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DIGITALIZATION AND INDONESIA'S MACROECONOMI RESILIENCE: AN EMPIRICAL VAR STUDY OF EXCHANGE RATE, INFLATION, FOREIGN DIRECT INVESTMENT AND DIGITAL ADOPTION

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ABSTRACT
This study examines the relationship between digitalization and Indonesia's macroeconomic resilience, utilizing Fixed Broadband Subscriptions (FBS) and FBS per 100 people as indicators. Based on endogenous growth theory, which emphasizes the role of technology as a driver of long-term growth, this study uses the Vector Error Correction Model (VECM) approach, developed from the VAR concept by Sims (1980), to address endogeneity issues and examine short- and long-term relationships between variables. The research procedures include stationarity, cointegration, Granger causality, Impulse Response Function (IRF), and Variance Decomposition (VD) tests. The estimation results show that digitalization significantly impacts the exchange rate, inflation, and Foreign Direct Investment (FDI). In the short term, increased FBS encourages exchange rate appreciation but tends to weaken with increasing imports of digital devices, while the adoption of FBS per capita has a more stable positive impact. Digitalization also suppresses inflation by increasing distribution and production efficiency, although its contribution is relatively small compared to FDI. The impact of digitalization on FDI is twofold: FBS expansion attracts initial investment, but the sustainability of capital flows is heavily influenced by the quality of the digital ecosystem, regulations, and workforce readiness. Overall, these findings confirm that inclusive digitalization is a strategic tool for strengthening Indonesia's economic resilience to external shocks and building a foundation for more sustainable growth.

Keywords: Exchange Rate, Inflation, Foreign Direct Investment (FDI), Digital Adoption

INTRODUCTION

Over the past few decades, digital transformation has experienced significant development. In developing countries, internet usage has increased by 10 percent, reflecting increasingly widespread and in-depth technology adoption (Emara & Zecheru, 2024). Rapid technological development has become a catalyst for global transformation in various aspects of life, particularly in the economic sector (Brunetti et al., 2020). This is reflected in the increasingly widespread adoption of digital technologies such as Artificial Intelligence (AI), internet networks, big data, and cloud computing across various aspects of life, including by businesses, regulators, and the wider public (Amelia et al., 2023). In developing countries like Indonesia, this phenomenon reflects the spirit of openness and innovation as the foundation for driving digital transformation in the economy.

Digital transformation in the economic sector has a significant impact on economic dynamics, creating innovative opportunities for economic growth and efficiency (Amelia et al., 2023). However, the acceleration of digitalization also presents new challenges, particularly related to macroeconomic stability. Rapid change is often not matched by adequate infrastructure, economic structure, and regulatory framework readiness, increasing the risk of volatility and turmoil in a country's economic resilience (Omol, 2024). Furthermore, the digitalization process also requires significant capital investment in the early stages of development, which can be a constraint for developing countries with limited fiscal capacity (Pang et al., 2023).

Macroeconomic resilience can essentially be reflected through key indicators such as the inflation rate and the exchange rate. The stability of these two variables is an important signal of national economic health. According to the IMF working paper (2019), digital transformation is a key determinant in shaping the structure of inflation and the direction of long-term global economic trends. In addition to inflation, digitalization also impacts

exchange rate volatility. In the context of exchange rates, digitalization also has a significant impact. Sudrajad et al. (2023) found that electronic money, as a proxy for economic digitalization, has a positive and significant impact on exchange rate volatility. This aligns with the findings of Bwalya & Dhawale (2024), who stated that the exchange rate market is highly sensitive to developments in digital technology in the financial and economic sectors.

Fluctuations in inflation and exchange rates not only impact domestically but can also influence foreign direct investment (FDI) inflows (Elian et al., 2025). FDI is a key driver of economic growth and increased international competitiveness (Enguang, 2023). In some cases, digital transformation can actually create uncertainty that hinders investment inflows, especially if the transformation is not accompanied by adequate macroeconomic stability (Hao et al., 2025). On the other hand, a study by Huang (2023) Shows that digitalization can improve cost efficiency and productivity, which are attractive to foreign investors.

To empirically measure the level of digital technology adoption, this study uses the Fixed Broadband Subscriptions (FBS) indicator, or the number of active fixed internet service subscriptions, both in terms of FBS per capita and FBS per person. FBS is considered a representative indicator because it reflects the availability and access to high-speed digital infrastructure, the main backbone supporting national digital transformation. A study by Elbahnasawy (2014) Shows that FBS is strongly correlated with productivity and capital flows, making it an important measure in linking digitalization to macroeconomic performance.

In reality, a significant gap remains between Indonesia and developed countries like China. In 2017, China recorded 27.9 FBS subscribers per 100 residents, while Indonesia only achieved 2.32 (Wahab, 2019). This situation illustrates that China's digital infrastructure implementation is more mature and has the potential to support digital transformation more effectively than Indonesia. Furthermore, research by Purnama (2018) Found a positive causal relationship between fixed broadband penetration and economic growth in ASEAN, underscoring the importance of digital infrastructure in driving economic growth.

