



## Modelling Economic Growth in Indonesia Using Dynamic Data Panel Regression

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### ABSTRACT

The Covid-19 pandemic had a major impact on the economy with the economy slowing down and the financial system deteriorating. The value of economic growth in 2020 was -2.07%, the worst figure in the last 10 years. The aim of this research is to model economic growth in Indonesia. Variables that are thought to influence economic growth in Indonesia include population growth, banking credit and domestic investment. The data used is panel data from 34 provinces in Indonesia from 2015 to 2023. The model used is dynamic panel data regression with GMM Arellano-Bond estimation. The research results show that economic growth modeling is significantly influenced by population growth, banking credit and domestic investment both simultaneously and partially.

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## INTRODUCTION

The Arellano-Bond Generalized Method of Moments (GMM) is a dynamic model in economic research, as it includes a dependent variable that is influenced by independent variables at time  $t$  and by its own past values at time  $t-1$ . If the dependent variable in this study is economic growth, then using the Arellano-Bond GMM approach means that the model also accounts for economic growth conditions at  $t-1$  as an independent variable. Economic growth research has been widely discussed in international studies over the past decade. For example, (Levine et al, 2019) highlighted the role of financial sector development in driving economic growth while considering historical factors. Similarly, (Beck and Rahman, 2021) found a bidirectional relationship between financial development and economic growth, where a strong financial sector fosters economic growth, and sustained economic growth enhances financial stability. The fundamental difference in this study lies in the use of a dynamic approach that incorporates economic growth at  $t-1$  as a key determinant in the model. This allows for a more comprehensive analysis of long-term impacts and historical interconnections in economic growth dynamics.

Population (human resources), natural resources, physical capital, and human capital all have a theoretical influence on economic growth. The primary role of the population in driving economic growth is through labor supply. An increasing workforce enables a region to produce more goods and services for society. However, research has shown that rapid population growth can pose challenges to economic development. For example, (Lutz et al. 2019) highlight that while a growing population can boost economic activity, it may also strain natural resources and public infrastructure, particularly in developing countries. Similarly, recent studies by (Acemoglu and Restrepo, 2018) indicate that a high dependency ratio – comprising a large proportion of non-productive individuals such as children and the elderly – can slow economic growth by increasing fiscal pressures on social welfare and public services. Moreover, (Acemoglu and Restrepo, 2018) suggest that demographic shifts, particularly aging populations, necessitate policy adjustments to maintain productivity and economic sustainability.

Banking plays a crucial role in providing credit to the real sector by supplying liquidity that enables companies to expand their operations a concept known as the balance sheet channel. The allocation of credit based on usage and economic sector is vital for economic growth, as it enhances capital availability and ensures sufficient liquidity to achieve high economic performance. Recent international studies have explored the relationship between bank credit, economic growth, and technological innovation. (Manaresi and Pierri, 2019) found that increased access to bank credit positively impacts firm productivity, suggesting that credit availability can stimulate technological innovation and improve total factor productivity. Similarly, a study by (Zhang et al, 2023) examined the effects of financial development on total factor productivity growth in India, highlighting the complex interplay between financial development, human capital, and productivity. These

findings indicate that the relationship between banking credit and economic growth is endogenous, as both respond to market imperfections and uncertainties, thereby promoting long-term economic development.

The endogeneity of banking credit in relation to economic growth can be interpreted as a stimulus for accelerated economic development, aligning with established monetary and fiscal policies. By facilitating technological advancements and more efficient production processes, bank credit serves as a catalyst for sustained economic growth.

