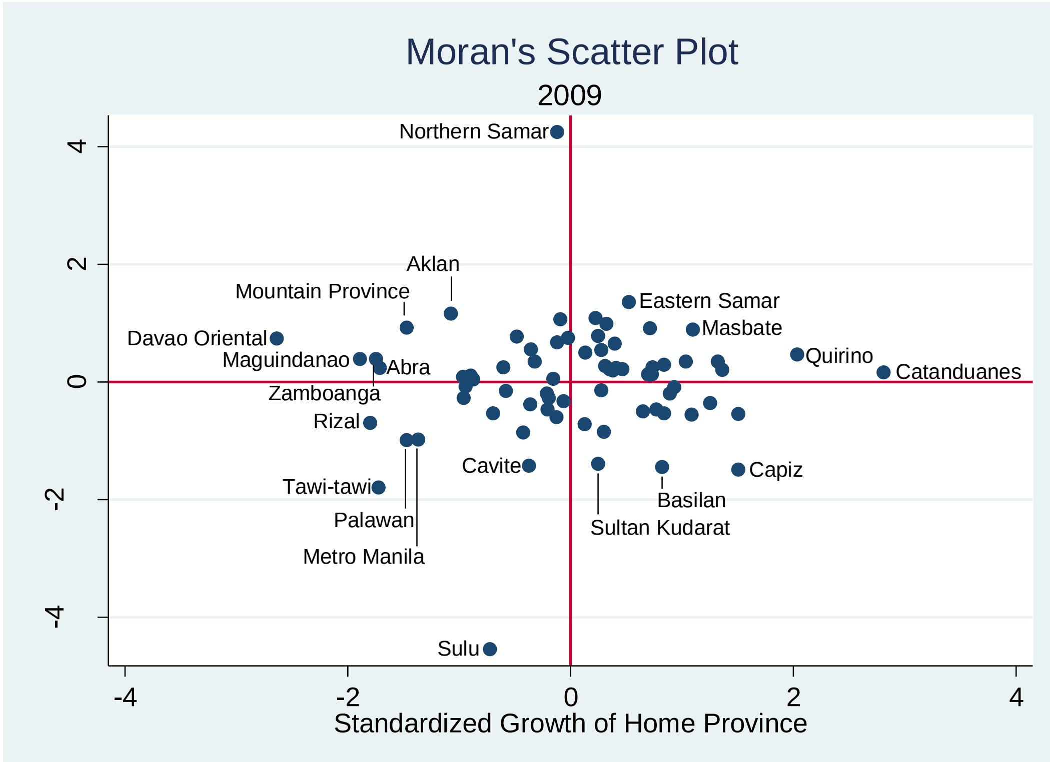
Figure 2. Moran's Scatter Plot (1994-2000)



For the period 1994 to 2000, the percentage of provinces having similar growth rates in per capita income with the neighboring provinces (higher or lower than the national average) dropped to about 54% (from 60% for the period 1988 to 1994). Moreover, only 22% of the provinces are in the High-High quadrant (quadrant 1), while a higher 32% are in the Low-Low quadrant (quadrant 1).

