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Robust Determinants of Income Growth in the Philippines*

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ABSTRACT

Recent researches using econometric models fitted to cross-country data show that demographic transition is fundamental to explaining economic growth for developing countries. A study by Mapa and Balisacan (2004) finds that the Philippines is paying a high price for its unchecked population growth. This paper studies the relationship between population dynamics and income growth in the Philippines using data from 74 provinces for the period 1985–2003. Simulation techniques were used to quantify the effect of population dynamics on the differences in income of the provinces. It also examines the robustness of the explanatory variables to determine "deep" determinants of income growth. The study shows that population variable is

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robustly related with growth and while it is not the sole culprit for the dismal growth performance over the years, it shows that the opportunities associated with the demographic transition are real and can provide the stimulus needed by the country.

POPULATION DEBATE AND THE DEMOGRAPHIC TRANSITION

The population issue has been dynamic as well as contentious, especially in the Philippines, where it borders on being hostile. The debate centers on the consequences of population growth on economic development, specifically whether population growth curtails, promotes, or is independent of economic growth. On one hand, there are strands of evidence suggesting a negative impact of population growth on economic growth. Most probably, the first economist to hypothesize this is the Reverend Thomas Malthus who, more than 200 years ago, argued that high population growth would strain food supply and limit the standard of living of the masses. This notion on the negative effect of population growth on the economic well-being is often referred to as the "Mathusian population trap." This constricting effect of population growth on economic growth is supported empirically by the study of Barro and Sala-i-Martin (2004). Using 87 countries from 1960 to 2000, they showed that a one-standard deviation decline in the log fertility rate is estimated to raise average growth rate by 0.006. On the other hand, there is an even more popular side to this debate saying that population growth is independent of economic growth, and points to other culprits—notably the "rule of law" or "quality of public/economic institutions" as the most important determinant of economic growth (Norton 2003). The thesis that institution is the "deep" determinant of growth is supported by the studies of Easterly and Levine (2002) and Acemoglu et al. (2001). Other researchers, notably Simon (1981) and Boserup (1998), even ascribed more than a neutral effect of population growth arguing that there are benefits associated with population growth such as "inducing technological change and stimulating innovation" and therefore, it positively impacts on economic growth.

In the 1990s, the debate on the effect of population growth on economic growth shifted from the issue of population growth per se to the age structure of the population, that is, the way in which the population is distributed across the various age groups. Since individuals have different economic behaviors at different stages in life, a nation's age structure has an important impact on its economic performance (Bloom et al. 2001). Cross-country data, covering several decades and made available in the recent years, motivated researchers to revisit the relationship between population and economic growth, emphasizing this time-demographic transition as the process crucial to economic growth in most developing countries.

Bloom et al. (2001) describes demographic transition as "a change from a situation of high fertility and high mortality to one of low fertility and low mortality." Demographic transition results in sizable changes in the age distribution of the population. The changes in the age structure are because of two reasons: (1) initial decline in mortality, due to better health practices, that is concentrated among young individuals, notably infants, or those at the lower end of the age pyramid; and (2) decline in fertility, with impact entirely at age zero. The low mortality and low fertility create a bulge in the age pyramid that will move over time from young people (infants and children) to prime age (workers) for productive work, saving and reproduction, and eventually to old age (elderly). Depending on the position of this bulge on the age pyramid, the value of output per capita, the most widely used measure of economic performance, will change correspondingly. The change from high to low mortality and fertility rates can create the so-called "demographic dividend."

Demographic transition has three phases and each phase has a different impact on the economy. Phase one is triggered by an initial decline in infant mortality but fertility remains high resulting in the swelling of the youth dependency group (aged 0 to 14) as well as demand for basic education and primary health care. This phase creates a big challenge to the economy as it may impede economic growth.

In the second phase of the transition, these "baby boomers" enter the adult labor market (some 20 years later) and if the market is able to absorb them, they can accelerate the phase of economic growth. This is the phase when the proportion of working-age population is highest and the age-dependency ratio or the ratio of young dependents (0 to 14 years) and elderly (65 years and above) over the working age (15 to 64 years) is lowest, thereby creating the so called "demographic dividend."

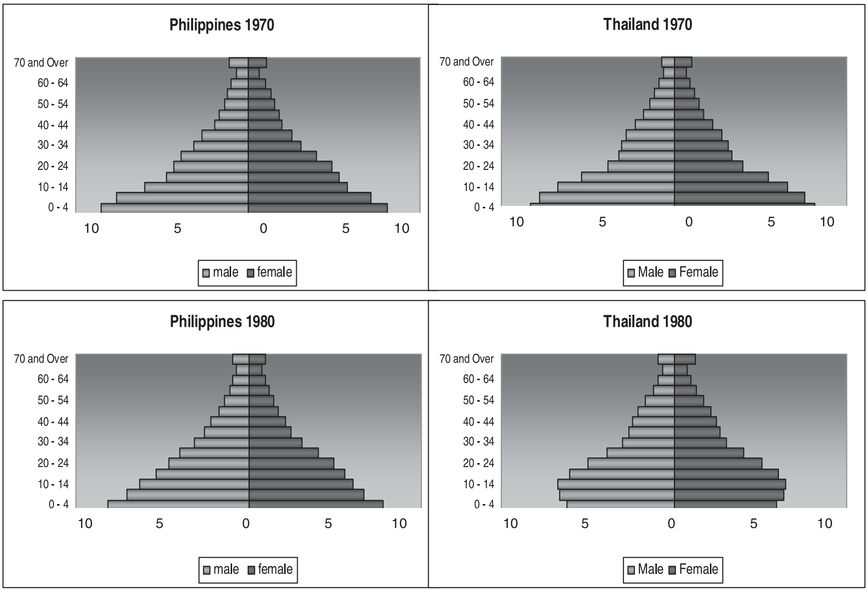
The last phase of the transition is when the elderly cohort swells. This phase may or may not burden economic growth. It appears from empirical analyses that a rising elderly share neither depresses nor elevates the rate of economic growth since, although they are "dependent," they either live using their own savings or are being supported by their families and/or the state.

