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Research Article

Economic Growth of Aceh: A Dynamic Model Analysis

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ABSTRACT

Economics growth is influenced by many variables that are interrelated. Each variable is a variable that influences and even influenced. Economic growth over the past ten years has experienced positive growth. However, economic growth has not been able to improve macroeconomic indicators such as unemployment, employment opportunities, inflation, investment and others. Although the economy is growing, poverty is still high. This research was conducted in Aceh. This study aims to determine how economic growth can occur and increase in Aceh. The data in this study comes from reports by the government, We used data on GRDP, unemployment, poverty, investment, labor and others. The data to be taken is 13 years from 2010-2023. To analysis data in this study, we uses dynamic model analysis. which is a method of solving complex problems that arise due to the tendency of cause and effect from various variables in the system. This methodology focuses on policy and how its determines the behavior of problems that can be modeled by dynamic systems. The stages in the process of dynamic system modelling are as follows: problem identification, system building, formulation, simulation and validation, and policy or scenario. From the simulation results, it was obtained that the trend of economic growth will increase if the capital output ratio can be achieved lower than 5, and the capital age can be increased more than 25 years. The local government needs to increase investment to increase output as a consequence of increasing ICOR.

Keywords: Economic Growth; Dynamic System; Validation; Simulation

1. INTRODUCTION

Since the beginning of the decentralization era in 2008. The receipt of autonomy funds has made the regions in Indonesia have large fiscal resources. Providing an opportunity to realize the acceleration of development through priority programs that have been mandated by regulations, that is infrastructure development and maintenance, empowerment of the people's economy, poverty alleviation, and funding for education, social and health, (Tasrif, n.d.); (Busra et al., 2019). Aceh is one of the regions that receives autonomy funds from the central government, however, the large amount of revenue has not been able to improve welfare or lift the population out of poverty. Based on the BPS report as of March 2024, the poverty rate is still14.23 percent, and is still above the national average, (BPS, 2024). The Human Development Index (HDI) of Aceh Province in 2023 reached 74.70, an increase of 0.59 points (0.80 percent) compared to the previous year's achievement Aceh's economy experienced a growth of 5.17 percent in the third quarter of 2024, while the economic growth of Aceh was around 4.21 percent, up from 2022, the level of the previous year. In 2023, economic growth was 4.23 percent. Aceh's economic growth is currently supported by several sub-sectors that predominantly contribute to the GDP, that are the agricultural sector, industry, wholesale and retail trade, tourism, information and communication sector, while other sectors contribute a smaller portion to the economy. Aceh has significant potential for development. The support of the economic sector in the form of trade and MSME sectors is significant. Aceh has the potential to become a center for MSME growth with a fairly high number of MSMEs and good growth. The micro, small and medium business sectors are the mainstay for each region in supporting economic growth.

Economic growth of Aceh is closely related to decentralization, especially fiscal decentralization (Fitrawaty et al., 2023). This relationship arises regional financial performance. Research indicates that fiscal decentralization has a positive impact on regional economic growth, especially in the short term, although it can be negative in long term, (Sofilda et al., 2023). Another finding is that decentralization has a small impact on regional growth dynamics, but its impact is clearly visible politically (Sima et al., 2023). Decentralization can be seen in various dimensions, especially concerning fiscal aspects, changes in administration and government systems, and social and economic development. explains that decentralization is the process of transferring power in making decisions and policies on regional development (Hornstein, 2024); (He & Xu, 2019). Decentralization is the transfer of some or all government authority from the center to the regions.

So that the regions that receive authority are autonomous, so they can determine their own methods (Canavire-Bacarreza et al., 2020). Decentralization in various countries has been shown to have an impact on economic growth through increasing GDP per capita, but the impact varies from country to country (Canavire- Bacarreza et al., 2020; Lina, 2024).

Economic growth is also influenced by the availability of capital accumulation in a country. Capital accumulation is formed from investments from the private sector and the government. Foreign investment plays an important role. As stated (Hornstein, 2024) the impact of foreign investment on the economy is very diverse, the findings of GDP growth in various countries are consistent with FDI growth. Determinants of economic growth are influenced by many factors such as natural resources, humans and capital accumulation and local revenue, (He & Xu, 2019). Many studies on economic growth have been conducted both nationally and regionally. However, those using dynamic analysis are still very limited, particularly in the case of regional economic growth. This study examines the dynamics of Aceh's economic growth using a dynamic approach that allows for simultaneous observation of changes in indicators.

