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Research paper

Exploring The Strength of Apparently Uncorrelated Regression A Model for Analyzing and Detecting Economic Growth and Poverty through Financial Inclusion in Indonesia

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Abstract

In recent years, financial inclusion (FI) has emerged as an important topic with the potential to directly impact most countries around the world. Indonesia is a developing country and therefore suffers from economic problems, most notably slow economic growth (EG) and limited use of formal financial services. In addition, research has not shown a decrease in the Gini coefficient, despite a decrease in poverty rates. Therefore, further research is necessary to verify this. This research adopted an important model, the seemingly unrelated regression (SUR), to examine and determine the strength of the model and the relationship. The results showed that the effect of the SUR model on economic growth was not positive. However, the significant negative effects revealed that the availability dimension is the most effective and optimal in reducing poverty, alleviating its severity, and reducing income inequality in Indonesia. In contrast, the results did not show any significant effect for the accessibility and ease of use dimensions.

Keywords: *SUR Model; GDP Growth; Inequality; Poverty Rate; Economic; Financial Inclusion; JEL Codes: F43; O47.*

1. Introduction

Joint development agreements seek to achieve sustainable development and reduce and alleviate poverty. Among these agreements are the Millennium Development Goals (MDGs), which emphasize the need to reduce poverty to continue achieving sustainable development. These MDGs emphasize that alleviating poverty, improving people's living standards, and achieving well-being are linked to financial services, which lead to higher levels of EG (Ze et al., 2023). The importance of financial inclusion (FI) has emerged as it promotes the 17 Sustainable Development Goals (SDGs), including poverty alleviation and reducing inequality (Bank, 2018; Ziwei et al., 2023).
Furthermore, FI has expanded globally due to the availability of communication networks such as the internet and the widespread ownership of mobile phones. However, the problem of FI is not distributed equally across countries (Raisi & Forutan, 2017). In 2017, the World Bank reported that 3.8 billion adults had bank accounts, representing 69% of the global adult population. Figure 1 shows bank accounts of people according to the country's income level classification over the years 2011, 2014, and 2017.

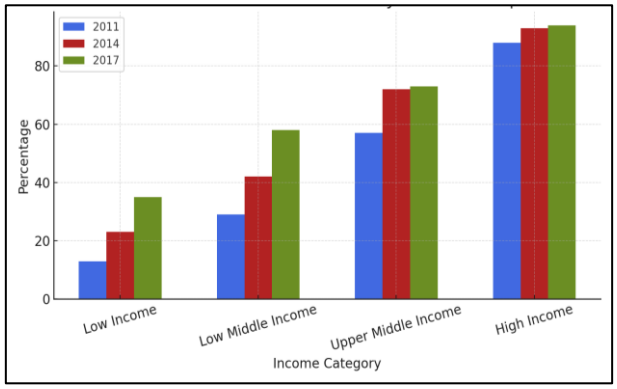

Fig. 1: Illustrates the Distribution of Bank Accounts Among People by Country Income Level Classification (2011–2017) (Demirgüç-Kunt, 2018).

Although the rate of individual bank account ownership has increased rapidly in many developed countries, it has been slow in other, less advanced countries with less EG. Therefore, it is imperative to focus on increasing FI in these countries, including Indonesia. According to the results of the Otoritas Jasa Keuangan (OJK) Financial Inclusion Survey conducted in Indonesia in 2019, the average income of its citizens was low(Amit, 2018). The FI index increased to 76.19%, compared to 67.8% in 2016 (Keuangan, 2020). In addition, World Bank data revealed the extent of development in the dimensions of financial inclusion, represented by savings and credit levels in Indonesia, as well as GDP growth rates from 2004 to 2019, as shown in Figure 2. This figure illustrates an increase in the savings rate and credit rate compared to 2019, where the savings rate decreased while GDP growth increased slowly (Chlaihawi, 2024).
It was found that there was disparity and irregularity in savings and credit rates. It was observed that in 2010, the savings rate increased and the credit rate decreased compared to 2009(Lei & Ibrahim, 2024). Conversely, in 2019, the credit rate increased and the savings rate decreased compared to 2018.
As a result of this disparity in the dimensions of FI, it was necessary to verify the extent of the use of FI with empirical evidence (Khan & Taha, 2023).