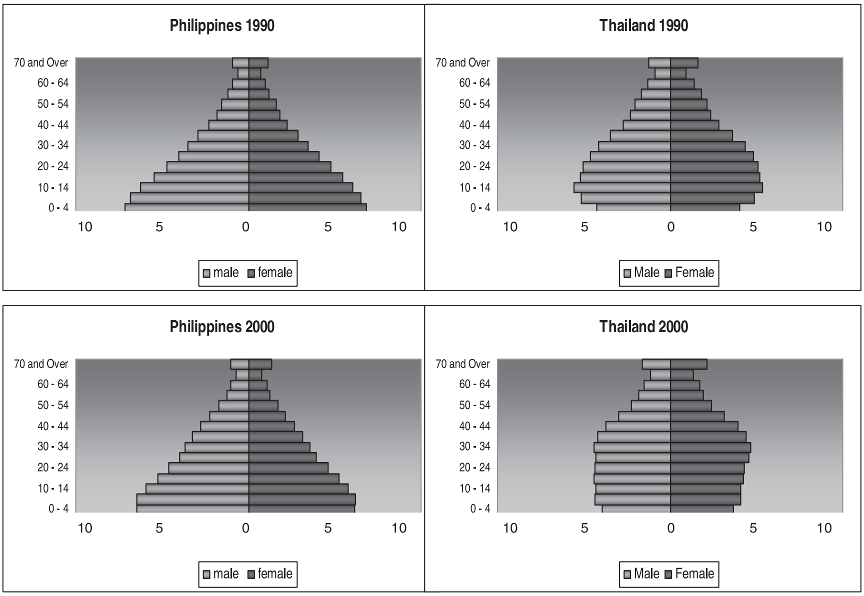
Bloom et al. (2003) points out that countries entering demographic transition face significant challenges, especially during the first phase of the transition. However, these countries could take advantage of the appealing opportunities for economic growth, which happens during the second phase of the transition and could last up to 50 years. It should be pointed out that the "demographic dividend," while essential to economic growth, is not automatic. It should be given the right kind of policy environment to produce a sustained period of economic growth. The critical policy areas are public health, family planning, education, and economic policies promoting labor-market flexibility, openness to trade, and saving. The growing number of adults during the second phase of the transition will be productive only when there is flexibility in the labor market to allow expansion. Therefore, governments play a vital role to guarantee the creation of this "demographic dividend."

It is interesting to note that the age structure of the Philippines' population in 2000 represents the first phase of the demographic transition. This is in contrast with Thailand, where its 2000 age structure demonstrates the second phase of the demographic transition, thereby enjoying the benefits of a higher economic growth. Japan's age structure in 2000, meanwhile, is near (if not there yet) the third phase of the demographic transition.

A comparison of the age structure between the Philippines and Thailand from 1970 to 2000 shows that while Thailand's population age structure has moved from the first phase to the second phase of the demographic transition during the period, that of the Philippines is still glued to the first phase in the last 30 years (Figure 1). This partly explains why Thailand's gross domestic product (GDP) per person (in purchasing power parity) grew at an amazing rate of 8.8 percent per year from 1975 to 2000 and managed to double its income per person after only eight years while the Philippines' GDP per person only increased by 4.1 percent during the same period.

Figure 1. Comparison of age structure: Philippines vs. Thailand (1970–2000)





Note: X-axis denotes percentage to total population.

Demographic transition and economic growth: cross-country experiences

Studying the population dynamics and economic growth in Asia, Bloom et al. (1999) concluded that the "demographic dividend" was essential to the success of East Asia's economic "tigers" during the period 1965 to 1990. They pointed out that the working-age population of East Asian countries was 57 percent in 1965 and 65 percent in 1990, increasing four times compared with the number of dependents. In contrast, the Philippines, using census data from 1980 to 2000, had a working-age population of below 60 percent, with 52 percent in 1980, 55 percent in 1990, 56 percent in 1995, and 58.5 percent in 2000.

The effect of demographic transition on economic growth was studied by several authors, notably Radelet et al. (1997). In their paper, "Economic Growth in Asia," they analyzed the dramatic economic growth experienced by Asia using cross-country data during the period 1965–1995 and pointed out that "demographic changes following World War II worked in favor of more rapid growth in East Asian countries."

Meanwhile, Bloom and Williamson (1997) and Bloom et al. (1999) studied the effects of the demographic transition and the economic miracles in emerging Asia using cross-country data. They concluded that "a sizeable portion, about one-third, of East Asia's economic success is attributable to demographic influences."

More recently, Mapa and Balisacan (2004) investigated the impact of demographic transition on economic growth and poverty using more updated data sets.

The demographic transition in their model is explained by two population growth variables: average population growth and average workers' (15–64 years) population growth rates. The authors' econometric results showed that population growth rates have opposing effects on economic growth, as expected. On one hand, total population growth has a negative and significant effect on economic growth. On the other hand, the workers' population growth is positively correlated and significant to economic growth, supporting the concept of the "demographic dividend." Aside from its main effects, population growth also affects economic growth through its interaction with illiteracy rate, a variable used to proxy for human capital. The econometric result shows that at a fixed level of illiteracy rate, a higher level of population growth constricts economic growth.

The authors made simulations to estimate the impact of population growth on the overall economic growth of the Philippines. Simulation exercises done by the two authors showed that difference in the population growth rates between the Philippines and Thailand accounted for about 0.768 percentage point of forgone growth for the Philippines. This implies that had the Philippines followed Thailand's population growth path during the period 1975 to 2000, the average income per person in the Philippines would have been 0.768 percentage point higher every year. Thus, the reduction in the population growth results in a cumulative increase of about 22 percent in the average income per person for the year 2000, adding some US$253 to the average income per person in the Philippines, to US$1,404 from US$1,151.