2. RESEARCH METHOD

2.1 System Dynamic Conceps

A model is a description made to explain a structure or system, the models that are often described consist of three types, namely quantitative models, qualitative models and iconic models (Rusiawan et al., 2015). Dynamic models include quantitative models that are often used in various analyses, both economic, environmental and manufacturing processes. The considerations used in choosing a dynamic system are the process that follows time and the complexity of the problems being tested and requires feedback (Hornstein, 2024). Dynamic systems are used to understand the complex structure and dynamics in a system. This model is a modeling that allows researchers to simulate and design better policies. A system is defined as an element consisting of several subsystems and the structure in the system is greatly influenced by its elements. Dynamic modeling is carried out in four stages, observing field conditions, conceptualization, interpretation and modeling. Field observations will produce a framework in the form of a cause and effect diagram, modeling in a dynamic system follows several stages that are regular.

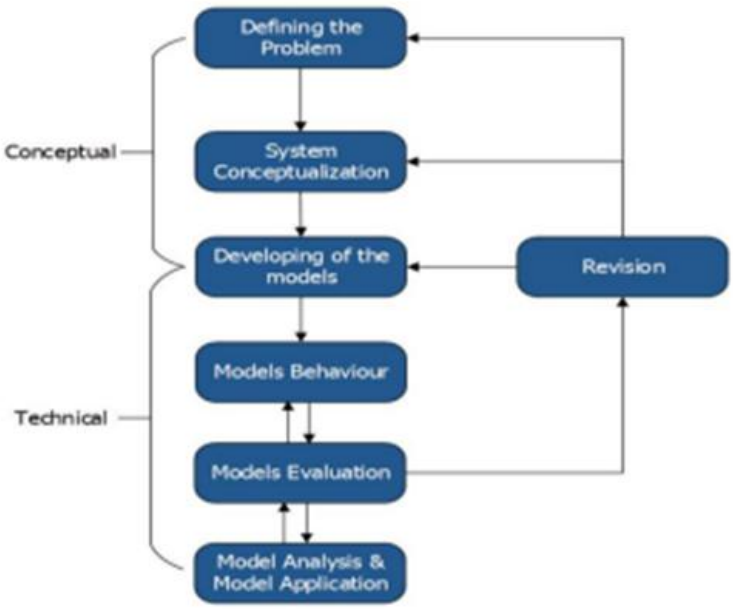

Figure 1. Stages of dynamic system modeling

Stage 1. Modeling

At this stage, a study is conducted to conceptualize the model through a literature review that is useful for seeing the reality that will be modeled. Economic growth is a dynamic interaction of variables that influence and are interrelated. This concept applies to all economies.

Stage 2. Creating a dynamic model structure

At this stage, the concept of the relationship between variables in one causal loop diagram and stock flow diagram model will be illustrated. The creation of both model illustrations is done with the help of Vensim software.

