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ABSTRACT

The provincial per capita income growth in the Philippines can be considered as generally dismal in the last three decades. In trying to investigate this phenomenon, the paper applies robustness procedures to identify variables strongly correlated with provincial income growth in the Philippines. The extreme bound analysis and Bayesian averaging of classical estimates procedures are applied to fifteen determinants of income growth from a data set consisting of 74 Philippine provinces for the period 1985 to 2003. Results show that the high level of inequality is a serious obstacle to Philippine economic growth. The study also shows that the percentage of young dependents, or those aged 0 to 14 years, over the total population also hinders the provincial income growth.

Keywords: Extreme Bound Analysis, Bayesian Averaging of Classical Estimates, Inequality, Young Dependents

JEL Categories: O18, O15, R11

I. INTRODUCTION

The provincial per capita income growth in the Philippines can be considered as generally dismal in the last three decades. While there are provinces where average yearly per capita income growth has been moderately high (more than 5%) during the period 1985 to 2003, majority of the provinces have income growth that is comparable with 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".[i] Several papers have come out in recent years, specifically explaining what went wrong in the case of the Philippines.[ii]

Recent cross-country empirical analysis (Mapa and Balisacan, 2004) has point 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 88 million in 2007), next only to Indonesia (about 225 million), and has among the highest population growth rates in Asia during the last three decades.[iii] According to the United Nations' estimate, the country's population is expected to reach 116 million by 2025. Moreover, the country has also a high number of poor households – 4.7 million households in 2007 – equivalent to 27.6 million Filipinos living below the poverty line.

Mapa, Balisacan and Briones (2006; 2008) and Mapa and Briones (2007) tried to answer the question of what seems to curtail the income growth in the Philippines during the period when most of its East Asian neighbors experienced high economic growth. Using robustness procedures, the authors find that the high level of inequality and high percentage of young dependents (relative to the total population) are contributing negatively to the average provincial per capita income growth and they concluded that the two variables are robust determinants of provincial income growth. The authors also showed that the long running conflict in the provinces of the Autonomous Region of Muslim Mindanao (ARMM)[iv] results to a lower average per capita income growth in these provinces relative to the other provinces in the Philippines.

Other studies notably that of Balisacan (2005, 2007) and Balisacan and Fuwa (2002), using provincial data from 1988 to 2003, show that the level of human stock capital (using child mortality rate as the proxy variable in the studies) is a statistically significant determinant of provincial income growth rate. The time-varying policy variables that are positive and significant determinants of provincial income growth rate are literacy rate and access to infrastructure. The studies 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 a political variable, the Balisacan papers utilize the initial political conditions which the authors define as the extent of dynasty within a province– measured as the proportion of provincial officials related by blood or affinity. The results on this political variable are mixed: Balisacan and Fuwa (2002) show that the variable dynasty has a negative and significant effect on income growth while Balisacan (2007) results show that the dynasty variable, while negative, is insignificant.

This paper revisits the approach made by Mapa and Briones (2007) in identifying the robust determinants of provincial per capita income growth in the Philippines from 1985 to 2003. The two authors identified 15 potential determinants of provincial per capita income growth that include initial economic indicators, initial geographical conditions, initial demographic conditions, time-varying variables and neighborhood effects. In running the robustness procedures, the authors assume a fixed number of explanatory variables in the number (7 variables) with two variables always present in the model (natural logarithm of initial income and average years of schooling of the household head as proxy for education). The assumption of a fixed number of regressors, with two variables always present in the model, create some undue restrictions in the model. This paper relaxes some of the restrictions imposed by Mapa and Briones (2007) in running the robustness procedures to identify the determinants of provincial income growth. This paper will not assume a specific number of regressors in the model and does not impose any condition on the variables that will always be included in the model.

The next section presents the theoretical framework of the growth model used in the intra-country analysis. Then, the presentation of the empirical results of the study including the robustness test applied comes next. The last section concludes.

II. INTRA-COUNTRY INCOME GROWTH ANALYSIS

In analyzing the impacts of population variables on provincial income growth, the paper uses an intra-country income growth equation derived from the neoclassical Ramsey-Cass-Koopmans model similar to the approaches used by Bloom and Williamson (1997), Bloom et al. (1999), and Radelet et al. (1997). The model assumes that consumers maximize utility over infinite horizon subject to a budget constraint. Moreover, the standard No-Ponzi-Game restriction applies, i.e., firms take wages and the interest rate as given. We assume a Cobb-Douglas production function of the form $Y = AK^{\alpha}L^{1-\alpha}$, where Y is the total output, K represents capital, L represents labor, and A represents total factor productivity. It is also assumed that the production per worker, y = Y/L, takes the form $y = f(k) = Ak^{\alpha}$, where k = K/L. Using the Ramsey-Cass-Koopmans model,

The average provincial growth rate of output per worker, denoted by g_y, between any time, say T_1 (year 1988) and T_2 (year 2003), is proportional to the log of the ratio of income per worker in the steady state (y^*) and the income per worker at time T_1 (the initial condition). Thus, the model is given by,

$$g_y = \frac{1}{T_1 - T_2}\log\left(\frac{y_{T_2}}{y_{T_1}}\right) = \alpha\log\left(\frac{y^*}{y_{T_1}}\right). \qquad (1)$$

The model in (1) is consistent with the empirical growth theory, especially explaining the concept of conditional convergence (Barro and Xala-i-Martin (1995), Romer, D. (1995) and Obstfeld and Rogoff (1996).