Moreover, the authors estimated the effect of the population dynamics to poverty reduction via the increase in economic growth that is primarily due to a reduction in population growth. In particular, they evaluated the impact on poverty reduction had the Philippines followed Thailand's population growth path. The reduction in poverty headcount due to the estimated increase in the mean income per capita of about US$ 253, had the Philippines followed the population growth of Thailand during the period 1976–2000, is about 4.03 million in the year 2000. This is equivalent to an average of 161,200 Filipinos taken out of poverty per year during the said period. The poverty reduction in terms of the number of households is 678,000 for the same period or equivalent to 56,500 households per year for 25 years.

This paper follows the same track used in the Mapa and Balisacan (2004) cross-country study wherein an econometric model will be used to estimate the impact of population dynamics on income (economic) growth, this time using the Philippines' provincial data from 1985 to 2003. Simulation techniques will again be used to quantify the effects of the population dynamics on income of the provinces and its effects on headcount and household poverty. The paper will show that the country is certainly paying a high price for its unsustainable high population growth.

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 penultimate section presents the simulation results on additional income growth and poverty reduction made based on the econometric exercise. The last section concludes.

POPULATION DYNAMICS – ECONOMIC GROWTH NEXUS: INTRA-COUNTRY ANALYSIS

The cross-country analysis in the Mapa and Balisacan (2004) study is extended, this time using provincial data of the Philippines, instead of cross-country data. Similarly, an econometric model is built to study the relationship between population growth and the demographic transition (population dynamics) on economic growth, controlling for other determinants of economic growth, using provincial data from 1985 to 2003. In doing this study, the authors hope to make empirical contributions to the population dynamics-economic growth debate. First, the data set of provinces covering a period of 18 years is quite a rich country-level data sufficient to study the determinants of income growth. Second, the Philippine data are collected using uniform definitions of the variables. And third, there is no exchange rate variation between the provinces, and price variation across provincial domains is smaller than across countries. Moreover, while the analysis of regional/provincial economic growth has been popular, only a few authors have incorporated in their models population dynamics as determinant of income growth. Most authors have focused on neighborhood effects (spatial dependence) in their analyses of the determinants of economic growth. Similar to the cross-country analysis of Mapa and Balisacan (2004), simulation techniques are to be used in this study to quantify the effects of population growth in the differences in income per person of the provinces.

Monchuk et al. (2005) examine the economic forces that underlie economic growth at the county level for the period 1990 to 2001. Their study shows that the initial population (1990) has a positive and significant impact on the average growth rate of county income. Moreover, using the population dynamics variables, the authors show that "the percentage of population over 65 years in 1990 has a negative and significant impact on the growth rate of income" (which is something that is expected) while the share of population between 20 and 34 years in 1990 also has a negative and significant effect on income growth (something that is unexpected). Finally, their econometric model shows that the share of population under 20 (youth population) has a positive but insignificant impact on income growth. Using a proxy variable for distance to a metro county, the authors find that this variable has a positive and significant impact on income growth, supporting the notion of neighborhood effects.

Demurger et al. (2002) provide evidence for the distinct roles of geography and policy to economic growth in China's 25 interior provinces for the period 1979 to 1998. Their paper suggests that geography (access to the sea and elevation/slope) and proposed alternative measures for preferential treatment given to some provinces have a positive and significant effect on the average growth rate of per capita GDP during the period. Moreover, they show that the proportion of provincial workforce with post-primary education has a positive and significant effect on economic growth.

Theoretical framework of the model

This 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^{a}, where k = K/L. Using the Ramsey-Cass-Koopmans model, the average growth rate of output per worker, denoted by g_y, between any time, say T_1 and T_2, 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,

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

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

For this paper, three modifications are made with the model in (1). First, following Radelet et al. (1997), the steady output is expressed as a function of the determinants of the steady state, that is, y^* will be expressed as,

$$y^* = \underline{X}\,\underline{\beta}, \quad (2)$$

where $\underline{X}$ is a vector consisting of the determinants of the steady state.

The vector $\underline{X}$ includes the initial conditions, education and health variables (proxy for human capital), inequality, measure of local good governance, and neighborhood effects.

The second modification introduced into the model involves changing the model from output per worker (y) to output per capita (y^o). Note that,

$$y^0 = \frac{Y}{P} = \frac{Y}{L}\frac{L}{P} = y\frac{L}{P}, \qquad (3)$$

where P is the total population, L is the number of workers, y is the output per worker, and y^0 is the output per capita.

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

$$g_{y^0} = g_y + g_{\text{workers}} - g_{\text{population}} \qquad (4)$$

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 econometric model will then be,

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

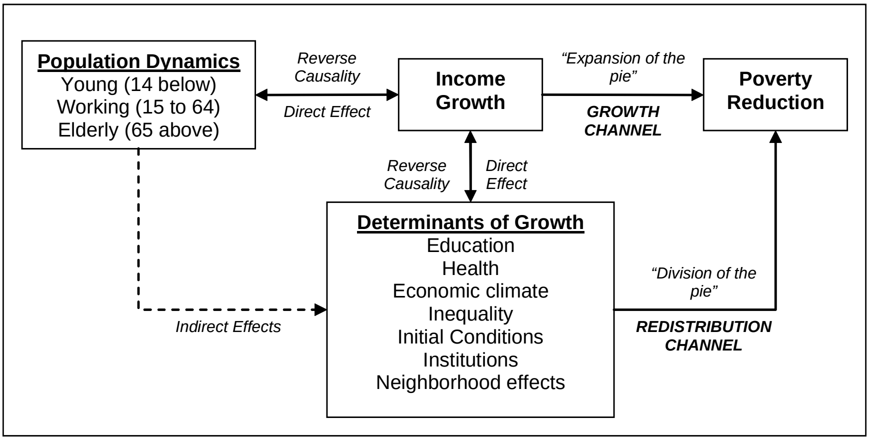
The final modification involves expressing the logarithm of the initial income per worker into income per capita and workers per capita. Thus, the final econometric model is given by,

$$g_{y^0} = X\beta - \alpha \log(y^0_{T_1}) + \alpha \log(L/P) + \phi_1 g_W + \phi_2 g_P + \varepsilon. \qquad (6)$$

