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Capital Investment and Diminishing Labor Returns in East Java Growth: Investasi Modal Dan Fenomena Diminishing Returns Tenaga Kerja dalam Pertumbuhan Ekonomi Jawa Timur

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Abstract

General Background: Regional economic growth is a key macroeconomic indicator for evaluating welfare improvement, industrial development, income generation, and distribution of development outcomes. **Specific Background:** East Java experienced fluctuating economic growth during 2006–2025, while domestic investment, foreign investment, and labor absorption expanded within the regional economy. **Knowledge Gap:** The empirical condition in East Java showed a mismatch between capital accumulation, labor growth, and stable regional economic acceleration, creating a gap with neoclassical growth assumptions and prior studies on regional growth determinants. **Aims:** This study aimed to evaluate the partial and simultaneous roles of Domestic Investment, Foreign Direct Investment, and Labor in East Java’s economic growth from 2006 to 2025. **Results:** Using a quantitative verificative approach, secondary time-series data with 20 observations were analyzed through a Lin-Log multiple linear regression model using EViews 12. Domestic Investment showed a negative and non-significant result, while Foreign Direct Investment showed a positive but non-significant result at the 5% significance level. Labor showed a negative and significant result at the 10% significance level, supporting the Law of Diminishing Returns. Simultaneously, all independent variables significantly related to economic growth, and the econometric model passed all classical assumption tests. **Novelty:** This study applies a Lin-Log model to re-examine investment and labor dynamics across a twenty-year East Java macroeconomic timeline. **Implications:** The findings can support regional policy adjustment related to capital-intensive investment direction and labor market structural reform.

Highlights:

- ♦ The workforce variable showed a negative significant result.
- ♦ Both investment variables were not significant individually.
- ♦ Classical diagnostic testing supported model reliability.

Keywords: Domestic Investment, Foreign Investment, Labor, Economic Growth, Lin-Log Model

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Introduction

Regional economic development is an essential macroeconomic agenda designed to improve public welfare through industrial development, income generation, and equal distribution of growth outcomes. Keberhasilan pembangunan ekonomi suatu wilayah umumnya diukur menggunakan indikator pertumbuhan ekonomi yang mencerminkan peningkatan kapasitas produksi barang dan jasa regional dari waktu ke waktu. East Java Province occupies a highly strategic position as one of the main drivers of national economic expansion. However, the dynamics of East Java's Gross Regional Domestic Product (GRDP) at constant prices during the 2006-2025 period recorded a highly fluctuating trend, including a deep economic contraction of -2.33% caused by the global pandemic shock in 2020. Theoretically, capital accumulation via Domestic Investment (PMDN), Foreign Direct Investment (FDI/PMA), and optimal deployment of labor input should act as primary engines to boost regional production capacity and aggregate output.

However, empirical conditions in East Java present a clear contradiction or research gap with neoclassical growth theories. According to data from the Central Bureau of Statistics (BPS), the volume of long-term PMDN realization in East Java surged rapidly, reaching Rp101,759.00 billion by the end of 2025. A similar expanding pattern occurred in FDI/PMA realization, which reached its highest peak in 2023 at 4,741.00 million USD. Unfortunately, this massive expansion of physical capital did not systematically trigger stable and consistent regional economic acceleration. On the other hand, the labor supply absorbed in East Java continuously expanded, reaching 23,864,700 individuals due to the momentum of the regional demographic bonus. This rapid accumulation of workers without proportional skill enhancement is suspected of triggering a decline in marginal productivity.

The urgency of this research is highly apparent, given that the mismatch between investment flows and labor productivity serves as a critical indicator for evaluating regional economic structural bottlenecks. Previous empirical literature documents inconsistent findings regarding growth determinants. Studies by Fazaalloh [1] as well as Arum and Kaluge [2] confirm the complex role of domestic and foreign investment dynamics as the economic growth determinants across Indonesian provinces. Meanwhile, Mustofa and Faizin [3] highlight that various macroeconomic factors continuously reshape national output stability. In contrast, Fiorentina and Galuh [4] alongside Naufal et al.[5], reveal that industrial input shifts, capital realization, and labor force dynamics can interact differently with regional output depending on sector technological absorption and regional market characteristics."