Investment is a critical driver of economic growth, as it enhances a country's production capacity and fosters technological innovation. Recent international studies over the past decade have provided empirical evidence supporting this relationship. (Ahamed, 2021) analyzed the impact of public and private investments on the economic growth of developing countries, finding that both types of investments significantly contribute to economic development. The study emphasized that public investment, in particular, has a strong positive effect on economic growth, suggesting that government spending on infrastructure, health, and education can stimulate economic activity. Similarly, a study by (Zhang et al, 2023) examined the role of financial development and human capital in total factor productivity growth in India. The research concluded that investments in human capital and financial development are crucial for enhancing productivity and, consequently, economic growth. This research discusses how the determinants of economic growth in the form of population growth rate, banking credit and domestic investment can influence the increase and decrease in economic growth using the GMM AB approach. Generalized Method of Moments (GMM) dynamic panel data regression with the Arellano-Bond (AB) approach has several advantages compared to static regression in the context of economic growth research. One of the main advantages of GMM AB is its ability to overcome endogeneity and simultaneity problems that often occur in economic growth models, where independent and dependent variables influence each other. GMM AB uses instruments to correct for bias in estimates, allowing the use of the lag of the dependent variable as an instrument for the independent variable, which helps produce more consistent estimates.

Although various previous studies have examined the relationship between economic growth, investment, banking credit, and population growth, several research gaps remain unexplored. Most prior studies have used static regression models that do not account for the dynamic relationships between variables over time. While Levine et al. (2019) and Beck and Rahman (2021) explored financial sector development and economic growth, they did not incorporate a dynamic model that considers past economic growth conditions. The Arellano-Bond GMM approach provides a methodological advantage by addressing endogeneity and simultaneity issues, allowing for a more accurate assessment of how economic growth evolves over time.

Additionally, while studies such as Manaresi and Pierri (2019) and Zhang et al. (2023) have analyzed the impact of banking credit on economic growth, there remains a gap in understanding how credit allocation across different

economic sectors influences overall growth. This study seeks to fill this gap by examining sector-specific banking credit allocation and its effects on economic expansion, particularly in the context of developing countries such as Indonesia.

Moreover, despite extensive research on investment and economic growth, existing literature has largely focused on developed economies, where financial markets and investment mechanisms function efficiently. Ahamed (2021) highlights the importance of public and private investments, but further investigation is needed on how domestic investment contributes to economic growth in developing countries, where structural challenges such as bureaucratic inefficiency and limited infrastructure may impact investment effectiveness. By using a dynamic panel regression model, this study provides a more comprehensive analysis of the long-term impacts of investment on economic growth.

Lastly, demographic factors have been widely studied concerning economic growth, with research such as Acemoglu and Restrepo (2018) emphasizing the effects of aging populations. However, few studies have examined the dynamic interplay between population growth, labor supply, and economic growth using a GMM approach. This study addresses this gap by integrating population growth rates into the dynamic model to evaluate their influence on economic performance over time.

By addressing these gaps, this research aims to contribute to a more robust understanding of the dynamic interconnections between banking credit, domestic investment, population growth, and economic growth, particularly in the context of developing economies.

## LITERATURE REVIEW

### *Economic Growth*

Economic growth is an increase in the output of goods and services in an economy over a certain period of time. In general, economic growth is measured through an increase in real Gross Domestic Product (GDP) and reflects progress in the production process which is influenced by capital accumulation, population growth and technological progress (Mankiw, Romer, & Weil, 1992). Understanding economic growth is the basis for formulating development policies and national economic development strategies.

### *Population Theory*

The demographic transition theory explains the process of changing the population structure from high birth and death rates to lower levels along with economic and social development. This process generally goes through several stages, starting from:

1. Initial stage: Birth and death rates are high so population growth is relatively stable.
2. Transition stage: A sharp decline in death rates is followed by a decline in birth rates, resulting in significant population growth.
3. Final stage: Both rates (birth and death) are low, resulting in a population structure with a higher proportion of productive age.

This demographic transition is considered a phenomenon that has the potential to provide a "demographic dividend" if the country is able to utilize the increasing proportion of the productive age population to encourage economic growth.

### ***Banking Credit Theory in Economic Growth***

Recent studies emphasize the crucial role of banking credit in stimulating economic growth, particularly in developing economies. According to (Beck, Levine, and Levkov, 2019), efficient credit allocation by banks enhances economic performance by directing financial resources toward productive investments. They argue that financial deepening – where banking institutions expand their credit provision – reduces capital misallocation and increases total factor productivity, thereby accelerating economic growth. Unlike earlier theories that focused primarily on the supply of credit, recent research highlights the importance of financial inclusion and accessibility, ensuring that businesses of all sizes, including small and medium enterprises (SMEs), can benefit from banking credit.

