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PUBLIC INVESTMENT IN HUMAN CAPITAL: THE PATH TO SUSTAINABLE AND INCLUSIVE ECONOMIC GROWTH

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ABSTRACT

Research Originality – This study contributes to the literature by examining the dynamic mechanisms through which public investment in human capital shapes economic growth outcomes. Unlike previous studies, it evaluates economic growth through the dimensions of sustainability and inclusiveness. It also identifies regional heterogeneity in the human capital-growth nexus by comparing provinces in Java and non-Java regions.

Research Objectives – This study examines the effects of mean years of schooling and life expectancy at birth on sustainable and inclusive economic growth across 33 Indonesian provinces from 2005 to 2023. It also assesses the impact of government spending on education and health on these human capital indicators.

Research Methods – The analysis is based on an endogenous growth model that emphasizes the role of human capital in promoting sustainable and inclusive economic growth. To address the endogeneity issue, this study employs dynamic panel data regression using the Generalized Method of Moments (GMM) technique.

Empirical Results – The empirical results show that mean years of schooling and life expectancy at birth have a positive and significant effect on sustainable and inclusive economic growth. Life expectancy at birth has a stronger impact than mean years of schooling. Furthermore, public investment in education and health has a substantial effect on increasing mean years of schooling and life expectancy at birth. This indicates that public investment in education and health contributes positively to sustainable and inclusive economic growth through improvements in the quality of human capital. The Java vs. non-Java subsample analysis further reveals that the growth effects of human capital are not spatially uniform across Indonesian provinces.

Implications – These findings underscore the importance of equitable and sustained public investment in education and health, particularly in non-Java regions, to maximize the growth-enhancing and inequality-reducing potential of human capital development.

Keywords: Dynamic Panel; Growth; Human Capital; Inclusive Growth; Public Investment; Sustainable.

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INTRODUCTION

For a long time, the Indonesian government has prioritized economic growth as a key strategy for maintaining economic stability. Indonesia is currently experiencing a demographic dividend, which is projected to peak between 2020 and 2030. During this period, the working-age population is expected to be twice as large as the combined population of children and the elderly (BPS, 2022). The substantial positive correlation (0.54) between the share of the working-age population and GDP per capita across provinces in 2020 highlights the importance of this demographic structure for economic performance (BPS,

2022). Therefore, effectively leveraging this demographic dividend is crucial for accelerating economic growth.

To fully capitalize on this demographic potential, demographic trends must be translated into concrete policy actions, particularly in education and health. These sectors serve as key drivers of productivity and social equity and are closely linked to sustainable and inclusive economic growth. In this study, sustainable economic growth refers to long-term economic progress that meets present needs without compromising the ability of future generations to meet their own needs (Brundtland, 2017).

It emphasizes maintaining economic stability, environmental balance, and social well-being through the efficient use of human and natural capital. Meanwhile, inclusive economic growth refers to a development process that ensures equitable access to economic opportunities and reduces income inequality across regions and social groups (Anand et al., 2013; Ali & Son, 2007; World Bank, 2014). These two dimensions are inherently interconnected: sustainable growth supports long-term economic resilience, while inclusive growth ensures that the benefits of development are broadly shared across society.

Both dimensions of growth are strongly shaped by investment in human capital. Improvements in education and health enhance productivity, expand economic opportunities, and support long-term development. In this context, strengthening human capital through effective education and health policies is essential for maximizing the demographic dividend. Government spending that improves access to and the quality of education and health, as reflected in mean years of schooling and life expectancy at birth, constitutes a key mechanism for transforming demographic potential into sustainable and inclusive economic growth. This reflects a clear transmission channel in which public investment in education and health enhances human capital, which in turn drives growth outcomes.

Endogenous growth theory supports this mechanism by emphasizing the central role of human capital in generating long-term economic growth (Pelinescu, 2015). Enhancing the quality of education and health is therefore fundamental to human capital development. A growing body of literature (Mankiw et al., 1992; Sultana et al., 2022; Li & Liang, 2010; Égert et al., 2020; Bloom et al., 2024) consistently demonstrates that education and health, as core components of human capital, are strongly associated with productivity and long-term growth.

Education is widely recognized as a key component of human capital in fostering economic growth (Teixeira & Queirós, 2016; Sultana et al., 2022; Li & Liang, 2010; Zhang & Wang, 2021; Glewwe et al., 2014). However, data from BPS-Statistics Indonesia reveal a declining trend in the Gross Enrollment Ratio (GER) as the level of education increases. In 2023, Indonesia's GER reached 105.62% at the primary level, 92.51% at junior secondary, 86.34% at senior secondary, and only 31.45% at higher education. While participation in basic education is relatively high, access to tertiary education remains limited. This gap may constrain Indonesia's ability to fully capitalize on its demographic dividend. Expanding access to higher education is therefore crucial for strengthening human capital and supporting long-term economic growth (Becker, 1993; Égert et al., 2020). Accordingly, public investment in education should remain a priority for the Indonesian government.

In addition to education, health plays a crucial role in improving labor productivity. Holland (2017) emphasized the importance of health in this regard, although the existing literature has not extensively explored its impact on economic growth. Osathanunkul et al. (2023) argue that healthier individuals can enhance productivity through increased public health investment. Furthermore, studies by Ogundari & Awokuse (2018) and Odhiambo (2021) find that life expectancy at birth, as an indicator of health-related human capital, has a stronger impact on economic growth than educational indicators such as mean years of schooling and enrollment rates. These studies also identify a unidirectional causal relationship between life expectancy at birth, health expenditure, and economic growth in both the short and long run. In contrast, Mohapatra (2017) finds only a long-term relationship between economic growth and health expenditure. Higher health spending can improve daily functioning, reduce the economic burden of disease, and enhance individual productivity (Sultana et al., 2024). Therefore, health is a key determinant of labor productivity

APPLICATIONS FOR PRACTICE

- Government spending on education and healthcare supports sustainable economic growth while fostering inclusivity by narrowing income disparities among people. Such investments improve human capital, reflected in higher mean years of schooling and increased life expectancy.
- The government should prioritize human capital development as a central focus of its policy agenda to achieve sustainable and inclusive growth. This can be accomplished through (1) Increasing educational participation at higher levels, (2) Improved health access and services, and (3) Effective and efficient expenditure allocation in funding social assistance programs in the education and health sectors.

and cross-country differences in income per worker, ultimately contributing to accelerated economic growth (Bloom et al., 2024).

Despite these contributions, previous studies on human capital and economic growth in Indonesia still exhibit several limitations. Anwar (2017) focused only on 114 districts in Java, using a static panel approach, thereby limiting the national relevance of the findings. Anwar (2018), the study most closely related to this research, expanded the analysis to 33 provinces using dynamic panel GMM but examined growth from a single dimension and did not assess the role of government expenditure on education and health as an intermediate channel through human capital. Kristyanto & Kaluge (2018) analyzed the relationship between human capital investment financing and inclusive growth, but restricted their analysis to East Java. Kesuma & Astuti (2020) employed the World Bank's composite Human Capital Index, making it difficult to isolate the distinct contributions of education and health. Dhiya et al. (2021) examined the direct effect of education and health expenditure on GDP using national time-series OLS without modeling the indirect role of human capital. Nurlaili & Sugiharti (2023) measured human capital solely through educational attainment, excluding health and adopting a single-dimensional view of growth. In addition, limited attention has been given to regional heterogeneity, particularly differences between Java and non-Java regions, despite their distinct development characteristics. Overall, previous studies have not jointly examined sustainable and inclusive economic growth within a unified framework.

To address these gaps, this study offers three main contributions. First, it models the dynamic mechanism linking public investment in human capital to growth outcomes using a two-stage analytical approach, explicitly capturing the transmission from public spending to human capital and, subsequently, to economic growth. Second, it examines economic growth through two complementary dimensions: sustainability and inclusiveness. Third, it analyzes heterogeneous effects by comparing Java and non-Java provinces, thereby extending the understanding of spatial variation in the human capital-growth relationship.