This evident research gap between theoretical assumptions, prior academic studies, and two decades of raw empirical data in East Java indicates that a re-examination is imperative. Therefore, this study aims to comprehensively analyze the partial and simultaneous effects of PMDN, PMA, and labor absorption on the economic growth of East Java Province over a comprehensive timeline (2006-2025). By applying the Lin-Log multiple regression approach, this study expects to provide crucial empirical insights for regional policymakers to re-evaluate capital-intensive investment directions and labor market structural reforms amid shifting global macroeconomic dynamics.

Methods

This study applies a quantitative verifikative approach to test macroeconomic causal relationships and determine the impact of physical capital and labor allocation on East Java's economic growth. The data utilized consist of annual secondary time series covering a 20-year observation span from 2006 to 2025. All macroeconomic indicators were gathered via documentation techniques from official publications of the Central Bureau of Statistics (BPS) of East Java Province and annual investment realization reports from the Ministry of Investment/Capital Coordinating Board (BKPM).

The sample selection employs a saturated sampling technique, whereby the entire macroeconomic data of East Java Province within the 2006-2025 period is utilized. Given that this study employs a multiple linear regression framework containing four specific variables over 20 years, the total analyzed information points accumulate to 80 data units (*20 years × 4 variables*). This data volume is deemed sufficient to satisfy sample adequacy requirements for running econometric diagnostic checks without encountering overparameterization or estimation bias.

The dependent variable is Economic Growth (Y), measured by the annual percentage growth rate of GRDP at constant prices in East Java. The independent variables comprise three indicators: (1) Domestic Investment (X_1), measured by the annual realized value of PMDN in billion rupiah; (2) Foreign Investment (X_2), measured by the annual realized value of PMA in million USD; and (3) Labor (X_3), operationalized as the total number of individuals actively working in East Java Province. To minimize heteroskedasticity and scale disparities, all independent variables are transformed into Natural Logarithms ($\ln$). The data are processed via EViews 12 using a *Lin-Log*

multiple linear regression model via Ordinary Least Squares (OLS) estimation. The function is mathematically formulated as follows:

$$Y = \alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \epsilon \quad (1)$$

Where Y is the economic growth rate, α represents the constant intercept, $\beta_1, \beta_2, \beta_3$ are the partial regression coefficients, and ϵ represents the error term. To ensure that the model yields Best Linear Unbiased Estimators (BLUE), a series of classical assumption diagnostic tests are executed sequentially:

- Normality Test: Utilizes the *Jarque-Bera* (JB) metric to verify whether the model's residual distribution is normal with a required probability value > 0.05 .
- Multicollinearity Test : Evaluates the Variance Inflation Factor (VIF) to confirm the absence of severe linear correlations among independent predictors (threshold $VIF < 10$).
- Heteroskedasticity Test: Employs the *Breusch-Pagan-Godfrey* procedure to verify whether the residual variance remains homoskedastic (*expected p-value* > 0.05).
- Autocorrelation Test : Conducted via the *Breusch-Godfrey Serial Correlation LM Test* to confirm the independence of residuals across time frames (*expected p-value* > 0.05).

Results and Discussion

A. Results

1. Analysis of Variable Trends

Figure 1 illustrates the empirical development of the annual economic growth rate alongside the structural accumulation of the labor force supply in East Java Province from 2006 to 2025.