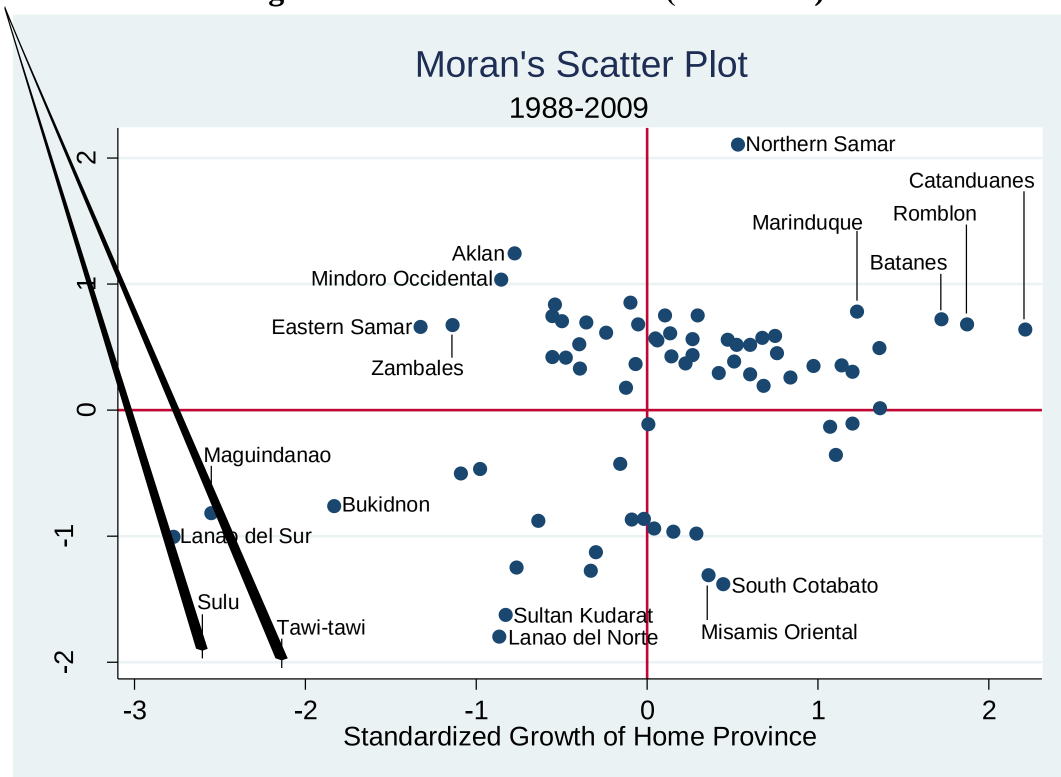
The percentage of the provinces showing dissimilar income growth rates with the neighboring provinces increase to 46% (from 40% for the period 1988 to 1994), with 27% in the Low-High quadrant (quadrant 2) and 19% in the High-Low quadrant (quadrant 4). The results suggest that the degree of similarity in the average per capita income growth of the home provinces with their neighbors weakened during the second period, as shown by the Moran's Index (in table 4), where the value decreased to 0.036 (for 1994 to 2000) from 0.196 (for 1988 to 1994).

Figure 3. Moran's Scatter Plot (2000-2009)



