BEING HEALTHY, WEALTHY, AND WISE: DYNAMICS OF INDONESIAN SUBNATIONAL GROWTH AND POVERTY

SUDARNO SUMARTO AND INDUNIL DE SILVA

TNP2K WORKING PAPER 09-2014
July 2014

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The TNP2K Working Paper Series disseminates the findings of work in progress to encourage discussion and exchange of ideas on poverty, social protection, and development issues. Support for this publication has been provided by the Australian Government through the Poverty Reduction Support Facility (PRSF).

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Suggested citation: Sumarto, Sudarno and Indunil De Silva. 2014. ‘Being Healthy, Wealthy, and Wise: Dynamics of Indonesian Subnational Growth and Poverty’. TNP2K Working Paper 09-2014. Jakarta, Indonesia: *Tim Nasional Percepatan Penanggulangan Kemiskinan* (TNP2K).

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Layout and typesetting: Purwa Rahmanto

Being Healthy, Wealthy, and Wise: Dynamics of Indonesian Subnational Growth and Poverty

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July 2014

ABSTRACT

The aim of this study is twofold. First, despite the vast empirical literature on testing the neoclassical model of economic growth using cross-country data, very few studies exist at the subnational level. We attempted to fill this gap by using panel data for 2002–12, a modified neoclassical growth equation, and a dynamic-panel estimator to investigate the effect of both health and education capital on economic growth and poverty at the district level in Indonesia. Second, although most existing cross-country studies tend to concentrate only on education as a measure of human capital, we expanded the analysis and probed the effects of health capital as well. As far as we are aware, no study has done a direct and comprehensive examination of the impacts of health on growth and poverty at the subnational level. Thus, this study is the first at the subnational level, and our findings will be particularly relevant in understanding the role of both health and education capital in accelerating growth and poverty reduction efforts.

The empirical findings are broadly encouraging. First, nullifying any doubts on the reliability of Indonesian subnational data, our results suggest that the neoclassical model augmented by both health and education capital provides a fairly good account of cross-district variation in economic growth and poverty in Indonesia. We found that the results on conditional convergence, physical capital investment rate, and population growth confirm the theoretical predictions of the augmented neoclassical model. We also found that both health and education capital had a relatively large and statistically significant positive effect on the growth rate of per capita income. Economic growth was found to play a vital role in reducing Indonesian poverty, reinforcing the importance of attaining higher rates of economic growth. Findings from the poverty–human capital model showed that districts with low levels of education are characterized by higher levels of poverty. We found that regions with mediocre immunization coverage

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The authors are grateful to Bambang Widianto and Suahasil Nazara, TNP2K, for encouraging and supporting this work. We would like to thank Christopher Roth, Oxford University, and Daniel Suryadarma, CIFOR, for providing useful comments. We also wish to gratefully acknowledge Pamela S. Cubberly for her editorial assistance. Any remaining errors are solely our responsibility.

and greater than average prevalence of waterborne diseases had higher poverty rates and lower output per capita. Similarly, regions with higher numbers of births attended by a skilled birth attendant were associated with lower poverty rates and higher economic output. Our results in particular suggest that, in designing policies for growth, human development, and poverty reduction, it is necessary to broaden the concept of human capital to include health as well.

Key Words: Neoclassical growth, poverty, human capital, health, education, dynamic panel
JEL *Classification: O47; O15; I12; R11; E23*

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1. Introduction

For many long years, severe disparities among regions in Indonesia have prevailed, especially between the western and eastern regions in the country. Lagging regions have long lobbied for more equal opportunities and development. In the 1990s, poorer regions persistently expressed their frustration with the central government's development policies and have demanded much larger income transfers and more autonomy in regional governance. Following the financial crisis in 1997 and the fall of the New Order regime, Indonesia in the early 2000s adopted a new political system placing decentralization at the forefront. Even in the aftermath of Indonesia's drastic transformation from a highly centralized to a highly decentralized government structure in 2001, the issues revolving around regional economic imbalances still existed; policy planners zealously debate the latent causes and determinants responsible for these spatial disparities. Thus, the growing interest in spatial income disparities has accentuated the need for research and knowledge on the determinants of regional economic growth and human development in Indonesia.

Numerous economic theories and models exist relating education and health to economic growth. Human capital in the form of education and health increases an individual's earning potential but also generates a 'ripple effect' throughout the economy through a series of positive externalities. Mankiw, Romer, and Weil (1992) demonstrated that the Solow model, when augmented to include education capital as a factor of production, did a satisfactory job of explaining the variations in per-capita real income that are witnessed across a large and heterogeneous sample of countries.

An equally important form of human capital for economic growth is health, which can directly augment labour force productivity by enhancing its physical capacities, such as strength and endurance, as well as mental aptitude, such as cognitive performance and reasoning ability. Unfortunately, little attention has also been paid in the past to the impact of poor health on growth, productivity, and poverty. Effects of education, trade openness, savings, inflation, and initial level of income have been used most commonly to explain regional differences in economic growth and productivity rates (Barro 1991; Mankiw, Romer, and Weil 1992; Barro and Sala-i-Martin 1995; Miller and Upadhyay 2000). However, many compelling reasons exist to believe that health is also an important determinant of productivity and standard of living in any region of a country or the world.

Nevertheless, empirical evidence on the relationship between human capital and economic growth have also been somewhat mixed. For example, Bils and Klenow (2000) argued that schooling may has only a limited impact on growth. Caselli, Esquivel, and Lefort (1996) and Islam (1995) in their panel data studies also failed to find any significance of schooling in standard growth regressions. Sachs and Warner (1995) found a positive but still insignificant impact of both primary and secondary education on growth, while Romer (1989) found no significant effect for literacy rates. Pritchett (2001) claimed that the weak institutional framework, low quality, and excess supply of schooling in developing countries are all accountable for the lack of an empirical link between changes in educational attainment and economic growth. Acemoglu and Johnson (2001) found no evidence that an increase in life expectancy leads to faster growth in income per capita. Thus, in this context, it will always be worthwhile to continue scrutinizing the intimate linkages between human capital and development at both the cross-country and subnational levels.

The originality of this study is that we linked regional or subnational disparities in economic growth and poverty with a rich set of socioeconomic information, particularly in relation to health capital. A limited number of studies have examined the determinants of regional economic performance in Indonesia. However, most studies have been done at the province level and with a limited number of explanatory variables, limited only to education capital using ordinary least squares (OLS) and fixed-effect estimators and with no formal conceptual growth model. An equally important form of human capital for economic growth is health, which can directly augment labour force productivity by enhancing physical capacities, such as strength and endurance, as well as mental aptitude, such as cognitive performance and reasoning ability. Unfortunately, as far as we know, no study has made any serious attempt to examine the effect of health capital on regional growth and poverty in Indonesia.

Furthermore, we went beyond conventional fixed-effect estimators by employing dynamic panel system–generalized method of moments (GMM) estimators and searched for significant determinants of regional disparities in Indonesia based on both the neoclassical growth model and cross-country growth regressions per Barro (1991, 1997), while paying particular attention to human capital proxies and controlling for a distinctive assortment of variables capturing macroeconomic stability. Doubts also exist about the reliability of Indonesian regional-level data among some authors (Manning 1997). Thus, this study presents an opportunity to test the reliability and performance of Indonesian regional data within standard economics frameworks and models.

2. Growth, Income Distribution, and Development: Some Evidence from Decentralized Indonesia

Indonesia, the largest country in Southeast Asia with the world's fourth largest population, is at present using its strong economic growth to accelerate the rate of poverty reduction. The economy almost doubled in size between 2002 and 2011, and per capita GDP rose from US$909 in 2002 to US$3,557 in 2012. Indonesia's economy has recovered from the devastation of the Asian financial crisis, benefitting from a boom in commodity prices, and has also weathered the recent global financial crisis well. Although Indonesian economic growth has been strong in aggregate, the level of income per person remains low relative to its neighbours and 43 percent of Indonesians were estimated to be surviving on less than US$2 per person per day in 2012. Lately, in spite of the sustained economic growth, the rate of poverty reduction has also begun to slow down and inequality has continued to rise. Indonesia is now facing the twin challenge of accelerating the rate of poverty reduction and at the same time adopting a pro-poor growth framework that allows the poor to benefit more from economic growth and thereby curb rising spatial disparities in human development. It is now well recognized that poverty in Indonesia is a complex and multidimensional phenomenon, which is not only evident in low levels of income but also in the poor's vulnerability, which is intrinsically linked with many factors such as infrastructure, access to services, and labour market conditions (figure 6). Thus, in this context, it is particularly important to examine latent regional-level factors associated with growth, poverty, and inequality in Indonesia from a dynamic perspective.

In recent years, high levels of income and human development disparities among regions have continued to emphasize the need for research in finding Indonesia's regional growth determinants. However, although there have been a wealth of studies on the analysis of growth, poverty, and inequality in Indonesia, there has been a dearth of microeconometric literature that explicitly examines the role that health capital plays in growth and human development in Indonesia at the subnational level.

The following summarizes research to date in this regard: Balisacan, Pernia, and Asra (2003) employed panel data from the National Socioeconomic Survey (Survei Sosial Ekonomi Nasional or Susenas) for 285 districts for three years—1993, 1996, and 1999—and found that education capital and infrastructure are one of the critical factors contributing to the growth and development of regional economies in Indonesia. Timmer (2004) investigated the growth process in Indonesia for the period 1960–1990. His study revealed that, during those three decades, the growth was instrumental in reducing poverty in Indonesia, while investment in infrastructure made overall growth more pro-poor. Furthermore, Suryadarma, Suryahadi, and Sumarto (2005) showed that high inequality reduced growth elasticity of poverty in Indonesia in 1999–2002. They found that poverty reduction between 1999 and 2002 was very successful because inequality in 1999 was at its lowest level in 15 years, leading to an increased impact of growth on poverty reduction. In another study, Suryahadi, Suryadarma, and Sumarto (2009) further examined the relationship between economic growth and poverty reduction by breaking down growth and poverty into their sectoral compositions and geographic locations. They found that the most effective way to accelerate poverty reduction is by focusing on rural agriculture and urban services growth. Resosudarmo and Vidyattama (2006) examined the growth process of Indonesian provinces for the period 1993–2002 and investigated the determinants of the country's interprovincial income disparity. Their study findings suggest that, despite the existence of substantial disparities, conditional convergence of regional incomes occurred and the contribution of the gas and oil sectors are an important determinant of the variation of growth across provinces. Garcia and Soelistianingsih (1998) revealed that poor provinces have a strong tendency to catch up with middle- and high-income provinces and that investments in education capital play a key role in reducing regional disparities in economic growth. Handa (2007) found that differences in the endowments of physical and human capital are primarily responsible for regional disparities in economic performance. Suryahadi, Hadiwidjaja, and Sumarto (2012) assessed the relationship between economic growth and poverty reduction before and after the financial crisis in Indonesia. They found that growth in the service sector was the largest contributor to poverty reduction and that the importance of agriculture sector growth for poverty reduction was confined only to the rural sector.

