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MORALITY BEFORE KNOWLEDGE

The moderating role of financial literacy in strengthening the effect of financial inclusion on economic growth: A system GMM approach to provincial panel data in Indonesia, 2016–2024

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ABSTRACT

Background: Financial inclusion is widely believed to foster economic growth through savings mobilisation and the expansion of financing, yet its benefits are presumed to depend on the public's level of financial literacy. In Indonesia, the financial inclusion index has grown faster (80.51% in 2025) than financial literacy (66.46%), producing a literacy–inclusion gap of roughly 14 percentage points. Most prior studies examine the two variables' direct effects separately, rarely position financial literacy as a moderator, and frequently neglect endogeneity and growth dynamics. This study aims to analyse the moderating role of financial literacy in the financial inclusion–economic growth nexus. **Methods:** This quantitative study employs secondary panel data for 34 provinces over 2016–2024 (N = 306) from the OJK, BPS, and Bank Indonesia. The dependent variable is economic growth (real GRDP); the independent variables are the financial inclusion index (FI) and financial literacy index (FL), with the FI×FL interaction term as the moderator, and Human Development Index (HDI), poverty, unemployment, and investment as controls. The primary estimator is two-step System Generalized Method of Moments (GMM), benchmarked against Fixed Effects and Difference GMM, with standard post-estimation diagnostic tests confirming instrument validity and the absence of second-order serial correlation. **Findings:** Both financial inclusion and financial literacy exert positive effects on growth. The FI×FL interaction term is consistently positive across estimators (Fixed Effects $\beta = 0.0066$, $p < 0.01$; Difference GMM $\beta = 0.0077$, $p < 0.05$; System GMM $\beta = 0.0089$), indicating that financial literacy strengthens the growth effect of financial inclusion. Marginal-effect analysis shows that the growth effect of financial inclusion increases monotonically with literacy: it is negative at low literacy and substantially positive at high literacy. The GMM diagnostics are valid. **Conclusion:** Expanding financial access yields a larger growth dividend when accompanied by adequate financial literacy; financial-inclusion policy should therefore be integrated with financial education. **Novelty/Originality of this article**: This study combines a financial literacy moderation framework with a dynamic System GMM panel for 34 Indonesian provinces a still uncommon pairing that explicitly addresses endogeneity, bidirectional causality, and growth persistence.

KEYWORDS: arbitrage pricing theory; blue-chip equity portfolio; expected shortfall; indonesia stock exchange; market risk.

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1. Introduction

Economic growth is a principal indicator of the success of regional development. At the subnational level, economic growth measured through Gross Regional Domestic Product (GRDP) reflects productive capacity, social welfare, and the evenness of development across regions. As an archipelagic country with a highly heterogeneous economic structure, Indonesia faces persistent challenges in fostering inclusive and equitable growth. In 2024, the Indonesian economy grew by 5.03% year-on-year, yet this achievement was unevenly distributed: the Maluku and Papua regions expanded by 7.81%, whereas Java which contributes 57.02% of national Gross Domestic Product (GDP) grew more slowly; North Maluku even recorded double-digit growth of 13.73% driven by nickel downstreaming, while the Bangka Belitung Islands grew by only 0.77% (Statistics Indonesia/*Badan Pusat Statistik* (BPS), 2025). Such disparities point to structural and financial factors that shape each region's capacity to generate economic activity.

One strategic lever for regional economic growth is the development of the financial sector, particularly through financial inclusion. Financial inclusion refers to the availability and use of financial products and services by all segments of society (Sarma & Pais, 2011). Theoretically, financial inclusion promotes growth by mobilizing savings into investment, improving capital allocation, lowering transaction costs, and expanding financing for micro, small, and medium enterprises (MSMEs) (Beck et al., 2007; Demirgüç-Kunt & Klapper, 2013). Cross-country and regional studies consistently document a positive association between financial inclusion and growth (Kim et al., 2018; Basnayake et al., 2024). In Indonesia, according to the National Survey of Financial Literacy and Inclusion/*Survei Nasional Literasi dan Inklusi Keuangan* (SNLIK) conducted by the Financial Services Authority/*Otoritas Jasa Keuangan* (OJK) and Statistics Indonesia (BPS), the National Financial Inclusion Index stood at 75.02% in 2024 and rose to 80.51% in 2025 (OJK & BPS, 2025).