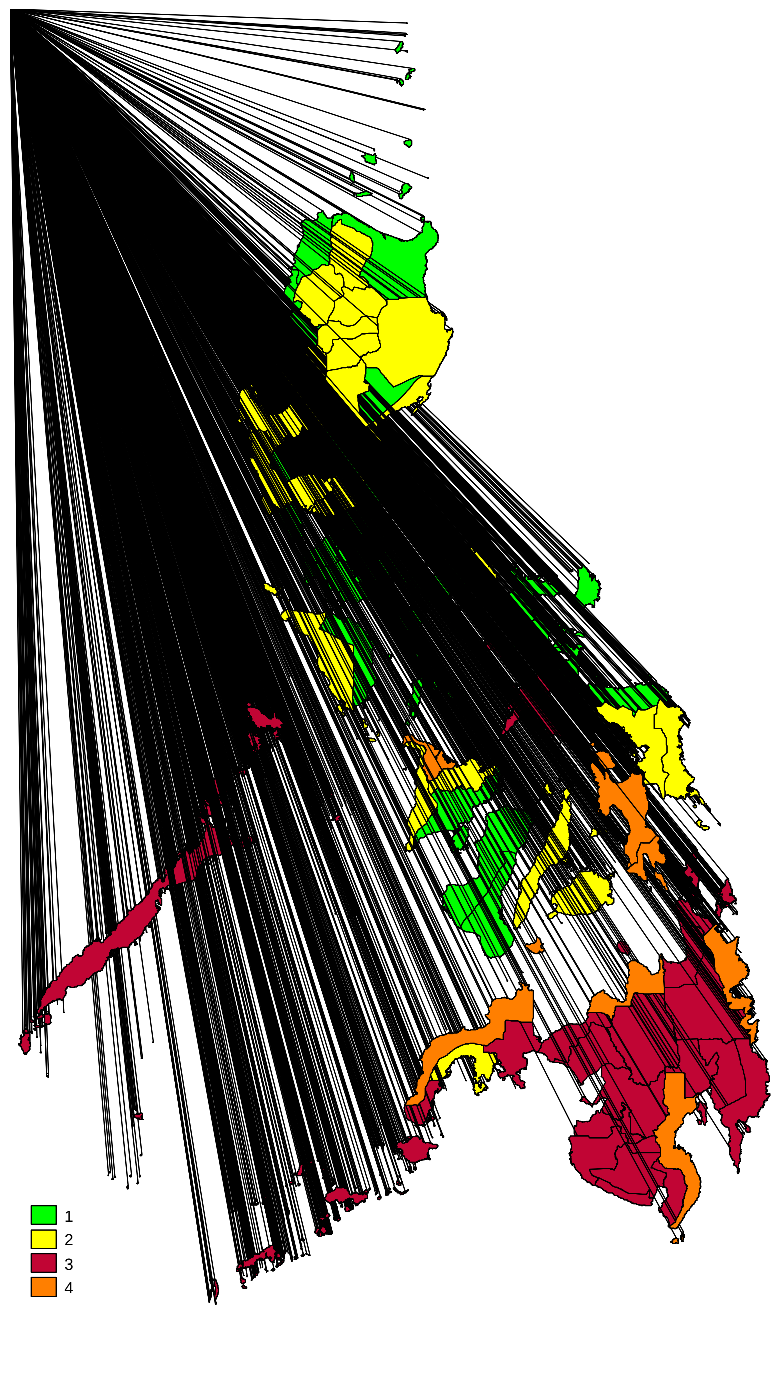
For the period 2000 to 2009, the percentage of provinces having similar growth rates in per capita income with the neighboring provinces is about 55% (with 32% in the High-High quadrant (quadrant 1) and 23% in the Low-Low quadrant (quadrant 1)). The percentage of the provinces showing dissimilar income growth rates with the neighboring provinces increase is about 45% (with 26% in the Low-High quadrant (quadrant 2) and 19% in the High-Low quadrant (quadrant 4). Similar to the period 1994 to 2000, the degree of similarity of the income growth rate between the home provinces and the neighbors is very weak as shown by the Moran's Index for this period which is about 0.030.

Figure 4. Moran's Scatter Plot (1988-2009)



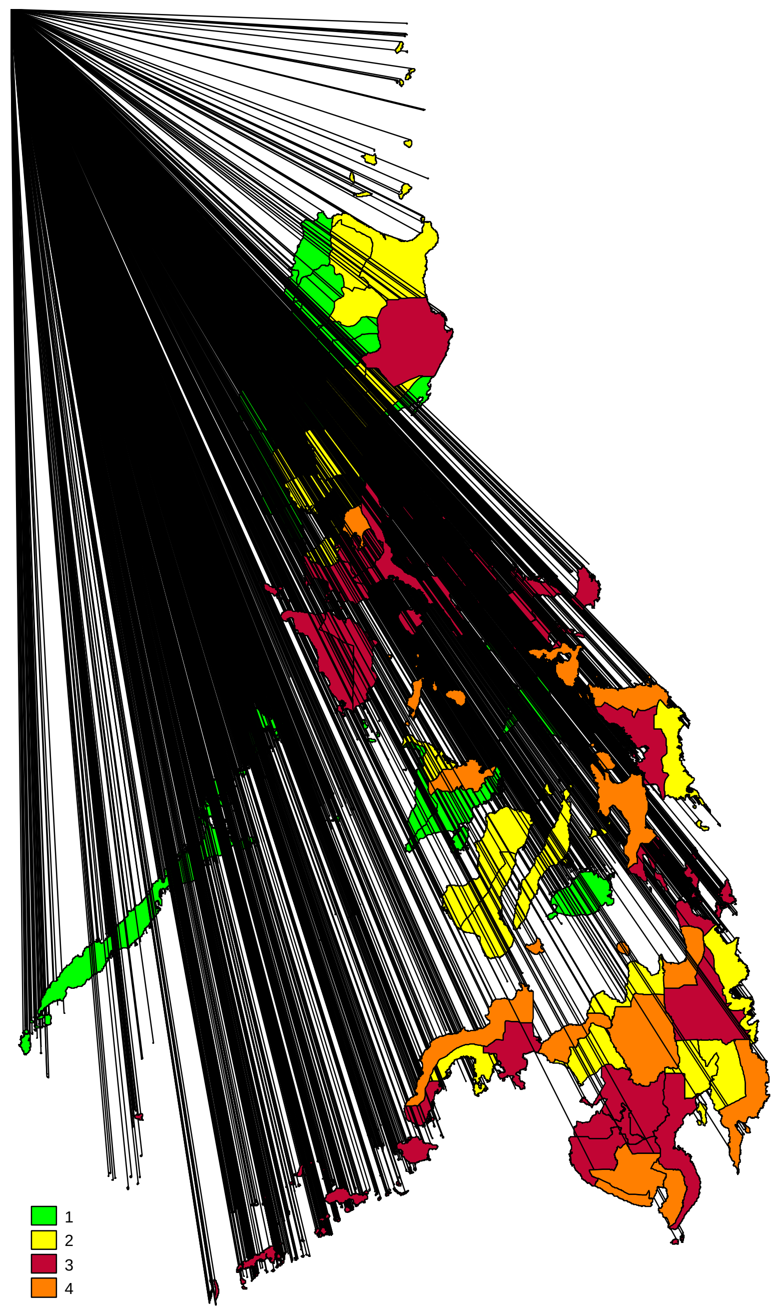
For the overall period 1988 to 2009, the percentage of provinces having similar growth rates in per capita income with the neighboring provinces is about 64% (with 42% in the High-High quadrant (quadrant 1) and 22% in the Low-Low quadrant (quadrant 1)). The percentage of the provinces showing dissimilar income growth rates with the neighboring provinces increase is about 36% (with 24% in the Low-High quadrant (quadrant 2) and 12% in the High-Low quadrant (quadrant 4). The degree of similarity of the income growth rate between the home provinces and the neighbors is positive and significant, with a Moran's Index of about 0.12.