The most striking characteristics of the geography of economic activity in Indonesia is concentration and unevenness. Heterogeneities in income, output, infrastructure, and human capital across regions have resulted in unbalanced development. This has left large regional disparities, particularly between Java and non-Java and especially eastern Indonesia. There has also been a tendency for regional inequalities to rise in recent years. Sakamoto (2007), for example, suggested that for the 28 years before and including 2005, there has been evidence of increasing regional disparity. Concentration of economic activities in Indonesia has been overwhelmingly in the Java and Sumatra Islands. Regional data for recent years have shown that the spatial structure of the Indonesian economy has been dominated by provinces on Java, which has contributed to Indonesia's gross domestic product (GDP) of around 60 percent, followed by about 20 percent from the island of Sumatra, and the remaining 20 percent from Indonesia's Eastern Regions.

Table 1 provides some regional-level disparities in income, poverty, inequality, and human development. Vast disparities among provinces become evident: provincial income shares vary from 0.1 to 16.4 percent. Jakarta—the capital of Indonesia—and other resource-abundant provinces, such as Riau and East Kalimantan, have remarkably high income shares. Comparatively, Jakarta records the highest regional GDP per capita and East Kalimantan, a resource-rich province, has the next-highest regional GDP per capita. Other resource-rich provinces such as Riau and Papua Barat (West Papua) usually come next in regional per-capita income rankings. At the other extreme are provinces that are lagging, such as Gorontalo, Maluku, and Nusa Tenggara where regional income and human development are the lowest in the country. Table 1 also shows that regional economic growth varies significantly by province; resource-rich provinces, such as Papua Barat, Riau, and all provinces in Sulawesi grew more than the average national economic growth rate.

Regional disparities in poverty are also evident from table 1. Although rates of poverty vary across and within all regions, provinces with low income shares are mostly in the eastern part of the country. East Nusa Tenggara, Maluku, and Papua had the highest poverty rates; in contrast, Bali, Jakarta, and South Kalimantan exhibit low poverty rates. In absolute numbers, the poor are nevertheless concentrated in Java: Central Java, East Java, and West Java each have around 4.5 million poor people on average. Papua has the highest inequality among Indonesian provinces, and Bangka Belitung has the lowest inequality, together with highest rate of poverty reduction in recent years. Generally, income distribution tends to be more equal in provinces where nonfood crops are important than in mineral-rich provinces. Oil and mineral-abundant areas tend to have significantly greater inequality than areas that are not mineral dependent, which means that usually a smaller share of income goes into the hands of the poor.

The status of health and education varies vastly among districts and provinces in Indonesia. There are significant differences in educational access and quality across the country, and effective targeting of additional resources is required to provide lagging districts and provinces with sufficient funds to catch up with better-performing regions. For example, enrolment rates in Indonesia vary widely by region and these regional gaps are more pronounced than the enrolment gaps in income levels. The poor's likelihood of enrolment varies by region, even within the same income quintile. The poor in Papua have low net enrolment rates even at the primary school level (80 percent). National averages also hide wide variations in health within Indonesia. For instance, the poorer provinces of Gorontalo and West Nusa Tenggara have post-neonatal mortality rates that are five times higher than in the best-performing provinces in Indonesia. Similar regional discrepancies are shown in under-five mortality rates (infant and child). Although most provinces are below or only slightly above the 40 deaths for every 1,000 live births mark, nine provinces have rates above 60. The rates for Gorontalo, Southeast Sulawesi, and West Nusa Tenggara are as high as 90 or 100. Figures 1–6 portray some of the regional disparities that exist in the health and education sectors.

3. Human Capital, Poverty, and Growth Empirics

It is well-known in the growth literature that education capital differences account for a significant part of the variation observed in regional income distribution. Based on several decades of thought about human capital and centuries of emphasis on education, especially in advanced countries, it is natural to propose that any effective development strategy should be to raise the education level of all population groups in any country. Indeed, this is exactly the policy approach of many developing countries, while also a central element of the Millennium Development Goals.

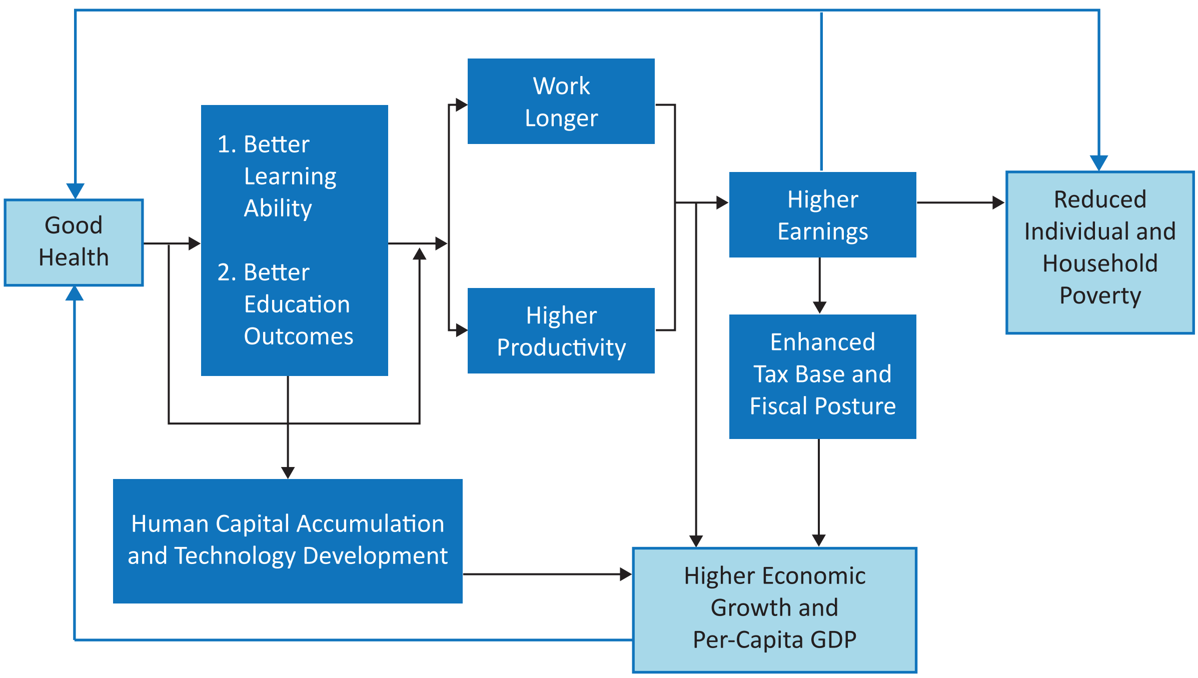
The importance of human p_4 capital generally and of education in particular in growth theory started to receive attention only in the 1980s and 1990s mainly due to endogenous growth models and the augmented neoclassical growth model of Mankiw, Romer, and Weil. The augmented neoclassical growth model assumes human capital as an additional factor; hence, countries that have faster growth rates in education will have faster transition growth rates and ultimately higher incomes. Endogenous growth models view education as a process that (a) has an impact on production technology itself, that is, innovations, processes, or knowledge (Romer 1989, 1990; Aghion and Howitt 1998; Nelson and Phelps 1966), (b) makes it easier to adapt foreign technology (Barro 1997, 1999; Barro and Sala-i-Martin 1995; Sala-i-Martin 1999; Hall and Jones 1999), or (c) facilitates resource transfer to the most technologically dynamic sector of the economy (Kim and Kim 2000; Schiff and Wang 2004). In the endogenous growth literature, education is seen as subject to increasing returns so it could overcome the growth-reducing effect of diminishing returns to physical capital (Romer 1989; Lucas 1988).

A vast amount of empirical literature investigates the nexus among growth, poverty, and education capital. This literature in general reveals that education has a positive and significant impact on economic growth and poverty. Nevertheless, empirical evidence on the relationship between human capital and economic growth has also been somewhat mixed. For example, Bils and Klenow (2000) argued that schooling may only have a limited impact on growth. Caselli, Esquivel, and Lefort (1996) and Islam (1995) in their panel data studies failed to find any significance of schooling in standard growth regressions. Sachs and Warner (1995) found a positive but still insignificant impact of both primary and secondary education on growth, while Romer (1989) found no significant effect for literacy rates. Pritchett (2001) claimed that the weak institutional framework, low quality, and excess supply of schooling in developing countries are all accountable for the lack of an empirical link between changes in educational attainment and economic growth.

An equally important form of human capital for economic growth is health, which can directly augment labour force productivity by enhancing physical capacities, such as strength and endurance, as well as mental aptitude, such as cognitive performance and reasoning ability. Unfortunately, few studies have attempted to examine the effect of health capital on economic growth and poverty. Health influences economic well-being through many channels (Diagram 1), such as labour productivity lost to sickness and disease, often leading societies to be locked into 'poverty traps' due to poor health. Enhancement of health in a country will encourage individuals to have more savings through reduction in morbidity and mortality and increase in life expectancy, which in turn will indirectly enhance labour force productivity and economic growth (Weil 2007).

It is important to recognize that poor health is an element of poverty itself. Poor health interacts with low income to constrain the ability of the poor to attain adequate nutrition and to learn, gain knowledge, and enhance their capabilities. Susceptibility to diseases and illness makes the poor vulnerable to morbidity, disability, and premature mortality, leading them to an increased state of powerlessness. Furthermore, ill health may push some households that are above an income-defined poverty line to fall below it. Households naturally fall into poverty when prices for health services are too high; income earners lose substantial income-earning work time due to poor health, disability, or caring for others who fall sick; or income earners die prematurely. Increased risks of premature death also lead families to increase fertility to ensure the survival of a target-size family. This puts mothers' health at risk and takes them out of the workforce more than would otherwise have been the case. Thus, health status is itself an indicator of poverty in multiple dimensions and good health is a protector of income or wealth.