For this paper, three modifications are added to the model in (1). First, following Barro (1997) and Radelet, Sachs and Lee (1997), the natural logarithm of the steady state output is expressed as a function of the determinants of the steady state, that is, $\log(y^*)$ is expressed as,

$$\log(y^*) = X\beta \qquad (2)$$

where **X** is a vector consisting of the determinants of the steady state.

The vector **X** includes variables identified as the Barro's core economic and political variables that affect the steady state. The second modification introduced into the model involves changing the model from output per worker (y) to output per capita (y°). Note that,

$$y^{\circ} = \frac{Y}{P} = \frac{Y}{L}\frac{L}{P} = y\frac{L}{P} \qquad (3)$$

where P is the total population, L is the number of workers, y is the output per worker and y° is the output per capita.

The equation given in (3) can be converted to growth rates by taking natural logarithm and then the derivative with respect to time, resulting in,

$$g_{y^{\circ}} = g_y + (g_{workers} - g_{pop}) \qquad (4)$$

where g_{y^0} is the growth rate of per capita output, g_y is the growth rate of per-worker output, $g_{workers}$ is the growth rate of the labor force population (a proxy variable, the growth rate of the working-age population, is used based on the absence of employment rates data and the problematic quality of labor force estimates) and g_{pop} is the growth rate of the total population.

Equation (4) neatly translates a traditional neoclassical model formulated in per worker output growth into a comparable model formulated in per capita output growth. The two components in the right-hand side are the (a) labor productivity component (g_y) and (b) the translation component ($g_{workers} - g_{pop}$). This decomposition is an important contribution of the Harvard demographic framework (Bloom and Williamson (1997), Radelet, Sachs and Lee (1997)) emphasizing the fact that any per capita output growth rate can be separated into an economic production (productivity) component and a translations component.

Kelly and Schmidt (2007) point out that without an accounting structure to translate labor-productivity impacts into per capita terms, demographic coefficient estimates (mainly using population growth) are biased and thus explains the mixed results from empirical studies done in the 1960s to 1980s on the impact of population growth on economic growth. The two authors argue that the population growth coefficient in the previous empirical studies captures the net demographic impacts (can be positive, negative or neutral) that may vary depending on the time and place.

Substituting equations (1) and (2) into (4) and adding a stochastic term (ε) to account for other factors that may affect the growth rate, the following econometric model is expressed as,

$$g_{y^0} = \alpha X\beta - \alpha \log(y_{T_1}) + \phi_1 g_{workers} + \phi_2 g_{pop} + \varepsilon \qquad (5)$$

The final modification involves expressing the logarithm of the initial income per worker (log (y_{T1})) into income per capita and workers per capita (L/P). Thus, the final econometric model is given by,

$$g_{y^o} = X\beta^* - \alpha \log(y_{T_1}^o) + \alpha \log(L/P) + \phi_1 g_{workers} + \phi_2 g_{pop} + \varepsilon \qquad (6)$$

where $\beta^* = \alpha\beta$.

The authors modify the econometric model in (6) to arrive at the final econometric model for the intra-country growth regression. The term ($\phi_1 g_{workers} + \phi_2 g_{pop}$) is referred to as the translations component and that in theory, $\phi_1 = -\phi_2 = 1$. Bloom and Williamson (1998) and Kelly and Schmidt (2007) point out that for a stable population, the growth rate of the workforce is the same as the growth rate of the population and therefore the net demographic effects is zero. Thus, the effect of the translations component is zero or near zero in a demographic steady state or during conditions of slowly evolving demographic change. Data from the National Statistics Office (NSO) show that for the period 1980 to 2000, the average population growth rate of the Philippines is 2.29 percent per year, while the average working age population growth rate is 2.76 percent. The comparative figures for Thailand are 1.32 percent for the average population growth rate and 2.18 percent for the average working-age population growth. These figures suggest that the Philippines exhibit a slowly evolving demographic change where the net demographic effect on income growth is zero and model drops the translations component. Instead of the translations component, the author introduces a demographic variable that may have a direct bearing not only on per capita income growth but also on the labor productivity growth – the proportion of young dependents, defined as the ratio of individuals aged 0 to 14 years to that of the total population (measured in 1985). Kelly and Schimdt (2007) cross-country growth regression shows that the dependency ratio (named D_1), defined as the ratio of population 0 to 14 years to that of working ages 15 to 64 years (measured in natural logarithm) has a negative and significant impact on the productivity growth rate. The new econometric model is given as,

$$g_{y^{o}} = X\beta^{*} - \alpha \log(y^{o}_{T_1}) + \theta(YD/P) + \varepsilon \qquad (7)$$

where YD/P is the proportion of young dependents.

For the vector of economic and political variables (or the Barro's core) that may have impact on the steady state, this essay is benefiting from the earlier works of Balisacan (2007, 2005, and 2003) and Balisacan and Fuwa (2003) that identify most of these variables. In this study, the vector includes initial mean per capita income, initial human capital, mortality rate, an infrastructure index, expenditure GINI ratio and its square, as a measure of inequality, access to infrastructure and a variable that measures the Comprehensive Agrarian Reform Program implementation.

