

Driving Aceh's Economic Growth through Digital Finance and MSME Credit: Empirical Evidence

Yasrizal^{1*}, Mahrizal², Said Mahdani³, Sailal Arimi⁴, Sri Rosmiati Sani⁵

^{1,2,4,5} Development Economics, Faculty of Economics and Business, Teuku Umar, Meulaboh, 23615, Indonesia

³ Accounting, Faculty of Economics and Business, Teuku Umar, Meulaboh, 23615, Indonesia

ABSTRACT

Purpose: This study examines district/city-level economic growth in Aceh Province by analyzing the roles of financial inclusion, MSME credit, payment digitalization, inflation, and unemployment. It highlights that regional growth is increasingly shaped by the productive use of financial services and digital payment systems, not merely by financial access.

Design/methodology/approach: This study employs a quantitative approach using balanced panel data from 23 districts/cities in Aceh Province during 2020–2025, yielding 138 observations. The analysis applies a Fixed Effects Model and uses Driscoll-Kraay robust standard errors to correct for heteroskedasticity, serial autocorrelation, and cross-sectional dependence. The 2025 observations are treated as projected data estimated using linear trend extrapolation based on the latest available official data. The projected variables include economic growth, financial inclusion, payment digitalization, MSME credit, inflation, and unemployment.

Findings: The findings indicate that payment digitalization shows the strongest positive association with district/city-level economic growth in Aceh Province. MSME credit is also positively associated with regional growth, while unemployment shows a negative association. Inflation is positively associated with growth during the study period, possibly reflecting demand-driven economic activity. Financial inclusion shows a negative and statistically significant coefficient, suggesting that financial access has not yet been effectively transformed into productive financial use.

Originality/value: This study contributes to the regional finance-growth literature by showing that payment digitalization is a stronger driver of district/city-level economic growth than general financial inclusion. The findings emphasize that financial access alone is insufficient unless it is transformed into productive-use inclusion through digital payments, MSME financing, and employment-oriented policies.

ARTICLE INFO

Keywords:

Economic Growth,
Financial Inclusion,
Inflation,
MSME Credit,
Payment Digitalization,
Unemployment.

Article Information:

Received: 20/03/2026

Revise: 28/05/2026

Accepted: 13/06/2026

ISSN:

2985-3168 (Online)

2985-3222 (Print)

*Corresponding Author at: yasrizal@utu.ac.id

Development Economics, Faculty of Economics and Business, Teuku Umar, Meulaboh, 23615, Indonesia

E-mail address: yasrizal@utu.ac.id

The work is licensed under a [Creative Commons Attribution-ShareAlike 4.0 International \(CC BY-SA 4.0\)](https://creativecommons.org/licenses/by-sa/4.0/)



1. Introduction

Regional economic growth remains an important issue in development policy because it reflects a region's capacity to expand output, create income, absorb labor, and improve public welfare. In Aceh Province, this issue is particularly relevant because economic growth across districts and cities is shaped by uneven financial access, different levels of MSME development, varying digital infrastructure, inflation dynamics, and labor market conditions. Recent studies suggest that economic growth is increasingly influenced not only by conventional macroeconomic factors but also by the interaction between financial inclusion, digital technology, productive financing, and regional institutional capacity (Basnayake et al., 2024; Daud et al., 2024; Pal et al., 2025).

Financial inclusion is increasingly viewed as a development instrument because it allows households and businesses to access savings, credit, payment services, and other formal financial products. However, the effect of financial inclusion on economic growth is not automatic. Financial inclusion contributes to growth when access to financial services is followed by productive usage, adequate digital support, and institutional readiness. Daud et al. (2024) argue that digital technology can strengthen the role of financial inclusion in promoting economic growth by expanding the use of financial services and reducing access barriers. Similarly, Pal et al. (2025) show that the relationship between financial inclusion and economic growth in emerging economies is complex, indicating that financial inclusion requires supporting infrastructure, regulation, and effective use to generate inclusive growth. In Aceh Province, this issue is becoming increasingly important because financial access may expand without necessarily producing stronger regional output. Access to bank accounts, financial institutions, or formal financial services does not automatically increase economic growth if these services are not used for business expansion, investment, savings mobilization, or productive transactions. Liu et al. (2021) show that digital financial inclusion can promote economic growth when it stimulates entrepreneurship, consumption, and productive financial participation. This suggests that Aceh's financial inclusion policy should be assessed not only from the access side, but also from its ability to generate real economic activity at the district/city level.

MSME credit is another important factor in regional growth because MSMEs are closely linked to employment creation, income distribution, local entrepreneurship, and economic resilience. In many developing economies, MSMEs face financing constraints due to limited collateral, weak financial records, and information asymmetry between lenders and borrowers. Amin and Motta (2023) explain that institutional barriers can worsen SMEs' access to external finance, while stronger financial institutions and better credit information systems can reduce financing constraints. Therefore, examining MSME credit in Aceh is important because productive financing can become a bridge between the financial sector and the real economy. When MSME credit is effectively distributed and used for working capital, equipment, production expansion, and market development, it can strengthen local economic activity and contribute to district/city growth.

At the same time, payment digitalization has transformed the way households, MSMEs, and local markets conduct transactions. Digital payment instruments such as QRIS, electronic money, mobile banking, and other digital platforms reduce transaction costs, accelerate payment processes, improve transparency, and support the formalization of economic activities. Birigozzi et al. (2025) show that digital payment adoption is positively associated with GDP growth because digital payments reduce transaction costs, expand financial access,

and reshape financial behavior. In Aceh, digitalization of payments may become a practical growth channel because it can help MSMEs record transactions, reach more customers, and connect with formal financial services.

The relevance of payment digitalization is also connected to the broader literature on digital financial inclusion. Basnayake et al. (2024) emphasize that digital financial services can reach unbanked and underbanked groups at lower cost, especially in Asia-Pacific economies. This is highly relevant for district/city-level development in Aceh, where access to physical financial infrastructure may differ across regions. Through digital payment expansion, financial participation can be improved even in areas where conventional banking infrastructure remains limited. Therefore, payment digitalization should not be treated merely as a technological variable, but as a form of economic infrastructure that can affect trade, consumption, MSME transactions, and regional output.

However, regional economic growth cannot be explained solely by financial inclusion, MSME credit, and digitalization of payments. Inflation also plays an important role because it affects household purchasing power, business costs, consumption and investment expectations. Although inflation is often expected to negatively affect growth when it becomes high and unstable, its effect may vary depending on the level of inflation and the economic structure. In this study, inflation was included to capture how price dynamics influence economic growth across districts/cities in Aceh Province.

Unemployment is also essential for understanding the quality of economic growth. A region may experience higher output, but if the growth process does not create sufficient employment, the welfare effect will remain limited. High unemployment can reduce household income, weaken aggregate demand, and limit the productive use of labor resources. Therefore, unemployment is included in this study because Aceh's economic growth should be evaluated not only from output expansion, but also from its ability to absorb labor and support inclusive development.

The main problem addressed in this study is that previous studies often examine financial inclusion, MSME financing, digital payment systems, inflation, unemployment, and economic growth separately. Studies on financial inclusion usually focus on access to and usage of financial services, while MSME finance studies emphasize firm-level financing constraints. Digital payment studies tend to discuss transaction efficiency and financial behavior, whereas inflation and unemployment are often treated in conventional macroeconomic models. This fragmented approach limits our understanding of how financial access, productive credit, digital transactions, price dynamics, and labor market conditions jointly explain district/city economic growth. In Aceh Province, this gap is important because each district/city has different economic structures, levels of financial access, digital readiness, and labor market conditions.

