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How The Demographic Dividend Affects Economic Convergence: Insights from Indonesia

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Abstract

This study investigates the effect of the demographic dividend on the convergence of regional economic growth in Indonesia post-fiscal decentralization from 2001-2023. Considering the two phases of the demographic dividend, namely the first dividend measured by economic support ratio and the second dividend measured by the accumulation of human capital, this paper uses the frontier and the conventional convergence approaches. The models are empirically estimated by static (Ordinary Least Square, fixed effect, random effect) and dynamic (Generalized Method of Moments) panel data regressions. The results confirm that per capita income growth in Indonesia's provinces is converging, using both the frontier and conventional approaches. This implies that provinces with low per capita income are catching up to the national average and higher-income provinces. However, the speed of convergence of approximately 1.06–2.10% is considered slow, implying that the disparity will be halved over a relatively long period (33–66 years). Demographic dividend interventions, such as improving economic support ratio and human capital, significantly boost convergence speed and reduce the time needed for half-convergence. Further analysis indicates that slow convergence may be due to the low-level equilibrium trap in fertility rates and economic support ratios, hindering regional economic growth convergence in Indonesia.

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INTRODUCTION

The demographic dividend, brought by the demographic transition, affects economic development through the increase in per capita income. The demographic dividend typically unfolds in two phases. The first phase is characterized by the highest proportion of the working-age population, and the second phase is by increases in capital and labor productivity, leading to higher levels of income Mason (2007).

The first phase of the demographic dividend is transitory, depending on fertility rates. The window of opportunity for the first dividend in Indonesia is predicted to end as early as 2030 and at the latest by 2040 (Adioetomo, 2006; Mason et al., 2017; Bappenas, 2023). Mason et al. (2017) estimate that the high proportion of the working-age population results in an additional per capita income of approximately 0.44% per year throughout the first phase of the demographic dividend. The IMF (2018) projected that Indonesia would receive an additional 0.2% in per capita income from the demographic transition over the period 2020-2050.

The second phase occurs after the first demographic dividend, provided that the benefits from the first demographic dividend are transformed into greater and more sustainable physical and human capital (Lee and Mason, 2006). Bloom et al. (2003) argue that human capital has a broad impact on optimizing the demographic dividend. In the case of Indonesia, in terms of education, the rate of return on education ranges from 6-11% per annum (Duflo, 2001; Purnastuti et al., 2013; Yubilianto (2020), and in terms of health, a one-year increase of life expectancy increases 4% in economic output (Bloom et al., 2004).

The first and second demographic dividend periods can overlap, implying the period of the highest proportion of the working-age population and capital accumulation simultaneously contribute to per capita income. As depicted in Figure 1, Mason et al. (2017) predict that the second demographic dividend commenced in 2003 with a dividend of approximately 0.08% and peaked in 2018 at 1.94%. On average, the post-first-dividend capital accumulation generates an additional 0.71% in per capita income annually. Unlike the first phase, the second demographic dividend is long-lasting and has no time limits (Lee and Mason, 2006).

Studies on demographic dividends by provinces in Indonesia show different results. Samosir (2019) finds that provinces like DKI Jakarta, DI Yogyakarta, East Java, South Kalimantan, and North Sulawesi have entered the final phase of the first demographic dividend. At the regency level, 4.7% are in the pre-dividend stage, 71.4% are in the initial stage, and 23.9% are in the final stage. In terms of human capital quality, finds that Indonesia's human capital ranks at a middling level among ASEAN countries based on per capita income, life expectancy, working-age population, and infant mortality rate indicators. However, Miranti and Mendez-Guerra (2020) report a narrowing gap in human development among Indonesian regions from

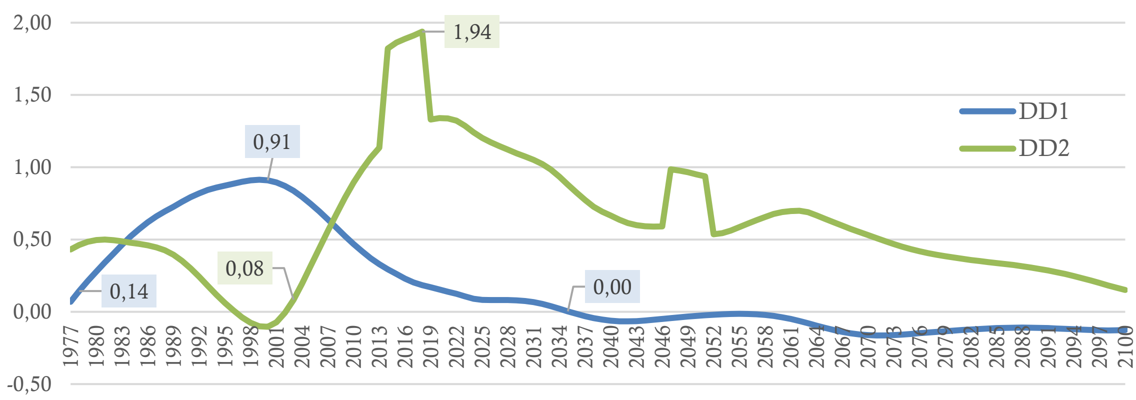

Figure 1. Indonesia’s First and Second Demographic Dividends, 1977-2100
Source: Mason et al., 2017 (Processed)

2010 to 2018, attributed largely to improvements in education.

Fiscal decentralization after 2001 also had an impact on regional disparities in both income and human development in Indonesia. Siburian (2020) found that fiscal decentralization reduces regional income inequality, partly through the more efficient provision of public goods. Similarly, Soejoto et al. (2015) find that this policy positively affects economic growth and human development, but no impact on poverty. Therefore, how decentralization and the demographic dividend affect economic growth convergence in Indonesia warrants further investigation.

Numerous studies on regional economic growth convergence in Indonesia over different periods have been conducted, yielding diverse findings. Studies conducted before fiscal decentralization era, such as Sodik (2006) with a research period of 1993-2003, found evidence of regional economic convergence. Meanwhile, Vidyattama (2006), using a period of 1975-2002, found that convergence was influenced by policies and macroeconomic conditions, particularly structural transformation from mining to industry. Post-decentralization studies, including Malik (2014) with a period of 2001-2012 and Santos-Marquez et al. (2022) with a period of 2010-2017, also found evidence of regional economic convergence. However, Anjani and Prasetyo (2024), using a period of 2017-2021, found evidence of both absolute beta convergence and sigma convergence, but conditional beta convergence only occurred in western part of Indonesia.

Studies with relatively long research periods, such as Kurniawan et al. (2019) covering the 1969-2012 period using club convergence, found evidence of convergence within both the rich and poor province groups but not between the two groups. Studies by Gunawan (2011) with a period of 1988-2008 and Affandi et al. (2019) also found evidence of growth convergence, which was confirmed by the study of Purawan (2010) for the period 1992-2007 and Kharisma and Saleh (2013) for the period of 1984-2008. These latter studies specifically found differences in convergence before and after decentralization in Indonesia.

While previous studies have successfully demonstrated regional economic growth convergence in Indonesia, they have several limitations. Firstly, none of these studies have specifically utilized measures of the first and second demographic dividend to examine regional economic growth convergence. The study by Ha and Lee (2016), which investigated the relationship between the demographic dividend and economic growth convergence in Asian countries, can be a reference for this approach.

Secondly, even though studies such as Malik (2014) and Affandi et al. (2019) have incorporated the second demographic dividend, namely human capital accumulation, into convergence models, the scope of human capital remains restricted to years of schooling and the Human Development Index (HDI). Meanwhile, the study by Miranti and Mendez-Guerra (2020) solely focused on the convergence of components of the HDI rather than its relationship with regional economic growth convergence. The inclusion of human capital accumulation in convergence models should include the return to education, for instance, by employing the Mincerian approach (Mincer, 1974). Thirdly, studies using the frontier approach as proposed by Kumar and Russell (2002) have not been found. The approach can be used as an alternative to analyze and compare regional economic growth convergence models in Indonesia.

This study aims to fill the gap in the empirical literature. The objective of this paper is three folds. First, to investigate how the first and second demographic dividend affect regional economic growth convergence in Indonesia. Secondly, beyond updating the results of beta and sigma convergence after decentralization, this study also explores the Mincerian approach to measure human capital accumulation and applies a frontier approach relative to the national average to convergence models. Lastly, this study identifies scenarios of regional economic growth convergence in Indonesia by examining the demographic dividend aspect, namely the fertility rate. This study focuses on the 34 provinces in Indonesia, with a post-fiscal decentralization observation period of 2001-2023.