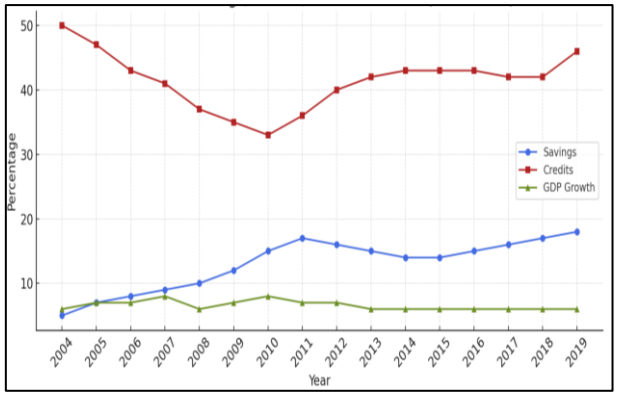

Fig. 2: Illustrates Development in the Dimensions of Financial Inclusion Levels (Savings, Credit, and GDP Growth) in Indonesia from 2004 to 2019 (World Bank Data).

The Gini coefficient is an indicator that determines the level of poverty in any country. It was used to determine the poverty rate in Indonesia from 2004 to 2019. According to data obtained from the Central Bureau of Statistics, it was observed that the number of poor people gradually decreased with increasing economic development (Figure 3). The poverty rate was 16.66% in 2004 and gradually decreased to 9.22% in 2019. This decrease in poverty rates indicates increased implementation of financial inclusion(Praveenchandar et al., 2024).
However, the Gini ratio was relatively high despite a clear decrease in the poverty rate. The Gini ratio ranged between 0.3 and 0.5 from 2004 to 2019 in Indonesia, as shown in Figure 4. This suggests that income inequality among individuals was relatively high before 2014 but showed a marked decline during the period from 2014 to 2019 (Figure 4).

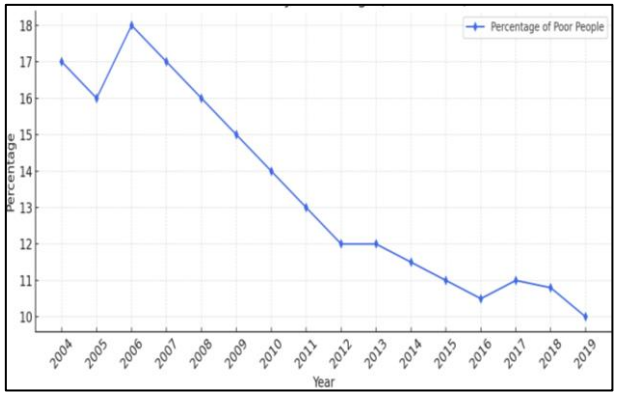

Fig. 3: Illustrates the Trend in the Percentage of the Population Living in Poverty in Indonesia from 2004 to 2019, Based on Data from the Central Bureau of Statistics.

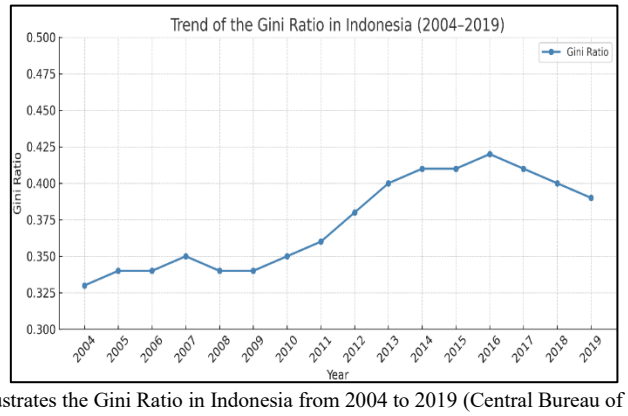

Fig. 4: Illustrates the Gini Ratio in Indonesia from 2004 to 2019 (Central Bureau of Statistics).