Figure 5. Mapping of the Philippine Provinces Income Growth (1988-1994) using the Moran's Quadrant



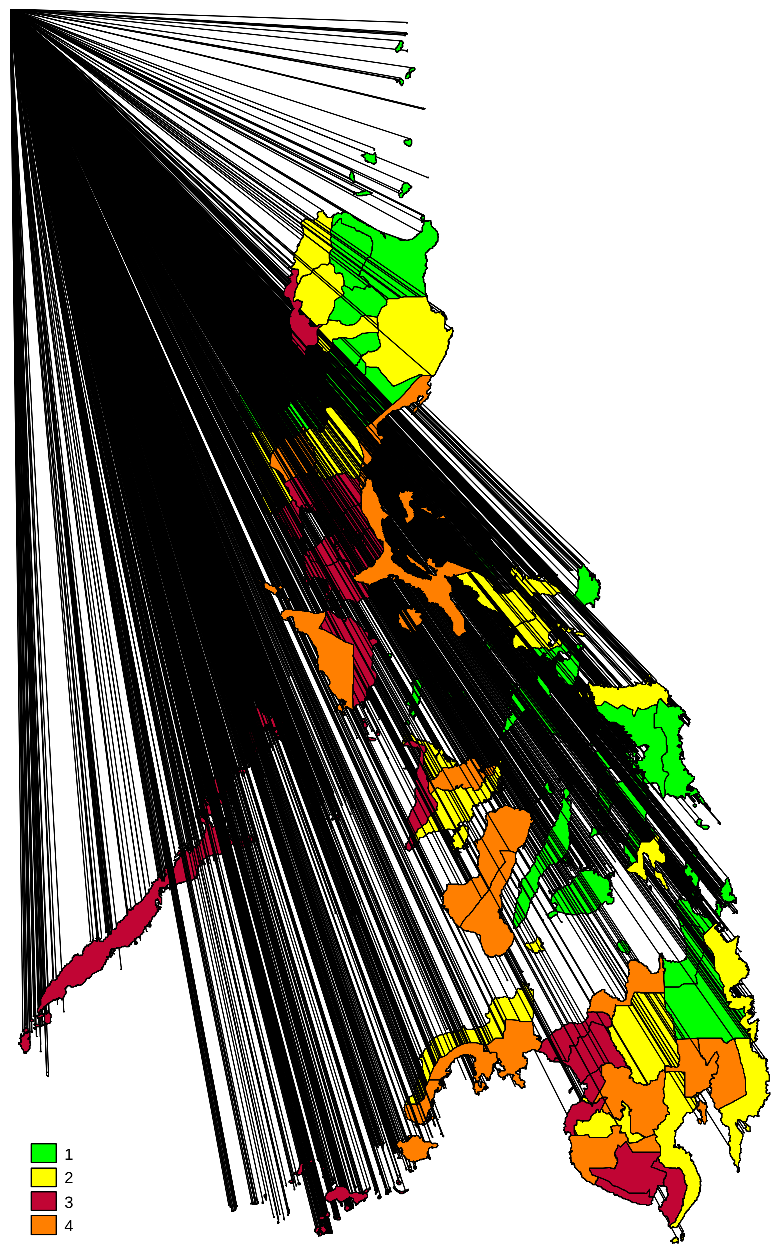
Note: (Quadrant 1 is High-High; Quadrant 2 is Low-High; Quadrant 3 is Low-Low and Quadrant 4 is High-Low)

