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Assessing the Dynamic Effects of Macroeconomic factors and Financial Inclusion on Poverty: Evidence from an ARDL Approach

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ABSTRACT

Background: Poverty is still a hot topic in economic growth, especially in developing countries such as Indonesia. In recent years, the advancement of digital infrastructure play an important role to poverty alleviation.

Aims: This research investigated the shortrun and longrun effects variables on poverty levels in Indonesia, This research was conducted in Indonesia, using data from 2001 to 2024 obtained from various sources.

Methods: This research adopts a quantitative methodology with an exploratory–causal research design to investigate the dynamic relationships among variables. The Autoregressive Distributed Lag model is employed due to estimating dynamic relationships. The aim to examine the short-term and long-term relationships between variables

Result: The findings indicate that in the long run, per capita income, inflation, and internet penetration have a significant impact on poverty levels. However, internet penetration shows a unidirectional relationship with increasing poverty, while financial inclusion is not significant. The short run shows a delayed effect of each variable on poverty, except that internet penetration has no significant effect.

Conclusion : This study analyzes the impact of each variable on poverty reduction in Indonesia in the short and long term. Per capita income, inflation, and internet penetration are important variables for long-term poverty reduction.

Implication : The results of this study contribute to the literature that shows the importance for the government to increase revenue, maintain price stability and improve digital infrastructure followed by skills development, and productive internet use among vulnerable populations.

Keywords: Poverty; Financial inclusion; Economics; Digital, GDP

1. Introduction

Poverty remains one of the most persistent and complex socio-economic challenges in developing countries, including Indonesia. Despite substantial progress in economic growth and social development over the past three decades, a significant proportion of Indonesia's population continues to live at or below the poverty line. As of 2023, approximately 9.36 percent of Indonesians were classified as poor, with poverty disproportionately concentrated in rural areas and among vulnerable groups such as informal workers and women (BPS 2023). One of the key contributing factors to this persistent poverty is the lack of adequate access to financial resources, (Álvarez-Gamboa et al., 2021)

In developing economies, financial exclusion can be addressed by expanding financial infrastructure and improving access to financial services. Digital financial services, in particular, have shown the potential to reach underserved populations who have historically been excluded from conventional banking systems. Recent research (Azmeh, 2025), using panel data from 108 developing countries, demonstrates that digital financial inclusion has a significant poverty-reducing effect.

Access to financial resources or financial inclusion is widely recognized as a crucial enabler of poverty alleviation and economic growth in low-income countries (Cicchiello et al., 2021);(Lannquist, 2023). Marginalized groups, especially the urban poor, benefit significantly from access to financial services, as it enables the mobilization of critical resources, particularly financial capital, thereby enhancing opportunities for inclusive development and more equitable resource distribution (Erlando et al., 2020); (Lannquist, 2023). The World Bank defines financial inclusion as the availability and effective use of formal financial services by all segments of society, particularly the poor and underserved.

A growing body of literature has documented the potential of inclusive finance to promote savings, reduce vulnerability, support investment in human capital, and improve household resilience (Tabash et al., 2024); (Azmeh, 2025)(Allen et al., 2021). Financial services are considered inclusive when they are both accessible and adequate for all population segments, particularly those historically excluded from formal financial systems ((Koranteng & You, 2025); (Osuma, 2025). Over the past decade, financial inclusion has gained prominence as a tool to combat poverty by enabling individuals and households to access a broad spectrum of financial products, including savings, credit, insurance, and digital payment services (Omar & Inaba, 2020);(Johnen et al., 2025)

However, despite broad acknowledgment of the positive link between financial inclusion and poverty reduction, the causal and dynamic mechanisms through which inclusion affects entrenched poverty remain underexplored. Indonesia presents an important case for examining this relationship. On one hand, the country has made significant progress in expanding access to formal financial services. According to the Global Findex Database (word bank) 2022, more than 76% of Indonesian adults now own a formal bank account, a dramatic increase from just 20% in 2011. On the other hand, structural issues such as regional inequality, informality, low financial literacy, and

limited internet access due to underdeveloped infrastructure continue to undermine the transformative potential of inclusion.

Moreover, most existing studies rely on static or linear models, assuming a stable relationship between financial inclusion and poverty over time. Such assumptions overlook structural shifts driven by financial reforms, digital innovations (e.g., fintech), or macroeconomic shocks like the COVID-19 pandemic. The uneven distribution of internet infrastructure further complicates equitable access to digital finance, especially in remote areas. Nevertheless, studies provide empirical evidence that internet penetration increases household income and reduces poverty incidence in Vietnam. Similarly, (Huang et al., 2023), argue that internet access can help reduce regional inequality by improving the spatial distribution of opportunities.

Although previous studies confirm the positive relationship between financial inclusion and poverty alleviation, several important limitations remain. First, many studies rely on cross-sectional or short panel data, which are insufficient to capture the long-term dynamics of poverty. Second, most models treat the inclusion–poverty nexus as linearly stable, ignoring potential non-linear effects or thresholds. Several research (Muliantari and Auwalin, 2026; Fitriatinnisa, Khoirunurrofik, 2021; Inoue, 2024) conducted research on financial inclusion and poverty in Indonesia using panel data methods, spatial econometrics, SEM, and dynamic panel GMM. Third, few studies employ robust time-series methods to test whether financial inclusion can disrupt the persistence of poverty especially in Indonesia.

Several empirical works have advanced our understanding of the role of financial inclusion in poverty reduction. For instance, (Park dan Mercado ,2018) using panel data from multiple Asian countries, identified a negative relationship between financial inclusion and poverty rates. Similarly, (Marcelin & Sun, 2025) documented the positive impact of inclusive finance in reducing poverty across South Asia. However, these studies tend to assume temporal homogeneity and do not examine how financial shocks, institutional reforms, or digitalization may reshape poverty dynamics over time. Furthermore, few studies investigate whether financial inclusion can effectively break the poverty trap a situation in which poverty is not a temporary state but a stable equilibrium. As (Johnen et al., 2025) note, overcoming poverty traps requires structural changes to household income dynamics, rather than short-term income support. Financial inclusion, if well-structured and equitably distributed, has the potential to serve as a transformative policy tool. Nevertheless, empirical evidence on the specific pathways through which this transformation occurs remains limited, particularly in the context of Indonesia.

This study adopts a dynamic approach to the poverty trap, emphasizing adjustment processes toward long-run equilibrium. Unlike previous research that evaluates poverty reduction as a level change using static models, our approach distinguishes between short-run and long-run effects and captures temporal persistence. Specifically, this paper investigates whether financial inclusion can alter the long-term dynamics of poverty, thereby addressing the issue of chronic or structural poverty. The central question is not merely whether inclusion reduces poverty, but whether it fundamentally changes the conditions that sustain poverty over time.