Diagram 1: Health-Growth Linkage



The literature on the relationship between health and growth has grown over time. Many channels have been identified in arguing that health matters for growth (Aghion and Howitt 1998). Mankiw, Romer, and Weil (1992) and Lucas (1988) suggested that health should be viewed as a regular factor of production and, accordingly, output growth should be correlated with the rate of improvement of health. According to Lopez, Rivera, and Currais (2005), good health is a crucial element for overall well-being and human development. Based on economic grounds, good health raises levels of human capital, which has a positive effect on individual productivity and economic growth rates.

The significance of health capital for a country's economic growth via its effects on labour market participation, worker productivity, savings, fertility, and population age structure has been well documented in the literature. Knowles and Owens (1995, 1997) included health capital in the economic growth model that Mankiw, Romer and Weil augmented (1992); the two researchers found that per-capita income growth had a more robust relation with health than with the education variable. Barro (1999) and Bloom, Canning, and Sevilla (2004) found life expectancy at birth to be a positive and significant determinant of economic growth rates. Bhargava et al. (2001) found that human capital proxied by the adult survival rate has a significant effect on economic growth, particularly in poor countries.

McDonald and Roberts (2002) developed an augmented Solow model that incorporates both health and education capital and found the coefficient on health capital to be significant for the full sample. However, when they disaggregated the sample by less-developed and Organisation for Economic Co-operation and Development countries, health capital had a positive and significant effect on economic growth only in the former, not the latter, countries. Cole and Neumayer (2006) found poor health to be a key factor in reducing aggregate productivity, thus explaining the existence of persistent underdevelopment in many regions of the world.

As an important element of human capital, health capital can affect productivity through the ability of firms to innovate and adopt new technologies and through labour productivity. A healthy workforce has a larger capacity to produce, while being more productive. For example, workers that are mentally and physically fit are less likely to be absent from work. Healthy workers are also likely to be more willing to acquire education and skills because of an increase in the returns they receive from education. Furthermore, a large number of studies suggest that healthier children have better cognitive abilities (Morley and Lucas 1997; Watanbe et. al. 2005). The disease environment can also affect the development of institutions. Acemoglu, Johnson, and Robinson (2001) argued that higher mortality rates of European settlers in tropical countries induced them to develop exploitative institutions in these countries.

One of the key objectives of this study was to include health capital in a well-specified aggregate production function in an attempt to test for the existence of an effect of health on growth and poverty and to gauge its significance. In this regard, we primarily used four indicators that capture and represent both the common causes of poor health and the status of the health service and system: prevalence of waterborne diseases, skilled birth attendance, immunization rate, and incidence of self-medication. The prevalence of waterborne diseases was captured by the incidence of diarrhoea. In developing countries, waterborne diseases are a major problem that contributes to a vicious circle confronting people every day: Waterborne diseases make many people weak who are then more susceptible to other infections. Their physical capacity decreases and they cannot work to provide their families with money and food. A lack of sufficient nutritional food weakens people, especially children, even further, who then become more susceptible to diseases. Children fall behind at school, because they cannot be educated when they are ill. In this manner, waterborne diseases diminish the lives and economic development of many people in developing countries. During natural disasters such floods, the likelihood of people getting infected with waterborne diseases rises, especially when water and sewage treatment no longer functions well. Thus, the treatment of drinking water, sewage, waste, and sewage water and personal and food hygiene education are important elements of a country's human development strategy.

We measured the level of health system coverage through indicators of immunization and skilled birth attendance. Higher immunization coverage is generally found to decrease mortality rates and reduce the risk that disease will spread. Much of the rest of child mortality worldwide is accounted for by vaccine-preventable diseases—most notably diphtheria, tetanus, and measles (Murray and Lopez 1996). Vaccines exist for many diseases that drive families or individuals into poverty. Many diseases, such as measles, polio, serious forms of tuberculosis, diphtheria, tetanus, and pertussis, that are covered by vaccines can be killers and costly to treat even when they are not fatal. Some of these diseases (e.g., polio and tuberculosis) leave their victims disabled and, hence, much more vulnerable to poverty, as their income-earning potential is limited. Thus, many preventable illnesses become a cause of poverty due to lost income and output. Hamoudi and Sachs (1999) found increased immunization rates to have a very strong positive impact on overall economic growth.

We use the skilled birth attendance rate to capture the level of health system coverage and also to proxy for the maternal mortality rate. It is established that one primary reason for the high levels of maternal mortality is that too few births take place in the presence of skilled attendants. We also used the incidence of self-medication as a link with poverty and welfare, because people are forced to self-medicate to treat diseases due to financial constraints and poor access to medical facilities, although medical experts have warned of serious health problems from this practice. It is believed that the majority of the people belonging to poor regions even avoid visiting public hospitals, as they cannot afford travelling and medicines cost money. Sometimes, people consume antibiotic medicines based on old prescriptions, which increases the risk of developing other harmful diseases (Chang and Trivedi 2003).

4. Analytical and Conceptual Framework

Theoretical underpinning for our analysis is the augmented neoclassical growth model. Our analysis closely followed recent advances in cross-country growth-modelling approaches, particularly starting with Mankiw, Romer, and Weil (1992), Islam (1995), and Caselli, Esquivel, and Lefort (1996). First, a canonical neoclassical Solow model is assumed and a production function in Cobb-Douglas framework at time t is given by:

$$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha}$$

Where Y is output, K is capital, L is labour, A is technology, and α is the share of capital in total output. L and A are assumed to grow exogenously at rates and respectively, so that

$$L(t) = L(0)e^{nt}$$

$$A(t) = A(0)e^{gt}$$

Letting y^* be the steady-state level of income per capita and y the actual income per capita at time t, the steady-state approximation for the speed of convergence is given by

$$\frac{dlny(t)}{dt} = \lambda[\ln(y^*) - lny(y)]$$

where λ is the rate of convergence, given by $\lambda=(n+g+\delta)+(1-\alpha)$. Furthermore, a district's growth rate can be approximated in the neighbourhood of the steady state as[1]

$$\ln(y_{i,t}) - \ln(y_{i,t-\tau}) = -(1-e^{-\lambda\tau})\ln(y_{i,t-\tau}) + (1-e^{-\lambda\tau})\frac{\alpha}{1-\alpha}\ln(s)$$

$$-(1-e^{-\lambda\tau})\frac{\alpha}{1-\alpha}\ln(n+g+\delta)$$

where s is the investment rate, δ is the rate of depreciation of physical capital, and $\tau=t_2-t_1$ in district i.

Second, we used the Islam (1995) dynamic model to incorporate the accumulation of human capital to capture its explicit role in determining economic growth productivity. Re-writing the human capital augmented production function as

$$\mathrm{Y(t)} = \mathrm{K(t)}^{\alpha}H(t)^{\beta}(A(t)L(t))^{(1-\alpha-\beta)}$$

in the steady state

$$\dot{k}(t) = s^k\tilde{y}(t) - (n+g+\delta)\tilde{k}(t)$$

$$\dot{h}(t) = s^h\tilde{y}(t) - (n+g+\delta)\tilde{h}(t)$$

[1] See, for example, Barro and Sala-i-Martin (1995).

where $\tilde{y}=Y/AL$, $\tilde{k}=k/AL$, $\tilde{h}=H/AL$ are quantities of per capita, and s^k and s^h are physical and human capital respectively. Approximating around the steady state and rearranging, we have

$$lny(t_2) = \left(1-e^{-\lambda\tau}\right)\frac{\alpha}{1-\alpha}\ln(s) - \left(1-e^{-\lambda\tau}\right)\frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \left(1-e^{-\lambda\tau}\right)\frac{\beta}{1-\alpha}\ln(h)$$
$$+e^{-\lambda\tau}\ln[y(t_1)] + \left(1-e^{-\lambda\tau}\right)\ln[A(t_1)] + g(t_2-t_1)$$

where $y=Y/L$, $k=K/L$, $h=H/L$ are quantities of per capita, and $\lambda=(n+g+\delta)+(1-\alpha-\beta)$.

In summary, growth in output per capita in the augmented neoclassical model is a function of initial output, technological progress, rate of investment in physical capital, rate of investment in human capital, depreciation rate of capital, growth rate of the population, share of physical capital in output, share of human capital in output, and rate of convergence to the steady state. Higher physical investment and human capital will increase the growth rate of output per worker, whereas higher labour force growth, when adjusted for depreciation and technological progress, is expected to have a negative impact on growth in output per worker.

5. Empirical Methodology

We largely used panel fixed effects and GMM estimation methods and relied less on the cross-sectional analysis that is sometimes used in the economic growth literature. As Islam (1995) correctly stated, single cross-country growth regressions suffer from omitted variable bias because country-specific technical efficiency is unobservable. This unobservable technical efficiency is then most likely to be correlated with other growth determinants such as education and investment. Thus, in such instances, the standard least-squares estimator from cross-sectional data will not only be inefficient but also biased and inconsistent.

Mankiw, Romer, and Weil (1992) proposed the augmented Solow model, that is, including human capital in the production function and solving the problem of excessive savings to income growth. Later, Islam (1995) assembled the Solow model for the first time into a proper dynamic form empirically. Caselli, Esquivel, and Lefort (1996) adopted the Islam (1995) dynamic-panel data framework and employed the Arellano and Bond (1991) generalized method of moments (GMM), correcting the inconsistency problem. However Caselli, Esquivel, and Lefort (1996) overlooked the cross-sectional autocorrelation among countries. Improving on these previous studies, this paper applies the more efficient system GMM, but for comparative robustness purposes, we performed and reported both the fixed effects and the difference GMM estimator employed by Caselli, Esquivel, and Lefort (1996); Hoeffler (2002);and Bond, Hoeffler, and Temple (2001).

The regional per-capita GDP growth equation that we sought to estimate broadly represents the augmented growth model and can be expressed in the following form:

$$y_{i,t} = \gamma y_{i,t-1} + \sum_{j=1}^{3} \phi_j x_{it}^{j} + \eta_t + \mu_i + \varepsilon_{it}$$

with $y_{i,t}=lny_{it_2}$; $y_{i,t-1}=lny_{it_1}$; $x_{it}^{1}= lns_{i\tau}^{k}$; $x_{it}^{2} = ln(n+g+\delta)$; $x_{it}^{3}= lns_{i\tau}^{h}$; $\eta_t=g(t_2 - exp^{\lambda\tau}\, t_1)$; and $\mu_i=(1- exp^{-\lambda\tau})\ln A_i$, and ε_{it} is the idiosyncratic error term mean zero. Existence of the lagged dependent variable $y_{i,t}$ renders the classical least-square dummy variable estimator inconsistent for fixed *T* (Nickel 1981; Judson and Owen 1999). Among the various estimation techniques proposed for estimating the above model, we focused more on GMM estimators of Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998).

