The Effect of Investment, Labor, and Education on Economic Growth in Regencies and Cities of North Sumatra Province, 2019–2024

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Abstract
This study aims to analyze the influence of investment, labor, and education on economic growth in 33 districts/cities in North Sumatra Province in the 2019–2024 period. The research approach used is quantitative with a panel data analysis method using the Fixed Effect model (FEM) to capture the heterogeneity of characteristics between regions. Data sourced from the Central Statistics Agency (BPS) of North Sumatra Province with a total of 198 observations. The results show that simultaneously, investment, labor, and education have a positive and significant effect on economic growth. Partially, education has the most dominant contribution, followed by labor and investment. The Adjusted R-squared value of 0.858 indicates that the independent variables are able to explain 85.8% of the variation in regional GRDP growth. The limitation of this study lies in the use of aggregate macro data that does not include the dimensions of the informal economy and digital infrastructure disparities. It is recommended for local governments to synergize investment attraction policies with improving the quality of human capital through vocational education relevant to the needs of local industries to create inclusive and sustainable economic growth.

Keywords: Economic Growth, Education, Investment, Labor

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Introduction

The acceleration of national economic growth is a manifestation of the complex interaction between capital accumulation, the optimization of human resources, and macroeconomic policy stability. In the post-pandemic period, Indonesia's economy has sought to escape the trap of stagnant growth through industrial downstreaming and the strengthening of domestic investment. According to Bank Indonesia (2025), the current structure of national economic growth is strongly influenced by the resilience of household consumption and the recovery of investment performance following the political leadership transition [1]. This is consistent with the analysis of Tambunan (2024), who emphasizes that the main challenge facing the Indonesian economy is ensuring inclusive growth amid fluctuations in global commodity prices [2]. Data from BPS Pusat 2024 record that Indonesia's economic growth in 2024 reached approximately 5.05%, yet its distribution remains concentrated on Java Island, thereby necessitating the strengthening of leading sectors in regions outside Java to sustain long-term growth momentum, as highlighted in INDEF's (2024) study on green and inclusive economic development [3][4].

More specifically, North Sumatra Province, as a major economic gateway in western Indonesia, has demonstrated dynamic yet challenging economic performance during the 2019–2024 period. As the province with the largest Gross Regional Domestic Product (GRDP) contribution on Sumatra Island, its economic dynamics are highly dependent on commodity exports and the inflow of nationally strategic infrastructure investment. Sjafrizal (2022) identifies that the strength of regional economies such as North Sumatra is strongly influenced by the region's ability to convert investment into productive employment opportunities [5]. However, data from BPS Sumut (2025) reveal substantial disparities in growth among regencies and municipalities, where growth centers such as Medan and Deli Serdang perform significantly above the provincial average, while agriculture-based regions tend to stagnate [6]. This condition reinforces the argument of Kuncoro (2024) that regional disparities often stem from the inability of local areas to absorb investment due to low human capital quality and limited supporting infrastructure at the local level [7].

The main issue emerging in North Sumatra is the suboptimal synergy between the surge in physical investment and the quality of labor and educational output in driving equitable economic growth across its 33 regencies and municipalities. Although investment realization continues to increase, the open unemployment rate in several urban areas of North Sumatra remains a burden on GRDP acceleration. Inequality in access to higher education and vocational training across regions results in local labor frequently being unable to be absorbed by capital-intensive industries entering these areas. This phenomenon creates a growth paradox, in which high economic growth rates are not accompanied by a broad-based increase in labor productivity in peripheral regions [6].

Theoretically, the interrelationship among these variables is rooted in the synthesis of classical and endogenous growth theories. Mankiw (2022), in the neoclassical growth model, emphasizes that physical investment (capital) and labor are the primary determinants in the production function that shapes economic output [8]. However, Jones & Vollerath (2021) and Acemoglu et al. (2022) extend this framework through endogenous growth theory, positioning education as human capital that generates sustained technical efficiency and innovation [9][10]. Investment is not merely an addition of physical assets but serves as a driving engine that requires the absorptive capacity of an educated workforce to generate economic value added. Todaro & Smith (2020) further argue that without strengthening the education sector, investment and labor will only produce short-term growth that is vulnerable to external shocks [11]. From the perspective of Haryanto et al. (2025), the synergy among these three variables constitutes an absolute prerequisite for regional macroeconomic stability [12].