Specifically, this study investigates the dynamic relationship between public investment in human capital, the quality of human capital, and regional economic growth across 33 Indonesian provinces over the period 2005–2023. Public investment is proxied by government expenditure on education and health, while human capital quality is measured by mean years of schooling and life expectancy at birth. Consistent with the empirical framework, economic growth is captured using two indicators: real GDP per capita for sustainable economic growth and inequality-adjusted real GDP per capita for inclusive economic growth.

LITERATURE REVIEW

A substantial body of literature shows that human capital contributes positively to economic growth across different contexts. Improvements in education and health increase productivity, expand economic opportunities, reduce regional disparities, and improve income distribution. Expanding access to and improving the quality of education and health promote broader economic participation and support more equitable regional growth (Sultana et al., 2022; Li & Liang, 2010). Cognitive and non-cognitive skills further foster inclusive development by supporting industrial upgrading, regional convergence, and better alignment between skills and local economic needs (Zhang et al., 2023). Moreover, the interaction between human capital and structural transformation toward knowledge-based industries influences growth outcomes, although persistent skill mismatches in transition economies highlight the importance of region-specific and inclusive skill policies (Teixeira & Queirós, 2016).

In the context of Indonesia, recent studies emphasize the multidimensional importance of human capital, particularly through the education and health sectors. In the health sector, progress toward universal health coverage has been reflected in improved healthcare infrastructure, reduced child mortality, and increased life expectancy. However, persistent regional and socioeconomic disparities, stagnant maternal and neonatal mortality rates, and weak institutional coordination indicate the need for stronger equity-oriented and preventive health policies (Agustina et al., 2019). In the education sector, Yusuf & Sumner (2015) show that integrating the Kartu Jakarta Pintar into the Kartu Indonesia Pintar program can reduce inequality, lowering the Gini coefficient from 0.41 to 0.40. By contrast, Siburian (2023) finds that longer average years of schooling may increase income inequality under fiscal decentralization, although this effect weakens in provinces with greater fiscal capacity. These findings suggest that improvements in education and health do not automatically lead to equitable outcomes, highlighting the importance of policy design and regional context.

These empirical findings are consistent with endogenous growth theory, which provides the main theoretical foundation for understanding the role of human capital in long-term economic growth. This theory recognizes knowledge as a central driver of growth alongside conventional production factors. Romer (2019) argues that knowledge increases output through increasing returns to scale, particularly when it is non-rival and interacts with labor, fixed costs, and research and development inputs. This

perspective addresses a key limitation of neoclassical growth theory, which emphasizes physical capital accumulation while giving less attention to knowledge and human capital accumulation.

Mankiw et al. (1992) further extended this framework by incorporating human capital accumulation—measured by educational attainment—into the augmented Solow model, in which output is represented by a Cobb-Douglas production function that treats human capital as an essential factor of production. As a result, the production function is determined by three components: labor, physical capital, and human capital:

$$Y_t = K_t^\alpha H_t^\beta [A_t L_t]^{1-\alpha-\beta} \quad 0 < \alpha, \beta < 1, \quad (1)$$

where Y_t is output or national income, K_t is physical capital, H_t is human capital, L_t is the quantity of labor, and A_t is the level of technology. If equation (1) is transformed into per effective labor terms with $y_t = Y_t/A_t L_t$ (output per unit of effective labor), $k_t = K_t/A_t L_t$ (physical capital per unit of effective labor), and $h_t = H_t/A_t L_t$ (human capital per unit of effective labor), then the equation becomes:

$$y_t = k_t^\alpha h_t^\beta \quad (2)$$

Assuming that individuals allocate a portion of their income for investment, denoted as s , where s_k represents the share invested in physical capital and s_h represents the share allocated to human capital, the variations in physical capital per unit of effective labor (\dot{k}_t) and human capital per unit of effective labor (\dot{h}_t) in the economy can be expressed as:

$$\dot{k}_t = s_k y_t - (n + g + \delta) k_t \quad (3.a)$$

$$\dot{h}_t = s_h y_t - (n + g + \delta) h_t \quad (3.b)$$

By incorporating equation (2) into equations (3.a) and (3.b) and assuming that both physical capital and human capital follow the same production function and share an identical depreciation rate, the steady-state levels of physical capital per unit of effective labor and human capital per unit of effective labor can be determined as:

$$k^* = \left[\frac{s_k^{1-\beta} s_h^\beta}{n+g+\delta} \right]^{1/(1-\alpha-\beta)} \quad (4.a)$$

$$h^* = \left[\frac{s_k^\alpha s_h^{1-\alpha}}{n+g+\delta} \right]^{1/(1-\alpha-\beta)} \quad (4.b)$$

If equations (4a) and (4b) are substituted into equation (2) and then transformed into logarithmic form, equation (2) based on the research model of Mankiw et al. (1992) becomes:

$$\ln(y_t) = \frac{\alpha}{1-\alpha-\beta} \ln(s_k) + \frac{\beta}{1-\alpha-\beta} \ln(s_h) - \frac{\alpha+\beta}{1-\alpha-\beta} \ln(n+g+\delta) \quad (5.a)$$

$$\ln(y_t) = \frac{\alpha}{1-\alpha-\beta} \ln(s_k) + \frac{\beta}{1-\alpha-\beta} \ln(h^*) - \frac{\alpha+\beta}{1-\alpha-\beta} \ln(n+g+\delta) \quad (5.b)$$

These equations indicate that per capita income is determined by investment in human and physical capital, as well as population growth. Investment in both human and physical capital is positively associated with per capita income, whereas population growth is negatively associated with it. In the steady state, an increase in human capital investment (h^*) raises per capita income and promotes long-term economic growth.

Importantly, this theoretical framework also implies a policy-relevant mechanism: public investment in education and health enhances human capital, which in turn drives sustainable and inclusive economic growth. This mechanism underpins the empirical strategy of this study.

Based on this framework, this study focuses on sustainable and inclusive economic growth as two complementary dimensions of development. Sustainable economic growth refers to long-term economic progress that meets present needs without compromising the ability of future generations to meet their own needs (Brundtland, 2017). A commonly used indicator in the literature is per capita GDP growth. However, to better capture long-term welfare and consistency with the empirical model, this study employs real GDP per capita as a proxy for sustainable economic growth. This measure reflects an economy's capacity to generate value-added goods and services and is associated with broader welfare outcomes, including improved health, education, and environmental sustainability (Joshua et al., 2021; Hamid et al., 2022; Sial et al., 2021).

Sustainable economic growth must be accompanied by inclusive economic growth, which emphasizes equitable income distribution and equal access to economic opportunities. Inclusive growth ensures that the benefits of development are widely shared and that disadvantaged groups can improve their economic

conditions (Anand et al., 2013; Vellala, 2014; Ali & Son, 2007). While the literature often measures inclusive growth using growth–inequality ratios, this study adopts an inequality-adjusted income measure real GDP per capita adjusted by the Gini ratio, to better reflect both income levels and distribution. In line with Goal 8 of the SDGs, inclusive and sustainable economic growth is recognized as a key pillar of development, alongside productive employment and decent work (Bappenas, 2020). Similarly, the World Bank (2014) defines inclusive growth as expanding access to economic assets, strengthening markets, and creating equal opportunities for future generations.

Finally, despite the extensive literature, important gaps remain. Previous studies have not simultaneously examined sustainable and inclusive economic growth within a unified framework, nor have they explicitly modeled the transmission mechanism from public investment to human capital and subsequently to growth outcomes. In addition, limited attention has been given to regional heterogeneity, particularly differences between Java and non-Java regions. These gaps provide the foundation for the empirical analysis conducted in this study.