An additional contribution of this paper over the already rich results from the Balisacan studies is the addition of three variables into the intra-country econometric model: the population variables (a) proportion of young dependents, (b) net in-country migration, and (c) incorporating the concept of spatial correlation into the econometric model by introducing the "neighborhood effects" into the model.

B. Incorporating Spatial Correlation 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. Positive spatial autocorrelation happens when similar values of the variable of interest (such as 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 (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), politically unstable regions may have negative externalities or spillover effects on the other regions.

This paper incorporates the possibility of provincial spatial dependence in the intra-country growth regression model by using the commonly used spatial lag model to capture this location dependency. The two other methods to capture spatial dependence are the spatial error model and the spatial cross-regressive model.[v] Substantive spatial dependence is incorporated into the unconditional growth regression specification through a spatially lagged dependent variable,

$$g_{y^o} = X\beta^* - \alpha \log(y^{o}_{T_1}) + \theta(YD/P) + \rho W g_{y^o} + \varepsilon \qquad (8)$$

where W is the spatial weights matrix with elements w_{ij} corresponding to the province (i,j). Different definition of interaction between provinces (or regions) leads to different spatial weight. The commonly used definition is the binary contiguity matrix W, whose w_{ij} = 1 if provinces i and j share the same border and w_{ij} = 0, otherwise. Other definitions of spatial weights are the distance-based (using distances between provincial/regional capitals), combination of binary contiguity and distance and the k-nearest neighbors. This paper combines the contiguity and distance measures to arrive at a binary contiguity-distance measure of defining the neighboring provinces.

III. EMPIRICAL ANALYSIS OF THE MODELS

The data set consists of 74 provinces with variables recorded for the period 1985 to 2003, covering 18 years[vi]. The objective of this study is to determine long run effects of the determinants of income growth, particularly the provinces population dynamics.

A. Data and Variable Specification

The dependent variable of the econometric model is the average growth rate of provincial per capita income, as estimated from the FIES, from 1985 to 2003, measured in 1997 pesos and adjusted for price differences in the provinces.

The explanatory variables comprise of a set representing initial economic, demographic and institutional conditions, a set of time-varying policy variables and neighborhood effects. These variables are defined as follows:

(a) *Initial economic conditions*: (i) initial mean per capita income, (ii) initial human capital stock as measured by average years of schooling of the household head, (iii) mortality rate per 1,000 of 0 to 5 year-old children, (iv) infrastructure index measured as the average of binary variables indicating presence of street pattern, highway, telegraph, postal service, community waterworks and electricity, and (v) expenditure GINI ratio and its square, as a measure of inequality;

(b) *Initial geographical conditions*: (i) an indicator variable, landlock, with value 1 if the province is landlocked and 0 otherwise, (ii) an indicator variable for the provinces of ARMM, namely, Basilan, Lanao del Sur, Maguindanao, Sulu and Tawi-Tawi, and (iii) the average annual number of typhoons;

(c) *Initial demographic conditions*: (i) proportion of young dependents in 1985 defined as the ratio of the population aged 0 to 14 to the total population and (ii) net migration defined as the number of within country net migrants that is, the in-migrants less the out-migrants relative to the province during the period 1985 to 1990;

(d) *Time-varying policy variables* (variables that measure the difference of specific policy variables from 1988 to 2003): (i) electricity access defined as the change in the proportion of households with access to electricity, (ii) change in road density defined as the proportion of roads (adjusted for quality differences), and (iii) the Comprehensive Agrarian Reform Program implementation defined as the cumulative CARP accomplishment to 1990 potential land reform area; and,

(e) *Neighborhood effects*: a variable measuring the average growth rate of per capita income of the neighboring provinces (1985 to 2003) using a combination of contiguity and distance measure.

The identified determinants of economic (income) growth included in this study, together with the data sources, are presented in table 1. The population variable used in this study is the proportion of young dependents to the total population in 1985. This variable is chosen to explain the effects of the population dynamics on income growth due to the fact that the Philippines have not entered into the second phase of the demographic transition. This study will therefore measure the effects of having a big bulge at the bottom of the age pyramid on the provincial income growth.

The summary statistics of the variable of interest and the hypothesized determinants of income growth are provided in table 2. Two interesting values stand out: on one hand, the dismal economic performance of the country during the past years is highlighted by the fact that the average growth rate of provincial per capita income from 1985 to 2003 is only 1.85 percent. This measly income growth performance suggests that it will take about 38 years before average (real) income per person doubles. This means there is a high likelihood that most people will not experience the doubling of their real income in their lifetime!

On the other hand, the mean proportion of young dependents in 1985 is 41.56 percent, with some provinces having a proportion close to 50 percent. It should be noted that while the proportion of young dependents has been decreasing over the years, its decline is very slow compared to say that of Thailand. This large proportion in the young cohort implies that the resources of the provinces had to be allocated to social investments like health and education instead of economic investments, such as infrastructure. While it is said that the young cohort's education and health are future investments, a continuing high and unsustainable population growth resulting in a population with a large proportion of young dependents will surely strain the resources of the national and provincial governments both in the short and long terms.

B. Determinants of Income Growth

The results of the intra-country regression models are given in Table 3. The regression models (in two variants) are representative specifications from the growth literature that includes initial income, human capital variable (education), measure of inequality, geographical factor, institutional conditions and demographic variables.