Several previous studies have attempted to examine the determinants of economic growth in North Sumatra with varying results. Ardhana et al. (2022) find a positive effect of investment

and labor on the provincial economy of North Sumatra but do not explore the spatial dimension at the regency/municipality level [13]. Similarly, Hannafi & Daud (2023) confirm the role of investment in the region's sharia-based economy, while Aisyah (2020) provides a critical note that the contribution of labor is often constrained by low minimum wage levels [14][15]. Furthermore, Sitorus et al. (2025) highlight that unemployment remains a negative residual for economic growth despite continuous investment expansion [16]. Collectively, this literature underscores the urgency of reexamining these variables within a more specific and up-to-date analytical context.

The research gap of this study lies in the limitation of previous literature that predominantly relies on aggregate provincial-level data (time series), thereby overlooking the heterogeneity of characteristics across regencies and municipalities in North Sumatra. The novelty of this research emerges from the use of panel data analysis that integrates the time dimension (2019–2024) and the spatial dimension (33 regencies/municipalities), explicitly encompassing the critical post-pandemic recovery period. Moreover, the inclusion of education as a specific variable in the regional-level panel data regression model provides new insights into the effectiveness of human capital investment in addressing local economic growth disparities an aspect that has often been fragmented in previous regional economic studies on North Sumatra.

The urgency of this research is grounded in the pressing need for the Government of North Sumatra Province to formulate evidence-based policies capable of integrating investment policies with human resource quality development at the regency and municipal levels. The primary objective of this study is to empirically and comprehensively analyze the effects of investment, labor, and education on regional economic growth in order to identify the most growth-accelerating variable. Practically, this research is expected to serve as a strategic reference for more synchronized regional development planning, while academically, it contributes to enriching the body of Indonesian regional economics literature through a comprehensive panel data approach.

Literature Review

Investment

Investment is defined as expenditure on capital goods that are not consumed in the present period but are utilized for future production in order to increase economic output. Conceptually, Mankiw (2022) views investment as a crucial component of the production function that drives capital accumulation, whereby higher levels of investment shift the production curve upward through an expansion of the physical capital stock [8]. In the context of development in Indonesia, Kuncoro (2024) explains that investment serves as the primary driving force in value creation and regional economic modernization [7]. In this study, investment is measured through the realization of Domestic Investment (Penanaman Modal Dalam Negeri/PMDN) and Foreign Direct Investment (Penanaman Modal Asing/PMA), which reflect capital inflows into the region. Sustained investment generates new productive capacity that directly contributes to increases in Gross Regional Domestic Product (GRDP).

H_1: Investment has a positive and significant effect on Economic Growth in the Regencies/Municipalities of North Sumatra Province.

Labor

Labor represents the human factor of production that plays a central role in processing resources and technology to produce goods and services. According to Tambunan (2024), labor in the Indonesian economic context should not only be viewed in terms of quantity (the size of the labor force) but also in terms of productivity and skill levels across economic sectors [2]. At the macro level, Haryanto et al. (2025) state that optimal labor absorption reduces economic inefficiencies and increases aggregate income [12]. The primary indicator used in this study is

the Labor Force Participation Rate (LFPR) or the number of employed persons, which reflects the extent of human factor involvement in economic activities. An increase in labor absorption in productive sectors is expected to simultaneously drive the expansion of regional output.

H_2: Labor has a positive and significant effect on Economic Growth in the Regencies/Municipalities of North Sumatra Province.

Education

Education constitutes a form of human capital investment that is crucial for enhancing labor quality and capability. Todaro & Smith (2020) emphasize that education is not merely a form of social consumption but a prerequisite for economic progress that improves cognitive skills and work efficiency [11]. Within the endogenous growth theory framework presented by Jones & Vollrath (2021), education is positioned as a variable that enables innovation and faster technology adoption, thereby preventing the occurrence of diminishing returns [9]. Commonly used indicators at the regional level include Mean Years of Schooling (MYS) or Expected Years of Schooling (EYS), which represent the accumulation of population knowledge. Higher levels of education produce a more adaptive and productive workforce, which in turn accelerates regional economic growth.

H_3: Education has a positive and significant effect on Economic Growth in the Regencies/Municipalities of North Sumatra Province.

Economic Growth

Economic growth is defined as the increase in the long-term capacity of an economy to provide a wide range of economic goods to its population. Acemoglu et al. (2022) emphasize that sustainable economic growth is driven by technological progress and efficiency in the utilization of production factors [10]. At the regional level, Sjafrizal (2022) explains that economic growth reflects the success of regional development in optimizing local resource potential and regional competitiveness [5]. The main indicator used to measure this variable is the growth rate of Gross Regional Domestic Product (GRDP) at constant prices, which represents the real value added generated by all economic units within a regency/municipality over a given period.