Investigating the impact of per capita GDP, inflation, financial inclusion, and internet penetration on poverty reduction offers both academic and practical contributions, particularly

within the development context of countries like Indonesia. Academically, this study enriches the existing literature by providing updated empirical evidence on how these macroeconomic and structural variables influence poverty. Practically, the findings are expected to inform and support government efforts in designing effective poverty reduction strategies that are evidence-based and context-sensitive. The paper proceeds as follows: Section 2 presents a review of the relevant theoretical and empirical literature. Section 3 outlines the empirical methodology, including data measurement, variable construction, and the analytical framework employed to assess both short-run and long-run effects. Section 4 discusses the empirical results and provides a comprehensive interpretation. Section 5 concludes the paper with a summary of the findings and their implications for policy and future research.

2. Literature Review

2.1. Empirical Evidence on the Impact of Economic Growth on Poverty

Poverty and economic growth remain central themes in development economics. Numerous studies have examined the relationship between these two phenomena, with financial inclusion frequently emerging as a key mechanism linking economic growth and poverty reduction (Nizam et.al, 2020); (Andini, 2009); (Hussain et. al, 2024). Many governments in developing countries express concern over uneven financial infrastructure, which may hinder both inclusive growth and poverty alleviation efforts. (Nizam, et.al, 2020), using dynamic panel data across countries, found a strong association between financial sector development and economic growth, emphasizing the role of financial intermediaries in facilitating access to credit and services. Improved access to banking services contributes to poverty alleviation and enhances human development outcomes, such as health and education.

Internet penetration, in tandem with financial inclusion, has also been shown to promote income distribution and inclusive development (Briano-Turrent, 2025). These findings support the argument that in developing countries, financial inclusion must be actively promoted through public policy, particularly in rural areas where poverty is most prevalent. Access to banking and financial services helps rural populations improve their standard of living by enabling them to mobilize capital for productive use.

The Inclusive Intermediation Theory (Mishra et.al., 2024), argues that the effectiveness of the financial system in promoting economic growth depends not only on the depth and efficiency of financial intermediation, but also on accessibility, equality of access, and active use by all segments of society, especially the previously excluded. Meaningful inclusion requires financial services to be geographically and digitally accessible, affordable to vulnerable groups, and tailored to user needs—such as small-scale farmers, MSMEs, and women (Tabash et al., 2024).

An inclusive financial system not only improves capital allocation efficiency but also acts as a mechanism for institutionalizing economic equity by broadening access to productive assets, enabling risk management, and empowering poor households. The long-term outcome is a reduction in structural and multidimensional poverty, not merely a temporary increase in income. Financial inclusion provides access to savings, microloans, digital payments, and insurance helping

the poor avoid informal debt traps, plan for the future, and better cope with economic shocks , (Siddiki & Bala-Keffi, 2024).

In developing countries, the relationship between poverty and financial inclusion has attracted significant interest. Access to financial services is increasingly viewed as a powerful tool for accelerating poverty reduction, particularly in the Global South ((Allen et al., 2021; Sawadogo & Semedo, 2021). In many cases, financial exclusion has exacerbated poverty by limiting people's ability to leverage financial tools to build income sources (Ogunleye T S, 2017)

Digital financial services, including mobile banking and e-finance platforms, have enabled SMEs and underserved populations to participate in the formal financial system, which contributes to poverty alleviation (Osabutey & Jackson, 2024). A certain level of economic growth is needed to stimulate financial inclusion, and studies such as (Afonso & Blanco-Arana, 2024; Johnen et al., 2025) confirm that financial inclusion positively affects per capita income in low-income countries, especially through expanded access to digital financial services in rural areas. In Indonesia, (Fitriatinnisa, Khoirunurrofik, 2021) found that financial inclusion, measured by access dimensions such as account ownership and service utilization, significantly reduces poverty, particularly when considering access indicators. The report contrasting findings financial inclusion did not significantly reduce poverty in 2015, likely due to low financial inclusion scores at the time. (Ibrohim et al., 2025) examined latent variables of financial inclusion that affect economic growth, such as debit card ownership, credit card usage, and e-money use, while (Ayu Az Zahra & Ajija, 2023), analyzing data from 34 Indonesian provinces, found that indicators such as the savings-to GDP ratio and third-party funds have a significant impact on inclusive economic growth, although the number of bank branches did not.

2.2. Per Capita Income, Inflation, and Poverty Reduction

The relationship between per capita income and poverty alleviation especially in developing countries has been widely studied. (Ozili et al., 2023) found a strong positive relationship between per capita GDP and poverty reduction in low-income countries. Similarly, (Erlando et al., 2020; Hussain et al., 2024), using panel data from 21 Asian countries (2004–2019), observed a strong negative effect of economic growth on poverty, particularly in developing economies. For poor populations to escape poverty and achieve empowerment, sustained economic growth is essential (Busra et al., 2019).

Increasing per capita income, especially for vulnerable rural populations, requires government support in the form of infrastructure development, including financial infrastructure and access to credit. Many rural communities rely on agriculture and informal trade, and access to capital is critical for their daily economic activities. Economic growth can also generate employment opportunities, which in turn provide income for poor households.

Inflation has long been regarded as a macroeconomic factor influencing poverty, especially in developing countries. Rising prices reduce purchasing power, disproportionately affecting low-income households. However, recent findings indicate that the impact of inflation on poverty is not linear and varies depending on social context and income distribution.

Investigated the impact of exchange rates, economic growth, and inflation on extreme poverty from 2003 to 2023 In Indonesia, confirm that inflation worsens conditions for vulnerable groups by sharply reducing purchasing power. also concluded that inflation contributes to income inequality at low to moderate levels (Puspitasari et al., 2024).

As outlined, the relationship between per capita income, inflation, financial inclusion, and internet penetration is strongly linked to poverty reduction. While some studies offer divergent findings, the majority of the literature suggests that these variables have significant impacts on poverty, particularly in developing. Financial inclusion stands out as a key policy tool to combat rural poverty, However, successful inclusion requires adequate infrastructure, including equitable internet access. Uneven internet penetration hampers the delivery of digital financial services. Moreover, uncontrolled inflation can have detrimental effects, as shown by several studies in Indonesia (Puspitasari et al., 2024) confirming its role in deepening poverty.