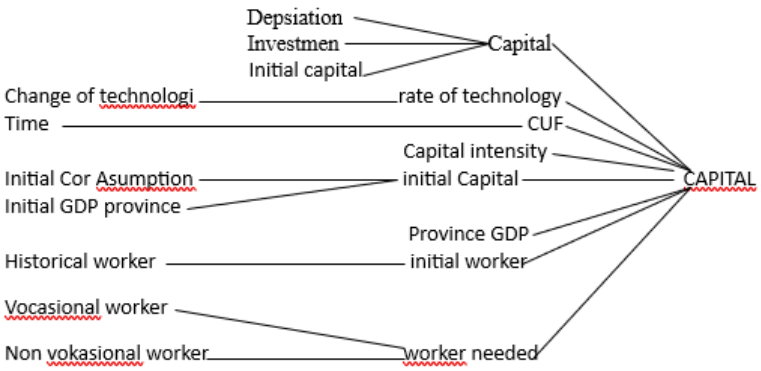

Figure 2. Illustration of economic growth model

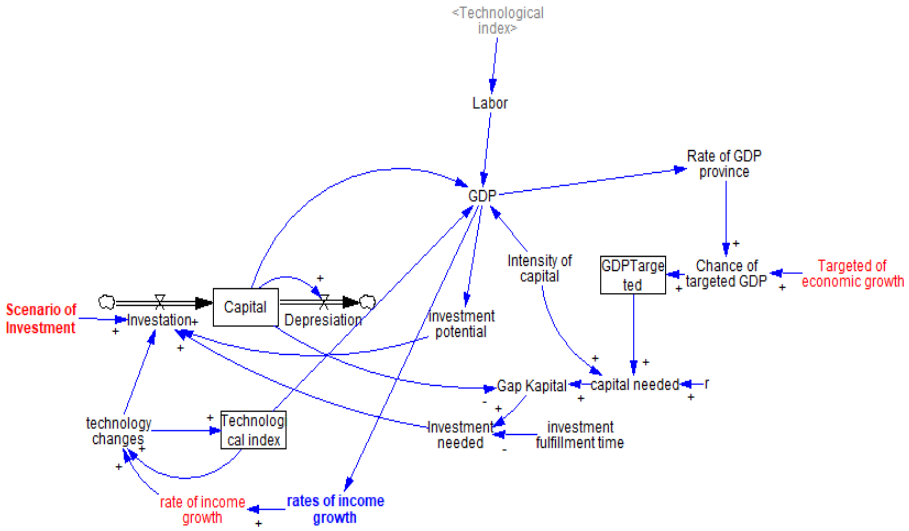

Figure 3. Causal loops diagram

The simulation stage is a process of imitating the behavior of a phenomenon that aims to understand the phenomenon, then conducting an analysis to make policies in the future. The stage is carried out by entering data into the symbols of system dynamics. In this study, the data entered in the stock flow is secondary data in the form of investment data, depreciation, economic growth, GDP, number of workers, coefficients, technology and depreciation. After all data has been inputted, the next step is to carry out a simulation.

Stage 3. Model Validation

At the validation stage, compare simulation data with historical data or compare simulation data with statistical results in conducting simulations on the variable parameters used as in the **Table 1.**

Table 1. Used variables in the flow diagram and calculation levels

Variables	Documentation
PDRB	PDRB Value of goods and services produced
Capital	Capital Availability of capital for additional assets
Investation	Investment growth
Capital to output ratio	Capital to output ratio Ratio
Saving	saving Amount per year
Unployment	Number of workers
Technology	Technology growth
Capital age	Length of time capital is used
MPS	Savings rate
Intencity of capital	Comparison of assets to workers
GDP Targetting	Expected GDP growth
Capacity Utilization factor	Level of fixed asset use
Economic growth rate	Change in output value

3. RESULTS AND DISCUSSION

The relationship between various macroeconomic indicators can be seen as a whole that produces the desired goal in an economy. The relationship and influence produced by one variable on other variables that can be seen simultaneously with dynamic model analysis. Figure 4, is a stock flow diagram that describes the economy of Aceh.

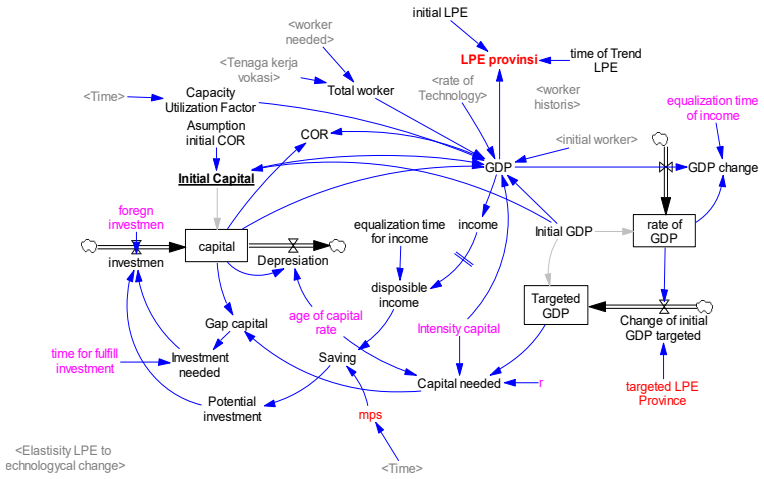

Figure 4. Stock Flow Diagram (SDF) of GDP and Investment

The growth GDP has historically continued to increase until 2019, after that year growth experienced a decline due to shock, but recovery occurred quickly, where economic growth recovered after 2021, as in Figure 5. Investment growth in Aceh continues to increase in driving GDP growth.

