

Dependency Ratio, HDI, and Economic Growth in Central Java

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Submit: 15 Agustus 2026	Revision : 16 Agustus 2026	Accepted: 22 Agustus 2026
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ABSTRACT

This study examines the relationship between dependency ratio, human development, and economic growth in Central Java Province. The study uses a quantitative approach with panel data covering 35 regencies/cities for the 2021–2023 period, resulting in 105 observations. Dependency ratio is used as a quantitative proxy for demographic bonus, while the Human Development Index (HDI) represents the quality of human resources and economic growth is measured by the real economic growth rate. Panel regression is estimated using the Fixed Effect Model after model-selection tests, and robust standard errors are used to address heteroskedasticity. The Chow test indicates that the Fixed Effect Model is preferable to the Common Effect Model, while the Hausman test confirms the Fixed Effect Model over the Random Effect Model. The regression results show that the dependency ratio has a negative coefficient of -0.052118 with a probability of 0.2371, indicating no statistically significant partial effect on economic growth. HDI has a positive coefficient of 0.084321 with a probability of 0.2173 and likewise has no statistically significant partial effect. However, the two variables jointly have a significant effect on economic growth, as indicated by an F-statistic probability of 0.006721. The adjusted R-squared of 0.695284 indicates that the model explains approximately 69.53% of the variation in economic growth within the sample. The findings imply that demographic structure and human development should be addressed jointly with employment creation, productive-sector development, and other structural policies.

Keywords: demographic bonus; dependency ratio; economic growth; human development index.

DOI: 10.31949/fbmj.v4i1.19714

INTRODUCTION

Regional economic development is a multidimensional process aimed at increasing productive capacity and improving community welfare. Economic growth is one of the principal indicators used to assess regional economic performance because it reflects changes in the production of goods and services over time (Capello, 2015). In regional analysis, economic growth is commonly represented by the growth rate of Gross Regional Domestic Product (GRDP) at constant prices so that changes in output are separated from price movements. The development process, however, is not determined solely by economic variables. Demographic structure and the quality of human resources also shape a region's capacity to transform its population into productive economic resources (Pikushina et al., 2018).

One demographic condition that has received considerable attention is the demographic bonus. A demographic bonus occurs when the proportion of the working-age population is relatively larger than the non-working-age population (Adriani & Yustini, 2021). Such a structure can create an opportunity to accelerate economic growth because a larger working-age population can expand production, household income, saving capacity, and domestic demand. Nevertheless, the demographic bonus is not an automatic source of growth. Its economic benefits depend on the capacity of the economy to absorb productive-age workers and on the quality of human resources available to participate in productive activities (Bloom et al., 2003).

Dependency ratio is one of the principal indicators used to describe demographic structure. A lower dependency ratio indicates a smaller burden borne by the working-age population in supporting children and older persons and is therefore often associated with a stronger demographic-bonus opportunity. In contrast, a high dependency ratio may constrain household saving and productive investment. The relationship is nevertheless contextual because the effect of demographic structure can be conditioned by employment opportunities, education, health, productivity, and the sectoral structure of the regional economy (Bidisha et al., 2020).

Human resource quality is another important dimension. The Human Development Index (HDI) summarizes achievements in health, education, and a decent standard of living. In the endogenous growth perspective, human capital is an important source of productivity and long-run growth because education and knowledge accumulation can improve worker capability and innovation (Herrero et al., 2012). Thus, a productive demographic structure is more likely to generate economic benefits when accompanied by adequate human capital.

Central Java provides an important setting for examining these relationships because it contains 35 regencies/cities with substantial differences in demographic structure, human development, and economic performance. During 2021–2023, the province's economic growth increased from 3.33% in 2021 to 5.31% in 2022 before moderating to 4.98% in 2023. Over the same period, the provincial HDI increased from 72.16 to 73.39, while the dependency ratio declined from 46.34 in 2021 to 43.72 in 2022 and then increased slightly to 44.12 in 2023. These aggregate movements indicate that demographic and human-development conditions changed during the study period, but they do not by themselves establish whether such changes affected economic growth across districts.

