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Determinants of Economic Growth and Labor Productivity in Indonesia

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Abstract

Economic growth and labor productivity are important things for a region. This research analyzes the influence of investment, technological change, health, and minimum wages on economic growth and labor productivity. The geographically weighted regression (GWR) model is used to analyze spatial data, which produces local parameter estimates for each point/location where the data is collected. It was found that investment significantly affects economic growth in 18 provinces in Indonesia. ICT has a significant effect on economic growth in 3 provinces, and education (PPT) has a significant impact on labor productivity in 23 provinces. Low quality of health significantly affects the economic decline in 2 provinces and the decline in labor productivity in 4 provinces. The provincial minimum wage variable (UMP) significantly increases labor productivity in 17 provinces. Overall, of the 34 provinces, economic growth was most influenced by significant investment in almost all provinces except for Sumatra Island and half of Java Island. Meanwhile, labor productivity is most influenced by education, which is significant in almost all provinces except in eastern Indonesia and half of Sumatra Island.

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INTRODUCTION

Indonesia is a developing country facing persistent social and economic challenges, including stagnant economic growth. Research by Rustam (2010) indicates that the success of a country's development is reflected in its economic growth rate. Economic growth represents an increase in the production capacity of a country or region. This aligns with Todaro's (2006) assertion that economic growth is a continuous increase in productive capacity over time, leading to progressively higher national income and output levels.

Several factors influence economic growth, such as the quality of health, investment, technology, and efficient use of natural resources. Inclusive growth theory emphasizes that the benefits of economic growth should be distributed across all segments of society. Additionally, equal income distribution and improved community welfare are essential indicators of regional economic growth, as Ostry et al. (2014) noted. In 2022, Indonesia's economic growth reached 5.31%. This shows that there has been an increase from 2017, when the value of economic growth in Indonesia was 5.07%.

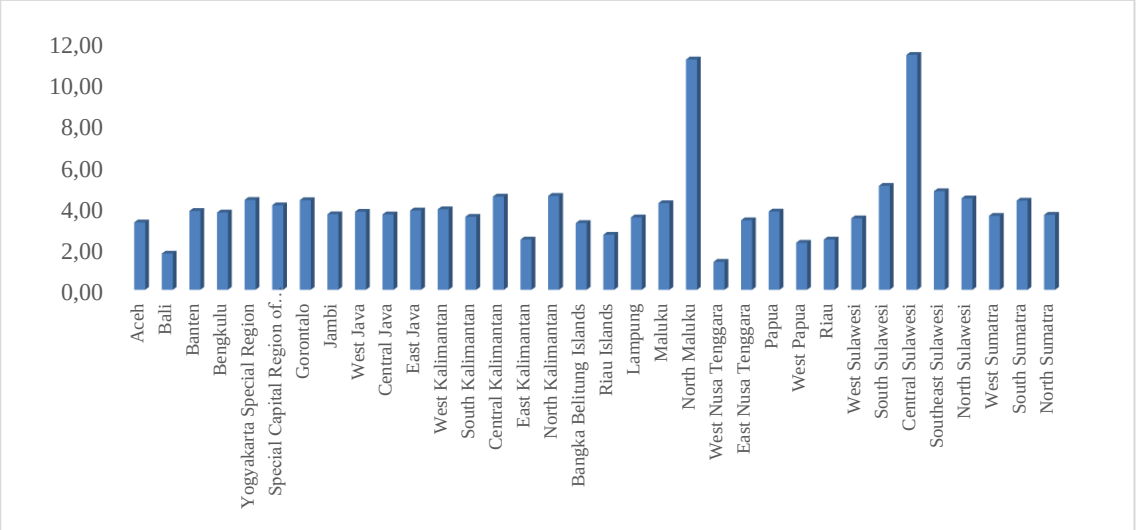

Figure 1. Average Economic Growth During the 2017-2022 According to Province
Source: BPS-Statitsics Indonesia, 2024

The graph shows that the average economic growth in 34 provinces over the last five years has generally exceeded the national economic growth rate in 2022. Central Sulawesi recorded the highest economic growth at 11.38%, while West Nusa Tenggara had the lowest at 1.35%. The data highlights the significant variation in economic growth across provinces, which can be attributed to the differing availability of human and natural resources in each region.

Economic growth is measured through increases in physical capital, such as investments in infrastructure and machinery; the development of human capital, assessed by improvements in education, skills, and workforce productivity; and technological progress, seen through innovation, adoption of new technologies, and improvements in production processes (Shinta, 2020).

Macroeconomic growth in physical capital (investment) represents one component of national income, as reflected in Gross Domestic Product (GDP). The impact of investment on a country's economy is evident in its national income. Lewis stated that economic growth influences labor absorption, starting with investment in the industrial sector and that overall capital accumulation in the modern sector leads to an expansion of output in this sector (Todaro, 2006).

Subramanian, Belli, and Kawachi (2002) emphasized that health plays a crucial role in economic stability as a component of human capital. An unhealthy population can hinder economic development. The report also notes that the relationship between economic prosperity and improved health is not automatic or universal. Porca and Harrison (2005) support this view, showing that government spending on improving human resource quality (health and education), tax efficiency, and a robust regulatory system can foster economic growth. Furthermore, Mankiw Romer Weil's economic growth model, which incorporates the role of government in influencing income, explains how physical capital, human capital, and technological advancements optimize labor and government-imposed expenditure to drive economic growth.

The production function is:

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} \left(\left(A(t) L(t) \right)^{1-\alpha-\beta} \right. \quad \text{.....(1)}$$

Where, K is the amount of physical capital, H is the amount of human capital, A is technology advances, and L is amount of total Income.

The International Labor Organization (ILO) stated that increasing employment opportunities can drive economic growth in a country. However, the availability of employment opportunities alone is insufficient to support national development; improvements in the quality of the workforce must accompany this. Labor productivity is a crucial factor in reflecting improvements in the quality of labor. Key components that contribute to this include advancements in health and technology, particularly within the education sector. These elements are essential in shaping policies that enhance worker productivity.

Labor productivity also serves as an important indicator for determining development direction and understanding the economic structure of a region. The role of each sector in labor productivity helps evaluate the scale of current development efforts and future priorities. Focusing on labor productivity is critical to ensuring the long-term sustainability of a nation. The growth rate of labor productivity reflects the effectiveness of development initiatives. According to data from the Central Statistics Agency (BPS), labor productivity in Indonesia has increased consistently over the years.