The standard GMM estimator of Arellano and Bond (1991) begins with a first-differencing growth equation in order to eliminate the fixed effects, where the transformed model is expressed as follows:

$$\Delta y_{i,t} = \Delta \gamma y_{i,t-1} + \phi' \Delta x_{i,t} + \Delta \varepsilon_{it}$$

Because the lagged difference in dependent variable is correlated with the error term and the explanatory variables are potentially endogenous, the use of instruments is necessary. Assuming that the error term is not serially correlated and that the lagged levels of the endogenous variables are uncorrelated with future error terms, the GMM difference estimator uses the lagged levels of the endogenous variables as instruments (for exogenous variables, their first differences serve as their own instruments). The following moment conditions are used to compute the difference estimator:

$$E(y_{i,t-s}\Delta\varepsilon_{it}) = 0 \;\; for\; s \geq 2;\; t = 3, \dots T,$$

$$E(x_{i,t-s}\Delta\varepsilon_{it}) = 0 \;\; for\; s \geq 2;\; t = 3, \dots T,$$

The GMM approach uses all available lags of the dependent and the exogenous variables to form an optimal instrumental variable matrix $Z = [Z_1, \dots Z_N]$.

Where:

$$Z_i = \begin{bmatrix} y_{i1}x_{i1} \dots x_{i3} & 0 & 0 \\ 0 & y_{i1}\, y_{i2}\, x_{i1} \dots x_{i4} & 0 \\ 0 & 0 & y_{i1} \dots y_{i,T-2}, x_{i1} \dots x_{iT} \end{bmatrix}$$

Bond et al. (2001) found that the first-difference GMM estimator is subject to a large downward finite sample bias, particularly when the number of time series observations is small, as the lagged levels of variables tend to serve as weak instruments for subsequent first-differences. Instead, they advocated using a system-GMM estimator with superior finite sample property developed by Arellano and Bover (1995) and Blundell and Bond (1998). The system-GMM estimator combines the equations in first-differences with suitably lagged levels as instruments, with an additional set of equations in levels with suitably lagged first-differences as instruments. The moment conditions for the regression in levels follow:

$$E[\,\Delta y_{i,t-s}(\mu_i + \Delta\varepsilon_{it})] = 0 \;\; for\; s = 1$$

$$E[\,\Delta x_{i,t-s}(\mu_i + \Delta\varepsilon_{it})] = 0 \;\; for\; s = 1$$

By augmenting the original equation in levels to the system, Arellano and Bover (1995) and Blundell and Bond (1998) found remarkable improvements in efficiency and sizable reduction in finite sample bias by exploiting these additional moment conditions. Thus, in this study, the panel-data system-GMM estimator will be the favoured estimation method, with two specification tests: the Arellano-Bond test in which the error term of the difference equation is not serially correlated and the Sargan test in which the instruments are valid. (In the context of the system GMM, this is the Hansen J test, which is robust to heteroskedasticity and autocorrelation within panels.)

Departing from the neoclassical Solow-Swan framework, we also adopted more general Barro-style specifications for both growth and poverty, which can be expressed respectively in the standard panel regression form as follows:

$$\ln y_{i,t} = (1+\beta)\ln y_{i,t-1} + \psi \mathrm{X}_{i,t-1} + \eta_i + \zeta_t + \nu_{i,t}$$

$$\ln p_{i,t} = (1+\beta)\ln p_{i,t-1} + \psi \mathrm{X}_{i,t-1} + \eta_i + \zeta_t + \nu_{i,t}$$

Where η_i is a district-specific fixed effect that allows for all unobservable heterogeneity across regions and ζ_t is a period-specific shock common to all districts, X_i is a vector of variables that represents a wide array of growth and poverty auxiliary determinants that allow for predictable heterogeneity of each region's steady state. Apart from the education and health indicators, key additional auxiliary variables that will be considered here are initial income and poverty, mean household income, inequality, inflation, total government revenue, general purpose local transfers (dana alokasi umum or DAU), total government spending, public social protection expenditure, and unemployment rate.

Initial income and poverty are expected to capture, respectively, income convergence and persistence (or inertia) in impoverishment. The literature has found that growth in average income is correlated with reductions in the incidence and depth of poverty. Ravallion and Chen (1997) found that poverty declines are strongly correlated with growth in mean incomes. Dollar and Kraay (2002) also found that ‘growth is good for the poor’: in a sample of 92 countries during four decades, the mean incomes of the poorest 20 percent of the population grew on average at the same rate as overall mean incomes. State-level public expenditures and social safety nets are expected to directly affect the welfare and income-generating capacity of the poor. Because large public expenditures do not always automatically translate into large outlays for social services, we included the ratio of social protection expenditures separately in the regression specification. The rate of inflation is also included and treated as a regressive tax, which erodes the purchasing power of the poor and distorts productive investment decisions in the economy. How much poverty rises with inflation will ultimately depend on the consumption expenditure pattern of the poor and their ability to ‘smooth’ consumption through dissaving and borrowing.

6. Data

Data used in this study largely cover about 300 Indonesian districts for the period 2001 to 2012, except for regional output and public expenditure data that are available only until 2010/11. In constructing the district panel, data from various sources were used, including (a) Susenas (Statistics Indonesia), (b) The Indonesian Sub-National Growth and Governance Dataset from the Institute of Development Studies, (c) fiscal data from the Regional Financial Information System, Directorate General of Fiscal Balance, and Ministry of Finance, and (d) the World Bank. Susenas is the main source of data for poverty, inequality, socioeconomic, and human capital variables that capture the status of health and education levels of each district over time.

The two income proxies used are regional real GDP per capita ($GDPPC_{i,t}$) and real household expenditure per capita ($Mean\ Income_{i,t}$). To investigate the impact of education capital on growth and poverty, we used data on three indicators: the gross secondary school enrolment ratio (h_{it}^{gersec}), share of population with secondary education ($h_{it}^{popsharesec}$), and years of schooling ($h_{it}^{eduyears}$). Similarly, to examine the impact of health on growth and poverty, we used four indicators that capture and represent both the common causes of poor health and the status of the health service and system: prevalence of waterborne diseases ($waterbornedisease_{it}$) in each district is proxied by the incidence of diarrhoea, the incidence of nonimmunized children ($Poorimmunization_{it}$), coverage of skilled birth attendance at delivery ($Skillbirthattendence_{it}$), and the incidence of self-medication ($Selfmedication_{it}$) among the general population in each region.

In addition, on the macroeconomic front, seven control variables were used to capture real and fiscal sector conditions, labour markets, and price levels: total government revenue–to-GDP *(Revratio)*, DAU transfer revenue per capita *(DAUPC)*, total government expenditure to GDP *(EXPratio)*, capital expenditure to GDP (S_{it}), ratio of social protection spending to GDP *(SPEXPratio)*, unemployment rate *(Unemprate)*, and change in general price level *(Inflation)*.

7. Estimation Results

We first tested how well the Indonesian data fit against predictions of the augmented neoclassical growth model. We employed four alternative estimators—pooled OLS, within group, and difference and system GMM—to gauge the performance of the data in the neoclassical growth framework. All within-group regressions include district-specific and time-invariant fixed effects. As highlighted by Lorentzen, McMillan, and Wacziarg (2008) in cross-country growth regressions, we too abstained from attaching any definitive interpretations to partial correlations causally, recognizing the fact that causality might run both ways, especially with the OLS estimator. Instead, the attention will be on partial associations and whether the estimated coefficients are big enough to depict a picture that can account for a large portion of cross-regional differences in economic performance.

Table 2 presents the estimates from the basic neoclassical growth model and the augmented Solow model with education capital. Education capital at the district level is captured by three variables: gross secondary school enrolment ratio, share of population with secondary education and years of education. The four subcolumns present the estimates from pooled-OLS (POLS), within-group (WG), difference GMM (Diff-GMM), and system GMM (Sys-GMM), respectively.

First, for the canonical neoclassical model, it is evident from table 2 that the coefficient on lagged output has the expected negative sign and is strongly significant for all of the four different estimators. Thus, after controlling for other factors, initially poorer-than-average districts tend to grow faster, which is consistent with the augmented Solow model. The estimated coefficients on the investment rate and the rate of population growth are also statistically significant with proper signs and are thus consistent with the predictions of the neoclassical growth model. Overall, all of these confirm the principal neoclassical growth paradigm results that lower initial income and population growth rates and higher investment rates are associated with an increase in long-run per-capita output growth.

Second, results for the neoclassical model augmented with education-capital variables in table 1 suggest that, for all four estimators, gross secondary enrolment rates have a positive and significant effect on the growth rate of output per capita. The share of population with secondary education in each district also exhibits a significant positive role in regional growth. As expected, the coefficients for years of schooling are also positive and statistically significant. A comparison of the coefficients across the four estimators indicate that the magnitude of system-GMM estimates are higher relative to simple pooled OLS. Furthermore, statistical significance is also higher for the years of education variable relative to enrolment and share of population with secondary education in all four estimators. In all GMM regressions, the Sargan/Hansen test did not reject the validity of the over-identifying restrictions. The Arellano-Bond test also accepted the hypothesis of no autocorrelation of the second order. The GMM estimator is consistent only when second-order correlation is not significant, although first-order correlation need not be zero (Nkurunziza and Bates 2003). Therefore, both the serial correlation and the Sargan/Hansen test supported the validity of all GMM estimates.

Third, table 3 presents the results for the neoclassical growth model augmented by several indicators capturing the population's health and status of the health service and system of each district. The table also presents our preferred GMM coefficient estimates of the growth equation and the fixed-effects estimates for the purpose of comparison. The diagnostic statistics for the GMM estimates indicate that the model is well specified and fits the data relatively well. In particular, there is no second-order serial correlation and the Hansen test statistic, which is a joint test of identification and model specification, indicates that the model is well specified with the appropriate instrument vector.

Both within-group and dynamic-panel-system GMM coefficient estimates for all health variables are significant and have the expected signs, except for self-medication, which appears insignificant with the within-group estimator. This result is consistent with other studies such as Cole and Neumayer (2006), in which increased prevalence of waterborne diseases such as diarrhoea tends to have a significant negative association with economic growth. The skilled birth attendance rate is statistically significant for both estimators and exhibits a positive impact on growth. Growth also tends to be lower for districts that lack immunization coverage and for those that have high self-medication rates. Overall, independent of the estimation method, we found a fairly robust association of health capital with district economic performance. Furthermore, levels of significance and the magnitudes of our coefficient estimates reinforce findings at the cross-country level (Lorentzen, McMillan, and Wacziarg 2008; Bloom, Canning, and Sevilla 2004; Mankiw, Romer, and Weil 1992; and Lucas 1988), namely, that health seems to have an important effect on growth.