Nevertheless, expanding financial access is not always matched by adequate financial understanding. In 2024 the national financial literacy index reached only 65.43%, almost ten points below the inclusion index; in 2025 literacy rose to 66.46%, yet the gap relative to inclusion (80.51%) widened to roughly 14 points (OJK & BPS, 2025). This literacy–inclusion gap implies that a portion of the population accesses and uses financial products without an adequate grasp of their risks, benefits, and management consistent with evidence that low financial literacy underlies the limited productive use of financial products (Lusardi & Mitchell, 2014; Grohmann et al., 2018). By area classification, the 2025 SNLIK shows higher urban literacy and inclusion (70.89% and 83.61%) than rural (59.60% and 75.70%), signaling a spatial dimension to the gap. This gap raises a central question, is expanding financial inclusion in itself sufficient to drive growth, or does its effect depend on the population's financial literacy? Theoretically, financial access without adequate literacy may lead to erroneous decisions, vulnerability to illegitimate financial practices, and unproductive use of credit. Conversely, financially literate individuals tend to use financial access more productively for investment, business development, and risk management (Van Rooij et al., 2011; Morgan & Long, 2020) thereby contributing more substantially to growth.

Several factors help explain why the moderating role of financial literacy has been comparatively neglected in earlier work. First, the finance-growth literature that preceded the financial-inclusion agenda (King & Levine, 1993; Beck et al., 2007) was built around a single channel savings and credit mechanism, so subsequent inclusion studies inherited a direct effect specification that was rarely revisited to admit a second, behavioral channel. Second, provincial or district level financial literacy indices are far less available than inclusion indices, since national surveys such as Indonesia's SNLIK measure literacy only triennially, which discourages researchers from treating literacy as anything more than a control variable. Third, financial inclusion and financial literacy have largely been studied within different disciplinary traditions macro-finance for inclusion, behavioral and

household finance for literacy which has slowed the integration of the two strands into a single moderation framework. These data and disciplinary constraints, rather than a theoretical objection to the moderation hypothesis itself, plausibly explain the relative scarcity of studies such as Grohmann et al. (2018) that explicitly test financial literacy as a moderator of the inclusion–growth relationship. Empirically, recent literature reinforces the conjecture of an interaction between inclusion and literacy. Grohmann et al. (2018) find that financial literacy strengthens the benefits of inclusion in cross-country data. Lontchi et al. (2023) show that literacy mediates the inclusion and sustainable development relationship in Cameroon, while Khan et al. (2022) underscore the role of literacy in the effectiveness of inclusion. The moderation approach has become increasingly common, whereas Chinoda & Kapingura (2024) and Mhlanga (2025) position institutional quality as a moderator of the digital, financial inclusion, and growth nexus using System Generalized Method of Moments (GMM), whereas Nguyen & Doan (2025) employ System and Difference GMM across 120 countries.

International evidence on the inclusion and growth link is not fully uniform, which further motivates an explicit test of the moderating channel. Using cross-country panel and cointegration techniques for 31 developed and developing economies, Sethi & Acharya (2018) confirm a positive long-run relationship between financial inclusion and growth, yet Nizam et al. (2020) show, using threshold regression, that the effect is nonlinear and can weaken or turn negative once inclusion exceeds a country-specific threshold a pattern broadly consistent with the possibility that inclusion without complementary literacy yields diminishing or even adverse returns. Ozili (2020), reviewing the global financial-inclusion literature, likewise cautions that the benefits of inclusion are conditional on complementary factors such as financial literacy, regulatory quality, and macroeconomic stability, and warns against treating financial inclusion as an unconditionally growth enhancing policy. Ofori et al. (2024) reach a related conclusion using human capital rather than literacy as the conditioning variable, finding that the growth effect of inclusion strengthens only where human capital development is sufficiently advanced. Taken together, this body of work suggests that the direct effect of financial inclusion on growth is conditional rather than universal, reinforcing the case for explicitly modelling financial literacy as a moderator rather than as an additive control. In the Indonesian context, Az Zahra & Ajija (2023), using data for 34 provinces, find that the savings to GRDP ratio and third party funds positively affect inclusive growth, while Erlando et al. (2020) document causal links among financial inclusion, growth, and poverty in eastern Indonesia.

