Analysis of the Effect of Labor, Investment, and Per Capita Income in North Sumatra Province, 2015–2024

Aprianto Situmorang, Annisa Ilmi Faried, Suhendi

Abstract

Per capita income is frequently used as a concise indicator to describe the average level of economic welfare of a region's population. Within the framework of neoclassical growth theory, movements in per capita income are influenced by capital accumulation (investment), labor input dynamics, and the quality of human capital (education) that enhances productivity. This study aims to empirically examine the effects of labor, investment, and education on per capita income in North Sumatra Province during the period 2015–2024. This research employs a quantitative approach using multiple linear regression analysis, with classical assumption testing as well as partial and simultaneous significance tests, based on secondary data obtained from Statistics Indonesia (BPS) for the years 2015–2024. The estimation results indicate that labor and education have a positive and statistically significant effect on per capita income, whereas investment (FDI and DDI) does not show a statistically significant partial effect. Simultaneously, the three variables significantly affect per capita income, with a high coefficient of determination (R^2), indicating that the model has strong explanatory power.

These findings suggest that improving the quality of human resources through education and optimizing labor productivity play a strategic role in increasing per capita income in North Sumatra. Investment policies should be directed toward productive and labor-intensive sectors to generate a greater multiplier effect on community welfare. The results of this study are expected to provide policy implications for strengthening a productive investment climate, enhancing human capital through education, and expanding employment absorption to sustainably increase per capita income.

Keywords: Per capita income, Labor, Investment, Education, Economic growth, North Sumatra.

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Introduction

Per capita income, commonly proxied by Gross Regional Domestic Product (GRDP) per capita, is a concise indicator widely used to describe the average economic welfare of a region. In official statistical concepts, GRDP per capita at current prices reflects the nominal value of GRDP per person, while GRDP per capita at constant prices is used to measure real per capita economic growth. In the context of regional development, this concept is relevant as a summary indicator to monitor improvements in economic welfare as well as average regional productivity over time, as it captures a region's capacity to generate value added which, in aggregate, supports improvements in living standards.

North Sumatra Province is one of the economic growth centers in western Indonesia, with an economic structure supported by manufacturing, trade, agriculture, and service sectors. As an indicator of economic welfare, per capita income is often used to describe the average economic capacity of people within a region. According to Statistics Indonesia (BPS), per capita income is calculated by dividing the Gross Regional Domestic Product (GRDP) by the total population, reflecting the relative level of prosperity of a region (BPS, 2024).

Theoretically, the neoclassical growth model developed by Robert Solow (1956) emphasizes that output growth is determined by capital accumulation and labor, with technological progress treated as an exogenous factor. In this model, an increase in investment expands the capital stock, thereby enhancing production capacity and output per capita.

Investment, whether through Foreign Direct Investment (FDI) or Domestic Direct Investment (DDI), plays a crucial role in promoting regional economic growth through job creation, increased production, and technology transfer (BPS, 2024). However, several empirical studies suggest that the impact of investment on welfare is not always directly significant, depending on sectoral distribution and the effectiveness of labor absorption. In the Indonesian context, investment and labor have strategic roles in enhancing regional economic growth (Arsyad, 2015). Pratama Risky et al. (2017), in their regional economic study of North Sulawesi, also found that investment and human capital quality significantly contribute to GRDP per capita, reinforcing the importance of investment in increasing regional output.

Research by Annisa Ilmi Faried (2020; 2025) demonstrates that improvements in education quality significantly influence societal welfare through productivity enhancement and poverty reduction mechanisms. Meanwhile, Suhendi (2025) confirms that human development indicators contribute to improving regional economic conditions. Nevertheless, most of these studies focus primarily on poverty and the Human Development Index (HDI), rather than directly examining per capita income as the main dependent variable. Empirically, BPS data for the period 2015–2024 show an increasing trend in average years of schooling and the labor force in North Sumatra, followed by a rise in per capita income. However, fluctuations in FDI and DDI realization are not always aligned with increases in per capita income, making it interesting to examine econometrically.

Despite this, there has been no study that simultaneously examines labor, investment (FDI/DDI), and education on per capita income in North Sumatra for the most recent period of 2015–2024. This constitutes the research gap underlying the present study. The contribution (novelty) of this research lies in simultaneously testing three classical determinants (labor, investment—FDI/DDI, and education) within a single provincial region over the 2015–2024 period, and directly linking them to an average welfare indicator (GRDP/per capita income) using proxies commonly applied in the Solow-augmented and human capital literature, with indicator definitions based on official BPS metadata.

Literature Review

Labor

Labor is one of the primary factors of production in economic growth theory. In the neoclassical growth model proposed by Solow (1956), economic output is determined by the combination of capital and labor. An increase in the labor force expands production capacity

and promotes aggregate output growth. However, in the context of per capita income, the impact of labor is not determined solely by its quantity but also by labor productivity.

Within this framework, labor endowed with higher levels of education and skills generates greater output per worker, thereby contributing to higher per capita income.