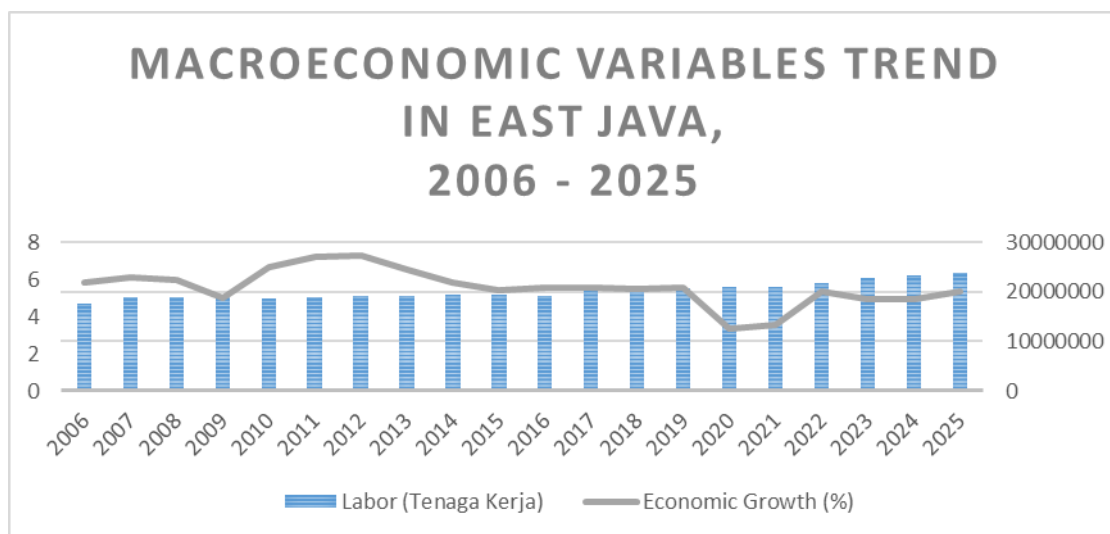


Figure 1. Macroeconomic Variables Trend in East Java, 2006-2025

The empirical movement structured in Figure 1 demonstrates a clear macroeconomic misalignment between labor force absorption and the actual economic growth trajectory across the two-decade observation span. The line chart tracking the economic growth rate of East Java Province captures a volatile trend, experiencing its highest expansion peak in 2012 at 7.27%, followed by a severe economic collapse in 2020 at -2.33% due to global pandemic disruptions.

In stark contrast to this fluctuating growth trend, the bar chart representing the regional labor force pool depicts a continuous, aggressive, and linear expansion. The volume of active working labor surged systematically from 17,669,660 individuals in 2006 to 23,864,700 individuals by the end of 2025, driven by the structural momentum of

East Java's demographic bonus. The graphical crossing of a steadily rising labor supply and a degrading or stagnant regional output line provides an immediate, observable visual indication of a structural congestion problem in the local labor market.

2. Diagnostic Model Testing

To ensure that the ordinary least squares (OLS) estimation functions as the Best Linear Unbiased Estimator (BLUE), this study executed a comprehensive set of classical assumption tests. The multicollinearity check aims to detect whether there is a severe linear dependency among the independent predictors within the production function, evaluated using the Variance Inflation Factor (VIF) indicator, where a Centered VIF score below 10.0 indicates the total absence of multicollinearity defects, consistent with structural validation procedures by Renaldi [5] and Rijoly et al. [6]. Furthermore, stability checks across the 20-year observation timeline are crucial to ensure that the error terms are normally distributed, homoskedastic, and free from severe serial correlation sequences across time frames [7], [8]."

a. Normality Test

The normality test is performed to determine whether the residual values generated by the Lin-Log regression model are normally distributed. This diagnostic check employs the empirical *Jarque-Bera* (JB) framework. Statistically, the residuals achieve a normal distribution if the computed *Jarque-Bera* probability value exceeds the standard critical alpha level of 5% ($p > 0.05$). Based on the computer processing via EViews 12, the model records a *Jarque-Bera* statistic of 1.5198 with a corresponding probability score of 0.4677. Since the empirical probability value is substantially higher than the alpha threshold ($0.4677 > 0.05$), the null hypothesis (H_0) cannot be rejected. Therefore, it is mathematically proven that the model's error terms are normally distributed and clean from structural skewness.