2.3 Hypotesis and Conceptual Framework

Based on these theoretical arguments, the following hypotheses are formulated as follow:

H1 : Financial inclusion has a negative and significant effect on poverty in Indonesia.

H2 : penetration has a negative and significant effect on poverty in Indonesia.

H3 : Per capita income has a negative and significant effect on poverty in Indonesia.

H4 : Inflation has a positive and significant effect on poverty in Indonesia.

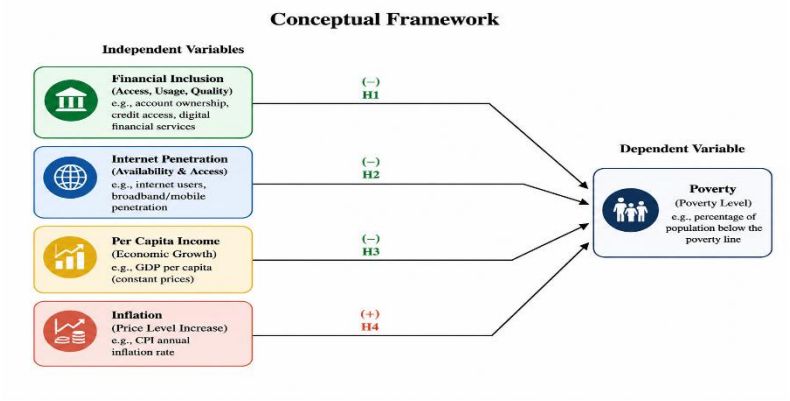


Figure 1. Conceptual Framework

3. Methods

3.1. Research Design

This study employs a quantitative approach with an exploratory-causal research design, aiming to analyze the dynamic relationship between per capita GDP, inflation, financial inclusion, internet penetration, and poverty rates in both the short and long run. The Autoregressive Distributed Lag (ARDL) model is adopted due to its ability to estimate dynamic models with small sample sizes, its flexibility in handling variables with mixed integration orders I(0) and I(1), and its

capacity to mitigate simultaneity bias through the inclusion of lag structures (Daly et al., 2024);(Soufiene et al., 2024).

3.2. Data Type and Sources

This research utilizes annual time series data spanning the period from 2001 to 2024, chosen based on the availability and consistency of data across all variables of interest.

Table 1. Type Of Data.

Variable	Code	Measurement	Measurement Scale	Source
Poverty Rate	POV	Annual percentage of people living below the poverty line	%	BPS, World Development Indicators (WDI)
Per Capita GDP	GDP	GDP per capita (in natural logarithm)	Ratio	BPS, Ministry of Finance
Financial Inclusion	IFI	Index of access to and usage of financial services	%	SNLIK, WDI
Internet Penetration	PI	Percentage of population with internet access	%	SNLIK, WDI
Inflation	INF	Annual inflation rate	%	BPS Indonesia

3.3. Estimation technigue

Prior to model estimation, it is essential to ensure that the data fulfill the requirements for ARDL analysis. The stationarity of each time series variable is tested using the Augmented Dickey-Fuller (ADF) test, specified as follows:

$$\Delta Y_t = \beta_0 + \delta Y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta Y_{t-i} + \epsilon_t \ (1)$$

Following this, the optimal lag length for each variable is determined using selection criteria such as the Akaike Information Criterion (AIC) or Schwarz Bayesian Criterion (SBC). Given that ARDL is employed to capture both short-run and long-run dynamics, cointegration testing is required and is conducted using the Bounds Testing Approach.

Subsequent diagnostic tests are performed to verify that the classical linear regression model assumptions are satisfied (BLUE), including:

- Serial correlation: Breusch-Godfrey LM test
- Heteroskedasticity: White's test
- Normality: Jarque-Bera test

Model stability: CUSUM and CUSUMQ tests (Awan & Yaqoob, 2023).

3.4 Model Specification

The general functional form of the ARDL model is given by:

$POV_t = fCap_{GDP}{}_t, IFI_t, Int_Pen_t, Infl_t$…….

This can be expressed as a linear regression model

$$POV_{t=} \propto_0 + \propto_1 Cap_GDP_t + \propto_2 IFI_t + \propto_3 Int_Pen_t + \propto_4 Infl_t + \in_t$$

he general ARDL (p, q_1, q_2, q_3, q_4) specification is formulated as:

$$POV_t = \beta_0 + \sum_{i=1}^{p} \beta_1^{(i)} POV_{t-i} + \sum_{j=0}^{q1} \beta_2^{(j)} Cap_{GDP_{t-j}} + \sum_{k=0}^{q2} \beta_3^{(k)} IFI_{t-k} + \sum_{i=0}^{q3} \beta_3^{(i)} Int_{Pen_{t-i}} + \sum_{i=0}^{q4} \beta_4^{(l)} Infl_{t-l} + \epsilon_t$$

If a long-run relationship exists among the variables, an Error Correction Model (ECM) is estimated to assess short-run dynamics:

$$\Delta POV_t = \gamma_0 + \sum_{i=1}^{p} \gamma_1^{(i)} \Delta POV_{t-i} + \sum_{j=0}^{q1} \gamma_2^{(j)} \Delta Cap_GDP_{t-j} + \sum_{k=0}^{q2} \gamma_3^{(k)} \Delta IFI_{t-k} + \sum_{i=0}^{q3} \gamma_4^{(i)} \Delta Int_Pen_{t-i} + \sum_{k=0}^{q4} \gamma_5^{(l)} \Delta Infl_{t-l} + \gamma + \mu_t$$

Where:

- POV = Poverty rate
- Cap_GDP = GDP per capita
- IFI = Financial Inclusion Index
- Int_Pen = Internet Penetration
- Infl = Inflation rate
- Δ = First-difference operator
- γ$ECT_{(t-1)}$) = Error Correction Term from the long-run equation
- λ = Adjustment coefficient (expected to be negative and significant)

3.5. ARDL Estimation Steps

The estimation proceeds through the following sequential steps:

- Unit Root Test: Confirm the stationarity of each variable using ADF to ensure variables are I(0) or I(1), but not I(2).
- Lag Selection: Determine optimal lag length based on AIC or SBC.
- Cointegration Test: Employ the Bounds Testing Approach to verify the existence of a long-run relationship.
- ARDL Model Estimation: Estimate both long-run and short-run parameters using the ARDL framework.
- Diagnostic Checking: Conduct residual diagnostics to ensure model robustness.
- Model Stability: Test parameter stability using CUSUM statistics.