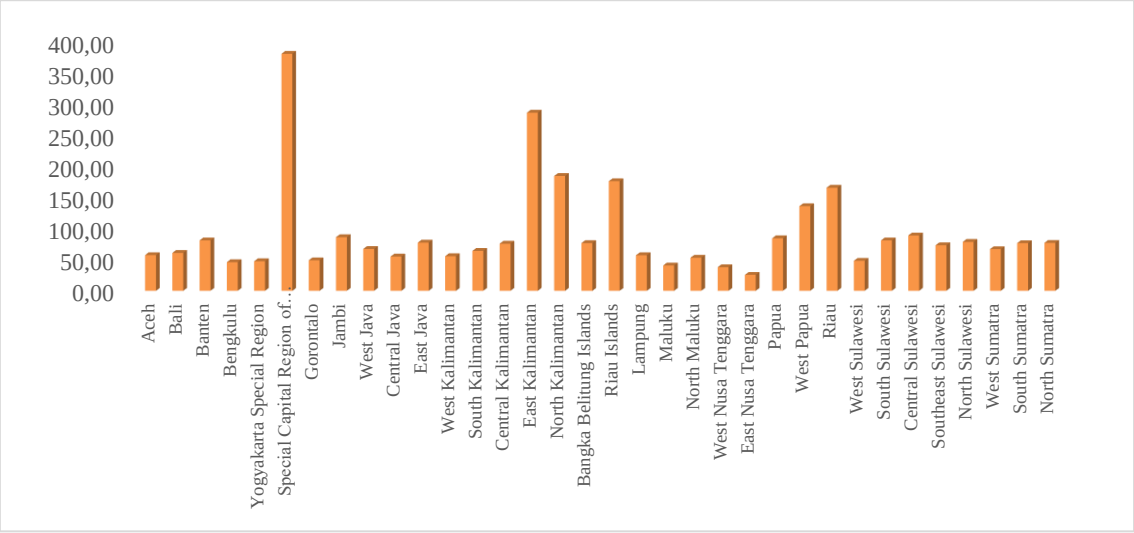

Figure 2. Average Labor Productivity During 2017-2022 According to Province
Source: BPS-Statistics Indonesia, 2024

In 2022, Indonesian labor productivity was recorded at IDR 86.55 million per worker. The highest average was in the Special Capital Region of Jakarta Province, amounting to IDR 380.90 million per worker, while the lowest productivity was in East Nusa Tenggara, at IDR 25.65 million per worker. The data shows that labor productivity varies significantly across provinces.

This variation is due to differences in the number and quality of the workforce, as well as the availability of job opportunities in each region (Fitri et al., 2013). Despite these figures, Indonesia's labor productivity remains lower than that of developed countries (BPS-Statistics Indonesia, 2022)

Health plays a central role in physical, mental, and social well-being, which enables a socially and economically productive life. Welfare is also a crucial factor in children's school attendance. Healthy children perform better in school and can learn more efficiently. Over time, these children grow into healthier workers whose better learning outcomes lead to increased competence and productivity. Health is key to improving productivity; educational success depends on good health. Economic growth is closely linked to health. Investments in health, such as access to medical services and nutritional supplements, enhance life expectancy and improve workforce quality. A healthier workforce can work longer and more efficiently, thus contributing to economic growth.

According to human capital theory, in addition to education, health is a key factor that determines the quality of a region's human resources (Todaro, 2008). The better the health of the population, the higher the human productivity in production. Healthy individuals can produce goods and services for longer periods and in greater quantities. Poor health quality, on the other hand, leads to suboptimal productivity. This condition impacts the quality of development in the region.

The new economic growth theory proposed by Solow emphasizes the role of technological progress, which plays a critical role in a country's economy. Technological progress is a strategic component in various growth theories (Inekwe, 2014). Technology and knowledge are important factors in economic growth and development. Research by Barney et al. (2021) indicates that education and investment in employee skills enhance their understanding of technology. A higher level of education among workers leads to better mastery of technology, such as computer use, which increases productivity. This represents labor-augmenting technological progress, which occurs when skills or labor quality improve, for example, through education using telecommunications media.

Research by Dio et al. (2018) shows that health positively and significantly affects economic growth in Indonesia. Similarly, research by Pipid et al. (2022) finds that health positively and significantly affects labor productivity. Healthy employees tend to have higher energy levels, better cognitive function, and fewer sick days, resulting in greater efficiency and productivity. Improved health reduces absenteeism, increases focus, and enables employees to contribute more effectively. Enhancing the quality of public health, technology, and investment is crucial to creating a productive and competitive workforce, supporting the demographic bonus, and realizing the vision of an Indonesia Emas or Golden Indonesia. Policies that ensure a cognitively and physically healthy workforce are essential. A productive workforce will increase regional output and stimulate the local economy, which aligns with the study by McGovern et al. (2017).

In recent research, Hanim et al. (2022) studied the relationship between investment technological development and economic growth in Indonesia. The results showed that the foreign direct estimate (foreign direct investment) did not affect economic growth in Indonesia. This shows that factors other than foreign direct investment determine Indonesia's economic growth. In Indonesia, domestic direct investment positively and significantly impacts economic growth. The ICT index positively and significantly influences Indonesia's economic growth.

Puspasari (2020) finds that education, wages, and health positively and significantly affect labor productivity. Labor productivity reflects a worker's capability to produce output. The higher the output a worker produces, the higher their productivity level. The quality of labor directly influences the productivity of the output produced.

This research investigates the impact of investment, technology in ICT, education, wages, and poor health on economic growth and labor

productivity. Unlike previous research, this study clarifies the relationship between development variables and their effect on economic growth and labor productivity, considering geography and distance. Furthermore, there has been limited research on the impact of poor health quality on economic growth and labor productivity, and few studies have statistically explained the cyclical relationship between economic growth, labor productivity, ICT technology, education, investment, wages, and poor health quality.

Based on the background and literature review, this research hypothesizes that ICT and investment significantly and positively affect economic growth in most Indonesian provinces. Education and minimum wages are expected to significantly and positively affect productivity across most Indonesian provinces. Low-quality health is assumed to significantly and negatively affect economic growth and productivity in most Indonesian provinces in 2022.

Research that examines the factors influencing economic growth and labor productivity remains limited. This study analyzes the effects of investment, poor public health, technological changes, and minimum wages on economic growth and labor productivity, accounting for spatial heterogeneity using the Geographically Weighted Regression (GWR) model.