METHODS

The theoretical model in this study is derived from the intensive form of endogenous growth theory presented in equation (2), which focuses on human capital per labor (h_{it}). In line with the analytical framework, human capital is proxied by mean years of schooling (vos_{it}) to represent the education dimension and life expectancy at birth ($e0_{it}$) to capture the health dimension. Accordingly, the per capita income function can be expressed as:

$$y_{it} = f(h_{it}) = f(vos_{it}, e0_{it}) \quad (6)$$

Where the subscript it denotes province i in year t . Equation (6) is then extended into an empirical model to examine how human capital influences sustainable and inclusive economic growth. Consistent with the conceptual framework, this study employs two measures of economic growth. Sustainable economic growth is proxied by real GDP per capita ($gdrppc_{it}$), reflecting long-term economic performance. Inclusive economic growth is proxied by inequality-adjusted income (ik_{it}), defined as real GDP per capita divided by the Gini ratio, which captures both income levels and distribution. The empirical specification adopts a log-log (elasticity) model as follows:

$$\log(gdrppc_{it}) = \alpha + \beta_1 \log(vos_{it}) + \beta_2 \log(e0_{it}) + \gamma \log(N_{it}) + \varepsilon_{it} \quad (7.a)$$

$$\log(ik_{it}) = \alpha + \beta_3 \log(vos_{it}) + \beta_4 \log(e0_{it}) + \gamma \log(N_{it}) + \varepsilon_{it} \quad (7.b)$$

where ε_{it} is the error term and N_{it} represents population size. The research hypotheses are formulated as follows: $\beta_1, \beta_3 > 0$, indicating that mean years of schooling positively affect sustainable and inclusive economic growth; and $\beta_2, \beta_4 > 0$, indicating that life expectancy at birth also positively affects sustainable and inclusive economic growth.

To explicitly capture the transmission mechanism from public investment to growth outcomes, this study further examines how government expenditure on education and health contributes to human capital formation. Human capital (h_{it}) is modeled as a function of human capital investment (hc_{it}), which consists of public ($hc_{pub_{it}}$) and private ($hc_{priv_{it}}$) components:

$$h_{it} = f(hc_{it}) = f(hc_{pub_{it}}, hc_{priv_{it}}) \quad (8)$$

However, consistent with the research focus, this study emphasizes the role of public investment, particularly government expenditure in the education and health sectors, which can be specified as:

$$h_{edu_{it}} = vos_{it} = f(hc_{pub_{edu_{it}}}) \quad (9.a)$$

$$h_{health_{it}} = e0_{it} = f(hc_{pub_{health_{it}}}) \quad (9.b)$$

Where $h_{edu_{it}}$ represents human capital in the education dimension (measured by mean years of schooling), and $h_{health_{it}}$ represents human capital in the health dimension (measured by life expectancy at birth). Government expenditure on education ($hc_{pub_{edu_{it}}}$) is proxied by per capita central government spending on education ($geepc_{it}$), while government expenditure on health ($hc_{pub_{health_{it}}}$) is proxied by per capita central government spending on health ($gehpc_{it}$). Accordingly, the empirical models linking public investment to human capital are specified as:

$$\log(vos_{it}) = \alpha + \beta_5 \log(geepc_{it}) + \varepsilon_{it} \quad (10.a)$$

$$\log(e0_{it}) = \alpha + \beta_6 \log(gehpc_{it}) + \varepsilon_{it} \quad (10.b)$$

The corresponding hypotheses are: $\beta_5 > 0$, indicating that education expenditure positively affects mean years of schooling; and $\beta_6 > 0$, indicating that health expenditure positively affects life expectancy at birth.

This study uses panel data from 33 Indonesian provinces over the period 2005–2023, subject to data availability, particularly for government expenditure variables. Newly established provinces (North Kalimantan, Southwest Papua, Papua Mountains, Central Papua, and South Papua) are merged with their parent provinces for periods prior to the administrative division. Detailed descriptions of variables, measurements, and data sources are presented in Table 1.

Several estimation techniques are employed in this study, including static panel data approaches such as Fixed Effects (FE), Random Effects (RE), and Ordinary Least Squares (OLS). The Hausman and Breusch–Pagan Lagrange Multiplier (LM) tests are applied to determine the most appropriate model among these estimators. Specifically, the Hausman test is used to choose between the FE and RE models, while the Breusch–Pagan LM test is used to distinguish between OLS and RE specifications. However, given the dynamic nature of equations (7.a) and (7.b), particularly their dependence on initial conditions and potential persistence in the dependent variables, a dynamic panel data approach is more appropriate. Therefore, this study employs the System Generalized Method of Moments (System GMM) estimator.

The System GMM approach offers several advantages. It provides consistent and efficient estimates in the presence of heteroskedasticity and autocorrelation (Sultana et al., 2022). In addition, it effectively controls for unobserved individual heterogeneity, reduces omitted-variable bias, addresses measurement error, and accounts for potential endogeneity issues that commonly arise in empirical growth models (Bond et al., 2001). These advantages are particularly important given the limitations of OLS and fixed effects estimators, where such biases tend to be more pronounced (Mutiri et al., 2020). The validity of the GMM estimator depends on the assumption of overidentifying restrictions, which is tested using the Hansen test (Hansen, 1982). Furthermore, model validity requires the absence of second-order serial correlation in the error term, which is examined using the Arellano–Bond AR (2) test.

Table 1 Research Variables and Data

No	Variables	Description/ Measurement	References	Data Sources
1.	Sustainable economic growth ($gdrppc_{it}$)	Measured by real GRDP (2010=100) per capita (million IDR). Real GRDP for 2005-2009 is backcasting using 2000=100 base year growth	Haque et al. (2022)	BPS-Statistics Indonesia
2.	Inclusive economic growth (ik_{it})	Measured by real GRDP (2010=100) per capita divided by Gini ratio	Kristyanto & Kaluge (2018)	BPS-Statistics Indonesia
3.	Mean years of schooling (yos_{it})	Average years of schooling completed by individuals aged 15 and over	Sultana et al. (2022), Teixeira & Queirós, (2016), Zhang & Wang (2021)	BPS-Statistics Indonesia
4.	Life expectancy at birth ($e0_{it}$)	Average number of years an individual is expected to live	Sultana et al. (2022)	BPS-Statistics Indonesia
5.	Population (N_{it})	Population data for the years 2005-2019 uses the results of backcasting and forecasting from the 2010 Population Census, while data for the years 2020-2023 is derived from the 2020 Population Census	Sultana et al. (2022), Teixeira & Queirós, (2016)	BPS-Statistics Indonesia
6.	Public investment in education sector ($geepc_{it}$)	Per capita central government spending (expenditure) on education (excluding the subfunction of civil service education)	Dhiya et al. (2021), Li & Liang (2010)	DGB, MoF
7.	Public investment in health sector ($gehpc_{it}$)	Per capita central government spending (expenditure) on health	Sultana et al. (2022), Dhiya et al. (2021)	DGB, MoF
8.	Regional dummy	1 if province is located in Java; 0 otherwise	-	-

Source: Processed by the authors

RESULT AND DISCUSSION

Human capital, proxied by mean years of schooling and life expectancy at birth, exhibits a statistically significant positive effect on both sustainable and inclusive economic growth across all model specifications. The System GMM estimator provides the most reliable results compared to OLS, FE, and RE, which are subject to potential upward bias (Tables 2 and 3). The transformation from static panel estimators to the dynamic panel framework, using internal instruments in the GMM approach, leads to

lower estimated intercepts and coefficient magnitudes, indicating a correction of potential endogeneity bias.

In terms of diagnostic tests, the Hansen test indicates that the null hypothesis of overidentifying restrictions cannot be rejected across all specifications, confirming the validity of the instruments used. Furthermore, the Arellano–Bond AR (2) test is statistically insignificant, suggesting the absence of second-order serial correlation. These results collectively support the consistency and reliability of the System GMM estimates.

Focusing on sustainable economic growth, human capital, measured by mean years of schooling and life expectancy at birth, has a positive and significant effect on per capita income growth (Table 2). The GMM results indicate that a 1% increase in mean years of schooling and life expectancy at birth increases sustainable economic growth by 1.54% and 3.84%, respectively. These findings are consistent with previous empirical studies highlighting the positive role of both education and health in driving economic growth (Sultana et al., 2022; Teixeira & Queirós, 2016; Li & Liang, 2010; Zhang & Wang, 2021; Anwar, 2017; Anwar, 2018).