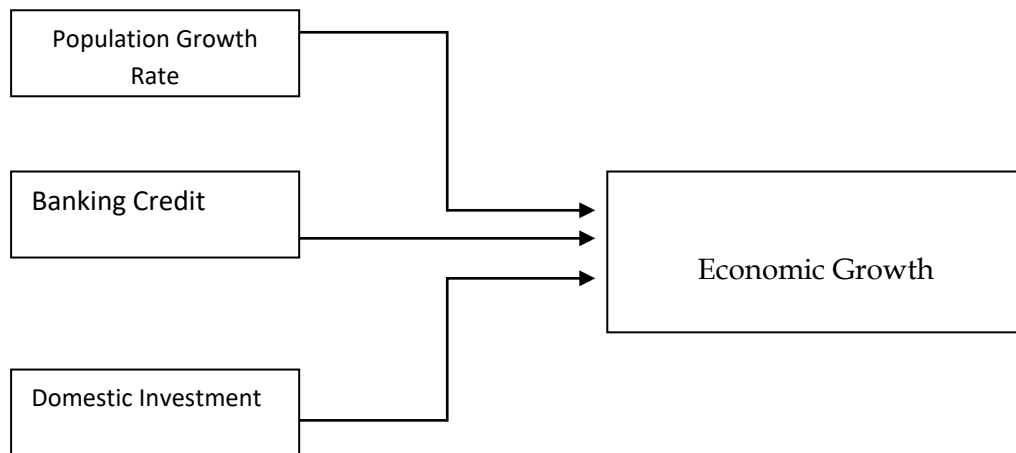
Furthermore, (Demirgüç-Kunt, Klapper, and Singer, 2020) emphasize the role of digital banking and fintech innovations in reshaping credit markets. Their research suggests that technological advancements in banking have lowered borrowing costs, improved risk assessment through big data analytics, and expanded access to credit for underserved populations. This shift is particularly significant in emerging economies, where traditional banking systems often fail to reach rural and informal sector businesses. By leveraging digital financial services, banks can efficiently allocate credit to sectors with high growth potential, fostering long-term economic expansion.

Another key perspective comes from (Greenwood, Hanson, and Shleifer, 2022), who argue that the impact of banking credit on economic growth depends on the stability and regulatory environment of financial institutions. They highlight that while access to credit promotes investment and innovation, excessive credit growth especially in unregulated markets can lead to financial instability and crises, ultimately hampering economic progress. Their findings suggest that policymakers must balance credit expansion with sound regulatory frameworks to ensure that banking credit contributes positively to sustainable economic growth.

### ***Domestic investment in Economic Growth***

Domestic investment is investment made by the domestic sector, whether by private companies, the government, or financial institutions to increase production capacity, expand infrastructure, and develop technology and human resources. This investment includes the formation of physical capital (e.g., factories, machinery and infrastructure) and non-physical capital (e.g., investment in research, development and education). Meanwhile, economic growth is measured by the increase in output of goods and services in an economy during a certain period. The two are interrelated, where increasing domestic investment can encourage capital accumulation and increase productivity, which ultimately contributes to economic growth.