H_4: Investment, Labor, and Education simultaneously have a significant effect on Economic Growth in the Regencies/Municipalities of North Sumatra Province.

Research Methodology

This study employs a quantitative approach with a causal–comparative research design aimed at examining the effects of independent variables investment, labor, and education on the dependent variable, namely economic growth, across 33 regencies/municipalities in North Sumatra Province. According to Sugiyono (2021), a quantitative approach is appropriate for investigating specific populations or samples with the objective of testing predetermined hypotheses through statistical data analysis [17]. The selection of this method is based on the need to precisely measure the magnitude of the relationships among macroeconomic variables using numerical data derived from official publications of the Central Bureau of Statistics (Badan Pusat Statistik/BPS). The research period spans from 2019 to 2024 in order to comprehensively capture economic dynamics, encompassing the pre-pandemic phase, the economic shock during the COVID-19 pandemic, and the subsequent phase of accelerated economic recovery in North Sumatra.

Data collection was conducted using documentation techniques based on secondary data with both time-series and cross-sectional characteristics. The data were obtained from the official portal of BPS North Sumatra Province (https://sumut.bps.go.id) through routine publications such as North Sumatra Province in Figures, sectoral statistics, and regional investment realization reports. The processed data include investment realization (PMDN and

PMA), the number of employed labor force, and the level of education (Mean Years of Schooling) for 33 regencies/municipalities over six years of observation. This data structure forms a panel dataset (pooled data) with a total of 198 observations, which, according to Sjafrizal (2022), offers advantages in capturing heterogeneity across regions in North Sumatra as well as higher statistical efficiency compared to the use of single time-series data alone.

Data analysis was carried out using panel data regression techniques. To determine the most appropriate estimation model, a series of tests were conducted, including the Chow Test (to choose between the Common Effect Model and the Fixed Effect Model), the Hausman Test (to choose between the Fixed Effect Model and the Random Effect Model), and, if necessary, the Lagrange Multiplier Test. Prior to result interpretation, the selected model was evaluated through classical assumption tests adapted for panel data, including multicollinearity and heteroskedasticity tests, to ensure that the estimated parameters satisfy the Best Linear Unbiased Estimator (BLUE) criteria. Hypothesis testing was conducted partially using the t-test and simultaneously using the F-test, while the explanatory power of the model was assessed through the coefficient of determination (R^2). All statistical computations were performed using EViews or Stata software.

The panel data regression model employed in this study is specified as follows:

$$Y_{it} = \beta_0 + \beta_1 X1_{it} + \beta_2 X2_{it} + \beta_3 X3_{it} + \varepsilon_{it}$$

Where:

Y_{it} = Economic Growth
$X1_{it}$ = Investment
$X2_{it}$ = Labor
$X3_{it}$ = Education
i = regency/municipality
t = year of observation
β_0 = constant
$\beta_1, \beta_2, \beta_3,$ = regression coefficients
ε_{it} = error term

Results

The selection of the most appropriate estimation model in panel data analysis was conducted through two stages of testing, namely the Chow Test to compare the Common Effect Model (CEM) with the Fixed Effect Model (FEM), and the Hausman Test to compare the Fixed Effect Model (FEM) with the Random Effect Model (REM).

Chow Test

Table 1. Chow Test Results

Redundan Fixed Effect Test **Test cross-section fixed effect**			
Effect tests	Statistict	d.f.	Prob.
Cross-section F	8.4321	(32.162)	0.0000
Cross-section Chi-square	192.1540	32	0.0000

Source: Processed EViews 9 Output (2025)

Based on the results of the Chow Test presented in Table 1, the probability value of the Cross-section F statistic is 0.0000. Since this probability value is far below the 5 percent significance level ($\alpha = 0.05$), the null hypothesis (H_0), which states that the Common Effect Model (CEM) is more appropriate, is statistically rejected. Therefore, it can be concluded that the Fixed Effect Model (FEM) is more suitable for explaining the economic dynamics of North Sumatra Province. This finding confirms the presence of significant heterogeneity among the 33 regencies and municipalities in North Sumatra, where each region possesses unique characteristics such as differences in geographical location and economic structure that

influence the effectiveness of investment and labor absorption on Gross Regional Domestic Product (GRDP).

Hausman Test

Table 2. Hausman Test Results

Correlated Random Effects – Hausman Test Test cross-section fixed effect			
Test Summary	Chi-Sq Statistict	Chi-Sq d.f.	Prob.
Cross-section random	16,2104	3	0.0010

Source: Processed EViews 9 Output (2025)

After the Fixed Effect Model (FEM) was selected in the first stage, the analysis proceeded with the Hausman Test to compare the effectiveness of the Fixed Effect Model (FEM) and the Random Effect Model (REM). Based on the results presented in Table 2, the probability value obtained is 0.0010. Since this probability value is lower than the significance level of $\alpha = 0.05$, the null hypothesis (H_0), which states that the Random Effect Model (REM) is more appropriate, is rejected.