The selection of the research period from 2000 to 2023 was based on the consideration that this time span reflects a crucial phase in the history of global digitalization. The early 21st century marked the beginning of the digital era, with a massive expansion of digital transformation infrastructure and significant growth in internet usage and fixed broadband services. According to the OECD (2024) Fiber-optic connections accounted for 42% of total fixed broadband subscriptions by the end of 2023, up from 38% the previous year, reflecting the transition to more advanced network technologies to support ongoing digital transformation. Furthermore, this period encompasses significant events such as the 2008 global financial crisis and the COVID-19 pandemic, which drastically accelerated digital adoption and emphasized the importance of digital infrastructure in maintaining national economic resilience. A study by Niebel (2018) Also reinforces the relevance of this timeframe, where the impact of digital transformation on economic growth has been strongest in the last two decades, particularly in developing countries.

Interestingly, a research gap emerged when previous literature focused more on digitalization in a fragmented way, for example, its relationship to economic growth in developed countries (Czernich et al., 2011), the impact of broadband as a general-purpose technology in the OECD (Koutroumpis, 2019), or the differences in the influence of ICT on growth in developed and developing countries (Niebel, 2018). However, few studies have integrated the variables of digital adoption, inflation, exchange rates, and FDI flows into a single, comprehensive empirical framework.

Therefore, this study presents a novelty by examining the dynamic interaction between digital adoption (measured through Fixed Broadband Subscriptions (FBS) and FBS per Person) and Indonesia's macroeconomic resilience with Exchange Rate, Inflation, and FDI indicators throughout the period 2000–2023. By applying the Vector Autoregression (VAR)

approach, this study is expected to be able to capture the complex interrelationships between variables, as well as provide theoretical and practical contributions in understanding how digital transformation not only drives growth but also has implications for Indonesia's macroeconomic resilience in the global digital era.

LITERATURE REVIEW

Endogenous Growth Theory

Endogenous Growth Theory is an approach in economics that emphasizes the role of internal factors as the primary determinant of long-term economic growth. Unlike neoclassical growth theory, which views technological progress as an exogenous factor, this theory asserts that knowledge accumulation, technological innovation, and improvements in human resource quality are the result of economic decisions and investments originating from within the economic system itself (Elfaki & Ahmed, 2024).

Ghura (1997) Emphasizes the importance of human capital as a primary factor driving productivity growth. Romer (1986) Adds that technological progress is not a random event, but rather the result of research and development activities influenced by economic incentives. Meanwhile, Aghion and Howitt (1992) Using the Schumpeterian growth model, highlight the role of innovation and creative destruction in creating sustainable growth.

In the context of digitalization, endogenous growth theory provides a relevant conceptual framework for understanding how the adoption of digital technology, particularly broadband infrastructure, can be a strategic instrument in driving economic growth (Zhang et al., 2024). Digital infrastructure not only improves the efficiency of production processes but also expands access to information, accelerates the diffusion of knowledge, and facilitates cross-sector innovation (Elfaki & Ahmed, 2024). These impacts have implications for increased productivity, price stability (through its influence on inflation), strengthened external competitiveness, which influences the exchange rate, and increased attractiveness to foreign direct investment (FDI) inflows.

In line with the endogenous growth theory framework, digitalization can be viewed as an internal driver of growth, as the resulting technological advances can improve production processes, expand trade networks, and strengthen the economy's adaptive capacity to external shocks (Qi & Chu, 2022). In the Indonesian context, digital penetration and adoption have the potential to be important catalysts in strengthening macroeconomic resilience by controlling inflation, stabilizing the exchange rate, increasing FDI inflows, and accelerating innovation-based economic transformation.

METHODS

This study uses the Vector Autoregressive (VAR) model, as introduced by Sims Christopher A. Sims. (1980), which views all variables in the system as endogenous and influencing each other through their past values. The VAR approach was chosen because it overcomes the endogeneity problem that often arises in macroeconomic analysis and provides a comprehensive framework for evaluating the dynamic relationships between economic variables. Furthermore, VAR is widely used to predict the behavior of time series systems and assess the short- and long-term impacts of shocks in economic systems (Sims, Christopher A., (1980) ; Lütkepohl, (1993)).

Before building the model, all data were normalized to ensure uniformity of units and avoid bias in estimation. The initial stage of the analysis was conducted through a stationarity test using the Augmented Dickey-Fuller (ADF) method, which aims to detect the presence of a unit root in the data. This test is important because non-stationary data can produce spurious regression, making stationarity a key requirement for the validity of a VAR model (Dickey & Fuller, (1979) ; Enders, (2014)).

After ensuring stationarity, the next step is to determine the optimal lag length. Lag determination is carried out by considering information criteria, specifically the Akaike Information Criterion (AIC), where the lag with the lowest AIC value is selected as the best representation. Selecting the appropriate lag is crucial to avoid autocorrelation and the loss of dynamic information between variables (Lütkepohl, 1993).

Next, a cointegration test is conducted to identify whether there is a long-run relationship between the variables in the system. The presence of cointegration indicates that although the variables are non-stationary, there is a stable linear combination between them in the long run (Johansen, 1991). Thus, this test helps confirm the existence of a long-run equilibrium in the economic system being analyzed.