**Theoretical Framework**



**METHODOLOGY**

The research design used in this research is an explanatory study or hypothesis testing study which aims to explain and test hypotheses about the relationship between variables. The data analysis technique used is dynamic panel regression. This method was chosen to overcome the problems of dynamics, endogeneity and individual heterogeneity that often arise in panel data. Dynamic panel regression allows researchers to integrate time effects, lag variables, as well as control for unobserved factors that are individual and time. In this research, the dynamic panel regression estimation technique was carried out using the Arellano-Bond approach (Arellano & Bond, 1991). The Arellano-Bond Estimator is a Generalized Method of Moments (GMM) method designed to handle the problem of endogeneity of lag variables and individual heterogeneity. This approach uses instruments generated from differences and levels of variables to produce consistent parameter estimates. The type of data used in this research is secondary data. The secondary data is cross section and time series data so that it takes the form of panel data for the 34 provinces in Indonesia. The sampling technique used is non-probability sampling in the form of purposive sampling. Meanwhile, the sample used in this research is data for the last 9 years, starting from 2015 to 2023. The research model developed using the GMM AB dynamic panel regression approach in this research is as follows:

$$Y_{it} = \alpha_0 + \lambda Y_{it-1} + \alpha_1 X_{it} + \alpha_2 X_{it} + \alpha_3 X_{it} + V_{it}$$

Information

Y = Economic Growth

$\beta_0$  = Equation constant

$\beta_{1,2,3}$  = Coefficients of Eq

x1 = Population Growth Rate

x2 = Banking Credit

x3 = Domestic Investment

$\epsilon$  = Standard error

i = cross section data for 34 provinces

t = 9 year time series data

**RESEARCH RESULTS**

*Analysis of Classical Assumptions*

The following is the output of the normality test using the EViews 10 application. From the test results obtained the following normality test results.

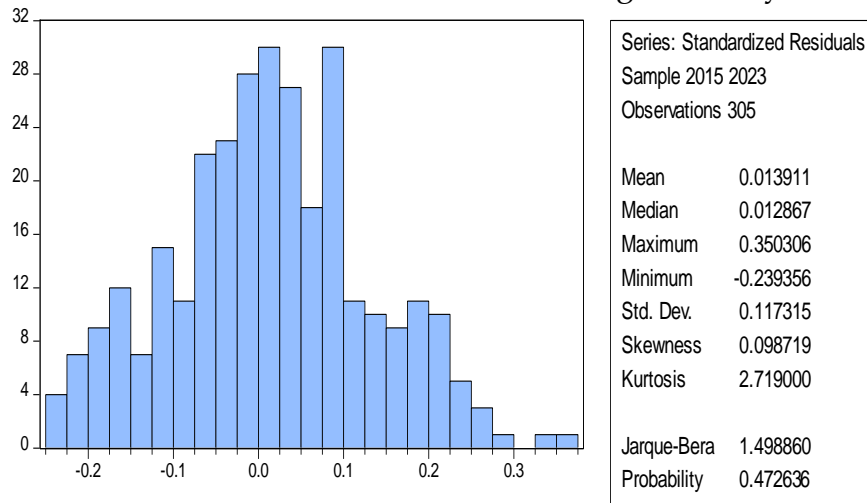


Figure 1. Normality Test

Based on Figure 1 above this research model passed the normality test because mark Probability is greater than 0.05 which is 0,472636. The probability value of the error or p-value model 1 above 0.05 or  $p\text{-value} > (\alpha = 0.05)$ . Thus, it was decided that the model residue was normally distributed at the 5% error level. The normality of this distribution is also shown by the histogram of data distribution which tends to form a normal curve (in the form of genta). Other classic assumptions in this study were multicollinearity tests, heterosceded run tests, autocorrelation tests, homogeneity tests showed that all research data passed the classical assumption test

*Multicollinearity Test*

The method used is the Correlation Matrix method. If the correlation coefficient is low or below 0.80, it is suspected that the model does not contain multicollinearity. The following are the results of the Multicollinearity Correlation Matrix test, as follows:

Table 1. Multicollinearity Test Results

	X1	X2	X3
X1	1.000000	0.050419	0.249013
X2	0.050419	1.000000	-0.211598
X3	0.249013	-0.211598	1.000000

Based on the results of the correlation test in the table above, it can be seen that there are no variables that have a value above 0.80. This shows that this

regression model does not contain multicollinearity problems, so these variables are free from multicollinearity problems

**Stationary Test**

Table 2. Summary of stationary test results (level level) using the augmented method Dicky Fuller (ADF)

Research Variables	Probabilities	Test Level
Y_Economic Growth	0.0000	First Difference
X1_Population Growth Rate	0.0000	First Difference
X2_Banking Credit	0.0000	First Difference
X3_Domestic Investment	0.0000	First Difference

Source: EViews Data Processing Results 10

The root test results using the Augmented Dicky Fuller (ADF) method show that at the level, all variables are stationary because the probability is below 0.05 at the first difference level, this is done because the model developed is a dynamic regression of the GMM First Difference approach.