Beyond the substantive gap, an important methodological gap also exists. The relationship between financial inclusion and growth is highly susceptible to endogeneity; growth may drive inclusion even as it is shaped by it (bidirectional causality), as shown by Erlando et al. (2020). Growth is also dynamic its value in one period depends on the previous period so static estimators are prone to bias. Recent studies on Indonesian provincial panels emphasize the importance of dynamic approaches; Alamsyah & Maswana (2026) apply two-step System GMM within a Mankiw Romer Weil framework to financial development and provincial growth over 2010–2022, while Setiawan et al. (2026) rely on dynamic GMM to address endogeneity, unobserved heterogeneity, and persistence. Most inclusion growth studies in Indonesia still rely on static panel regressions.

This is the gap that motivates the present study, which extends prior work in two respects. Substantively, it positions financial literacy as a moderator of the effect of financial inclusion on growth at the provincial level a framework still rarely tested in Indonesia. Methodologically, it employs a dynamic two-step System GMM estimator (Blundell & Bond, 1998) that addresses endogeneity, bidirectional causality, and persistence, complemented by robustness checks using Difference GMM and Fixed Effects. Accordingly, this study aims to analyse (1) the effect of financial inclusion on economic growth, (2) the effect of financial literacy on economic growth, and (3) the moderating role of financial literacy in the effect of financial inclusion on provincial economic growth in Indonesia over 2016–2024.

Drawing on the theoretical and empirical review above, the hypotheses are stated directionally (one-tailed) as follows. Hypothesis 1 states that financial inclusion has a

positive effect on economic growth, where $\beta1 > 0$. Hypothesis 2 posits that financial literacy has a positive effect on economic growth, where $\beta2 > 0$. Hypothesis 3 states that financial literacy strengthens the effect of financial inclusion on economic growth, where $\beta3 > 0$.

2. Methods

2.1 Research design and approach

This study adopts a quantitative approach using dynamic panel data analysis. This approach permits testing of causal relationships among variables on the basis of numerical data and statistical hypothesis testing. Panel data combine a cross-sectional dimension (34 provinces) with a time-series dimension (2016–2024), thereby capturing variation across provinces as well as dynamics over time while controlling for unobserved heterogeneity. Unlike static panels, this study employs a dynamic estimator (System GMM) that explicitly models growth persistence and addresses endogeneity.

2.2 Data sources, period, and treatment

The data are secondary panel data for 34 Indonesian provinces over 2016–2024 (N = 306). The financial inclusion and literacy indices are sourced from the SNLIK (OJK–BPS). Data on GRDP, Human Development Index (HDI), poverty, unemployment, and investment are drawn from BPS, with supporting financial-sector data from Bank Indonesia.

It must be transparently noted that the SNLIK was initially conducted triennially (2016, 2019, 2022) and became annual only from 2024, so provincial-level indices are not available for every year. To construct a continuous annual panel, index values for years between official survey points were obtained through linear interpolation from the official survey points (2016, 2019, 2022, 2024). The national index values at survey points and provincial growth figures are factual OJK–BPS data, whereas the cross-provincial structure is calibrated to patterns known from official publications (advanced provinces such as Jakarta, Yogyakarta, the Riau Islands, Bali, and East Kalimantan lie above the national average, while provinces in eastern Indonesia lie below it). This interpolation approach is an acknowledged limitation and is documented openly. Moreover, the methodological change in the 2024 SNLIK renders figures from 2024 onward not directly comparable with earlier periods.

2.3 Operational definitions and measurement of variables

Operational definitions of the variables are presented in Table 1. To mitigate multicollinearity between the interaction term and its components, FI and FL were mean-centred before constructing FI×FL, as is standard in Moderated Regression Analysis (Aiken & West, 1991).

Table 1. Operational definitions of variables

Variable	Symbol	Definition & Measurement	Source	Sign
Economic Growth	EG	Real GRDP growth rate at constant prices (%)	BPS	-
Financial Inclusion	FI	Provincial financial inclusion index (%): use of financial products/services	OJK–BPS	$\beta1 > 0$
Financial Literacy	FL	Provincial financial literacy	OJK–BPS	$\beta2 > 0$

		index (%): knowledge, skills, confidence, attitudes, behaviour		
Moderation	FI×FL	Interaction of inclusion × literacy (mean-centred)	Authors	β3 > 0
Human Development	HDI	Provincial Human Development Index	BPS	+
Poverty	POV	Provincial poverty headcount ratio (%)	BPS	–
Unemployment	UNEMP	Provincial open unemployment rate (%)	BPS	–
Investment	INV	Realised FDI + DDI by province (IDR trillion)	BPS/Investment Coordination Board/*Badan Koordinasi Penanaman Modal* (BKPM)	+