If the cointegration test results indicate a long-term relationship, the model used is no longer a pure VAR, but rather a Vector Error Correction Model (VECM). The VECM model is a development of VAR that explicitly includes an error correction term (ECT) to capture short-term deviations from long-term equilibrium. Thus, the VECM is able to explain the short-term dynamic relationships between variables while simultaneously demonstrating the adjustment mechanisms toward long-term equilibrium. Within this framework, the ECT coefficient reflects how quickly variables in the system return to equilibrium after a shock (Engle & Granger, (1987) ; Lütkepohl, (1993)).

To complement the analysis, the Granger causality test is also used, which aims to assess the direction of the causal relationship between variables, whether one-way or two-way. This test is relevant in understanding dynamic interaction patterns, thus providing a clearer picture of the role of one variable on other variables in the system (Engle & Granger, 1987).

After the causal relationship is identified, this study uses the Impulse Response Function (IRF) to observe the response of one variable to shocks from another variable over a specific time period. IRF analysis allows researchers to understand how a shock propagates through an economic system, whether its impact is temporary or persistent (Engle & Granger, 1987). Furthermore, IRF results are typically visualized graphically, facilitating the interpretation of dynamic response patterns.

As a final step, this study applies Variance Decomposition (VD) to calculate the relative contribution of each variable to the variation or prediction error of other variables. VD provides information on the extent to which a particular variable explains the fluctuation dynamics of other endogenous variables in the system, thus enhancing understanding of the relative roles of each variable (Enders, 2014).

Thus, a combination of methods within the VAR and VECM frameworks, ranging from stationarity testing, optimal lag determination, cointegration, to causality analysis, IRF, and VD, is used. This series of testing stages provides a holistic approach to analyzing the relationships between macroeconomic variables. This model not only allows for testing short-term relationships but also identifies long-term equilibrium, causality patterns, and the relative contribution of each variable to the dynamics of the economic system.

RESULTS

Stationarity Test

The Augmented Dicky Fuller (ADF) model with a second difference approach was used to test stationarity in the study. The test results indicate that all variables used inflation, exchange rate, foreign direct investment (FDI), fixed broadband subscriptions, and fixed broadband subscriptions (per 100 people) are stationary. This is evidenced by the probability value of each variable being smaller than the 5% significance level (<0.05), thus, the data meet the requirements for use in further econometric analysis.

Table 1. Stationarity Test Unit Root

Variabel	t-Statistik	Prob.*
Inflation	-7.899223	0.0000
Exchange Rate	-14.66553	0.0000
Foreign Direct Investment (FDI)	-7.453544	0.0000
Fixed Broadband Subscriptions (FBS)	-13.51057	0.0000
Fixed Broadband Subscriptions (per 100 people)	-6.194669	0.0000

Source: Processed Data (2025)

Lag Optimal Test

The results of the optimal lag test on all research variables indicate that the optimal lag is lag 2. This recommendation is obtained based on the lag selection criteria, where the Final Prediction Error (FPE), Akaike Information Criterion (AIC), and Hannan-Quinn (HQ) values are at the lowest point compared to other lags. Thus, the use of lag 2 is considered the most appropriate because it can minimize the value of prediction errors and provide a more efficient model for further analysis (Hamilton, 1994).

Table 2. Lag Optimal Test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1744.552	NA	2.41e-12	-12.55994	-12.49453	-12.53369
1	1929.066	361.0355	7.63e-13	-13.71167	-13.31918*	-13.55419
2	1984.398	106.2688	6.13e-13*	-13.93067*	-13.21110	-13.64195*
3	2006.195	41.07573*	6.28e-13	-13.90755	-12.86090	-13.48759
4	2015.071	16.40625	7.06e-13	-13.79113	-12.41740	-13.23994
5	2018.716	6.605174	8.25e-13	-13.63694	-11.93613	-12.95451

Source: Processed Data (2025)

Johansen Cointegration Test

Table 3. Johansen Cointegration Test

Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value
None *	149.3401	69.81889
At most 1 *	104.9267	47.85613
At most 2 *	66.76040	29.79707
At most 3 *	37.72708	15.49471
At most 4 *	11.02771	3.841465

Source: Processed Data (2025)

Granger Causality Test

The Johansen Cointegration approach was used in this study. This approach is based on a comparison between the trace statistic and the critical value. According to the test criteria, an equation is considered cointegrated if the trace statistic is greater than the critical value at the 5% significance level. In other words, the presence of cointegration indicates a long-term relationship between the variables in the system being tested.

Based on the test results, the data met the cointegration criteria. This is reflected in the trace statistic values being consistently higher than the critical value at the 5% significance level. This finding indicates that the research variables Inflation, Exchange Rate, Foreign Direct Investment (FDI), Fixed Broadband Subscriptions, and Fixed Broadband

Subscriptions (per 100 people) do not move independently in the long run, but rather are interrelated and maintain a long-term equilibrium relationship.

With evidence of cointegration, this research model cannot be analyzed solely using the Vector Autoregression (VAR) approach in level form. Therefore, the next stage of analysis will use the Vector Error Correction Model (VECM), which is able to describe the dynamics of short-term relationships as well as the adjustment mechanism towards long-term equilibrium between these variables.