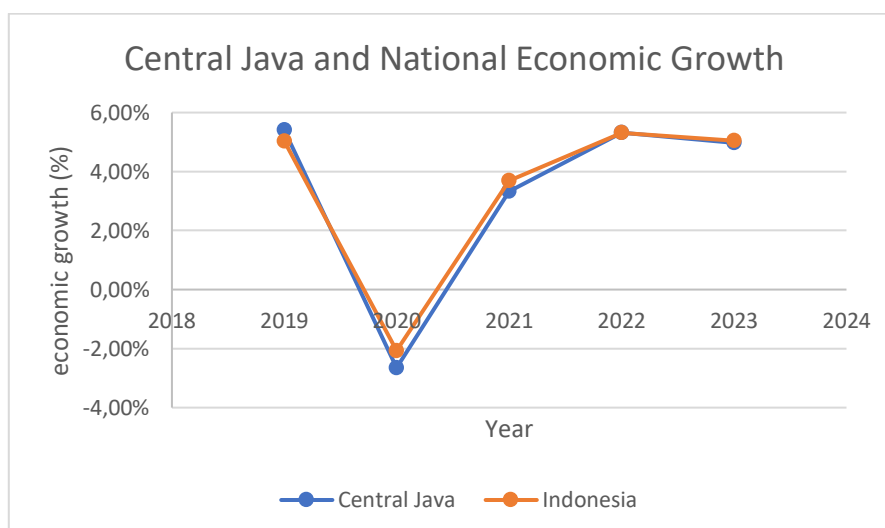


Figure 1. Central Java and National Economic Growth

Previous studies have produced mixed findings. (Syukri et al., 2024) reported that the dependency ratio was not significant while HDI was positively significant in explaining economic growth in Java. (Bidisha et al., 2020) found a negative significant relationship between dependency ratio and economic growth, whereas (Huda et al., 2021) reported an insignificant relationship. (Wardani, 2024) found that demographic bonus was not significant while HDI had a positive significant effect. These differences suggest that the economic effect of demographic structure and human development may depend on regional characteristics and the period examined.

Based on this research gap, this study analyzes the effect of dependency ratio and HDI on economic growth in Central Java using panel data for 35 regencies/cities during 2021–2023. The study focuses on three questions: whether dependency ratio affects economic growth, whether HDI affects economic growth, and whether the two variables jointly affect economic growth. The results are expected to provide empirical evidence for regional development policy, particularly on the need to integrate demographic management, human-capital development, employment creation, and productive-sector expansion

LITERATURE REVIEW, FRAMEWORK AND HYPOTHESIS

Economic growth

Economic growth describes the increase in an economy's capacity to produce goods and services over time. (Mankiv, 2018) explains growth as the development of economic activities that increases the production of goods and services, while Todaro and Smith emphasize the long-run increase in the capacity of an economy to provide goods and services to its population. At the regional level, economic growth is commonly measured using the growth rate of GRDP at constant prices. The general calculation is: $\text{Growth} = \frac{[\text{GRDP}_t - \text{GRDP}_{t-1}]}{\text{GRDP}_{t-1}} \times 100$. This measure captures real changes in output and is therefore appropriate for comparing economic performance across years and regions (Henderson et al., 2012).

Economic growth is influenced by multiple factors, including human resources, capital accumulation, technology, natural resources, and economic policy. Because the present study focuses on demographic structure and human development, these variables are treated as key explanatory factors

rather than as exhaustive determinants of growth. This limitation is important because a statistical model with only two explanatory variables cannot capture every structural factor that affects regional growth.

Demographic bonus and dependency ratio

A demographic bonus refers to a period in which the share of the working-age population is relatively high compared with the dependent population. The condition emerges from demographic transition and may create a window of opportunity for growth. It emphasizes that the opportunity depends on employment, education, health, and other supporting conditions. The dependency ratio measures the number of dependents relative to the working-age population. It is calculated as: $DR = [(Population\ aged\ 0-14 + population\ aged\ 65\ and\ over) / population\ aged\ 15-64] \times 100$. A lower value generally indicates a smaller demographic burden and a larger potential for the working-age population to contribute to productive activities (Risandini & Silvi, 2021).

The expected relationship between dependency ratio and economic growth is negative. A higher dependency ratio may reduce the resources available for saving, investment, and productive expenditure. Conversely, a lower ratio may increase the economic space available to working-age households. However, the relationship can be weak in the short run when changes in demographic structure are small or when labor-market absorption is insufficient (Ahmad & Shah, 2021).