The FI has a clear positive impact on inequality, poverty, and growth. However, it also hurts the economy, which is why it is necessary to discuss this. Among the negative impacts of FI on the economy are subprime mortgages, which are considered high-risk. This was demonstrated in 2008 when the United States (US) economy was affected by subprime mortgages. Also, easy access to credit leads financial institutions and their management to lend money. Several previous studies have reported the negative impacts of FI on economies (Ayensu, 2017). Ductor reported that when examining the impact of FI on poverty reduction in sub-Saharan Africa, it had no significant impact (Ductor, 2015). In addition, Sun et al. reported that financial developments, such as financial inclusion, if they do not show growth in the real sector, negatively impact EG (Sun et al., 2023). The SUR model indicates that other factors affect poverty rates and growth, not just financial inclusion. Therefore, it is necessary to consider the variables that control EG, including unemployment and the real interest rate, in addition to determining the poverty level using the Gini ratio.

Due to global developments, interest in and development of FI programs has increased, becoming a priority in all countries around the world. This has been highlighted by the establishment and development of international forums, including the Alliance for Financial Inclusion (AFI) and the Group of Twenty (G-20). This has also been highlighted by the development of World Bank policies and programs aimed at promoting financial inclusion, including the establishment of FI units in central banks in many countries (Sadalia et al., 2015). To achieve strategic steps to promote EG, accelerate poverty reduction, and achieve equality between individuals and regions within an institution or ministry, the implementation of FI is a fundamental requirement to ensure and achieve the well-being of all individuals in Indonesia (Presidential Decree, 2016).

FI is a measure based on three basic dimensions: availability, accessibility, and use of banking services (Sarma, 2008). The three dimensions of FI were compiled by SNKI. Each dimension has a distinct meaning. Accessibility refers to the speed with which financial services are accessed and utilized, while availability refers to the availability of various financial products that individuals need. Finally, the use of banking services refers to individuals' use of financial products.

Several prior studies have reported indicators related to financial inclusion, including the number of bank branches per 100,000 adults and the number of bank offices per 1,000 square kilometers (Siddik et al., 2019; Joseph & Varghese, 2014; Mwaitete & George, 2018; Wang'oo, 2013; Park & Mercado Jr., 2015; Zia & Prasetyo, 2018; Nasution et al., 2019; Iqbal & Sami, 2017; Nasution et al., 2013), the number of automated teller machines (ATMs)(Park & Mercado Jr., 2015; Wang'oo, 2013; Joseph & Varghese, 2014; Mwaitete & George, 2018; Bakari et al., 2019; Julie, 2013; Iqbal & Sami, 2017), savings account usage (Bakari et al., 2019; Ravikumar, 2013; Nasution et al., 2019; Zia & Prasetyo, 2018; Wang'oo, 2013; Siddik et al., 2019), use of debit and credit cards (Iqbal & Sami, 2017; Zia & Prasetyo, 2018; Ravikumar, 2013; Park & Mercado Jr., 2015; Siddik et al., 2019; Bakari et al., 2019), small depository institutions and loan accounts in commercial banks per 1,000 adults (Moaiti & George, 2018), and the number of depositors in commercial banks (Park & Mercado Jr., 2015).

1.1. Financial inclusion and economic growth

Numerous empirical studies have demonstrated a positive correlation between FI and EG. These studies have confirmed that FI has an impact on EG. Among these studies is a study conducted in Tanzania, which demonstrated that FI has a significant impact on EG (Mwaiti & George, 2018). Similarly, Hariharan and Marktaner (2012) and Levine et al. (2000) also reported that FI is directly and closely linked to the EG of countries, significantly impacting their EG through resource allocation and total factor productivity. In addition, Sharma (2016), in a study conducted in India, indicated that FI significantly contributes to building a financial structure that is robust and resilient to economic challenges and problems, which helps increase EG. However, a study by Arcand et al. (2012) on high-income developed countries indicated that FI hurts EG.

2. Research Methodology

2.1. Data

The current study relied on a quantitative approach because it aligns with the objectives of this study and facilitates the analysis of measurable indicators. Secondary data were used on FI over 16 years, from 2004 to 2019, in Indonesia. The sample size was small compared to the sample population due to the difficulties and challenges we faced in obtaining data for the years before 2004. This is a limitation of the study. The data were processed and analyzed using EViews 10.0. The three variables on which the study relied, FI, EG, and poverty level, are shown in Table 1.