Table 4. Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
FBS PER PEOPLE does not Granger Cause FBS	286	0.52180	0.5940
FBS does not Granger Cause FBS PER PEOPLE		**3.20283**	**0.0421**
EXCHANGE RATE does not Granger Cause FBS	286	0.87224	0.4191
FBS does not Granger Cause EXCHANGE RATE		1.84346	0.1602
FDI does not Granger Cause FBS	**286**	**4.17560**	**0.0163**
FBS does not Granger Cause FDI		1.31374	0.2705
INFLATION does not Granger Cause FBS	286	2.22284	0.1102
FBS does not Granger Cause INFLATION		0.31190	0.7323
EXCHANGE RATE does not Granger Cause FBS PER PEOPLE	**286**	**4.58571**	**0.0110**
FBS PER PEOPLE does not Granger Cause EXCHANGE RATE		1.33860	0.2639
FDI does not Granger Cause FBS PER PEOPLE	286	1.94635	0.1447
FBS PER PEOPLE does not Granger Cause FDI		0.21429	0.8072
INFLATION does not Granger Cause FBS PER PEOPLE	286	2.85893	0.0590
FBS PER PEOPLE does not Granger Cause INFLATION		**3.26454**	**0.0397**
FDI does not Granger Cause EXCHANGE RATE	286	0.03479	0.9658
EXCHANGE RATE does not Granger Cause FDI		0.39231	0.6759
INFLATION does not Granger Cause EXCHANGE RATE	286	1.92442	0.1479
EXCHANGE RATE does not Granger Cause IINFLATION		1.72410	0.1802
INFLATION does not Granger Cause FDI	286	0.31820	0.7277
FDI does not Granger Cause INFLATION		0.14434	0.8657

Source: Processed Data (2025)

The Granger causality test results above demonstrate several one-way causal relationships between the variables in this study. First, the variable FBS per Person is shown to influence FBS with a probability value of 0.0421, which is lower than the 5 percent significance level, indicating a one-way causal relationship from FBS per Person to FBS, but not the reverse. Furthermore, the variable FDI also influences FBS with a probability value of 0.0163 <0.05, indicating a one-way relationship from FDI to FBS, while the reverse direction is not significant. The test results also show that the Exchange Rate influences FBS per Person with a probability of 0.0110 <0.05, indicating a one-way relationship from the exchange rate to FBS per Person, but not the reverse. Furthermore, the variable FBS per Person influences inflation with a probability of 0.0397 <0.05, indicating a one-way causal relationship from FBS per Person to inflation, but no reverse effect was found. Thus, in general, it can be concluded that the causal relationship between variables in this study is limited and dominated by a one-way relationship pattern, while most of the other variables do not show a significant relationship because their probability value is greater than the 5 percent significance level.

Impulse Response Function (IRF) Test

The Impulse Response Function (IRF) is used to observe how one variable responds to a shock from another variable over a period of time, and the results are usually visualized graphically. The following are the results of the IRF test:

Response of the Exchange Rate to FBS and FBS Per People Innovation

Figure 1 shows that the Exchange Rate variable responded positively by 0.001 points to the FBS variable shock at the beginning of the study period. It then responded negatively in subsequent periods until the end of the study period. The Exchange Rate variable's response tended to fluctuate in the intermediate period and showed a fairly stable value of -0.0007 to -0.0008 points in the middle to end of the study period. In contrast to the response to the FBS variable, Figure 2 shows a positive response to the FBS Per Person variable shock. The response was 0.0005 points at the beginning of the study period. It decreased to 0.0002 points in the second and third periods. Then, it stagnated at 0.0003 points until the end of the study period.

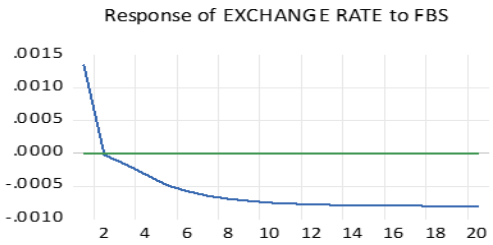

Figure 1. Respons of the Exchange Rate to FBS
Source: Processed Data (2025)

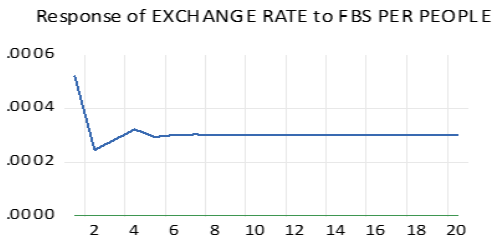

Figure 2. Respons of the Exchange Rate to FBS per People
Source: Processed Data (2025)

Response of Inflation to FBS and FBS Per People Innovation

The next variable is inflation. The IRF test results in Figure 3 show that, similar to the exchange rate, inflation responded negatively from the beginning to the end of the study period due to shocks from the FBS variable. At the beginning of the period, the response to the shock was -0.2 points, then fluctuated in the second to sixth periods, and stagnated at -0.03 points until the end of the study period. Similar to the response to the FBS variable shock, Figure 4 shows that inflation consistently responded negatively to shocks caused by the FBS Per Person variable. At the beginning of the study period, the inflation response was -0.13 points, increasing to -0.05 points in the third period. It fluctuated in subsequent periods and stagnated at -0.07 points in the middle to the end of the study period.