Based on this problem, this study addresses five research questions. First, does financial inclusion affect economic growth in the Aceh Province? Second, does MSME credit contribute to district/city's economic growth? Third, does digitalization of payments strengthen regional economic growth? Fourth, how does inflation influence economic growth? Fifth, does unemployment weaken regional growth? These questions are important because they help clarify whether Aceh's economic growth is driven mainly by financial access, productive financing, digital transaction infrastructure, or macroeconomic conditions.

The objective of this study is to analyze the effect of financial inclusion, MSME credit, payment digitalization, inflation, and unemployment on economic growth across 23 districts/cities in

Aceh Province during the 2020–2025 period. Complete official annual data at the district/city level for 2025 were not available at the time of the analysis. Therefore, the 2025 observation was treated as projected data based on the latest available official data trends. The use of projected data is intended to maintain the balanced panel structure, consisting of 23 districts/cities observed over six years, and to capture the most recent regional economic dynamics in Aceh. However, the 2025 data should be interpreted as an analytical projection rather than as final official statistics. The study applies a Fixed Effects Model because district/city-level panel data may contain unobserved regional characteristics that remain relatively constant over time, such as geographic conditions, economic base, institutional capacity, and infrastructure differences. By controlling for these unobserved regional characteristics, the model provides a clearer estimation of the relationship between explanatory variables and economic growth.

This study does not view regional economic growth solely as an outcome of conventional macroeconomic factors, but also as a process shaped by financial transformation and economic digitalization. By incorporating financial inclusion, MSME credit, payment digitalization, inflation, and unemployment into a single analytical framework, this study explains how financial, digital, and macroeconomic factors jointly shape district/city-level economic performance in Aceh Province.

This study contributes to the regional finance-growth literature by integrating financial inclusion, MSME credit, digitalization of payments, inflation, and unemployment within a district/city-level growth framework. Empirically, it provides evidence from Aceh Province, where financial access, MSME capacity, digital readiness, and labor market conditions vary across districts and cities. Methodologically, it applies panel data analysis using a Fixed Effects Model to account for unobserved regional heterogeneity. This framework allows us to examine how financial, digital, and macroeconomic factors are associated with sub-provincial economic growth.

2. Literature Review & Hypothesis Development

2.1 Regional Economic Growth

Regional economic growth represents the ability of the local economy to expand production, increase income, absorb labor, and improve social welfare. At the district and city level, economic growth is not merely a statistical increase in Gross Regional Domestic Product, but also reflects the capacity of a region to mobilize resources, strengthen productive sectors, and create broader economic participation. In this sense, growth is an important indicator for assessing the effectiveness of regional development, especially in areas with different levels of financial access, productive financing, digital infrastructure, and labor market conditions.

In recent development studies, economic growth is increasingly understood through the interaction between financial transformation and macroeconomic stability. Financial inclusion, digital financial services, MSME financing, inflation dynamics, and unemployment are no longer treated as separate issues but as interconnected factors that shape regional economic performance. Financial inclusion and digital technology can strengthen growth by expanding access to financial services, reducing transaction barriers, and improving the participation of households and firms in formal economic activity (Basnayake et al., 2024; Daud et al., 2024; Pal et al., 2025). Therefore, regional economic growth in Aceh Province must be examined using a framework that combines financial access, productive credit, digital payment transformation, price stability, and labor absorption.

The complexity of Aceh's regional economy makes this framework particularly relevant. Each district and city has different economic structures, MSME development levels, access to financial institutions, digital readiness, and labor market conditions. These differences imply that economic growth cannot be explained by a single determinant. Instead, growth must be viewed as the result of multiple forces that work simultaneously. Therefore, this study places economic growth as the dependent variable influenced by financial inclusion, MSME credit, digitalization of payments, inflation, and unemployment.

2.2 Financial Inclusion

Financial inclusion refers to the ability of individuals, households, and businesses to access and use formal financial services, including savings, credit, payment systems, insurance, and other financial products. In development economics, financial inclusion is expected to reduce financial exclusion by integrating underserved groups into the formal financial system. Through greater financial access, households can manage their income more effectively, smoothen consumption, and reduce vulnerability, while firms can obtain capital, expand production, and participate in formal markets.

Recent empirical evidence shows that financial inclusion can contribute to economic growth when access to finance is translated into productive usage. Liu et al. (2021) show that digital financial inclusion can promote economic growth through entrepreneurship and consumption channels. Daud et al. (2024) further explain that digital technology strengthens the role of financial inclusion by increasing the use of financial services and reducing access barriers. Similarly, Basnayake et al. (2024) find that financial inclusion through digitalization supports economic growth in Asia-Pacific countries because digital financial services can reach unbanked and underbanked groups at a lower cost.

However, financial inclusion does not automatically lead to economic growth. Access to bank accounts, financial institutions, or digital financial services may remain economically weak if not followed by active and productive usage. Pal et al. (2025) emphasize that the relationship between financial inclusion and economic growth in emerging economies is complex and depends on infrastructure, institutional readiness, regulatory support, and quality of financial usage. In this context, financial inclusion should not be understood only as access, but also as the ability of communities and business actors to use financial services for productive activities.

In Aceh Province, this issue is crucial because increased financial access may not necessarily lead to a stronger regional output. If financial services are used mainly for passive saving, consumption, or basic transactions, their effect on growth may be limited. Conversely, if financial inclusion is connected with MSME financing, digital payment adoption, business expansion, and productive investment, it may become an important economic growth driver. Therefore, financial inclusion is expected to positively influence economic growth, but its actual effect must be tested empirically within the district/city context of Aceh.

2.3 MSME Credit

MSME credit is one of the main channels through which the financial sector supports real economies. Micro, small, and medium enterprises play an essential role in regional development because they are closely linked to employment creation, local entrepreneurship, income distribution, and economic resilience. In many local economies, MSMEs are the foundation of community-level economic activity. However, their growth potential is often

limited by financing constraints, weak collateral, poor financial records and information asymmetry between borrowers and lenders.

The importance of MSME credit lies in its ability to transform financial intermediation into a productive economic activity. When MSMEs receive adequate financing, they can increase their working capital, purchase raw materials, improve their equipment, expand their production, and strengthen their market access. These activities may stimulate local demand, increase household income, and support employment. Amin and Motta (2023) show that institutional barriers and information problems can worsen SMEs' access to external finance, whereas stronger credit information systems and financial institutions can reduce financing constraints. This indicates that access to credit remains a central issue in strengthening MSME performance and regional growth.

In Aceh Province, MSME credit is expected to act as a bridge between financial development and real-sector expansion. Credit distributed to productive businesses can create multiplier effects through higher output, increased business turnover, and broader labor absorption. However, the effect of MSME credit depends heavily on the quality of credit allocation and the capacity of business actors to use financing productively. Credit that is not linked to productive activities may have a limited impact on regional growth.

Therefore, MSME credit should not be interpreted as the amount of financing disbursed by financial institutions. It must also be understood as a productive instrument that supports business continuity, income generation, and local economic expansion. In this study, MSME credit is positioned as a key determinant of economic growth because it directly connects financial resources to productive activity in the real sector.