RESEARCH METHODS

Regression analysis is one of the statistical methods that can be used to analyze this case. However, multiple linear regression analysis produces global estimator values. In reality, analysis that produces local, regional-based models is often necessary because the results of the cases studied may vary from region to region, which is called spatial heterogeneity. A model that can overcome the problem of spatial heterogeneity is Geographically Weighted Regression (GWR) (Brundson et al. 2002). The GWR model is used to analyze spatial data that produces local parameter estimates for each point/location where the data is collected (Brundson et al. 2002). So far, research has rarely been carried out to look at the factors that influence economic growth and labor productivity, especially in the location where the data is collected. In the model's case, no spatial effect or spatial dependence occurs due to the correlation between regions consisting of lag dependence and spatial error in both dependent, independent, and error variables. However, spatial heteroscedasticity in the model means the GWR model can be used.

This research adopts a quantitative approach, utilizing secondary data from 34 provinces, from Aceh to West Papua. The dependent variable in the first equation is Economic Growth (PE), while in the second equation, the dependent variable is Labor Productivity (PTK). The spatial data includes (1) a map of 34 Indonesian provinces, sourced from the December 2019 boundary map provided by the Directorate General of Population and Civil Registration (Dukcapil), and (2) the x and y coordinates of the centroids of each province, adjusted to their respective provincial capitals. Centroids located at sea or in neighboring regions are also taken into account. Detailed information can be found in the table below.

Table 1. Results of testing and checking the classical assumptions of the equation of economic growth and labor productivity

Variable	Description	Reference	Data Source
Economic Growth (PE)	Economic growth in the province.	(Naibaho, 2023; Wang 2022; Hanim 2022)	Central Bureau of Statistics (BPS)
Labor Productivity (PTK)	Labor productivity in the province.	(Puspasari, 2020)	Central Bureau of Statistics (BPS) and Ministry of Manpower Indonesia

Variable	Description	Reference	Data Source
ICT Development Index (ICT)	The ICT Development Index is a standard measure of the level of ICT development in a region that can be compared over time and between regions.	(Wang 2022; Hanim 2022)	Central Bureau of Statistics (BPS)
Investment (RPMTB)	Investment is proxied by the ratio of gross fixed capital formation to GRDP.	(Hanim 2022)	Central Bureau of Statistics (BPS)
Low quality of health (RKK)	Low quality of health is proxied by the prevalence of stunting	(Naibaho, 2023 ;Puspasari, 2020)	Ministry of Health
Provincial Minimum Wage (UMP)	Regional minimum wage levels (UMR) are determined by considering factors such as the need for a decent living.	(Puspasari, 2020)	Ministry of Manpower Indonesia
Education (PPT)	The education sector is represented by the ratio of workers graduating from high school to university.	(Puspasari, 2020)	Central Bureau of Statistics (BPS)

Source: Data Processed, 2024

The multiple linear regression model is called global regression because one parameter describes the relationship between variables at all observation points, so variations due to geographic differences can be ignored (Shabrina, Buyuklieva, and Ng, 2021). The general form of the multiple linear regression model is as in the following equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots + \beta_k X_k + \varepsilon \quad \ldots\ldots\ldots\ldots (2)$$

Where, Y is dependent variable, $\beta_1, \beta_2, \ldots, \beta_k$ are parameter, $X_1, X_2, \ldots, X_k$ are independent variables, and ε is error term.

A simultaneous test was carried out with the F-test statistic, and a partial t-test was carried out. After that, proceed with testing the classical assumptions for the normality test with Jarque Bera:

$$JB_{hit} = n\left[\frac{s^2}{6} + \frac{(K-3)^2}{24}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, n is number of observation, coefficient skewness, and K is coefficient kurtosis.

The decision to reject H0 is carried out if the p-value<0.05. It can be said that with a significance level of 5%, the error is not normally distributed. After that, we carried out a spatial heterogeneity test with Breusch Pagan. Where, $H_0: \sigma_1^2 = \sigma_2^2 = \cdots = \sigma^2$ (There is no heterogeneity between regions), and H_1: at least there is one $\sigma_i^2 \neq \sigma^2$ (There is heterogeneity between regions), with the following statistical test:

$$BP = \frac{1}{2} f^T Z (Z^T Z)^{-1} Z^T f \sim \chi^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where an element of a vector f acquired by:

$$\mathbf{f} = \left(\frac{e_i^2}{\sigma^2} - 1\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where e_i is the least square residual for the ith observation, and Z is an n×p sized matrix containing a vector of independent variables transformed into standard normal (z) in each observation. If $BP > \chi_p^2$ or p-value < 0,05, H_0 is rejected, it can be said that there is heterogeneity between regions.

Then, we should check the case of local non-multicollinearity that can be carried out with VIF value. It is stated if the Variance Inflation Factor (VIF) value for each k predictor variable at the i location is less than the value 10. The VIF value for each predictor variable for each location is expressed as follows (Brunsdon et al., 2002):

$$VIF_j = \frac{1}{1 - R_k^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

After conducting the classical assumption test and finding spatial heterogeneity in the model, multiple linear regression can no longer be used. Spatial heterogeneity in the multiple linear regression model results in the need for another model that can overcome this, namely Geographically Weighted Regression (GWR). The GWR model identifies spatial variation between independent and dependent variables. Thus, the GWR model can produce different (local) parameter estimates for each province.

According to Brunsdon et al. (2002), the GWR model can be written as follows:

$$Y_i = \beta_0(u_i, v_i) + \sum_{j=1}^{p} \beta_k(u_i, v_i) X_{ik} + \varepsilon_i, i = 1,2, \dots, n \quad \text{.....(7)}$$

Where, $\beta_0(u_i, v_i)$ is i region intercept coefficient, $\beta_k(u_i, v_i)$ is the slope coefficient of the k independent variable in the i region, (u_i, v_i) is coordinates (longitude, latitude) of the I region, ε_i is i error with assumption $\varepsilon_i \sim NIID(0, \sigma^2)$.

The GWR model uses the estimation method Weighted Least Square (WLS) parameter estimates as follows:

$$\hat{\beta}(i) = (\mathrm{X}^T\mathrm{W(i)X})^{-1}\mathrm{X}^T\mathrm{W(i)Y} \quad \text{.....(8)}$$

After that, a partial test is needed to determine how each independent variable influences the dependent variable in each province. Partial Test is a parameter testing method that is carried out to determine the influence of individual predictor variables on response variables. The partial test hypothesis is as follows (Nakaya et al., 2005): $H_0: \beta_k(u_i, v_i) = 0$ (There is no significant influence of the independent variable x_k on location i-th.); and $H_1: \beta_k(u_i, v_i) \neq 0$ (There is a significant influence of the independent variable x_k on location i-th). Where: $i = 1,2,3, \dots,34$ and $k = 1,2,3,..,5$. The test statistics in this test are stated as follows:

$$t_{hit} = \frac{\widehat{\beta_k}(u_i, v_i)}{\hat{\sigma}\sqrt{c_{kk}}} \quad \text{..... (9)}$$

where c_{kk} is the kth diagonal element of the matrix $\mathrm{C_i C_i^T}$, Where:

$$\mathrm{C_i} = (\mathrm{X}^T\mathrm{W(i)X})^{-1}\mathrm{X}^T\mathrm{W(i)} \quad \text{.....(10)}$$

If $|t_{hit}| > t(\frac{\alpha}{2}, \mathrm{df})$ or with df $2trace(\mathrm{S}) + trace(\mathrm{S'S})$ so there is significant influence of the independent variable x_k on location i-th.

$$\mathrm{S} = \mathrm{X}(\mathrm{X^T W(i) X})^{-1}\mathrm{X^T W(i)} \quad \text{.....(11)}$$

Moreover, trace(S) is the main diagonal sum of the matrix S.