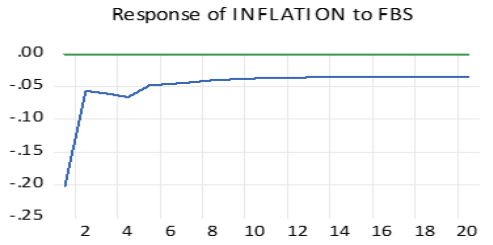

Figure 3. Respons of Inflation to FBS
Source: Processed Data (2025)

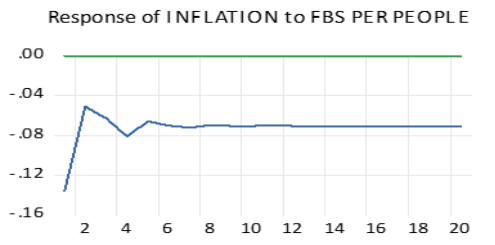

Figure 4. Respons of Inflation to FBS per People
Source: Processed Data (2025)

Response of FDI to FBS and FBS Per People Innovation

Similar to the Exchange Rate variable, Figure 5 shows a similar response. At the beginning of the period, FDI responded positively to the FBS variable shock, ranging from 0.002 to 0.03 points in the third period. It then responded negatively in the following period, with values ranging from -0.001 to -0.009 points. It stagnated at -0.01 points until the end of the study period. In contrast to the FDI response to the FBS variable shock, Figure 6 shows a consistent negative response from the beginning to the end of the study period to the FBS Per Person shock. It can be seen that at the

beginning of the period, the response fluctuated, ranging from -0.02 to -0.07 points. However, it stabilized and stagnated at -0.03 points from the fifth period to the end of the study period.

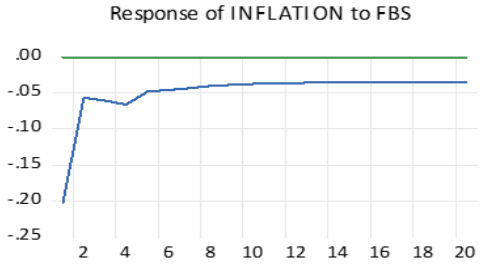

Figure 5. Respons of FDI to FBS
Source: Processed Data (2025)

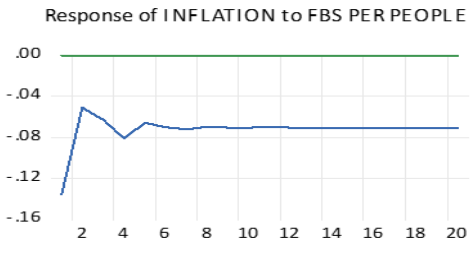

Figure 6. Respons of FDI to FBS per People
Source: Processed Data (2025)

Variance Decomposition (VD) Test

Variance Decomposition (VD) calculates the contribution of each variable to the fluctuation or forecast error of other variables in the VAR/VECM system. Figure 7 shows that the FBS variable is predominantly influenced by itself and FDI. At the beginning of the period, FBS was 100 percent influenced by itself. Then, midway through the period, FBS's influence declined to 83 percent, followed by an increase in the contribution of FDI at 14.4 percent. The remaining contributions were made by Inflation, Exchange Rate, and FBS for People, which had relatively low contributions. Despite this decline, FBS's contribution to itself remained dominant at 64.9 percent. This was followed by FDI, which continued to increase by 30.2 percent, Inflation by 3 percent, Exchange Rate by 1.8 percent, and FBS Per Person, which had the lowest contribution at 0.02 percent.

Slightly different from the FBS variable, Figure 8 shows that FBS per Person at the beginning of the period was dominated by two main variables: FBS Per Person at 87 percent and FBS at 13 percent. In the middle of the period, the variable's contribution continued to increase, reaching 93 percent. In contrast, the FBS variable's contribution continued to decline to 6.5 percent, followed by increases in FDI contributions of 0.3 percent, inflation of 0.05 percent, and the exchange rate of 0.02 percent. By the end of the period, the FBS variable's fluctuation per person was dominated by the variable itself, accounting for 95 percent of the total. FBS contributed 4.4 percent, FDI 0.5 percent, inflation 0.07 percent, and the exchange rate 0.02 percent.

