ANALYSIS OF THE IMPACT OF ECONOMIC DIGITALIZATION ON ECONOMIC GROWTH ON THE ISLAND OF SUMATRA

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Abstract

This study examines the impact of economic digitalization on economic growth in Sumatra from 2013 to 2023. As economic digitalization plays a significant role in shaping growth trajectories, this research focuses on analyzing its effect on various economic indicators, including government spending and production. Using panel data from 49 districts/cities on the island of Sumatra, the study employs a dynamic panel data model with the Generalized Method of Moments (GMM) approach, particularly the Arellano-Bond estimator, to estimate the long-term and short-term impacts. The results indicate that economic digitalization significantly influences economic growth in Sumatra, with digitalization showing positive effects both in the short and long term. Furthermore, government spending is found to have a notable impact on the region's digitalization efforts, whereas production does not exhibit a significant effect. The study concludes that fostering digitalization through targeted policies, investments in digital infrastructure, and increased government expenditure can drive sustainable economic growth in Sumatra. The findings suggest that enhancing digitalization initiatives and inter-regional cooperation could maximize economic potential and ensure equitable growth across the island.

Keywords: Economic Digitalization, Government Spending, Production.

1. INTRODUCTION

The digitalization of the economy has become one of the main driving forces in the modern era, especially in developing countries like Indonesia. This transformation involves the adoption of digital technologies across various economic sectors, including industry, trade, and services. On the island of Sumatra, which is one of the regions with significant economic potential in Indonesia, economic digitalization plays a crucial role in driving economic growth. According to McKinsey & Company (2020), the adoption of digital technologies can enhance productivity and efficiency across different economic sectors, ultimately contributing to overall economic growth (Labaye & Remes, 2015).

Sumatra Island holds significant potential in adopting economic digitalization, given its diverse natural resources and the presence of industrial hubs in the region. However, challenges such as unequal access to technology, uneven infrastructure development, and a lack of skilled human resources in digital technology remain major obstacles. A study by Ummasyroh et al. (2024) reveals that regions with better digital

infrastructure tend to experience higher economic growth compared to those lagging in digital development (Ummasyroh et al., 2024).

The economic performance of a region is influenced by various factors, including economic digitalization. According to González-Álvarez and Montañés (2023), economic digitalization can impact economic performance by improving production efficiency, enhancing market access, and reducing transaction costs. However, these effects may vary depending on the level of technology adoption in each area (Akyol & AĞIRKAYA, 2024). In Sumatra, where there are significant disparities in the levels of digitalization across districts and cities, it is crucial to explore how economic digitalization affects economic performance in these diverse regions.

Government spending and GRDP (Gross Regional Domestic Product) production are often used as indicators to measure a region's economic performance. A study by Fan et al. (2023) indicates that effective government spending can stimulate economic growth through investments in infrastructure, education, and technology (W. Li et al., 2024). Meanwhile, GRDP per capita provides an overview of a region's economic output, which can be influenced by various factors, including economic digitalization.

The dynamic panel data model developed by Arellano & Bond (1991) provides a robust framework for analyzing the relationship between economic digitalization and economic performance (Arellano & Bond, 1991). This model allows researchers to include lagged dependent variables as independent variables, enabling a deeper analysis of the dynamics of economic performance changes over time. The use of dynamic panel data in this context is particularly relevant, given the complexity of the relationships between the variables being analyzed.

Economic digitalization holds significant potential to drive economic growth in Sumatra, but this relationship is not always linear and can be influenced by various factors. Using a dynamic panel data model, this study aims to identify the impact of economic digitalization on economic performance in Sumatra from 2013 to 2023. The findings of this research are expected to provide valuable insights for policymakers in developing effective digitalization strategies to promote economic growth in the region.

Based on the background above, the research problem formulated in this study is: Does economic digitalization influence economic growth in Sumatra during the period 2013-2023? This study is expected to provide valuable insights for policymakers in designing effective digitalization strategies to promote economic growth in the region.