In Indonesian development economics literature, Arsyad (2015) argues that labor is a key determinant of regional economic growth, as it is directly associated with production capacity and real sector activities. Kindangen and Walewangko (2017), in their regional economic study, found that labor significantly influences regional GDP per capita through the mechanism of increased regional production capacity. Regions with higher labor force participation rates tend to experience faster economic growth.

Empirical research by Ardiansyah, Zuhroh, and Abdullah (2018) also found that labor absorption in the industrial sector contributes to regional economic growth dynamics. Furthermore, Rusniati, Sudarti, and Agustin (2018) explain that economic growth and investment activities influence labor absorption, which ultimately affects community welfare levels. Annisa Ilmi Faried (2020) demonstrates that improvements in human resource quality contribute to enhanced economic welfare. In the context of human development, Suhendi (2025) emphasizes that employment indicators are closely related to regional economic dynamics and community welfare. This indicates that labor, as a factor of production, should be assessed not only in terms of quantity but also quality and its linkage to human development.

Conceptually, the influence of labor on per capita income can be explained through three main mechanisms:

1. Production effect – an increase in the labor force raises total output.
2. Productivity effect – more productive labor increases output per worker.
3. Welfare effect – higher labor absorption reduces unemployment and improves income distribution.

Therefore, theoretically, an increase in both the quantity and quality of labor in a region will positively contribute to the improvement of per capita income.

H_1: Labor has a positive and significant effect on per capita income in North Sumatra during the period 2015–2024.

Investment

In macroeconomics, investment is understood as expenditure on the formation or addition of capital goods (capital formation) that increases future production capacity. In Indonesia, the formal definition of capital investment is also specified in official statistical metadata. Statistics Indonesia (BPS) defines capital investment as all forms of capital placement activities carried out by domestic and foreign investors to conduct business activities within the territory of Indonesia. Meanwhile, Foreign Direct Investment (FDI/PMA) is defined as investment activities undertaken by foreign investors to conduct business in Indonesia, either fully financed by foreign capital or in joint ventures.

Implications for per capita income studies**:** an increase in the realization of Foreign Direct Investment (FDI/PMA) and Domestic Investment (DI/PMDN) is expected to promote capital accumulation, productivity growth, job creation, and regional multiplier effects, which ultimately enhance output per capita (per capita income). Investment constitutes a key component in economic growth theory, as it plays a central role in capital formation that expands a region's production capacity. In the neoclassical growth theory developed by Robert Solow (1956), capital accumulation (K) together with labor (L) determines the level of economic output. Investment increases the capital stock, thereby encouraging capital deepening (an increase in capital per worker), which ultimately raises output and per capita income.

Earlier, the Harrod–Domar growth model, developed by Roy Harrod (1939) and Evsey Domar (1946), emphasized that the level of investment determines the rate of economic growth through capacity formation. Within this framework, the higher the investment-to-output ratio, the greater the potential for economic growth and improvement in per capita income.

In the context of regional development in Indonesia, investment may take the form of Domestic Investment (PMDN) and Foreign Direct Investment (PMA). Based on national regulation (Law No. 25 of 2007 on Investment), FDI refers to investment activities conducted by foreign investors within the territory of Indonesia, whereas DI refers to capital placement by domestic investors. FDI is often associated with technology transfer, modern management practices, and access to global markets, while DI strengthens domestic industrial structures and promotes local economic empowerment.

Theoretically, investment operates through several main channels:

1. Capital accumulation and productivity

Investment increases the capital stock (machinery, production facilities, technology), thereby improving labor productivity and regional output.

2. Job creation

Investment directed toward productive or labor-intensive sectors tends to increase employment absorption, expand household income, and strengthen purchasing power.

3. Technological and managerial spillovers (particularly FDI)

FDI is frequently associated with technology transfer, production standards, and market networks that may enhance local productivity. However, this effect depends on human capital readiness and the strength of local industrial linkages.

Empirical evidence in Indonesia often indicates that investment is associated with regional economic performance. For example, district-level studies have found that investment and labor significantly influence sectoral output (regional GDP), which forms the foundation for increasing per capita income. Furthermore, research examining the relationship between investment and employment opportunities emphasizes that investment contributes to economic growth through production expansion and labor absorption.

Empirically, investment contributes to increased regional output through production capacity expansion, job creation, and productivity enhancement. Mankiw, Romer, and Weil (1992) demonstrated that savings and investment rates affect per capita income levels in long-run equilibrium. Thus, regions with higher levels of investment tend to exhibit higher levels of per capita income.

However, the impact of investment on per capita income is not always immediate or direct. The effects may occur in the long term (lag effect), depending on the type of investment, targeted sector, and industrial linkages (multiplier effect). Capital-intensive investments with limited labor absorption may generate only modest short-term impacts on per capita income, whereas productive investments integrated with the local economy tend to produce greater and more sustainable effects.