Bloom and Williamson (1997) point out that theoretically, $\phi_1 = -\phi_2 = 1$ in (6). That is, for a stable population, the growth rate of the workforce should be the same as the growth rate of the population, therefore making the net demographic effect zero. However, during a dynamic transition, wherein the population is unstable, the demographic effects could matter.

The framework of the econometric model is given in Figure 2. The econometric model estimates the direct effect of the population dynamics, particularly the impact of the young population (0 to 14 years) on economic growth (the impact of the first box on the second box). At the same time, the model also estimates the effects of other determinants of economic growth (the impact of the lower box on the second box). The reverse causality is represented by the arrow coming from growth (box 2) going to the population dynamics (box 1) and the other determinants of growth, notably education (lower box). This reverse causality creates a problem in the estimation of the regression model, resulting in biased and inconsistent estimates. This problem is remedied through the introduction of instrumental variables into the regression equation.

Figure 2. Theoretical framework



EMPIRICAL ANALYSIS OF THE MODEL

The data set consists of 74 provinces with variables recorded for the period 1985 to 2003 or covering 18 years[1]. The objective of this study is to determine the long-run effects of the determinants of income growth, particularly the population dynamics in the provinces. The complete list of provinces included in the study is provided in Table 1.

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 Family Income and Expenditure Survey 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; time-varying policy variables; and neighborhood effects. These variables are defined as follows:

- *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

[1] Note that the data set includes only 74 provinces, instead of the current 79 provinces. The geographical boundaries of the provinces were kept constant throughout the period 1985 to 2003.

Table 1. Provinces in the intra-country econometric models

Metro Manila	Capiz	Maguindanao	Rizal
Abra	Catanduanes	Marinduque	Romblon
Agusan del Norte	Cavite	Masbate	Samar
Agusan del Sur	Cebu	Misamis Occidental	Siquijor
Aklan	Davao	Misamis Oriental	Sorsogon
Albay	Davao del Sur	Mt. Province	South Cotabato
Antique	Davao Oriental	Negros Occidental	Southern Leyte
Basilan	Eastern Samar	Negros Oriental	Sultan Kudarat
Bataan	Ifugao	Cotabato	Sulu
Batanes	Ilocos Norte	Northern Samar	Surigao del Norte
Batangas	Ilocos Sur	Nueva Ecija	Surigao del Sur
Benguet	Iloilo	Nueva Vizcaya	Tarlac
Bohol	Isabela	Mindoro Occidental	Tawi-Tawi
Bukidnon	Kalinga Apayao	Mindoro Oriental	Zambales
Bulacan	La Union	Palawan	Zamboanga del Norte
Cagayan	Laguna	Pampanga	Zamboanga del Sur
Camarines Norte	Lanao del Norte	Pangasinan	Aurora
Camarines Sur	Lanao del Sur	Quezon	
Camiguin	Leyte	Quirino	

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;

- *Initial geographical conditions*: (i) an indicator variable, landlock, with value 1 if the province is landlocked and 0 if otherwise, (ii) an indicator variable for the provinces of the Autonomous Region of Muslim Mindanao (ARMM), namely, Basilan, Lanao del Sur, Maguindanao, Sulu, and Tawi-Tawi, and (iii) the average annual number of typhoons;
- *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;
- *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 (CARP) implementation defined as the cumulative CARP accomplishment to 1990 potential land reform area; and

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

The identified determinants of economic (income) growth included in this study, together with the data sources, are presented in Table 2. 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 has 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 3. 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 1.87 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!

Table 2. Variable definitions and data sources

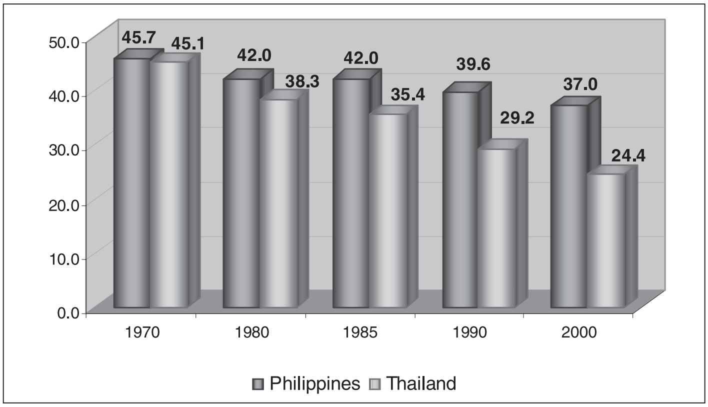
Variable name	Definition	Source of basic data
Actual per capita income growth rate	Average growth rate of provincial per capita income from 1985 to 2003; income is measured in 1997 pesos and adjusted for price differences in the provinces.	FIES, 1985 and 2003
Log of initial income	Natural logarithm of 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

Variable name	Definition	Source of basic data
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 if 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 3. 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	1.87	5.66	-1.36	1.36	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

Figure 3. Percentage of young dependents (1970–2000)



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 that of Thailand, as shown in Figure 3. 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.