RESEARCH METHODS

The demographic dividend model in this study is adapted from Lee and Mason (2010). The first demographic dividend is determined by examining the relationship between the economic support ratio (the proportion of the working-age population to the total population) and per capita income, with the following equation:

$Y_{it}/N_{it} = w_{it}esr_{it}$ .... (1)

where Y_{it} represents total income, N_{it} represents total population, w_{it} denotes wage per worker, esr_{it} represents economic support ratio, and subscript it denotes the i-th province in year t. With the simplification of $Y_{it}/N_{it} = y_{it}$ or per capita income, the function can be written as:

$y_{it} = f(w_{it}, esr_{it})$ .... (2)

In this context, the first demographic dividend occurs when an increase in economic support ratio (esr_{it}) is accompanied by a rise in per capita income (y_{it}) or $\delta[f(w_{it}, esr_{it})]/\delta esr_{it} > 0$.

Meanwhile, the second demographic dividend is measured by examining the relationship between human capital and per capita income using the following function:

$y_{it} = f(H_{it}/L_{it}) = f(h_{it})$........................ (3)

where H_{it} represents human capital stock, L_{it} represents the number of the labor force, and h_{it} represents human capital stock per worker. In this case, the second demographic dividend occurs when an increase in human capital per worker (h_{it}) is accompanied by a rise in per capita income (y_{it}) or $d[f(h_{it})]/dh_{it} > 0$.

Based on equations (2) and (3), the empirical model for the first and second demographic dividends in this study is as follows:

$log\, y_{it} = \alpha_1 + \beta_1 log\, esr_{it} + \varepsilon_{1.it}$ .... (4.a)

$log\, y_{it} = \alpha_2 + \beta_2 log\, h_{it} + \varepsilon_{2.it}$ .... (4.b)

In addition, this research proposes an empirical model to capture the overlap between the first and second demographic dividend, as follows:

$log\, y_{it} = \alpha + \beta_1 log\, esr_{it} + \beta_2 log\, h_{it} + \varepsilon_{it}$ (4.c)

The research hypothesis is $\beta_1 > 0$ which implies that the first demographic dividend is ongoing, characterized by economic support ratio growth driving per capita income growth. The next hypothesis is $\beta_2 > 0$ which implies that the second demographic dividend is ongoing, characterized by human capital per worker growth driving per capita income growth. If equation (4.c) yields $\beta_1 > 0$ and $\beta_2 > 0$, it means that both the first and second demographic dividends are occurring simultaneously (overlapped).

The convergence model has been a focal point in growth studies as it provides insights into steady-state per capita income and explains how a region reaches this state. Empirical analyses of this model have gained popularity since the studies of, Baumol (1986), Barro (1991), and Barro and Sala-i-Martin (1992). In this study, the convergence model incorporating demographic dividend follows Ha and Lee (2016) who modified the Mankiw et al. (1992) model into the following production function:

$Y_{it} = A_{it}K_{it}^{\alpha}(h_{it}L_{it})^{\theta} = A_{it}K_{it}^{\alpha}(h_{it}L_{it})^{1-\alpha}$ ......(5)

where Y_{it} represents output, K_{it} represents the stock of physical capital, h_{it} denotes human capital stock per worker, L_{it} represents the number of the labor force, A_{it} represents the level of technology, α represents the elasticity of physical capital with respect to output, and it is assumed that $\alpha + \theta = 1$.

If equation (5) is divided by the total population (N_{it}), the following intensive form is obtained:

$Y_{it}/N_{it} = A_{it}(K_{it}/L_{it})^{\alpha}h_{it}^{1-\alpha}(L_{it}/N_{it})$ ....(6.a)

$y_{it} = A_{it}k_{it}^{\alpha}h_{it}^{1-\alpha}esr_{it}$ .... (6.b)

where y_{it} denotes per capita income (or Y_{it}/N_{it}), k_{it} represents the stock of physical capital per worker (or K_{it}/L_{it}), and esr_{it} ($= L_{it}/N_{it}$) signifies the measure of economic support ratio or the ratio of the employed population (effective producer) to the total population (effective consumer). Equation (6.b) is the basic convergence model used in this study.

The frontier approach was initially proposed by Kumar and Russell (2002) and later applied by Ha and Lee (2016) to analyze convergence among Asian countries, using the US as the frontier. For Indonesia, Resosudarmo and

Vidyattama (2006) utilized the national average in their analysis of regional income disparity. Referring to these aforementioned studies, we adopt the national average as the frontier. Therefore, using the frontier approach, equation (6.b) can be rewritten as follows:

$$\frac{y_{it}}{y_{max.t}} = \frac{A_{it}}{A_{max.t}} \frac{k_{it}^{\alpha}}{k_{max.t}^{\alpha}} \frac{h_{it}^{1-\alpha}}{h_{max.t}^{1-\alpha}} \frac{esr_{it}}{esr_{max.t}} \quad \text{.............. (7)}$$

Here, the subscript $max.$ refers to variables at the national level. By logarithmic transformation and subsequent differentiation with respect to time (t), we arrive at the following equation for decomposing the speed of convergence of each region relative to the national average:

$$g\left(\frac{y_{it}}{y_{max.t}}\right) = g\left(\frac{A_{it}}{A_{max.t}}\right) + \alpha g\left(\frac{k_{it}^{\alpha}}{k_{max.t}^{\alpha}}\right) + (1 - \alpha) g\left(\frac{h_{it}^{1-\alpha}}{h_{max.t}^{1-\alpha}}\right) + g\left(\frac{esr_{it}}{esr_{max.t}}\right) \quad \text{........(8)}$$

where $g(.)$ denotes growth rate of the respective variables.

Besides decomposing the speed of convergence, this research further quantifies beta convergence (β), encompassing both absolute and conditional convergence, employing conventional and frontier approaches. Absolute beta convergence measures how convergence is achieved without any intervention or control of other variables. The absolute beta convergence is derived through the following equation:

$$\frac{1}{T} log\, y_{iT}/y_{i0} = \alpha + \left(\frac{1-e^{-\lambda T}}{T}\right) log\, y_i^*/y_{i0}$$

$$\frac{1}{T} log\, y_{iT}/y_{i0} = \alpha + \left(\frac{e^{-\lambda T}-1}{T}\right) log\, y_{i0}/y_i^*$$

$$\frac{1}{T} log\, y_{iT}/y_{i0} = \alpha + \left(e^{-\lambda T} - 1\right) log y_{i0}$$

$$\frac{1}{T} log\, y_{iT}/y_{i0} = \alpha + \beta log y_{i0} \quad \text{..................... (9)}$$

Based on equation (9), the empirical models for absolute beta convergence, both employing conventional (10.a) and frontier (10.b) approaches, can be expressed as:

$$\frac{1}{T} log\, y_{iT}/y_{i0} = \alpha + \beta log y_{i0} + \varepsilon_i \quad \text{...........(10.a)}$$

$$g\left(\frac{y_{it}}{y_{max.t}}\right) = \alpha + \beta log\, {}^{y_{it}}/_{y_{max.t}} + \varepsilon_{it} \quad \text{..... (10.b)}$$

Meanwhile, the conditional beta, where the convergence occurs with the control or intervention of other variables, using conventional (11.a) and frontier (11.b) approaches, is as follows:

$$\frac{1}{T} log\, y_{iT}/y_{i0} = \alpha + \beta log y_{i0} + X_{i0}'\varphi + \varepsilon_i \quad \text{.. (11.a)}$$

$$g\left(\frac{y_{it}}{y_{max.t}}\right) = \alpha + \beta log\, {}^{y_{it}}/_{y_{max.t}} + \left({}^{X_{it}}/_{X_{max.t}}\right)' \varphi + \varepsilon_{it} \quad \text{......... (11.b)}$$

where i represents the province ($i = 1,2, \ldots, N$) and t represents the year ($t = 0,1, \ldots, T$) so that $t = 0$ is the initial period (2001) and $t = T$ is the final period (2023). For the conditional beta convergence, $\boldsymbol{X}$ represents a matrix of control variables, which in this study consists of economic support ratio (esr_{it}), human capital stock per worker (h_{it}), and physical capital investment per capita (i_{it}).