Table 1: Research Variables Categorized by Main Components and Dimensions

Main Component	Dimension	Variable Indicator
Financial Inclusion	Accessibility	Number of commercial bank branches (per 100,000 adults)
	Accessibility	Number of ATMs (per 100,000 adults)
	Availability	Net national savings (% of GNI)
	Availability	Domestic credit provided by the financial sector (% of GDP)
	Usability	Number of borrowers (per 1,000 adults)
Macroeconomic Factors	—	Interest rate (%)
	—	Unemployment rate (%)
	—	GDP growth rate (%)
Poverty and Inequality	—	Poverty rate (%)
	—	Gini index

2.2. Estimation technique

The Feasible Generalized Least Squares (FGLS) estimation technique was used with SUR, an econometric approach used to estimate systems of equations with correlated error terms. The data were analyzed using SUR modeling, and model quality was measured using SUR. Normal distribution and heteroscedasticity were applied to test SUR assumptions and interpret the model.

2.3. Seemingly unrelated regression

The SUR model was first developed by Arnold Zellner in 1962 (Santosa, 2018). This model differs from the least squares (LS) method in that it produces a more accurate estimator than the estimator obtained using the LS method, particularly when the error terms across multiple equations are contemporaneously correlated (Conniff, 1982). SUR modeling applied in this study includes the following equations:

$$EG_t=\alpha_0+\alpha_1 BBR_t+\alpha_2 \log(ATM_t)+\alpha_3 SV_t+\alpha_4 \log(CR_t)+\alpha_5 \log(BRW_t)+\alpha_6 IR_t+e_1 \quad (1)$$

$$PVR_t=\beta_0+\beta_1 BBR_t+\beta_2 \log(ATM_t)+\beta_3 SV_t+\beta_4 \log(CR_t)+\beta_5 \log(BRW_t)+\beta_6 IR_t+\beta_7 EG_t+e_2 \quad (2)$$

$$GR_t=\gamma_0+\gamma_1 BBR_t+\gamma_2 \log(ATM_t)+\gamma_3 SV_t+\gamma_4 \log(CR_t)+\gamma_5 \log(BRW_t)+\gamma_6 IR_t+\gamma_7 EG_t+e_3 \quad (3)$$

$$UNM_t=\delta_0+\delta_1 BBR_t+\delta_2 \log(ATM_t)+\delta_3 SV_t+\delta_4 \log(CR_t)+\delta_5 \log(BRW_t)+\delta_6 IR_t+e_4 \quad (4)$$

Where: EG: Economic Growth, PVR: Poverty Rate, GR: Gini Ratio (Income Inequality), t: Period of Observation (2004 – 2019), UNM: Unemployment Rate, BBR: Bank Branches per 100,000 adults, ATM: Automated Teller Machines per 100,000 adults, SV: Net National Savings (% of GNI), CR: Domestic Credit (% of GDP), BRW: Borrowers per 1,000 adults, α, β, γ, and δ: Coefficients, IR: Inflation Rate, and e: Error Terms.

3. Results and Discussion

The estimation results of the SUR FGLS model for the first equation (Eq. 1) related to the access dimension (bank branches) and impact on poverty after applying the system's procedures showed that the model quality reached 0.7539 (Table 2). This indicates that the SUR FGLS model can explain changes in EG at a good level of 75.39%. The results also showed that each one-unit increase in the logarithm of ATMs/adult decreased the poverty rate by 2.16 percentage points ($p < 0.01$), indicating a statistically significant association between increased ATMs and decreased poverty rates. In addition, the effect of bank branches on increased poverty was not significant (0.19, $p < 0.01$). Interest rates were inversely related to poverty levels (-0.118, $p < 0.01$). Finally, financial inclusion indicators (savings, credit, and number of borrowers) were not statistically significant ($p > 0.01$) (Table 2). The results of Eq. 1 show that the impact of FI on EG was not positive, except for bank branches. The ATM variable had a significant negative impact on the poverty rate, while bank branches had a negligible impact on the poverty rate. This result is consistent with the results of a study conducted in Africa (MIGAP et al., 2015) and others conducted in both developed and developing countries (Ductor, 2015). The results of the current study show that FI significantly reduced EG. Furthermore, the results show that increased savings do not always lead to increased GDP growth (Figure 2). In recent years, it has been observed that GDP growth has been slowing in Indonesia. In addition, household consumption contributes to Indonesian GDP. It was found that household consumption expenditures represent 55.74% of GDP, making them a dominant factor in the Indonesian economy (Tempo, 2019).