2. LITERATURE REVIEW

First, Integrated Monetary-Fiscal Policy in Sumatra IslandMonetary policy has been widely described by researchers as an integrated mechanism aimed at controlling and directing macroeconomic activities towards better conditions, particularly by regulating the money supply. (Masrufah, 2022). Menurut Todaro & Smith (2011), According to Todaro & Smith (2011), economic growth is the process of increasing productive capacity in a specific economy over time, either continuously or intermittently, leading to higher levels of output and national income. Economic growth can also be defined as the process of enhancing an economy's ability to generate higher average national income, reflected in the average national wage levels.(Hutomo & Faridatussalam, 2023).

Monetary policy in Sumatra Island is the same as throughout Indonesia, regulated by Bank Indonesia (BI), which is the central bank of Indonesia. Some of these include regulating interest rates, where the benchmark interest rate is set through the BI 7-Day Reverse Repo Rate (Hermawan et al., 2023). Changes in interest rates affect banking interest rates in Sumatra and have an impact on consumption, investment, and economic growth in the region. Managing inflation is also part of Bank Indonesia's duties, collaborating with regional governments to control the prices of goods and services, especially essential commodities circulating in the market. Stabilizing the value of the rupiah is also part of monetary policy, involving intervention in the foreign exchange market to maintain exchange rate stability. The implementation of monetary policy in North Sumatra is influenced by regional economic conditions, including economic growth, unemployment rates, and the development of agriculture, industry, and other service sectors.(Golpe et al., 2023)

Second, Financial Stability. Financial stability is often defined as a condition in which the financial system is able to withstand economic shocks and continue to perform its core functions, such as channeling funds from savers to investors, facilitating payment transactions, and providing liquidity to the economy.

Several studies highlight that financial stability is also related to the absence of significant distortions in asset prices and extreme instability in the behavior of financial institutions(Al-Rjoub, 2021).

Monetary and fiscal policies play a crucial role in maintaining financial stability. An excessively loose or tight monetary policy can lead to distortions in asset prices and imbalances in the financial sector. Unsustainable fiscal policies can also increase risks to financial stability (Ahnert et al., 2023).

Source : HarianMomentum.com

Here is a graph of economic growth in several regions on Sumatra Island. In Aceh, it ranges from 3-4%, in North Sumatra from 2-4%, Riau from 0.29-5%, the Riau Islands from 2-5%, Jambi from 4-5%, the Bangka Belitung Islands from 4-5%, South Sumatra from 4-5%, Lampung stands as the highest with 4-9%, Bengkulu ranges from 3-7%, and West Sumatra ranges from 1-5%. The economy on Sumatra Island grows between 3-5%.

Third, Regional trade refers to the exchange of goods and services between regions or areas within a country. It includes transactions that occur both between neighboring regions and more distant areas. Regional trade is important because it can reduce economic disparities between regions, promote local economic growth, and strengthen the integration of the national market (Indrajit et al., 2021). Regional trade is often influenced by geographical factors, infrastructure, government policies, and the level of economic interconnection between regions. For instance, regions with a comparative advantage in certain production tend to export to other regions that require those products, creating mutually beneficial trade networks (Tran, 2024).

Good infrastructure, such as highways, railways, ports, and airports, is crucial to support inter-regional trade. Adequate infrastructure reduces transportation costs, travel time, and accelerates the flow of goods (Yue Liu, 2024). Fiscal policies, regulations, and government incentives play a significant role in promoting or hindering regional trade. For instance, policies that support infrastructure development and provide tax incentives for local industries can encourage inter-regional trade (Zhu, 2024). Regions that possess unique natural resources, skills, or technology tend to become production hubs for certain goods or services, which are then traded with other regions. This is based on the theory of comparative advantage proposed by David Ricardo (1817). The size of the market and local demand also influence inter-regional trade. Regions with large populations or high income levels tend to have greater demand, which stimulates trade with other regions that can supply these needs (Bettarelli, 2024).