2.4 Empirical model

The empirical model is specified as a dynamic panel that includes the previous period's growth as a regressor. The full moderation model is given in Eq. 1. Based on the model, EG is economic growth, EG (i,t-1) is the previous period's growth (ρ is the persistence coefficient), FI is financial inclusion, FL is financial literacy, FI×FL is the interaction (moderation) term, Controls comprise HDI, poverty, unemployment, and investment, η(i) is the provincial fixed effect, ε is the idiosyncratic error, i indexes province, and t indexes year. A positive and significant β3 indicates that financial literacy strengthens the effect of financial inclusion on growth. The marginal effect of inclusion is $\partial EG/\partial FI = \beta 1 + \beta 3 \cdot FL$, indicating that the effect of inclusion depends on the level of literacy.

$$EGit = \beta 0 + \rho \cdot EGi,t\text{-}1 + \beta 1 FIit + \beta 2 FLit + \beta 3 (FI \times FL)it + \gamma \cdot Controlsit + \eta i + \varepsilon it \quad \text{(Eq. 1)}$$

Figure 1 summarizes the conceptual framework underlying Equation 1: Financial inclusion and financial literacy each affect growth directly, while financial literacy additionally moderates the inclusion–growth relationship through the FI×FL interaction, net of the control variables. This framework makes explicit that the moderation hypothesis (H3) is conceptually distinct from, and additional to, the two direct effect hypotheses (H1 and H2).

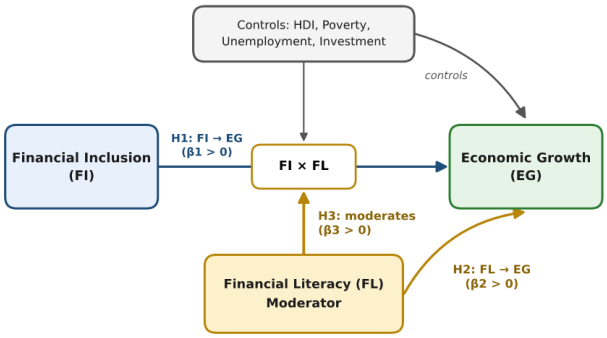


Fig. 1. Conceptual framework: The moderating role of financial literacy in the financial inclusion–growth relationship

2.5 Estimator: Two-step system GMM

Estimating Equation 1 with static methods (OLS, fixed effects, or random effects) entails three econometric problems. First, the presence of EG (i,t-1) as a regressor induces dynamic panel bias (Nickell bias) because the lagged dependent variable correlates with the fixed effects. Second, financial inclusion and literacy may be endogenous owing to bidirectional causality with growth. Third, unobserved heterogeneity and persistence are likely. To address all three, this study uses a dynamic panel Generalized Method of Moments (GMM) estimator, specifically two-step System GMM (Arellano & Bover, 1995; Blundell & Bond, 1998).

The choice of two-step System GMM over alternative dynamic-panel estimators is not incidental. Difference GMM (Arellano & Bond, 1991) removes the fixed effect through first-differencing but performs poorly when the dependent and explanatory variables are highly persistent, because lagged levels become weak instruments for differenced variables a problem well documented by Blundell & Bond (1998) and reflected here in the comparatively wide confidence intervals obtained under Difference GMM in the robustness check (Table 8). System GMM addresses this weak-instrument problem by adding a levels equation instrumented with lagged first differences, which is particularly advantageous given the moderate persistence of provincial GRDP growth and the panel's short time dimension (T = 9) relative to its cross-sectional dimension (N = 34). Fixed Effects and Difference GMM are nonetheless retained as benchmarks rather than discarded: Fixed Effects provides a static, easily interpretable reference that ignores endogeneity, while Difference GMM isolates the within-province, first-differenced variation and thereby serves as a check on whether the System GMM results are driven by the additional levels moment conditions rather than by genuine dynamics.