4. Results

4.1. Descriptive Statistics

Table 2 presents the descriptive statistics for each variable used in this study, including the mean, median, minimum, maximum, standard deviation, skewness, and kurtosis. The average value

of GDP per capita (Cap_GDP) is 1.06, with a standard deviation of 0.28. The financial inclusion index (IFI) has a mean of 51.69 and a standard deviation of 14.50, indicating a moderate variation across the data. The average poverty rate (POV) is 56.57, with a relatively high standard deviation of 208.73, suggesting substantial dispersion in the poverty variable. The mean value of internet penetration (Int_Pen) is 24.25, accompanied by a standard deviation of 25.28, while the inflation rate (Infl) averages 5.49 with a standard deviation of 3.20. In terms of distribution, skewness and kurtosis values show that the poverty variable is highly skewed and leptokurtic, indicating a non-normal distribution, whereas other variables exhibit moderate deviations from normality

Table 2. Discriptive Statistic.

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
POV	13.25	12.36	19.14	8.95	3.12	0.45	2.10
Infl	5.49	4.30	11.50	1.57	3.20	0.53	1.97
IFI	51.69	52.40	72.80	30.00	14.50	-0.05	1.49
Int_Pen	24.25	14.50	78.20	2.02	25.28	1.11	2.89
Cap_GDP	1.06	1.07	1.58	0.62	0.28	0.11	1.94

4.2. Augmented Dickey-Fuller (ADF) Unit Root Test

To examine the stationarity properties of the time series data, the Augmented Dickey-Fuller (ADF) test was employed. Stationarity refers to the condition where statistical properties of a variable such as mean and variance remain constant over time. Identifying stationarity is a critical step in time series analysis, as non-stationary variables can lead to spurious regression results. In the table 3 summarizes the results of the ADF test at both level and first difference. The results indicate that:

- Cap_GDP is non-stationary at level but becomes stationary after first differencing at the 5% significance level.
- POV and Inflation are stationary at level at the 5% significance level.
- IFI is stationary after first differencing at the 1% level.
- Internet Penetration (Int_Pen) becomes stationary at first difference as well.

These results suggest that some variables are integrated of order zero, I(0), while others are integrated of order one, I(1). None of the variables are integrated of order two, I(2), which satisfies the necessary condition for applying the ARDL (Autoregressive Distributed Lag) modeling approach.

Table 3. Results of the Augmented Dickey-Fuller Unit Root Test.

Variable	Variables Augmented Dickey Fuller Test (at level)	Augmented Dickey Fuller Test (at 1st difference)
POV	0.0009	0.0025
Cap_ GDP	0.9691	0.0014
IFI	0.9001	0.0001
Int_Pen	0.9996	0.0347
Infl	0.0443	0.0001

Sources: Based on Authors' calculations.

The mixed order of integration confirms the appropriateness of the ARDL methodology for further empirical estimation. (Pesaran, 2001), ARDL Bounds Test approach can be used on a combination of variables I(0) and I(1), because the lower limit value is given for variable I(0) while the upper limit is given for variable I(1).

4.3. Optimal Lag Selection

Determining the optimal lag length is an essential component of time series analysis. The number of lags determines how many past values of the variables are included in the model, which can affect both the accuracy and the explanatory power of the results. An insufficient lag may overlook important dynamics, while excessive lag length may result in overfitting, particularly when sample size is limited. To determine the optimal lag, this study utilized the Akaike Information Criterion (AIC). Based on the information criteria

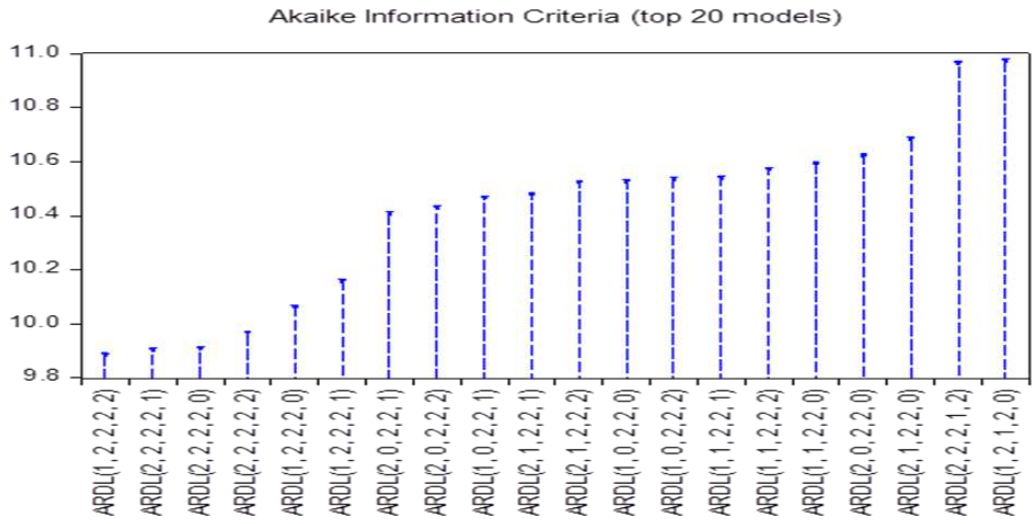


Figure 2. Optimal Lag Selection.

Therefore, the lag length according to Figure 2 above is ARDL (1,2,2,2,1) as the upper limit in the ARDL model construction. This selection aims to provide the model with sufficient flexibility to

automatically determine the appropriate lag length for each endogenous and exogenous variable based on the underlying data structure and dynamic relationships between the variables. The use of this maximum lag also supports the consistency of short-term and long-term estimates in subsequent stages, including cointegration testing through Bounds Tests and the development of Error Correction Models (ECMs).

The choice of optimal lag length based on information criteria establishes a solid foundation for the ARDL model, ensuring that it is not only accurate but also econometrically valid in capturing the dynamic relationships among poverty (POV), economic growth (Cap_GDP), financial inclusion (IFI), internet penetration (Int_Pen), and inflation in Indonesia.

4.4. Cointegration and Bounds Test

The Bounds Test, developed by (Pesaran, 2001) is employed to examine the presence of a long-run equilibrium relationship (cointegration) among the variables in the ARDL framework, regardless of whether the variables are stationary at level I(0) or first difference I(1). A confirmed cointegration relationship permits the estimation of both long-run parameters and the error correction model (ECM) to capture short-run dynamics.

Table 4 reports the results of the Bounds Test. The F-statistic value is 35.09948, which exceeds both the upper bound I(1) and lower bound I(0) critical values at all conventional significance levels. This strongly indicates the existence of a cointegrating relationship within the model

Table 4. Results of the Bounds Test.