Fourth, Economic digitalization is the process of integrating digital technology into all aspects of the economy, including how businesses operate, how consumers interact with products and services, and how data is used for decision-making (X. Dong et al., 2024). Digitalization involves various technologies such as the internet, big data, artificial intelligence (AI), blockchain, and the Internet of Things (IoT), enabling rapid and comprehensive transformation across economic sectors. Economic digitalization is often seen as part of the fourth industrial revolution, which characterizes the digital era with increased automation, connectivity, and advanced data processing (Zhang, 2024). This process allows for greater efficiency, new business models, and structural changes in the global economy.

The rapid advancement of information and communication technology is a key driver of economic digitalization. Strong digital infrastructure, such as fast and extensive internet networks, allows businesses and consumers to connect easily and efficiently (H. Li, 2024). Economic digitalization is also influenced by globalization, where access to global markets and increased competition push companies to adopt digital technologies to enhance their competitiveness (H. Wang, 2024). Changes in consumer behavior, where individuals are increasingly digitally connected and more reliant on technology to meet their needs, have driven companies to shift to digital business models (W. Li, 2024). Many governments worldwide have adopted policies that encourage economic digitalization, including investments in digital infrastructure, regulations that support technological innovation, and educational programs to enhance the digital skills of the population (X. Li, 2024).

Economic digitalization is also closely linked to sustainable development. By accelerating innovation, digitalization can support inclusive and environmentally friendly economic growth. However, to achieve this, efforts must be made to ensure that the benefits of digitalization are felt by all segments of society and are not limited to specific groups (Tian & Xiang, 2024). Economic digitalization is a fundamental transformation that has broad impacts on various aspects of economic and social life. While it offers many benefits such as increased efficiency, the creation of new business models, and more inclusive economic growth, digitalization also presents new challenges, such as digital inequality, cybersecurity threats, and the need for adaptive regulation. Therefore, proper management and inclusive strategies are essential to ensure that economic digitalization can provide the maximum benefits for all members of society.

3. METHODS

The aim of this study is to analyze the impact of economic digitalization on economic performance in Sumatra Island. The research question to be developed is whether economic digitalization has influenced economic growth in Sumatra Island from 2013 to 2023. The regions to be analyzed include 49 districts/cities on Sumatra Island, with a sample size of 490. The realization of digitalization in the economic sector is one of the key concerns regarding development on Sumatra Island. In this regard, it is necessary to include variables that can help measure financial digitalization. Following the work of González-Álvarez and Montañés (2023) and Fan et al. (2023), common variables used include Government Expenditures and Gross Regional Domestic Product (GRDP) Production.

This study uses panel data sourced from the Statistics Indonesia (BPS), the Regional Development Planning Agency (Bappeda), and Bank Indonesia (BI), covering the period from 2013 to 2023, with all variables expressed on a per capita basis. We use the dynamic panel data model developed by Arellano & Bond (1991). The selection of this model is due to the fact that dynamic panel data is a type of panel data modeling that includes lagged dependent variables as independent variables. In the dynamic panel data model, using Eviews software, several tests are conducted, including validity tests, consistency tests, and bias tests.

The following is the performance framework that will be used in this study.
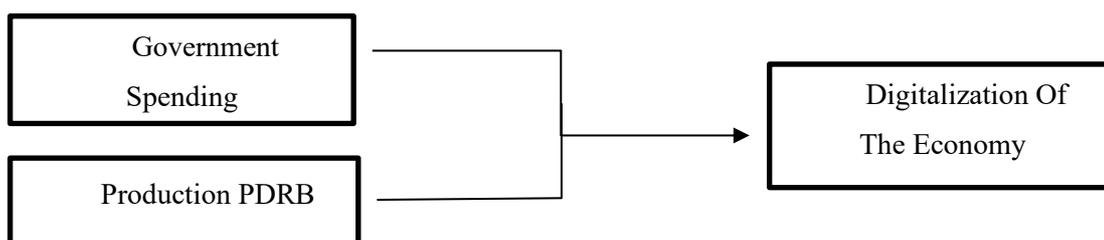
Figure 1. Research Framework

Figure 1 shows that the economic performance of a region is influenced by factors such as CO_2 emissions and energy consumption, which are crucial points in enhancing the economic performance of a country. When economic performance improves, the growth of the economy in that region increases, making it appear more advanced compared to other regions.