For the poverty–human capital model, tables 4 to 7 present the within-group and system-GMM estimation results for the district-level poverty specifications. Tables 4 and 6 present the fixed-effects and system-GMM results, respectively, for the baseline poverty–human capital model. Tables 5 and 7 give the fixed-effects and system-GMM results, respectively, for the extended specification with additional economic controls respectively.

First, we included lagged poverty, mean household income, and later per-capita GDP to capture persistence effects (inertia) and to examine trickle-down effects: whether increases in average living standards have translated into poverty reduction. The coefficient for lagged poverty is significant and positive for all specifications under both the fixed-effects and GMM estimators, highlighting the tendency towards poverty persistence when poor districts have some socioeconomic traits that make them stay poor. Our estimates also yielded a significantly negative coefficient for mean income, thus suggesting that poverty is intimately linked to the average income of the population.

Second, the coefficient for per-capita GDP is significant and negative in tables 5 and 7 for both the fixed-effects and system-GMM estimators, reflecting the effectiveness of economic growth in alleviating impoverishment across districts in Indonesia. The inequality elasticity of poverty also appears to be positive and significant, revealing how poverty-reducing growth effects can easily be diluted by high levels of inequality across districts. Across all specifications and estimators, we found that increased education capital is associated with a lower level of district poverty.

According to tables 3–7, both fixed-effects and system-GMM results indicate that districts with low standards of living are also ones with poor immunization coverage and high prevalence of waterborne diseases such as diarrhoea. This highlights the fact that poorer regions tend to be more precarious, with less sanitary environments and limited access to health care, which contribute to increasingly poorer health, lower productivity, and lower income. Similarly, our results from tables 3–7 suggest that poorer districts are strongly linked with lower access to skilled birth attendance during birth delivery.

Inflation is found to have a significant poverty-increasing effect. System-GMM results also suggest that the impact of inflation becomes insignificant after controlling for the district-level unemployment rate. Results for total government expenditures and spending on social protection are statistically significant and exhibit powerful poverty-reducing impacts in both the fixed-effect and GMM estimators. This result is consistent with other accounts in the literature such as by Barro and Sala-i-Martin (1995) and Soares (2006). Results also suggest that employment remains a significant factor in reducing the district-level poverty rate.

8. Conclusion and Policy Implications

Despite the vast empirical literature on testing the neoclassical model of economic growth using cross-country data, very few studies exist at the subnational level. We first attempted to fill this gap by using panel data for 2002–12, a modified neoclassical growth equation, and a dynamic-panel estimator to investigate the effect of both health and education capital on economic growth and poverty at the district level in Indonesia. Second, whereas most existing cross-country studies tend to concentrate only on education as a measure of human capital, we expanded the analysis and probed into the effects of health capital as well. As far as we are aware, no study has directly and comprehensively examined the impacts of health on growth and poverty at the subnational level. Thus, this study is the first of its kind at the subnational level and our findings will be particularly relevant in understanding the role of both health and education capital in accelerating growth and poverty reduction efforts.

The empirical findings are broadly encouraging. First, nullifying any doubts on the reliability of Indonesian subnational data, our results suggest that the neoclassical model augmented by both health and education capital provides a fairly good account of cross-district variation in economic growth and poverty in Indonesia. We found that the results on conditional convergence, physical capital investment rate, and population growth confirm the theoretical predictions of the augmented neoclassical model. We also found that economic growth plays a vital role in reducing Indonesian poverty, reinforcing the importance of attaining higher rates of economic growth. Furthermore, we found that education human capital has a relatively large and statistically significant positive effect on the growth rate of per capita income. We found the growth impact of education human capital to be much larger than the growth impact of physical capital investment. This may imply that reliance on only increased physical capital investment as a means of accelerating growth in Indonesia may not be the most appropriate policy and strategy. Findings from the poverty–human capital model also found that districts with low levels of education are characterized by higher levels of poverty.

In the course of examining the association between health and economic performance, we used four indicators that capture and represent both the common causes of poor health and the status of the health service and system: prevalence of waterborne diseases, skilled birth attendance, immunization rate, and the incidence of self-medication. Findings from the study reveal that the linkages of health to poverty reduction and to long-term economic growth in Indonesia are powerful and much stronger than generally understood. Results indicated that health disparities are mostly related to location, and typically, the less healthy are those living in the poorest districts and regions.

Our results suggest that poor regions often do not have the same opportunity as non-poor regions to benefit from the protection of immunizations. Thus, capabilities of poor regions are lowered by poor health and, furthermore, have a reduced ability to benefit from capacity-building educational opportunities. Estimates from district-level poverty regressions suggest that, generally, the different types of disparities overlap and interact. Poorer districts with less educated people are also likely to be those without adequate immunization coverage. As a result, improvements in just one aspect of their lives might not make much difference to their health. The benefits of better access to health services, for example, might still be outweighed by the effects of low income or lack of education. But in some cases, even a single factor could become a stumbling block. In some districts, for example, just improving the level of income could on its own lift the health standard of the whole region. Overall, our results are consistent with the view that investment in human capital today will contribute to lower poverty tomorrow, not only through the expected impact on growth rates but also by increasing the poverty-reducing power of growth.

Both research and policy implications emanate from our results. First, regional disparities in human and physical capital were found to be a major hindrance to income and output growth. Minimization of regional imbalances requires a set of prudential economic policies such as developing infrastructure in less-developed regions, stimulating private sector investment to develop characteristic regional industries, provision of additional fiscal transfers to local governments in consideration of disparities and lagging characteristics, and augmenting the administrative capabilities of local government bodies by strengthening their human resource capacities.

Investment was proven to play an important role in overcoming spatial disparities, and hence, incentives such as preferential tax and land-use policies are necessary to attract foreign direct investment to backward regions. Sensible monetary and labour market policies may not do any harm to the poor; in particular, managing inflation and job-creation efforts are likely to make a substantial contribution to recent poverty reduction efforts at the local and central government level in Indonesia. Additionally, inequality-reducing, distributionally aware public policy will generate many positive contributions to growth and poverty reduction.

Persistence or the inertia effects of poverty found in this study also signify the need for policies such as improving the structural environment of markets, employment, and security to avoid poverty traps across districts in Indonesia. The government should allocate funds to provide lagging districts and provinces with sufficient resources to 'catch up' with leading regions. Central government transfers should ensure that spending results in more equitable access to services. Transfers, such as potentially the Special Allocation Fund (Dana Alokasi Khusus or DAK), could be increased or better aligned with poverty and the degree of lack of access.

The association of education capital with higher regional economic growth rates and lower poverty rates highlights the importance of policies related to schooling and learning. Enrolment is still particularly low in secondary education, and efforts are needed to further enhance the quality of teaching. Because Indonesia has already achieved very high primary school rates, the current development challenge should be to place more emphasis on improving the quality of education throughout the system and increasing enrolment rates for junior secondary education. With robust community-based monitoring systems in place, the government's new policy of providing supplementary financial incentives for teachers working in remote schools is expected to improve the quality of services significantly and, in turn, contribute to long-run efforts in poverty reduction and growth in the country.

Indonesia will need at least to sustain current levels of education spending in relation to GDP in the long term to accomplish long-lasting improvements in learning outcomes. Measures also need urgently to be taken to inject the needed investments in renovating school buildings and other assets that have deteriorated badly over the years. Strengthening the management and governance of district education systems will also assist in minimizing education inequalities and aid the Indonesia central government in laying the groundwork that guarantees no child is left behind in the development process. At the macro level, our results suggest that Indonesia should also take steps to stem the tide of the massive 'brain drain' through emigration long experienced in the country. Concerted efforts by the government to attract the expertise of these émigrés back home will no doubt foster the growth and development process.

Powerful linkages of health with poverty reduction and long-term economic growth in Indonesia underscore the importance of health policies at the regional and national levels. Improving the health and longevity of the poor is an end in itself and, thus, needs to be identified as a fundamental goal of economic development in Indonesia. The status of health in poor low-income districts stands as a stark barrier to economic growth and therefore must be addressed front and centre in any comprehensive development strategy, at least at the district level in Indonesia. Our findings provide enough justification for including immunizations as a major element in all poverty reduction strategies in any region. Taken together, our results strongly indicate that expansion in health system coverage would, on average, lead to an increase in per capita income and lower poverty across Indonesia. But at the same time, local government needs to undertake a more integrated approach, looking beyond health to address many other intertwined issues, such as poverty, unemployment, nutrition, water supply and sanitation, and women's empowerment. Findings from the study underline the importance of improving the quality and effectiveness of health services by strengthening governance of health systems and ensuring sufficiently trained staff, better infrastructure, along with access to improved water supply and sanitation. One final principal message that emerges from this study is that, if the Indonesian government is to reduce welfare disparities and raise standards of health and education, it must focus much more sharply on the needs of the poor and vulnerable.