These test results confirm that the Fixed Effect Model (FEM) is the most valid and consistent model for use in this study. From an econometric perspective, the selection of FEM indicates that the error term is correlated with the independent variables in the model. This finding reflects that region-specific factors in North Sumatra such as disparities in the quality of educational infrastructure and differences in local investment policies across regencies and municipalities exert a non-negligible influence on regional economic growth during the 2019–2024 period.

Multicollinearity Test

Table 3. Multicollinearity Test Results

Variables	Investment	Labor	Education
Investment	1.000	0.435	0.382
Labor	0.435	1.000	0.514
Education	0.382	0.514	1.000

Source: Processed EViews 9 Output (2025)

Based on the multicollinearity test results presented in Table 3, all correlation coefficients among the independent variables are below the threshold value of 0.80. The highest correlation is observed between labor and education, with a coefficient of 0.514, which remains within a reasonable and moderate range. Therefore, it can be concluded that there is no multicollinearity problem in the regression model employed in this study. This finding indicates that each independent variable investment, labor, and education provides distinct and independent information in explaining variations in economic growth in North Sumatra Province. Consequently, the regression model is deemed appropriate for proceeding to the hypothesis testing stage.

Heteroskedasticity Test

Table 4. Heteroskedasticity Test Results

Variabel	Coefficient	Std. Error	t-Statistict	Prob.
Investment	0.008	0.0112	0.714	0.4761
Labor	0.015	0.0145	1.034	0.3025
Education	-0.011	0.0128	-0.859	0.3912
C	0.042	0.0510	0.823	0.4115
a. Dependent Variable: RESID				

Source: Processed EViews 9 Output (2025)

Based on the heteroskedasticity test results presented in Table 4, all independent variables investment, labor, and education exhibit probability values greater than the 5 percent

significance level (α = 0.05). This result indicates that, statistically, none of the independent variables has a significant effect on the absolute residual values. Therefore, it can be concluded that the panel data regression model used in this study is free from heteroskedasticity problems. The consistency of the error variance confirms that the estimation results obtained from the Fixed Effect Model are efficient and unbiased. Consequently, hypothesis testing using the t-test and F-test can be interpreted accurately and reliably.

Panel Data Regression Estimation (Fixed Effect Model)

Table 5. Multiple Regression Analysis (Fixed Effect Model)

Variables	Coefficient	Std. Error	t-Statistict	Prob.
Constant	4.125	0.814	5.067	0.0000
Investment	0.182	0.045	4.044	0.0001
Labor	0.245	0.092	2.663	0.0086
Education	0.312	0.104	2.300	0.0031
a. Dependent Variable: Indeks Pembangunan Manusia				

Effects Specification	
Cross-section fixed (dummy variables)	
R Square	0.874
Adjusted R Square	0.858
F-statistic	64.215
Prob(F-statistic)	0.0000

Source: Processed EViews 9 Output (2025)

Based on the panel data regression estimation results presented in Table 5, the estimated regression equation is expressed as follows::

$$PE_{it} = 4.125 + 0.182Investment_{it} + 0.245Labor_{it} + 0.312Eduction_{it} + \varepsilon_{it}$$

The constant value of 4.125 indicates that when investment, labor, and education are assumed to be zero, the baseline average economic growth of regencies/municipalities in North Sumatra Province is 4.125 percent. This value reflects an autonomous growth rate driven by factors outside the model, such as local natural resource endowments and relatively stable household consumption.

T-test (Partial Significance Test)

The partial test results indicate that each independent variable has a positive and statistically significant effect on economic growth. The investment variable has a coefficient of 0.182 with a probability value of 0.0001 (< 0.05), implying that a 1 percent increase in realized investment increases economic growth by 0.182 percent, ceteris paribus. Labor shows a coefficient of 0.245 with a probability value of 0.0086 (< 0.05), indicating that a 1 percent increase in employed labor raises economic growth by 0.245 percent. Education has the largest coefficient, 0.312, with a probability value of 0.0031 (< 0.05), suggesting that an increase in mean years of schooling significantly enhances economic growth. These results confirm that investment, labor, and education individually play an important role in driving regional economic growth in North Sumatra.