Human Development Index

HDI is a composite indicator reflecting three fundamental dimensions of human development: a long and healthy life, knowledge, and a decent standard of living. The theoretical basis for expecting a positive relationship between HDI and growth is consistent with endogenous growth theory (Howitt et al., 1998). Emphasize knowledge, education, and human capital as sources of productivity and long-run growth. In regional economies, higher human development can improve worker capability, health, and productivity, but the economic effect may take time to materialize and depends on the ability of regional industries and services to absorb qualified labor (Hanushek & Woessmann, 2020).

Previous research and research gap

Empirical evidence regarding demographic structure and human development remains mixed. (Wardani, 2024) found that the dependency ratio was positive but insignificant and HDI was positive and significant in a study of Java. (Hermawan, 2019) found a negative significant effect of dependency ratio in North Kalimantan, while Huda et al. (2021) found no significant effect in South Kalimantan. (Purwati & Prasetyanto, 2022) reported an insignificant demographic-bonus effect but a positive significant HDI effect in Indonesia. (Headey & Hodge, 2009) also found different signs across demographic variables. The inconsistency indicates that regional context, period, and supporting economic conditions may influence the empirical relationship.

The contribution of this study is its focus on the 35 regencies/cities of Central Java over the 2021–2023 period and its simultaneous examination of demographic structure and human development using a panel-data framework. The short observation period is also analytically relevant because it allows the study to assess whether demographic and human-development changes are already reflected in short-run regional growth.

Conceptual framework and hypotheses

The conceptual framework places dependency ratio as a proxy for demographic structure and HDI as a proxy for human-resource quality. A lower dependency ratio is theoretically associated with a stronger demographic-bonus opportunity, while higher HDI is expected to improve productivity. Both variables are therefore expected to be associated with economic growth, although their effects may not be statistically significant over a short period (Pokhrel & Khadka, 2019).

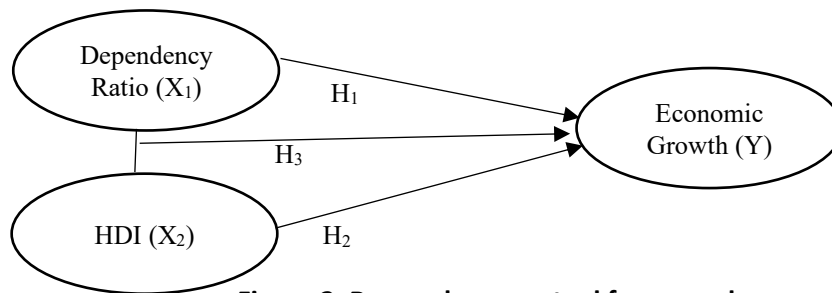


Figure 2. Research conceptual framework

H1: Dependency ratio affects economic growth in Central Java during 2021–2023.

H2: Human Development Index affects economic growth in Central Java during 2021–2023.

H3: Dependency ratio and Human Development Index jointly affect economic growth in Central Java during 2021–2023.

METHODS

This study uses a quantitative explanatory design and secondary panel data. The unit of analysis comprises all 35 regencies/cities in Central Java Province, consisting of 29 regencies and 6 cities, observed annually during 2021–2023. The resulting balanced panel contains 105 observations. The data are obtained from official publications of the Central Java Provincial Statistics Agency (BPS) and relevant district/city statistical publications.

The dependent variable is economic growth (PE), measured by the annual growth rate of real GRDP at constant prices. The first independent variable is dependency ratio (RK), calculated as the ratio of the non-working-age population (0–14 years and 65 years and over) to the working-age population (15–64 years), multiplied by 100. RK is used as a quantitative proxy for demographic structure and the demographic-bonus opportunity. The second independent variable is HDI, obtained directly from BPS publications.

Table 1. Operational Definition of Variables

Variable	Operational definition	Measurement
Economic Growth (PE)	Annual change in real regional output	GRDP growth rate (%)
Dependency Ratio (RK)	Non-working-age population relative to working-age population	$[(0-14 + 65+)/15-64] \times 100$
HDI	Composite human-development indicator	BPS HDI index

Source: Research design based on BPS indicators and the study variables.

The empirical model is specified as a linear panel model:

$$PE_{it} = \alpha_i + \beta_1 RK_{it} + \beta_2 HDI_{it} + \varepsilon_{it}$$

where PE_{it} denotes economic growth in region *i* and year *t*; RK_{it} denotes dependency ratio; HDI_{it} denotes the Human Development Index; α_{*i*} represents region-specific fixed effects; and ε_{*it*} is the error term.