Test Statistic	Value	Significant Level	I (0) bound	I (1) Bound
F- Statistic	35.0995	10 %	2.2	3.09
K	3	5 %	2.56	3.49
		2,5 %	2.88	4.87
		1 %	3.29	4.37

Sources: Based on Authors' calculations.

Based on the residual plot of the cointegration equation, the long-term relationship among the variables in the ARDL model remained relatively stable during the period from 2002 to 2019. However, there were notable extreme fluctuations in 2021–2022, which likely reflect the impact of external shocks such as the global pandemic. Despite these short-term disturbances, the residuals returned toward zero in subsequent years, indicating that the long-run adjustment mechanism continued to function effectively.

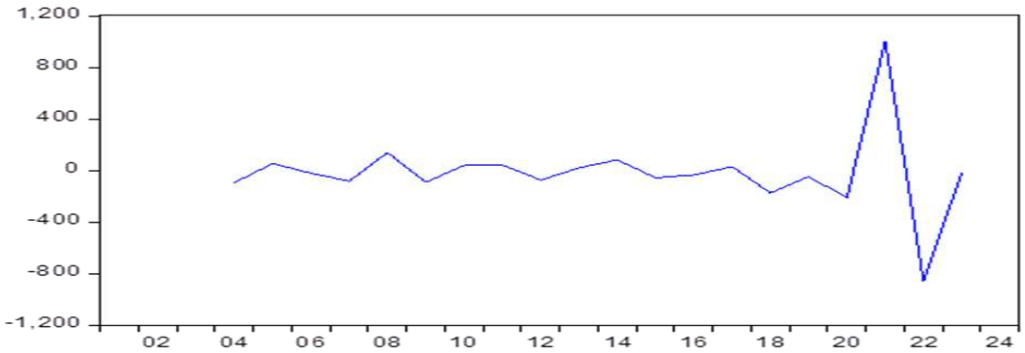


Figure 3. Plot of Cointegration residual.

4.5. Diagnostic Test

Diagnostic testing is essential in regression analysis as it helps to verify whether the classical assumptions of regression are satisfied. Table 5 presents the results of diagnostic tests, including normality test, heteroscedasticity test, autocorrelation test, and stability test (CUSUM test).

Table 5. Diagnostic Test Results.

Test type	F-Statistic	Obs*R-Squared	Probability	Jarque -Berra
Normality			0.318873	2.285926
Heteroscedastisity	0.546754	10.84515	0.5617	
Otocorelasi	5.220326	14.46008	0.0767	

Sources: Based on Authors' calculations.

The diagnostic results indicate that the model does not suffer from heteroscedasticity, as the F-test is not significant ($p > 0.05$), implying no evidence of heteroscedasticity. Similarly, the Chi-square test is not significant ($p > 0.05$), reinforcing the F-test result. The autocorrelation test also shows no significant autocorrelation at the 10% significance level ($\alpha = 0.1$), This can still be used even though it has limited influence on inference, confirming the absence of autocorrelation in the model residuals. Furthermore, the model residuals are normally distributed, as evidenced by the Jarque-Bera test p-value exceeding 0.05. The model stability is assessed via the CUSUM test, which is depicted in Figure 4.

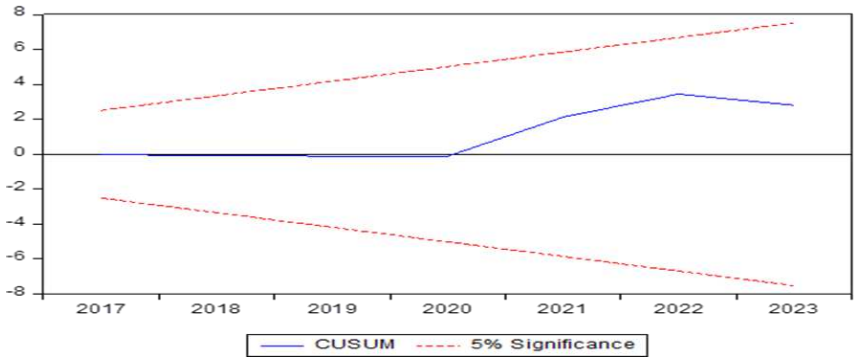
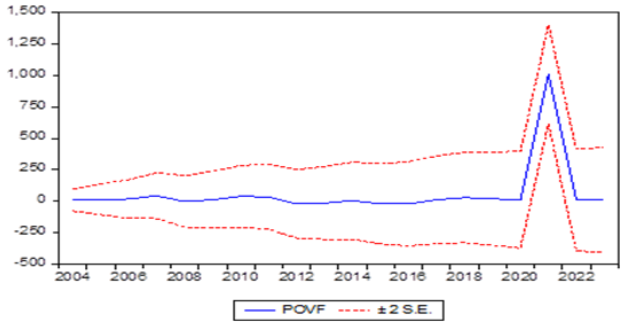


Figure 4. Results of the Cusum test.



Forecast: POVF	
Actual: POV	
Forecast sample: 2001 2024	
Adjusted sample: 2004 2023	
Included observations: 20	
Root Mean Squared Error	18.27309
Mean Absolute Error	13.73813
Mean Abs. Percent Error	114.3116
Theil Inequality Coefficient	0.040291
Bias Proportion	0.053653
Variance Proportion	0.000852
Covariance Proportion	0.945495
Theil U2 Coefficient	0.066939
Symmetric MAPE	85.37792

Figure 5. Forecasting test.

4.6. CUSUM Test Results

The CUSUM (Cumulative Sum Control Chart) test is employed to detect structural parameter changes within a regression model for example, to assess whether the regression coefficients remain stable over time or exhibit signs of a structural break. The CUSUM line (in blue) remains within the 5% significance bounds throughout the entire observation period. This indicates that the regression model is stable and does not experience any statistically significant structural changes during the observed period.

4.7. ARDL Test Results

The ARDL test is conducted to examine both the short-run and long-run relationships of the estimated model. Table 6 presents the ARDL estimation results. In the short run, several variables exhibit varying effects on poverty reduction, with only a few showing statistically significant impacts. Notably, the Financial Inclusion Index (IFI) at lag 2 has a negative and statistically significant effect on poverty, indicating that improvements in financial inclusion two periods earlier contribute to poverty reduction in the current period. This finding aligns with existing literature suggesting that access to financial services enables low-income populations to engage in productive activities and invest in human capital (Sarma & Pais, 2023). The effect of financial inclusion is not instantaneous but requires a lag of two periods to manifest.