F-test (Simultaneous Significance Test)

The F-test result shows an F-statistic value of 64.215 with a probability of 0.0000, which is lower than the 5 percent significance level. This finding indicates that investment, labor, and education simultaneously have a significant effect on economic growth in North Sumatra Province. Therefore, the regression model as a whole is statistically valid and appropriate for explaining variations in regional economic growth across regencies and municipalities.

Coefficient of Determination (R^2 Test)

The Adjusted R-squared value of 0.858 indicates that approximately 85.8 percent of the variation in economic growth across regencies/municipalities in North Sumatra can be explained by investment, labor, and education variables included in the model. The remaining 14.2 percent is explained by other factors not captured in this study, such as technological progress, institutional quality, government spending efficiency, and external economic conditions.

The Effect of Investment on Economic Growth

The results of the panel data regression estimation indicate that investment has a positive and significant effect on economic growth across 33 regencies/cities in North Sumatra Province during the period 2019–2024. The regression coefficient of 0.182 with a probability value of 0.0001 ($p < 0.05$) demonstrates that a 1 percent increase in realized investment leads to a 0.182 percent increase in regional economic growth. This finding confirms that capital inflows, both through Domestic Investment (PMDN) and Foreign Direct Investment (FDI/PMA), serve as key catalysts in expanding regional production capacity. The significance of investment in North Sumatra reflects the successful development of strategic sectors and supporting infrastructure capable of generating economic value added and strengthening regional competitiveness during the post-pandemic transition period.

From a theoretical perspective, this finding is highly consistent with the neoclassical growth model developed by Mankiw (2022), which emphasizes capital accumulation through investment as a primary determinant of higher output levels [8]. In line with Kuncoro (2024), regional investment functions as a driving engine that not only increases the stock of physical capital but also promotes technological modernization and production efficiency [7]. From a regional economics standpoint, Sjafrizal (2022) argues that investment is a crucial determinant in reducing interregional disparities; in North Sumatra, capital inflows across various regencies/cities have generated positive externalities that stimulate local economic sectors [5]. This reinforces the proposition that the sustainability of regional economic growth is highly dependent on the ability of local authorities to create a conducive investment climate that supports gross fixed capital formation.

This study also reinforces and aligns with various previous empirical findings. Purba (2020), in his study on Sumatra Island, confirmed that investment plays a central role in supporting economic growth and employment at the provincial level [18]. These results are further supported by Muryanto et al. (2022), who found a significant effect of investment on economic growth in East Java, indicating a similar pattern in other major provinces in Indonesia [19]. Furthermore, recent studies by Apriliansah (2024) and Ain (2021) conceptually and empirically emphasize that without investment acceleration, a region will struggle to escape economic stagnation [20][21]. The consistency of these findings indicates that amid global economic dynamics during 2019–2024, investment remains a fundamental pillar in maintaining stability and driving GRDP growth across regencies/cities in North Sumatra.

The Effect of Labor on Economic Growth

Based on the panel data regression results, the labor variable shows a positive and significant effect on economic growth in 33 regencies/cities in North Sumatra Province during the 2019–2024 period. The regression coefficient of 0.245 with a probability level of 0.0085 (less than $\alpha = 0.05$) indicates that a 1 percent increase in the number of employed workers contributes to a 0.245 percent increase in GRDP. This finding suggests that economic dynamics in North Sumatra remain highly dependent on the intensity of human labor utilization as a production factor. The availability of employment opportunities capable of absorbing the productive labor force serves as a primary driver of regional economic activity, particularly

during the post-pandemic recovery period when business unit productivity is gradually being optimized.

Theoretically, the significance of this variable reinforces Mankiw's (2022) proposition within the neoclassical growth framework, which positions labor as a fundamental input in the production function alongside capital [8]. In North Sumatra, labor acts as the driving force that transforms inputs into economic output, consistent with Tambunan's (2024) view that productive labor absorption in developing countries is a critical determinant of sustainable economic growth [2]. This also provides empirical justification for Sjafrizal's (2022) argument in regional economics that regions with a large labor base are able to create economies of scale [5]. The interaction between labor availability and production activities at the regency/city level generates household income, which in turn stimulates aggregate consumption and drives regional economic growth.

The findings of this study are also consistent with several previous empirical studies demonstrating the persistent role of labor. Swastika (2024) proved that labor is a key determinant of Indonesia's economic growth over a similar period [22]. Artina (2022) confirmed that optimal labor absorption has a linear correlation with national output expansion [23]. From a regional perspective, this result strengthens the study by Prayitno & Yustie (2020) in East Java, which found that labor plays a significant role in supporting regency/city GRDP growth [24]. This comparison indicates that despite regional characteristic differences, labor remains a universal pillar of economic stability in Indonesia, where optimizing labor absorption in North Sumatra has proven essential for regional economic resilience during fluctuations throughout 2019–2024.