The magnitude of the coefficient of the natural logarithm of initial income (at -3.0720 for model 1) implies that (conditional) convergence of provincial income occurs at the rate of about 3% per year[vii]. 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 income. Thus, on the average, provinces with higher income per capita at the start of the sample period (1985) experienced a lower average growth rate from 1985 to 2003 relative to provinces with lower initial income per capita, all other things being equal. In other words, poorer provinces can catch up with richer provinces. 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. At a conditional convergence rate of 3%, it would take about 23 years before half the initial gap, between the average income per person (in 1985) and the steady state income per person, will be eliminated (half life of convergence). In other words, the average provincial per capita income is currently (in 2008 – 23 years from 1985) about halfway between the average per capita income in 1985 and its steady state per capita income.

From both models, the population variable, proportion of young dependents, has a negative and significant effect on income growth. The estimated coefficient of -0.09 (for model 1) implies that a one-percentage point reduction in the percentage of young dependents in 1985 results in an estimated 9 basis points increase on the average growth rate of income per person from 1985 to 2003, all things being the same. The absolute figure of 9 basis points might be small at first glance but it should be considered that the estimated increase in income growth, as provided by the model, is cumulated over 18 years which can result in a significant increase in the 2003 per capita income, as what the succeeding section will show using simulation techniques. Moreover, the percentage of young dependents in the Philippines in 1985 is quite high at 42 percent, compared to that of Thailand's figure of 35 percent – a huge gap of 7 percentage points. This implies that reducing the proportion of young dependents by this amount (in 1985), the estimated increase on average per capita growth per year would be 0.63, surely not a small value.

The results support 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 and that the only way to enjoy the "demographic bonus" of positive growth in the medium term is to enter into the second phase of the demographic transition. The Philippines has not benefited much from this "bonus" since the reduction of the proportion of young dependents had been very slow since 1985. In the next section, the study will show that such negative relationship is "robust" across various specifications of the models.

The measures of initial inequality (in the models expenditure Gini and its square were used instead of income or land (asset) Gini) are both significant but with opposite signs. The coefficient of inequality has a positive sign, while its square has a negative sign, all things being the same. The opposite signs of the coefficients imply that the relationship between inequality and income growth follows that of an inverted U shape.[viii] In particular, low levels of inequality do not create hindrance for growth, but high levels of inequality are associated with lower income growth. In fact, there is a "turning point" where below this value, inequality has a positive effect on income growth but above this value it has a negative effect on income growth. This "turning point" is estimated to be 0.34, which is about the same as the average GINI for the 74 provinces. It means that GINI values below 0.34 (GINI coefficient is between 0 and 1) have positive effects on the average income growth while GINI values higher than 0.34 have constricting effects on income growth. Out of the 74 provinces in the sample, only 35 provinces have Gini coefficient values of less than 0.34, while 39 provinces have values greater than 0.34. This tells us that the net effect of inequality on income growth, using the results of the regression model, is negative for majority of provinces in the Philippines.

The location variable ARMM has a negative and significant impact on the average provincial income growth suggesting that these provinces have been experiencing "growth discount" over the years, relative to the other provinces. Provinces in the ARMM region have lower average per capita income growth of about 2.29 percentage points compared to that of the average of the other provinces, all things being equal.

Net migration has a negative and significant effect on average provincial growth rate.[ix] The estimated coefficient implies that for every 10,000 net migrants entering the province during the period 1985 to 1990, the estimated average growth rate per person decreases by 0.08 percentage point (or 8 basis points) all things being the same. The negative coefficient for net migration is consistent with the Solow-Swan theory of growth where expansion of the supply of in-migrants lowers the steady-state capital intensity of the domestic economy primarily because the in-migrants come with relatively little physical capital (Barro and Sala-i-Martin; 2004).

To capture potential spatial/spillover effects which indicates how the average growth rate of per capita income in the province is affected by its neighboring provinces, after conditioning for the initial level of income per person, a "neighborhood effect" is introduced in the regression model. This variable is computed as the average growth rate of the neighboring provinces (from 1985 to 2003) where the "neighbors" are identified using a contiguity-distance based measure. The inclusion of this spatial variable, neighborhood effect, into the growth regression model, conforms to the spatial auto-regressive model discussed by Anselin (1988). 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 for U.S. states/counties, European regions, and China's provinces, to name a few. 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). By introducing a "spatial variable" the dynamics of how the regions/provinces' economic performance interact with each other can be better understood.

The negative and significant effect of the neighborhood variable in the regression model signifies a negative spatial correlation among the neighboring provinces. As the average growth rate of per capita income of the neighbors increase, the average growth rate of per capita income in the home province decreases.[x] One possible explanation to this is that the neighboring provinces are competing with each other in terms of investment for the province. This "beggar thy neighbor" phenomenon experienced by the provinces in the Philippines is highlighted in the case of the province of Cebu where the home province (Cebu) has a higher growth rate than the national average (3.21% vs. 1.86%), while its neighbors' average income growth is lower than the national average (1.71% vs. 1.86%).