A convergence is said to occur when the estimated coefficient beta (β) is negative. This means that, according to the conventional approach, low-income provinces will be able to catch up with high-income provinces. Conversely, under the frontier approach, low-income provinces will be able to converge towards the national average. The speed of convergence can be calculated using the following formula:

$$\lambda = -ln\,(1+\beta)/T \quad \text{................................. (12)}$$

Additionally, the time required to achieve half of the convergence can be calculated using the following formula:

$$T_{1/2}^* = -ln(1/2)/\lambda = ln(2)/\lambda \quad \text{................. (13)}$$

This study will also measure sigma convergence. This measure explains the dispersion of per capita income, which is expected to decrease over time. Sigma convergence can be calculated using the variance of the logarithm of income (Vidyattama, 2006):

$$\sigma_t^2 = \frac{1}{N} \sum_{i=1}^{N} (log y_{it} - log y_t)^2 \quad \text{..................... (14)}$$

In this equation, σ_t^2 refers to the variance of the logarithm of per capita income, while $\bar{y}_t$ represents the average per capita income across all provinces.

The study further examines convergence scenarios by analyzing the relationship between fertility rates, economic support ratio, and long-term economic growth convergence. The empirical model below captures the influence of fertility rates on economic support ratio:

$$log\ esr_{it} = \alpha + \beta log f_{it} + \varepsilon_{it} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots (15)$$

Meanwhile, the convergence scenario follows the quantity-quality tradeoff model from Galor (2011), with the empirical model as follows:

$$log\ f_{it} = \alpha + \eta log\ y_{it-1}/y_{max.t-1} + \xi log\ h_{it-1} + \varepsilon_{it} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots (16)$$

where f represents the fertility rate, $y_{it-1}/y_{max.t-1}$ denotes the ratio of per capita income to the national average in the previous period, and h_{it-1} represents human capital per worker in the previous period. The research hypothesis in this empirical model is that $\eta < 0$ (negative) and significant, indicating a balance between fertility rates and economic support ratio to promote long-term regional economic growth convergence.

This study gathers and processes a substantial amount of data, considering the specific requirements of the empirical models for demographic dividend, convergence, and quantity-quality tradeoff. The variables and data sources employed in this study are presented in Table 1.

Table 1. Variables and Data

Variables	Description	Data Sources	Notes/Data Processing
y_{it}	Real per capita income (million Indonesian Rupiah (IDR))	BPS-Statistics Indonesia	It represents the Gross Regional Domestic Product (GRDP) at constant prices (2010=100) divided by the total population. GRDP for the years 2001-2009 was backcasted using the ratio of GRDP at constant prices (2000=100).
k_{it}	Real physical capital stock per worker (million IDR)	Penn World Table, BPS-Statistics Indonesia, Bank Indonesia, and World Bank	National-level physical capital stock data was sourced from the Penn World Table, converted into IDR using the mid-rate exchange rate, and re-referenced to 2010=100. This data was allocated to each province using an initial provincial-level physical capital stock allocator calculated using the Perpetual Inventory Method (PIM).
h_{it}	Human capital per worker (index)	BPS-Statistics Indonesia, Hendajany et al. (2016), and Global Data Lab (GDL)	Employing a Mincerian approach, the model is specified as $h = \exp(\theta s)$ where θ represents the return to education from Hendajany et al. (2016) and s denotes the average years of schooling based on data from BPS-Statistics Indonesia and GDL.
esr_{it}	Economic support ratio	BPS-Statistics Indonesia	The data required to calculate this variable, namely the number of employed persons, the labor force, and the population, were obtained from BPS.
A_{it}	Total factor productivity (TFP)	-	This variable is calculated as a residual, which is defined by the equation $A_t = y_t/k_t^{\alpha}h_t^{1-\alpha}esr_t$. Where α is a constant set to 0.3, following assumptions in many macroeconomic literatures.
i_{it}	Real physical capital investment per capita (million IDR)	BPS-Statistcs Indonesia	Using a real Gross Fixed Capital Formation (GFCF) approach (2010=100) divided by the total population. GFCF for the years 2001-2009 was backcasted using the ratio of constant price GFCF (2000=100).
f_{it}	Fertility rate	Global Data Lab (GDL)	It represents the Total Fertility Rate (TFR). Data availability is limited to 29 observations (provinces and combined provinces) spanning the years 2001-2020.

Source: Data Processed, 2024

Specifically, province-level data on physical capital stock is unavailable. Therefore, this study constructs a physical capital stock variable through the following procedure. Real Indonesian physical capital stock data (2017=100, US dollars) from the Penn World Table is converted to IDR using the Bank Indonesia mid-rate. Subsequently, the base year is referenced to match the GDP base year (2010=100) using the price index of physical capital stock at current prices. At the provincial level, a physical capital stock allocator is constructed using the capital-to-output ratio at the base year of 2010 and subsequent years using the Perpetual Inventory Method (PIM), expressed as $K_{it} = (1 - \delta_{it})K_{it-1} + I_{it})$, where δ_{it} represents the depreciation rate or consumption of fixed capital of Indonesia, data for which is obtained from the Integrated Institutional Accounts published by the BPS and supplemented with the data from the World Bank, and I_{it} represents real Gross Fixed Capital Formation (2010=100). After obtaining the allocator, the Indonesian physical capital stock data is then proportionally distributed to each province.

Apart from physical capital, data on human capital stock is also unavailable at the provincial level. This study constructs this measure using the Mincerian approach ($h = \exp(\theta s)$) and requires data on average years of schooling (s) and the rate of return to education (θ). Data on average years of schooling is fully available at the provincial level as it is one of the indicators for constructing the Human Development Index (HDI). However, the average years of schooling data from BPS is missing for the years 2001 and 2003, thus it is interpolated using data from the Global Data Lab.

However, data on the rate of return to education is unavailable, both at the provincial and national levels. Therefore, this study adopts the findings of Hendrajany et al. (2016), who measured the rate of return to education using data from the Indonesian Family Life Survey (IFLS) waves 1-5 for the sampled provinces (13 provinces). This study uses the average of waves 1-5, and for non-sample provinces, it employs the nearest province approach and the average of all sample provinces to represent the national figure[1]. North Sumatra data is used as a reference for Aceh; West Sumatra for Riau, Jambi, and Riau Islands; South Sumatra for Bengkulu and Bangka Belitung Islands; West Java for Banten; South Kalimantan for all provinces in Kalimantan, and South Sulawesi for all provinces in Sulawesi, Maluku, and Papua.

All data was collected for each unit of observation, namely provinces (i), with an annual period (t) post-fiscal decentralization, from 2001 to 2023 (23 years). The number of provinces (N) in this study is 34 provinces (before the division of Papua and West Papua), resulting in a total of 782 observations (NT). However, not all data was complete, especially in the early years, generally due to two reasons. First, the province had not yet been established or divided. Of the 34 provinces, three were newly formed after 2001: Riau Islands (2002), North Kalimantan (2012), and West Sulawesi (2004). Second, data was either unavailable or combined with another province. For cases of combined data, such as the number of employed people in Papua and West Papua, an extrapolation was conducted using the proportion in the year when the data was available. The completeness of observations for each variable per province can be seen in Appendix 2.

Consequently, this study divides the data into three sets. First, a complete dataset (34 provinces, 23 years) is used to test the empirical models of the demographic dividend and convergence model with a frontier approach. Second, dataset “A” (31 provinces and combined provinces, 23 years) is employed to test the conventional convergence model, which requires a balanced panel dataset. Three provinces are combined in this dataset: Riau and Riau Islands, East and North Kalimantan, and South and West Sulawesi. Third, dataset “B” (29 provinces and combined provinces, 20 years from 2001 to 2020)

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[1] This study utilizes the empirical results in Table 5 of Hendajany et al. (2016) by averaging the rates of return across all IFLS waves for each sampled province. The consideration for using the average is that the IFLS period does not occur every year, resulting in fluctuations in outcomes, and it accounts for the variation in human capital of a province over time by using the average years of schooling. The average rates of return to education are as follows: North Sumatra (11.26%), West Sumatra (11.20%), South Sumatra (15.98%), Lampung (10.64%), DKI Jakarta (11.18%), West Java (14.20%), Central Java (12.76%), Yogyakarta (12.06%), East Java (12.90%), Bali (12.94%), West Nusa Tenggara (12.32%), South Kalimantan (9.66%), and South Sulawesi (13.46%).

is used to test the empirical model of the quantity-quality tradeoff. Two additional provinces are combined: Maluku and North Maluku, and Papua and West Papua. The estimation methods considered for parameter estimation in the above empirical model include Ordinary Least Squares (OLS), panel fixed effects (FE) , panel random effects (RE), and dynamic panel data regression with the Generalized Method of Moments (GMM) which can address endogeneity issues.