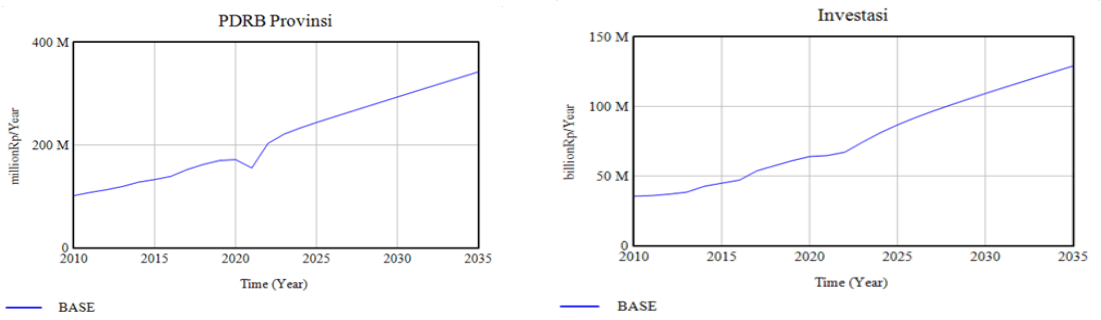

Figure 5. GDP and Investment Growth

Validation Model

Validation in dynamic models aims to ensure that the model can accurately explain the behavior of real systems and can reflect real trends in a system. Validation is done by comparing the model created with the real model that occurs (Kumari & Devadas, 2017). Then see whether the model built and the simulation performed show similarities with the real model. In Figure 6, the data behavior approaches the behavior of its historical data at least until 2023 that the behavior of GDP data and Investment data approaches the behavior of the historical data.

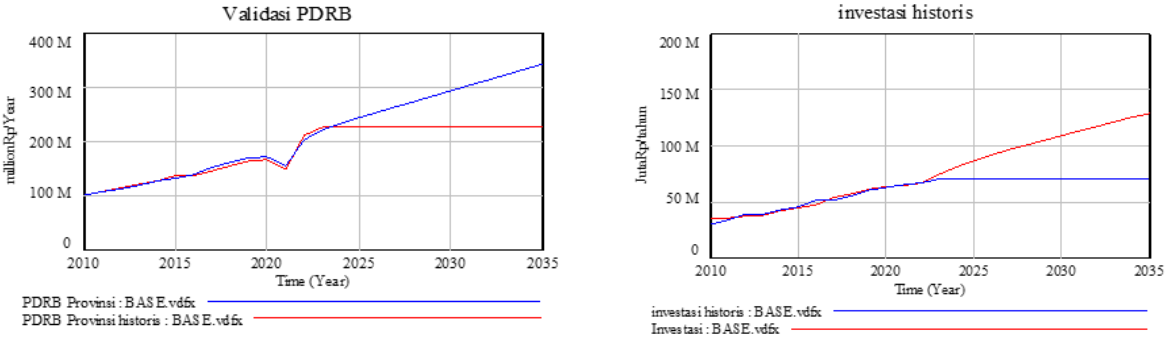

Figure 6. Validations of GDP and Investation Value

Scenario Model and Simulation

Economic growth will increase in the future if several simulated variables change (Wang et al., 2018); (Aminullah & Erman, 2021). The simulation scenario will be carried out on several economic growth variables in Aceh to see changes in the economy, which can be used as a consideration for decision makers. Aceh's historical GDP growth is assumed with a capital to output ratio (COR) of 5 and a capital intensity of 0.5. While the average age of capital more than 25 years, the utilization of production invoices is 1, the utilization of production factors has decreased during the Covid-19 pandemic. If the capital to output ratio is increased in the economy, it means that more labor is used as seen in Figure 7.b, the economy slows down, the use of more labor reduces efficiency in the economy, but if it is reduced to 4 which means that more capital resources in the economy are used compared to human labor, the economy will grow higher as in Figure 7.c. the economy will be more efficient with a greater level of capital utilization.