2.4 Payment Digitalization

Payment digitalization refers to the transformation of payment activities from cash-based to digital transactions. This includes the use of QRIS, electronic money, mobile banking, Internet banking, and other digital payment platforms. In the digital economy, payment systems are no longer merely technical instruments for completing transactions. They have become economic infrastructures that can reduce transaction costs, increase speed, improve transparency, and strengthen formal economic participation.

For households and MSMEs, payment digitalization can significantly improve the efficiency of transactions. Digital payments make transactions faster, safer, and easier to record. For MSMEs, this is particularly important because transaction records can support business management, strengthen financial visibility, and improve access to formal credit. Birigozzi et al. (2025) show that digital payment adoption is positively associated with GDP growth because digital payments reduce transaction costs, expand financial access, and reshape financial behaviors. This finding strengthens the argument that digital payment systems are directly connected to economic growth.

Digitalization of payments is also closely related to broader financial inclusion. Daud et al. (2024) argue that digital technology complements financial inclusion by expanding the use of financial services and reducing access barriers. Basnayake et al. (2024) also show that digital financial services can reach unbanked and underbanked groups more efficiently. In this sense, payment digitalization can function as a practical mechanism through which financial inclusion becomes active and productive.

In Aceh Province, payment digitalization is highly relevant because districts and cities differ in terms of their physical financial infrastructure and digital readiness. Digital payment

systems can help reduce geographical barriers, support MSME transactions, strengthen market access, and improve the formalization of local economic activities. When digital payments are widely adopted, economic actors can participate more easily in modern financial ecosystems. Therefore, digitalization of payment is expected to have a positive effect on economic growth.

2.5 Inflation

Inflation refers to the general increase in the prices of goods and services over a period. In macroeconomic analysis, inflation affects economic growth through household purchasing power, production costs, consumption behavior, business expectations, and investment decisions. High and unstable inflation can reduce real income, increase uncertainty, weaken consumption, and lower business profits. For local economies, inflation can be especially harmful when it affects food prices, transportation costs, and other basic needs.

However, the relationship between inflation and economic growth is not always linear. In some cases, moderate inflation may coexist with economic expansion, especially when price increases reflect a stronger demand and higher market activity. Ghossoub (2023) explains that the relationship between inflation and economic growth may vary depending on the financial sector conditions and the level of inflation itself. This means that inflation should not be interpreted mechanically as always being harmful or beneficial. Its effect depends on whether inflation reflects healthy demand expansion or damaging price instability.

In Aceh Province, inflation is an important variable because price movements directly affect household consumption and MSME production costs. If inflation remains moderate, it may indicate stronger economic activity and an increase in demand. However, excessive inflation may reduce purchasing power, suppress consumption, and weaken regional economic performance. Therefore, inflation is included in the model to capture the role of price dynamics in explaining district/city economic growth.

Although the empirical results may show different directions depending on the study period, the theoretical expectation generally suggests that inflation can negatively affect growth when it creates instability and reduces real purchasing power. In this study, inflation is hypothesized to have a negative effect on economic growth, particularly when price pressure disrupts household welfare and business performance.

2.6 Unemployment

Unemployment reflects an economy's inability to absorb available labor into productive employment. It is one of the most important indicators for assessing the quality of economic growth because output expansion without job creation may have limited welfare impact. High unemployment reduces household income, weakens aggregate demand, lowers productivity, and limits human resource use. Therefore, unemployment is not only a labor market problem, but also a constraint on regional economic development.

Recent studies have confirmed the importance of unemployment in explaining regional economic performance. Suparman and Muzakir (2023) showed that unemployment, human capital, regional inequality, and economic growth are interconnected in regional development outcomes. Aginta et al. (2023) also examine regional Okun's law across Indonesian districts and show that the relationship between output and unemployment varies by region. These findings suggest that labor market conditions must be considered when analyzing district/city economic growth.

In Aceh Province, unemployment is particularly relevant because regional growth needs to be evaluated not only by output expansion, but also by its ability to create employment. Growth concentrated in sectors with limited labor absorption may not significantly improve household welfare. Conversely, growth supported by MSMEs, trade, agriculture-based processing, tourism, and digital services may create wider employment opportunities.

Unemployment is expected to negatively affect economic growth because it reduces income, weakens consumption, and lowers the productive capacity. If the labor force is not absorbed into productive sectors, the economy loses potential output, and the benefits of growth become less inclusive. Therefore, unemployment was included in this study as a macroeconomic variable that may weaken regional economic growth.

Research Hypothesis

Based on the synthesis of theory and previous empirical studies, this study developed five hypotheses. Financial inclusion is expected to support economic growth because access to financial services can improve savings mobilization, productive financing, and formal economic participation. MSME credit is expected to increase growth because financing can strengthen working capital, expand production, and support employment creation. Payment digitalization is expected to positively influence growth because digital transactions reduce transaction costs, increase efficiency, and improve financial transparency. Inflation is expected to have a negative effect when price increases weaken purchasing power and raise the production costs. Unemployment is also expected to negatively affect growth because it reduces household incomes, aggregate demand, and productive capacity.

Therefore, the research hypotheses are formulated as follows:

H1: Financial inclusion has a positive effect on economic growth in Aceh Province.

H2: MSME credit has a positive effect on economic growth in Aceh Province.

H3: Payment digitalization has a positive effect on economic growth in Aceh Province.

H4: Inflation has a negative effect on economic growth in Aceh Province.

H5: Unemployment has a negative effect on economic growth in Aceh Province

3. Methodology

This study employs a quantitative approach using panel data analysis to examine the determinants of economic growth in the Aceh Province. The quantitative approach is appropriate because the study uses numerical regional data to estimate the relationship between economic growth and five explanatory variables: financial inclusion, payment digitalization, MSME credit, inflation, and unemployment. Panel data analysis was selected because the data combine cross-sectional and time-series dimensions, covering 23 districts/cities in Aceh Province during the 2020–2025 period. This structure enables the study to capture regional heterogeneity across districts/cities and temporal variations over the observation period.

To ensure the reliability of the panel estimation, this study conducted several diagnostic tests. Heteroskedasticity was examined using the Breusch-Pagan test to assess whether the residual variance was constant across observations. Serial autocorrelation was tested using the Wooldridge test for panel data to identify whether residuals were correlated over time within each district/city. Cross-sectional dependence was evaluated using the Pesaran CD test to determine whether shocks or unobserved factors were correlated across districts/cities. If the

diagnostic tests indicate violations of these assumptions, the model is re-estimated using robust standard errors. In particular, Driscoll-Kraay robust standard errors are applied to obtain more reliable statistical inferences in the presence of heteroskedasticity, serial autocorrelation, and cross-sectional dependence.

The research context is Aceh Province, Indonesia, with the unit of analysis consisting of district/city-year observations. All 23 districts/cities in Aceh Province were included in the sample; therefore, this study applied a saturated sampling approach. The observation period covered six years, from 2020 to 2025, resulting in a balanced panel dataset with 138 observations. The use of all districts/cities is considered appropriate because Aceh has diverse regional characteristics in terms of the economic structure, financial access, MSME development, digital payment readiness, inflation exposure, and labor market conditions. Therefore, district/city-level panel data provide a suitable basis for analyzing regional economic growth.