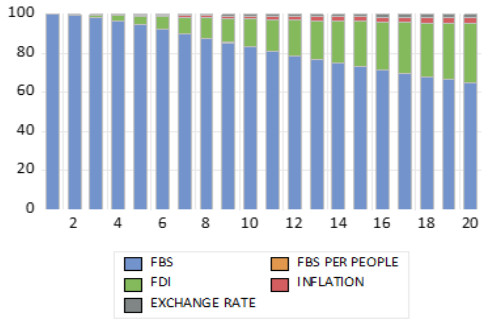

Figure 7. Variance Decomposition of FBS
Source: Processed Data (2025)

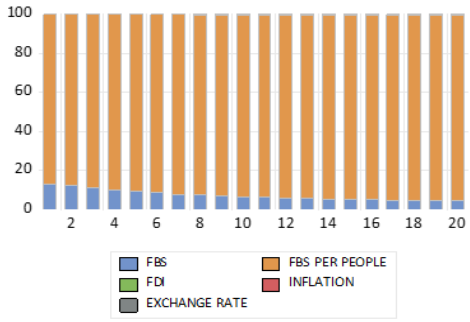

Figure 8. Variance Decomposition of FBS per People
Source: Processed Data (2025)

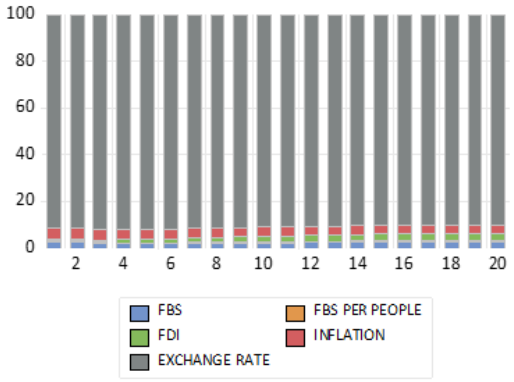

Figure 9. Variance Decomposition of the Exchange Rate
Source: Processed Data (2025)

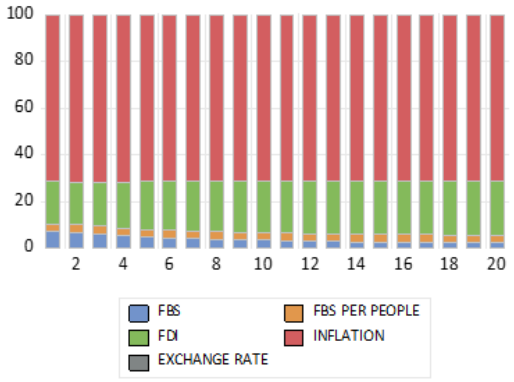

Figure 10. Variance Decomposition of Inflation
Source: Processed Data (2025)

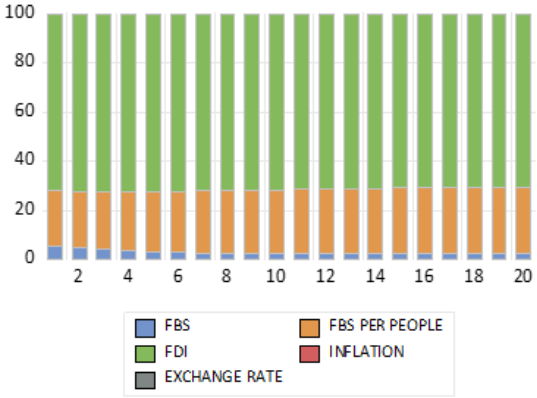

Figure 11. Variance Decomposition of FDI
Source: Processed Data (2025)

In the Exchange Rate variable, fluctuations are dominated by the variable itself. Figure 9 shows that at the beginning of the period, the Exchange Rate variable itself was 91.2 percent influenced, followed by Inflation by 4.8 percent, FBS by 3 percent, FDI by 0.6 percent, and FBS per person by 0.4 percent. There was no significant change in the magnitude of the influence of the variable itself by mid-period. By the end of the period, the variable's contribution decreased to 90 percent. This was followed by Inflation by 3.6 percent, FDI by 3.1 percent, FBS by 2.8 percent, and FBS per person by 0.5 percent.

Figure 10 shows that the fluctuations in the Inflation variable were predominantly influenced by the variable itself, accounting for 71 percent of the impact from the beginning to the end of the study period. This was followed by FDI, which contributed the second-largest contribution at 18 percent at the beginning of the period and continued to increase to 23.5 percent by the end of the study period. The FBS variable's influence or contribution tended to fluctuate, reaching 7.1 percent at the beginning of the period and declining steadily to 2.2 percent at the end. Furthermore, FBS Per Person maintained a stable contribution of 3 percent from the beginning to the end of the study period. For the Inflation variable, the VD test results indicated that the Exchange Rate had the lowest influence, with a maximum value of 0.02 percent at the end of the study period.

Finally, the FDI variable was also affected. The VD test results in Figure 12 show that fluctuations in the FDI variable were predominantly influenced by the FDI variable itself, with 72.3 percent, 22.5 percent by the FBS Per Person variable as the second largest contributor, and 5.2 percent by the FBS variable as the third largest contributor at the beginning of the study period. At the beginning of the study period, inflation and the

exchange rate had no contribution or influence on the fluctuations in the FDI variable. By the end of the study, the influence of the FDI variable itself and FBS decreased to 70.2 and 2.3 percent, respectively. Conversely, the contribution of the FBS Per Person variable increased to 27.2, making it the second-largest contributor. Similarly, the Inflation and Exchange Rate variables experienced increases, albeit relatively small, to 0.14 and 0.06 percent, respectively.