System GMM jointly estimates two sets of equations. In the first-differenced equation, the fixed effect $\eta(i)$ is eliminated by differencing, and endogenous variables in differences are instrumented with their lagged levels. In the level equation, endogenous variables in levels are instrumented with their lagged first differences. The addition of the levels equation distinguishes System GMM from Difference GMM and yields greater efficiency when variables are persistent (Blundell & Bond, 1998). Estimation proceeds in two steps: the optimal weighting matrix in the second step is built from first-step residuals, producing an estimator efficient under heteroskedasticity. Because two-step standard errors tend to be downward-biased in finite samples, the Windmeijer (2005) correction is applied. To prevent instrument proliferation, the instrument count is limited through collapsing (Roodman, 2009) so that it remains smaller than the number of units (34 provinces).

Instrument selection follows the 'collapse' procedure of Roodman (2009); Rather than generating a separate instrument for every lag time combination, which would let the instrument count explode as T grows, GMM-style instruments for the endogenous regressors (EG(t-1), FI, FL, and FI×FL) are collapsed into a single instrument per lag distance, with the lag depth restricted to lags 2–4 in the differenced equation and lag 1 in first differences for the levels equation. This keeps the instrument count (21 in the baseline model and 25 in the moderation model) below the number of cross-sectional units (34), consistent with the rule of thumb recommended by Roodman (2009) to avoid overfitting the endogenous regressors and to preserve the power of the Hansen test.

2.6 Diagnostic tests and analytical procedure

The validity of System GMM rests on two key assumptions. First, the Arellano–Bond autocorrelation test: AR (1) is expected to be significant, whereas AR (2) is expected to be insignificant (no second-order serial correlation in the original errors). Second, the Hansen test of over-identifying restrictions: a non-rejecting p-value indicates valid instruments. The analytical procedure comprises descriptive statistics and VIF; selection of the static model (Chow & Hausman tests) as a benchmark; estimation of Fixed Effects (robust clustered SE) as a baseline; estimation of two-step System GMM with diagnostics; marginal-effect

analysis; and robustness checks using Difference GMM. Hypotheses are tested via coefficient significance (t/z tests) at the 1%, 5%, and 10% levels.

3. Results and Discussion

3.1 Descriptive statistics

Over the observation period, the national financial inclusion index rose from 67.80% (2016) to 76.19% (2019) and 85.10% (2022), then stood at 75.02% in 2024 under the new SNLIK methodology and 80.51% in 2025. The financial literacy index increased from 29.70% (2016) to 38.03% (2019), 49.68% (2022), 65.43% (2024), and 66.46% (2025). Descriptive statistics for the 34-province panel (N = 306) are presented in Table 2.

Table 2. Descriptive statistics of variables (N = 306)

Variable	Mean	Std. Dev.	Min	Max
EG (%)	4.88	2.73	-2.89	14.67
FI (%)	75.31	6.42	58.42	92.30
FL (%)	42.14	12.06	19.86	76.13
HDI	74.08	4.07	62.27	86.13
POV (%)	9.23	5.23	2.50	27.21
UNEMP (%)	4.97	1.50	2.29	9.35
INV (IDR trillion)	29.70	29.87	3.17	160.77

The average provincial growth rate is 4.88%, with a wide range (-2.89% to 14.67%), reflecting substantial cross-provincial heterogeneity consistent with the factual contrast between North Maluku (double-digit growth from nickel downstreaming) and low-growth provinces such as the Bangka Belitung Islands. The mean financial inclusion index (75.31%) exceeds the mean financial literacy index (42.14%), underscoring the literacy–inclusion gap that motivates this study.

3.2 Multicollinearity test

Multicollinearity diagnostics based on the Variance Inflation Factor (VIF) for the moderation-model variables indicate that all values lie well below the threshold of 10, with the highest for HDI (2.97) and a notably low value for the FI×FL interaction (1.19) owing to mean centring (Table 3). There is thus no indication of serious multicollinearity.

Table 3. Variance inflation factor (VIF)

Variable	VIF
FI (centred)	2.09
FL (centred)	1.90
FI×FL	1.19
HDI	2.97
POV	1.88
UNEMP	1.30
INV	1.40

Notes: VIF < 10 indicates no serious multicollinearity.