The data used in this study are secondary data obtained from official sources, including Statistics Indonesia/BPS Aceh, Bank Indonesia, the Financial Services Authority/OJK, and other relevant government publications. The data collection process involved identifying the required indicators, compiling annual district/city-level data, checking the data completeness, and arranging the dataset into a balanced panel format. Since complete official annual district/city-level data for 2025 were not fully available at the time of the analysis, the 2025 observations were treated as projected data rather than final official statistics. The projected values were estimated using linear trend extrapolation based on the latest available observations from 2020 to 2024. This procedure was applied to variables for which complete 2025 official data had not yet been released, including economic growth, financial inclusion, payment digitalization, MSME credit, inflation and unemployment. The projection was consistently applied across all 23 districts/cities to preserve a balanced panel structure. Therefore, the 2025 values should be interpreted as analytical estimates rather than as final official statistics. Variables with large nominal values, particularly digitalization of payments and MSME credit, were transformed into logarithmic form to reduce scale differences across districts/cities and improve coefficient interpretation.

The dependent variable in this study is economic growth, denoted as PE , which represents the annual growth rate of regional economic output in each district or city. The independent variables are financial inclusion (IK), payment digitalization ($LNDP$), MSME credit ($LNPk$), inflation (IF), and unemployment (PT). Financial inclusion (IK) is measured by the number of formal banking accounts per 1,000 adults at the district/city level. The indicator is calculated as the total number of formal banking accounts divided by the adult population, multiplied by 1,000. Thus, the IK captures the usage dimension of formal financial services rather than a composite financial inclusion index. Payment digitalization ($LNDP$) represents the logarithmic value of digital transaction activities, including QRIS, electronic money, mobile banking, and other digital payment instruments. MSME credit ($LNPk$) represents the logarithmic value of credit or financing distributed to micro, small, and medium enterprises. Inflation (IF) represents the annual price increase, whereas unemployment (PT) is measured by the open unemployment rate.

The empirical model is specified as follows:

$$PE_{it} = \beta_0 + \beta_1 IK_{it} + \beta_2 LNDP_{it} + \beta_3 LNPk_{it} + \beta_4 IF_{it} + \beta_5 PT_{it} + \varepsilon_{it} \quad (1)$$

where PE_{it} denotes economic growth in district/city i at year t , IK_{it} denotes financial inclusion, $LNDP_{it}$ denotes payment digitalization, $LNPk_{it}$ denotes MSME credit, IF_{it} denotes inflation, and PT_{it} denotes the open unemployment rate. Furthermore, β_0 represents the constant term, β_1 to β_5 represent the estimated coefficients of the explanatory variables, and ε_{it} represents the error term.

This study applies the Fixed Effects Model (FEM) because each district/city in Aceh may have specific characteristics that are not directly observed but may influence economic growth. These characteristics include geographical location, local economic structure, infrastructure quality, institutional capacity, urbanization level, and historical development patterns. Because these characteristics are relatively stable over time, the FEM is suitable for controlling unobserved time-invariant heterogeneity across districts/cities. The fixed-effects specification is written as follows:

$$PE_{it} = \alpha_i + \beta_1 IK_{it} + \beta_2 LNDP_{it} + \beta_3 LNPk_{it} + \beta_4 IF_{it} + \beta_5 PT_{it} + \varepsilon_{it} \quad (2)$$

In Equation (2), α_i captures district/city-specific effects, while β_1 to β_5 measure the effect of each explanatory variable on economic growth after controlling for unobserved regional characteristics. The expected signs of the coefficients are expressed as follows:

$$\beta_1 > 0, \beta_2 > 0, \beta_3 > 0, \beta_4 < 0, \beta_5 < 0 \quad (3)$$

Data analysis was conducted using RStudio with the `plm`, `lmtest`, and `sandwich` packages. The analysis began by organizing the dataset into a balanced panel structure, followed by a descriptive examination of the variables. The Fixed Effects Model was estimated using panel least squares with cross-section fixed effects to examine the relationship between financial inclusion, payment digitalization, MSME credit, inflation, unemployment, and economic growth. Model selection was conducted using the F-test for individual effects, the Redundant Fixed Effects Test, and the Hausman test. The F test was used to compare the Fixed Effects Model with the pooled model, while the Hausman test was applied to compare the Fixed Effects Model with the Random Effects Model. The Redundant Fixed Effects Test produced mixed evidence, as the Cross-section F statistic was not significant, whereas the Cross-section Chi-square statistic was significant. Therefore, the model selection decision was not based solely on the redundant fixed effects test but was further supported by the Hausman test. Since the Hausman test rejected the Random Effects Model, the Fixed Effects Model was retained as the baseline specification. Driscoll-Kraay robust standard errors were then estimated using the `vcovSCC` procedure to obtain robust inferences in the presence of heteroskedasticity, serial autocorrelation, and cross-sectional dependence..

The significance of each explanatory variable was evaluated using the t-statistic and probability value, whereas the joint significance of the model was assessed using the F-statistic. The explanatory power of the model is evaluated using R-squared and Adjusted R-squared. However, the interpretation of statistical significance is not based solely on conventional standard error. After conducting the diagnostic tests, the results indicate the presence of heteroskedasticity, serial autocorrelation, and cross-sectional dependence. Therefore, the Fixed Effects Model is re-estimated using Driscoll-Kraay robust standard errors to obtain more reliable t-statistics and probability values. The coefficients' interpretation is

based on their direction, magnitude, and robust statistical significance. For logarithmic variables such as LN_{NDP} and LN_{PK}, the coefficients are interpreted as semi-log effects, meaning that a one percent increase in the explanatory variable is associated with a change in economic growth equal to the coefficient divided by 100, assuming that other variables remain constant.

4. Result and Discussion

Results Research

Model Selection Results

The analysis of regional economic growth was conducted using panel data covering 23 districts/cities in Aceh Province during the 2020–2025 period, resulting in 138 balanced panel observations. Before interpreting the regression results, this study first examined the appropriate panel specification through model selection tests. This step is important because district/city-level data may contain unobserved regional characteristics such as differences in economic structure, financial access, MSME development, digital payment readiness, inflation exposure, labor market conditions, and local institutional capacity.

The results of the model selection are presented in Table 1. The F test for individual effects shows an F-statistic of 1.4467 with a p-value of 0.1091, indicating that individual effects are not statistically significant at the 5 percent level. However, the Cross-section Chi-square statistic from the Redundant Fixed Effects Test is 35.0709 with a p-value of 0.0381, suggesting the presence of district/city-specific effects. Since the redundant fixed effects procedure provides mixed evidence, the Hausman test was further conducted to compare the Fixed Effects Model and the Random Effects Model. The Hausman test reports a chi-square statistic of 45.153 with a p-value of 0.0000135, leading to the rejection of the Random Effects Model. Therefore, the Fixed Effects Model is retained as the baseline specification because unobserved district/city-specific effects are likely to be correlated with the explanatory variables.

Table 1. Model Selection Tests

Test	Statistic	p-value	Decision	Implication
F test for individual effects	F = 1.4467	0.1091	Individual effects not significant at 5%	Pooled OLS cannot be rejected by this test alone
Redundant Fixed Effects Test: Cross-section Chi-square	$\chi^2 =$ 35.0709	0.0381	Individual effects are significant at 5%	District/city-specific effects are present
Hausman test	$\chi^2 =$ 45.153	0.0000135	Reject Random Effects	Fixed Effects is preferred

Notes: The F test and Cross-section Chi-square test evaluate the relevance of individual effects, while the Hausman test compares the Fixed Effects Model and Random Effects Model.

Source: Author’s calculation based on panel data estimation output.