RESULTS AND DISCUSSION

Based on the data, Indonesia's real per capita income in 2023 was recorded at 44.12 million IDR. Regionally, DKI Jakarta recorded the highest figure at 190.77 million IDR, while East Nusa Tenggara had the lowest at 13.57 million IDR. (*) The economic support ratio in 2023 was recorded at 50.16%, with Bali having the highest at 58.59% and Banten the lowest at 44.34%.

Figure 2. Real per Capita Income, Economic Support Ratio, and Human Capital
Source: Data Processed, 2024

Figure 2 illustrates the temporal changes in the three variables and the potential relationships among them. In most provinces, there is an upward trend in real per capita income, economic support ratio, and human capital stock. However, real per capita income in Aceh, Riau, East Kalimantan, and Papua tends to stagnate. Overall, Figure 2 suggests a positive correlation between the demographic dividend, as measured by economic support ratio and human capital stock, and real per capita income in Indonesia.

Table 2. Identification of the First and Second Demographic Dividends

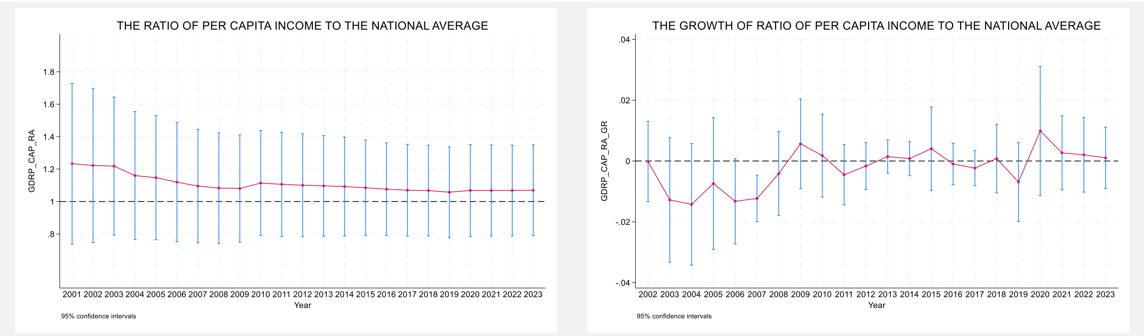
Dependent variable: real per capita income	First dividend			Second dividend			First and second dividends		
	OLS	FE	RE	OLS	FE	RE	OLS	FE	RE
Economic support ratio	0.769*** (4.25)	2.000*** (19.78)	1.987*** (19.68)				0.727*** (3.8)	0.373*** (4.76)	0.392*** (4.99)
Human capital per worker				0.634*** (5.41)	2.608*** (46.3)	2.589*** (45.69)	0.622*** (5.31)	2.421*** (34.29)	2.394*** (33.91)
Constant	1.709*** (27.28)	2.138*** (60.46)	2.143*** (37.63)	1.175*** (23.39)	0.340*** (14.24)	0.358*** (7.01)	1.432*** (16.84)	0.547*** (10.66)	0.576*** (8.39)
Observation	759	759	759	765	765	765	759	759	759
R-square	0.018	0.351	0.351	0.033	0.746	0.746	0.050	0.753	0.753
Breusch-Pagan LM	(p-value=0.0000)***			(p-value=0.0000)***			(p-value=0.0000)***		
Hausman	(p-value=0.0173)**			(p-value=0.0001)***			(p-value=0.0000)***		

Note: All variables are in logarithmic form. Numbers in parentheses are t-statistics. Asterisks (*, **, *) denote significance levels at the 10%, 5%, and 1% levels, respectively.
Source: Data Processed, 2024

The transition of the demographic dividend, as seen from the influence of economic support ratio and human capital on per capita income, is presented in Table 2. The best model, based on the comparison of the Breusch-Pagan LM and Hausman tests, is the fixed effects (FE) model. The results indicate that the first demographic dividend is identified by the significance and positive sign of economic support ratio, suggesting that Indonesia is in the window of opportunity for the first demographic dividend. Furthermore, the identification of the second demographic dividend also shows that human capital per worker has a positive and significant effect, indicating that Indonesia is also in the second demographic dividend phase. Thus, throughout the study period, Indonesia has been in both the first and second phases of the demographic dividend.

The combined demographic dividend column in Table 2 presents the magnitude of the demographic dividend obtained throughout the study period (2001-2023). The first demographic dividend is recorded at 0.37%, indicating that growth in the economic support ratio has increased the average per capita income by 0.37%. Meanwhile, the second demographic dividend obtained is much larger at 2.42%, meaning that human capital accumulation has increased average per capita income by 2.42%. This result is recorded to be higher than the study by Ogawa et al. (2021), which estimated Indonesia's second demographic dividend during the 2010-2020 period at 1.97%. In total, the combined demographic dividend obtained by Indonesia in the period 2001-2023 is 2.79% per year. Berde and Kurbanova (2023) explain in their findings that the increase in the working-age population is a potential source for accelerating economic growth, and human capital also has a positive impact on economic growth, which is closely linked to the demographic dividend. This demographic dividend is expected to drive convergence and contribute to reducing regional income disparities in Indonesia.

The initial step in identifying regional economic growth convergence is to examine the confidence intervals of the ratio of provincial per capita income to the national average (frontier) as depicted in Figure 3. The average ratio of per capita income to the national average has moved closer to 1 over the period 2001-2023 with a decreasing deviation or narrowing confidence interval. This indicates the presence of regional economic growth convergence in Indonesia after decentralization. The average growth rate of the ratio of real per capita income to the national average, which hovers around 0 percent, also supports this argument. Additionally, a significant deviation in growth is observed in 2020 due to the COVID-19 pandemic. The impact of the pandemic is varied, with some provinces recording negative growth and others still managing to grow positively.



Note: The red line represents the mean; the blue lines indicate the upper and lower bounds of the 95% confidence interval.

Figure 3. Ratio of Real per Capita Income to the National Average, 2001-2023
Source: Data Processed, 2024

Statistical tests indicate the occurrence of regional economic growth convergence in Indonesia using the frontier approach, both for absolute and conditional beta convergence (Table 3). All considered methods yield consistent estimates of beta convergence. The results of absolute beta convergence suggest that low-income provinces will be able to catch up to the national average. However, the speed of convergence to reach a ratio of 1, or equal to the national average, is relatively slow, ranging from 1.06% to 2.10% per year, resulting in a relatively long half-time of convergence (33-66 years).

Table 3. Absolute and Conditional Beta Convergence Using the Frontier Approach

Dependent variable: real per capita income growth	**Absolute beta**			**Conditional beta**		
	OLS	**RE**	**GMM**	**OLS**	**RE**	**GMM**
Real per capita income	-0.0208***	-0.0105	-0.0180***	-0.0675***	-0.0550***	-0.0466***
	(-3.54)	(-1.12)	(-8.44)	(-2.98)	(-3.13)	(-13.66)
Real per capita income growth (lagged)			0.131***			0.109***
			(57.52)			(15.54)
Economic support ratio				0.067	0.062	0.0752***
				(1.46)	(1.43)	(6.31)
Human capital per worker				0.0400**	0.0251	0.0381***
				(2.34)	(0.76)	(2.75)
Real physical capital investment per capita				0.0473**	0.0439***	0.0353***
				(2.38)	(2.81)	(11.8)
Constant	-0.00320**	-0.0027	-0.0025***	-0.00235	-0.00176	-0.00168***
	(-2.09)	(-1.08)	(-10.62)	(-1.60)	(-0.72)	(-2.98)
Observation	734	734	700	728	728	697
R-square	0.019	0.016		0.055	0.0042	
Breusch-Pagan LM	(p-value=0.0000)***			(p-value=0.0000)***		
Hansen	(p-value=1.0000)			(p-value=1.0000)		
Speed of convergence (%)	2.10	1.06	1.82	6.99	5.66	4.77
Half-time (years)	33	66	38	10	12	15

Note: All variables are ratios relative to the national average (frontier). All independent variables are in logarithmic form. The numbers in parentheses are t-statistics. Asterisks (*, **, *) denote significance levels at the 10%, 5%, and 1% levels, respectively.