Three alternative panel estimators are considered: Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). The Chow test is used to compare CEM and FEM, while the Hausman test is used to compare FEM and REM. The Lagrange Multiplier test is used as supplementary evidence for comparing CEM and REM. The final model is selected based on the combined evidence from these tests.

After selecting the panel estimator, diagnostic testing is conducted. The study examines residual normality using the Jarque–Bera test, multicollinearity through the correlation between explanatory variables, heteroskedasticity using the panel error diagnostic reported in the estimation output, and serial correlation using the Breusch–Godfrey Serial Correlation LM test. Because the estimated FEM exhibits heteroskedasticity, robust standard errors (White cross-section) are used for statistical inference. Hypotheses are evaluated at the 5% significance level using t-tests for partial effects and the F-test for joint significance. The adjusted R-squared is used to describe the explanatory capacity of the model.

RESULTS AND DISCUSSION

Descriptive development of the provincial indicators

The aggregate provincial figures show that economic growth accelerated from 3.33% in 2021 to 5.31% in 2022 and then moderated to 4.98% in 2023. During the same period, HDI increased consistently from 72.16 to 73.39. The dependency ratio fell from 46.34 in 2021 to 43.72 in 2022 before increasing slightly to 44.12 in 2023. These movements illustrate that human development improved continuously, while demographic structure fluctuated. Because the regression analysis is conducted at the district/city level, these provincial aggregates are used only as contextual evidence rather than as the observations used in estimation.

Table 2. Development of Central Java Indicators, 2021–2023

Year	Economic growth (%)	HDI	Dependency ratio (%)
2021	3.33	72.16	46.34
2022	5.31	72.79	43.72
2023	4.98	73.39	44.12

Source: BPS Central Java Province, processed by the researcher.

Fixed Effect estimation and diagnostic results

Table 4. Fixed Effect Regression with Robust Standard Errors

Variable	Coefficient	Robust probability	Partial conclusion
Dependency ratio (RK)	-0.052118	0.2371	Not significant
HDI	0.084321	0.2173	Not significant

Source: EViews output, White cross-section robust estimation.

The estimated equation is $PE_{it} = \alpha_i - 0.052118RK_{it} + 0.084321HDI_{it} + \varepsilon_{it}$. The dependency-ratio coefficient is negative, meaning that a one-point increase in the dependency ratio is associated with a 0.052118-point decrease in economic growth, ceteris paribus. However, the probability value of 0.2371 exceeds 0.05, so the effect is not statistically significant. The HDI coefficient is positive, indicating that a growth, ceteris paribus. Its probability value of 0.2173 is also above 0.05, so the partial effect is not statistically significant.

The diagnostic results indicate that the residuals are not normally distributed based on a Jarque–Bera probability of 0.0000. The correlation between dependency ratio and HDI is -0.452318, which does not indicate a strong linear relationship between the two explanatory variables. The heteroskedasticity diagnostic indicates a probability of 0.0000, so heteroskedasticity is present and robust standard errors are therefore used. The Breusch–Godfrey test reports a probability of 0.9774, indicating no evidence of serial correlation at the 5% level.

Table 5. Joint Test and Model Fit

Statistic	Value	Interpretation
F-statistic	5.284731	Jointly significant
Prob(F-statistic)	0.006721	$p < 0.05$
Adjusted R-squared	0.695284	69.53% explanatory capacity
Observations	105	35 regions $\times$ 3 years

Source: EViews output, processed by the researcher.

The F-test produces a probability of 0.006721, below 0.05, indicating that dependency ratio and HDI are jointly significant in explaining economic growth. The adjusted R-squared is 0.695284, meaning that approximately 69.53% of the variation in economic growth within the research sample is associated with the model, while the remaining variation is attributable to factors outside the model and idiosyncratic components. The adjusted R-squared should not be interpreted as evidence that the two variables are individually significant; the partial tests show otherwise.

Dependency Ratio and Economic Growth

The negative coefficient of dependency ratio is consistent with the theoretical expectation that a higher demographic burden can constrain the economic space available to the working-age population. Nevertheless, the relationship is statistically insignificant. This result suggests that changes in demographic structure during 2021–2023 were not sufficiently strong or immediate to translate into measurable changes in regional economic growth after controlling for fixed district/city characteristics and HDI.