Table 2 The Effect of Human Capital on Sustainable Economic Growth

Dependent variable: Per capita income	OLS	FE	RE	GMM
Mean years of schooling	1.408*** (0.212)	1.505*** (0.167)	1.373*** (0.156)	1.535*** (0.168)
Life expectancy at birth	5.419*** (0.736)	8.293*** (0.777)	7.861*** (0.750)	3.841*** (0.458)
Population	-0.059** (0.028)	-0.507*** (0.091)	-0.332*** (0.071)	0.016 (0.047)
Regional dummy	-0.072 (0.082)	<i>omitted</i>	0.275 (0.258)	-0.133 (0.144)
Per capita income (lagged)				0.112*** (0.030)
Constant	-21.549*** (2.871)	-27.116*** (2.884)	-27.728*** (2.789)	-16.681*** (1.497)
Observations	638	638	638	602
R-squared	0.355	0.776	0.775	
Breusch-Pagan LM test			0.0000***	
Hausman test			0.0253**	
AR (1)				0.917
AR (2)				0.197
Hansen test				1.000

Note: all variables are in logs. Standard errors in parentheses. The *, **, *** refer to the significance level, 10%, 5%, and 1%, respectively. The regional dummy is omitted under the fixed effects model due to perfect multicollinearity with province-specific effects. Reported values for Breusch–Pagan LM, Hausman, and Hansen tests represent p-values.

Source: BPS-Statistics Indonesia and MoF (processed by the authors)

The results further show that life expectancy at birth has a stronger effect on sustainable economic growth than mean years of schooling. This suggests that health-related human capital plays a more immediate and direct role in enhancing economic performance than education-related human capital.

From a theoretical perspective, improvements in population health, as captured by higher life expectancy, enhance workers' physical capacity and cognitive functioning, thereby increasing labor productivity and economic output (Bloom et al., 2024). In contrast, the economic returns to education tend to materialize over a longer horizon, as they depend on the gradual accumulation of skills and their effective utilization in the labor market (Li & Liang, 2010).

This finding is also consistent with Ogundari & Awokuse (2018), who argue that the stronger impact of health relative to education may be attributed to differences in the quality and effectiveness of human capital formation. In the Indonesian context, constraints on educational quality and access—particularly at higher levels—may further limit education's immediate contribution to productivity growth. The relatively low tertiary education enrollment rate (31.45%) indicates that only a small share of the population reaches higher education, where returns to human capital are typically higher. This structural limitation helps explain why the elasticity of growth with respect to education remains lower than that of health.

This study also examines the impact of human capital on inclusive economic growth. Consistent with the sustainable economic growth model (Table 2), the estimation results reported in Table 3 indicate coefficient adjustments under the System GMM specification, with relatively moderate corrections for both mean years of schooling and life expectancy at birth.

In line with previous findings, both mean years of schooling and life expectancy at birth have statistically significant positive effects on inclusive economic growth, measured as per capita income

adjusted for inequality using the Gini ratio.

Table 3 The Effect of Human Capital on Inclusive Economic Growth

Dependent variable: Per capita income adjusted for the Gini ratio	OLS	FE	RE	GMM
Mean years of schooling	1.516*** (0.202)	1.814*** (0.206)	1.578*** (0.188)	1.316*** (0.182)
Life expectancy at birth	5.238*** (0.757)	6.234*** (0.959)	5.746*** (0.909)	3.622*** (0.698)
Population	-0.046 (0.030)	-0.605*** (0.114)	-0.333*** (0.080)	-0.028 (0.035)
Regional dummy	-0.194*** (0.085)	<i>Omitted</i>	0.263 (0.265)	-0.196** (0.095)
Per capita income adjusted for the Gini ratio (lagged)				0.248*** (0.048)
Constant	-20.130*** (2.925)	-16.490*** (3.546)	-18.129*** (3.378)	-14.268*** (2.338)
Observations	634	634	634	594
R-squared	0.352	0.656	0.652	
Breusch-Pagan LM test			0.0000***	
Hausman test		0.0123**		
AR (1)				0.000***
AR (2)				0.999
Hansen test				1.000

Note: all variables are in logs. Standard errors in parentheses. The *, **, *** refer to the significance level, 10%, 5%, and 1%, respectively. The regional dummy is omitted under the fixed effects model due to perfect multicollinearity with province-specific effects. Reported values for Breusch-Pagan LM, Hausman, and Hansen tests represent p-values.

Source: BPS-Statistics Indonesia and MoF (processed by the authors)

The System GMM estimations indicate that human capital has a statistically significant effect on inclusive economic growth. Specifically, a 1% increase in mean years of schooling leads to a 1.32% increase in inclusive economic growth, while a 1% increase in life expectancy at birth results in a 3.62% increase. The stronger effect of health-related human capital compared to education-related human capital suggests that improvements in health not only enhance labor productivity and extend working life but also facilitate broader participation in economic activities, particularly among vulnerable and low-income groups. Better population health reduces inequality of opportunity by enabling a larger share of the population to engage productively in the labor market and benefit from economic growth, thereby strengthening the inclusiveness of economic expansion.

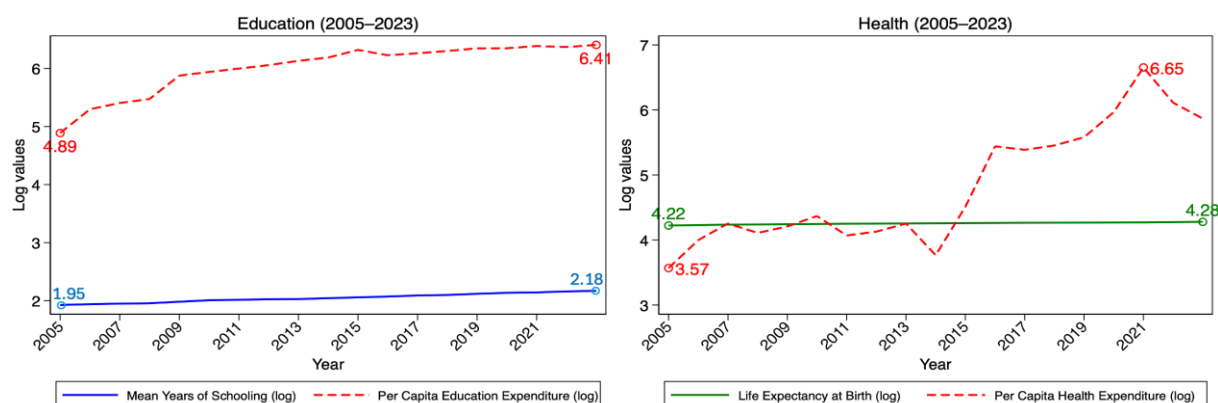
These findings highlight the importance of human capital development, particularly through education and health, in reducing income inequality. Expanding access to education can reduce disparities in educational attainment, enhance social mobility, and lower income inequality, especially across generations (Kearney & Levine, 2016). Similarly, improvements in population health can reduce productivity inequality, with Weil (2007) estimating a 9.9% reduction in GDP-per-worker inequality associated with better health outcomes. In addition, prior evidence suggests that a 1% increase in public health investment is associated with a 0.3% improvement in inclusive growth, as reflected in higher living standards, increased labor productivity, and longer life expectancy (Kristyanto & Kaluge, 2018).

A comparison between Tables 2 and 3 shows that the estimated elasticities of human capital are slightly higher for sustainable economic growth than for inclusive economic growth. The coefficient of life expectancy at birth is 3.84% for sustainable growth and 3.62% for inclusive growth, while the coefficient of mean years of schooling is 1.54% and 1.32%, respectively. This indicates that although human capital investment strongly promotes per capita income growth, its equalizing effect is relatively more limited, as inclusive growth depends not only on human capital accumulation but also on broader institutional and social factors (Hall & Jones, 1999). Nevertheless, the consistently positive and significant effects across both growth measures reinforce the conclusion that investment in education and health is a key driver of sustainable and inclusive economic development in Indonesia.