Figure 6. Mapping of the Philippine Provinces Income Growth (1994-2000) using the Moran's Quadrant



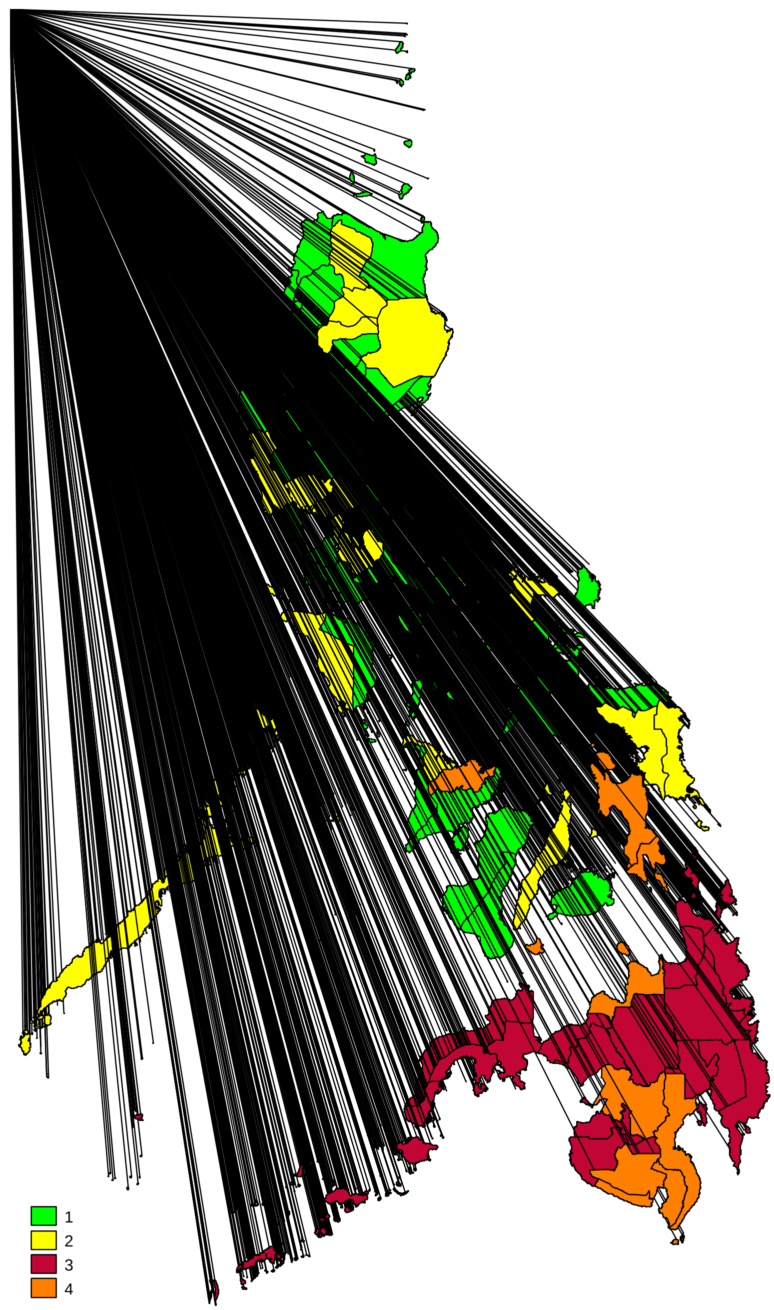
Note: (Quadrant 1 is High-High; Quadrant 2 is Low-High; Quadrant 3 is Low-Low and Quadrant 4 is High-Low)