Source: Data Processed, 2024

In conditional beta, using the GMM method, the demographic dividend is shown to significantly increase the speed of convergence towards the national average. The first demographic dividend, through economic support ratio, increases the speed of convergence by 7.52%, and the second demographic dividend, through human capital stock per worker, increases the speed of convergence by 3.81%. Meanwhile, other control variables, such as real per capita physical investment per capita, also contribute positively to increasing convergence by 3.53%. With this control, the speed of convergence can be increased to 4.77-6.99% per year, with the half-life of convergence to the national average being around 10-15 years.

Table 4. Absolute and Conditional Beta Convergence Using the Conventional Approach

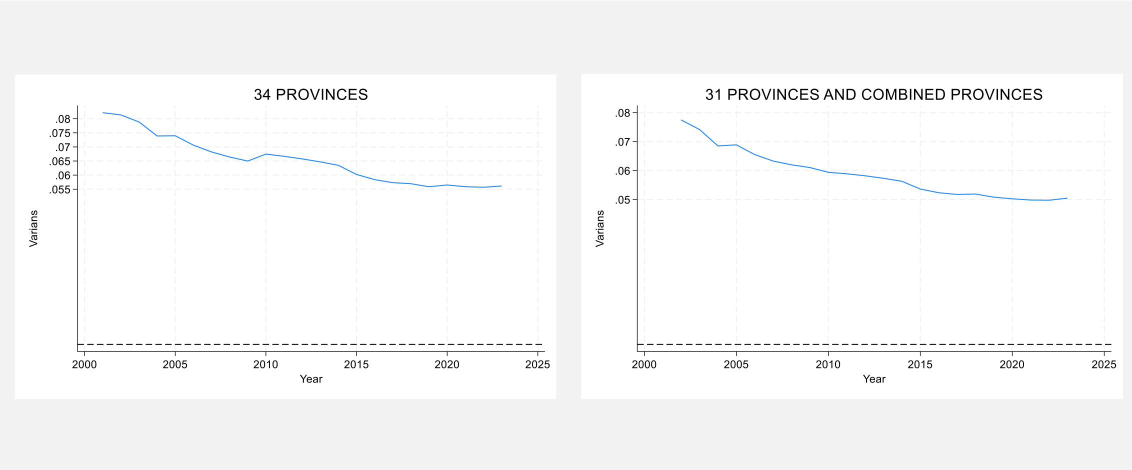
Dependent variable: real per capita income growth	**Absolute beta**			**Conditional beta**		
	OLS	**RE**	**GMM**	**OLS**	**RE**	**GMM**
Real per capita income (initial)	-0.0050***	-0.00593***	-0.0104***	-0.0137***	-0.0153***	-0.0482***
	(-4.55)	(-4.94)	(-3.30)	(-6.25)	(-6.44)	(-5.09)
Real per capita income growth (lagged)			-1.670***			-3.843***
			(-3.90)			(-3.05)
Economic support ratio (initial)				-0.00981*	-0.0130**	0.0950**
				(-1.79)	(-2.11)	(2.16)
Human capital per worker (initial)				-0.00255	-0.00576	0.0313*
				(-0.89)	(-1.42)	(1.8)
Real physical capital investment per capita (initial)				0.00380***	0.00419***	0.0145***
				(4.37)	(4.59)	(3.92)
Constant	0.0114***	0.0127***	0.0276***	0.0139***	0.0155***	0.0818***
	(7.37)	(7.37)	(7.56)	(4.5)	(4.49)	(4.08)
Observation	93	93	62	93	93	62
R-square	0.192	0.343		0.335	0.510	
Breusch-Pagan LM	(p-value=0.0606)*			(p-value=0.0239)**		
Speed of convergence (%)	0.50	0.59	1.05	1.38	1.54	4.94
Half-time (years)	138	117	66	50	45	14

Note: All independent variables are in logarithmic form. Numbers in parentheses are t-statistics. Using 31 provinces with 3 time intervals (2001-2009, 2010-2019, 2020-2023) resulting in a total of 93 observations. The Hansen test is not presented because the short period results in a just-identified model. Asterisks (*, **, *) denote significance levels at the 10%, 5%, and 1% levels, respectively.

Source: Data Processed, 2024

The convergence results using the frontier approach are in line with the conventional convergence results as presented in Table 4. The absolute beta convergence indicates that low-income provinces will be able to catch up with high-income provinces, although the beta coefficients obtained are lower compared to the frontier approach. Therefore, the speed of convergence to catch up with high per capita income provinces is slower, ranging only between 0.50-1.05% per year, and the time to reach half-convergence is longer (66-138 years). This is the slowest convergence speed compared to past studies. Santos-Marquez et al. (2022) found a speed of 1.44% (half-time 48.6 years) for 2010-2017, while Kharisma and Saleh (2013) found 2.37% (half-time 29 years) for 1984-2008.

The conditional beta analysis, employing the GMM method, reveals that the demographic dividend exerts a significant accelerating effect on convergence. The first dividend, manifested through economic support ratio, is statistically significant at the 10% level, indicating that a 1% increase in economic support ratio can boost convergence by 9.50%. Moreover, the second dividend, realized through a 1% growth in human capital accumulation per worker, drives a 3.13% increase in convergence. Additionally, physical capital per capita, as a control variable, is found to foster convergence by 1.45%. These interventions collectively expedite the convergence process, elevating the annual convergence rate to 4.94% and substantially reducing the time required to achieve half-convergence to 14 years.



Note: Real per capita income is in logarithmic form.

Figure 4. Sigma Convergence, 2001-2023
Source: Data Processed, 2024

While beta convergence is a necessary condition for convergence, sigma convergence serves as a complementary sufficient condition. Figure 4 illustrates that the variance of per capita income across provinces, as measured using both the frontier approach (34 provinces) and the conventional approach (31 provinces and combined provinces), has exhibited a declining trend over the study period. These findings are consistent with Santos-Marquez et al. (2022), who reported a quotient of income dispersion of 1.06, indicating that regional disparities have been decreasing over time. Despite this downward trajectory, the level of disparity remains substantial, and the rate of convergence towards a zero variance is relatively slow. This observation aligns with the slower convergence speed indicated by the absolute beta convergence analysis and the prolonged time required to attain full convergence.

The data on per capita income at the beginning and end of the study period (Appendix 2 column 3) provides further insights into the observed convergence patterns. While most provinces experienced a substantial increase in per capita income, approximately doubling between 2001 and 2023, several provinces exhibited divergent trends. Notably, Aceh, Riau, and Papua recorded declines in per capita income, whereas East Kalimantan experienced relatively stagnant growth. In contrast, Central Sulawesi achieved the most significant growth, with a five-fold increase in per capita income. These heterogeneous growth patterns across provinces contribute to the overall slow pace of regional economic convergence in Indonesia.

The heterogeneity in per capita income growth and the relatively slow pace of regional economic convergence in Indonesia can be attributed to the varying contributions of different growth drivers, as revealed by the decomposition of speed of convergence in Appendix 2. On average, total factor productivity emerges as the primary determinant of speed of convergence across most provinces, including DKI Jakarta, East Kalimantan, and South Sulawesi. Meanwhile, there are 7 provinces where convergence is primarily driven by the economic support component (the first demographic dividend), namely West Sumatra, South Sumatra, Bali, South Kalimantan, Gorontalo, and West Sulawesi. Moreover, physical capital accumulation is the dominant factor in driving convergence in Bengkulu, West Java, and West Papua. In contrast, human capital accumulation appears to play a less prominent role in the convergence process.