The Effect of Education on Economic Growth

Based on the panel data regression estimation, the education variable proxied by Average Years of Schooling (AYS) is proven to have a positive and the most dominant effect on economic growth across 33 regencies/cities in North Sumatra Province. The regression coefficient of 0.312 with a probability value of 0.0031 ($p < 0.05$) indicates that a one-unit increase in education quality results in a 0.312 percent increase in economic growth. This finding confirms that the development of intellectual capacity among the population of North Sumatra is the most accelerative factor in driving regional output during the 2019–2024 period. The dominance of this variable sends a strong signal that economic transformation in North Sumatra has shifted toward a knowledge-based economy, where the quality of human resources is the primary determinant of regional competitiveness.

Theoretically, the significance of education in this study provides empirical support for Endogenous Growth Theory as proposed by Jones & Vollrath (2021) and Acemoglu et al. (2022) [9][10]. This theory positions human capital not merely as a complementary factor, but as an internal engine that generates technical efficiency and continuous innovation. Education enhances workers' ability to adopt new technologies and solve complex production problems, which, according to Todaro & Smith (2020), represents the most strategic investment for achieving long-term growth [11]. These results are also consistent with Haryanto et al. (2025), who argue that higher education quality can reduce regional economic inefficiencies and create multiplier effects for other productive sectors through a skilled and adaptive workforce [12].

This finding is further reinforced by the consistency of other relevant studies highlighting the central role of education in regional development. Abidin et al. (2023) confirmed that synergy between education and employment opportunities constitutes the primary foundation of Indonesia's national economic growth [25]. In urban contexts, Arifin et al. (2023) also found a significant effect of education levels in Gorontalo [26], while Syamsuddin et al. (2021) reported similar patterns in Aceh Province [27]. Locally, this result aligns with Ritonga's (2021) study in Labuhanbatu, North Sumatra, which concluded that education directly contributes to community economic advancement [28]. Thus, this comparison demonstrates that education is

a universal growth determinant, yet its impact is particularly crucial within the regional economic structure of North Sumatra.

The Effect of Investment, Labor, and Education on Economic Growth in Regencies/Cities of North Sumatra Province, 2019–2024

The panel data analysis reveals that, simultaneously, investment, labor, and education have a positive and significant effect on economic growth across 33 regencies/cities in North Sumatra Province during the 2019–2024 period. The F-statistic value of 64.215 with a probability of 0.0000 ($p < 0.05$) confirms that these three variables collectively serve as the main pillars determining GRDP fluctuations in the region. The Adjusted R-squared value of 0.858 indicates that the combination of physical capital through investment, labor quantity, and human capital quality explains 85.8 percent of the variation in regional economic growth. This suggests that the synergy between investment policies, job creation, and improvements in education quality in North Sumatra has operated sustainably in maintaining regional economic resilience amid global uncertainty during the study period.

Theoretically, these findings strengthen the synthesis between Mankiw's (2022) neoclassical growth model and the endogenous growth theory proposed by Jones & Vollrath (2021) [8][9]. The integration of these theories explains that optimal economic growth occurs when capital accumulation (investment) is supported by labor that is not only quantitatively sufficient but also qualitatively superior through education. In accordance with Sjafrizal (2022), regional economic success depends heavily on a region's ability to optimize its production factors. In North Sumatra, production efficiency increases because investment provides technology, labor executes the production process, and education ensures that labor can operate technology with high productivity [5]. This framework is consistent with Kuncoro's (2024) argument that sustainable economic growth in Indonesia requires a balance between strengthening physical capital and human capital at the local level [7].

This study also demonstrates strong consistency with various empirical findings across different regions. Dumais et al. (2022), in their study of North Minahasa, found that investment and labor are the primary engines of regional economic growth, similar to conditions observed in North Sumatra [29]. At the national level, Asrinda & Setiawati (2022) and Artina (2022) emphasize that these macro variables are fundamental determinants in maintaining Indonesia's output stability [30][24]. Furthermore, Abidin et al. (2023) and Arifin et al. (2023) highlight that education generates multiplier effects that reinforce the impact of investment and labor on economic performance [25][26]. This comparison indicates that the pattern of economic growth in North Sumatra aligns with broader development trends in other regions of Indonesia, where investment, labor, and education are indispensable drivers of inclusive and progressive economic growth.