b. Multicollinearity Test

The multicollinearity check aims to detect whether there is a severe linear dependency or strong correlation configuration among the independent predictors (*ln PMDN, ln PMA, and ln Labor*) within the production function. This diagnosis is evaluated using the *Variance Inflation Factor* (VIF) indicator, where a Centered VIF score below 10.0 ($VIF < 10.0$) indicates the total absence of multicollinearity defects. The empirical processing records the Centered VIF scores at 3.7392 for Domestic Investment ($\ln X_1$), 2.0012 for Foreign Investment ($\ln X_2$), and 2.7732 for Labor absorption ($\ln X_3$). Because all structural VIF parameters are below the critical threshold of 10.0, the model is confirmed to be free from multicollinearity.

c. Heteroskedasticity Test

The heteroskedasticity test evaluates whether the variance of the residuals remains constant (*homoskedastic*) or varies (*heteroskedastic*) across the 20-year observation timeline. This study applies the *Breusch-Pagan-Godfrey* (BPG) diagnostic procedure. The homoskedastic requirement is fully satisfied if the *Prob. Chi-Square* value is greater than 0.05. The OLS estimation output displays an *Obs R-squared* value of 1.7581 with a *Prob. Chi-Square(3)* of 0.6241. Because the probability metric is higher than 0.05 ($0.6241 > 0.05$), the residual variance is mathematically stable, meaning the permodelan is completely free from heteroskedasticity.

d. Autocorrelation Test

The serial autocorrelation test is implemented to verify whether there is a correlation sequence between the residuals of a specific period and the preceding time frames. This study performs the *Breusch-Godfrey Serial Correlation LM Test* to confirm the baseline properties of the time series residuals. The absence of serial correlation is verified when the *Prob. Chi-Square* value falls above the 5% alpha level ($p > 0.05$). The diagnostic run yields a *Prob. Chi-Square(2)* score of 0.0991. Since this value exceeds the significance threshold ($0.0991 > 0.05$), the model is declared free from any serial correlation defects, ensuring the statistical independence of the error terms across the timeline. In order to verify the structural eligibility of the OLS parameters, the statistical metrics and alpha thresholds are systematically summarized in Table 1 before executing the final coefficient estimation.

Table 1. Econometric Classical Assumption Diagnostic Results

Diagnostic Test	Statistical Metric	Prob.	Threshold	Status
Normality (<i>Jarque – Bera</i>)	Probability	0.4677	>0.05	Normally Distributed
Multicollinearity	<i>Centered VIF ((lnX₁))</i>	3.7392	<10.0	No

				Multicollinearity
	<i>Centered VIF ((lnX₂)</i>	2.0012	<10.0	No Multicollinearity
	<i>Centered VIF ((lnX₃)</i>	2.7732	<10.0	No Multicollinearity
Heteroskedasticity (<i>BPG</i>)		0.6241	>0.05	Homoskedastic Variance
Autocorelation (<i>LM Test</i>)		0.0991	>0.05	No Serial Correlation

3. Multiple Regression Analysis

Following successful diagnostic confirmation, the partial and simultaneous parameter coefficients for the Lin-Log multiple regression model were estimated using Ordinary Least Squares (OLS), with the empirical values detailed in Table 2.

Table 2. Lin-Log Multiple Linear Regression Estimation Results

Variable	Coefficient	t-Statistic	Prob.
Constant (<i>C</i>)	141.4901	2.13636	0.0484
PMDN (<i>lnX₁</i>)	-0.090839	-0.359501	0.7239
PMA (<i>lnX₂</i>)	0.0606539	1.558551	0.1387
Labor (<i>lnX₃</i>)	-8.296152	-2.053600	0.0567
<i>R – squared: 0.386064</i>		<i>f – statistic: 3.353787</i>	
<i>Adj R – squared: 0.270951</i>		<i>Prob(F – statistic): 0.045319</i>	

The estimation results yield the following empirical macro-equation:

$$Y = 141.4901 - 0.090839 \ln X_1 + 0.0606539 \ln X_2 - 8.296152 \ln X_3 + \epsilon.$$

The simultaneous test indicates an *F*-statistic of 3.353787 with a *Prob(F-statistic)* of 0.045319 (**< 0.05**), validating that PMDN, PMA, and Labor simultaneously exert a statistically significant impact on East Java's regional economic growth. The coefficient of determination (*R-squared*) stands at 0.386064, revealing that 38.61% of the variation in regional growth is explained by the independent predictors, while the remaining 61.39% is explained by outside variables.