Determinants of income growth

The results of the intra-country regression models are given in Table 4. 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 a rate of about 3 percent per year[2]. This result is congruent with the

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

Table 4. 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 percent; ** significant at 5 percent; * significant at 10 percent;
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.

expectation of conditional convergence, that is, the economy grows faster the farther 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 percent, 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 2006, 21 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 that 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, which surely is not a small value.

The results support the earlier studies of Mapa and Balisacan (2004) and other researchers (notably Bloom, Williamson, and Sachs), 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.

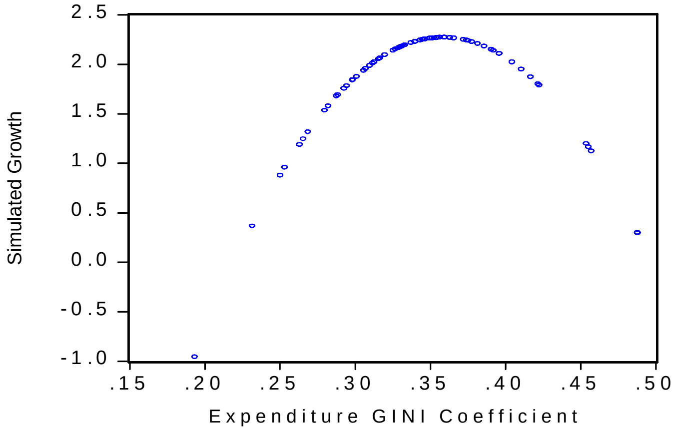
The measures of initial inequality[3] are both significant but with opposite signs. The coefficient of inequality has a positive sign while its square has a negative sign, all things being the same. The opposite signs of the coefficients imply that the relationship between inequality and income growth follows that of an inverted U shape, similar to the one given in Figure 4.[4] 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; 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

[3] In the models, the expenditure Gini and its square were used instead of the income or land (asset) Gini.

[4] 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 (2004) 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.

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 the majority of provinces in the Philippines.

Figure 4. Inverted U-shaped relationship between inequality and income growth



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.[5] 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 equal. 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 spillover effects that indicate 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

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

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 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). 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 et al. 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.[6] 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.[7]

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[6] Similar studies using European regions (Baumont et al. 2001) and US states show that the neighborhood effect is positive.

[7] Mankiw et al. (1992) used the percentage of working-age population that is in the secondary school as their proxy for human capital and found this to be positively 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.

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 point increase in infrastructure index results to 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 5

Table 5. 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[α]		Model 4[β]	
	Coefficient	Standar error	Coefficient	Standard error
Log of initial income	-3.1957***	0.4839	-3.4786***	0.419215
Education	0.1360	0.1869	0.2715*	0.150888
Proportion of young dependents	-0.1306**	0.0534	-0.1011**	0.040808
Expenditure Gini	49.1290**	21.9622	68.4040***	13.90763
Square of expenditure Gini	-73.1441**	29.6190	-99.7146***	19.75772
ARMM dummy	-2.2077***	0.6602	-1.1409***	0.340229
Net migration	-0.0051	0.0069	-0.0060*	0.003346
Neighborhood effect	-0.3640*	0.2139	-0.3852**	0.175629
Infrastructure index	-	-	-	-
Change in electricity	-	-	-	-
Constant	30.2969***	7.1310	27.4932***	5.435676

*** significant at 1 percent; ** significant at 5 percent; * significant at 10 percent.

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

[α] Estimation is by two-stage least squares.
[β] 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.

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.

Robustness procedures – Bayesian averaging of 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. But since Levine and Renelt's test is considered too strong by some researchers for any variable to really pass it, Sala-i-Martin (1997) suggests moving away from the extreme bound test and instead assign some level of confidence to each of the variables. One way to do this is to look at the whole distribution of the estimators.

On the other hand, Sala-i-Martin et al. (2003) used the Bayesian approach in averaging across models while following the classical method.[8] This paper uses the BACE approach to determine the variables that are strongly or robustly related to income growth. The discussion as to how this procedure is applied in this paper is provided in the Appendix. In testing for the robustness of the 14 explanatory variables defined in Table 2, it is assumed that the logarithm of initial mean income (initial condition) and education (proxy for human capital) are always present in the model (12 variables remain in the pool). The number of explanatory variables for every model is pegged at seven, a typical number for a growth regression model. In the process, a total of 792 models were run, with each of the 12 variables in the pool appearing 330 times. The two fixed variables (initial condition and education) appear 792 times in the regression runs. The result of the robustness procedure is provided in Table 6.

[8] The BACE procedure is highly technical and will not be discussed in detail in this paper. However, interested readers may refer to the paper of Sala-i-Martin et al. (2003) for a full discussion of the procedure.

Table 6. Robustness of the coefficients based on the Bayesian averaging of classical estimates (BACE) approach

Variable	Mean beta	Mean standard error	Sign certainty probability (one side of 0/ + or -)	Remarks
Log of initial income	-2.81	0.28752	1.00	**robust**
Education	0.16	0.03103	0.82	not robust
Proportion of young dependents	-0.09	0.00140	0.99	**robust**
ARMM dummy	-2.15	0.62946	1.00	**robust**
Change in CARP	-1.12	1.19384	0.85	not robust
Change in electricity	0.01	0.00010	0.84	not robust
Change in road	0.25	0.94198	0.60	not robust
Expenditure Gini	43.76	397.2149	0.99	**robust**
Square of expenditure Gini	-65.21	719.2251	0.99	**robust**
Infrastructure index	1.21	1.00117	0.89	not robust
Landlock	0.42	0.09433	0.91	not robust
Mortality rate	0.15	1.49960	0.45	not robust
Neighborhood effect	-0.36	0.03827	0.97	marginal
Net migration	-0.01	0.00003	0.97	marginal
Typhoon	0.29	0.15905	0.77	not robust

The determinants of income growth are listed in column 1 while the means and standard errors of the coefficients computed from all the models are given in columns 2 and 3, respectively. The fourth 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 -2.81, which is very close to the value in model 1 (given in Table 4) previously discussed. The probability that such coefficient will always be negative using the BACE approach is 1.00 (with certainty). Thus, the logarithm of the initial mean income can be considered strongly or robustly correlated with income growth. This result is not surprising because of the concept of conditional convergence.