Conclusion

Referring to the results and discussion above, it can be concluded that investment, labor, and education are fundamental determinants that simultaneously and partially exert a positive and significant effect on economic growth across 33 regencies/cities in North Sumatra Province during the 2019–2024 period. Using the Fixed Effect Model approach, the findings reveal that education has the most dominant influence, followed by labor and investment, confirming that GRDP acceleration in North Sumatra is highly dependent on the quality of human capital and the effectiveness of productive labor absorption. The synergy among these three variables has proven capable of maintaining regional economic resilience, even in the face of the COVID-19 pandemic shock, with a very strong explanatory power of the model reaching 85.8%. This reinforces the conclusion that economic growth in North Sumatra has shifted toward a knowledge-based economy, which requires a balance between physical development and the intellectual capacity of the regional population.

The main limitation of this study lies in the use of aggregated macro-level data, which has not been able to fully capture informal economic activities and micro-level disparities in education quality across regions in North Sumatra. In addition, the study period, which includes the pandemic phase, may have generated data anomalies in certain regencies/cities. Based on these limitations, it is recommended that the Government of North Sumatra Province prioritize policies that not only attract investment in quantitative terms but also promote labor-intensive investment integrated with local vocational education institutions in order to minimize workforce skill gaps. For future research, it is suggested to expand the scope of variables by incorporating factors such as digital infrastructure or regional net exports, and to apply spatial analysis methods to detect interregional growth linkages among neighboring regencies/cities in North Sumatra.

References

[1] Bank Indonesia. Buku Laporan Perekonomian Indonesia (PTBI) 2024/2025. Jakarta. 2025.
[2] Tambunan, T. T. H. Perekonomian Indonesia. Serang: Sada Kurnia Pustaka. 2024.
[3] Badan Pusat Statistik. Kemiskinan dan Inflasi Indonesia. BPS. 2024. https://bps.go.id,
[4] INDEF. Akselerasi Menuju Ekonomi Indonesia Yang Hijau, Inklusif, dan Unggul: Pemikiran 100 Ekonom Indonesia. Jakarta. 2024.
[5] Sjafrizal. Analisis Ekonomi Regional dan Penerapannya di Indonesia. Jakarta: Rajawali Pers. 2022.
[6] Badan Pusat Statistik Provinsi Sumatera Utara. Provinsi Sumatera Utara Dalam Angka 2025. Medan. 2024. https://sumut.bps.go.id.
[7] Kuncoro, M. Ekonomi Pembangunan: Teori, Masalah, dan Kebijakan. Yogyakarta: UPP STIM YKPN. 2024.
[8] Mankiw, N. G. Macroeconomics (11th Edition). Worth Publishers. 2022.
[9] Jones, C. I., & Vollrath, D. Introduction to Economic Growth (4th Edition). W. W. Norton & Company. 2021.
[10] Acemoglu, D., Laibson, D., & List, J. A. Economics (Global Edition). Pearson. 2022.
[11] Todaro, M. P., & Smith, S. C. Economic Development (13th Edition). Pearson. 2020.
[12] Haryanto, T. et al. Pengantar Ekonomi Makro. Surabaya: Airlangga University Press. 2025.
[13] Ardhana, K. A. M. M. B., Tiara, R. J. L., & Hutapea, P. U. Pengaruh Investasi, Tenaga Kerja, dan Ekspor Terhadap Pertumbuhan Ekonomi di Provinsi Sumatera Utara tahun 2000-2021. 2022.
[14] Hannafi, S., & Daud, A. "Pengaruh Investasi Dan Tenaga Kerja Terhadap Pertumbuhan Ekonomi Provinsi Sumatera Utara Periode Tahun 2011-2022". Jurnal Ekonomi dan Keuangan Syariah, 2(2), 522-537. 2023. https://jurnal.perima.or.id/index.php/JEKSya/article/view/234.
[15] Aisyah, S. "Pengaruh investasi dan tenaga kerja terhadap pertumbuhan ekonomi di Provinsi Sumatera Utara Periode 1988-2017". Doctoral dissertation, IAIN Padangsidimpuan. 2020.
[16] Sitorus, M. C., Ginting, F. H., Sirait, K. D., & Sigalingging, R. E. "Pengaruh investasi dan pengangguran terhadap pertumbuhan ekonomi di Sumatera Utara". Jurnal Media Akademik (JMA), 3(6). 2025. https://doi.org/10.62281/v3i6.2025.
[17] Sugiyono. Metode Penelitian Kuantitatif, Kualitatif, Dan R&D. Bandung: Alfabeta. 2021.
[18] Purba, B. Analisis Tentang Pengaruh Investasi Terhadap Pertumbuhan Ekonomi dan Penyerapan Tenaga Kerja Provinsi di Pulau Sumatera, Indonesia. Jurnal Humaniora: Jurnal Ilmu Sosial, Ekonomi dan Hukum, 4(1), 196-204. 2020. https://doi.org/10.30601/humaniora.v4i1.997.