The education variable, measured by the number of years of schooling of the household head, is included in the model to measure human capital. However, the education coefficient (0.1483 for model 1) while positive is not significant in explaining variations in the average provincial income growth in the Philippines. The insignificant result is in contrast to the results established in the cross-country regressions where education is a positive determinant of economic growth. One possible explanation is that the education variable in the model was not able to capture very well the level of human capital in the provinces. One potential improvement in the choice of proxy for human capital is to estimate the average number of years of schooling of individuals 15 years and above, representing the working group, similar to the work of Barro and Lee (2001), instead of using the years of schooling of the household head.[xi]

In model 2, two time-varying policy variables, infrastructure index and change in electricity, are included while the variables education and net migration are excluded. The result for the population variable remains significant, although slightly lower than the result in model 1. A one-percentage point decrease in the proportion of young dependents in 1985, increases the estimated mean provincial per capita income from 1985 to 2003 by about 7.5 basis points, all things being equal. The time-varying policy variables have positive signs, as expected. However, of the two, only the infrastructure index is a significant determinant of income growth, while improvement in the access to electricity is not. A 10 percentage points increase in infrastructure index, results in an increase of 0.17 percentage point (or 17 basis points) in the estimated average provincial per capita income, all things being the same.

Since some of the explanatory variables, particularly education and the proportion of young dependents, are not strictly exogenous variables, the models are estimated again, this time using instrumental variables in the regression. Table 4 shows the results of the model 1 specification, re-estimated using two stage least squares (model 3) and the generalized method of moments (model 4). These two estimation procedures are better than the ordinary least squares since they provide consistent estimates of the coefficients.

The coefficient of the proportion of young dependents is negative and significant for both procedures. Moreover, the magnitude of the coefficient is larger than that of the two previous models. This is one indication that the proportion of young dependents is a robust determinant of income growth.

C. Robustness Procedures – Bayesian Averaging of the Classical Estimates (BACE)

The main argument in empirical growth econometrics is the choice of control variables--which explanatory variables are to be included or excluded in the regression models. The problem is that variables, such as population growth, may be a significant determinant of income growth depending on which other variables are held constant. The question now is, "Which variables should be included in the growth regression?" (Barro and Sala-i-Martin: 2004). The very first of these robustness procedures was the extreme bound analysis (EBA) suggested by Leamer (1983) and used by Levine and Renelt (1992) to test the robustness of the variables in the growth regression using cross country data. To identify whether variable z is robust, Levine and Renelt initially proposed using the extreme bound test. The first step is to estimate regressions of the form:

$$\gamma = \alpha_j + \beta_{yj} y + \beta_{zj} z + \beta_{xj} x_j + \varepsilon \quad , \qquad (9)$$

where y is a vector of fixed variables that appear in all the regressions (in income growth regressions, these are usually the log of initial income and education), z is the variable of interest, and $x_j \in X$ is a vector of variables taken from the pool X of N variables available. One needs to estimate this regression or model for the M possible combinations of $x_j \in X$. For each model j, one finds and estimate, β_{zj}, and the corresponding standard deviation, σ_{zj}.

The next step is to compute for the lower and upper extreme bounds. The lower extreme bound for variable z is defined to be the lowest value of $\beta_{zj} - 2\sigma_{zj}$ and the upper extreme bound for z is defined to be the largest value of $\beta_{zj} + 2\sigma_{zj}$.

The extreme bound test for variable z states that if the lower extreme bound is negative and the upper extreme bound is positive, then variable z is not robust. This means that the variable is considered not robust if one finds at least one regression for which the sign of the coefficient, β_z, changes or becomes insignificant.

Table 5 presents the results of the extreme bound analysis. The determinants of income growth are presented in the first column while column two shows the number of regression equations where the variable is included. Columns six and seven report the lower and upper extreme bounds, respectively, for all the fifteen variables of interest.

From the table, it shows that twelve out of the fifteen variables have lower extreme bounds which are negative and upper extreme bounds which are positive. This means that under the extreme bound analysis, only three can be considered as robust while the remaining twelve variables are non-robust. The three robust determinants of economic growth under this test is the log of initial income, the expenditure GINI and its square. The results show that the Extreme Bound Analysis (EBA) is too strong for variable to really pass it.

Despite the fact that EBA is difficult to pass, the results show that inequality is a strong determinant of provincial per capita income growth in the Philippines. Moreover, the result suggests that low inequality level is pro-growth while high inequality level is anti-growth. As pointed out by Canlas (2008), "one of the features of Philippine economic growth is that income inequality has stayed high." The high level of inequality is a serious obstacle to Philippine economic growth.

Sala-i-Martin, Doppelhofer and Miller (SDM; 2003) used the Bayesian approach in averaging across models, while following the classical spirit.[xii] This paper uses the Bayesian Averaging of Classical Estimates (BACE) approach to determine the variables that are strongly or robustly related to income growth. Instead of assigning the label "fragile" or "robust", each of the explanatory variables is provided with a "level of confidence" known as sign certainty probability and is set at 97.5 percent. [xiii]

Following Sala-i-Martin, X, G. Doppelhoffer, and R. Miller (2003), represent a model, M_j, as a length K binary vector in which a one indicates that a variable is included in the model and a zero indicates that it is not. Then the prior probability of model j, as specified by the researcher, is given as:

$$P(M_j) = \left[\prod_{i=1}^{k_j} M_{ji} \frac{\bar{k}}{K}\right]\left[\prod_{i=1}^{k_j} \left(1 - M_{ji}\right)\left(1 - \frac{\bar{k}}{K}\right)\right] \qquad \text{(i)}$$

where k_j is the number of included variables in model j, $\bar{k}$ is the prior mean model size, and M_{ji} is the ith element of the vector.