Digital Adoption (FBS and FBS per People) and Exchange Rate

The VECM estimation results and IRF analysis show that digitalization has a significant relationship with exchange rate dynamics in Indonesia. The increase in the number of broadband subscribers (FBS) initially drove exchange rate appreciation, reflecting market optimism and positive perceptions of increased national productivity. However, this response was only temporary, as the exchange rate depreciated in the subsequent period and stabilized at a small negative level. This condition can be explained by the increasing need for imports of digital hardware and infrastructure, which increased pressure on foreign exchange demand (Yuan et al., 2025).

Conversely, per capita broadband adoption (FBS per person) exhibited a more consistent response pattern. The exchange rate reacted positively from the outset and remained relatively stable over the long term. This indicates that more inclusive and equitable digitalization has a more sustainable impact on exchange rate stability. Widespread digital access across the community can improve production efficiency, accelerate information flow, and strengthen export competitiveness. Thus, equitable digital adoption is not merely a technological transformation but also a strategic instrument in maintaining rupiah exchange rate stability (Xi & Wang, 2023).

Digital Adoption (FBS and FBS per Person) and Inflation

The relationship between digitalization and inflation shows a consistently negative trend. The IRF results show that shocks to the number of broadband subscribers (FBS) and to broadband adoption per capita (FBS per Person) reduce the inflation rate from the initial period, although they subsequently stabilize at a small negative level. This indicates that digitalization acts as a mechanism to suppress inflation by increasing the efficiency of production and distribution costs. Broadband access accelerates the flow of information, shortens supply chains, and reduces transaction costs, ultimately suppressing price pressures (Koutroumpis, (2009) ; Kouam & Asongu, (2023).

However, despite its clear short-term effects, the Variance Decomposition results indicate that digitalization's contribution to inflation is relatively small compared to other factors, particularly FDI. Foreign investment inflows have the potential to drive inflation by increasing aggregate demand and production costs (Glam & Böke, 2017). Thus, although digitalization has been shown to support price stability, its impact will only be optimally felt if supported by macroeconomic stability and consistent inflation control policies.

Digital Adoption (FBS and FBS per Person) and Foreign Direct Investment (FDI)

VECM and IRF results show that digitalization has a dual impact on FDI. When FDI receives a shock from the number of broadband subscribers (FBS), the initial response is positive, indicating that broadband subscriber expansion is seen as a signal of digital infrastructure growth that attracts foreign investors. However, in the long run, this response turns negative, indicating that simply increasing the number of subscribers is not enough to guarantee sustainable investment flows if it is not accompanied by a quality digital ecosystem, workforce readiness, and regulatory certainty (Chen, L., K.Ramli, 2023).

Meanwhile, the FDI response to broadband adoption per capita (FBS per Person) is consistently negative from the beginning to the end of the period. This suggests that equitable broadband access is not necessarily seen as a primary factor in foreign investment decisions. Investors tend to pay more attention to the quality of digital utilization, potential economic value-added, and regulatory readiness than simply to the distribution of internet access (Arbia & Sobhi, 2024). Nevertheless, the VD results show that the

contribution of digitalization, particularly FBS per person, to FDI dynamics is increasing in the long term. This confirms that digital inclusion remains a crucial indicator of a country's readiness to support modern business activities and global integration (Aleca, 2025).

Digital Adoption (FBS and FBS per Person) and Indonesia's Macroeconomic Resilience

Digitalization, measured in this study through Fixed Broadband Subscriptions (FBS) and FBS per 100 people, functions not merely as a technological indicator but as a structural factor that modulates the economy's vulnerability and adaptive capacity. The findings from the VECM, IRF, and VD demonstrate that digitalization plays a role in two key channels determining macroeconomic resilience: (1) the productivity and efficiency channel, which mitigates price pressures and strengthens the production base; and (2) the market signaling channel, which influences investors' expectations of the national economic outlook, thus impacting capital flows and exchange rates. These findings align with empirical literature showing that more digitalized firms and sectors experience smaller revenue losses during recessions and recover more quickly after shocks, which in turn enhances the aggregate resilience of the economy (Copestake et al., 2022).

Theoretically, in the context of digitalization, endogenous growth theory provides a relevant conceptual framework for understanding how the adoption of digital technology, particularly broadband infrastructure, can be a strategic instrument in driving economic growth (Zhang et al., 2024). Koutroumpis (2009) Presents macro evidence that broadband penetration is positively correlated with economic growth through investment and productivity channels. In the Indonesian context, this productivity effect explains why FBS per person, as a measure of access equity, shows a more stable long-term impact on macro variables such as the exchange rate and inflation. Equitable access enlarges the user base that can adopt productive digital services, resulting in broader and more durable efficiency impacts.

However, this relationship is not linear and is susceptible to global phenomena that moderate the impact of digitalization on resilience. Two important global phenomena need to be considered. First, the COVID-19 pandemic accelerated digital transformation (telework, e-commerce, digital finance) but also highlighted infrastructure and skills gaps. Countries or regions with less resilient digital infrastructure experienced slower recovery and increased inequality (Organization for Economic Cooperation and Development (OECD), 2021). Second, global supply chain dynamics, such as semiconductor shortages and rising demand for devices, increased imports of capital goods for rapid digital expansion, can depress foreign exchange reserves and put downward pressure on the exchange rate if not offset by increased exports of digital services or capital inflows (Group, 2024). This phenomenon aligns with the results of the IRF test, where very short-term exchange rate appreciation during the FBS shock is followed by medium-term weakening.