Variables strongly or robustly correlated with income growth

Aside from the initial income, the other variables that are strongly correlated with income growth are the ARMM variable, which is negatively correlated with growth with certainty (100 percent probability), the inequality measures [the Gini coefficients (positively correlated with growth) and its square (negatively correlated with growth)], and the proportion of young dependents (negatively correlated with growth). All three variables have certainty probability of 99 percent.

Variables marginally correlated with growth

The authors next identify the variables whose certainty probability is less than 97.5 percent but greater than 95 percent (significant at the 10 percent level). These variables are the net migration and neighborhood effects and are said to be marginally correlated with income growth.

Variables not robustly related with 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 weak determinants include education, change in CARP, change in the proportion of households with electricity, change in the quality of roads, infrastructure index, the indicator variable landlock, mortality rate, and the number of typhoons.

POPULATION DYNAMICS-INCOME GROWTH-POVERTY REDUCTION NEXUS

From population dynamics to income growth

Once the impact of a reduction in the proportion of young dependents on income growth has been estimated using the econometric models given in the previous section, the next step is to simulate the average provincial per capita income growth rate that could have been achieved had the proportion of young dependents of the provinces in 1985 been lower than the actual, particularly at the level equivalent to the average of the 10 provinces with the lowest proportion of young dependents. This simulation exercise will present what could have been the income growth picture under a lower population scenario that yields a lower proportion of young dependents. Table 7 provides the 10 provinces with the lowest proportion of young dependents in 1985. The average value for these 10 provinces is 35.89 percent.[9]

The estimated coefficient taken from model 2 (Table 4) showed that a one-percentage point reduction in the proportion of young dependents in 1985 results in an estimated 7.5 basis points increase on the average provincial per capita income growth rate.[10] Under the lower proportion of young dependents scenario, had the provinces with high percentage of young dependents reduced their proportion to 35.89 percent in 1985, the estimated national average per capita income in year 2003 (18 years later) would have been higher by 1,620 pesos (from 27,443

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[9] This value is almost the same as the proportion of young dependents of Thailand in 1985, which is 35.4 percent.

[10] This reduction is the lowest of the four models presented (models 1 to 4) and even lower than the mean of the 330 estimated coefficients of proportion of young dependents generated using the BACE approach reported in Table 6. The corresponding increase in mean per capita income reported here is more likely at the lower end of the figure.

pesos to 29,063; all in 1997 prices), or this would mean an increase of 7.12 percent in national average per capita income. The graph showing the actual average income per person and the simulated income per person under the lower proportion of young dependents scenario is given in Figure 5. Adjusting for inflation, this amount corresponds to an additional increase of 2,227 pesos on the average income per person in 2003.

Table 7. Lowest 10 provinces in terms of proportion of young dependents (1985)

Province	Proportion of young dependents
Metro Manila	33.15
Cavite	34.39
Ilocos Norte	35.76
Siquijor	35.96
Nueva Vizcaya	36.34
Quirino	36.38
Zambales	36.44
Bulacan	36.62
Camiguin	36.83
Southern Leyte	37.08
Average	35.89

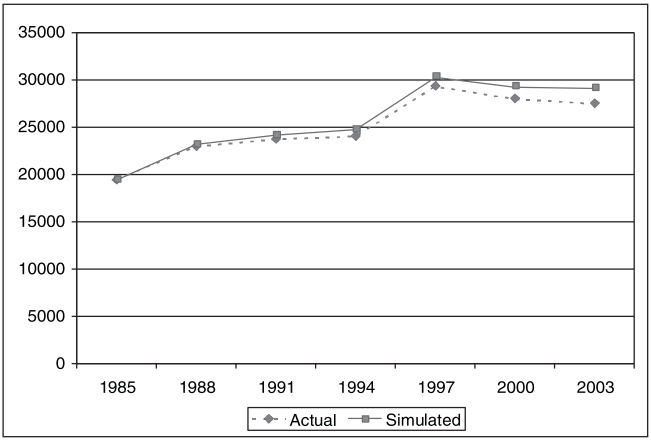
A higher income per person in some provinces

The potential increase in average per capita income is larger for provinces where the proportion of young dependents is somewhat large in 1985. These are the cases of Camarines Norte with 47.03 percent, Camarines Sur with 45.86 percent, and Davao Oriental with 44.37 percent, to name a few. Figure 6 illustrates the actual average income per person as well as the simulated average income per person if these provinces had a low level of proportion of young dependents in 1985, equivalent to 35.89. The figure shows that Camarines Norte's income per person in 2003 would have been 3,297 pesos higher (in 1997 prices) or an increase of 16.18 percent in the province's per capita income. Camarines Sur's average income per person would have been higher by 2,764 pesos (an increase of 14.37%) and Davao Oriental's higher by 2,152 pesos (an increase of 12.11%) in 2003.

Growth accounting: population dynamics explains large component of provincial growth differentials

To determine the reasons for the relatively low growth rate of the average income per person in certain provinces and how the population dynamics explain such

Figure 5. Simulated average per capita income



low growth, the estimates from the econometric model is used to account for the growth differentials of selected provinces. These provinces were selected in such a way that the values of the other determinants of income growth based on the model are more or less the same, except for the population dynamics in order to isolate the would-be contribution to income growth of having a lower proportion of young dependents. Table 8 reports a growth accounting comparison between Camarines Norte, with per capita income growth of 2.10 percent, and Misamis Occidental, with a higher per capita income growth of 3.30 percent.