Based on the theoretical framework above, it can be conceptually expected that increased realization of investment (FDI/DI) has a positive effect on per capita income in North Sumatra Province during the 2015–2024 period.

The investment climate is not solely determined by capital availability, but also by regulatory certainty, licensing procedures, and governance quality. Regulatory reforms and licensing simplification are typically positioned to accelerate investment realization and reduce transaction costs. Sutrisno and Poerana (2020) discuss the dynamics of legal reform and foreign investment realization in the context of national policy, supporting the argument that regulatory certainty and policy design influence investment interest and realization. Nadhiroh (2022) reviews the Online Single Submission (OSS) licensing policy and its relationship with investment from an environmental perspective, suggesting that licensing reform has implications for investment dynamics. Additionally, studies on investment literacy and behavior by Adnyaswari & Sinarwati, as well as Budiman et al., emphasize the importance of rational decision-making and risk management in investment decisions. Although these studies are conducted at the micro level (capital markets), conceptually they suggest that the quality of investment decisions determines long-term economic impact.

H_2**:** Investment (FDI/DI) has a positive effect on per capita income in North Sumatra Province during the 2015–2024 period.

Education (Average Years of Schooling – RLS)

Education is an indicator that reflects the number of years of formal schooling completed by the population. According to Statistics Indonesia (Badan Pusat Statistik/BPS), the Average Years of Schooling (Rata-Rata Lama Sekolah, RLS) is defined as the average number of years spent in formal education by individuals aged 25 years and above (BPS, SIRUSA). This indicator is widely used as a proxy for the quantity of education (school attainment) in studies on economic growth and per capita income.

In development economics theory, education is regarded as an investment in human capital. This concept emphasizes that improvements in education enhance individuals' abilities, skills, and productivity, which ultimately lead to higher income and welfare. Within the framework of endogenous growth theory, Robert Lucas Jr. (1988) argues that the accumulation of human capital not only increases labor productivity but also stimulates innovation, technology diffusion, and long-term economic growth. Therefore, education plays a strategic role in strengthening a region's productive capacity and accelerating the growth of per capita income.

Conceptually, the relationship between education and per capita income can be explained through the following mechanism:

Education → Increased Productivity → Higher Output (GRDP) → Higher Per Capita Income

The higher the level of education within a society, the better the quality of the labor force produced, thereby enhancing efficiency and value added in economic activities.

In the Indonesian context, the education dimension in measuring human development is commonly proxied by Average Years of Schooling (RLS). This indicator reflects the accumulated educational attainment of the population and constitutes one of the components of the Human Development Index (HDI).

The use of RLS in economic research has several advantages:

1. It represents the long-term stock of education that has been formed.
2. It is relatively stable and consistently available in regional time-series data.
3. It is relevant as a proxy for human capital quality in growth models.

Thus, RLS can be considered an aggregate indicator representing the level of human capital in a region.

Various empirical studies in Indonesia show that education plays an important role in improving regional economic performance. A study by Risky Pratama, Paulus Kindangen, and Een N. Walewangko (2019) found that the level of education contributes to regional economic growth alongside investment and labor. These findings reinforce the argument that the quality of human resources is a crucial factor in driving regional output. Furthermore, Arsyad (2015), in his development economics analysis, states that improving the quality of education is a prerequisite for accelerating regional economic growth, as education enhances labor competitiveness and strengthens the regional economic structure. Other studies examining education and economic development indicate that increases in RLS tend to be followed by improvements in productivity and income levels, although the effects are often observed in the medium to long term.

Based on human capital theory and economic growth theory, education is predicted to have a positive influence on per capita income. In this study, education is proxied by Average Years of Schooling (RLS). Theoretically, an increase in RLS reflects an improvement in the quality of human resources, which should enhance productivity and income growth. However, it should be noted that the impact of education on per capita income often involves a time lag effect, as improvements in educational attainment generate economic returns only when individuals enter the labor market and contribute to productive activities.

H_3: Education (RLS) has a positive effect on Per Capita Income in North Sumatra.

Per Capita Income

In regional statistical practice, per capita income is generally proxied by Gross Regional Domestic Product (GRDP) per capita, calculated as total GRDP divided by the population in a given period. Because this variable reflects an average value, it does not necessarily capture income distribution or inequality. Nevertheless, it is useful for assessing the direction of changes in "average welfare" and economic productivity per capita.

Theoretical implication**:** An increase in GRDP per capita indicates a rise in average output per person. In growth models, this is associated with capital accumulation, total factor productivity, labor quality, and the structure of the economy.

Per capita income is an economic indicator that represents the average income or output received by each resident in a particular region during a specific period. Dian Yustriawan (2021) examined per capita income across regencies/cities in North Sumatra in relation to intergovernmental fiscal transfers and capital expenditure, while Masrida Zasriati (2022) positioned per capita income as a key variable that has a positive and significant effect on regional economic performance. Hadi Sasana (2019) also frequently employed per capita income in empirical studies, testing it as one of the determinants of consumption behavior.