In the case of equal prior inclusion probabilities for each variable, the prior probability of model j given above is simplified to:

$$P(M_j) = \left(\bar{k} / K\right)^{k_j} \left(1 - \bar{k} / K\right)^{K - k_j}, \forall j = 1, \ldots, J \qquad \text{(ii)}$$

The weights can then be computed using the prior probabilities. The weight of a given model is normalized by the sum of the weights of all possible models with K possible regressors:

$$P(M_j \mid y) = \frac{P(M_j) T^{-k_j/2} SSE_j^{-T/2}}{\sum_{i=1}^{2^K} P(M_i) T^{-k_i/2} SSE_i^{-T/2}}, \quad \forall\ j = 1, \ldots, J \qquad \text{(iiii)}$$

where T is the sample size and SSE_i is the OLS sum of squared errors under model *i*.

Using the equations above, the posterior mean of β,

$$E(\beta \mid y) = \sum_{j=1}^{2^K} P(M_j \mid y) \hat{\beta}_j \qquad \text{(vi)}$$

where $\hat{\beta}_j = E\left(\beta \mid y, M_j\right)$ is the OLS estimate for β with the regressor set that defines model *j*. Moreover, the posterior variance of β is given by:

$$Var(\beta \mid y) = \sum_{j=1}^{2^K} P(M_j \mid y) Var(\beta \mid y, M_j) + \sum_{j=1}^{2^K} P(M_j \mid y) \left[\hat{\beta}_j - E(\beta \mid y) \right]^2 \qquad \text{(vii)}$$

The BACE procedure applied in this study relaxes some of the restrictions imposed by Mapa and Briones (2007). This paper does not specify a fixed number of regressors in running the model nor does it specify variables that will always be included in the model. The total number of estimated regression models is 2^{14} or 16,384. The result of the robustness procedure is provided in table 6.

The determinants of income growth are listed in column 1, while the posterior means and posterior variances of the coefficients computed from all the models, are given in columns 3 and 4, respectively. The last column provides the sign certainty probability, or the probability that the estimated coefficient is on one side of zero (positive or negative). In the table, the estimated mean of all the coefficients of the logarithm of initial mean income (initial condition) is -2.63 which is very close to the value in model 1 (given in table 3) previously discussed. The probability that such coefficient will always be negative using the BACE is 1.00 (with certainty). Thus, the logarithm of initial mean income can be considered as strongly or robustly correlated with income growth. This result is not surprising because of the concept of conditional convergence.

Aside from the initial income, the other variables that are strongly correlated with income growth are the change in proportion of households with electricity which is positively correlated with income growth, proportion of young dependents (negatively correlated with growth), the inequality measures, Gini coefficients (positively correlated with growth) and its square (negatively correlated with growth), ARMM variable which is negatively correlated with growth, net migration and neighborhood effects, both are negatively correlated with income growth.

The rest of the variables show little evidence of robust partial correlation with income growth using the empirical test. These variables that are considered as weak determinants are education, change in CARP, change in the quality of roads, infrastructure index, the indicator variable landlock, mortality rate, and the number of typhoons.

IV. CONCLUSIONS

This paper aims to identify variables strongly correlated with per capita income growth in the Philippines using robustness procedures. The extreme bound analysis (EBA) and Bayesian averaging of classical estimates (BACE) were applied to fifteen explanatory variables from a data set consisting of 74 Philippine provinces for the period 1985 to 2003. These explanatory variables considered to be determinants of income growth comprise of a set representing initial economic, demographic and institutional conditions, a set of time-varying policy variables, and neighborhood effects. From the EBA, the log of initial income (initial condition) and inequality measure (expenditure GINI and its square) stand out as robust estimators. Under the BACE, on the other hand, the proportion of young dependents is shown to be strongly correlated with income growth. The other variables that are identified as strong determinants of income growth are ARMM indicator, change in the proportion of households with electricity, net migration and neighborhood effect.

High level of inequality creates a hindrance to income growth. The paper is able to show that the population dynamics indeed play an important role in the country's provincial income growth. The opportunities associated with the demographic transition are real and can stimulate additional income growth through the demographic dividend. While this paper does not cite population dynamics as the only reason for the poor economic performance of majority of the provinces, tests done in this study show that the proportion of young dependents is a robust determinant of income growth and can explain a significant portion of the growth differentials between provinces with high proportion of young dependents and those with low proportion of young dependents. This paper supports the earlier conclusion made by Mapa and Balisacan (2004) in their cross-country analysis wherein they concluded that the Philippines pays a high price for its unchecked high population growth. The results from this study reiterate the call for a clear population policy backed by strong government support.