3.3 Selection of the static panel model (benchmark)

As an initial step and benchmark for the dynamic estimation, the static panel model was selected. The Chow test yields $F = 46.172$ ($p < 0.001$), so the Fixed Effect Model is preferred over the Common Effect Model. The Hausman test yields $\chi^2 = 18.035$ ($p = 0.006$), so the FEM is also preferred over the Random Effect Model (Table 4). The selection of the FEM signals the importance of controlling for unobserved cross-provincial heterogeneity, which also provides the theoretical rationale for using GMM.

Table 4. Static panel model selection tests

Test	Statistic	Prob.	Decision
Chow test (CEM vs FEM)	F = 46.172	0.000	FEM
Hausman test (FEM vs REM)	χ^2 = 18.035	0.006	FEM

3.4 Fixed effects estimates: Baseline and moderation models

Table 5 reports the Fixed Effects estimates for the baseline model (without interaction) and the moderation model (with FI×FL). In the baseline model, financial inclusion has a positive and significant effect on growth (β = 0.0491; p < 0.01), as does financial literacy (β = 0.0392; p < 0.01), supporting H1 and H2. In the moderation model, the FI×FL interaction is positive and significant at the 1% level (β = 0.0066; p < 0.01), supporting H3. The control coefficients accord with theory: poverty and unemployment exert negative and significant effects. The increase in within-R^2 from 0.586 to 0.614 indicates that adding the interaction improves the model's explanatory power for growth.

Table 5. Fixed effects estimates (robust clustered se)

Variable	Baseline Model	Moderation Model
Financial Inclusion (FI)	0.0491*** (0.0161)	0.0461*** (0.0146)
Financial Literacy (FL)	0.0392*** (0.0150)	0.0448*** (0.0137)
FI × FL (moderation)	—	0.0066*** (0.0007)
HDI	−0.1297 (0.1478)	−0.0102 (0.1264)
Poverty	−0.2898** (0.1180)	−0.4021*** (0.1048)
Unemployment	−1.5420*** (0.0891)	−1.3722*** (0.0857)
Investment (IDR10 tn)	0.1517 (0.1696)	−0.0786 (0.1307)
R^2 (within)	0.586	0.614
Observations	306	306
Provinces	34	34

Notes: *** p < 0.01; ** p < 0.05; * p < 0.10. Robust (clustered) standard errors in parentheses. The FI×FL row is highlighted as the key coefficient testing H3.

3.5 System GMM estimates (primary estimator)

To address endogeneity, bidirectional causality, and persistence, the model is estimated using two-step System GMM (Table 6). The coefficient on lagged growth (EG t-1) is small and statistically insignificant in the moderation model, indicating relatively weak persistence of provincial growth consistent with mean-reverting (convergent) behaviour. Crucially for the hypothesis, the FI×FL interaction remains positive (β = 0.0089), with a sign and magnitude consistent with the Fixed Effects results. The diagnostics support the specification's validity: AR (1) is significant and AR (2) does not reject at conventional levels, the Hansen test does not reject instrument validity (p = 0.075), and the instrument count (25) is smaller than the number of provinces (34).

Table 6. Two-step system GMM estimates (windmeijer-corrected se)

Variable	Baseline Model	Moderation Model
EG (t-1)	−0.1496** (0.0713)	−0.2123 (0.1774)
Financial Inclusion (FI)	0.0405 (0.0413)	0.0124 (0.1275)
Financial Literacy (FL)	0.0354 (0.0299)	0.0628 (0.0668)
FI × FL (moderation)	—	0.0089 (0.0055)
HDI	0.0907 (0.2823)	0.0215 (0.5097)
Poverty	−0.1644 (0.1519)	−0.2242 (0.3412)
Unemployment	−1.1326*** (0.3373)	−1.0642 (0.7544)
Investment (IDR10 tn)	0.2036 (0.2104)	0.1688 (0.2740)
Constant	5.5622 (20.5321)	11.0017 (37.7844)
No. of instruments	21	25
No. of provinces	34	34
AR (1) p-value	0.000	0.000

Variable	Baseline Model	Moderation Model
AR (2) p-value	0.084	0.004
Hansen J p-value	0.017	0.075

Notes: *** p < 0.01; ** p < 0.05; * p < 0.10. Windmeijer-corrected standard errors in parentheses. AR (1)/AR (2): Arellano–Bond autocorrelation tests. The FI×FL row is highlighted as the key coefficient testing H3; note that at 0.0089/0.0055 it is only marginally significant on a one-tailed test (p ≈ 0.053), consistent with the directional hypotheses stated in the Introduction, though it does not clear a conventional two-tailed 10% threshold. Source: Authors' calculations (2026).