In neoclassical economic growth theory, the level of output or per capita income moves in line with capital accumulation, labor utilization, and technological progress. Meanwhile, the augmented growth approach incorporates the role of human capital quality. This framework is widely applied in development economics and regional development planning (for example, in economic development references that discuss output and welfare indicators, including per capita income). However, per capita income as an indicator has limitations. Despite these limitations, in regional macroeconomic analysis, per capita income remains a primary indicator for assessing regional economic performance.

In this study, per capita income is treated as the dependent variable influenced by labor, investment (FDI and DDI), and average years of schooling. Theoretically, improvements in production factors and human capital are expected to increase regional output, which is reflected in higher per capita income in North Sumatra Province during the 2015–2024 period.

Research Methodology

This study employs a quantitative research approach, meaning that the data used are numerical in nature or converted into numerical form. Hypothesis formulation is essential in quantitative research (Suhendi et al., 2025). The hypotheses represent provisional assumptions that will be tested to determine the validity of their relationships through data collection and analysis methods.

This research examines four variables, consisting of three independent variables and one dependent variable. The independent variables include labor, investment, and education, while the dependent variable is per capita income. The study utilizes secondary data published by the Central Bureau of Statistics (BPS) of North Sumatra Province, covering a time series period from 2015 to 2024. Data processing is conducted using multiple linear regression analysis with the assistance of SPSS software.

Multiple linear regression analysis aims to measure or test the influence of independent variables on the dependent variable. The testing is conducted to determine the effect of variables both simultaneously (collectively) and partially (individually). In this method, several statistical tests are performed, including the coefficient of determination (R^2), the simultaneous significance test (F-test), and the partial significance test (t-test). Prior to conducting these tests, classical assumption tests are performed to ensure that the regression model is valid, unbiased, efficient, and consistent. These tests include normality testing, multicollinearity testing, heteroscedasticity testing, and autocorrelation testing.

Classical Assumption Test

The classical assumption test in the multiple linear regression analysis method consists of four tests, which include:

Normality Test

The normality test is conducted to examine whether, in the regression model, both the dependent and independent variables are normally distributed. In this testing procedure, the criteria can be observed through the Kolmogorov–Smirnov test. The Kolmogorov–Smirnov (K–S) test is performed by assessing the normality of the residuals using the non-parametric Kolmogorov–Smirnov statistical test (Darmadi, 2013). In the Kolmogorov–Smirnov test, the data are considered to be normally distributed if they meet the criterion that the Asymp. Sig. (2-tailed) value is greater than 0.05.

In addition to examining the Kolmogorov–Smirnov (K–S) test, normality is also evaluated by observing the Normal P–P Plot graph. In the Normal P–P Plot, the diagonal line serves as a reference; if the data points are distributed around and follow the direction of the diagonal line, the residuals are considered to be normally distributed.

Multicollinearity Test

According to Ghozali as cited in Sumantri et al. (2018), the multicollinearity test aims to determine whether there is a correlation among independent variables in a regression model. A commonly used cutoff value to indicate the presence of multicollinearity is a tolerance value ≤ 0.10 or equivalently a Variance Inflation Factor (VIF) ≥ 10.

Heteroskedasticity Test

According to Ghozali as cited in Sumantri et al. (2018), the heteroskedasticity test aims to examine whether, in the regression model used in the study, there is inequality of variance in the residuals from one observation to another. If the variance of the residuals remains constant across observations, it is referred to as homoskedasticity; if it differs, it is called heteroskedasticity. The presence or absence of heteroskedasticity can be identified by observing a scatterplot graph. If a specific pattern appears in the graph, such as a wave-like pattern that expands and contracts, then the data fail the heteroskedasticity test (Ghozali, 2006).

Autocorrelation Test

According to Ghozali as cited in Herdiyanto (2015), the autocorrelation test aims to examine whether, in a linear regression model, there is a correlation between the error term in period t (current period) and the error term in period t−1 (previous period). According to Ghozali (2007) as cited in Sorongan (2015), the criteria used in the autocorrelation test are as follows: a Durbin–Watson (D-W) value between 0 and 1.5 indicates positive autocorrelation; a D-W value between 1.5 and 2.5 indicates no autocorrelation; and a D-W value between 2.5 and 4 indicates negative autocorrelation.

In this study, the hypothesis formulation is constructed using the following regression model:

$Y=\alpha+\beta1X1+\beta2X2+\beta3X3+\varepsilon$

In this regression model, economic growth (Y) is equal to a constant term (α) plus the coefficients of X1, X2, and X3, and an error term (ε).

Coefficient of Determination Test

According to Amimah (2022), the coefficient of determination test is intended to demonstrate the model's ability to explain the variation in the dependent variable. If the R-square value is small, it indicates that the ability of the independent variables to explain the dependent variable is limited. The coefficient of determination used in this study is the Adjusted R-square. This measure is selected because it is more appropriate when the model includes more than one independent variable.