The first column of Table 8 identifies the variables used in the model. The second column corresponds to the actual values of these variables for Camarines Norte while the third column reports the values for the comparator province, Misamis Occidental. The last column uses the estimates from the model to compute for the additional growth rate that Camarines Norte would have enjoyed if it had the values of Misamis Occidental. Thus, the last column provides estimates of the forgone income growth for Camarines Norte.

The values from column 4 of Table 8 show that differences in the proportion of young dependents between the two provinces (47.03% vs. 39.34%) accounts for about 0.58 percentage point of the forgone growth for Camarines Norte, the largest component in the table. This figure implies that had the proportion of young dependents in Camarines Norte been the same as that in Mindoro Occidental in 1985, the provincial average income per person would have been 0.58 percentage point higher every year. Differences in the proportion of young dependents account for about 48 percent of the total growth differential between the two provinces.

Figure 6. Simulated per capita income

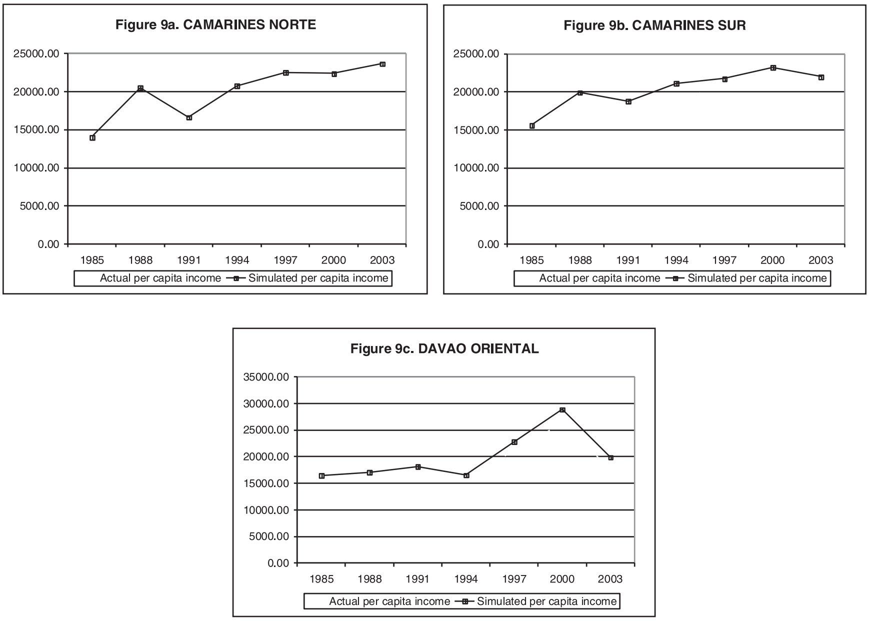


Table 8. Why some provinces grew slow: Camarines Norte vs. Misamis Occidental

Variable	Camarines Norte	Misamis Occidental	Forgone growth	
INITIAL CONDITION				
Log of initial income	9.55	9.39		0.40
POPULATION DYNAMICS				
Proportion of young dependents	47.03	39.34		0.58
INEQUALITY				0.04
Expenditure Gini	0.29	0.38	4.37	
Square of expenditure Gini	0.08	0.15	-4.33	
LOCATION DUMMY	0	0		0
NEIGHBORHOOD EFFECT	1.93	1.48		0.20
INFRASTRUCTURE				0.29
Infrastructure index	0.39	0.39	-0.01	
Change in electricity	1.28	34.11	0.30	
Actual per capita income growth rate	2.10	3.30		1.20

A similar comparison is made between the provinces of Camarines Sur (where the 1985 proportion of young dependents is 45.86%) and Nueva Ecija (with low proportion of young dependents at 37.98%). The forgone growth rate for Camarines Sur, due to its high proportion of young dependents in 1985, is about 0.59 (Table 9). In other words, had Camarines Sur's proportion of young dependents been only 37.98 percent (equivalent to Nueva Ecija), its average income growth per person would have been 0.59 percentage point higher. The growth accounting exercise shows that the proportion of young population certainly matters to the provincial per capita income growth and having a higher proportion of the young does constrict income growth.

From income growth to poverty reduction

The final step in the simulation exercise is to estimate the effect of the population dynamics to reduction in poverty, via the growth channel (or the "expansion of the pie"). Previous empirical studies (notably by Balisacan 2005, Balisacan and Pernia 2003, and Balisacan and Fuwa 2002) have shown that the growth factor is an important determinant of poverty reduction.[11] The scatter plot of the average

Table 9. Why some provinces grew slow: Camarines Sur vs. Nueva Ecija

Variable	Camarines Sur	Nueva Ecija	Forgone growth	
INITIAL CONDITION				
Log of initial income	9.66	9.52		0.33
POPULATION DYNAMICS				
Proportion of young dependents	45.86	37.98		0.59
INEQUALITY				0.19
Expenditure Gini	0.39	0.34	-2.38	
Square of expenditure Gini	0.15	0.12	2.57	
LOCATION DUMMY	0	0		0
NEIGHBORHOOD EFFECT	2.38	2.49		-0.05
INFRASTRUCTURE				0.11
Infrastructure index	0.48	0.52	0.06	
Change in electricity	19.08	24.96	0.05	
Actual per capita income growth rate	1.16	1.85		0.70

[11] The equation of Balisacan (2005) on poverty reduction showed that once growth is incorporated, no other variable is significant in explaining poverty reduction.

growth rate of per capita income and rate in reduction of headcount poverty, from 1985 to 2003, for the provinces in the data set is given in Figure 7. The graph illustrates a positive relationship between average per capita income growth rate and the rate of headcount poverty reduction. The "growth elasticity" is estimated by running a regression model with the rate of poverty reduction as the dependent variable and rate of income growth as the explanatory variable. The result of the regression model is given in Table 10. The growth elasticity of poverty reduction is estimated at 1.45 percent, that is, a one-percent increase in the rate of average income growth increases the rate of poverty reduction by roughly 1.45 percent.[12]