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TABLES

Table 1: Variable Definitions and Data Sources

VARIABLE NAME	DEFINITION	SOURCE OF BASIC DATA
Actual per capita income growth rate	Average growth rate of provincial per capita income from 1985 to 2003; Income is measured in 1997 pesos and adjusted for price differences in the provinces.	FIES; 1985 and 2003
Log of initial income	Natural logarithm of the initial mean per capita income adjusted for provincial cost of living differences	FIES; 1985
Education	Average education of the household heads measured by the average years of schooling	FIES; 1994
Proportion of young dependents	Defined as the ratio of young dependents (population aged 0 to 14 years) to the total population	FIES; 1985
ARMM	Variable for the provinces of ARMM (namely, Basilan, Lanao del Sur, Maguindanao, Sulu, and Tawi-Tawi)	
Change in CARP	Change in the proportion of cumulative CARP (DENR and DAR) accomplishments to 1990 Potential Land Reform Area from 1988 to 2003	DENR and DAR; 1988 and 2003
Change in electricity	Change in the proportion of households with access to electricity from 1988 to 2003	FIES; 1988 and 2003
Change in road	Change in road density from 1988 to 2003	DPWH and NSO; 1988 and 2003
Expenditure GINI and its square	Measure of expenditure inequality	FIES; 1985
Infrastructure index	Provincial average of binary variables indicating presence of street pattern, highway, phone, telegraph, postal service, community waterworks system and electricity	CPH; 1990
Landlock	Variable with value 1 if the province is landlocked and 0 otherwise	
Mortality rate	Mortality rate per 1,000 of 0 to 5 year-old children	NSO; 1991
Neighborhood effect	Measured by the average growth rate of per capita income of the neighboring provinces using a contiguity measure	FIES; 1985 and 2003
Net migration	The number of within country net migrants computed as in migration less out migration (x 1000); 1985 to 1990	CPH; 1990

Table 2: Summary Statistics of the Variables in the Econometric Model

VARIABLE	Mean	Maximum	Minimum	Standard Deviation	Number of Observations
Growth rate of provincial per capita income	1.85	5.21	-1.36	1.34	74
Log of initial income	9.73	10.40	9.07	0.29	74
Education	6.60	9.80	3.40	1.05	74
Proportion of young dependents	41.56	48.92	33.15	3.47	74
ARMM	0.07	1.00	0.00	0.25	74
Change in CARP	0.80	1.00	0.26	0.14	73
Change in electricity	21.92	67.92	-13.25	16.50	74
Change in road	0.12	2.47	-0.08	0.29	74
Expenditure GINI	0.34	0.49	0.19	0.06	74
Square of expenditure GINI	0.12	0.24	0.04	0.04	74
Infrastructure index	0.41	0.91	0.08	0.16	74
Landlock	0.20	1.00	0.00	0.40	74
Mortality rate	0.85	1.21	0.56	0.15	73
Neighborhood effect	1.83	3.52	0.21	0.63	74
Net migration	0.00	39.63	-83.52	21.61	74
Typhoon	0.50	1.55	0.00	0.38	74

Table 3: Determinants of Provincial per Capita Income Growth Rate (a)

Regression results explaining income growth; Dependent variable is average provincial per capita income growth rate from 1985 to 2003.

Variable	MODEL 1		MODEL 2	
	Coefficient	s.e. $^{\alpha}$	Coefficient	s.e. $^{\alpha}$
Log of initial income	-3.0720***	0.429	-2.4620***	0.493
Education	0.1483	0.164	-	-
Proportion of young dependents	-0.0912***	0.031	-0.0752*	0.040
Expenditure GINI	43.0895**	19.018	46.9507**	20.720
Square of expenditure GINI	-64.1636**	26.271	-69.3848**	28.292
ARMM dummy	-2.2910***	0.668	-2.1451***	0.671
Net migration	-0.0080*	0.004	-	-
Neighborhood effect	-0.3257*	0.176	-0.4381**	0.211
Infrastructure index	-	-	1.6724**	0.793
Change in electricity	-	-	0.0091	0.008
Constant	28.2902***	5.365	21.2817***	7.049

*** significant at 1%; ** significant at 5%; * significant at 10%;
α: standard errors are White's heteroscedasticity consistent standard errors

	MODEL 1	MODEL 2
N	74	74
R-squared	0.5599	0.5657

Note: In both models, estimation is by least squares.

Table 4: Determinants of Provincial per Capita Income Growth Rate (b)

Regression results explaining income growth; Dependent variable is average provincial per capita income growth rate from 1985 to 2003.

Variable	MODEL 3$^{\alpha}$		MODEL 4$^{\beta}$	
	Coefficient	Std. Error	Coefficient	Std. Error
Log of initial income	-3.1957***	0.4839	-3.4786***	0.4192
Education	0.1360	0.1869	0.2715*	0.1509
Proportion of young dependents	-0.1306**	0.0534	-0.1011**	0.0408
Expenditure GINI	49.1290**	21.9622	68.4040***	13.9076
Square of expenditure GINI	-73.1441**	29.6190	-99.7146***	19.7577
ARMM dummy	-2.2077***	0.6602	-1.1409***	0.34023
Net migration	-0.0051	0.0069	-0.0060*	0.0033
Neighborhood effect	-0.3640*	0.2139	-0.3852**	0.1756
Infrastructure index	-	-	-	-
Change in electricity	-	-	-	-
Constant	30.2969***	7.1310	27.4932***	5.4357

*** significant at 1%; ** significant at 5%; * significant at 10%

	MODEL 3	MODEL 4
N	74	74
R-squared	0.5944	0.5640
Adjusted R-squared	0.5404	0.5059

$^{\alpha}$: Estimation is by two-staged least squares.

$^{\beta}$: Estimation is by generalized method of moments.

NOTE: For both models, instruments are actual values of all variables including lagged values of education and proportion of young dependents.