Simultaneous Significance Test (F-Test)

The F-statistic test essentially shows whether all independent variables included in the model simultaneously affect the dependent variable (Herdiyanto, 2015). According to Amimah

(2022), if the significance value is greater than 0.05 and the calculated F-value is smaller than the critical F-table value, it indicates that the independent variables do not have a statistically significant simultaneous effect on the dependent variable.

Partial Significance Test (t-Test)

The t-statistic test essentially measures the extent to which each independent variable individually explains the variation in the dependent variable (Herdiyanto, 2015). According to Amimah (2022), if the significance value is less than 0.05 and the calculated t-value is greater than the critical t-table value, it indicates that the independent variable has a statistically significant partial effect on the dependent variable.

Results

Descriptive Statistics

Table 1. Descriptive Statistics

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pendidikan	10	8,94	9,75	9,4110	,25835
Investasi	10	4287400000000,00	4236000000000,00	1723532000000,00	1115439920049 4,844
Tenaga Kerja	10	6360000,00	7723000,00	6957300,0000	459177,53768
Pendapatan Per Kapita	10	41019539,00	73570000,00	55729326,3000	10285347,1598 4
Valid N (listwise)	10				

The descriptive statistics table provides an overview of the characteristics of the research data for the 2015–2024 period, with a total of 10 annual observations (N = 10). The results can be described as follows:

- Education (Average Years of Schooling) in North Sumatra during the study period averaged 9.41 years, indicating that, on average, the population completed education up to the junior secondary level and was approaching senior secondary level.
  The relatively small standard deviation (0.258) indicates that educational attainment was stable and increased gradually from year to year. In other words, there were no extreme fluctuations in the education indicator.
  Substantively, this reflects a consistent improvement in human capital quality throughout the study period.
- The average realization of investment during 2015–2024 was approximately IDR 17.23 trillion, with a significantly high maximum value recorded in 2024.
  The large standard deviation (IDR 11.15 trillion) indicates that investment was highly volatile. This suggests substantial inter-annual differences, possibly influenced by national/global economic conditions, the COVID-19 pandemic, or the implementation of specific strategic projects.
  From an economic perspective, high investment volatility may lead to unstable effects on per capita income growth.
- The average number of employed persons (labor force employed) during the study period was approximately 6.96 million people.
  The relatively moderate standard deviation indicates that employment increased gradually and remained relatively stable. There were no drastic spikes or declines, although slight dynamics occurred during the pandemic period.
  This suggests that the regional labor structure was sufficiently consistent in supporting economic activity.

- The average per capita income in North Sumatra during 2015–2024 was approximately IDR 55.7 million per year.
  A standard deviation of IDR 10.28 million indicates a fairly significant increase throughout the observation period, particularly after 2021.
  The high maximum value reflects a positive regional economic growth trend.

Overall, the data demonstrate an upward trend across all variables during the 2015–2024 period, with the greatest fluctuation occurring in the investment variable. Education and employment were relatively stable, while per capita income showed consistent growth.
These descriptive findings provide a strong empirical foundation for proceeding to regression analysis in order to examine the effect of each independent variable on per capita income.

Normality Test of Data

Table 2. Normality Test of Data

One-Sample Kolmogorov-Smirnov Test

			Unstandardized Residual
N			10
Normal Parameters[a,b]	Mean		,0000000
	Std. Deviation		1298979,27310091
Most Extreme Differences	Absolute		,155
	Positive		,134
	Negative		-,155
Test Statistic			,155
Asymp. Sig. (2-tailed)[c]			,200[d]
Monte Carlo Sig. (2-tailed)[e]	Sig.		,721
	99% Confidence Interval	Lower Bound	,710
		Upper Bound	,733

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

e. Lilliefors' method based on 10000 Monte Carlo samples with starting seed 334431

The purpose of the Kolmogorov–Smirnov (K–S) test is to determine whether the regression residuals are normally distributed. In classical linear regression analysis, one of the key assumptions is that the error terms (residuals) follow a normal distribution. This assumption is essential to ensure that the t-test and F-test are statistically valid, that parameter estimates are statistically unbiased, and that the regression model is appropriate for inferential analysis.

Based on the results of the One-Sample Kolmogorov–Smirnov Test, the Asymp. Sig value is 0.200 > 0.05. Therefore, the model residuals are considered to be normally distributed. Thus, the normality assumption in the regression model is satisfied, and the regression analysis can proceed to the hypothesis testing stage.

Multicollinearity Test

Table 3. Multicollinearity Test

Coefficients[a]

Model	Collinearity Statistics	
	Tolerance	VIF

1	(Constant)		
	Pendidikan	,132	7,585
	Investasi	,210	4,771
	Tenaga Kerja	,124	8,073

a. Dependent Variable: Pendapatan Per Kapita

The next test conducted was the multicollinearity test. Based on the results, the education variable (X) has a tolerance value of 0.132 > 0.10 and a VIF of 7.585 < 10, indicating that the education variable does not experience serious multicollinearity, although there is a moderate correlation with other variables.