Human capital investment, proxied by mean years of schooling and life expectancy at birth, is closely linked to government policies in the education and health sectors aimed at improving the quality of human capital. In Indonesia, such policy is reflected in the allocation of central government expenditure to support improvements in education and health outcomes. Article 31(4) of the Indonesian Constitution mandates that the education budget must constitute at least 20% of the state and regional budgets (APBN and APBD). Similarly, Law No. 36 of 2009 on Health stipulates that the health budget should be at least 5% of the state budget, excluding salaries. Figure 2 presents the trend of central government spending on education and health over the period 2005–2023.

Figure 2 illustrates a steady upward trend in central government education expenditure since 2005, while health expenditure remained relatively stagnant during the 2005–2014 period and increased substantially only in subsequent years. The analysis indicates a generally positive relationship between public expenditure on education and health and improvements in human capital indicators, namely mean years of schooling and life expectancy at birth.

Figure 2 Public Investment in Human Capital and Human Capital Accumulation



Source: BPS-Statistics Indonesia and MoF (processed by the authors)

In particular, health expenditure increased significantly in 2015 and 2016 following the implementation of the National Health Insurance (Jaminan Kesehatan Nasional, JKN) program in 2014. This policy led to adjustments in health budget allocations in subsequent years and contributed to a substantial increase in program participation, with approximately 23.3 million new enrollees in 2015 and an additional 15.2 million in 2016 (DJSN & BPJS Kesehatan, 2020). The expansion of JKN coverage has consequently increased government health expenditure. As of September 2022, the program covered approximately 244.6 million people, equivalent to 90.24% of the total population (DJSN & BPJS Kesehatan, 2022). With such extensive coverage, public health expenditure is expected to further improve the quality and accessibility of healthcare services, contributing toward universal health coverage in Indonesia.

Table 4 The Effect of Public Investment in Education on Mean Years of Schooling

Dependent variable: Mean years of schooling	Without a lag			Lag 1		
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in education	0.100*** (0.016)	0.088*** (0.005)	0.088*** (0.005)	0.096*** (0.017)	0.082*** (0.005)	0.083*** (0.005)
Regional dummy	0.010 (0.010)	<i>omitted</i>	0.011 (0.049)	0.010 (0.011)	<i>omitted</i>	0.012 (0.049)
Constant	1.484*** (0.093)	1.557*** (0.028)	1.555*** (0.034)	1.514*** (0.097)	1.598*** (0.027)	1.595*** (0.033)
Observations	637	637	637	603	603	603
R-squared	0.285	0.365	0.365	0.277	0.361	0.361
Breusch-Pagan LM test		0.0000***			0.0000***	
Hausman test		0.5588			0.4664	
Dependent variable: Mean years of schooling	Lag 3			Lag 5		
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in education	0.088*** (0.019)	0.069*** (0.004)	0.070*** (0.004)	0.079*** (0.018)	0.057*** (0.004)	0.057*** (0.004)
Regional dummy	0.012 (0.011)	<i>omitted</i>	0.015 (0.049)	0.014 (0.012)	<i>omitted</i>	0.018 (0.048)
Constant	1.579*** (0.108)	1.687*** (0.026)	1.684*** (0.032)	1.644*** (0.105)	1.776*** (0.024)	1.772*** (0.031)
Observations	535	535	535	467	467	467
R-squared	0.254	0.329	0.329	0.233	0.301	0.301
Breusch-Pagan LM test		0.0000***			0.0000***	
Hausman test		0.3732			0.2700	

Note: all variables are in logs. Standard errors in parentheses. The *, **, *** refer to the significance level, 10%, 5%, and 1%, respectively. The regional dummy is omitted under the fixed effects model due to perfect multicollinearity with province-specific effects. Reported values for Breusch–Pagan LM, Hausman, and Hansen tests represent p-values.

Source: BPS-Statistics Indonesia and MoF (processed by the authors)

Several studies have shown that public expenditure on education and health, as key forms of human capital investment, can effectively enhance human capital accumulation (Baldacci et al., 2008; Paczos et al., 2023). Table 4 presents the effect of public education expenditure on mean years of schooling, while Table 5 reports the short- and long-run effects of public health expenditure on life expectancy at birth using lagged independent variables up to five years. The use of lag structures is based on the notion that human capital accumulation reflects a cumulative process over time. For example, a child completing primary education cannot be separated from educational investments accumulated over the entire schooling period, not only from current-year spending. Similarly, life expectancy at birth reflects not only current health conditions but also cumulative health investments across generations, including maternal health and early-life conditions.

Table 5 The Effect of Public Investment in Health on Life Expectancy at Birth

Dependent variable: Life expectancy at birth	Without a lag			Lag 1		
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in health	0.003** (0.001)	0.002*** (0.001)	0.002*** (0.001)	0.002* (0.001)	0.002*** (0.0006)	0.002*** (0.001)
Structural break (2015)	0.022*** (0.003)	0.021*** (0.001)	0.021*** (0.001)	0.021*** (0.003)	0.019** (0.001)	0.019*** (0.001)
Regional dummy	0.051*** (0.003)	<i>omitted</i>	0.050*** (0.015)	0.051*** (0.003)	<i>Omitted</i>	0.050*** (0.015)
Constant	4.204*** (0.005)	4.214*** (0.003)	4.206*** (0.007)	4.207*** (0.005)	4.217*** (0.002)	4.209*** (0.007)
Observations	637	637	637	603	603	603
R-squared	0.315	0.605	0.605	0.312	0.638	0.638
Breusch-Pagan LM test			0.0000***			0.0000***
Hausman test			0.3276			0.3503
Dependent variable: Life expectancy at birth	Lag 3			Lag 5		
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in health	0.002* (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.003* (0.001)	0.006*** (0.000)	0.006*** (0.000)
Structural break (2015)	0.018*** (0.003)	0.016*** (0.001)	0.016*** (0.001)	0.015*** (0.003)	0.013** (0.001)	0.013*** (0.001)
Regional dummy	0.050*** (0.003)	<i>omitted</i>	0.049*** (0.015)	0.050*** (0.003)	<i>Omitted</i>	0.049*** (0.015)
Constant	4.210*** (0.005)	4.215*** (0.002)	4.207*** (0.007)	4.212*** (0.005)	4.211*** (0.002)	4.203*** (0.006)
Observations	535	535	535	467	467	467
R-squared	0.304	0.656	0.657	0.297	0.674	0.674
Breusch-Pagan LM test			0.0000***			0.0000***
Hausman test		0.3151			0.2535	

Note: all variables are in logs. Standard errors in parentheses. The *, **, *** refer to the significance level, 10%, 5%, and 1%, respectively. The regional dummy is omitted under the fixed effects model due to perfect multicollinearity with province-specific effects. Reported values for Breusch-Pagan LM, Hausman, and Hansen tests represent p-values.

Source: BPS-Statistics Indonesia and MoF (processed by the authors)

According to Table 4, public investment in education significantly improves human capital as measured by mean years of schooling. Based on the Hausman and Breusch-Pagan LM tests, the random effects model is identified as the most appropriate specification. The results indicate that a 1% increase in per capita public education expenditure is associated with a 0.09% increase in mean years of schooling. This finding is consistent with Li et al. (2024), who show that public education spending contributes positively to human capital formation.

Moreover, public investment in education exhibits a long-term effect on human capital development. Even with a five-year lag, government education expenditure remains statistically significant and continues to contribute positively to mean years of schooling. Specifically, a 1% increase in education spending five years earlier is associated with a 0.06% increase in mean years of schooling. This finding is consistent with Baldacci et al. (2008), who argue that approximately two-thirds of the direct impact of education spending materializes within five years, while the full effects are realized over a 10–15 year horizon.