H1 (Alternative Hypothesis): Economic digitalization has a significant positive impact on economic growth in Sumatra from 2013 to 2023.

H0 (Null Hypothesis): Economic digitalization does not have a significant impact on economic growth in Sumatra from 2013 to 2023.

H2 (Alternative Hypothesis**):** Government spending positively influences the adoption of economic digitalization in Sumatra.

H0 (Null Hypothesis): Government spending does not significantly influence the adoption of economic digitalization in Sumatra.

H3 (Alternative Hypothesis): Production (PDRB) has a significant positive effect on economic growth in Sumatra.

H0 (Null Hypothesis): Production (PDRB) does not have a significant effect on economic growth in Sumatra.

4. DISCUSSION

Dynamic panel data consists of model approaches such as the First Difference GMM (FD-GMM) and System GMM (SYS-GMM). Next, model specification testing is conducted using the Sargan test to assess the validity of the variables used, as well as the Arellano-Bond test for consistency. After these tests, the next step is to conduct bias testing by comparing the lagged dependent GMM estimator with FEM (Fixed Effect Model) and PLS (Pooled Least Squares), with the results used to determine the best model. Statistical hypothesis testing is also performed both partially and simultaneously.

Table 1. The Result of Validity Test

Variable	Coefficient	Standard Error	t-Statistic	Probability
GDP	0.051044	0.117171	0.435638	0.6652
PRODUKSI	-0.276951	0.567442	-0.488070	0.6279
GS	-2.549923	0.709258	-3595197	0.0008
Effects Specification				
Mean dependent var			-0.057269	
S.E. of regression			0.858310	
J-statistic			20.96859	
Prob (J-statistic)			0.281001	

Table 1 shows the validity results, where the decision is that when the p-value > 0.05, the model is valid, and when the p-value < 0.05, the model is invalid. The FD-GMM value is p-value > 0.05, or 0.281001 > 0.05, meaning the FD-GMM model is valid, or the instrumental variables are not correlated with the error. Meanwhile, the SYS-GMM value is also p-value > 0.05, or 0.281001 > 0.05, indicating that the SYS-GMM model is valid, or the instrumental variables are not correlated with the error.

Table 2. The result of the Arellano-Bond Test

Test Order	m-Statistic	rho	SE(rho)	Probability
AR(1)	-3.384429	-0.741619	0.219127	0.0007
AR(2)	-1.477466	-0.241386	0.163378	0.1396

Table 2 shows the consistency test results, where the decision is that when the p-value at AR(2) > α (0.05), the model is consistent and does not experience autocorrelation, whereas when the p-value at AR(2) < α (0.05), the model is inconsistent and experiences autocorrelation. The AR value at order 2 is p-value > α (0.05), or 0.1396 > 0.05, meaning the model does not experience autocorrelation, and the data is consistent.

Table 3. The result of Unusability Test

FEM	GMM	CEM
0.670261***	0.659495	0.994113

After performing the estimation and reviewing the validity test, consistency test with Arellano-Bond (AB), and bias test, it can be concluded that the data did not pass the bias test. Therefore, this data can be estimated using the Arellano-Bond Generalized Method of Moments (AB GMM) model.

Eviews : descriptive analysis table.

	DE	PP	PR
Mean	2.880277	88892.22	33.01621
Median	3.816683	14702.70	23.90000
Maximum	43.47965	6337433.7	95.52000
Minimum	-29.78715	247.4000	0.000000
Std. Dev	5.670057	145771.7	32.77924
Skewness	-0.563944	2.251148	0.520323
Kurtosis	18.42494	7.517380	1.719832
Jarque-Bera	3867.082	657.6179	44.01027
Probability	0.078123	0.1542101	0.064512
Sum	1117.547	34460181	12810.29
Sum Sq. Dev	12441.87	822E+12	415823.1
Observations	388	388	388

After conducting a descriptive analysis on each variable with Economic Digitalization (DE) as the independent variable and Government Expenditures (PP) and Production or Gross Regional Domestic Product (PR) as the dependent variables, it is observed that the probability of each variable exceeds the 10% alpha level or 0.05. This indicates that each variable follows a normal distribution.