For the investment variable (X), the tolerance value is 0.210 > 0.10 and the VIF is 4.771 < 10. These values indicate that investment is relatively independent of the other variables, does not create disturbances in the model, and does not exhibit multicollinearity.

Meanwhile, the labor variable (X) has a tolerance value of 0.124 > 0.10 and a VIF of 8.073 < 10, showing that this variable also does not experience multicollinearity. Although the VIF value is close to 10, it remains below the critical threshold and is therefore still acceptable. This is reasonable because, in economic growth theory, labor and education are indeed interrelated.

Based on the test results, it can be concluded that none of the three independent variables exhibit multicollinearity, and the analysis can proceed to the next stage.

Heteroskedasticity Test

Based on the results of the heteroskedasticity test using the scatterplot method, the residual points are randomly distributed and do not form any specific pattern. Therefore, it can be concluded that the regression model does not suffer from heteroskedasticity. Thus, the classical regression assumptions are satisfied, and the model is appropriate for hypothesis testing.

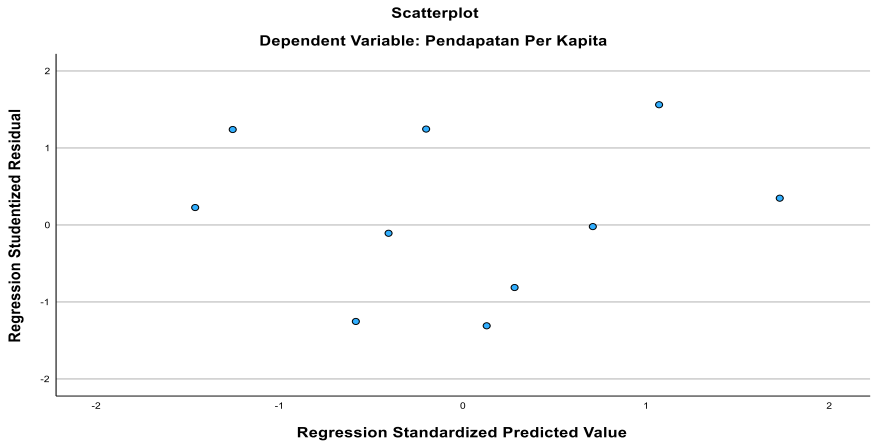

Figure 1. Heteroscedasticity Test Graph

Autocorrelation Test

Table 4. Autocorrelation Test

Model Summary[b]

Model	Change Statistics		Durbin-Watson
	df2	Sig. F Change	
1	6	<,001	2,306

a. Predictors: (Constant), Tenaga Kerja, Investasi, Pendidikan
b. Dependent Variable: Pendapatan Per Kapita

The Durbin–Watson test (autocorrelation test) produced a value of 2.306, which falls within the no-autocorrelation range (1.5–2.5). Therefore, it can be concluded that the regression model does not suffer from autocorrelation, meaning that the assumption of residual independence is satisfied and the regression coefficient estimates can be considered reliable. Consequently, the research may proceed to the next stage of analysis.

Although the DW value is slightly above 2, indicating a very small tendency toward negative autocorrelation, it remains within the statistically acceptable range and does not compromise the validity of the model.

Multiple Linear Regression Analysis

The multiple linear regression analysis in this study entitled "Analysis of the Effect of Labor, Investment (FDI/DDI), and Education on Per Capita Income in North Sumatra Province" can be observed in the model presented below.

Table 5. Regression Analysis Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-148678692,693	40030339,126		-3,714	,010
	Pendidikan	13509543,181	5653293,719	,339	2,390	,054
	Investasi	1,959E-7	,000	,212	1,887	,108
	Tenaga Kerja	10,621	3,281	,474	3,237	,018

a. Dependent Variable: Pendapatan Per Kapita

Based on the data table above, the regression equation for economic growth is obtained as follows:

$$Y = -148{,}678{,}692.693 + 13{,}509{,}543.181X1 + 0.0000001959X2 + 10.621X3 + \varepsilon$$

In the model above, the constant is negative. This implies that if education, investment, and labor are equal to zero, per capita income would be negative. Economically, however, the constant has no practical meaning because such a condition is impossible in reality.

The regression results indicate that labor is the main determinant of per capita income in North Sumatra during the 2015–2024 period. Education has a positive and statistically significant effect at the 90% confidence level, while investment shows a positive but statistically insignificant effect.

These findings suggest that in the short run, an increase in the labor force has a direct impact on raising per capita income, whereas education and investment tend to generate medium- to long-term effects.

Coefficient of Determination Test

Table 6. Coefficient of Determination Test

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,992[a]	,984	,976	1590918,20277

a. Predictors: (Constant), Tenaga Kerja, Investasi, Pendidikan

b. Dependent Variable: Pendapatan Per Kapita

The results of the coefficient of determination test show an R Square value of 0.984 and an Adjusted R Square value of 0.976, indicating that the model is not only statistically strong but also econometrically stable. This means that 97.6% of the variation in per capita income can be explained by the variables of labor, investment, and education, while the remaining 2.4% is influenced by other factors outside the model. Therefore, the regression model has very strong explanatory power and is appropriate for inferential analysis.