The positive long-run impact of education spending highlights its role in sustaining human capital accumulation over time. Such accumulation is closely associated with improvements in technological productivity and the time individuals allocate to schooling (Dissou et al., 2016). In addition, Yang et al. (2024) emphasize that technological progress can indirectly enhance human capital formation by increasing the effectiveness of public education investment. The observed upward trend in public education expenditure from 2005 to 2023 (Figure 2) is therefore consistent with the gradual increase in mean years

of schooling as an outcome of improved educational investment. Based on the trend of public health expenditure shown in Figure 2, a structural break is introduced into the model to capture differences before and after 2015, and the results are reported in Table 5. Supported by the Breusch–Pagan LM and Hausman tests, the random effects model is identified as the most appropriate specification. The results indicate a statistically significant positive relationship between public health expenditure and life expectancy at birth across all lag structures.

Quantitatively, a 1% increase in per capita public health expenditure is associated with a 0.002% increase in life expectancy at birth. Furthermore, the inclusion of the structural-break dummy indicates a statistically significant shift after 2015, with life expectancy increasing by 0.021% in the post-2015 period. This suggests that the expansion of the National Health Insurance (Jaminan Kesehatan Nasional, JKN) program has had a measurable impact on health outcomes. These findings are consistent with Sultana et al. (2024), who show that health expenditure improves life expectancy through better healthcare facilities and increased availability of medical personnel, particularly in underserved regions. In this context, health expenditure can be interpreted as an investment in human capital, as it enhances health status and extends life expectancy (Schultz, 1961).

When time lags are introduced, the magnitude of the coefficients increases, rising from 0.002 in the contemporaneous specification to 0.006 after five years, indicating that the effects of public investment in health accumulate over time. This suggests that the impact of health expenditure is not only immediate but also persistent, reflecting long-term improvements in health outcomes and policy effectiveness.

In the short run, public health investment contributes directly to reductions in the Maternal Mortality Rate (MMR) and the Under-Five Mortality Rate (U5MR). As shown by Bokhari et al. (2007), government health expenditures can reduce MMR by approximately 0.42–0.52% and U5MR by about 0.25–0.42%. Similarly, Moler-Zapata et al. (2022) find that increases in health expenditure reduce U5MR by 0.38%. In addition, James et al. (2017) report that a 10% increase in health expenditure is associated with a 3.5-month increase in life expectancy. While short-run effects are reflected in immediate declines in MMR and U5MR, long-run effects are characterized by sustained improvements in overall health outcomes, including reductions in Infant Mortality Rate (IMR) (Mohapatra, 2017).

Miranda-Lescano et al. (2024) further support the role of public investment in human capital formation through government expenditure in both education and health. Their findings show that public spending can mitigate the adverse effects of income inequality on educational attainment, particularly years of schooling. Moreover, health expenditure is found to significantly improve life expectancy at birth. Similarly, Sapriyadi et al. (2022) document that both education and health expenditures have direct positive effects on human capital outcomes. These findings are consistent with the results of this study, which show that education expenditure significantly increases mean years of schooling, while health expenditure positively affects life expectancy at birth.

The Indonesian government has prioritized public spending in education and health to strengthen human capital through various programs, including Program Indonesia Pintar (PIP), Kartu Indonesia Pintar Kuliah (KIP Kuliah), School Operational Assistance (BOS), the Non-Contributory Health Insurance scheme under the National Health Insurance program (PBI–JKN), and Supplementary Feeding Programs (PMT). As part of human capital investment, these programs aim to expand access to education and health services for low-income populations within the social protection system. Through the BOS program, disadvantaged households can access formal education at lower cost. In addition, supplementary feeding programs for young children are expected to reduce stunting during the critical first 1,000 days of life and improve life expectancy at birth.

Baldacci et al. (2008) confirm that investments in education increase mean years of schooling, while health expenditure improves child survival rates, particularly under-five mortality. The government therefore plays a crucial role in addressing inequality in access to education and health through more equitable public spending. Accordingly, public investment in human capital not only aims to enhance income and welfare in a sustainable manner but also to improve income distribution.

Recent evidence from Indonesia further supports this transmission mechanism. In the education sector, Yusuf & Sumner (2015) show that targeted assistance programs, including the precursor to KIP Kuliah, reduced inequality by increasing school participation among low-income households. In the health sector, Agustina et al. (2019) find that the expansion of the National Health Insurance (JKN) program improved access to essential health services, particularly for poor households covered under PBI–JKN, although challenges remain in service quality and geographic equity. Taken together, these findings support the mechanism identified in this study: public investment in education and health improves the quality of human capital, as reflected in mean years of schooling and life expectancy at birth, which in turn promotes sustainable and inclusive economic growth.

However, despite the expansion of JKN, a substantial share of health expenditure is allocated to PBI–

JKN and financed through the state budget (DJSN & BPJS Kesehatan, 2020; DJSN & BPJS Kesehatan, 2022). The relatively low elasticity of health expenditure on life expectancy suggests that its effectiveness in improving health outcomes among the poor remains limited.

To assess whether the aggregate results mask regional heterogeneity, this study further examines the differential effects of human capital on sustainable and inclusive economic growth across Java and non-Java provinces. Given the long-standing development gap between these regions, the returns to human capital investment are expected to differ in both magnitude and significance. This analysis is based on Tables 6–9, which report region-specific estimates for both the growth models and the human capital accumulation models.

Table 6 Heterogeneous Effect of Human Capital on Sustainable Economic Growth

Dependent variable: Per capita income	Java Region				Non-Java Region			
	OLS	FE	RE	GMM	OLS	FE	RE	GMM
Mean years of schooling	4.714*** (0.245)	1.279*** (0.232)	1.525*** (0.232)	-0.127 (12.842)	0.365* (0.203)	1.366*** (0.198)	1.183*** (0.182)	0.891*** (0.191)
Life expectancy at birth	-4.242*** (0.873)	6.930*** (1.421)	7.200*** (1.380)	1.798 (39.316)	8.976*** (0.641)	8.407*** (0.858)	8.271*** (0.826)	5.220*** (0.079)
Population	0.343*** (0.040)	0.744*** (0.205)	0.398*** (0.143)	2.042 (7.136)	-0.137*** (0.026)	-0.497*** (0.102)	-0.339*** (0.078)	-0.042 (0.029)
Per capita income (lagged)				-0.076 (0.526)				0.149*** (0.048)
Constant	6.034 (4.206)	-41.182*** (4.975)	-37.088*** (5.052)	-37.762*** (58.174)	-33.267*** (2.593)	-27.547*** (3.235)	-28.961*** (3.106)	-20.445*** (2.426)
Observations	114	114	114	108	524	524	524	494
R-squared	0.818	0.931	0.929		0.399	0.752	0.751	
Breusch-Pagan LM test			0.0000***				0.0000***	
Hausman test			0.0069***				0.0953*	
AR (1)				0.990				0.350
AR (2)				0.928				0.295
Hansen test				1.000				1.000

Note: all variables are in logs. Standard errors in parentheses. The *, **, *** refer to the significance level, 10%, 5%, and 1%, respectively.

Source: BPS-Statistics Indonesia and MoF (processed by the authors)

The results in Table 6 reveal clear regional differences in the impact of human capital on sustainable economic growth. The System GMM estimates indicate that both education (mean years of schooling) and health (life expectancy at birth) have positive and statistically significant effects on per capita income in non-Java regions, while these effects are not statistically significant in Java.

This suggests that improvements in education and health contribute more strongly to income growth in non-Java regions, where the marginal returns to human capital investment remain relatively high. In non-Java regions, a 1% increase in mean years of schooling is associated with a 0.89% increase in per capita income, while a 1% increase in life expectancy at birth is associated with a 5.22% increase in per capita income. In contrast, the insignificant effects observed in Java may reflect a higher initial stock of human capital in more developed regions, where additional increases in human capital generate diminishing marginal returns to economic growth. This pattern is consistent with the well-documented development gap between Java and non-Java regions, reflecting persistent spatial inequality in Indonesia.