Per capita income exhibits a mixed impact, suggesting a non-linear relationship between income and poverty levels in the short run. An increase in current per capita income correlates positively with poverty, implying that the initial phases of economic growth are not immediately beneficial for low-income groups. Conversely, per capita income at lag 1 significantly reduces poverty, while the reappearance of a positive effect at lag 2 suggests possible inequality in the distribution of growth benefits. This supports the notion that the economic advantages of growth are only gradually transmitted to the poor a phenomenon consistent with the delayed trickle-down effect. These findings underscore the importance of promoting inclusive and equitable economic growth, rather than focusing solely on growth figures.

is found to have a positive and statistically significant effect at lag 2, indicating that rising inflation may exacerbate poverty. This is consistent with the general view that disproportionate inflation is particularly detrimental to low-income households

Table 6. Short term ARDL estimation test.

Variable	Coefficient	Standard Error	t-Statistic	Probability
C	143.3158	64.31735	2.228261	0.0611
D(POV(-1))	-0.105463	0.157456	-0.669796	0.5245
D(IFI)	2.687108	4.856637	0.553286	0.5973
D(IFI(-1))	-4.703049	5.347433	-0.879496	0.4083
D(IFI(-2))	-17.45414	5.029004	-3.470696	0.0104*
D(Cap_GDP)	29.82443	48.30970	6.100481	0.0005*
D(Cap_GDP(-1))	-10.9953	34.79121	-8.768610	0.0001*
D(Cap_GDP(-2))	45.2561	79.78486	2.539891	0.0387*
D(Int_Pen)	-2.222181	6.717113	-0.330824	0.7505
D(Int_Pen(-1))	10.00513	7.621469	1.312756	0.2307
D(Infl)	2.162278	4.769288	0.453376	0.6640
D(Infl(-1))	6.647396	4.846484	1.371591	0.2125
D(Infl(-2))	11.05134	4.214204	2.622404	0.0343*
CointEq(-1)*	-0.705463	0.058180	-19.00061	0.0000*
R-Squared	0.815427			
Adjusted R-Squared	0.807587			
F-Statistic	105.9716			
Prob (F-Statistic)	0.000001			

Sources: Based on Authors' calculations

Note: * Significant at 5 percent
** Singificant at 10 percent

4.8. Long-Run Relationship

The cointegration results from the ARDL model indicate a significant long-run relationship between poverty (POV) and the explanatory variables, as evidenced by the coefficient of the error correction term, CointEq(-1), which is -0.705463 and statistically significant at the 1% level (p = 0.0000). The negative and significant coefficient indicates the presence of an adjustment mechanism toward long-run equilibrium. From an econometric perspective, this implies that any deviation from the long-run equilibrium relationship will be corrected by approximately 70.5

percent within a single period. In other words, the system will adjust back to its equilibrium path in less than a year. This finding highlights the system's responsiveness to short-term economic shocks and its strong tendency to return to long-run equilibrium

Table 7. long run ARDL estimation result.

Variable	Coefficient	Standard Error	t-Statistic	Probability
Infl	17.96624	11.25807	2.595854	0.0446*
IFI	-17.61260	11.10430	-1.586106	0.1567
Cap_GDP	-22.43130	16.17420	-1.943170	0.0931**
Int_Pen	7.040441	3.029233	2.324166	0.0531**
C	129.6432	44.85659	2.890171	0.0233

Sources: Based on Authors' calculations

Note: * Significant at 5 percent
** Singificant at 10 percent

The long-run estimation results from the ARDL model reveal that several variables exert a significant influence on poverty levels over the long term. Inflation demonstrates a positive and statistically significant effect on poverty, indicating that sustained price pressures contribute to an increase in the number of people living in poverty. In contrast, higher per capita income has a negative effect on poverty, suggesting that sustained economic growth remains a key instrument in poverty alleviation.

Interestingly, internet penetration measured in this context through the percentage of population using the internet shows a significant positive relationship with poverty. This may reflect the unintended consequence of increased internet usage imposing additional financial burdens on low-income households. Meanwhile, the Financial Inclusion Index (IFI), though exhibiting a negative coefficient, is statistically insignificant in the long-run model.

5. Discussion

This study investigates the impact of per capita GDP, financial inclusion, inflation, and internet penetration on poverty reduction in Indonesia. Our findings suggest that in the short term, poverty is influenced by changes in per capita GDP, inflation, and financial inclusion. Increases in per capita income significantly reduce poverty, highlighting the importance of raising national income to alleviate poverty. Financial inclusion also plays a critical role; access to financial services such as banking, credit, cooperatives, and fintech enables the poor to engage in economic activities, consistent with findings by (Cicchiello et al., 2021); (Nyarko et al., 2023); (Ibrohim et al., 2025)

Inflation, on the other hand, exerts a negative impact by eroding the real purchasing power of low-income households, aligning with classical economic theory which argues that uncontrolled inflation disproportionately harms the poor by reducing their access to hedging assets

In the short run, internet penetration does not significantly reduce poverty. This is likely due to the unequal distribution of internet access across Indonesia. While urban areas enjoy better infrastructure, rural areas where poverty is more prevalent continue to suffer from inadequate internet services. These findings contrast with (Zhang et al., 2022), who found that internet usage facilitates access to financial and employment information, but align with, who found that internet penetration can exacerbate poverty.

In the long run, only per capita GDP, Internet Penetrations and inflation show significant impacts on poverty levels. Empirical evidence confirms that sustained increases in per capita income and controlled inflation contribute to poverty reduction in Indonesia, consistent with (Fischer, 1999.) who emphasized the effectiveness of economic growth in reducing poverty. However, inflation continues to exert upward pressure on poverty rates by decreasing the real income of poor households, especially those lacking access to financial instruments for value preservation.

Internet penetration is found to have a positive effect on poverty, indicating that rising internet usage may, paradoxically, worsen poverty in Indonesia. While internet access is increasing, service quality and availability remain highly unequal. Urban populations enjoy faster, more stable connections, while rural and underdeveloped areas face limited or poor-quality access. Moreover, internet usage entails additional economic costs. The need for devices and data packages can place a financial strain on poor households. Without corresponding increases in income, these new expenses may deepen poverty. These results support (Zhang et al., 2022)

Financial inclusion, despite its growing aggregate index in recent years, has not had a statistically significant effect on long-term poverty reduction. This may be due to the predominantly quantitative nature of financial inclusion indicators in Indonesia, such as the number of accounts per capita or the number of financial service outlets. These indicators do not necessarily reflect productive use of services by the poor. Many accounts are opened due to administrative requirements, such as receiving social assistance, rather than for active financial management. Consequently, they do not contribute to income growth or economic resilience.