Table 5. The Impact of Fertility Rate on Economic Support Ratio

Dependent variable: economic support ratio	OLS	FE	RE
Fertility rate	-0.285***	-0.0721***	-0.0913***
	(-12.25)	(-2.62)	(-3.43)
Constant	0.117***	0.0257**	0.0340***
	(11.58)	(2.17)	(2.63)
Observation	580	580	580
R-square	0.206	0.0120	0.0124

Note: All variables are in logarithmic form. The numbers in parentheses are t-statistics. The Breusch-Pagan Lagrange Multiplier (LM) test yields a p-value of 0.0000*** and the Hausman test yields a p-value of 0.0048***. Asterisks (*, **, *) denote significance levels at the 10%, 5%, and 1% levels, respectively

Source: Data Processed, 2024

Furthermore, based on previous findings, maintaining a high level of economic support ratio or optimizing the first demographic dividend is necessary to accelerate regional growth convergence in Indonesia. One way to do this is by maintaining the birth rate at a stable level or at the replacement level. Statistically, the effect of the fertility rate on economic support ratio is presented in Table 5. The test results show that the best model is fixed effects (FE). The results show that the fertility rate has a negative effect on economic support ratio. Spesifically, a 1% decrease in the fertility rate causes economic support ratio to increase by 0.07%. These results also confirm the findings of Rostiana and Rodesbi (2020) and Ridho et al. (2016), who identified a positive impact of declining birth rates and the performance of the working-age population on per capita income and economic growth. Therefore, enhancing economic support ratio can help maintain per capita income stability and foster investment in both physical and human capital.

However, a continuous decline in birth rates could have negative long-term effects on the economy. This is due to the increasing elderly population becoming a burden on the working-age group and reducing the economic support itself. The study by Goeltom and Juhro (2013) found that a growing elderly population lowers economic growth by about 0.5-0.7% per year. Therefore, Lee et al. (2014) conducted an analysis of the steady-state birth rate that can maximize economic support ratio. Furthermore, Ha and Lee (2016) discuss the possibility of a region becoming trapped in a low equilibrium of birth rates and economic support ratio during the convergence process. This model equilibrium does not guarantee long-term convergence. This trap occurs because increases in per capita income are not accompanied by increases in the child-rearing costs, which can reduce the number of children, as explained by the quantity-quality tradeoff theory (Becker and Lewis, 1973).

Ha and Lee (2016) explain that three possible scenarios for convergence may occur. First, a relatively rapid convergence cycle, where low fertility rates drive an increase in economic support ratio, accelerating the convergence rate, increasing the income-to-national-average ratio, and raising child-rearing costs, which then maintains the birth rate at a low level similar to before. Second, a scenario of no convergence or slow convergence, where fertility rates experience fluctuations at very low levels, leading to a decrease in economic support ratio and speed of convergence. This condition causes income ratios to fluctuate up and down, resulting in fluctuating child-rearing costs at high levels, which in turn causes birth rates to fluctuate at similar levels as before. Third, a steady-state condition where a low fertility rate equilibrium has been achieved, leading to stagnation in economic support ratio and a convergence rate approaching zero. This condition causes the income-to-national-average ratio and child-rearing costs to remain stagnant at high levels, and results in a stable birth rate at its equilibrium.

This study attempts to investigate the existence of a low-level equilibrium trap in fertility rates and economic support ratio that may impede convergence, as well as the possible scenarios that may occur. Following Ha and Lee (2016), who empirically tested the quantity-quality tradeoff model from Galor (2011), the empirical results for the regional case in Indonesia can be seen in Table 6. Based on the Breusch-Pagan LM test, Hausman test, and R-squared, the best model is the one involving human capital (model 2) with fixed effects (FE) estimation. The results indicate a negative but not significant relationship between per capita income in the previous period and fertility rates. Meanwhile, human capital in the previous period has a positive and significant effect on birth rates. A 1% increase in human capital in the previous period is associated with a 0.51% growth in the birth rate.

Table 6. Quantity-Quality Tradeoff Analysis

Dependent variable: fertility rate	**Model 1**			**Model 2**		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**
Real per capita income relative to the national average (lagged)	-0.0467***	-0.0168	-0.0259	-0.0433***	-0.0254	-0.029
	(-3.90)	(-0.56)	(-1.03)	(-3.87)	(-0.86)	(-1.15)
Human capital per worker (lagged)				-0.144***	0.513***	0.176
				(-4.36)	-3.22	-1.56
Constant	0.426***	0.428***	0.427***	0.428***	0.420***	0.424***
	(158.09)	(195.03)	(39.01)	(159.68)	(131.02)	(38.04)
Observation	570	570	570	570	570	570
R-square	0.028	0.001	0.0006	0.051	0.019	0.015
Breusch-Pagan LM	(p-value=0.0000)***			(p-value=0.0000)***		
Hausman	(p-value=0.5747)			(p-value=0.0097)***		

Note: All variables are in logarithmic form. The numbers in parentheses are t-statistics. Asterisks (*, **, *) denote significance levels at the 10%, 5%, and 1% levels, respectively.
Source: Data Processed, 2024

The insignificance of per capita income in reducing child-rearing costs and fertility rates, along with the positive impact of human capital (which ideally should be negative), indicates that the ongoing convergence scenario is the second scenario. This scenario describes the occurrence of slow convergence with the potential for a low-level equilibrium trap in birth rates and support ratio. In the long term, this demographic trap has the potential to hinder the process of regional economic growth convergence in Indonesia.

CONCLUSION

This study reaffirms the occurrence of regional economic growth convergence in post-fiscal decentralization Indonesia. This means that provinces with low per capita income are able to catch up, both with the national average (frontier) and with provinces that have higher per capita income. However, the convergence speed is relatively slow, and the time required to achieve half-convergence is very long. Demographic dividend interventions through economic support ratio and human capital accumulation have been proven to contribute positively to accelerating convergence. Sigma convergence also confirms this, as evidenced by the continuous downward trend in the variance of per capita income throughout the study period.

This study also investigates the reasons behind the relatively slow pace of regional economic growth convergence in Indonesia. Three empirical findings can be considered to explain this phenomenon. First, there is a significant disparity in per capita income across provinces. For instance, in 2023, DKI Jakarta's average per capita income was 14 times that of East Nusa Tenggara. Second, the drivers of per capita income growth vary across provinces. Decomposition analysis of speed of convergence indicates that a significant portion of income growth is driven by total factor productivity, while a smaller portion is dominated by economic support ratio. Meanwhile, human capital has not yet optimally contributed to driving convergence. Third, the convergence scenario, viewed from the quantity-quality tradeoff model, is considered slow. This is because per capita income does not significantly drive a decrease in birth rates, potentially leading to a long-term trap of low birth rates and economic support ratio.

Ultimately, this study contributes to the empirical literature and policy implications. First, it elaborates on an empirical strategy for calculating physical capital and human capital stocks at the regional level. The limited availability of data on returns to education for all provinces and every year is an area that needs further development in future research. Second, the study provides a perspective on convergence from two approaches, namely the frontier approach (relative to the national average) and the conventional approach, comparing their consistency, and the resulting speed of convergence. The frontier approach, aside from the national average, such as using a reference to specific provinces, can be considered as an alternative for future research. Third, this study attempts to decompose the speed of convergence and finds that human capital has not yet become the main driving force behind convergence. Therefore, increasing investment in human capital, primarily through education, is crucial to focus policy on accelerating convergence in Indonesia. Fourth, the empirical results indicate the potential for a low-level equilibrium trap in fertility rates and economic capacity in the long term. Therefore, maintaining high economic support ratio by controlling birth rates at a stable or replacement level (TFR = 2.1) should be positioned as the epicenter of population policy in Indonesia.