The model selection results indicate mixed evidence from the redundant fixed effects procedure. The Cross-section F probability value is 0.1091, which is higher than the 5 percent significance level, suggesting that individual effects are not strongly supported by the F

statistic. However, the Cross-section Chi-square probability value is 0.0381, which is lower than 0.05, indicating the presence of district/city-specific effects. Because these two statistics provide non-uniform evidence, the Hausman test was conducted to further determine the appropriate panel specification. The Hausman test reports a chi-square statistic of 45.1530 with a p-value of 0.0000135, leading to the rejection of the Random Effects Model. Therefore, the Fixed Effects Model is retained as the baseline specification because unobserved district/city-specific effects are likely to be correlated with the explanatory variables. This decision is also theoretically justified because districts/cities in Aceh differ in terms of economic structure, financial access, MSME development, digital payment readiness, labor market conditions, and institutional capacity.

Analysis of Regression Results and Robust Inference

The baseline Fixed Effects Model shows that the model has an R-squared value of 0.804286 and an Adjusted R-squared value of 0.756247. This indicates that approximately 75.62 percent of the variation in economic growth across districts/cities in Aceh Province can be explained by financial inclusion, payment digitalization, MSME credit, inflation, and unemployment after controlling for cross-section fixed effects. The probability value of the F-statistic is 0.000000, indicating that the model is statistically significant as a whole.

However, the baseline Fixed Effects result is treated only as an initial estimation because the Durbin-Watson statistic of 1.496820 indicates the possibility of a positive serial correlation. Therefore, additional diagnostic tests were conducted to examine heteroskedasticity, serial autocorrelation, and cross-sectional dependence before drawing final statistical inferences. The final interpretation is based on the Fixed Effects Model with Driscoll-Kraay robust standard errors, which is presented after the diagnostic test results.

Table 2. Baseline Fixed Effects Regression Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.460716	1.330240	-0.034634	0.9724
IK	-0.244739	0.206109	-1.187424	0.2376
LNDP	1.281853***	0.260318	4.924176	0.0000
LNPK	3.780526*	2.128578	1.776080	0.0785
IF	0.308062***	0.067240	4.581565	0.0000
PT	-0.347742*	0.194451	-1.788328	0.0765

Model statistics:

R-squared = 0.804286;
 Adjusted R-squared = 0.756247;
 F-statistic = 16.74235; Prob(F-statistic) = 0.000000;
 Durbin-Watson stat = 1.496820;
 Total observations = 138.

Notes: This table reports the baseline Fixed Effects estimation using conventional standard errors.

* p < 0.10, ** p < 0.05, *** p < 0.01.

The baseline Fixed Effects estimation indicates that the model has strong explanatory power, as shown by the Adjusted R-squared value of 0.756247. This suggests that approximately 75.62 percent of the variation in district/city economic growth in Aceh can be explained by financial

inclusion, payment digitalization, MSME credit, inflation, and unemployment after controlling for cross-section fixed effects. However, the Durbin-Watson statistic of 1.496820 indicates the possibility of a positive serial autocorrelation. Therefore, additional panel diagnostic tests are required before drawing final statistical inferences from the regression results.

Based on the baseline Fixed Effects estimation in Table 2, the estimated regression equation can be written as follows:

$$PE_{it} = -0.460716 - 0.244739IK_{it} + 1.281853LNDP_{it} + 3.780526LNPK_{it} + 0.308062IF_{it} - 0.347742PT_{it} + \varepsilon_{it}$$

The baseline fixed-effects estimation shows that payment digitalization and inflation have positive and statistically significant coefficients at the 1 percent level. MSME credit has a positive coefficient and is marginally significant at the 10 percent level, while unemployment has a negative coefficient and is also marginally significant at the 10 percent level. Financial inclusion has a negative coefficient but is not statistically significant in the baseline estimation. However, these results should be interpreted cautiously because the baseline model relies on conventional standard errors. Therefore, further diagnostic tests are required to assess whether the statistical significance of the variables remains robust after correcting for heteroscedasticity, serial autocorrelation, and cross-sectional dependence.

Panel Diagnostic Tests

Before conducting the final interpretation of the regression results, several panel diagnostic tests were performed to assess the reliability of the baseline Fixed Effects Model. These tests include the Breusch-Pagan test for heteroskedasticity, the Wooldridge test, and the Breusch-Godfrey/Wooldridge test for serial autocorrelation, and the Pesaran CD test for cross-sectional dependence. The results of these diagnostic tests are presented in Table 3.

Table 3. Panel Diagnostic Tests

Diagnostic Test	Statistic	p-value	Result	Methodological Implication
Breusch-Pagan Heteroskedasticity Test	BP = 14.104	0.01496	Heteroskedasticity detected	Conventional standard errors may be biased
Wooldridge Serial Autocorrelation Test	F = 6.8932	0.00985	Serial autocorrelation detected	Residuals are correlated over time
Breusch-Godfrey/Wooldridge Test	$\chi^2 = 42.661$	1,36E-04	Serial autocorrelation detected	Confirms serial correlation
Pesaran CD Test	z = 18.388	< 0.0001	Cross-sectional dependence detected	Shocks are correlated across districts/cities

The diagnostic test results indicate that the baseline fixed-effects model violates several classical panel regression assumptions. The Breusch-Pagan test confirms the presence of heteroskedasticity, while the Wooldridge and Breusch-Godfrey/Wooldridge tests indicate serial autocorrelation in the panel residuals. In addition, the Pesaran CD test reveals strong cross-sectional dependence across districts and cities. These findings suggest that conventional Fixed Effects standard errors may produce unreliable statistical inferences. Therefore, the

model is re-estimated using Driscoll-Kraay robust standard errors to obtain more reliable t-statistics and probability values.

Table 4. Fixed Effects Model with Driscoll-Kraay Robust Standard Errors

Variable	Coefficient	Driscoll-Kraay Std. Error	t-value	p-value	Result
IK	-0.244739**	0.118569	-2.064	0.041360	Significant at 5%
LNDP	1.281853***	0.236299	5.425	0.000000	Significant at 1%
LNPK	3.780526***	1.290201	2.930	0.004120	Significant at 1%
IF	0.308062***	0.110751	2.782	0.006367	Significant at 1%
PT	-0.347742**	0.157482	-2.208	0.029310	Significant at 5%

Notes: Driscoll-Kraay robust standard errors are reported. *p < 0.10, **p < 0.05, ***p < 0.01.

Source: Author’s calculation based on RStudio output.

The Driscoll-Kraay robust estimation results show that digitalizing payments remains positive and highly significant, confirming its important role in supporting regional economic growth in Aceh. MSME credit also becomes positive and statistically significant at the 5 percent level, indicating that productive financing contributes to district/city-level economic performance. Unemployment remains negative and statistically significant at the 5 percent level, suggesting that labor market weakness constrains regional growth. Inflation remained positive and significant, which may reflect demand-driven economic activity during the study period. Meanwhile, financial inclusion becomes negative and statistically significant after robust correction, indicating that broader financial access has not yet been fully transformed into a productive economic use. Therefore, the final interpretation of the regression results is based on the Driscoll-Kraay robust estimation rather than the baseline Fixed Effects estimation.

Analysis of Financial Inclusion

Financial inclusion has a coefficient of -0.244739 with a Driscoll-Kraay robust p-value of 0.041360. This result indicates that financial inclusion is negatively and statistically significantly associated with economic growth after correcting for heteroscedasticity, serial autocorrelation, and cross-sectional dependence. Although this finding differs from the initial theoretical expectation, it should not be interpreted as evidence that financial inclusion is inherently harmful to regional economic growth. This suggests that the usage-based financial inclusion proxy in Aceh may not yet capture productive financial use.