Figure 7. Mapping of the Philippine Provinces Income Growth (2000-2009) using the Moran's Quadrant



Note: (Quadrant 1 is High-High; Quadrant 2 is Low-High; Quadrant 3 is Low-Low and Quadrant 4 is High-Low)

Figure 8. Mapping of the Philippine Provinces Income Growth (1988-2009) using the Moran's Quadrant



Note: (Quadrant 1 is High-High; Quadrant 2 is Low-High; Quadrant 3 is Low-Low and Quadrant 4 is High-Low)

IV. ECONOMETRIC MODELS

This section discusses the empirical results of the econometric model using country's intra-country data for the period 1988 to 2009. The econometric model for the average per capita income growth (the dependent variable) is a Barro-type (Barro and Xala-i-Martin, 2004) growth regression model, augmenting it to incorporate the provincial spatial dependence using the distance measure of identifying the neighboring provinces of a particular home province (using the maximum distance of 655 kilometers to identify the neighbor). The weight used is the inverse of the distance implying that the correlation between income growth of the two provinces decreases with distance. The spatial dependence is referred to as the neighborhood effect. The explanatory variables include the initial per capita income of the province (to capture the conditional convergence or catching-up effect), the proportion of young dependents (aged 0 to 14) in the population (demographic factor), measure of inequality (using the expenditure Gini and its square), geographical variables such as average amount of rainfall, average slope of the land and an indicator variables if the province is landlocked or not. An indicator variable if the province has mineral resources is also included in the model. Measures of infrastructure are also included in the model using the proxy variables growth rates of households with electricity and the national road. A political indicator variable is incorporated in the model using the percentage of mayors and governors in the provinces who are affiliated with the same political party as the incumbent president of the country. The vector of economic and political variables (known as the Barro's Core) is included in the econometric since these usually affect the steady state growth of income.

The empirical results are shown in tables 5 and 6 below. The results in table 5 show the full model, while table 6 shows the results of the reduced model after eliminating the statistically insignificant coefficients. In tables 5 and 6, the coefficient of the neighborhood effect (or the spatial effect) is positive and significantly affecting the average income growth of the home province, controlling for other factors. In particular, if the average per capita income growth of the neighboring provinces increase by 1 percentage point, the average per capita income growth of the home province will increase by about 0.5 percentage points, all things being the same. This value shows a strong and positive spatial dependence between the home province and its neighbors. The positive sign of the spatial effect is also consistent with the values of the Moran's indices. The other variables that are significantly affecting the average growth of provincial per capita income are the initial income, percentage of young dependents and the political variable.

The magnitude of the coefficient of the natural logarithm of initial income (at -8.054 for the final model) implies that (conditional) convergence of provincial income occurs at the rate of about 8 percent per year.[22] This result is congruent with the expectation of conditional convergence, that is, the economy grows faster the further it is from its own steady state level of

[22] This estimate of the rate of conditional convergence of the model is higher than that previously estimated by Balisacan (2005) at 4% per year and closer to the estimate of Balisacan and Fuwa (2002) which was 9% per year for the Philippines provincial data.

income. Thus, on the average, provinces with higher per capita income at the start of the sample period experienced lower average growth rate relative to provinces with lower initial income per capita, all other things being the same. In other words, poorer provinces have the opportunity to catch up (in terms of income growth) with the richer provinces in the long run. Note, however, that this convergence is conditional in that it predicts a higher growth in response to a lower starting provincial income per person if the other explanatory variables are held constant.