Several variables are thought to influence economic growth and labor productivity based on the literature review that has been carried out. Based on the description above, the framework for this research is as follows:

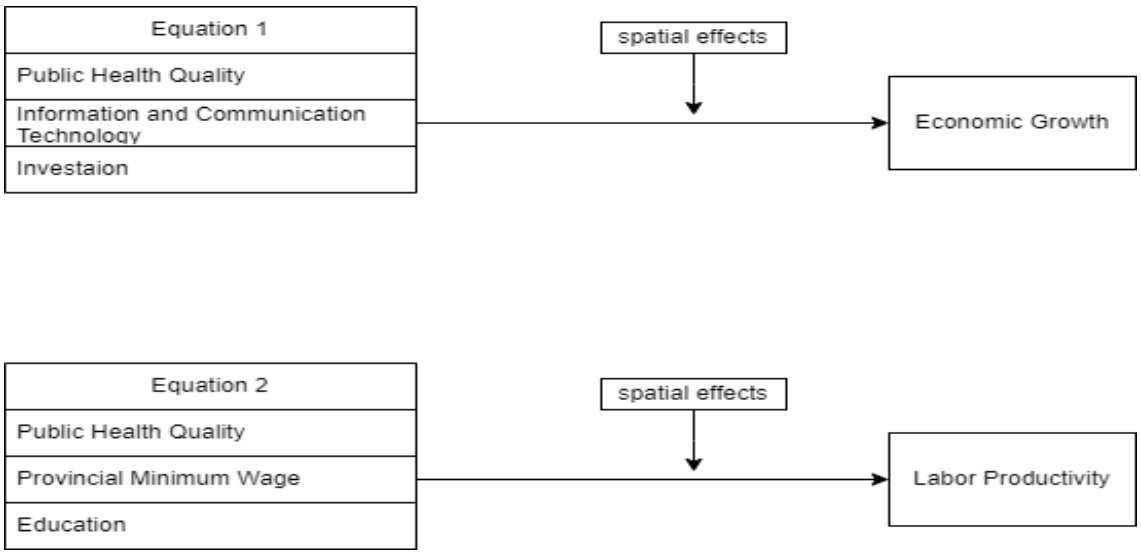

Figure 3. Research Framework
Source: Processed by Author, 2024

In the picture above, the research framework is divided into two equations. In equation 1, economic growth is influenced by three independent variables: low quality of health, investment, and technology. Equation 2 is influenced by low quality of health, minimum wage, and education. The strong influence of spatial effects shapes both models. The equations are as follows:

Equation 1:

$$PE_i = \gamma_{10} + \gamma_{11} RKK_i^* + \gamma_{12} RPMTB_i^* + \gamma_{13} TIK_i^* + \varepsilon_i \quad \text{.....(12)}$$

Equation 2:

$$PTL_{it} = \gamma_{20} + \gamma_{21}KKM^{*} + \gamma_{22}UMP_{i}^{*} + \gamma_{23}PPT_{i}^{*} + \varepsilon_{i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

Where: $i = 1,2,\ldots,34$

The research data analysis techniques used are Excel, Geoda, QGIS, and GWR 4 software. The steps in the data analysis technique include descriptive analysis, which examines the data's mean, median, mode, and standard deviation. This research compares the weighting functions, specifically Fixed Gaussian and Fixed Bi-square. The suitability of the GWR model to RLB is tested as a global regression model, along with the analysis of variance (ANOVA) test. Following that, partial variables are tested locally. The best model is selected based on the Akaike Information Criterion-corrected (AICc) and the largest adjusted R^2. Using GWR 4, 34 models are generated for each province to test the hypothesis.

RESULTS AND DISCUSSION

From 2021 to 2022 the average value of all variables increased in 34 provinces in Indonesia, but we also need to see how big and what the increase was in each province.

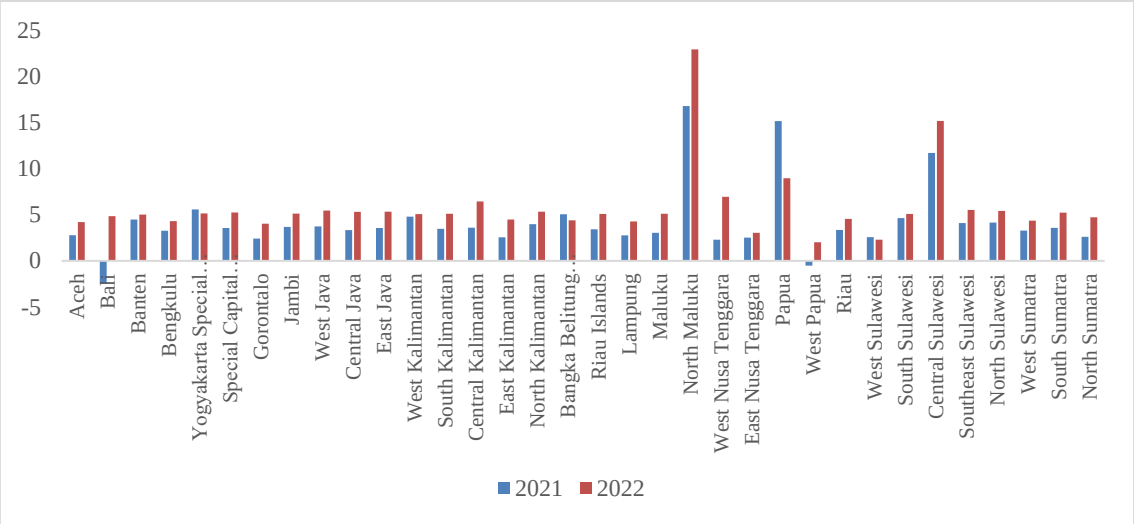

Figure 4. Economic Growth By Province 2021-2022
Source: BPS-Statistics Indonesia, 2023

According to BPS-Statistics Indonesia (2022), Indonesia's economy grew by 5.31% in 2022, higher than the 3.70% growth achieved in 2021. Regarding production, the highest growth occurred in the transportation and warehousing sector, at 19.87%. Of the 34 provinces, 3 experienced a slowdown in economic growth, while Bali recorded the highest growth at 7.3%.