**Dynamic Panel Data Regression Analysis**

The output EViews results to estimate the model in this study are as follows

Table 3. Dynamic regression estimation test results GMM AB Model

Variable	Coefficien			
	t	Std. Error	t-Statistic	Prob.
LOGY(-1)	0.14671	0.001101	195.0213	0.0000
LOGX1	-0.47511	0.005111	-101.2490	0.0000
LOGX2	0.93853	0.003265	-34.86772	0.0000
LOGX3	0.68645	0.010940	24.55584	0.0000
Effects Specification				
Cross-section fixed (first differences)				
Mean dependent var	0.024414	S.D. dependent var	0.348753	
S.E. of regression	0.403567	Sum squared resid	4.78495	
J-statistic	32.97229	Instrument rank	27	
Prob(J-statistic)	0.086525			

Source: EViews Data Processing Results 10

Based on the results of the output views above, the dynamic regression model GMM AB Model 1 can be written as follows:

$$Y_{it} = 6,47 + 0,14671 Y_{i,t-1} - 0,47511 X_{1it} + 0,93853 X_{2it} + 0.68645 X_{3it} + \epsilon_1$$

Based on the dynamic panel regression output above, the following is a detailed analysis, Dependent Lag Variable (LOGY(-1)) with Coefficient: 0.14671. This positive coefficient value indicates a persistence effect, meaning that the value of the dependent variable in the previous period (LOGY(-1)) has a positive effect on the current value. With a coefficient of 0.14671, a 1% increase in the Y value in the previous period is associated with an increase of 0.14671% in the current period, provided that a logarithmic assumption is used. t-Statistic of 195.0213 with a p-value of 0.0000 indicating that this lag effect is very statistically significant. Likewise, the research variables as predictors, namely population growth rate, banking credit and domestic investment, were declared to have a significant effect from a probability value of 0.000.

**Simultaneous Significance Test (Simultaneous)**

The results of the Wald test output below appear that the Wald Test value  $38033.29 > \chi^2 (K)$  is 14.61141 with a p-value value of 0.0000  $< \alpha$  0.05. Through the use of the significance level used 5% so that the Wald test value exceeds the value of  $\chi^2 (K)$ . The resulting decision is rejecting  $H_0$  because the statistical value of the test  $w > \chi^2 (k)$  or p-value  $< \alpha$  (0.05) so that there is at least one coefficient in variables that have significant characteristics in the model so that the dynamic panel data regression model in economic growth In Indonesia has a suitable model.

Table 4. Wald Test

Wald Test:  
Equation: Untitled

Test Statistic	Value	df	Probability
t-statistic	195.0213	232	0.0000
F-statistic	38033.29	(1, 232)	0.0000
Chi-square	38033.29	1	0.0000

Null Hypothesis: C(1)=0  
 Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.214671	0.001101

Source: EViews Data Processing Results 10

**Partial Significance Test**

Based on table 2 above, it appears that all the variables examined in this research, namely the Gini index, population growth rate, banking credit have a

significant effect on economic growth, indicated by a Prob value <0.05, namely 0.0000

**Test Model Specifications**

Model specification tests in dynamic panel regression include the Arellano-Bond test, Sargan test and unusualness criteria

*1. Consistency Test (arrelano bond test)*

Model Consistency test is a test to check whether the residual on the instrument is consistent or not using the arrelano bond approach. The condition for consistency is that the second order prob value (AR2) must be more than the alpha value (>0.05). The following are the results of Arelano bond testing on the model.