The demographic variable, proportion of young dependents, has a negative and significant effect on the average per capita income growth of the provinces. The estimated coefficient of -7.342 (in the final model) implies that a one-percentage point reduction in the percentage of young dependents at the start of the period will results in an estimated 7.3 basis points increase on the average growth rate of income per person, all things being the same. The absolute figure of 7.3 basis points may seem small but it should be considered that the estimated increase in income growth, as provided by the model, is accumulated over the period 1988 to 2009 (over 21 years), which is substantially large at the end of the period 2009. This result supports the earlier studies, notably Mapa and Balisacan (2004) and Bloom and Williamson (1997), using cross-country data, that a country with a large proportion of young dependents will experience constricting effects on its economic growth during the first phase of the demographic transition.

The political variable, percentage of mayors and governors that are affiliated with the same party as the country's president, is also a significant determinant of per capita income growth. However, the sign of the estimated coefficient for this variable is negative, somewhat inconsistent with the expectation that being affiliated with the same party as the country's president may result higher, rather than lower income growth. Being affiliated with the seating president's political party may bring in more infrastructure projects that will likely increase income growth. A study on the impact of political variable on infrastructure development by Balisacan, Mapa, Fuwa, Abad-Santos and Piza (2011) showed that growth rate in the percentage of household with electricity (the authors' proxy for infrastructure) is targeted to provinces with higher proportion of mayors and governor affiliated with the President's party.

Table 5. Results of the Spatial Lag Econometric Model for Average Provincial Growth Rate (Full Model)

Description	Estd Coeff	SE	p-value
Neighborhood Effect (Spatial Effect)	0.522	0.226	0.021
Initial Income (in natural logarithm)	-9.515	1.701	0.000
Percentage of young dependents	-5.808	4.495	0.196
Average Rainfall	0.000	0.000	0.239
Percentage of Mayor and Gov with the President's Party	-3.239	1.454	0.026
Gini Coefficient	22.688	36.155	0.530
Square of Gini	-31.165	51.383	0.544
Growth Rate - HHs with Electricity	-0.018	0.042	0.668
Growth Rate - National Road	-0.028	0.025	0.268
Dummy Variable for Geography (Landlock)	-0.428	0.323	0.186
Slope of the Land	0.297	0.221	0.180
Province with Mineral Resources	0.186	0.485	0.701

Year Indicator (for 1994-2000)	2.724	0.489	0.000
Year Indicator (for 2000-2009)	0.492	0.525	0.348
Constant Term	41.648	9.861	0.000

Wald's Test for Spatial Coefficient (Rho) = 0 (Test Stat = 5.335; p-value = 0.021)

Table 6. Results of the Spatial Lag Econometric Model for Average Provincial Growth Rate (Final Model)

Variables	Estd Coeff	SE	p-value
Neighborhood Effect (Spatial Effect)	0.548	0.216	0.011
Initial Income (in natural logarithm)	-8.054	1.497	0.000
Percentage of young dependents	-7.342	4.218	0.082
Percentage of Mayor and Gov with the President's Party	-2.895	1.441	0.045
Year Indicator (for 1994-2000)	2.465	0.406	0.000
Constant Term	39.416	7.114	0.000

Wald's Test for Spatial Coefficient (Rho) = 0 (Test Stat = 6.459; p-value = 0.011)

V. CONCLUSION

This study looks at the spatial relationship of the average per capita income growth using intra-country or provincial data from 1988 to 2009. The results from the study provide insights on the geographical dimensions of provincial income growth and showed evidence on the role of spatial effects in the formal econometric analysis of intra-country income growth models. Despite the data limitations, the study provides a strong empirical evidence of the presence of positive spatial dependence or degree of similarity in the average per capita income growth of the provinces, albeit the degree of positive spatial dependence weakens in the latter periods. This positive spatial correlation suggests the provinces may be converging in terms of their income growth and they do so in movements similar to their neighbors. The finding of the study that spatial dependence weakened in the latter periods (1994-2000 and 2000-2009) needs to be analyzed further. The weakening of spatial dependence may provide insights on the uneven provincial/regional income growth experienced in the country. One possible explanation of the weak spatial dependence is that two or more groups of neighboring provinces are growing at similar rates within the group, but at different rates across groups. This opens the possibility of having different convergence clubs (of provinces) within the country. We hope this paper can stimulate others to investigate further the spatial dimensions of income growth in the country.

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