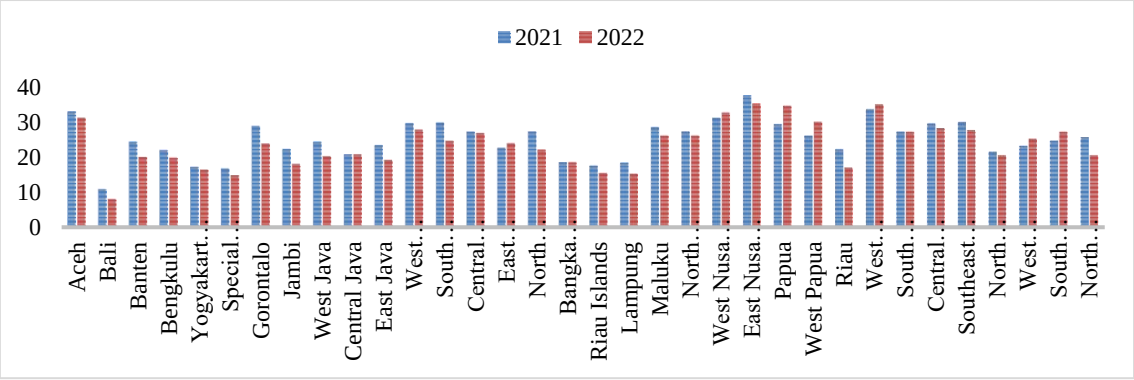

Figure 5. Low Quality Of Health According To The Province 2021-2022
Source: BPS-Statistics Indonesia, 2023

If we look at the graph of the prevalence of public health quality in 34 provinces, only Bali has achieved the national target, namely below 14%. In 2022, the province with the lowest public health quality score was Bali Province, with a score of 8%, while the province with the highest public health quality score was East Nusa Tenggara Province with 35.3%. It can be seen that there is a difference of 27.3% between the prevalence of the lowest quality of public health and the highest quality of public health.

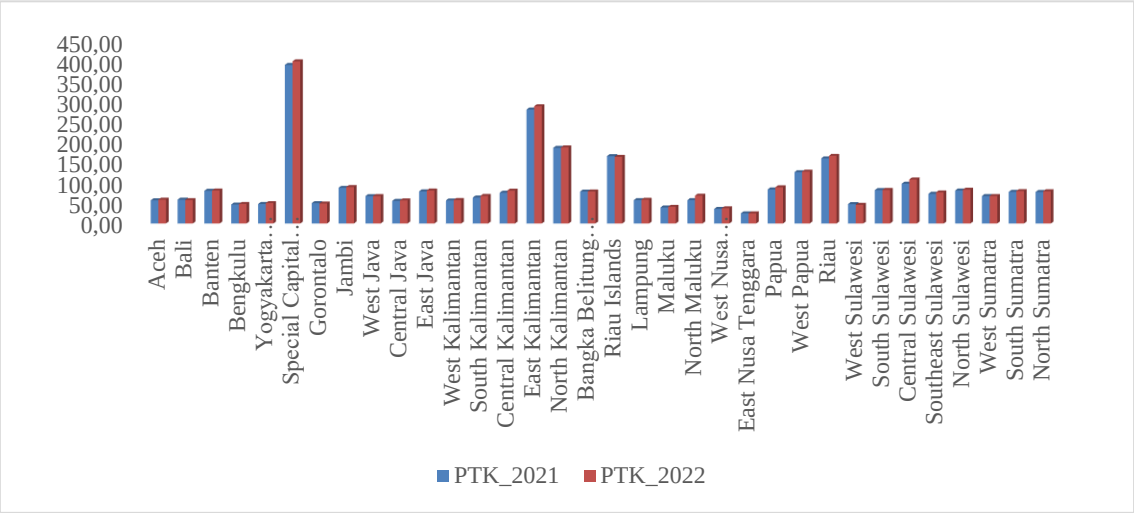

Figure 6. Labor Productivity by province in Indonesia
Source: BPS-Statistics Indonesia, 2023

The highest PTK was recorded in the Special Capital Region of Jakarta at 391.79 million per worker in 2021, increasing to 400.70 million per worker in 2022. The smallest PTK was in East Nusa Tenggara, at 25.12 million per worker in 2021, decreasing to 24.94 million per worker in 2022. A region's GRDP greatly influences PTK. In 2022, the average number of workers in the 34 provinces was 3.97 million, with an average provincial minimum wage of 2.72 million rupiah. The following equation represents economic growth:

$$\widehat{PE_{2022}} = 6.74 - 0.094KKM_{2022} + 0.27RPMTB_i - 1.32\text{TIK}_\text{i} \quad \text{.....(14)}$$

For labor productivity:

$$\widehat{PTK_{2022}} = -176.08 - 1.39KKM_i + 66.52\text{UMP}_\text{i} + 2.45\text{PPT}_\text{i} \quad \text{.....(15)}$$

Based on the Jarque-Bera test results in Table 2, a p-value greater than α (0.05) indicates that the normality assumption is met. However, the Breusch-Pagan test statistic, which produces a p-value lower than α, shows that the error variance is not constant, meaning the homoscedasticity assumption is not met. This violation also confirms the presence of spatial heterogeneity in the model. Additionally, an examination of the VIF indicator in Table 2 reveals no strong linear relationship between the six independent variables. In other words, the non-multicollinearity assumption is fulfilled.

Table 2. Results of testing and checking the classical assumptions of the equation of economic growth and labor productivity

Assumption	Equation 1			Equation 2		
	Test Values	**p-value**	**Decision**	**Test Values**	**p-value**	**Decision**
Normality	JB = 2,6649	0,264	Normally distributed	JB = 5,458	0,07	Normally distributed
Homoscedasticity	BP = 8,2314	0,0004	Heterosceda-sticity of data	BP = 3,0911	0,041	Heteroscedast icity of data
Non-multicollinearity		-	No multicolline-arity		-	No multicolline-arity

Source: Data Processed, 2024

Due to the spatial heterogeneity in the RLB, the GWR model is applied to obtain local parameters that represent the relationship between research variables in each observation unit. Two models with different kernel functions are compared using several criteria to determine the best one.

Table 3. Comparison of AICc, BIC, and adjusted R2 from the kernel function of the GWR model.