Economic performance in this context can be measured through various indicators, including Economic Digitalization, Government Expenditures, and Gross Regional Domestic Product (PDRB) Production. The impact of Financial Digitalization initiatives on these indicators may vary significantly across Sumatra Island. For example, regions that invest in financial digitalization may see short-term economic benefits through job creation and reduced energy costs, while others may face transition challenges, such as reduced revenue from traditional energy exports.(Hnainia & Mensi, 2024)

Estimasi Arellano-Bond GMM. The estimation used in this study employs the Arellano-Bond two-step GMM estimator. The simultaneous significance testing was performed using the Wald test, with the following results.

Tabel 1. Uji Wald

Wald (w)	p-value
4.041×3^{8}	0.000

From Table 1, it was decided to reject H_0 because the test statistic value $w = 4.041 \times 38$ is greater than $\chi^2(4) = 4.410544$ or the p-value is less than α (with $\alpha = 0.05$). Therefore, it can be concluded that at least one independent variable has an effect on the dependent variable. After the Wald test is fulfilled, the next step is to perform partial significance testing of the parameters using the Z-test, and the results of the Z-test can be seen in Table 2. From Table 2, it can be concluded that H_0 is rejected for the Economic Digitalization and Government Expenditure variables because the calculated Z-values are 2.88, 4.48, and 2.64, which are greater than $Z_{0.05/2} = 1.96$ or the p-value is less than 0.05. On the other hand, H_0 fails to be rejected for the EC variable because the calculated Z-value (-1.15) is less than $Z_{0.05/2} = 1.96$.

The conclusion drawn is that the variables Economic Digitalization and Government Expenditures have a significant partial effect on the model, while the Production variable does not have a significant effect on the model. Before performing the Sargan Test and the Arellano-Bond Test, the model will be re-estimated with only the variables that have a significant impact..

Parameter	Koefisien	Standar Eror	z	P-value
Digitalization economyi,T-1	0.9621	0.0280	46.15	0.000
Government spendingi,T	-114.9994	99.3855	-1.15	0.251
Productioni,T	0.0356	0.0123	2.88	0.004
β_0	53.99946	70.12968	0.77	0.441

Next, model specification testing is conducted for all variables that have a significant effect on the model. The best dynamic panel data model estimation can be seen from the criteria that the instrumental variables used are valid and the estimation obtained is consistent. Instrumental variable testing is conducted using the Sargan test, and the consistency of the estimation is tested using the Arellano-Bond test (Arellano-Bond, 1995). The results of the Sargan test are shown as follows.

Dynamic panel data regression can be used to determine the short-run (short-run multiplier) and long-run (long-run multiplier) effects of the independent variables. The results of the short-run and long-run elasticity of the Government Expenditure and Production variables based on the above equation can be seen in the following table.

Table 7 Short-Run and Long-Run Elasticities

Parameters	Coefficient	Short-term Elasticity	Long-term Elasticity
Digitalization economy,t-1	0.9422	-	-
Government spending,t	0.4169	0.2829	4.89
Production,t	1.6863	0.2344	4.06
β_0	-25.3382	-	-

Sargan Test Table

Test	Statistical value (S)	P-value
Uji Sargan	5.51104	0.7877

From Table 5, it can be concluded that we fail to reject H_0 because the Sargan test value (5.51104) is less than $\chi^2_6 = 12.592$ with a p-value of $0.7877 > \alpha = 0.05$, indicating that the overidentifying condition in the model estimation is valid. The Sargan test is also used to check for heteroscedasticity in the residuals. Therefore, we fail to reject H_0, meaning there is no heteroscedasticity, or the residuals from the GMM Arellano-Bond estimation are homogenous. The next step is to perform the Arellano-Bond test, and the results of the Arellano-Bond test can be seen as follows.