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APPENDIX

Appendix 1. Summary Statistics

Variabel	Obs	Mean	Std. dev.	Min.	Max.
(1)	(2)	(3)	(4)	(5)	(6)
Real per capita income (million IDR)	791	34.83	29.10	7.38	190.77
Real physical capital stock per worker (million IDR)	782	1,010.90	892.09	195.16	5,928.22
Human capital per worker (index)	790	2.68	0.48	1.71	4.23
Economic support ratio	782	0.4512	0.0479	0.3042	0.6002
Total Factor Productivity	782	4.65	2.46	1.91	15.15
Real physical capital investment per capita (million IDR)	791	10.80	10.59	1.29	70.96
Fertility rate	600	2.72	0.43	1.83	4.22

Source: Data Processed, 2024

Appendix 2. Decomposition of Speed of Convergence

Province	Year	Real per capita income		Physical capital stock per worker			Human capital stock per worker			Economic support ratio			Total Factor Productivity		
		level	g(.)	level	g(.)	c(%)	level	g(.)	c(%)	level	g(.)	c(%)	level	g(.)	c(%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Aceh	2002	32.66	19.05	599	15.05	24	2.28	0.53	7	0.37	-12.68	-58	7.37	26.83	127
	2023	26.80	-1.02	947	0.75	-18	2.93	0.25	31	0.45	-1.39	29	3.62	-0.03	59
	Mean	25.67	-3.07	779	-0.01	0	2.60	0.00	0	0.40	-0.24	8	4.55	-2.83	92
	Obs.	23		23			23			23			23		
North Sumatera	2002	17.59	0.41	590	-1.66	10	2.48	-0.05	33	0.41	1.62	31	3.34	-0.67	26
	2023	39.38	-0.07	1,030	-1.44	-30	3.02	0.25	23	0.49	1.42	96	4.59	-1.24	11
	Mean	27.98	0.48	823	-0.30	-19	2.69	-0.28	-41	0.44	0.33	69	4.17	0.43	90
	Obs.	23		23			23			23			23		
West Sumatera	2002	15.36	0.29	530	0.65	33	2.36	0.48	45	0.39	-0.45	-32	3.27	0.21	54
	2023	33.52	-0.30	862	-2.43	-40	2.83	0.13	22	0.50	2.43	131	4.27	-2.09	-12
	Mean	23.97	0.26	720	-0.56	-65	2.53	-0.32	-87	0.43	0.45	171	4.00	0.21	80
	Obs.	23		23			23			23			23		
Riau	2002	91.70	-3.67	1,577	-2.83	2	2.44	2.12	-311	0.48	1.62	-121	11.13	-5.92	530
	2023	81.93	-0.83	2,881	8.55	61	2.84	0.13	27	0.45	-8.99	-242	8.11	5.50	253
	Mean	73.45	-3.46	2,310	-0.05	0	2.58	-0.39	8	0.42	-0.75	22	8.84	-2.42	70
	Obs.	23		23			23			23			23		
Jambi	2002	22.09	0.50	736	-6.86	-38	2.17	0.48	44	0.43	5.80	158	4.11	-3.58	-64
	2023	46.04	-0.43	1,096	2.64	1	2.68	0.47	30	0.49	-3.15	-29	5.77	1.60	98
	Mean	32.63	0.14	920	-1.26	-266	2.37	-0.19	-92	0.45	0.26	185	5.07	0.39	273
	Obs.	23		23			23			23			23		
South Sumatera	2002	20.55	-1.72	511	-0.76	53	2.90	0.98	156	0.49	0.64	4	3.08	-2.81	-113
	2023	41.19	-0.06	1,102	0.73	-14	3.89	1.10	39	0.50	-0.87	35	3.88	-0.17	40
	Mean	29.16	-0.17	817	0.66	-113	3.35	0.24	-95	0.47	-0.46	262	3.55	-0.08	46
	Obs.	23		23			23			23			23		
Bengkulu	2002	11.98	0.63	316	-7.78	-46	3.18	1.52	66	0.50	8.25	227	1.91	-6.35	-146
	2023	24.94	-0.93	715	1.16	-14	4.23	0.93	47	0.51	-0.45	61	2.47	-1.48	6
	Mean	18.12	0.11	505	0.57	158	3.65	0.21	137	0.48	-0.10	-90	2.31	-0.11	-105
	Obs.	23		23			23			23			23		
Lampung	2002	14.44	1.27	425	0.16	21	1.99	0.11	28	0.44	0.13	-11	3.31	1.01	61
	2023	29.05	-0.25	771	-3.32	-46	2.42	0.18	22	0.51	3.67	163	4.21	-3.06	-39
	Mean	21.70	0.00	615	-0.06	-2,829	2.18	-0.28	-29,537	0.46	0.06	9,260	3.95	0.15	23,206
	Obs.	23		23			23			23			23		
Bangka Belitung Islands	2002	24.80	6.09	800	-0.28	8	2.72	2.63	33	0.42	-2.11	-29	3.96	6.44	88
	2023	39.80	-0.94	1,006	-0.11	-27	3.74	1.26	54	0.49	-1.08	39	4.02	-0.71	33
	Mean	31.35	-0.75	890	-1.71	69	3.18	0.41	-38	0.45	0.08	-11	4.03	-0.60	80
	Obs.	23		23			23			23			23		
Riau Island	2002	--		--			2.21	-0.41		--			--		
	2023	89.19	0.98	2,841	18.09	100	3.21	-0.54	7	0.45	-16.17	-314	7.99	12.10	307
	Mean	73.52	-0.70	2,306	-0.77	33	2.83	0.55	-55	0.36	0.02	-3	7.95	-0.87	124
	Obs.	21		19			23			19			19		
DKI Jakarta	2002	79.01	0.67	2,622	6.36	75	3.01	0.78	45	0.38	-5.17	-153	9.07	3.38	133
	2023	190.77	0.40	5,679	-0.18	-18	3.60	0.58	26	0.47	1.14	79	12.34	-1.09	14
	Mean	127.82	0.85	3,854	1.06	38	3.25	-0.33	-27	0.44	0.18	21	10.49	0.58	68
	Obs.	23		23			23			23			23		
West Java	2002	15.89	-1.74	556	1.15	101	2.57	0.21	105	0.39	-1.91	-206	3.17	-0.33	100
	2023	33.37	-0.10	852	2.55	0	3.50	-0.28	13	0.47	-3.19	-28	3.90	2.51	114
	Mean	23.50	0.00	719	-0.81	7,670	2.94	0.25	-5,599	0.41	0.15	-4,677	3.66	-0.09	2,706
	Obs.	23		23			23			23			23		
Central Java	2002	13.02	0.18	360	0.04	28	2.16	0.48	47	0.48	0.72	4	2.70	-0.89	21
	2023	29.55	0.53	721	-5.08	-49	2.78	0.03	16	0.54	5.51	175	3.75	-3.49	-41
	Mean	21.02	0.44	559	0.35	24	2.40	0.01	1	0.49	-0.11	-24	3.41	0.44	99
	Obs.	23		23			23			23			23		
DI Yogyakarta	2002	14.15	0.41	340	-0.05	25	2.50	-0.81	16	0.52	0.34	-7	2.51	0.65	66
	2023	31.13	0.40	684	8.02	39	3.27	-0.02	16	0.56	-7.82	-139	3.41	5.83	184
	Mean	21.06	0.38	491	0.40	32	2.85	0.02	4	0.54	-0.19	-50	2.86	0.43	114
	Obs.	23		23			23			23			23		
East Java	2002	17.89	0.02	506	0.18	31	2.18	0.89	59	0.48	0.47	-4	3.33	-1.12	14
	2023	44.54	0.39	998	-1.85	-30	2.85	0.04	17	0.55	2.09	101	4.92	-1.17	11
	Mean	30.05	0.85	758	0.29	10	2.45	0.09	7	0.50	-0.02	-3	4.26	0.73	85
	Obs.	23		23			23			23			23		
Banten	2002	17.69	-1.62	711	-3.10	-8	2.91	-0.50	62	0.38	2.02	115	3.11	-2.36	-69
	2023	40.79	0.44	1,179	11.56	64	3.67	-0.70	5	0.44	-10.55	-208	4.44	8.01	239
	Mean	27.77	0.65	904	-0.55	-25	3.19	-0.14	-15	0.40	0.33	52	3.90	0.57	89
	Obs.	23		23			23			23			23		
Bali	2002	18.16	-2.04	475	1.66	148	2.53	1.68	250	0.54	-2.91	-377	2.77	-0.81	78
	2023	35.69	0.65	859	2.60	0	3.40	-0.21	12	0.59	-2.94	-17	3.41	2.95	105
	Mean	27.02	-0.28	643	-0.03	3	2.82	0.26	-66	0.56	-0.38	137	3.34	-0.07	26
	Obs.	23		23			23			23			23		
West Nusa Tenggara	2002	11.51	-0.29	332	-5.98	-40	1.83	0.76	67	0.45	6.29	229	2.91	-5.32	-156
	2023	18.70	-3.35	552	-3.17	-320	2.59	0.62	217	0.52	2.55	929	2.77	-5.37	-726
	Mean	15.39	-0.87	476	-0.69	24	2.18	0.47	-38	0.46	0.35	-40	3.06	-1.34	154
	Obs.	23		23			23			23			23		

Decomposition of Speed of Convergence (cont.)