This may occur because financial inclusion in Aceh is more strongly associated with formal financial access or basic financial usage than with productive economic activities. Access to financial institutions, accounts, or formal financial services does not automatically increase regional output if these services are not used for business expansion, productive investment, MSME financing, savings mobilization, or digital transactions. In this context, financial inclusion may expand quantitatively without directly contributing to district/city economic growth.

This finding also provides an important contrast to previous studies that generally report a positive relationship between financial inclusion and economic growth. Basnayake et al. (2024), Daud et al. (2024), and Pal et al. (2025) show that financial inclusion contributes to economic growth when supported by digital technology, institutional readiness, and

productive financial usage. Therefore, the negative and significant coefficient in this study indicates that financial inclusion in Aceh still needs to be strengthened from access-based to productivity-based inclusion. Financial inclusion has stronger growth implications when formal financial services are integrated with MSME development, digital payment systems, financial literacy, and productive investment activities.

Analysis of Payment Digitalization

Payment digitalization has a coefficient of 1.281853 with a Driscoll-Kraay robust p-value of 0.000000. This result indicates that payment digitalization is positively and highly significantly associated with economic growth after correcting for heteroscedasticity, serial autocorrelation, and cross-sectional dependence. Among all explanatory variables, digitalization of payments shows the strongest positive association with district/city-level economic growth in Aceh Province, suggesting that digital payment systems have become an important economic infrastructure rather than merely financial technology instruments. Digital payments can reduce transaction costs, accelerate payment processes, improve transaction transparency, strengthen transaction records, and support the formalization of local economic activities. For MSMEs, digital payments are particularly important because they help improve financial visibility, expand customer access and facilitate more efficient business transactions. This result is consistent with Birigozzi et al. (2025), who showed that digital payment adoption is positively associated with GDP growth because it reduces transaction friction, expands financial access, and changes financial behavior. Similarly, Liu et al. (2021) demonstrate that digital financial inclusion can promote economic growth through entrepreneurship and consumption channels.

In Aceh, the strong effect of digitalization of payments may be explained by the increasing use of QRIS, mobile banking, electronic money, and other digital payment instruments in local economic transactions. Unlike general financial inclusion, which may remain passive when not used productively, digital payments directly affect daily economic activities by facilitating trade, household consumption, retail transactions, micro, small, MSME operations, and local market connectivity. Therefore, payment digitalization can be viewed as an active financial channel through which digital financial transformation directly contributes to regional economic growth.

Analysis of MSME Credit

MSME credit has a coefficient of 3.780526, with a Driscoll-Kraay robust p-value of 0.004120. This result indicates that MSME credit is positively and statistically significantly associated with economic growth after correcting for heteroscedasticity, serial autocorrelation, and cross-sectional dependence. The positive coefficient suggests that higher MSME credit is associated with higher district/city-level economic growth in Aceh Province. This finding supports the argument that productive financing plays an important role in linking the financial sector to the real economy.

The relatively large coefficient of MSME credit indicates that financing micro, small, and medium enterprises may generate substantial economic effects when used for working capital, production expansion, equipment improvement, business continuity, and market development. However, the magnitude of the coefficient should be interpreted carefully because the standard error in the baseline estimation is relatively large. This may reflect variations in MSME credit distribution and effectiveness across Aceh's districts and cities.

Some districts may have stronger MSME ecosystems, better access to formal finance, more active markets, and greater capacity to transform credit into productive output, while others may face weaker business capacity, limited market access, and lower financial infrastructure readiness.

This finding is consistent with Amin and Motta (2023), who emphasize that SMEs in developing economies often face financing constraints due to institutional barriers and information problems. Therefore, better access to external finance can improve MSME productive capacity, but its impact depends on how credit is allocated and used. MSME credit generates stronger growth effects when directed toward productive activities and supported by business mentoring, digital bookkeeping, financial literacy, market access, and integration with digital payment systems.

To address the reviewer's concern regarding the possible relationship between MSME credit and payment digitalization, this study also examines the correlation and Variance Inflation Factor. The correlation between MSME credit and payment digitalization is 0.670, indicating that both variables move together to some extent within the MSME and digital finance ecosystems. However, the VIF value for MSME credit is 1.955, while the VIF value for payment digitalization is 4.685. As both values were below the commonly used threshold of 5, multicollinearity was not considered a serious concern in the model. Therefore, MSME credit is retained as an independent determinant of economic growth, although its effectiveness remains conditional on regional business capacity, credit quality, and the ability of MSMEs to transform financing into productive economic activity.

Analysis of Inflation

Inflation has a coefficient of 0.308062, with a Driscoll-Kraay robust p-value of 0.006367. This result indicates that inflation is positively and statistically significantly associated with economic growth after correcting for the heteroskedasticity, serial autocorrelation, and cross-sectional dependence. Although this finding differs from the initial theoretical expectation that inflation may weaken economic growth, it may reflect the specific economic context of Aceh Province during 2020–2025.

The positive coefficient can be interpreted in the context of moderate inflation and post-pandemic economic recovery. Inflation does not always have a negative effect when price increases remain relatively controlled and are associated with stronger aggregate demand, household consumption, trade activity, and market circulation. The inflation-growth literature explains that the effect of inflation may depend on its level and the economic context. Inflation may coexist with growth at lower or moderate levels, but it can become harmful when it exceeds certain thresholds (Bick, 2010; Ibarra & Trupkin, 2016; Kremer et al., 2013).

In Aceh Province, the positive effect of inflation may indicate that price increases during the study period were associated with stronger demand and economic recovery rather than destabilizing the inflationary pressure. However, this result should be interpreted carefully. This does not imply that inflation should be encouraged as a policy objective. If inflation becomes excessive or unstable, it can reduce purchasing power, increase production costs, weaken household welfare, and constrain investments. Therefore, the policy implication is not to promote inflation but to maintain price stability while supporting productive demand and regional economic activity.

Analysis of Unemployment

Unemployment has a coefficient of -0.347742, with a Driscoll-Kraay robust p-value of 0.029310. This result indicates that unemployment is negatively and statistically significantly associated with economic growth after correcting for the heteroskedasticity, serial autocorrelation, and cross-sectional dependence. The negative coefficient suggests that higher unemployment is associated with lower district/city-level economic growth in the Aceh Province.

This finding is consistent with the basic macroeconomic argument that unemployment reduces household income, weakens purchasing power, lowers consumption, and limits the productive capacity. When more people are unemployed, fewer labor resources are used productively. As a result, local demand weakens, business activity slows, and regional output growth becomes more constrained. Recent Indonesian evidence also shows that unemployment is closely related to regional development outcomes and that the relationship between output and unemployment may differ across districts and cities (Aginta et al., 2025; Suparman & Muzakir, 2023).

In Aceh, unemployment remains an important challenge because economic growth will not be fully inclusive if it is not accompanied by employment creation. Even when payment digitalization and MSME credit support economic activity, the welfare impact of growth may remain limited if labor absorption is weak. Therefore, regional growth policies need to focus not only on increasing output, but also on expanding employment opportunities in labor-absorbing sectors such as MSMEs, agriculture-based processing, trade, tourism, the creative economy, and digital services

Discussion

The findings of this study provide important insights into the relationship between financial transformation and regional economic growth in Aceh Province. Rather than showing that all financial variables affect growth similarly, the results indicate that the growth effect depends on the type of financial channel involved. Payment digitalization appears to be more directly connected to regional economic activity than to general financial inclusion. This suggests that, at the district/city level, financial transformation contributes to growth not merely through access to financial services but through the actual use of financial instruments in daily economic transactions.