Arellano-Bond Table Test

Test	value ($|m(2)|$)	Statistics	P-value
Uji Arellano-Bond	-0.97809		0.328

From Table 6, it can be concluded that we fail to reject H_0 because the test statistic value $|(2)| = 0.97806$ is less than $Z_{0.05/2} = 1.96$, or the p-value is $0.328 > \alpha = 0.05$. This indicates that there is no autocorrelation in the first-difference error of order -1, and thus the estimation is consistent. After all the assumptions in the dynamic panel data regression using the GMM Arellano-Bond estimation are fulfilled, the model obtained is as follows.

Digitalization of the economy$_{i,t}$ = $-25.3382 + 0.9422$ Digitalization of the economy$_{,t-1}$ + 0.4169 government spending$_{i,t}$ + 1.6863 production$_{i,t}$

The R² value is very good, indicating that the obtained model is appropriate. The R² value of 83.97% means that 83.97% of the variation in economic growth in Sumatra Island can be explained by the independent variables in the model, while the remaining 16.03% is explained by other variables outside the model.

5. CONCLUSION

Based on the descriptive analysis and model estimation test using the GMM Arellano-Bond method, this study concludes that economic digitalization has a significant impact on economic growth in Sumatra during the period from 2013 to 2023. Economic digitalization, measured through the Economic Digitalization (DE) variable, shows a significant impact both in the short and long term on key economic indicators such as Government Expenditure (PP) and Production (PR). From the results of the Wald and Z tests, it is observed that economic digitalization and government expenditure significantly influence economic growth, while production does not show a significant effect. The long-term elasticity of economic digitalization on economic growth also shows positive and significant results, indicating that an increase in economic digitalization will lead to greater economic growth in the long run.

In conclusion, economic digitalization is a key factor driving economic growth in Sumatra, and policies that support digitalization should be a priority to achieve sustainable economic growth in the region. Therefore, this study successfully answers the research question posed, which is that economic digitalization does indeed affect economic growth in Sumatra during the period from 2013 to 2023.

The results of this study have several important implications, especially for policymakers, stakeholders, and economic actors in Sumatra:

First, formulation of Policies Supporting Economic Digitalization: Given the significant impact of economic digitalization on economic growth in Sumatra, both local and national governments need to develop policies that encourage the adoption of digital technologies across various sectors. This includes investing in digital infrastructure, enhancing digital literacy, and providing incentives for the private sector to adopt new technologies.

Second, focus on Sectors Vulnerable to Digitalization: Sectors such as agriculture, manufacturing, and tourism, which have great potential to be optimized through digitalization, should be a primary focus. The government and business actors must collaborate to integrate digital technologies into the value chains of these sectors to improve efficiency, productivity, and competitiveness.

Third, Increasing Strategic Government Expenditure: The research findings show that government expenditure has a significant influence on economic digitalization. Therefore, the allocation of government budgets should be more focused on programs that support digital infrastructure and digital skills training for the workforce, which will, in turn, accelerate economic growth.

Fourth, development of Long-term Policies: Given the long-term effects of digitalization on economic growth being greater than the short-term effects, the government and stakeholders must develop future-oriented policies. This includes long-term planning for sustainable digital transformation and readiness to face the evolving technological challenges.

Fifth, enhancing Inter-regional Cooperation: With disparities in the implementation of digitalization across various regions in Sumatra, collaboration between local governments needs to be strengthened. This could involve sharing best practices, integrating digitalization policies across regions, and ensuring the equitable distribution of digitalization benefits across Sumatra.

Sixth, continuous Monitoring and Evaluation: The implementation of economic digitalization requires careful monitoring and ongoing evaluation to ensure that the policies being applied are truly effective in driving economic growth. This will also help in making necessary policy adjustments in line with changes in economic and technological conditions.

With these implications, it is hoped that Sumatra can maximize its economic potential through targeted and sustainable digitalization, thereby creating inclusive and highly competitive economic growth.

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