The results related to the second equation (Eq. 2) of the FI dimensions include an impact on income inequality. The results indicated that credit provision significantly reduces the Gini index (-6.01, $p < 0.05$), while savings significantly reduce income inequality (-0.469, $p < 0.01$). EG had a statistically significant effect on the Gini index (0.705, $p < 0.01$). Conversely, the results of this model showed that financial indicators (branches, ATMs, borrowers, and interest rates) did not significantly affect income inequality. The model quality showed that it reached 0.9889. This indicates that this model can handle changes related to the dimensions of FI at an excellent level of 98.89%, as shown in Table 2. According to the findings from Equation 2, credit provision has a statistically significant impact on per capita income and EG. This relationship may stem from the increased accessibility of loans, which can enhance financial participation and reduce income inequality. Similarly, savings contribute to the reduction of inequality, potentially through the redistribution effects associated with deposit mobilization. These results align with prior empirical studies demonstrating that credit from the financial sector positively influences per capita income growth across both developed and developing economies (King & Levine, 1993; Levine, 1997; Rajan & Zingales, 1998). However, other studies have suggested that when the volume of credit becomes excessively large, it may exert a dampening effect on EG, indicating a nonlinear relationship between credit expansion and economic performance (Samarjandi et al., 2015; Arcand et al., 2012). During a year of monitoring FI levels in Indonesia, it was found that the ratio of financial sector credit to GDP ranged between 30% and 50%. It is worth noting that this level of EG is weak compared to Thailand, Malaysia, and Singapore, where the ratio of financial sector credit to GDP reaches 110% (Kontan.co.id, 2020). This indicates the need to encourage the financial sector to expand in Indonesia. Furthermore, from the second equation, FI has not contributed significantly to the desired level of poverty reduction in Indonesia. This result is inconsistent with the results of a study by Burgess and Pande (2005) but is consistent with a study by Ayensu (2017). Our study confirms that the availability dimension has a significant impact on poverty reduction in Indonesia. This is consistent with several previous studies (Abimbola et al., 2018; Coulibaly & Yogo, 2016; Bakari et al., 2019). The importance of the availability dimension of FI is highlighted by the fact that increasing it leads to an increase in the availability of many financial products, making a country's financial system more inclusive by meeting community needs, thus improving quality of life and reducing poverty (Aini et al., 2020).

Although the results show some negative indicators for some FI variables due to insufficient implementation, it can reduce poverty levels in Indonesia. A gap in FI dimensions between rural and urban areas was found to be 68% and 83%, respectively, according to data from the National Statistics Office (OJK) (ojk.go.id, 2021). Therefore, attention must be paid to expanding financial services in rural areas to increase access.

Regarding the results of the third equation (Eq.3) for the dimensions of FI and their impact on GDP growth, it was observed that bank branches and ATMs enhance GDP growth, and there was a statistically significant relationship between them, with a $p < 0.01$. Financial inclusion also significantly affects the Gini ratio through the dimensions of accessibility and availability. EG was statistically significant in its growth equation. In contrast, the results did not show any statistical significance between EG, borrowers, and interest rates. Eq3 yielded a value of 0.9485, indicating the model's quality. This explains the large variance of the Gini ratio (94.85%).