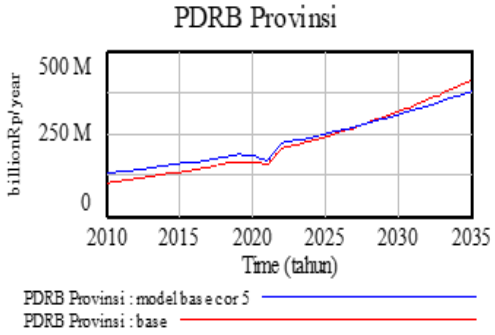

Figure 7.a

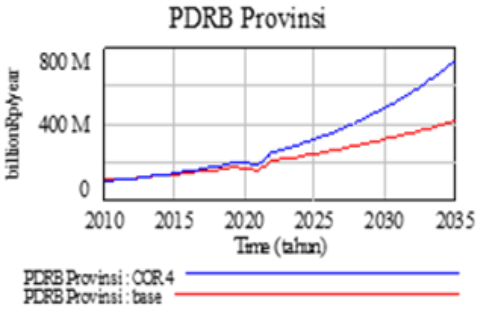

Figure 7.b

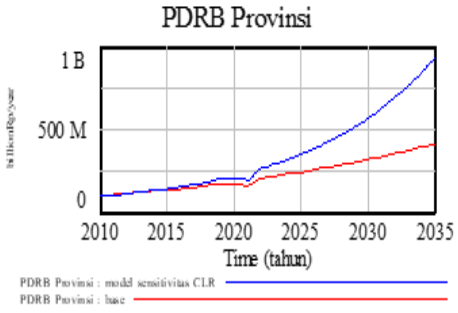

Figure 7.c

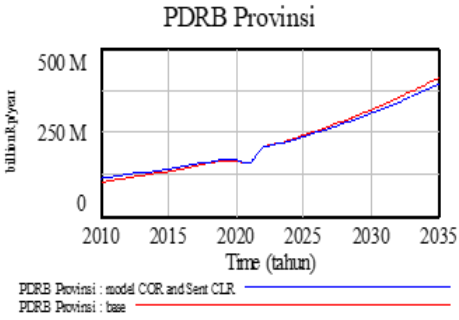

Figure 7.d

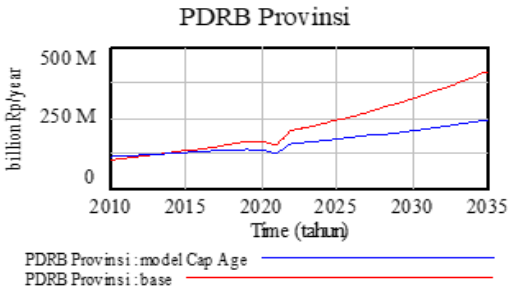

Figure 7.e

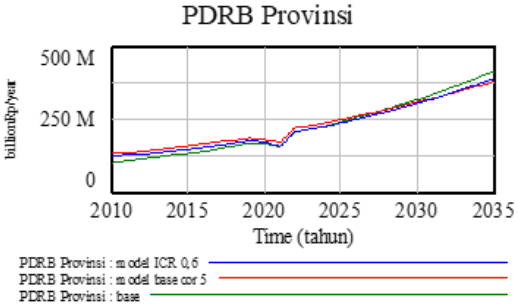

Figure 7.f

Figure 7. Simulation Economics Growth

If the COR assumption is 5, but the sensitivity of technology to capital labor ratio is increased to 4, the trend of economic growth will decline in the future. The capital to output ratio has a significant impact on the increase in output value in the Aceh economy. The age of use of production factors is also one of the variables that affects the Aceh economy. The age of use of production factors shows how long capital in the form of equipment and machinery has used econom. The longer the age of use of capital, the less investment capital must be spent on an annual average. The longer the age of use of capital, the more efficient the economy.