Figure 7. Scatter plot of average growth rate of per capita income and rate of reduction of headcount poverty

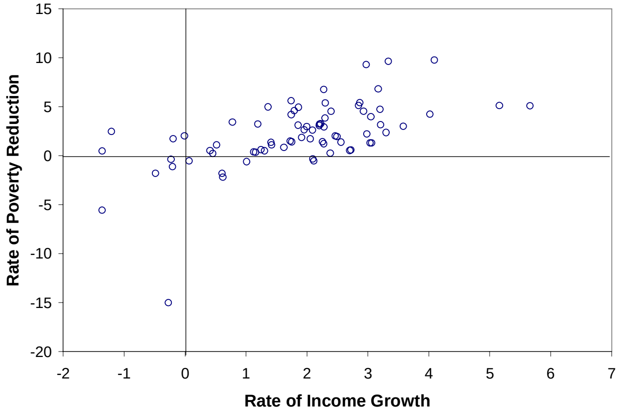


Table 10. Provincial poverty reduction results (dependent variable is annual rate of poverty reduction)

Variable	Coefficient	P-value
Constant	0.5295	0.4957
Growth rate of average per capita income	1.4531	0.0000
N	74	
R-squared	0.3495	
Adjusted R-squared	0.3405	

[12] This estimate of the growth elasticity is closer to the figure from the study of Balisacan and Fuwa (2002) using provincial data from 1988 to 1997 where the estimated growth elasticity is 1.6 percent. However, this value is lower than the growth elasticity of poverty reduction observed in other developing countries such as China (2.9%), Indonesia (3.0%), and Thailand (3.5%), according to a study made by Cline (2004). Balisacan (2005) noted that the growth elasticity in the Philippines is low by international standard.

To estimate the reduction in headcount poverty as a result of a lower proportion of young dependents, the result from the econometric model is used. Recall that the model estimates that the national average per capita income would have been higher by 7.12 percent had the provinces with high proportion of young dependents in 1985 followed the average of the 10 provinces with the lowest proportion (at 35.89%). The study then applies the growth elasticity of poverty reduction of 1.45 percent. Table 11 shows that under the status quo (high proportion of young dependents) scenario, the poverty headcount in 2003 is estimated at about 20.47 million Filipinos, representing about 26.12 percent of the entire population. Under the low proportion of young dependents scenario, the poverty headcount in 2003 is estimated at 17.65 million, lower by about 2.82 million individuals, or lower by 3.60 percentage points, from 26.12 percent to 22.52 percent. The reduction in poverty headcount is due to the estimated increase in the mean income per person of about 2,227 pesos in 2003. This reduction corresponds to an average of 156,000 Filipinos taken out of poverty every year beginning 1985, surely a large number to be serious about.

Table 11. Reduction in poverty

Scenarios	Poverty headcount (individuals)	
	Number	%
Status quo	20,465,409	26.12
With low proportion of young dependents	17,646,631*	22.52
Difference	2,818,778	3.60

* assuming the same population in 2003.

CONCLUSION

The provincial per capita income growth in the Philippines can be considered as generally dismal in the last two decades. While there are provinces where per capita income growth has been moderately high (more than 5%), majority of the provinces have income growth that is comparable with the poorest countries in the world. This paper looks at the relationship between the population dynamics, particularly the proportion of young dependents, and income growth and poverty reduction. The paper is able to show that population dynamics indeed play an important role in both the country's national income growth and the 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. In identifying the key drivers of income growth and poverty reduction, a young population certainly matters. And contrary to the cliché, more is not necessarily merrier.

APPENDIX

Bayesian averaging of classical estimates (BACE)

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:

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

Furthermore, if there are 14 potential variables (K), and the number of variables included in every model (k_j) is fixed to 7 with 2 of these variables present in <u>every</u> model, then, from equation (2), the prior probabilities of all the $J = \binom{2}{2}\binom{12}{5} = 792$ models would be the same. That is:

$$P(M_j) = P(M) = \left(\frac{\bar{k}}{14}\right)^{7}\left(1-\frac{\bar{k}}{14}\right)^{1-7}, \ \forall \ j = 1,\dots 792. \qquad \text{(iii)}$$

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:

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

where T is the sample size and SSE_i is the OLS sum of squared errors under model *i*. From equation (iii), equation (iv) becomes:

$$P(M_j \mid y) = \frac{SSE_j^{-T/2}}{\sum_{i=1}^{792} SSE_i^{-T/2}}, \quad \forall \; j = 1, \ldots, 792. \qquad \text{(v)}$$

The normalized weight for models where the number of included variables in every model is fixed is just a function of the OLS sum of squared errors of the models.

Therefore, 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 is the OLS estimate for β with the regressor set that defines model *j*, is computed as the weighted average of the OLS estimates using the OLS sum of squared errors:

$$E(\beta \mid y) = \sum_{j=1}^{792} \left(\frac{SSE_j^{-T/2}}{\sum_{i=1}^{792} SSE_i^{-T/2}} \right) \hat{\beta}_j \qquad \text{(vii)}$$

Moreover, the posterior variance of β given by:

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

is also a function of the OLS sum of squared errors:

$$Var(\beta \mid y) = \sum_{j=1}^{792} \left(\frac{SSE_j^{-T/2}}{\sum_{i=1}^{792} SSE_i^{-T/2}} \right) Var(\beta \mid y, M_j) + \sum_{j=1}^{792} \left(\frac{SSE_j^{-T/2}}{\sum_{i=1}^{792} SSE_i^{-T/2}} \right) \left[\hat{\beta}_j - E(\beta \mid y) \right]^2 \qquad \text{(ix)}$$

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