According to the results of Eq.3, it was observed that the relationship between EG and poverty is inverse. This may be because most of Indonesia's GDP comes from the consumer sector, rather than capital formation or the investment sector. Therefore, the quality of EG was not sufficient to reduce poverty. In addition, interest rates did not have a significant impact on poverty reduction. This may be because interest rates are one of the most important monetary policies, and this monetary policy has not played an effective role in addressing and reducing poverty in Indonesia (Prakarsa, 2019). In addition, the results of Eq.3 found that financial inclusion, through the availability

dimension, can significantly reduce EG inequality within a society, although its impact on poverty reduction was not significant. This result is consistent with the results of a study by Nazara et al. (2021) and another study by Erlando et al. (2020). The results of this study confirmed that FI can achieve equal income distribution in Indonesia, which contributes to achieving the Sustainable Development Goals. Although the Gini ratio was high (0.3-0.5) according to World Bank data, the Gini ratio has begun to decline in recent years.

While the results of the fourth equation (Eq.4) indicate that both access and availability dimensions have an impact on unemployment, it was observed that increasing the number of ATMs significantly reduces unemployment, meaning there is a statistically significant relationship between them, with a p-value <0.01. However, increasing the availability of credit leads to an increase in unemployment (p-value <0.05). Finally, bank branches, savings, borrowers, and interest rates showed no significant effect on unemployment, as there was no statistically significant relationship between them ($p > 0.01$). The model's quality of fit for this equation was 0.9729, indicating its high ability to explain 97.29% of the variance in unemployment.

Finally, the results of the fourth equation indicate that the dimensions of FI do not significantly reduce unemployment, except for the access dimension, which is represented by the increase in the number of ATMs, which led to a significant reduction in unemployment levels in Indonesian society. This result is consistent with the results of a study conducted by The Economist (2011), which reported that the increase in the number of ATMs could create many new jobs, such as ATM guards and maintenance officers. Conversely, bank branches did not have a significant impact on unemployment. This may be due to the development of digitalization in Indonesia, which has led to a decline in financial inclusion, as individuals now conduct their financial transactions via banking services on their phones or through ATMs without having to visit a bank branch.

Likewise, credit was found to significantly increase unemployment levels. This is because credit disbursed in Indonesia is more consumer credit than working capital. This result is consistent with the results of a study conducted by Dwiastuti (2020).

Table 2: Shows the Estimation Results from Equations (Eq 1–Eq 4) of the SUR Model FGLS.

Variable	Eq 1: Poverty Rate (Coeff.)	Eq 2: Gini Index (Coeff.)	Eq 3: GDP Growth Rate (Coeff.)	Eq 4: Unemployment Rate (Coeff.)
BBR (Bank Branches) Coeff.	0.1921 (0.0070)***	-0.1094 (0.0675)	0.0048 (0.0002)***	-0.0842 (0.0723)
LogATM (ATMs per adult) Coeff.	-2.1560 (0.0026)***	-0.2469 (0.6719)	0.0271 (0.0202)***	-1.2625 (0.0087)***
SV (Savings) Coeff.	0.0639 (0.3956)	-0.4693 (0.0000)***	-0.0053 (0.0003)***	-0.0910 (0.0877)
LogCR (Credit) Coeff.	6.0785 (0.0862)	-6.0139 (0.0420)***	-0.1578 (0.0111)***	5.5283 (0.0273)***
LogBRW (Borrowers) Coeff.	0.0919 (0.8574)	-0.0061 (0.9880)	-0.0013 (0.8750)	-0.2900 (0.4154)
IR (Interest Rate) Coeff.	-0.1176 (0.0066)***	0.0206 (0.5577)	0.0003 (0.6199)	-0.0391 (0.1636)
EG (Economic Growth) Coeff.	----	0.7048 (0.0000)***	0.0095 (0.0000)***	----
Intercept Coeff.	-13.0304 (0.3470)	38.9222 (0.0016)***	0.8468 (0.0012)***	-6.7338 (0.4797)
Model fit R^2	0.754	0.989	0.949	0.973

Significance: *** p < 0.01; ** p < 0.05; * p < 0.10; n.s. = not significant.