The literature on the relationship between digitalization and inflation also provides additional nuances. Many studies find a deflationary/inflation-suppressing effect of digitalization through digital market efficiency and competition, but the size of the effect depends on the level of adoption, market structure, and monetary transmission channels (Emara & Zecheru, 2024). Cross-country empirical studies show a reduction in income volatility for digital enabler sectors during crises, thus dampening price fluctuations in the aggregate (Copestake et al., 2022). However, the contribution of digitalization to inflation variance remains smaller than traditional macroeconomic factors such as FDI and monetary policy. This is supported by the findings of the VD test, which shows that the contribution of FDI to inflation increases over time. This occurs because the influx of foreign investment has the potential to increase aggregate demand and production costs, which then creates price pressures (Glam & Böke, 2017).

Regarding foreign direct investment (FDI) flows, theoretical and empirical evidence place digital infrastructure as one of the "location quality components" for multinational investors. Reliable connectivity lowers operating costs, enables digital business models, and opens new markets. A study by Choi (2003) found evidence that the internet or broadband can

encourage FDI, especially when accompanied by adequate institutional and human resource quality. However, FBS penetration without equitable distribution of FBS quality and capacity per person, and human resource or regulatory quality tends to result in a less sustainable investment response (Diouf et al., 2024). This occurs because investors assess not only user numbers but also "ecosystem readiness." Therefore, policies that focus solely on network expansion without building an ecosystem, such as digital skills, data regulation, cybersecurity, and innovation incentives, risk generating a short-term, unsustainable surge in FDI.

The identified reciprocal relationships indicate that digitalization, inflation, the exchange rate, and FDI influence and reinforce each other. Digitalization helps suppress inflation, supports exchange rate stability, and attracts foreign investment. Conversely, maintaining macroeconomic stability is also a prerequisite for accelerating digitalization. Therefore, inclusive and equitable digitalization has the potential to be a strategic instrument in strengthening Indonesia's economic resilience to external shocks, while building a foundation for more sustainable growth.

Therefore, based on the empirical synthesis and global phenomena above, there are clear macro and sectoral policy implications for strengthening the role of digitalization in economic resilience: (1) prioritize equitable access (FBS per person) and not just aggregate customers; (2) combine infrastructure investment with digital skills strengthening programs and regulatory reforms to improve the quality of utilization; (3) synchronize digital strategies with trade and industrial policies to capture opportunities for digital services exports and reduce pressure on capital goods imports; (4) strengthen the macro framework (monetary and fiscal) to manage transition effects, and strengthen external financing reserves and channels that support productive investment. Implementing these steps will increase the probability that digitalization will become a source of sustainable resilience, rather than simply a temporary growth driver.

CONCLUSION

The research results show that digitalization, through the Fixed Broadband Subscriptions (FBS) and FBS per Person indicators, plays a crucial role in strengthening Indonesia's economic resilience, particularly in relation to the exchange rate, inflation, and Foreign Direct Investment (FDI). In the short term, increasing FBS can encourage exchange rate appreciation and suppress inflation through distribution and production efficiencies, while FBS per Person provides more consistent stability to rupiah fluctuations. However, in the long term, increasing FBS tends to weaken the exchange rate due to a surge in imports, while FBS per Person maintains a positive impact on exchange rate stability. Regarding inflation, digitalization generally contributes to suppressing price pressures in both the short and long term, although the deflationary effect tends to be limited. Meanwhile, for FDI, digitalization through FBS provides a positive signal in the short term, while FBS per Person has a negative impact due to the uneven quality of the digital ecosystem. Nevertheless, in the long term, digitalization continues to attract FDI, provided it is supported by regulations, infrastructure, and human resource readiness.

Overall, these findings confirm that digitalization strengthens Indonesia's economic resilience by stabilizing the exchange rate, suppressing inflation, and increasing investment attractiveness, although the impact varies across indicators. Based on these findings, several policy recommendations are worth considering. First, the government needs to prioritize equitable broadband access (FBS per person) as an instrument for sustainable digital inclusion, rather than solely focusing on increasing the aggregate number of subscribers. Second, digital infrastructure development must be accompanied by programs to improve the digital skills of the community and regulatory reforms that support innovation, cybersecurity, and data protection, to improve the quality of use and make it more attractive to foreign investors. Third, digitalization strategies need to be synchronized with trade and industrial policies, particularly to strengthen digital services exports and reduce pressure on capital goods imports. Fourth, macroeconomic policies, both fiscal and monetary, must

be directed at managing the effects of the digitalization transition by strengthening foreign exchange reserves, maintaining exchange rate stability, and ensuring foreign investment in productive sectors. With these steps, digitalization has the potential to become a source of sustainable macroeconomic resilience for Indonesia, as well as a foundation for inclusive growth and global competitiveness in the era of digital transformation.

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