Additionally, poor populations in Indonesia especially in rural areas continue to face significant challenges in financial literacy. As of 2024, the national financial literacy rate stands at just 64% (SNLIK). Without a basic understanding of money management, debt risks, and simple investment tools, the poor are unable to leverage financial access as a means of social mobility. This results in a phenomenon of "pseudo-access" to finance. Most improvements in Indonesia's financial inclusion index are concentrated in urban areas, particularly Java. Geographic disparities in digital infrastructure and financial services have left the poorest regions largely excluded from these advancements. This also helps explain why internet penetration has failed to reduce poverty over the long term.

6. **Conclusions**

This study analyzed the short- and long-run impacts of per capita GDP, inflation, financial inclusion, and internet penetration on poverty reduction in Indonesia. The short run shows a delayed effect of each variable on poverty, except that internet penetration has no significant

short-run effect. Notably, in the long run, internet penetration, while statistically significant, exhibits a positive relationship with poverty rates indicating that connectivity without digital skill development may place additional financial strains on vulnerable households. Financial inclusion, though important in theory, does not have a statistically significant long-term effect. In Indonesia, financial inclusion remains largely focused on quantitative aspects rather than qualitative ones. Moreover, financial services among the poor are often used for consumption rather than productivity, compounded by severe disparities in financial literacy among rural populations.

7. Implications

Poverty reduction remains a key challenge for policymakers in Indonesia. The government must continue to increase household incomes, ensuring that economic growth is not only high in the aggregate but also inclusive across all segments of society. Long-term outcomes underscore the importance of controlling inflation as part of pro-poor macroeconomic policies. Price stability is crucial to ensure that the benefits of economic growth are widely enjoyed.

The positive relationship between internet penetration and poverty suggests that expanding internet access alone does not automatically improve socioeconomic well-being. These findings highlight the need for policies that emphasize digital literacy, skills development, and productive internet use among vulnerable populations. Governments should also address the digital divide by increasing access to quality education and digital infrastructure in disadvantaged areas. Such measures can help ensure that digitalization generates inclusive economic benefits and contributes to long-term poverty reduction.

8. Limitations and future research

Although there are several significant variables in the short and long term, this study still has several limitations that can be further research in the future. This study ignores several other important variables such as government spending on social protection, education, and other macroeconomic variables. Likewise, research at the household or provincial level may provide different results. Another limitation is that financial inclusion is a composite variable, where the author does not distinguish between productive and non-productive purposes. Other researchers can treat financial inclusion based on the purpose of use so that their respective impacts on poverty can be seen.

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Referenses

Afonso, A., & Blanco-Arana, M. C. (2024). Does financial inclusion enhance per capita income in the least developed countries? International Economics, 177, 100479. https://doi.org/10.1016/j.inteco.2024.100479

Allen, F., Carletti, E., Cull, R., Qian, J. Q. J., Senbet, L., & Valenzuela, P. (2021). Improving Access to Banking: Evidence from Kenya. Review of Finance, 25(2), 403-447. https://doi.org/10.1093/rof/rfaa024

Álvarez-Gamboa, J., Cabrera-Barona, P., & Jácome-Estrella, H. (2021). Financial inclusion and multidimensional poverty in Ecuador: A spatial approach. World Development Perspectives, 22, 100311. https://doi.org/10.1016/j.wdp.2021.100311

Andini, C. (2009). Financial intermediation and growth: Causality and causes without outliers. Portuguese Economic Journal, 8(1), 15-22. https://doi.org/10.1007/s10258-009-0035-y

Awan, A. G., & Yaqoob, R. (2023). Economic value of introducing technology to improve productivity: An ARDL approach. Innovation and Green Development, 2(3), 100069. https://doi.org/10.1016/j.igd.2023.100069

Ayu Az Zahra, D., & Ajija, S. R. (2023). The Effect of Financial Inclusion on Inclusive Economic Growth in Indonesia. Jurnal Ilmu Ekonomi Terapan, 8(1), 55-67. https://doi.org/10.20473/jiet.v8i1.45426

Azmeh, C. (2025). Financial globalization, Poverty, and inequality in developing countries: The moderating role of Fintech and financial inclusion. Research in Globalization, 10, 100277. https://doi.org/10.1016/j.resglo.2025.100277

BPS (Badan Pusat Statistik) Indonesia. (2023). Profil Kemiskinan di Indonesia September 2023. Jakarta: BPS Indonesia.

Briano-Turrent, G. del C. (2025). The effect of financial inclusion on economic and social indicators in Mexico. Latin American Journal of Central Banking, 6(1), 100161. https://doi.org/10.1016/j.latcb.2024.100161

Busra, B., Masbar, R., Agussabti, A., & Nasir, M. (2019). Does Government Responsibility and Social Capital Empower the Poor in Aceh, Indonesia? Proceedings of the 1st Aceh Global Conference, 52-59. https://doi.org/10.2991/agc-18.2019.52

Cicchiello, A. F., Kazemikhasragh, A., Monferrá, S., & Girón, A. (2021). Financial inclusion and development in the least developed countries in Asia and Africa. Journal of Innovation and Entrepreneurship, 10(1), 1-18. https://doi.org/10.1186/s13731-021-00190-4

Daly, H., Ahmed Abdulrahman, B. M., Khader Ahmed, S. A., Yahia Abdallah, A. E., Hasab Elkarim, S. H. E., Gomaa Sahal, M. S., Nureldeen, W., Mobarak, W., & Elshaabany, M. M. (2024). The dynamic relationships between oil products consumption and economic growth in Saudi Arabia: Using ARDL cointegration and Toda-Yamamoto Granger causality analysis. Energy Strategy Reviews, 54, 101470. https://doi.org/10.1016/j.esr.2024.101470

Erlando, A., Riyanto, F. D., & Masakazu, S. (2020). Financial inclusion, economic growth, and poverty alleviation: evidence from eastern Indonesia. Heliyon, 6(10), e05235. https://doi.org/10.1016/j.heliyon.2020.e05235

Fischer, S. (1999). Reassessing the role of macroeconomic policies in economic growth and poverty reduction. Journal of Money, Credit, and Banking, 31(2), 1-32.

Fitriatinnisa, F., & Khoirunurrofik, K. (2021). Financial Inclusion and Poverty Reduction in Indonesia: A District-Level Spatial Analysis. Jurnal Ekonomi & Pembangunan Indonesia, 21(2), 145-162.