The stronger role of payment digitalization can be explained by its active and transaction-based characteristics. Digital payment instruments, such as QRIS, mobile banking, electronic money, and other digital transaction platforms, directly facilitate trade, consumption, retail activities, and MSME operations. These instruments reduce transaction costs, accelerate payment processes, improve transaction records, and strengthen the formalization of local business activity. This finding is consistent with Birigozzi et al. (2025), who showed that digital payments are positively associated with GDP growth, and Liu et al. (2021), who argued that digital financial inclusion can stimulate economic growth through entrepreneurship and consumption channels. However, the present study extends these findings by showing that payment digitalization is also relevant at the sub-provincial level, particularly in a regional economy such as Aceh, where MSMEs and local trade play an important role.

In contrast, general financial inclusion does not automatically translate into stronger regional economic growth. The baseline Fixed Effects estimation shows that financial inclusion is negative but not statistically significant. However, after applying the Driscoll-Kraay robust standard errors, the coefficient becomes statistically significant. This change does not indicate

a change in the estimated coefficient itself, but rather a correction in the statistical inference after accounting for heteroskedasticity, serial correlation, and cross-sectional dependence. Since these diagnostic problems may bias conventional standard errors, robust correction provides a more reliable inference for assessing the relationship between financial inclusion and economic growth.

The negative and significant coefficient after robust correction suggests that broader access to formal financial services may not yet represent productive financial use. This finding qualifies the conventional finance-growth nexus by showing that financial access alone is insufficient when it is not connected to savings mobilization, productive credit, business expansion, digital transactions, and investment activities. In this sense, the Aceh case shows the distinction between passive financial inclusion and productive-use financial inclusion. Access-based inclusion may increase the number of accounts or formal financial users, but its growth effect remains limited if financial services are not actively used to support real economic activity

This finding also helps explain why digitalization of payments has a stronger effect than general financial inclusion. Payment digitalization captures actual financial usage in market transactions, whereas financial inclusion may still reflect access or the basic use of formal financial services. In regions where financial literacy, business capacity, infrastructure readiness, and institutional support remain uneven, financial inclusion may expand quantitatively without producing a proportional increase in output. Therefore, the results support recent studies arguing that the growth effect of financial inclusion depends on digital technology, institutional readiness, and productive financial behavior (Basnayake et al., 2024; Daud et al., 2024; Pal et al., 2025).

MSME credit remains an important complementary channel that links finance to the real economy. Its positive effect indicates that financing can support working capital, production expansion, business continuity, and market development. However, the effectiveness of MSME credit depends on regional business capacity, credit quality, market access, and enterprises' ability to transform financing into productive output. This is consistent with Amin and Motta (2023), who emphasize that SMEs in developing economies often face financing constraints due to institutional barriers and information problems. In Aceh, MSME credit is more likely to generate stronger growth effects when combined with digital payment adoption, financial literacy, business mentoring, and digital transaction records.

The macroeconomic variables further show that financial transformation alone is insufficient to sustain regional growth. Inflation appears to move together with economic activity during the study period, which may reflect demand recovery and stronger market circulation. However, this should not be interpreted as support for higher inflation. This implies that price stability is necessary so that demand growth does not weaken purchasing power or increase production costs. Similarly, unemployment reinforces the importance of labor absorption. Economic growth driven by digital payments and MSME financing will have limited welfare effects if it is not accompanied by job creation. Therefore, employment-oriented growth remains essential for making regional economic expansion more inclusive.

The theoretical contribution of this study lies in refining the finance-growth nexus in a sub-provincial context. The findings show that the relationship between finance and growth is not determined only by financial access but also by the extent to which financial services are transformed into productive and transaction-based economic activities. At the district/city level in Aceh, digital payment channels appear to be more decisive than general financial

inclusion because they are directly embedded in daily market transaction. This provides a more nuanced understanding of financial inclusion by distinguishing between access-based and productive-use inclusion.

Overall, this study suggests that Aceh's regional growth strategy should prioritize the integration of digital payment expansion, productive MSME financing, and employment-oriented development. Financial inclusion policy should move beyond expanding access and focus more on productive use, especially through MSME development, digital transactions, financial literacy, and market connectivity. In this way, financial and digital transformations can become more strongly connected to real economic activity and inclusive regional growth.

5. Conclusion and Suggestion

This study concludes that regional economic growth across districts/cities in Aceh Province is associated not only with financial access but also with the productive use of financial and digital instruments. The findings show that payment digitalization has the strongest positive association in the model, suggesting that digital transaction systems may serve as important economic infrastructure to support trade, MSME activity, household consumption, and local market connectivity. However, these findings should be interpreted as empirical associations rather than definitive causal effects, considering the use of projected 2025 data and the potential presence of endogeneity.

Theoretically, this study contributes to the finance-growth nexus by showing that financial inclusion at the sub-provincial level does not automatically generate stronger economic growth when it remains access-based or is passively used. The negative and significant coefficient of financial inclusion suggests that formal financial access has not yet been fully transformed into productive financial use in Aceh, Indonesia. Therefore, this study highlights the importance of distinguishing between access-based financial inclusion and productive-use financial inclusion. Financial inclusion is more likely to support growth when it is connected to MSME development, digital transactions, savings mobilization, productive credit and investment activities.

From a policy perspective, the Government of Aceh, Bank Indonesia, OJK, local banks, and regional development stakeholders should place payment digitalization and productive MSME financing at the center of regional growth policy. The expansion of QRIS, electronic money, mobile banking, and other digital payment systems should be strengthened in MSME centers, traditional markets, tourism areas, public services and local trade networks. At the same time, MSME credit should be integrated with financial literacy, business mentoring, digital bookkeeping, and market access so that financing can generate stronger effects on production, income, and employment.

The findings also imply that macroeconomic stability and labor absorption remain essential for inclusive regional development. Inflation should be kept under control to protect purchasing power and production costs, while employment-oriented policies should be strengthened through labor-absorbing sectors such as MSMEs, agriculture-based processing, trade, tourism, the creative economy, and digital services. Overall, Aceh's economic growth will be more sustainable and inclusive when digital payment expansion is connected to productive financial inclusion, effective MSME financing, price stability, and job creation.

6. Limitations and Future Research

This study had several limitations. First, the observation period only covers 2020–2025, so the findings may not fully capture the long-term effects of financial inclusion, MSME credit, payment digitalization, inflation, and unemployment on regional economic growth. In addition, the 2025 data are treated as projected data based on the latest available official trends, which means that the results should be interpreted with caution until complete official data are available. Second, the study is limited to 23 districts/cities in Aceh Province, which may reduce the generalizability of the findings to other Indonesian regions. Third, the use of aggregate secondary data limits the ability to observe household- and MSME-level behavior, particularly how financial services, credit, and digital payments are used in productive activities.

Another important limitation concerns potential endogeneity. Although the Fixed Effects Model controls for time-invariant regional heterogeneity, it does not fully address time-varying endogeneity or reverse causality. Payment digitalization and MSME credit may not only affect economic growth, but may also be influenced by economic growth. Districts/cities with stronger economic performance may attract more MSME credit, adopt digital payments more rapidly, and develop better financial infrastructure. This possibility may bias the estimated relationship between financial variables and regional economic growth. Therefore, future research should extend the observation period, compare Aceh with other provinces, and develop a more comprehensive financial inclusion index covering access, usage, quality, affordability, and productive use. Methodologically, future studies may apply System GMM, instrumental variable estimation, Dynamic Panel Models, Panel ARDL, or Spatial Panel Models to better address endogeneity, dynamic effects, and spatial spillovers.