Table 5: Robustness of the Coefficients: Extreme Bound Analysis (EBA)

Variable	No of Models	Sign	Significance		Extreme Bound		Comments
			Count	%	Lower	Upper	
Log of initial income	8192	-	8192	100.00	-4.56	-0.39	Robust
Education	8192	mixed	1264	15.43	-0.74	0.79	Not Robust
Change in CARP	8192	mixed	620	7.57	-4.67	3.75	Not Robust
Change in electricity	8192	+	7197	87.85	-0.01	0.06	Not Robust
Change in road	8192	mixed	34	0.42	-1.88	1.73	Not Robust
Proportion of young dependents	8192	mixed	2427	29.63	-0.19	0.11	Not Robust
Expenditure GINI	8192	+	8192	100.00	1.87	141.20	Robust
Square of expenditure GINI	8192	-	8192	100.00	-194.64	-6.82	Robust
ARMM indicator	8192	-	7375	90.03	-5.04	0.72	Not Robust
Infrastructure index	8192	+	2200	26.86	-1.59	4.41	Not Robust
Landlock	8192	mixed	1865	22.77	-0.99	1.47	Not Robust
Mortality rate	8192	mixed	474	5.79	-4.39	4.37	Not Robust
Typhoon	8192	mixed	1920	23.44	-0.75	1.93	Not Robust
Net migration	8192	mixed	2823	34.46	-0.03	0.02	Not Robust
Neighborhood effect	8192	mixed	3491	42.61	-1.26	0.66	Not Robust

Table 6: Robustness of the Coefficients: Bayesian Averaging of Classical Estimates[xiv]

Variable	Posterior Inclusion Probability	Posterior Mean	Posterior Variance	Sign Certainty Probability
Log of initial income	0.9999	-2.6337	0.3286	1.0000
Education	0.2530	0.1365	0.0265	0.7991
Change in CARP	0.2849	-0.9891	0.9457	0.8455
Change in Electricity	0.6207	0.0162	0.0000	1.0000
Change in Road	0.1970	0.1518	0.2600	0.6170
Proportion of Young Dependents	0.6323	-0.0808	0.0003	1.0000
Expenditure GINI	0.9487	54.1224	369.5701	0.9976
Square of Expenditure GINI	0.9487	-77.8200	639.1317	0.9990
ARMM Indicator	0.8899	-1.8554	0.2038	1.0000
Infrastructure Index	0.3581	1.1584	0.5294	0.9443
Landlock	0.3545	0.4058	0.0640	0.9457
Mortality Rate	0.2067	-0.4366	1.1558	0.6577
Typhoon	0.2881	0.3688	0.1129	0.8638
Net migration	0.6742	-0.0135	0.0000	1.0000
Neighborhood Effects	0.4963	-0.3639	0.0170	0.9973

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[i] During the period 1976-2000, for example, the average growth rates for the Philippines, Thailand and Korea are 4.1%, 7.98%, and 9.90%, respectively.

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

[iii] The country's annual population growth rate from 1975 to 2000 is 2.36%, although this has gone down to 2.04% during the period 2000-2007.

[iv] 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 in the region is 55.3% (2006) and three of its provinces belong to the top ten poorest provinces in the Philippines in 2006, namely: Tawi-Tawi (poverty incidence: 78.9%), Maguindanao (63.0%) and Lanao del Sur (52.5%).

[v] A good material on spatial econometrics is the paper of Abreu, De Groot and Florax (2004).

[vi] Note that the data set includes only 74 provinces, instead of the current 81 provinces. The geographical boundaries of the provinces were kept constant throughout the period 1985 to 2003.

[vii] This estimate of the rate of conditional convergence of the model is lower than that previously estimated by Balisacan (2005) at 4% per year and Balisacan and Fuwa (2002) which was 9% per year for the Philippines provincial data. The figure is closer to the estimates of regional income convergence for Japan, the United States and Europe, clustering at about 2% per year estimated by Barro and Sala-i-Martin (2004).

[viii] The result from the regression model is similar to the results of Banerjee and Dulfo (2003) where the researchers found a similar inverted U relationship between growth and changes in equality in cross country regression models. The positive sign for the measure of inequality was also established in the models of Balisacan and Fuwa (2002) where they find significant and positive effects of the initial inequality in farm

distribution (asset inequality) on income growth. However, the authors did not include a quadratic specification in their models.

[ix] The regression models of Barro and Sala-i-Martin (2004) show that net migration variable has a negative, albeit insignificant, effect on the growth rate of per capita income in their study using the U.S., Japan and 5 European countries data.

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

[xi] Mankiw, Romer and Weil (1992) used the percentage of working-age population that is in secondary school as their proxy for human capital and found this to be positive and significantly correlated with growth. Barro and Sala-i-Martin (2004) used the average years of male secondary and higher schooling (referred to as upper-level schooling) as their proxy.

[xii] The BACE procedure is highly technical and will not be discussed in details in this paper. However, interested readers are referred to the paper of SDM (2003) for full discussion of the procedure.

[xiii] In classical terms, a coefficient is 5 percent significant in the two-sided test if 97.5% of the probability in the sampling distribution were on the same side of zero as the coefficient estimate (Barro and Sala-i-Martin; 2004).

[xiv] The results of the BACE reported here are based on a k-bar (or average number of regressors) of 9. The k-bar is the only parameter needed in estimating the posterior mean and variance and the sign certainty probability (refer to SDM (2003) for more discussion). The authors also computed for the posterior means and variances and sign certainty probabilities using k-bar of 5 and 7. The results are basically the same as those reported in table 1.6.