Criteria	Equation1		Equation 2	
	Fixed Gaussian	***Fixed Bi-Square***	***Fixed Gaussian***	***Fixed Bi-Square***
AICc	162.05	152.53	367.059	366.279
BIC	167.54	157.92	369.104	368.583
Adjusted R^2	0.58	0.763	0.729	0.7406

Source: Data processed, 2024

Table 3 shows that the fixed bi-square kernel function for equation 1 and fixed Bi_square for equation 2 provides the most optimal criteria for accommodating spatial heterogeneity in modeling the percentage of poor people. This is shown by the smallest AICc and BIC and the largest adjusted R2 compared to other kernel functions.

According to Emsina (2014), increased productivity during a crisis is a significant driver of the economy after a certain period of time, but the Pearson Correlation test shows that:

Table 4. Pearson correlation test

Variable	Correlation	P-value
Economic Growth and Labor Productivity	-0,024	0,892

Source: Data Processed, 2024

It can be seen that the correlation between the two variables is only negative 0.024, and the p-value is 0.892, which shows that the relationship between the two variables is minimal and not significant between the two variables. Because there is no relationship between the two variables, each model must be formed for the dependent variable, which is done to answer the research objectives and to provide better assessment conditions following the ILO's statement (2015).

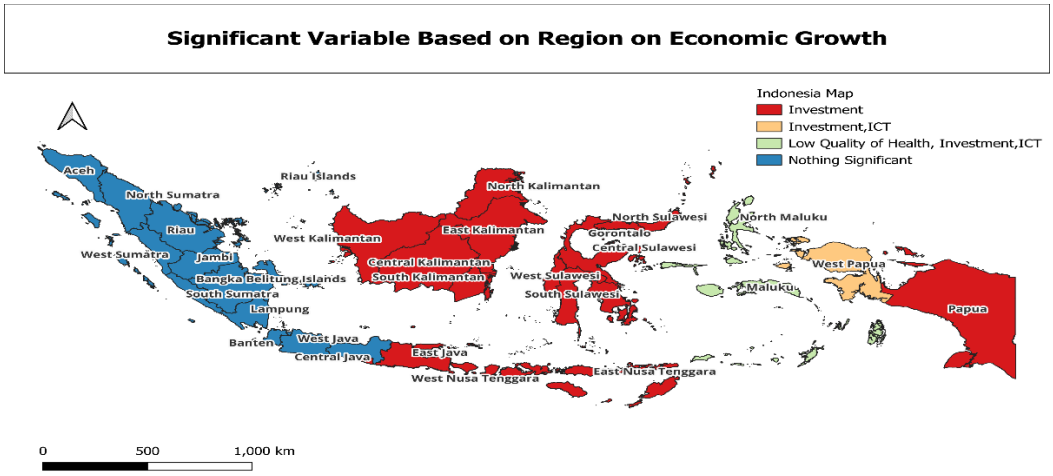

Figure 7. Thematic map groups provinces according to significant variables that influence economic growth.
Source: Data Processed, 2024

The image above illustrates spatial heterogeneity through four groupings of variables that significantly influence economic growth. A summary of the map is presented in the following table:

Table 5. Regional Summary for Economic Growth Model

Category	Significant Variable	Amount	Provinces Included
I	Low quality of health, Rasio of gross fixed capital formation, information and communication technology	2	Maluku, North Maluku
II	Ratio of gross fixed capital formation	17	Bali, Special Region of Yogyakarta (DIY), Gorontalo, East Java, West Kalimantan, South Kalimantan, Central Kalimantan, East Kalimantan, North Kalimantan, West Nusa Tenggara, East Nusa Tenggara, Papua, West Sulawesi, South Sulawesi, Central Sulawesi, Southeast Sulawesi, and North Sulawesi
III	Ratio of gross fixed capital formation, information and communication technology	1	West Papua
IV	Nothing Significant	14	Aceh, Banten, Bengkulu, Special Capital Region of Jakarta, Jambi, West Java, Central Java, Bangka Belitung Islands, Riau Islands, Lampung, Riau, West Sumatera, South Sumatera, and North Sumatera

Source: Data Processed, 2024

The variable Low quality of health (RKK) significantly affects two provinces. This is in line with Tasya et al. (2022), who state that low quality of health and poor people's lifestyles can negatively and significantly affect economic growth. The gross fixed capital formation ratio (RPMTB) variable has a significant effect in 18 provinces in Indonesia, according to research conducted by Zend et al. (2022).

The Technology and Information (ICT) variable is significant in 3 provinces in Indonesia, and this is in line with research conducted by Kim et al. (2017), which states that technology has a significant and positive effect on economic growth, while Haldar et al. (2023) states that technology has a significant and negative effect on economic growth. In contrast, it shows that 14 provinces without significant variables in the model affect economic growth.

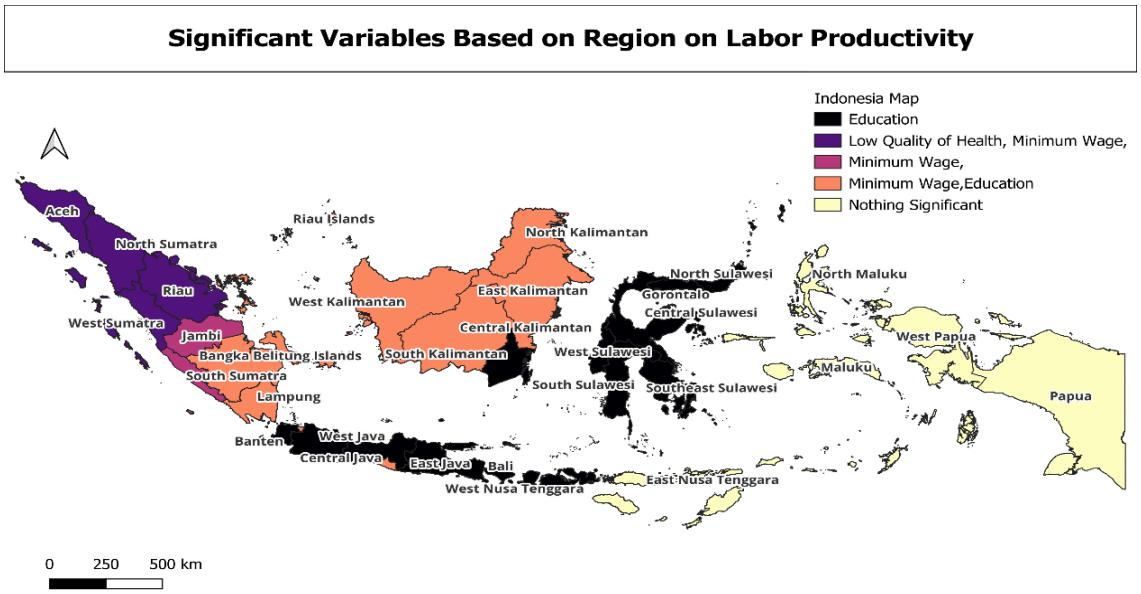

Figure 8. Thematic map grouping provinces according to significant variables that influence labor productivity.
Source: Data Processed, 2024