Simultaneous Significance Test (F-Test)

Table 7. Results of the Simultaneous Significance Test (F-Test)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9369091714176 45,900	3	312303057139215,30 0	123,390	<,001[b]
	Residual	1518612436751 2,045	6	2531020727918, 674		
	Total	9520952957851 57,900	9			

a. Dependent Variable: Pendapatan Per Kapita
b. Predictors: (Constant), Tenaga Kerja, Investasi, Pendidikan

The F-test results show an F-statistic of 123.390, indicating that the model has very strong explanatory power, with a significance level of < 0.001. This means that labor, investment, and education simultaneously have a significant effect on per capita income in North Sumatra. Therefore, the regression model used in this study is appropriate and can be employed to explain variations in per capita income. Although not all variables are strongly significant individually, collectively the three variables make a substantial contribution to the increase in per capita income. This implies that per capita income is not influenced by a single factor, but rather by a combination of production factors and the overall quality of human capital.

Partial Significance Test (t-test)

Table 8. t-Test Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-148678692,693	40030339, 126		-3,714	,010
	Pendidikan	13509543,181	5653293, 719	,339	2,390	,054
	Investasi	1,959E-7	,000	,212	1,887	,108
	Tenaga Kerja	10,621	3,281	,474	3,237	,018

a. Dependent Variable: Pendapatan Per Kapita

The t-test results indicate that labor has a positive and statistically significant effect on per capita income (p = 0.018). Education has a positive effect but is only significant at the 90% confidence level (p = 0.054), while investment has a positive but statistically insignificant effect (p = 0.108). This implies that during the 2015–2024 period, increases in investment have not yet demonstrated a direct and significant impact on per capita income. This condition may be explained by the long-term nature of investment effects, the possibility that investment has not been fully productive, and the economic structure has not been optimal in absorbing investment.

These findings suggest that, within the study period, the labor factor serves as the primary determinant of per capita income growth in North Sumatra.

The Effect of Labor on Per Capita Income in North Sumatra Province

Based on the test results above, Labor—one of the independent variables in this study—has a positive and statistically significant effect on per capita income in North Sumatra. The coefficient value of 10.621 indicates that for every increase of one additional worker, per capita income increases by IDR 10.621 (in the model's unit), assuming other variables remain constant. Since labor is measured in millions of people, economically this implies that if the labor force increases by 100,000 individuals, per capita income will increase proportionally according to the coefficient scale.

This finding indicates a positive relationship between labor and per capita income. The significance value of $0.018 < 0.05$ confirms that the increase in the number of workers has a statistically significant impact on the rise of per capita income during the 2015–2024 period.

The standardized beta coefficient ($\beta = 0.474$) is the highest among the other variables, suggesting that labor is the most dominant factor influencing per capita income in North Sumatra. The upward trend in labor participation moves in the same direction as the increase in per capita income. This indicates that the economic structure of North Sumatra remains highly labor-intensive, where higher labor force participation contributes to increased regional output, and employment absorption plays a key role in driving income growth.

The Effect of Investment on Per Capita Income in North Sumatra Province

The regression results indicate that investment in North Sumatra during the 2015–2024 period has a positive effect on per capita income, but the effect is not statistically significant in partial testing. The investment coefficient is positive (1.959E-7), implying that an increase in investment leads to an increase in per capita income. However, the significance value of 0.108 (>0.05) shows that, partially, the effect of investment is not statistically significant during the 2015–2024 period. This lack of statistical significance does not imply that investment is unimportant; rather, it reflects the presence of structural and contextual factors.

This finding is noteworthy because it differs from theoretical expectations. Simultaneously (F-test), the model is statistically significant, with an F-value of 123.390 ($p < 0.001$) and an R^2 of 0.984, meaning that 98.4% of the variation in per capita income can be explained by the variables included in the model. This suggests that investment still plays a role within the regional economic system, although it is not the dominant determinant.

Relatively (based on standardized beta coefficients), investment has a smaller influence compared to labor. This indicates that the economic dynamics of North Sumatra during the study period were more strongly driven by labor factors than by capital accumulation.

Descriptive statistics show that the standard deviation of investment is substantially larger than that of other variables. Sharp fluctuations—particularly the surge observed in 2024—indicate that investment has been unstable.

In short-term time series analysis (10 years), high volatility may weaken the statistical power of a variable in consistently explaining variations in per capita income.

From an economic perspective, investment rarely produces an immediate impact on per capita income. Infrastructure, factories, and large-scale projects require time before generating optimal output.

Thus, the effect of investment is likely to be a lagged effect. A regression model without lag variables may not adequately capture medium- and long-term impacts.

In other words, the empirical results of this study may reflect that investment in North Sumatra is still in a transitional phase or has not yet fully generated productive output.