Table 5. Model Consistency Test Results  
 Arellano-Bond Serial Correlation Test  
 Equation: Untitled  
 Sample: 2015 2023  
 Included observations: 238

Test order	m-Statistic	rho	SE(rho)	Prob.
AR(1)	-2.109373	-0.394217	0.186888	0.0349
AR(2)	0.581537	0.060066	0.103289	0.5609

*Source: EViews Data Processing Results 10*

Prob AR (2) value is 0.5609 > 0.05 so that this dynamic panel model meets the consistency requirements

*2. Test Instrument Validity (Sargan Test) Model*

The results of testing the model specifications for instrument validity in the proxy with a Jstatistic value with a valid instrument criterion if the value of p value > 0.05. The following are the results of the output testing sargan

Table 6. Model Instrument Validity Test Results

Cross-section fixed (first differences)			
Mean dependent var	-0.001263	S.D. dependent var	0.067379
S.E. of regression	0.096373	Sum squared resid	0.191922
J-statistic	32.35246	Instrument rank	28
Prob(J-statistic)	0.181723		

*Source: EViews Data Processing Results 10*

The probjstatic value of  $0.181723 >$  from Alpha 0.05 can be concluded that the resulting model meets the criteria of the instrument validity which shows the absence of an instrument overidentification problem at a significance level of 5%.

3. *Test the Criteria for Model Innovation*

The coefficient results of the dependent variable lag must not be biased, this impression requirement is met if the coefficient value of the dependent lag on the GMM FD model must be between the coefficient value on the FEM model and the coefficient value of the PLS/Cem model. So that if the GMM FD coefficient value  $>$  the FEM coefficient and the GMM FG coefficient value  $<$  PLS/CEM coefficient of the model meets the imposition of the intense. As follows:

Table 7. Estimated results of comparison of model coefficient values 2

FEM	GMM FD	PLS/CEM
0.257450	0.383436	0.949460

Source: EViews Data Processing Results 10

The GMM FD dependent lag coefficient value of 0.214671 is between the lower limit of the FEM model coefficient value of 0.257450 and the upper limit of the PLS model coefficient value of 0.949460 so that the model 2 developed in this study meets the criteria

**DISCUSSION**

Overall, the estimation results show that all variables (both the dependent lag and the independent variables LOGX1, LOGX2, and LOGX3) have a significant effect on the dependent variable. The lag effect (LOGY(-1)) indicates that there is dynamics in the dependent variable, while the independent variables have varying influences: X1 has a negative effect, while X2 and X3 have a positive effect. The instrument test results also support the validity of the model, although the Prob(J-statistic) value which is around 0.086525 suggests caution in interpretation if the standards used are very strict.

This analysis confirms that the use of dynamic panel regression has succeeded in handling time dynamics and controlling cross-sectional heterogeneity, so that the results obtained can be trusted for interpreting causal relationships between the variables studied.

The dependent lag variable coefficient (LOGY(-1)) of 0.14671 indicates the existence of a dynamic or autocorrelation effect on economic growth. This means that the value of economic growth in the previous period has a positive and significant impact on economic growth in the current period. This finding is in line with the dynamic growth model approach used by Mankiw, Romer, and Weil (2022) as well as other dynamic models that recognize the importance of lag effects in explaining the behavior of growth variables.

The coefficient for X1 = -0.47511 indicates that an increase in the population growth rate has a negative effect on economic growth. This negative

result is consistent with empirical research showing that high population growth rates can dilute capital accumulation, potentially hindering economic productivity. For instance, a study by Salsabila et al. (2021) in West Sumatra found that the population growth rate had a negative but insignificant impact on economic growth. Similarly, Datu et al. (2021) in the same region demonstrated a significant negative effect of population growth on economic growth. Meanwhile, Wulandari et al. (2023) in Agam Regency found that population growth had a positive and significant impact on economic growth. Additionally, a study by Sikana and Kusuma (2024) in West Java concluded that population growth positively influenced economic growth. These mixed findings suggest that the impact of population growth on economic growth can vary depending on regional contexts and other influencing factors.