Province	Year	Real per capita income		Physical capital stock per worker			Human capital stock per worker			Economic support ratio			Total Factor Productivity		
		level	g(.)	level	g(.)	c(%)	level	g(.)	level	g(.)	level	g(.)	c(%)	g(.)	c(%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
East Nusa Tenggara	2002	7.58	-0.18	203	1.20	44	1.99	-0.44	29	0.46	-1.73	-83	2.05	1.50	110
	2023	13.57	-1.65	403	4.98	34	2.62	0.49	49	0.52	-4.17	-96	2.19	0.68	113
	Mean	10.27	-0.60	299	0.39	-19	2.28	0.07	-8	0.47	-0.14	23	2.24	-0.63	104
	Obs.	23		23			23			23			23		
West Kalimantan	2002	14.37	1.81	385	-10.33	-52	1.75	0.59	34	0.46	12.48	265	3.54	-7.99	-147
	2023	27.62	-0.49	735	-4.80	-62	2.11	0.17	24	0.49	4.82	207	4.58	-3.98	-68
	Mean	20.93	-0.20	586	-0.31	47	1.90	-0.30	103	0.46	0.29	-145	4.21	-0.19	95
	Obs.	23		23			23			23			23		
Central Kalimantan	2002	18.69	0.85	546	-6.54	-32	2.01	-0.03	30	0.44	7.18	182	3.94	-4.35	-80
	2023	40.87	-1.09	1,127	3.63	12	2.32	-0.22	20	0.49	-3.16	-37	5.66	1.13	105
	Mean	28.47	0.36	792	0.23	19	2.15	-0.50	-96	0.47	0.18	50	4.76	0.46	127
	Obs.	23		23			23			23			23		
South Kalimantan	2002	18.09	-1.14	543	-3.36	-11	1.90	-0.85	30	0.47	2.15	91	3.75	-1.70	-11
	2023	35.19	-0.35	878	3.27	6	2.28	-0.12	18	0.49	-4.12	-57	5.27	2.87	133
	Mean	25.57	-0.31	686	-0.77	74	2.07	-0.36	82	0.48	-0.29	95	4.47	0.47	-151
	Obs.	23		23			23			23			23		
East Kalimantan	2002	134.54	-4.80	3,323	3.30	-103	2.21	0.71	-89	0.45	-5.70	345	15.08	-0.59	-52
	2023	137.47	0.93	4,452	-2.83	-32	2.62	-0.31	10	0.47	2.09	90	11.91	-0.09	33
	Mean	129.59	-3.12	3,857	-1.14	11	2.37	-0.35	8	0.46	-0.51	16	13.16	-2.02	65
	Obs.	23		23			23			23			23		
North Kalimantan	2002	--			--		--			--			--		
	2023	94.09	-0.93	2,262	-1.50	-40	2.47	-0.31	16	0.50	0.89	106	9.83	-1.15	17
	Mean	79.53	-0.08	2,328	-1.43	504	1.12	-0.23	190	0.18	1.12	-1,317	9.92	-0.61	722
	Obs.	14		9			11			9			9		
North Sulawes	2002	17.00	-1.47	546	4.26	140	3.09	2.83	202	0.41	-4.52	-328	2.85	-0.20	86
	2023	38.09	0.91	1,056	-3.67	-37	3.72	0.22	18	0.47	4.68	144	4.03	-2.82	-24
	Mean	25.94	0.41	796	0.43	32	3.31	-0.18	-32	0.42	-0.19	-46	3.51	0.59	146
	Obs.	23		23			23			23			23		
Central Sulawesi	2002	11.70	1.44	449	-3.61	-6	2.56	-0.24	22	0.41	3.94	77	2.37	-1.24	7
	2023	62.11	6.77	1,056	10.82	23	3.34	-0.05	6	0.50	-5.96	-36	6.65	9.51	107
	Mean	27.29	4.56	663	0.99	7	2.90	0.04	1	0.45	0.49	11	3.81	3.74	82
	Obs.	23		23			23			23			23		
South Sulawesi	2002	15.21	-1.01	487	-2.06	12	2.34	-0.32	48	0.45	1.16	30	2.90	-1.33	10
	2023	40.50	-0.33	1,031	1.43	-9	3.25	0.76	35	0.48	-0.03	63	4.59	-1.26	11
	Mean	25.99	1.31	762	0.60	14	2.71	0.31	17	0.43	-0.20	-15	4.01	1.11	84
	Obs.	23		23			23			23			23		
Southeast Sulawesi	2002	14.33	1.35	517	1.00	27	2.50	4.65	102	0.42	-1.95	-58	2.74	-0.25	30
	2023	39.41	-0.11	998	3.33	6	3.50	-0.18	15	0.49	-2.57	-11	4.19	1.59	89
	Mean	25.46	1.45	724	0.27	6	2.91	0.57	28	0.44	0.01	1	3.66	0.95	66
	Obs.	23		23			23			23			23		
Gorontalo	2002	10.39	2.83	467	14.70	87	2.25	0.06	19	0.34	-14.40	-242	2.75	12.78	235
	2023	26.28	-0.39	600	0.69	-16	2.98	0.09	22	0.52	-0.41	52	3.43	-0.25	41
	Mean	17.33	1.16	505	-0.92	-24	2.55	0.10	6	0.43	0.76	66	3.14	0.60	52
	Obs.	23		23			23			23			23		
West Sulawesi	2002	--		--			--			--			--		
	2023	23.93	-0.14	555	1.85	-5	2.99	-0.31	13	0.50	-2.16	1	3.33	1.69	92
	Mean	18.00	1.05	492	-1.35	-39	2.22	0.64	42	0.36	0.63	60	3.22	0.38	36
	Obs.	20		18			20			18			18		
Maluku	2002	9.74	-2.52	374	1.61	307	2.89	0.19	283	0.35	-3.22	-860	2.23	0.09	370
	2023	18.58	0.28	517	-2.00	-32	3.95	-0.85	2	0.45	2.15	106	2.43	-0.68	24
	Mean	13.46	-0.30	455	-1.16	117	3.35	0.26	-61	0.38	0.43	-146	2.41	-0.57	190
	Obs.	23		23			23			23			23		
North Maluku	2002	12.42	-2.05	507	15.99	459	2.82	2.98	257	0.35	-16.43	-1,341	2.66	7.49	725
	2023	36.20	13.86	695	-0.10	-4	3.48	-0.72	1	0.47	4.53	38	4.48	9.86	65
	Mean	17.59	1.89	514	-0.43	-7	3.05	-0.07	-3	0.42	0.18	9	2.89	1.90	100
	Obs.	23		23			23			23			23		
West Papua	2002	37.83	-3.10	1,537	-6.74	408	2.17	0.13	-404	0.49	2.59	-664	4.97	-3.76	760
	2023	53.69	-1.19	1,484	-11.70	-146	2.91	0.22	30	0.46	10.02	436	6.14	-7.85	-220
	Mean	50.67	-1.48	1,655	-3.14	64	2.49	0.18	-9	0.44	-0.64	43	6.50	-0.02	1
	Obs.	23		23			23			23			23		
Papua	2002	41.18	1.08	1,229	-7.86	-41	1.97	-0.08	28	0.33	7.65	183	9.31	-4.15	-70
	2023	40.60	3.60	1,000	-18.66	-79	2.62	0.76	16	0.55	22.10	315	4.77	-13.44	-152
	Mean	38.85	-1.90	1,184	-3.77	60	2.21	0.13	-5	0.44	2.58	-136	6.37	-3.44	181
	Obs.	23		23			23			23			23		
INDONESIA	2002	21.15		627			2.28			0.43			3.96		
	2023	44.12		1,168			2.95			0.50			4.95		
	Mean	31.65		908			2.57			0.45			4.60		
	Obs.	23		23			23			23			23		

Note: The 'level' column indicates the value of each variable: per capita income (in million IDR), physical capital stock per worker (in million IDR), human capital per worker (index), economic support ratio, and total factor productivity (index). The 'g(.)' column shows the growth rate of the ratio to the national average (frontier) in %. The 'c(%)' column shows the contribution of each variable's growth in %, with the total contribution being 100%. There are 3 provinces with unbalanced panel data in terms of the number of observations (Obs. row), namely Riau Islands, North Kalimantan, and West Sulawesi. These three provinces were newly formed after decentralization or after the 2001 period: Riau Islands (2002), North Kalimantan (2012), and West Sulawesi (2004).