The normal distribution of the model residuals was assessed and determined using the Cholesky test (a multivariate Jarque-Bera test with its components skewness and kurtosis) (Table 3). The probability values for all three tests were greater than 0.05, indicating that these tests exceeded the standard significance level. The skewness and kurtosis components showed p=0.4302 and p=0.9591, respectively. This indicates that the tails of the model residual distribution do not exhibit statistically significant asymmetry. This confirms that the distribution of the residuals is normally distributed. Similarly, the Jarque-Bera test showed a probability value of 0.8134, indicating that the model residuals in this study follow a multivariate normal distribution.

Table 3: Shows the Jarque–Bera Test with Skewness and Kurtosis (Cholesky Normality Test)

Test	Chi^2	df	p-value
Skewness	3.8251	4	0.4302
Kurtosis	0.6349	4	0.9591
Jarque–Bera	4.4601	8	0.8134

From Figure 5, the results show that the SUR model performs resiliently and well in explaining the dimensions of financial inclusion, including EG and GDP growth rates. This is evident in the presence of small, randomly distributed residuals. However, the results show that the unemployment and poverty equations have more pronounced and larger variances in the residuals, suggesting the possibility of omitted variables or nonlinear dynamics in these dimensions. It is worth noting that the plots in Figure 5 support the assumptions of the SUR model and confirm its validity, particularly the assumptions of linearity and independence of the residuals. This is demonstrated by the absence of trends or systematic bias in these plots.

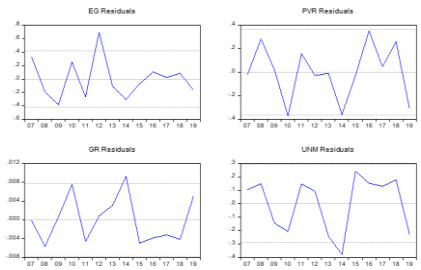

Fig. 5: Displays the Time Series of Residuals for (Eq. 1–Eq. 4) Estimated by the SUR Model.

4. Conclusion

This study investigated the impact of FI on economic growth, poverty reduction, and income inequality in Indonesia using the Seemingly Unrelated Regression (SUR) model. The findings indicate that, contrary to expectations, financial inclusion—when considered as a whole—does not exert a statistically significant positive effect on EG. However, a more nuanced analysis reveals that individual dimensions of FI yield varying effects. Specifically, the availability dimension (measured through indicators such as savings and credit provision) demonstrates a significant and favorable impact on poverty alleviation and the reduction of income inequality. This suggests that enhancing the availability of financial products and services can improve social equity and contribute to inclusive development. In contrast, the accessibility (e.g., the number of bank branches and ATMs) and usability (e.g., loan usage) dimensions show no significant relationship with EG or poverty reduction in the Indonesian context. These findings underscore the importance of targeting the most effective components of financial inclusion—particularly the availability of services—when designing policy interventions. Moreover, the results highlight the need to address regional disparities, especially between rural and urban areas, to ensure that FI translates into broader and more equitable development outcomes. Future research should consider expanding the dataset, incorporating non-linear effects, and exploring institutional factors that may moderate the relationship between FI and economic indicators.

5. Limitation and Recommendation

Given the importance of financial inclusion for any country seeking development in various fields, especially EG and poverty reduction, we conducted this study. However, there were some shortcomings. Therefore, we propose a set of recommendations for future studies specializing in financial inclusion, as follows:

It is necessary to pay attention to the factors influencing GDP growth and give them top priority, such as capital formation, developing the consumer sector, increasing investment, and promoting savings habits.

We recommend the need to focus on expanding access and support within the country through the application of technology to accelerate and support FI processes. These processes are accelerated by implementing a digital payment system to facilitate access to financial services for marginalized groups and provide various services that contribute to increasing the growth of the digital economy.

Banks and their branches must provide lower-cost credit that most small entrepreneurs can access.

Given the limitations facing research in the financial and economic field, we recommend that researchers focus on financial concepts and variables, such as financing, because expanding their circulation and understanding by members of society leads to enhanced financial inclusion.

The scope of FI studies must be expanded. Indonesia, so that future studies include all provinces and provide information that clarifies its financial and economic situation.

We recommend that decision-makers, policymakers, and officials in Indonesia increase their efforts to facilitate access and provide FI programs equitably across all regions, making access to and use of financial services easy and accessible.

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