The coefficient of  $X_2=0.93853$  indicates that an increase in bank credit has a positive and significant impact on economic growth. This supports the findings of King and Levine (2015), which argue that the development of the financial sector, including credit distribution, plays a key role in fostering economic growth by enhancing resource allocation efficiency and supporting productive investments. A healthy financial system, coupled with an effective credit distribution mechanism, is therefore crucial for stimulating economic growth. Recent studies from the past decade reinforce this view, showing that bank credit positively influences economic growth in various regions. For example, a study by Fitria (2017) on the impact of bank credit in Jambi Province found a significant positive effect on economic growth. Similarly, research by Suryani (2024) conducted in Nusa Tenggara Timur showed that banking credit positively impacted the region's economic performance. Furthermore, a study by Setiawan (2018) examining the role of bank credit in Indonesia revealed that bank lending had a notable positive impact on national economic growth, especially when coupled with sound fiscal policy. Finally, a study by Hidayat et al. (2021) focused on the economic effects during the COVID-19 pandemic found that while conventional bank credit was less impactful, Islamic financing schemes played a significant role in sustaining economic growth. These findings collectively demonstrate that efficient credit distribution is essential for fostering long-term economic development.

The coefficient  $X_3$  of 0.68645 indicates that domestic investment has a positive contribution to economic growth. Increased domestic investment, both in the form of physical capital (such as infrastructure development, industrial expansion, and machinery investment) and non-physical capital (such as research and development), enhances capital accumulation and productivity growth. These findings align with the modern endogenous growth theory, which highlights the role of investment in driving technological progress and long-term economic expansion.

Recent empirical studies support this relationship. Rodrik and Subramanian (2019) emphasize that domestic investment plays a crucial role in developing economies by improving productivity and fostering industrial transformation. Similarly, Wang and Wong (2021) found that sustained investment in human and physical capital significantly contributes to economic

resilience and output growth in emerging markets. In the case of Indonesia, research by Putra and Widodo (2020) and Siregar et al. (2022) confirms that increased domestic investment has a significant impact on GDP growth, particularly through the expansion of key economic sectors such as manufacturing, infrastructure, and digital economy development.

## CONCLUSION AND RECOMMENDATION

Overall, the dynamic panel regression results show that the Growth Dynamics Effect lags positive  $Y_{t-1}$  indicates that there is dynamics in the economic growth process. A high population growth rate (X1) has a negative impact, in line with Malthusian theory and empirical studies showing the effect of capital dilution. Increasing banking credit (X2) has a positive and significant effect, supporting the finding that a developing financial sector can increase economic growth. Domestic investment (X3) also has a significant positive effect, strengthening the role of investment as the main driver of economic growth. These findings overall support previous literature which emphasizes that economic growth is influenced by internal dynamics (through lag effects), as well as structural factors such as population growth, financial sector development, and domestic investment.

Policy recommendations that the government can consider to encourage sustainable economic growth are Optimizing family planning programs and education regarding reproductive health to reduce high population growth rates, so that there is no dilution of capital per capita, Investing in education and health services to improve the quality of human resources, which in turn can increase productivity and innovation, Strengthen the regulatory framework and supervision of the banking sector to ensure effective and efficient credit distribution to productive sectors.

Despite these valuable findings, this research has several limitations. First, the study relies on available data, which may be subject to measurement errors or limitations in coverage. Second, the scope of the research is limited to certain regions, which may not fully capture the complexities of economic growth dynamics at a global scale. Lastly, the model's assumptions might not fully account for external factors, such as global economic shocks or political changes, which can also influence economic growth. For future research, it would be beneficial to expand the study to a broader range of countries or regions to explore the varying impacts of these factors. Additionally, incorporating a broader set of variables, such as technological innovation or environmental factors, could provide deeper insights into the dynamics of economic growth. Finally, future studies could explore the role of international trade and foreign direct investment (FDI) in economic growth to provide a more comprehensive understanding of the global economic landscape.

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