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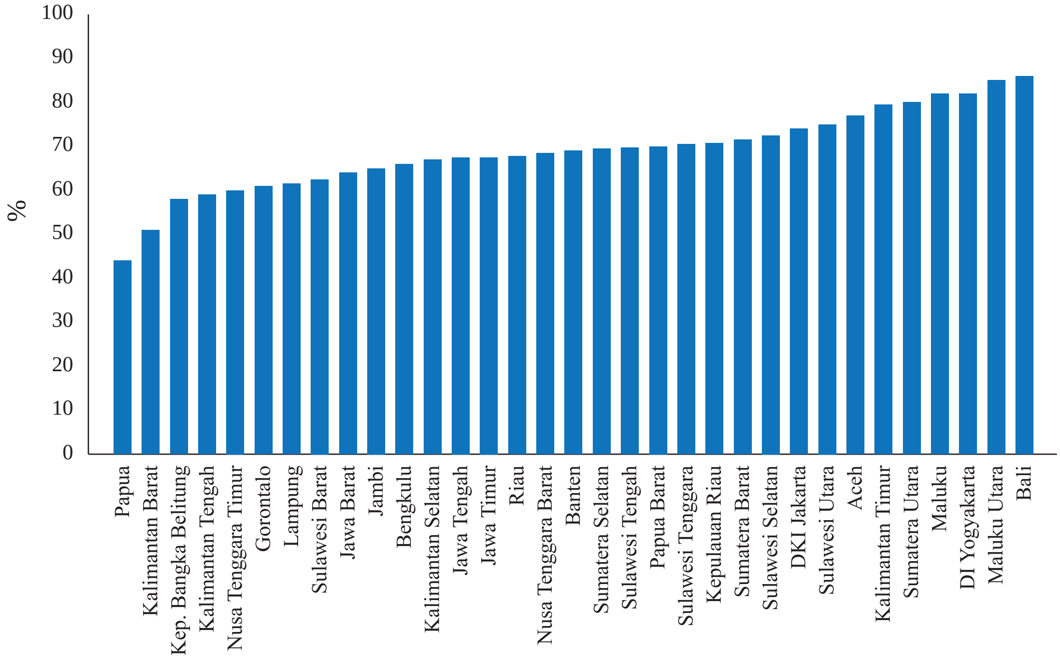
Figure 1: Net Enrolment Rates by Province, SMA, 2012



Note: Senior Secondary School (Sekolah Menengah Atas or SMA)

Figure 2: Child Mortality Rate by Province, 2012

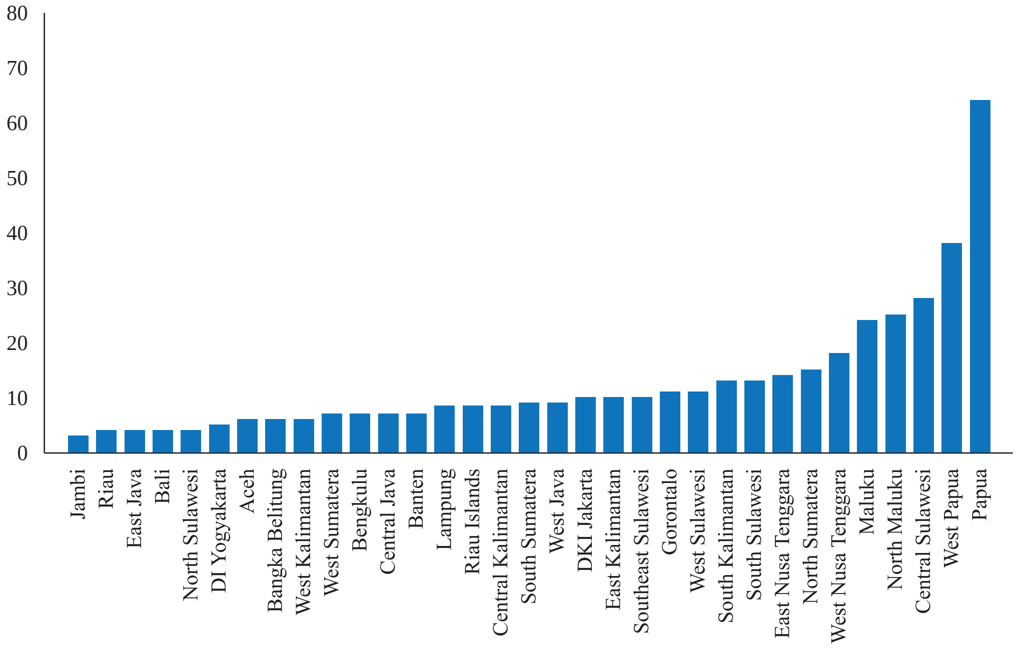


Figure 3: Births Delivered in Health Facility by Province, 2012

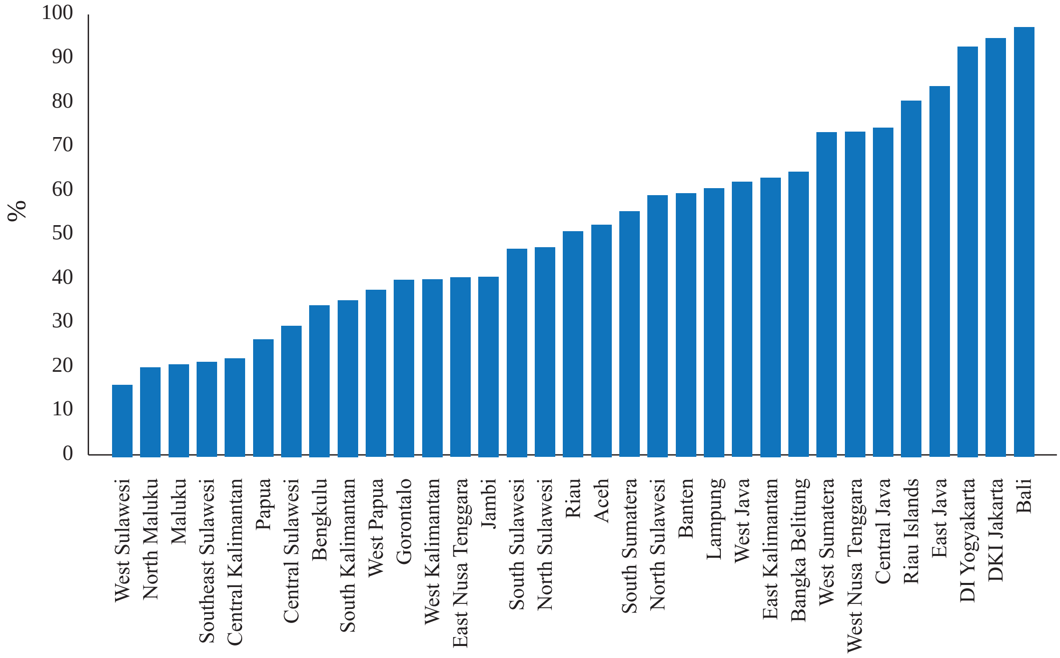


Figure 4: Birth Assisted by Skilled Birth Attendant by Province, 2012

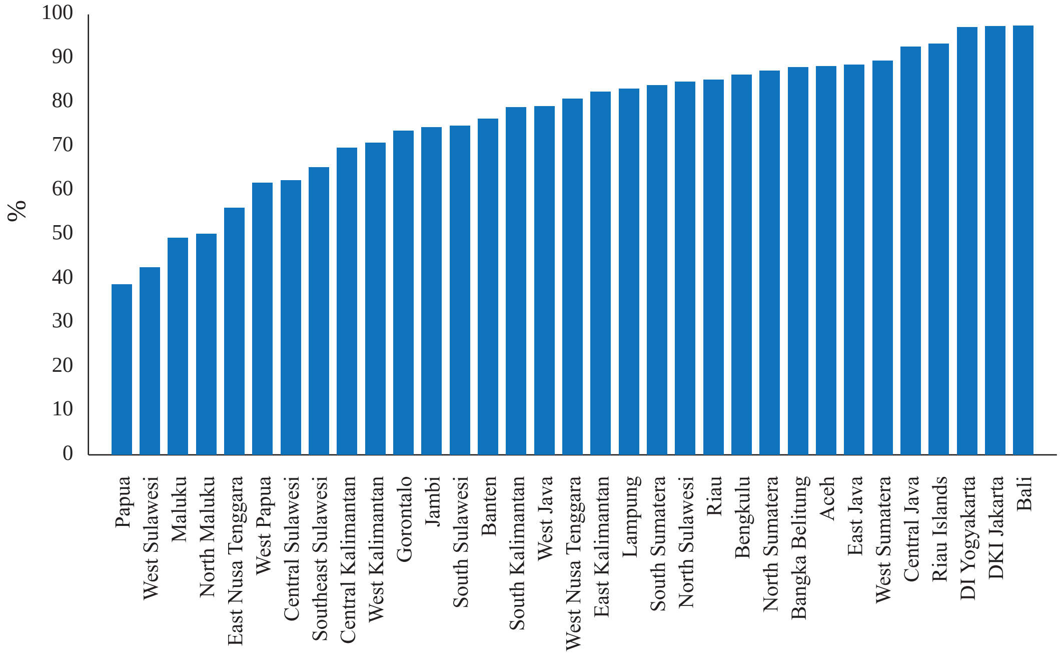


Figure 5: Children Receiving Basic Vaccinations by Province, 2012

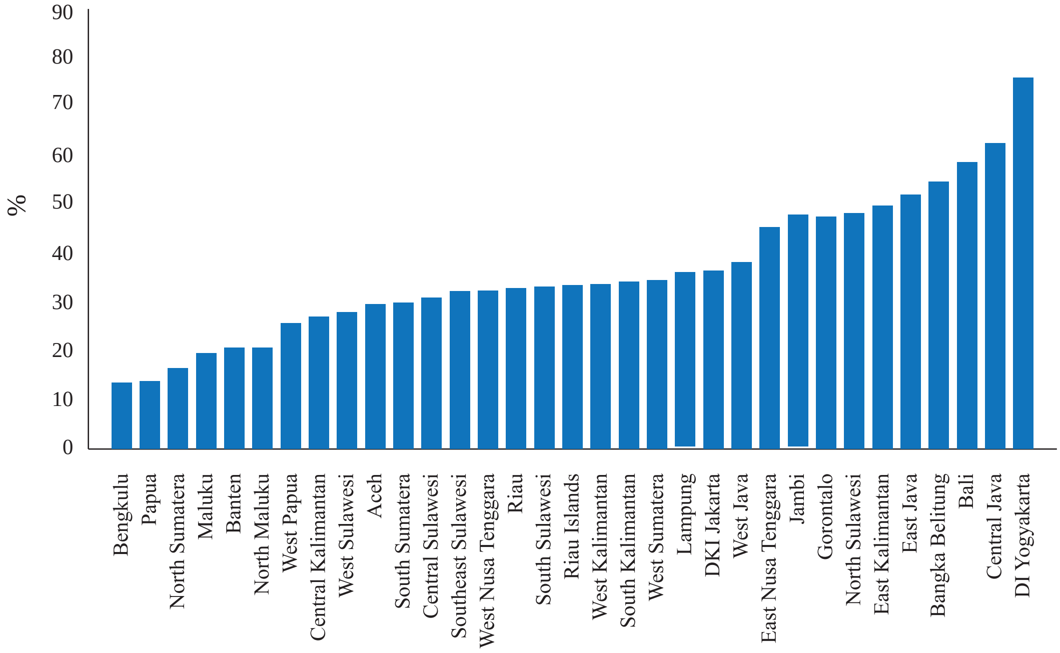


Figure 6: Linkages among Poverty, Per Capita GDP, and Other Socioeconomic Factors