Huang, W., Ding, S., Song, X., Gao, S., & Liu, Y. (2023). A study on the long-term effects and mechanisms of internet information behavior on poverty alleviation among smallholder farmers: Evidence from China. Heliyon, 9(9), e19174. https://doi.org/10.1016/j.heliyon.2023.e19174

Hussain, S., Rehman, A. ur, Ullah, S., Waheed, A., & Hassan, S. (2024). Financial Inclusion and Economic Growth: Comparative Panel Evidence from Developed and Developing Asian Countries. SAGE Open, 14(1), 1-15. https://doi.org/10.1177/21582440241232585

Ibrohim, M. A., Susilowati, D., & Yuli, S. B. C. (2025). Analisis Inklusi Keuangan Terhadap Pertumbuhan Ekonomi Di Indonesia. Journal of Financial Economics & Investment, 5(1), 14-25. https://doi.org/10.22219/jofei.v5i1.35486

Inoue, T. (2024). Financial Inclusion and Poverty Reduction in Developing Asia: Dynamic Panel Data Evidence. Asian Development Review, 41(1), 89-115.

Johnen, C., Mader, A., Nsengumuremyi, A., & Mußhoff, O. (2025). Financial inclusion along the Rural-Urban Continuum: Empirical evidence from a decomposition analysis in Kenya between 2012 and 2021. World Development, 194, 107073. https://doi.org/10.1016/j.worlddev.2025.107073

Koranteng, B., & You, K. (2025). Does P2P lending promote traditional bank-based financial inclusion? Spatial evidence from 34 developing economies. Research in International Business and Finance, 77, 102947. https://doi.org/10.1016/j.ribaf.2025.102947

Lannquist, A. (2023). Central Bank Digital Currency's Role in Promoting Financial Inclusion. IMF Fintech Notes, 2023(011), 1-24. https://doi.org/10.5089/9798400253331.063

Marcelin, I., & Sun, W. (2025). Financial inclusion, inequality, and retirement trends among older workers. Global Finance Journal, 66, 101121. https://doi.org/10.1016/j.gfj.2025.101121

Mishra, D., Kandpal, V., Agarwal, N., & Srivastava, B. (2024). Financial Inclusion and Its Ripple Effects on Socio-Economic Development: A Comprehensive Review. Journal of Sustainable Finance & Investment, 14(2), 210-235.

Muliantari, V. K., & Auwalin, I. (2026). The Effect of Financial Inclusion on Household Poverty in Indonesia. E-Jurnal Ekonomi dan Bisnis Universitas Udayana, 15(3), 318-329.

Nizam, R., Karim, Z. A., Rahman, A. A., & Sarmidi, T. (2020). Financial inclusiveness and economic growth: new evidence using a threshold regression analysis. Economic Research-Ekonomska Istraživanja, 33(1), 1465-1484. https://doi.org/10.1080/1331677X.2020.1748508

Nyarko, E. S., Amoateng, K., & Aboagye, A. Q. Q. (2023). Financial inclusion and poverty: evidence from developing economies. International Journal of Social Economics, 50(12), 1719-1734. https://doi.org/10.1108/IJSE-11-2021-0690

Ogunleye, T. S. (2017). Financial Inclusion and the Role of Women in Nigeria. African Development Review, 29(2), 249-258.

Omar, M. A., & Inaba, K. (2020). Does financial inclusion reduce poverty and income inequality in developing countries? A panel data analysis. Journal of Economic Structures, 9(1), 37. https://doi.org/10.1186/s40008-020-00214-4

Ojk (Otoritas Jasa Keuangan). (2024). Survei Nasional Literasi dan Inklusi Keuangan (SNLIK) 2024. Jakarta: Otoritas Jasa Keuangan.

Osabutey, E. L. C., & Jackson, T. (2024). Mobile money and financial inclusion in Africa: Emerging themes, challenges and policy implications. Technological Forecasting and Social Change, 202, 123339. https://doi.org/10.1016/j.techfore.2024.123339

Osuma, G. (2025). The impact of financial inclusion on poverty reduction and economic growth in Sub-Saharan Africa: A comparative study of digital financial services. Social Sciences and Humanities Open, 11, 101263. https://doi.org/10.1016/j.ssaho.2024.101263

Park, C. Y., & Mercado, R. (2018). Financial Inclusion, Poverty, and Income Inequality in Developing Asia. ADB Economics Working Paper Series, No. 539. Manila: Asian Development Bank.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289-326. https://doi.org/10.1002/jae.616

Puspitasari, S. D., Adianata, H., & Ahmed, I. (2024). Exchange Rate, GDP and Inflation: Their Impact on Extreme Poverty in Indonesia. ECCES: Economics Social and Development Studies, 11(2), 191-211. https://doi.org/10.24252/ecc.v7i1.13382

Sarma, M., & Pais, J. (2023). Financial Inclusion and Development. Journal of International Development, 23(5), 613-628. https://doi.org/10.1002/jid.1698

Sawadogo, R., & Semedo, G. (2021). Financial inclusion, income inequality, and institutions in sub-Saharan Africa: Identifying cross-country inequality regimes. International Economics, 167, 15-28. https://doi.org/10.1016/j.inteco.2021.05.002

Shin, Y., & Smith, R. J. (2001). *BOUNDS TESTING APPROACHES TO THE ANALYSIS*. *326*(February), 289–326. https://doi.org/10.1002/jae.616

Siddiki, J., & Bala-Keffi, L. R. (2024). Revisiting the relation between financial inclusion and economic growth: a global analysis using panel threshold regression. Economic Modelling, 135, 106707. https://doi.org/10.1016/j.econmod.2024.106707

Soufiene, A., Boukhatem, J., & Abbas, Q. (2024). What drives tax morale in selected North African economies? Empirical evidence from Algeria, Morocco and Tunisia using simulated ARDL and GMM quantile regressions. Regional Science Policy and Practice, 16(12), 100161. https://doi.org/10.1016/j.rspp.2024.100141

Tabash, M. I., Ezekiel, O., Ahmed, A., Oladiran, A., Elsantil, Y., & Lawal, A. I. (2024). Examining the linkages among financial inclusion, economic growth, poverty, and inequality reduction in Africa. Scientific African, 23, e02096. https://doi.org/10.1016/j.sciaf.2024.e02096

World Bank. (2022). Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19. Washington, DC: World Bank.

Zhang, G., Wu, X., & Wang, K. (2022). Research on the Impact and Mechanism of Internet Use on the Poverty Vulnerability of Farmers in China. Sustainability, 14(9), 5216. https://doi.org/10.3390/su14095216