Reference

- Aginta, H., Mendez, C., & Someya, M. (2025). Regional Okun's law and endogeneity: Evidence from the Indonesian districts. *Applied Economics Letters*, 32(3), 329–336. <https://doi.org/10.1080/13504851.2023.2267814>
- Ahmad, M., Majeed, A., Khan, M. A., Sohaib, M., & Shehzad, K. (2021). Digital financial inclusion and economic growth: Provincial data analysis of China. *China Economic Journal*, 14(3), 291–310. <https://doi.org/10.1080/17538963.2021.1882064>
- Amin, M., & Motta, V. (2023). The impact of corruption on SMEs' access to finance: Evidence using firm-level survey data from developing countries. *Journal of Financial Stability*, 68, 101175. <https://doi.org/10.1016/j.jfs.2023.101175>
- Badan Pusat Statistik Provinsi Aceh. (2025). *Aceh Province in figures 2025*. Banda Aceh, Indonesia: Badan Pusat Statistik Provinsi Aceh.
- Bank Indonesia. (2025). *Aceh Province economic report 2025*. Jakarta, Indonesia: Bank Indonesia.
- Basnayake, D., Naranpanawa, A., Selvanathan, S., & Bandara, J. S. (2024). Financial inclusion through digitalization and economic growth in Asia-Pacific countries. *International Review of Financial Analysis*, 96, 103596. <https://doi.org/10.1016/j.irfa.2024.103596>
- Bick, A. (2010). Threshold effects of inflation on economic growth in developing countries. *Economics Letters*, 108(2), 126–129. <https://doi.org/10.1016/j.econlet.2010.04.025>
- Birigozzi, A., De Silva, C., & Luitel, P. (2025). Digital payments and GDP growth: A behavioural quantitative analysis. *Research in International Business and Finance*, 75, 102768. <https://doi.org/10.1016/j.ribaf.2025.102768>

- Chowdhury, M. A. S., Chuanmin, S., Sokolová, M., Akbar, A., Ali, Z., Ali, H., & Alam, M. Z. (2022). Assessing the empirical linkage among access to finance, firm quality, and firm performance: New insight from Bangladeshi SMEs. *Frontiers in Psychology, 13*, 865733. <https://doi.org/10.3389/fpsyg.2022.865733>
- Daud, S. N. M., Ahmad, A. H., & Trinugroho, I. (2024). Financial inclusion, digital technology, and economic growth: Further evidence. *Research in International Business and Finance, 70*, 102361. <https://doi.org/10.1016/j.ribaf.2024.102361>
- Emara, N., & Zecheru, D. (2024). Asymmetric threshold effects of digitization on inflation in emerging markets. *Financial Innovation, 10*, 32. <https://doi.org/10.1186/s40854-023-00545-8>
- Fouejieu, A., Ndoye, A., & Sydorenko, T. (2023). Firms' access to finance in resource-based countries and the financial resource curse. *Journal of Comparative Economics, 51*(3), 1031–1047. <https://doi.org/10.1016/j.jce.2023.04.004>
- Ghossoub, E. A. (2023). Economic growth, inflation, and banking sector competition. *Economic Modelling, 129*, 106528. <https://doi.org/10.1016/j.econmod.2023.106528>
- Glawe, L., & Wagner, H. (2024). Inflation and inequality: New evidence from a dynamic panel threshold analysis. *International Economics and Economic Policy, 21*(2), 297–309. <https://doi.org/10.1007/s10368-023-00580-x>
- Ibarra, R., & Trupkin, D. R. (2016). Reexamining the relationship between inflation and growth: Do institutions matter in developing countries? *Economic Modelling, 52*, 332–351. <https://doi.org/10.1016/j.econmod.2015.09.011>
- Khera, P., Ng, S., Ogawa, S., & Sahay, R. (2022). Measuring digital financial inclusion in emerging market and developing economies: A new index. *Asian Economic Policy Review, 17*(2), 213–230. <https://doi.org/10.1111/aepr.12377>
- Kremer, S., Bick, A., & Nautz, D. (2013). Inflation and growth: New evidence from a dynamic panel threshold analysis. *Empirical Economics, 44*(2), 861–878. <https://doi.org/10.1007/s00181-012-0553-9>
- Liu, Y., Luan, L., Wu, W., Zhang, Z., & Hsu, Y. (2021). Can digital financial inclusion promote China's economic growth? *International Review of Financial Analysis, 78*, 101889. <https://doi.org/10.1016/j.irfa.2021.101889>
- Liu, T., Hu, M., Elahi, E., & Liu, X. (2022). Does digital finance affect the quality of economic growth? Analysis based on Chinese city data. *Frontiers in Environmental Science, 10*, 951420. <https://doi.org/10.3389/fenvs.2022.951420>
- Meniago, C. (2025). Digital financial inclusion and economic growth: The moderating role of institutions in SADC countries. *International Journal of Financial Studies, 13*(1), 4. <https://doi.org/10.3390/ijfs13010004>
- Otoritas Jasa Keuangan. (2025). *Indonesian banking statistics 2025*. Jakarta, Indonesia: Otoritas Jasa Keuangan.
- Ozturk, I., & Ullah, S. (2022). Does digital financial inclusion matter for economic growth and environmental sustainability in OBRI economies? An empirical analysis. *Resources, Conservation and Recycling, 185*, 106489. <https://doi.org/10.1016/j.resconrec.2022.106489>
- Pal, S., Vankila, S., & Fernandes, M. N. (2025). Interplay of financial inclusion and economic growth in emerging economies. *World Development Sustainability, 5*, 100201. <https://doi.org/10.1016/j.wds.2025.100201>

- Peláez-Herreros, O. (2025). Decomposing Okun's law: Evidence for the United States, 1970–2021. *Applied Economics Letters*, 32(1), 121–124. <https://doi.org/10.1080/13504851.2023.2257927>
- Siddiki, J., & Bala-Keffi, L. R. (2024). Revisiting the relation between financial inclusion and economic growth: A global analysis using panel threshold regression. *Economic Modelling*, 135, 106707. <https://doi.org/10.1016/j.econmod.2024.106707>
- Suparman, S., & Muzakir, M. (2023). Regional inequality, human capital, unemployment, and economic growth in Indonesia: Panel regression approach. *Cogent Economics & Finance*, 11(2), 2251803. <https://doi.org/10.1080/23322039.2023.2251803>
- Thathsarani, S., Jianguo, W., & Alariqi, M. (2023). How do demand, supply, and institutional factors influence SME financial inclusion: A developing country perspective. *SAGE Open*, 13(3). <https://doi.org/10.1177/21582440231187603>
- Ugwuanyi, U., Ugwuoke, R., Onyeonu, E. O., & Eze, E. F. (2022). Financial inclusion-economic growth nexus: Traditional finance versus digital finance in Sub-Saharan Africa. *Cogent Economics & Finance*, 10(1), 2133356. <https://doi.org/10.1080/23322039.2022.2133356>
- Xi, W., & Wang, Y. (2023). Digital financial inclusion and quality of economic growth. *Heliyon*, 9(9), e19731. <https://doi.org/10.1016/j.heliyon.2023.e19731>