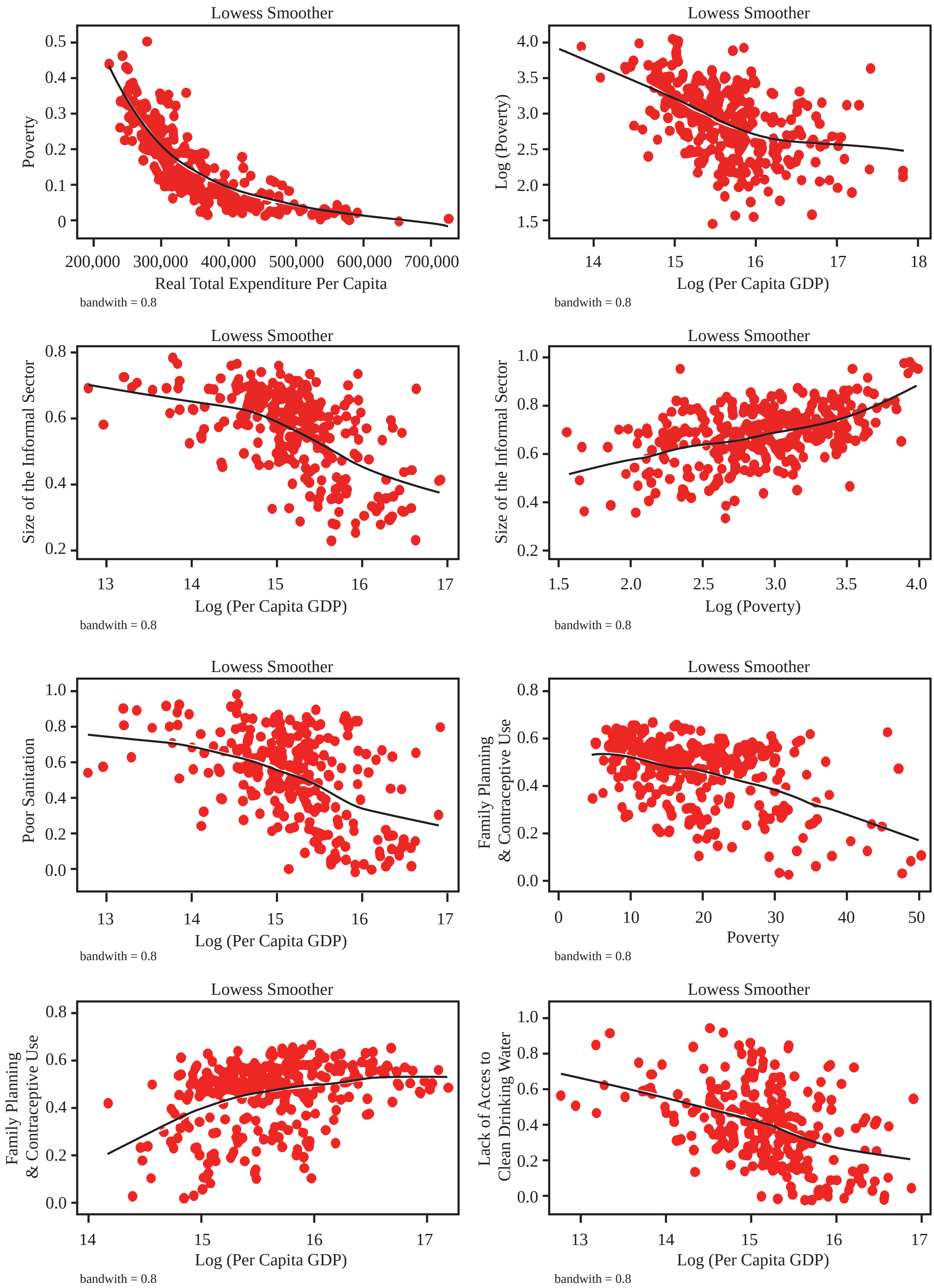


Table 1: Regional Socioeconomic Indicators, 2012/13

Province	GDP Share	GDP Growth	Human Development Index	Poverty Headcount Index	Gini
Aceh	1.40	6.10	72.51	17.72	0.32
North Sumatera	5.20	6.30	75.13	10.39	0.33
West Sumatera	1.60	6.30	74.70	7.56	0.36
Riau	7.00	7.80	76.90	8.42	0.40
Riau Islands	1.40	8.30	73.78	8.42	0.35
Jambi	1.10	8.70	73.99	14.06	0.34
South Sumatera	3.10	7.90	73.93	17.75	0.40
Bangka Belitung	0.50	5.80	72.45	14.39	0.29
Bengkulu	0.40	6.60	73.78	5.25	0.35
Lampung	2.10	6.50	76.20	6.35	0.36
DKI Jakarta	16.40	6.60	78.33	3.72	0.42
West Java	14.10	6.50	76.20	6.35	0.36
Banten	3.20	6.10	73.36	14.44	0.39
Central Java	8.30	6.70	76.75	15.03	0.38
DI Yogyakarta	0.80	5.30	72.83	12.73	0.43
East Java	14.90	7.30	71.49	5.89	0.36
Bali	1.20	6.70	73.49	4.49	0.43
West Nusa Tenggara	1.10	5.80	66.89	17.25	0.35
East Nusa Tenggara	0.80	6.70	68.28	20.24	0.36
West Kalimantan	1.10	5.90	70.31	8.74	0.38
Central Kalimantan	6.20	11.30	75.46	6.23	0.33
South Kalimantan	0.70	7.80	71.08	4.76	0.38
East Kalimantan	0.20	7.70	76.71	6.38	0.36
North Sulawesi	0.80	9.40	76.95	8.50	0.43
Gorontalo	2.40	8.40	72.14	14.32	0.44
Central Sulawesi	0.20	9.00	72.70	10.32	0.40
South Sulawesi	0.50	10.40	71.05	13.73	0.41
West Sulawesi	0.70	-1.10	71.31	18.01	0.31
Southeast Sulawesi	0.50	5.40	70.73	12.23	0.40
Maluku	0.20	7.80	72.42	19.27	0.38
North Maluku	0.10	6.70	69.98	7.64	0.34
Papua	1.20	1.10	70.22	27.14	0.44
West Papua	0.60	7.40	65.86	31.53	0.43
Indonesia	100.00	6.23	73.29	11.47	0.41

Table 2: Neoclassical Model Augmented with Education Capital

	Dependent Variable ΔY_{it}															
	POLS				WG				DIFF-GMM				SYS-GMM			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
ln ($Y_{i,t-1}$)	-0.011***	-0.012***	-0.015***	-0.007***	-0422***	-0.264***	-0.266**	-0.049***	-0.045**	-0.274***	-0.368**	-0.033***	-0.081**	-0.069***	-0.042*	-0.014***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.019)	(0.015)	(0.015)	(0.007)	(0.018)	(0.093)	(0.162)	(0.013)	(0.038)	(0.027)	(0.022)	(0.006)
ln (n_{it}+g+δ)	-0.058***	-0.057***	-0.057***	-0.057***	-0.027***	-0.047***	-0.046***	-0.055***	-0.029***	-0.034***	-0.023*	-0.68***	-0.035***	-0.020*	-0.034***	-0.058***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.005)	(0.003)	(0.003)	(0.005)	(0.011)	(0.011)	(0.012)	(0.024)	(0.010)	(0.012)	(0.007)	(0.011)
ln (S_{it})	0.008***	0.006***	0.006***	0.006***	0.051***	0.032***	0.032***	0.008***	0.015***	0.044***	0.050***	0.007**	0.017***	0.017***	0.014***	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.013)	(0.017)	(0.003)	(0.005)	(0.004)	(0.005)	(0.003)
ln (h_{it}^{gersec})		0.011**				0.028**				0.065**				0.062**		
		(0.005)				(0.012)				(0.029)				(0.025)		
ln ($h_{it}^{popsharesec}$)			0.019***				0.034**				0.116*				0.044*	
			(0.004)				(0.013)				(0.060)				(0.023)	
ln ($h_{it}^{eduyears}$)				0.027***				0.033***				0.050**				0.029***
				(0.010)				(0.012)				(0.023)				(0.009)
Constant	-0.172***	-0.083*	-0.040	-0.221***	5.007***	3.157***	3.210***	0.370***					0.709	0.623	0.255	-0.143
	(0.052)	(0.050)	(0.050)	(0.065)	(0.266)	(0.207)	(0.212)	(0.142)					(0.568)	(0.438)	(0.376)	(0.161)
Observations	2660	2211	2211	2039	2317	2211	2211	2039	2032	2211	2211	2211	2317	2211	2211	2039
R-squared	0.346	0.349	0.356	0.308	0.258	0.335	0.335	0.312								
Hansen Test									0.108	0.154	0.333	0.126	0.161	0.135	0.140	0.282
AR (1)									0.000514	0.000536	6.65e-05	0.00579	0.0292	0.000991	0.00118	0.00652
AR (2)									0.383	0.987	0.873	0.308	0.597	0.985	0.550	0.278

Table 3: Baseline Neoclassical Model Augmented with Health Capital

	Dependent Variable ΔY_{it}									
	WG					**SYS-GMM**				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
ln ($Y_{i,t-1}$)	-0.422***	-0.365***	-0.540***	-0.451***	-0.431***	-0.081**	-0.179***	-0.148***	-0.190***	0.425***
	(0.019)	(0.022)	(0.027)	(0.023)	(0.048)	(0.038)	(0.017)	(0.019)	(0.018)	(0.051)
ln ($n_{it}+g+\delta$)	-0.027***	-0.032***	-0.016**	-0.025***	-0.032***	-0.035***	-0.160***	-0.162***	-0.142***	-0.186***
	(0.005)	(0.006)	(0.007)	(0.007)	(0.008)	(0.010)	(0.012)	(0.015)	(0.014)	(0.019)
ln (S_{it})	0.051***	0.054***	0.057***	0.016*	0.018	0.017***	0.045***	0.044***	0.053***	0.101***
	(0.004)	(0.005)	(0.006)	(0.009)	(0.012)	(0.005)	(0.005)	(0.007)	(0.006)	(0.017)
ln ($Skillbirthattendance_{it}$)		0.011*					0.066***			
		(0.006)					(0.008)			
ln ($Poorimmunization_{it}$)			-0.061***					-0.087***		
			(0.019)					(0.025)		
ln ($Selfmedication_{it}$)				-0.040					-0.096***	
				(0.028)					(0.031)	
ln ($waterbornediseases_{it}$)					-0.009**					-0.050***
					(0.004)					(0.009)
Constant	5.007***	4.082***	6.689***	6.344***	6.026***	0.709	1.178***	0.682***	1.144***	3.108***
	(0.266)	(0.320)	(0.374)	(0.412)	(0.691)	(0.568)	(0.205)	(0.220)	(0.200)	(0.397)
Observations	2317	2135	2135	2135	2135	2317	2135	2135	2135	2135
R-squared	0.0258	0.234	0.311	0.273	0.286					
Hansen Test						0.161	0.193	0.184	0.165	0.169
AR (1)						0.0292	0	0	0	5.96e-07
AR (2)						0.597	0.284	0.355	0.259	0.253