The Effect of Education on Per Capita Income in North Sumatra Province

Based on the empirical results, education has a positive effect on per capita income. The Education variable (Average Years of Schooling/AYS) has a positive coefficient, indicating that, directionally, education increases per capita income. This means that every additional one year in the average years of schooling has the potential to increase per capita income by approximately IDR 13.5 million. However, at the 5% significance level ($\alpha = 0.05$), the p-value of 0.054 is slightly above the conventional threshold. This implies that education is not statistically significant at the 95% confidence level, but it is marginally significant at the 90% confidence level.

Simultaneously (F-test), the model is statistically significant (Sig < 0.001), and the R^2 value is very high (0.984), indicating that, collectively, labor, investment, and education explain nearly all variations in per capita income.

The classical assumption tests (normality, multicollinearity, heteroskedasticity, and autocorrelation) indicate that the model is valid and stable, suggesting that the estimated coefficients are econometrically reliable.

Despite the positive direction of the relationship, several empirical reasons may explain why statistical significance is not yet strong:

1. The Long-Term Nature of Education Effects
   Education does not immediately increase income in the short term. Its impact becomes visible only when graduates enter the labor market and contribute to productivity. The 2015–2024 period (10 years) may not be sufficiently long to fully capture the accumulated impact of educational attainment.
2. The Economic Structure of North Sumatra
   If the regional economic structure is still dominated by traditional labor-intensive sectors (such as agriculture and informal trade), additional schooling may not be fully translated into higher productivity gains. In other words, a mismatch between educational attainment and labor market demand may weaken the effect of education on per capita income.
3. The More Dominant Role of Labor
   The standardized Beta value shows that labor (0.474) is more dominant than education (0.339). This suggests that the absorption of labor may play a greater role in increasing per capita income than the length of schooling itself.

The Effect of Labor, Investment, and Education on Per Capita Income in North Sumatra Province

Simultaneously, the three independent variables have a significant effect on per capita income in North Sumatra Province during the 2015–2024 period. The regression results indicate that labor, investment, and education jointly exert a statistically significant influence on per capita income in North Sumatra ($F = 123.390$; $p < 0.001$). The Adjusted R^2 value of 0.976 suggests that nearly all variations in per capita income can be explained by these three variables. This finding confirms that regional welfare dynamics are largely determined by production factors and the quality of human resources.

Partially, labor emerges as the most dominant determinant ($\beta = 0.474$; $p = 0.018$). This result is consistent with the neoclassical growth model proposed by Solow, which positions labor as a primary factor of production. The relatively labor-intensive economic structure of North Sumatra implies that increases in the number of employed individuals directly contribute to higher regional output and per capita income.

Education shows a positive and statistically significant effect at the 10% confidence level ($p = 0.054$). This finding aligns with human capital theory and endogenous growth theory, which argue that improvements in human capital foster long-term productivity growth. However, the lack of significance at the 5% level suggests that the transition toward a knowledge-based economy in North Sumatra has not yet been fully optimized.

In contrast, investment exhibits a positive but statistically insignificant effect ($p = 0.108$). Theoretically, investment enhances production capacity; however, empirically, this result

indicates that investment realization has not yet been fully productive or has not directly translated into increased public welfare in the short term.

In conclusion, this study demonstrates that in the context of North Sumatra during 2015–2024, labor serves as the primary driving force behind per capita income growth, while education and investment require improved quality and longer implementation horizons to generate significant impacts on regional welfare.

Conclusion

The results of the study indicate that labor, investment, and education simultaneously have a significant effect on per capita income in the Province of North Sumatra during the 2015–2024 period ($F = 123.390$; $p < 0.001$), with a very high explanatory power (Adjusted $R^2 = 0.976$). This finding suggests that nearly all variations in per capita income can be explained by these three variables.

Partially, labor is found to have a positive and statistically significant effect ($p = 0.018$) and emerges as the most dominant variable. This result implies that the economic growth structure of North Sumatra remains largely driven by labor participation and employment expansion. This finding is consistent with neoclassical growth theory, which positions labor as a primary factor of production in increasing output.

Education shows a positive and statistically significant effect at the 10% level ($p = 0.054$), indicating that an increase in the average years of schooling tends to raise per capita income, although its short-term impact is not yet optimal. Theoretically, the effect of education is long-term in nature, as it is associated with human capital accumulation and productivity enhancement.

Meanwhile, investment has a positive but statistically insignificant effect ($p = 0.108$). This suggests that the realization of foreign and domestic investment (FDI/DDI) during the study period has not yet fully generated a direct impact on per capita income growth, possibly due to time lag effects or suboptimal absorption in productive sectors.

Therefore, it can be concluded that the increase in per capita income in North Sumatra is more strongly driven by labor dynamics than by investment and education in the short run. The policy implication is the need to strengthen workforce quality and enhance investment effectiveness in order to generate a greater multiplier effect on public welfare.

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