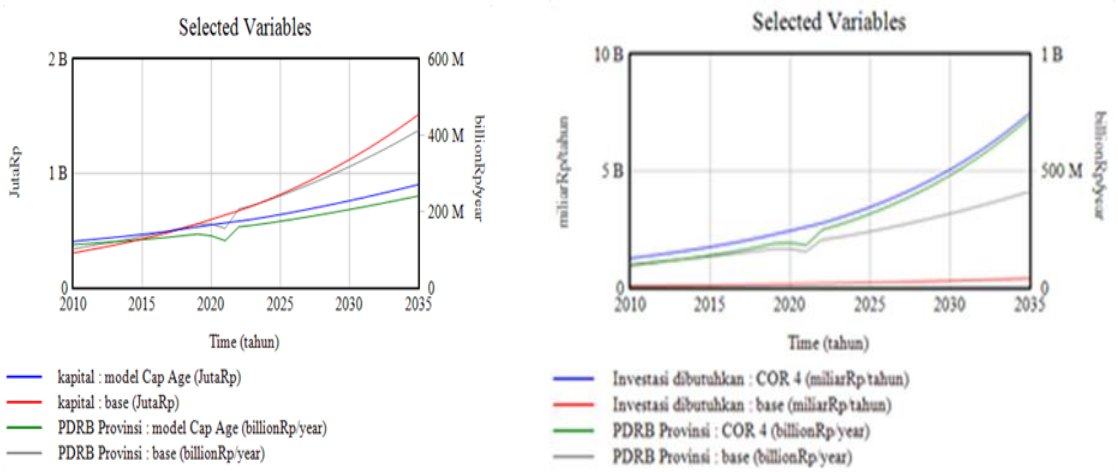

Figure 8. Simulation COR and Capital Age

The average age of use of capital in the Aceh economy to achieve growth equal to its historical growth is 25 years. If the age of use of capital is reduced to 15 years, the trend of economic growth will declined. To achieve a larger capital to output ratio, the government needs greater investment in the economy.

4. CONCLUSION

Aceh's economy has shown a steady pattern of growth since 2011, reflecting gradual progress in the region's development trajectory. However, this upward trend was temporarily interrupted during the 2019 Covid-19 pandemic, which caused a contraction in economic activity across multiple sectors. Despite the setback, Aceh's economy remains resilient, with recovery efforts focused on stimulating investment, improving productivity, and enhancing institutional capacity. The overall dynamics of Aceh's economic growth are influenced by various interrelated variables, making it essential to use a dynamic simulation model to understand their complex interactions and long-term implications. The results of the simulation indicate that Aceh's economic growth will improve significantly if the Incremental Capital Output Ratio (ICOR) can be reduced. A lower ICOR reflects higher efficiency in the use of capital to generate output, suggesting that resources are being allocated and utilized more effectively. This efficiency is a crucial indicator of economic performance, as it demonstrates how well investment translates into actual production growth. In essence, when less capital is required to produce each additional unit of output, the economy experiences faster and more sustainable expansion. Furthermore, the analysis highlights that the productive age of capital has a meaningful influence on economic trends. Longer utilization of capital assets such as machinery, infrastructure, and technology contributes positively to economic stability and growth. Efficient maintenance and reinvestment in capital goods extend their operational value, ensuring a continuous contribution to the economy. Conversely, an increase in the capital-to-output ratio, which indicates a higher dependency on labor inputs relative to capital, tends to slow down economic progress. This suggests that excessive reliance on labor-intensive production without corresponding improvements in capital efficiency can hinder productivity growth and limit the economy's long-term competitiveness. To address these challenges, government intervention through strategic investment policies is essential. The Aceh government should prioritize investments that enhance technological adoption, industrial modernization, and human capital development. Strengthening digital infrastructure and encouraging private-sector participation can further improve capital productivity. Additionally, policies promoting innovation, entrepreneurship, and sustainable resource management will help achieve a more favorable ICOR, thus driving long-term economic expansion.

RECOMENDATIONS

Aceh's economic future depends on its ability to balance efficient capital use, technological advancement, and productive workforce engagement. The Aceh government needs to focus on capital efficiency and extending the lifespan of productive assets. Supported by well-targeted investments, Aceh can achieve a more dynamic, inclusive, and resilient growth trajectory in the years to come. Future research in Aceh should focus on identifying sectoral strategies to improve capital efficiency and productivity. Studies could examine how digital transformation, innovation capabilities, and human resource development contribute to lower ICOR across various industries. Comparative analysis across regions in Indonesia could also provide valuable insights into best practices for sustainable growth.

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AUTHOR'S CONTRIBUTION

This article was written collaboratively, all authors provided significant contributions, discussions and suggestions in producing the manuscript, from the start to the final.

CONFLICT OF INTEREST

In connection with this research entitled: Economic Growth of Aceh, A Dynamic Model Analysis, the authors declare that they have no financial interests or personal relationships that could have influenced the work on this manuscript.

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