Based on the previous findings for sustainable growth, the results in Table 7 further indicate that the effect of human capital on inclusive economic growth also varies across regions. The Sys-GMM estimates show that both education and health have significant positive effects on inclusive economic growth in non-Java regions, whereas their effects are not statistically significant in Java. In non-Java regions, a 1% increase in mean years of schooling raises inclusive economic growth by 1.38%, while a 1% increase in life expectancy at birth increases it by 3.53%. These results reinforce the earlier findings that human capital plays a stronger role in improving welfare and equity in less-developed regions. In these regions, investments in education and health enhance labor force participation and productivity while expanding opportunities in income distribution, thereby fostering more inclusive economic growth.

These findings indicate that indicators such as mean years of schooling and life expectancy at birth remain highly relevant measures of development in non-Java regions. In the early stages of development, mean years of schooling has the greatest influence on economic growth convergence, while advanced skills become more relevant at later stages (Zhang & Wang, 2021). Developing regions benefit more from

investments in education in terms of boosting economic growth compared to developed regions (Idrees & Siddiqi, 2013). Consistent with this, Dartanto (2015) notes that over the past three decades, except during periods of economic crisis, Indonesia's socio-economic conditions have improved significantly. One key indicator of this progress is the gradual increase in life expectancy at birth.

Table 7 Heterogeneous Effect of Human Capital on Inclusive Economic Growth

Dependent variable: Per capita income adjusted for Gini ratio	Java Region				Non-Java Region			
	OLS	FE	RE	GMM	OLS	FE	RE	GMM
Mean years of schooling	4.499*** (0.229)	1.506*** (0.261)	1.713*** (0.254)	3.449 (13.026)	0.583*** (0.193)	1.863*** (0.251)	1.485*** (0.224)	1.380*** (0.372)
Life expectancy at birth	-5.249*** (0.955)	2.720* (1.597)	2.939* (1.509)	-19.376 (82.266)	8.827*** (0.661)	6.432*** (1.090)	6.368*** (1.028)	3.535*** (1.363)
Population	0.355*** (0.044)	0.644*** (0.231)	0.356** (0.154)	4.731 (5.065)	-0.144*** (0.028)	-0.689*** (0.131)	-0.388*** (0.088)	-0.082*** (0.024)
Per capita income (lagged)				-0.160 (0.421)				0.307*** (0.049)
Constant	11.561** (4.560)	- (5.592)	- (5.533)	1.794 (274.055)	- (2.651)	- (4.092)	- (3.855)	- (4.846)
Observations	114	114	114	108	520	520	520	486
R-squared	0.773	0.875	0.873		0.412	0.625	0.621	
Breusch-Pagan LM test			0.0000***				0.0000***	
Hausman test			0.0003***				0.0101**	
AR(1)				0.953				0.000
AR(2)				0.705				0.752
Hansen test				1.000				1.000

Note: all variables are in logs. Standard errors in parentheses. The *, **, *** refer to the significance level, 10%, 5%, and 1%, respectively.

Source: BPS-Statistics Indonesia and MoF (processed by the authors)

This pattern is consistent with the empirical findings of this study, which show that human capital significantly drives economic growth in non-Java regions, where development levels are generally lower. However, a gap remains between economic growth and inclusive growth, as reflected in persistent regional disparities. Although Indonesia's national poverty rate was 9.03% in 2024, poverty rates in non-Java regions, particularly in eastern Indonesia, remain nearly twice the national average. Rahayu & Fillaili (2007) argue that conflict, natural disasters, economic crises, and subsidy reductions often reduce household income. They also note that persistently high poverty rates in Papua and West Papua are closely linked to geographic isolation and inadequate infrastructure. Improvements in infrastructure, social mobility, social capital, and local governance are therefore essential for enhancing welfare in these regions.

Turning to the human capital accumulation models, the Breusch-Pagan LM and Hausman tests in Table 8 indicate that the random effects model is the most appropriate specification. The results show that public investment in education has a strong and significant positive effect on mean years of schooling across all lag structures and regions. Although the coefficient declines over longer lags, it remains positive and robust. This suggests that government spending on education effectively improves educational attainment in both Java and non-Java regions, although the effect is stronger in Java, where educational infrastructure and access are more developed.

However, despite this positive effect in Java, increases in years of schooling have not translated into higher sustainable or inclusive growth (see Tables 6 and 7). This implies that educational attainment alone may be insufficient to generate broad-based economic gains in more developed regions, where structural and institutional factors play a larger role. This finding is consistent with Teixeira & Queirós (2016), who show that in more advanced economies, the returns to basic educational attainment decline as production shifts toward knowledge-intensive industries requiring higher-order skills. In Java, the limited marginal return to schooling may therefore reflect a mismatch between the quality of education and labor market demand rather than insufficient years of schooling.

Sulaiman et al. (2021) find that education significantly supports inclusive economic development by improving skills, productivity, and employability, thereby enabling greater participation in economic activities. They further show that inclusive growth, driven by investment, generates employment

opportunities closely linked to the population’s educational profile. In this context, human capital determines the extent to which investment-led growth translates into more equitable welfare outcomes. Consistent with this argument, the present study finds that the effect of educational attainment on inclusive growth is stronger in non-Java regions than in Java (Rattekarua et al., 2025). One possible explanation is that in less-developed regions, even modest improvements in education yield relatively large economic and social returns, whereas in more developed regions, such as Java, the marginal returns to additional schooling are lower due to saturation effects and the increasing importance of educational quality and advanced skills. Thus, although public investment in education remains essential, its effectiveness in promoting inclusive growth depends on regional conditions, labor market structures, and the alignment between education outcomes and economic opportunities.

Table 8 Heterogeneous Effect of Public Investment in Education on Mean Years of Schooling

Dependent variable: Mean years of schooling	Java Region			Non-Java Region		
	Without a lag					
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in education	0.124*** (0.005)	0.103*** (0.012)	0.106*** (0.011)	0.084*** (0.020)	0.086*** (0.005)	0.086*** (0.005)
Constant	1.350*** (0.035)	1.479*** (0.073)	1.457*** (0.074)	1.580*** (0.118)	1.568*** (0.030)	1.570*** (0.037)
Observations	114	114	114	523	523	523
R-squared	0.742	0.404	0.404	0.147	0.360	0.360
Breusch-Pagan LM test			0.0000***			0.0000***
Hausman test			0.4331			0.8674
Dependent variable: Mean years of schooling	Lag 1					
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in education	0.124*** (0.005)	0.102*** (0.011)	0.106*** (0.011)	0.077*** (0.020)	0.079*** (0.005)	0.079*** (0.005)
Constant	1.354*** (0.035)	1.487*** (0.007)	1.467*** (0.070)	1.623*** (0.116)	1.612*** (0.029)	1.615*** (0.036)
Observations	108	108	108	495	495	495
R-squared	0.757	0.449	0.449	0.135	0.348	0.348
Breusch-Pagan LM test			0.0000***			0.0000***
Hausman test			0.4092			0.8682
Dependent variable: Mean years of schooling	Lag 3					
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in education	0.124*** (0.005)	0.100*** (0.010)	0.103*** (0.009)	0.065*** (0.020)	0.065*** (0.005)	0.065*** (0.005)
Constant	1.370*** (0.034)	1.516*** (0.059)	1.499*** (0.063)	1.709*** (0.117)	1.710*** (0.028)	1.713*** (0.035)
Observations	96	96	96	439	439	439
R-squared	0.776	0.540	0.540	0.109	0.299	0.299
Breusch-Pagan LM test			0.0000***			0.0000***
Hausman test			0.3531			0.8894
Dependent variable: Mean years of schooling	Lag 5					
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in education	0.121*** (0.005)	0.086*** (0.009)	0.090*** (0.009)	0.055*** (0.017)	0.052*** (0.005)	0.052*** (0.005)
Constant	1.408*** (0.037)	1.617*** (0.054)	1.596*** (0.060)	1.783*** (0.100)	1.796*** (0.026)	1.800*** (0.033)
Observations	84	84	84	383	383	383
R-squared	0.775	0.542	0.542	0.089	0.268	0.268
Breusch-Pagan LM test			0.0000***			0.0000***
Hausman test			0.1460			0.9067

Note: all variables are in logs. Standard errors in parentheses. The *, **, *** refer to the significance level, 10%, 5%, and 1%, respectively.