The image above illustrates spatial heterogeneity through five groupings of variables that significantly influence labor productivity. A summary of the data is presented in the following table:

Table 6. Regional Summary for Labor Productivity Model

Category	Significant Variable	Amount	Provinces Included
I	Low quality of health, regional minimum wage	4	Aceh, Riau, West Sumatera, and North Sumatera
II	Education	13	Bali, Banten, Gorontalo, West Java, Central Java, East Java, South Kalimantan, West Nusa Tenggara, West Sulawesi, South Sulawesi, Central Sulawesi, Southeast Sulawesi, and North Sulawesi

Category	Significant Variable	Amount	Provinces Included
III	Regional Minimum Wage, Education	10	Special Region of Yogyakarta (DIY), Special Capital Region of Jakarta, West Kalimantan, Central Kalimantan, East Kalimantan, North Kalimantan, Bangka Belitung Islands, Riau Islands, Lampung, and South Sumatera
IV	Minimum Wage Regional	2	Bengkulu and Jambi
V	Nothing significant	5	Maluku, North Maluku, East Nusa Tenggara, Papua, and West Papua

Source: Data processed, 2024

The variable low quality of health (RKK) significantly affects productivity in four provinces. This finding indicates that low health quality in an area reduces productivity and weakens workers.

The variable highly educated workers (PPT) significantly influences productivity in 23 provinces. These two variables align with research by Puspasari et al. (2020), which suggests that high education increases productivity when accompanied by good health.

The provincial minimum wage (UMP) variable is significant in 12 provinces. This aligns with research by Rahmi et al. (2022). The GWR model produces 34 regression equations corresponding to the number of provinces in Indonesia.

Table 7. Model from 34 Provinces for Economic Growth

Province	β_0	β_4RKK	β_5RPMTB	β_6TIK
Aceh	2.124	0.009	-0.024	0.543
Bali	-6.206	-0.014	0.216	0.895
Banten	1.015	0.047	0.021	0.409
Bengkulu	0.703	0.044	-0.017	0.646
Yogyakarta Special Region	3.859	0.000	0.134	-0.467
Special Capital Region of Jakarta	2.194	0.024	0.040	0.178
Gorontalo	-1.774	-0.129	0.363	-0.182
Jambi	1.007	0.040	-0.014	0.593
West Java	0.987	0.041	0.042	0.333
Central Java	0.253	0.028	0.077	0.332
East Java	-2.374	-0.014	0.185	0.394
West Kalimantan	2.960	-0.004	0.145	-0.363
South Kalimantan	0.142	-0.060	0.257	-0.236
Central Kalimantan	2.555	-0.036	0.206	-0.476
East Kalimantan	2.112	-0.085	0.290	-0.646
North Kalimantan	2.850	-0.100	0.309	-0.806
Bangka Belitung Islands	1.919	0.032	0.062	0.098
Riau Islands	1.512	0.037	0.013	0.384
Lampung	1.122	0.046	0.011	0.436
Maluku	10.642	-0.218	0.333	-1.855
North Maluku	8.343	-0.184	0.342	-1.630

Province	β_0	β_4RKK	β_5RPMTB	β_6TIK
West Nusa Tenggara	-11.942	-0.034	0.306	1.493
East Nusa Tenggara	-15.492	-0.048	0.361	1.879
Papua	-15.342	0.409	0.385	-0.305
West Papua	8.953	-0.152	0.343	-1.930
Riau	1.063	0.035	-0.018	0.616
West Sulawesi	-5.448	-0.090	0.344	0.389
South Sulawesi	-7.907	-0.084	0.354	0.742
Central Sulawesi	-5.498	-0.103	0.360	0.369
Southeast Sulawesi	-4.900	-0.112	0.356	0.323
North Sulawesi	2.274	-0.151	0.353	-0.745
West Sumatra	0.811	0.036	-0.022	0.674
South Sumatra	1.133	0.044	0.002	0.486
North Sumatra	1.272	0.027	-0.022	0.620

Source: Data Processed, 2024

The table above shows that the influence of low quality of health is highest in Papua Province, with a value of 0.409. This indicates that as the low quality of health increases, economic growth also increases. In contrast, the province with the lowest value, Maluku, has a value of -0.218, indicating that an increase in low health quality will lead to decreased economic growth. Additionally, most provinces in Indonesia show a negative relationship between economic growth and low quality of health.

The influence of the gross fixed capital formation ratio is highest in Papua Province, with a value of 0.385. This indicates that an increased gross fixed capital formation ratio increases economic growth. Conversely, the province with the lowest value, Aceh, has a value of -0.024, indicating that an increase in the gross fixed capital formation ratio will decrease economic growth. Furthermore, the majority of provinces in Indonesia show a positive relationship between economic growth and the gross fixed capital formation ratio.

The highest influence of technology is in East Nusa Tenggara Province, with a value of 1.87. This indicates that as technology increases, economic growth also increases. In contrast, the province with the lowest value is West Papua, with a value of -1.93, which indicates that an increase in technology will lead to a decline in economic growth. Additionally, the majority of provinces in Indonesia show a positive relationship between economic growth and technology. For interpretation, the Maluku area is used for equation 1 in the table, which shows significance with all variables.

$$\widehat{PE_{2022Maluku}} = 10.641804 - 0.218RKK^{*}_{Maluku} + 0.333\text{RPMTB}^{*}_{\text{Maluku}} - 1.854\text{TIK}^{*}_{\text{Maluku}} \quad ..(16)$$

From the estimation results above, a 1% increase in low health quality in Maluku leads to a decrease in economic growth in Maluku Province by 0.218%. Additionally, a 1% increase in RPMTB in Maluku increases economic growth in the province by 0.333%. Meanwhile, technological growth in Maluku Province causes economic growth to rise or fall by 18.54%, assuming all other variables remain constant.