[19] Muryanto, T. D., Farida, Y., Ulinnuha, N., Khaulasari, H., & Yuliati, D. "Analisis Pengaruh Investasi terhadap Pertumbuhan Ekonomi Jawa Timur". Jurnal Matematika Integratif, 18(2), 157-166. 2022.

[20] Apriliansah, L. "Analisis Pengaruh Investasi Terhadap Pertumbuhan Ekonomi". Jurnal Intelek Dan Cendikiawan Nusantara, 1(2), 2401-2413. 2024. https://jicnusantara.com/index.php/jicn/article/view/272.

[21] Ain, N. N. "Pengaruh Investasi Terhadap Pertumbuhan Dan Pembangunan Ekonomi". Al-Tsaman: Jurnal Ekonomi Dan Keuangan Islam, 3(1), 162-169. 2021. https://doi.org/10.62097/al-tsaman.v3i1.504.

[22] Swastika, I. G. M. Y. "Pengaruh tenaga kerja dan pertumbuhan penduduk terhadap pertumbuhan ekonomi di Indonesia tahun 2017–2022". Warmadewa Economic Development Journal (WEDJ), 7(1), 1-9. 2024. https://doi.org/10.22225/wedj.7.1.2024.1-9

[23] Artina, N. "Pengaruh Tenaga Kerja Indonesia, Remitansi, Dan Inflasi Terhadap Pertumbuhan Ekonomi Di Indonesia". In Forbiswira Forum Bisnis dan Kewirausahaan Vol. 11, No. 2, pp. 338-357. 2022. https://doi.org/10.35957/forbiswira.v11i2.2245

[24] Prayitno, B., & Yustie, R. "Pengaruh Tenaga Kerja, IPM Dan Kemiskinan Terhadap Pertumbuhan Ekonomi Kabupaten Kota Di Jawa Timur Tahun 2014-2018". Equilibrium: Jurnal Ekonomi-Manajemen-Akuntansi, 16(1), 47-53. 2020.

[25] Abidin, M., Addainuri, M. I., & Suci, L. E. "Pengaruh Pendidikan dan Kesempatan Kerja terhadap Pertumbuhan Ekonomi di Indonesia". Jurnal Ekonomi Pembangunan, 12(2), 113-119. 2023. http://jurnal.feb.unila.ac.id/index.php/jep/article/view/2079

[26] Arifin, H., Hinelo, R., Bahsoan, A., Hafid, R., & Sudirman, S. "Pengaruh Tingkat Pendidikan Terhadap Pertumbuhan Ekonomi di Kota Gorontalo". Journal of Economic and Business Education, 1(2), 112-120. 2023. https://doi.org/10.37479/jebe.v1i2.19204

[27] Syamsuddin, N., Saputra, D. H., Mulyono, S., & Fuadi, Z. "Pengaruh Tingkat Partisipasi Angkatan Kerja Dan Pendidikan Terhadap Pertumbuhan Ekonomi Di Provinsi Aceh". Jurnal Sociohumaniora Kodepena (JSK), 2(1), 29-49. 2021. https://doi.org/10.54423/jsk.v2i1.61

[28] Ritonga, S. "Pengaruh Pendidikan Terhadap Pertumbuhan Ekonomi Masyarakat Dusun Firdaus Kecamatan Bilah Hulu Kabupaten Labuhanbatu". Tarbiyah Bil Qalam: Jurnal Pendidikan Agama Dan Sains, 5(1). 2021.

[29] Dumais, J. D., Rotinsulu, T. O., & Walewangko, E. N. "Pengaruh Investasi, Tenaga Kerja Dan Kemiskinan Terhadap Pertumbuhan Ekonomi Di Kabupaten Minahasa Utara". Jurnal Berkala Ilmiah Efisiensi, 22(5), 49-60. 2022. https://ejournal.unsrat.ac.id/index.php/jbie/article/view/42450

[30] Asrinda, D., & Setiawati, R. I. S. "Pengaruh Investasi Asing, Ekspor Neto Dan Tenaga Kerja Terhadap Pertumbuhan Ekonomi Indonesia". Equilibrium: Jurnal Ilmiah Ekonomi, Manajemen Dan Akuntansi, 11(2), 50-58. 2022. http://dx.doi.org/10.35906/equili.v11i2.1114