Source: BPS-Statistics Indonesia and MoF (processed by the authors)

The heterogeneous effects of public health investment on life expectancy at birth across Java and non-Java regions are presented in Table 9. Based on the Breusch–Pagan LM and Hausman tests, the random effects model is identified as the most appropriate specification for both regions. The results indicate that public health investment has a positive and significant effect on life expectancy in non-Java regions across all model specifications, suggesting that government spending more effectively translates into improved health outcomes in these areas. In contrast, the effect in Java is smaller and becomes statistically significant only under longer lag structures, implying that the impact of health investment in more developed regions

is less immediate. The structural break in 2015 is also significant across all estimates, reflecting the effect of Indonesia's universal health coverage reform (JKN) on life expectancy improvements in both regions.

Table 9 Heterogeneous Effect of Public Investment in Health on Life Expectancy at Birth

Dependent variable: Life expectancy at birth	Java Region			Non-Java Region		
	Without a lag					
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in health	0.006*** (0.001)	-0.0003 (0.002)	0.0001 (0.002)	-0.002 (0.003)	0.004*** (0.001)	0.004*** (0.001)
Structural break (2015)	0.011** (0.005)	0.020*** (0.003)	0.020*** (0.003)	0.028*** (0.004)	0.021*** (0.001)	0.021*** (0.001)
Constant	4.246*** (0.005)	4.217*** (0.006)	4.265*** (0.001)	4.220*** (0.010)	4.200*** (0.003)	4.201*** (0.008)
Observations	114	114	114	523	523	523
R-squared	0.268	0.628	0.628	0.115	0.610	0.610
Breusch-Pagan LM test			0.0000***			0.0000***
Hausman test			0.6183			0.6432
Dependent variable: Life expectancy at birth	Lag 1					
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in health	0.006*** (0.001)	0.002 (0.001)	0.002 (0.001)	-0.003 (0.003)	0.003*** (0.001)	0.003*** (0.001)
Structural break (2015)	0.011** (0.005)	0.016*** (0.002)	0.016*** (0.002)	0.026*** (0.004)	0.020*** (0.001)	0.020*** (0.001)
Constant	4.249*** (0.005)	4.263*** (0.004)	4.262*** (0.0012)	4.225*** (0.0011)	4.205*** (0.003)	4.206*** (0.007)
Observations	108	108	108	495	495	495
R-squared	0.253	0.681	0.681	0.105	0.638	0.638
Breusch-Pagan LM test			0.0000***			0.0000***
Hausman test			0.8171			0.6184
Dependent variable: Life expectancy at birth	Lag 3					
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in health	0.006*** (0.001)	0.003*** (0.001)	0.003*** (0.001)	-0.003 (0.003)	0.004*** (0.001)	0.004*** (0.001)
Structural break (2015)	0.011** (0.005)	0.013*** (0.001)	0.013*** (0.001)	0.022*** (0.004)	0.016*** (0.001)	0.016*** (0.001)
Constant	4.251*** (0.006)	4.259*** (0.003)	4.259*** (0.011)	4.227*** (0.010)	4.205*** (0.002)	4.206*** (0.007)
Observations	96	96	96	439	439	439
R-squared	0.239	0.720	0.720	0.081	0.652	0.652
Breusch-Pagan LM test			0.0000***			0.0000***
Hausman test			0.9455			0.0249**
Dependent variable: Life expectancy at birth	Lag 5					
	OLS	FE	RE	OLS	FE	RE
Per capita public investment in health	0.006*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	-0.002 (0.003)	0.006*** (0.001)	0.006*** (0.001)
Structural break (2015)	0.011** (0.005)	0.011*** (0.001)	0.011*** (0.001)	0.018*** (0.004)	0.013*** (0.001)	0.013*** (0.001)
Constant	4.253*** (0.006)	4.258*** (0.003)	4.258*** (0.011)	4.226*** (0.011)	4.200*** (0.002)	4.202*** (0.007)
Observations	84	84	84	383	383	383
R-squared	0.213	0.744	0.744	0.056	0.669	0.669
Breusch-Pagan LM test			0.0000***			0.0000***
Hausman test			0.9875			0.1508

Note: all variables are in logs. Standard errors in parentheses. The *, **, *** refer to the significance level, 10%, 5%, and 1%, respectively.

Source: BPS-Statistics Indonesia and MoF (processed by the authors)

Overall, these findings indicate that public health investment contributes more strongly to improvements in life expectancy at birth in less-developed regions, thereby helping to reduce health disparities across Indonesia. However, the results also suggest that in the more developed Java region, increases in life expectancy do not translate significantly into higher sustainable or inclusive economic growth (Tables 6 and 7). Sari et al. (2025) find that health expenditure has a significant impact within Indonesia's decentralized fiscal context and emphasize the importance of integrating health system components, including the allocation of transfers to regions and village funds. Similarly, Sunarya &

Djameluddin (2023) show that regions outside Java, including Kalimantan, Maluku, and Papua, record below-average scores on the Public Health Development Index, highlighting the crucial role of public investment in improving the quality of health services. This evidence suggests that increased public investment in health can accelerate improvements in life expectancy, particularly in non-Java regions, by enhancing both access to and quality of healthcare services.

CONCLUSION

This study confirms that public investment in human capital is a key driver of sustainable and inclusive economic growth in Indonesia. The transmission mechanism operates through government spending on education and health, which significantly increases mean years of schooling and life expectancy at birth. Human capital generates substantial returns in both dimensions of economic growth, indicating that improvements in education and health not only support long-term income growth but also enhance inclusiveness by reducing inequality.

Notably, health capital, proxied by life expectancy at birth, has a stronger effect than education capital, proxied by mean years of schooling. The heterogeneous analysis further shows that the contribution of human capital is more pronounced in non-Java regions, where the returns to education and health investment remain relatively higher.

These findings imply that human capital development should be placed at the center of Indonesia's strategy for achieving sustainable and inclusive growth. First, participation in higher levels of education should be expanded, including through broader coverage of programs such as PIP and KIP Kuliah, to increase mean years of schooling and strengthen the income returns to education. Second, in the health sector, the government should continue to expand JKN coverage, as this study finds that public health investment positively affects life expectancy, particularly following the program's 2015 expansion. Third, education and health spending should be allocated more efficiently to improve access and service quality for poor and vulnerable groups, especially in less-developed regions outside Java, where the effects are more pronounced.

At the same time, the heterogeneous results suggest that increasing years of schooling alone is insufficient in more developed regions such as Java, where marginal returns appear to be diminishing. In these regions, policy attention should shift toward improving the quality and labor-market relevance of education. Similarly, the relatively small coefficient of health expenditure on life expectancy at birth (0.002%) suggests that broader coverage must be accompanied by improvements in service quality and accessibility, particularly in non-Java regions.

This study also examines the short- and medium-term effects of public investment in education using lag structures of up to five years. Future research could extend this analysis by applying alternative econometric approaches, such as the Autoregressive Distributed Lag (ARDL) model, to better capture both short-run and long-run dynamics and to strengthen the robustness of the findings. Furthermore, this study focuses exclusively on public investment as measured by central government expenditure on education and health. Future research should incorporate additional sources of financing, including local government expenditure, private sector investment (households and individuals), and contributions from non-profit organizations and firms, to obtain a more comprehensive understanding of human capital formation. In addition, future studies may consider other categories of public expenditure that also contribute to human capital development beyond education and health. Finally, this study uses mean years of schooling and life expectancy at birth as proxies for education and health outcomes; alternative indicators of educational attainment and health status could be explored in future research on sustainable and inclusive growth models.

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