B. Discussion

The partial estimation shows that the coefficient for Domestic Investment (PMDN) is -0.090839 with a probability value of 0.7239 (***p* > 0.05**), confirming that PMDN does not have a statistically significant effect on yearly growth. This supports the regional economic analysis of Fiorentina and Galuh [4], indicating that large-scale domestic investment exhibits a substantial *time lag* effect. Because PMDN in East Java is heavily directed toward long-term capital-intensive projects such as public utility networks, toll roads, and heavy chemical industrial plants, its capacity to expand PDRB output streams is deferred. The structural capital transformation requires a certain maturity timeline to generate downstream manufacturing multiplier impacts.

Similarly, Foreign Investment (PMA) exhibits a positive coefficient of 0.0606539, but its probability value sits at 0.1387 (***p* > 0.05**), indicating a non-significant partial impact. This aligns with Fazaalloh and Arum and Kaluge [2], who note that FDI flows are highly volatile and responsive to international financial instability and local institutional cycles [3]. During domestic electoral periods or global supply chain adjustments, international investors adopt a cautious *wait and see* approach. Additionally, as demonstrated by Zahro et al. [9], external factors such as the accumulation of foreign debt can limit the instant growth contribution of foreign capital flows inside the aggregate economy. The complexity of this interaction is further emphasized by Aliyara and Agness [10], who argue that the efficiency of foreign investment inflows in stimulating structural economic expansion is highly contingent upon local institutional framework qualities.

A critical finding appears within the Labor variable, which bears a negative coefficient of -8.296152, significant at the 10% level (***p* = 0.0567 < 0.10**). This offers strong empirical support for the operation of *The Law of Diminishing Returns* within East Java's aggregate production function, which is visually confirmed by the diverging trends in

Figure 1. A rapid influx of working individuals driven by the demographic bonus, without matching human capital investment, induces a decline in marginal labor productivity. As argued by Fadhillah et al. [11], the regional market is heavily weighted toward low-skilled informal or traditional agriculture activities, transforming a large labor volume into an economic burden that depresses overall expansion efficiency. The over-saturation of un-skilled workers on fixed capital infrastructure assets decreases individual marginal output, slowing down the regional structural transformation corridor, which remains a critical subject in broader macroeconomic output modeling [12], [13], [14], and further supported by the technological and productive sector findings of Ali et al. [15] and Naufal et al.[16].

Conclusion

This study successfully demonstrates that Domestic Investment (PMDN), Foreign Direct Investment (PMA), and Labor force absorption simultaneously exert a statistically significant influence on the economic growth rate of East Java Province over the 2006-2025 observation timeline. Partially, both physical capital investments (PMDN and PMA) display non-significant effects due to institutional wait-and-see periods and substantial structural time lags inherent in capital-intensive development projects. Conversely, a critical result highlights that labor force expansion brings a significant negative impact ($p = 0.0567$), providing robust empirical evidence for the operation of The Law of Diminishing Returns where a massive supply of low-skilled informal workers under demographic bonus momentum acts as a structural burden rather than an economic engine. The broader impact of these findings implies that regional policymakers cannot rely solely on raw capital injection; instead, local authorities must urgently realign investment directions toward labor-intensive manufacturing down-streaming and implement targeted vocational education. For future research, it is highly suggested to extend the analytical framework by integrating labor productivity indexes or employing non-linear econometric models like Threshold Regression to capture the exact saturation point where labor accumulation starts to yield diminishing marginal returns.

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