Table 4: Baseline Poverty-human capital Model: Fixed Effects

	Dependent Variable:* ln*(PHI)					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ln $(PHI_{i,t-1})$	0.460***	0.418***	0.459***	0.699***	0.263***	-0.039*
	(0.016)	(0.017)	(0.016)	(0.021)	(0.021)	(0.023)
ln $(Mean\ Income_{it})$	-0.184***	-0.182***	-0.179***	-0.105***	-0.276***	-0.385***
	(0.008)	(0.008)	(0.008)	(0.011)	(0.010)	(0.011)
ln $(Gini_{it})$		0.042*				
		(0.023)				
ln $(h_{it}^{eduyears})$			-0.037*			
			(0.019)			
ln $(Poorimmunization_{it})$				0.024***		
				(0.003)		
ln $(waterbornediseases_{it})$					0.013**	
					(0.005)	
ln $(Skillbirthattendance_{it})$						-0.030***
						(0.011)
Constant	1.234***	1.203***	1.234***	0.762***	2.088***	2.862***
	(0.081)	(0.105)	(0.082)	(0.119)	(0.109)	(0.133)
Observations	2,524	2,295	2,524	2,524	2,524	2,524
R-squared	0.622	0.540	0.623	0.687	0.556	0.532

Table 5: Poverty-Human Capital Model Agumented with Other Economic Variables: Fixed-Effects Estimates

	Dependent Variable:* ln*(PHI)									
	(1)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
ln $(PHI_{i,t-1})$	0.456***	0.439***	0.437***	0.688***	0.493***	0.491***	0.419***	0.408***	0.200***	0.414***
	(0.016)	(0.018)	(0.018)	(0.024)	(0.018)	(0.019)	(0.020)	(0.022)	(0.028)	(0.017)
ln $(Mean\ Income_{it})$	-0.173***	-0.171***	-0.166***	-0.100***	-0.148***	-0.151***	-0.126***	-0.154***	-0.430***	-0.173***
	(0.008)	(0.009)	(0.009)	(0.012)	(0.009)	(0.010)	(0.010)	(0.011)	(0.016)	(0.009)
ln $(GDPPC_{i,t})$	-0.068***	-0.059***	-0.056**	-0.062**	-0.075***	-0.048**	-0.084***	-0.057**	-0.107***	-0.062***
	(0.022)	(0.023)	(0.023)	(0.030)	(0.022)	(0.022)	(0.024)	(0.025)	(0.039)	(0.023)
Inflation		0.264***	0.269***	0.188***	0.351***	0.334***	0.317***	0.354***	0.378***	0.359***
		(0.070)	(0.070)	(0.083)	(0.071)	(0.072)	(0.071)	(0.087)	(0.089)	(0.071)
ln $(h_{it}^{eduyears})$			-0.037*							
			(0.020)							
ln $(Poorimmunization_{it})$				0.022***						
				(0.004)						
Revratio$_{i,t-1}$					-0.263***					
					(0.064)					
ln $(DAUPC_{i,t-1})$						-0.018***				
						(0.006)				
$EXPratio_{i,t-1}$							-0365***			
							(0.057)			
$SPEXPratio_{i,t-1}$								-3.057		
								(1.481)		
UNEMPRATE									1.392***	
									(0.267)	
ln $(Gini_{i,t})$										0.040*
										(0.023)
Constant	2.125***	1.960***	1.906***	1.597***	2.043***	1.848***	1.813***	1.667***	5.429***	2.019***
	(0.292)	(0.310)	(0.311)	(0.426)	(0.297)	(0.300)	(0.321)	(0.348)	(0.565)	(0.321)
Observations	2,521	2,041	2,041	1,392	1,873	1,866	1,532	1,230	911	2,292
R-squared	0.624	0.580	0.581	0.654	0.637	0.644	0.541	0.571	0.704	0.541

Table 6: Baseline Poverty-human capital Model: System-GMM Estimates

	Dependent Variable: ln(*PHI*)					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$\ln(PHI_{i,t-1})$	0.774***	0.746***	0.842***	0.977***	0.767***	0.723***
	(0.079)	(0.088)	(0.060)	(0.020)	(0.036)	(0.068)
$\ln(Mean\ Income_{it})$	-0.114***	-0.0237***	-0.078***	-0.019	-0.119***	-0.083***
	(0.029)	(0.027)	(0.023)	(0.016)	(0.015)	(0.018)
$\ln(Gini_{it})$		0.154***				
		(0.047)				
$\ln(h_{it}^{eduyears})$			-0.071***			
			(0.026)			
$\ln(Poorimmunization_{it})$				-0.048***		
				(0.005)		
$\ln(waterbornediseases_{it})$					0.044***	
					(0.021)	
$\ln(Skillbirthattendance_{it})$						-0.136***
						(0.051)
Constant	0.953***	1.392***	0.748***	0.266	1.184***	0.363*
	(0.229)	(0.208)	(0.186)	(0.173)	(0.159)	(0.214)
Observations	2,524	2,295	2,524	1,694	1,948	2,419
Hansen Test	0.174	0.316	0.284	0.172	0.264	0.562
AR (1)	0.0133	0.0165	0.0188	0	0	0.0209
AR (2)	0.581	0.665	0.476	0.0139	0.157	0.563

Table 7: Poverty-Human Capital Model Agumented with Other Economic Variables: System-GMM Estimates

	Dependent Variable:* ln*(PHI)									
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
ln $(PHI_{i,t-1})$	0.726***	0.583***	0.646***	0.805***	0.735***	0.742***	0.740***	0.830***	0.595***	0.469***
	(0.083)	(0.087)	(0.077)	(0.037)	(0.038)	(0.032)	(0.046)	(0.041)	(0.054)	(0.105)
ln $(Mean\ Income_{it})$	-0.110***	-0.138***	-0.095***	-0.064***	-0.066***	-0.089***	-0.060*	-0.072***	-0.169***	-0.172***
	(0.026)	(0.026)	(0.023)	(0.019)	(0.022)	(0.017)	(0.030)	(0.021)	(0.033)	(0.024)
ln $(GDPPC_{i,t})$	-0.113***	-0.193**	-0.234***	-0.098*	-0.211***	-0.090**	-0.169***	-0.062*	-0.103*	-0.138*
	(0.034)	(0.081)	(0.085)	(0.051)	(0.065)	(0.039)	(0.061)	(0.035)	(0.055)	(0.056)
Inflation		1.166***	1.232***	0.324*	0.564***	0.741***	0.811***	0.453***	-0.033	0.217*
		(0.212)	(0.249)	(0.173)	(0.152)	(0.137)	(0.137)	(0.168)	(0.141)	(0.128)
ln $(h_{it}^{eduyears})$			-0.084***							
			(0.026)							
ln $(Poorimmunization_{it})$				0.031***						
				(0.006)						
$\text{Revratio}_{i,t-1}$					-0.757***					
					(0.203)					
ln $(DAUPC_{i,t-1})$						-0.025**				
						(0.010)				
$EXPratio_{i,t-1}$							-0.643***			
							(0.192)			
$SPEXPratio_{i,t-1}$								-8.126**		
								(3.265)		
UNEMPRATE									1.582*	
									(0.935)	
ln $(Gini_{i,t})$										0.103*
										(0.053)
Constant	2.521***	3.747***	4.074***	1.937***	3.549***	2.222***	2.815***	1.456***	2.788***	3.354***
	(0.597)	(1.052)	(1.124)	(0.700)	(0.797)	(0.492)	(0.666)	(0.503)	(0.776)	(0.777)
Observations	2,521	2,041	2,041	1,392	1,873	1,866	1,532	1,230	1,866	2,040
Hansen Test	0.418	0.391	0.293	0.413	0.526	0.412	0.396	0.428	0.318	0.353
AR (1)	0.0131	0.0211	0.0314	2.28e-07	0	0	0	4.77e-08	1.31e-07	0.0230
AR (2)	0.574	0.857	0.652	0.00346	0.573	0.261	0.948	0.478	0.101	0.802

The aim of this study is twofold. First, despite the vast empirical literature on testing the neoclassical model of economic growth using cross-country data, very few studies exist at the subnational level. We attempted to fill this gap by using panel data for 2002–12, a modified neoclassical growth equation, and a dynamic-panel estimator to investigate the effect of both health and education capital on economic growth and poverty at the district level in Indonesia. Second, although most existing cross-country studies tend to concentrate only on education as a measure of human capital, we expanded the analysis and probed the effects of health capital as well. As far as we are aware, no study has done a direct and comprehensive examination of the impacts of health on growth and poverty at the subnational level. Thus, this study is the first at the subnational level, and our findings will be particularly relevant in understanding the role of both health and education capital in accelerating growth and poverty reduction efforts.

The empirical findings are broadly encouraging. First, nullifying any doubts on the reliability of Indonesian subnational data, our results suggest that the neoclassical model augmented by both health and education capital provides a fairly good account of cross-district variation in economic growth and poverty in Indonesia. We found that the results on conditional convergence, physical capital investment rate, and population growth confirm the theoretical predictions of the augmented neoclassical model. We also found that both health and education capital had a relatively large and statistically significant positive effect on the growth rate of per capita income. Economic growth was found to play a vital role in reducing Indonesian poverty, reinforcing the importance of attaining higher rates of economic growth. Findings from the poverty–human capital model showed that districts with low levels of education are characterized by higher levels of poverty. We found that regions with mediocre immunization coverage and greater than average prevalence of waterborne diseases had higher poverty rates and lower output per capita. Similarly, regions with higher numbers of births attended by a skilled birth attendant were associated with lower poverty rates and higher economic output. Our results in particular suggest that, in designing policies for growth, human development, and poverty reduction, it is necessary to broaden the concept of human capital to include health as well.

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Printed on recycled paper

ISBN 9786022751083