One possible explanation is the short observation period. Demographic changes tend to operate over longer horizons than the three-year window used here. The economic effect of a lower dependency ratio also depends on labor-market absorption. A large working-age population does not automatically create higher output when productive employment, skills matching, and investment are insufficient. The result is consistent with (Huda et al., 2021), who also found an insignificant dependency-ratio effect, while differing from (Hermawan, 2019), who reported a negative significant effect. The difference reinforces the contextual nature of the demographic-growth relationship.

The finding also indicates that the demographic bonus should not be assessed solely from the size of the working-age population. Policy should focus on converting demographic potential into productive employment through skills development, job creation, and expansion of sectors capable of absorbing labor. A favorable dependency ratio without these supporting mechanisms may not produce an observable short-run growth effect.

HDI and Economic Growth

HDI has a positive but statistically insignificant coefficient. The positive sign is consistent with endogenous growth theory, in which human capital contributes to productivity and long-run growth. However, the insignificant result indicates that improvements in health, education, and living standards during 2021–2023 were not sufficient to generate a statistically detectable short-run effect on regional economic growth.

The result can be understood from the time lag between human-capital improvement and productivity. Education and health investments may require several years before they translate into higher worker productivity, innovation, and sectoral transformation. In addition, higher human development does not guarantee that qualified workers will be absorbed into productive sectors. If labor demand is weak or regional economic structures are concentrated in activities with limited demand for skilled labor, the immediate growth effect of HDI may remain small.

This finding differs from (Wardani, 2024) and (Pawitan et al., 2025), who reported positive significant HDI effects. The difference may be related to regional scope, observation period, model specification, and the post-pandemic recovery context of 2021–2023. Thus, the insignificant result should not be interpreted as evidence that human development is economically unimportant; rather, it indicates that its statistical effect is not yet identifiable in this particular short-run sample.

Joint Effect of Dependency Ratio and HDI

The joint significance of dependency ratio and HDI is an important finding because the variables are individually insignificant but jointly significant. This pattern is not contradictory. The F-test evaluates whether the explanatory variables, considered together, provide statistically meaningful information about the dependent variable. In this study, demographic structure and human development together capture dimensions of regional capacity that are not fully represented by either variable alone.

Conceptually, demographic quantity and human-resource quality are complementary. A large working-age population can become an economic resource only when it has sufficient education, health, and productive opportunities. Conversely, high human-resource quality requires a demographic and economic structure capable of absorbing skilled workers. The joint significance therefore supports an integrated development perspective in which demographic management and human-capital development are considered together rather than as isolated policy domains.

The finding provides a practical implication for Central Java. Regional development policy should combine demographic planning, human-resource investment, labor-market development, and productive-sector expansion. Such integration is more consistent with the empirical evidence than policies that rely solely on lowering dependency ratios or increasing HDI without improving the economic environment in which the population participates.

CONCLUSION

This study examined the effect of dependency ratio and HDI on economic growth across 35 regencies/cities in Central Java during 2021–2023 using panel regression. The Fixed Effect Model was selected based on the Chow and Hausman tests, and robust standard errors were used because the model exhibited heteroskedasticity.

The results show that dependency ratio has a negative but statistically insignificant partial relationship with economic growth, while HDI has a positive but statistically insignificant partial relationship. Therefore, the first two hypotheses are not supported at the 5% significance level. In contrast, the two variables are jointly significant, with a Prob(F-statistic) of 0.006721. The adjusted R-squared of 0.695284 indicates substantial explanatory capacity within the sample.

Theoretically, the findings suggest that demographic structure and human development should be understood as complementary dimensions of regional growth rather than isolated determinants. Practically, the results support integrated policies covering demographic management, education and health, labor-market absorption, investment, and productive-sector development. The absence of significant partial effects should not be interpreted as evidence that demographic or human-development policies are unnecessary; rather, it suggests that their economic effects may require longer time horizons and stronger supporting conditions.

This study has several limitations. First, the observation period covers only three years, which restricts the ability to identify long-run demographic and human-capital effects. Second, the model includes only dependency ratio and HDI, while regional growth is also affected by investment, government expenditure, inflation, infrastructure, employment, and sectoral structure. Future research should extend

the time horizon, consider additional explanatory variables, and examine whether the relationship differs across groups of regencies/cities or economic sectors.

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