Table 8. Model from 34 Provinces for Labor Productivity

Province	β_0	β_4KKM	β_5UMP	β_6PPT
Aceh	-115.487	-7.295	106.697	1.345
Bali	-172.062	1.147	15.711	3.991
Banten	-132.959	-0.291	37.023	2.681

Province	β_0	β_4KKM	β_5UMP	β_6PPT
Bengkulu	-105.540	-3.773	60.898	2.247
Yogyakarta Special Region	-497.054	4.455	87.031	5.362
Special Capital Region of Jakarta	-250.638	-2.656	96.162	2.861
Gorontalo	-164.900	0.289	23.794	3.756
Jambi	-125.440	-4.212	71.270	2.282
West Java	-144.831	0.419	31.137	2.952
Central Java	-155.873	0.921	23.833	3.360
East Java	-188.948	1.344	16.595	4.256
West Kalimantan	-305.853	1.433	55.874	4.641
South Kalimantan	-267.022	1.770	25.489	5.281
Central Kalimantan	-297.873	1.791	40.329	5.154
East Kalimantan	-340.993	2.338	37.772	5.870
North Kalimantan	-397.974	3.045	44.185	6.312
Bangka Belitung Islands	-218.963	-0.117	56.111	3.447
Riau Islands	-166.403	-3.358	75.648	2.575
Lampung	-138.851	-1.472	49.732	2.623
Maluku	-149.430	1.594	48.751	0.853
North Maluku	-141.954	0.940	46.449	1.330
West Nusa Tenggara	-160.907	0.867	17.317	3.751
East Nusa Tenggara	-100.480	0.074	24.297	2.358
Papua	-579.906	-4.217	203.766	3.204
West Papua	-235.596	3.187	54.709	1.256
Riau	-129.556	-5.239	83.502	2.077
West Sulawesi	-199.934	1.004	19.011	4.469
South Sulawesi	-175.983	0.737	19.687	4.022
Central Sulawesi	-178.589	0.639	21.368	4.030
Southeast Sulawesi	-144.985	0.291	24.666	3.247
North Sulawesi	-127.802	-0.155	26.548	2.989
West Sumatra	-110.106	-5.255	75.990	2.080
South Sumatra	-137.284	-2.810	61.538	2.502
North Sumatra	-131.830	-6.121	93.750	1.875

Source: Data Processed, 2024

The table above shows that the influence of low quality of health is highest in the Special Region of Yogyakarta Province, with a value of 4.45. This indicates that as low health quality increases, labor productivity also increases. In contrast, Aceh Province has the lowest value, -7.29, indicating that an increase in low health quality leads to decreased labor productivity. Additionally, most provinces in Indonesia show a positive relationship between labor productivity and low quality of health.

The highest wage effect is in Papua Province, with a value of 203.76, indicating that as wages increase, labor productivity increases. Bali Province has the lowest value, 15.71, indicating that increased wages lead to increased labor productivity. All provinces in Indonesia show a positive relationship between labor productivity and the minimum wage.

The highest influence of education is in North Kalimantan Province, with a value of 6.31. This suggests that labor productivity

increases as the ratio of higher education increases. Maluku Province, with the lowest value of 0.8, also indicates that an increase in the higher education ratio leads to an increase in labor productivity. All provinces in Indonesia show a positive relationship between labor productivity and the ratio of higher-educated workers.

For equation 2, Aceh Province is used as an example for interpretation, where one variable is significant at the 5% test level, represented by an asterisk (*).

$$\widehat{PTK_{2022Aceh}} = -115.487 - 7.295RKK^{*}_{Aceh} + 106.696\ \mathrm{UMP}^{*}_{\mathrm{Aceh}} + 1.345PPT_{Aceh} \quad ..(17)$$

From the estimation results above, a 1% increase in the low quality of public health in Aceh leads to a decrease in the PTK value in Papua Province by 7.295 million. Meanwhile, an increase of 1 million in the UMP increases the PTK value in Aceh Province by 106.69 million, assuming other variables remain constant. If the PPT percentage increases by 1%, the PTK value in Aceh Province increases by 1.345 million.

This research demonstrates that the GWR bi-square kernel model performs better than the Gaussian kernel model for studying the Economic Growth and Labor Productivity equations.

Furthermore, economic growth in the majority of regions in Indonesia is negatively influenced by low health quality. Of the 34 provinces, economic growth is most significantly influenced by investment in almost all provinces, except for Sumatra and part of Java. This aligns with research by Naiobaho (2023), which states that higher life expectancy positively affects economic growth, whereas low life expectancy has a negative effect, especially in Central Java. Additionally, economic growth in most regions of Indonesia is positively influenced by technology and investment, consistent with the findings of Hanim et al. (2023), which show the significant and positive impact of ICT and direct investment on economic growth.

The low quality of health has a positive influence on labor productivity. Of the 34 provinces, labor productivity is most influenced by education, which is significant in almost all provinces except in the eastern region of Indonesia and parts of Sumatra. This finding contrasts with Puspasari's (2020) research, which states that higher health quality positively influences labor productivity, while low life expectancy has a negative effect, particularly in Central Java.

Education and provincial minimum wages positively influence labor productivity in all regions of Indonesia, which aligns with Puspasari's (2020) research, showing a significant and positive influence of education and minimum wages on economic growth.

To encourage economic growth, the government should focus on increasing investment in Indonesia, as investment significantly affects economic growth in half of the country. To boost investment levels, the government should introduce new regulations to facilitate easier investment for investors.

For labor productivity, the government should prioritize improving education across Indonesia, as education impacts labor productivity in more than half of the country. To enhance education levels for workers, the government should implement policies that support and improve access to education

CONCLUSION

The conclusion obtained is that technological progress, poor health, and investment have different influences on economic growth in 34 provinces in Indonesia. The low quality of health has a significant influence in the two provinces, meaning the government must make policies and encourage quality improvement in these areas so that low health no longer affects these two regions. Technological progress in the ICT sector is significant in 3 provinces in Indonesia, and this means the government needs to review to see how big this influence is and how policies to make ICT do not affect economic growth so equality is achieved in 34 provinces. This variable must be improved so that health no longer affects economic growth. Significant investment in 18 provinces means the government must create

new regulations to make it easier for investors to invest capital.

Technological advances in education, poor health, and minimum wages have different influences on labor productivity in 34 provinces in Indonesia. The low quality of health has a significant impact in 4 provinces, meaning that the government must make policies and encourage quality improvement in these areas so that low health no longer affects these four regions and there is equality in 34 provinces in Indonesia. Technological progress in the education sector is significant in 23 provinces in Indonesia. This means the government must create new policies that support and make it easier for people to access education. The minimum wage is significant in 17 provinces, so the government needs to review the minimum wage in all provinces to optimize labor productivity.

Overall, of the 34 provinces, economic growth is most influenced by significant investment in almost all provinces except for the island of Sumatra and half of Java. Labor productivity is most influenced by education, which is significant in almost all provinces except in eastern Indonesia and half of the island of Sumatra.

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