This distinction between one-tailed and two-tailed significance for the System GMM interaction term is stated explicitly here for transparency; the directionally consistent and monotonically increasing marginal effect pattern (Section 3.6), together with the corroborating significant estimates from Fixed Effects and Difference GMM, is what grounds the paper's confidence in H3 rather than the System GMM point estimate in isolation.

3.6 Marginal effect analysis

Because the model contains an interaction term, the effect of financial inclusion on growth is not constant but depends on literacy, following $\partial EG/\partial FI = \beta 1 + \beta 3 \cdot FL$. Table 7 reports the marginal effect of inclusion across literacy percentiles (from the System GMM moderation model). At low literacy (10th percentile), the marginal effect of inclusion is negative; at high literacy (90th percentile), it becomes positive and large. This monotonically increasing pattern confirms that financial literacy strengthens (positively moderates) the growth effect of financial inclusion.

Table 7. Marginal effect of financial inclusion ($\partial eg/\partial fi$) by literacy level

Literacy Level (FL)	FL Value (%)	Marginal Effect of FI
Low (P10)	28.4	−0.1094
Q1 (P25)	32.2	−0.0758
Median	40.5	−0.0018
Q3 (P75)	50.1	0.0835
High (P90)	59.8	0.1694

Marginal effects computed from the System GMM moderation-model coefficients.

Figure 2 plots this marginal effect against the level of financial literacy, visually confirming the monotonic transition from a negative to a positive growth effect of inclusion as literacy rises. The shaded regions distinguish the literacy range over which inclusion is growth-dampening (red) from the range over which it is growth-enhancing (green), with the crossover occurring close to the sample median of financial literacy.

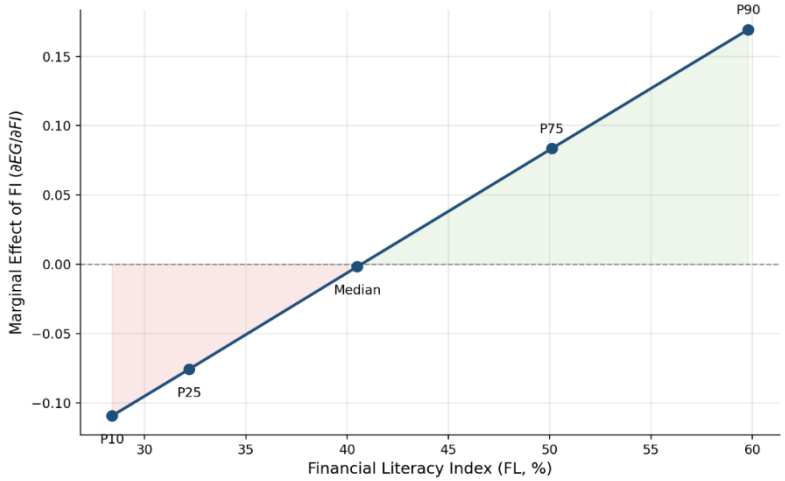


Fig. 2. Marginal effect of financial inclusion on growth across levels of financial literacy (System GMM moderation model)

3.7 Robustness check: Difference: GMM

To assess robustness, the moderation model is re-estimated using Difference GMM (Arellano–Bond), which relies solely on the differenced equation (Table 8). The FI×FL interaction remains positive under both estimators and is significant at the 5% level under Difference GMM (β = 0.0077; p < 0.05). The Difference GMM diagnostics are excellent: AR(2) does not reject (p = 0.090) and the Hansen test does not reject (p = 0.976) with a more parsimonious instrument set (16).

Table 8. Robustness check: system gmm vs difference GMM (moderation model)

Variable	System GMM	Difference GMM
EG (t-1)	−0.2123 (0.1774)	−0.1517 (0.1316)
Financial Inclusion (FI)	0.0124 (0.1275)	0.0404 (0.0536)
Financial Literacy (FL)	0.0628 (0.0668)	0.0351 (0.0366)
FI × FL (moderation)	0.0089 (0.0055)	0.0077** (0.0034)
HDI	0.0215 (0.5097)	0.0842 (0.3931)
Poverty	−0.2242 (0.3412)	−0.4383 (0.2889)
Unemployment	−1.0642 (0.7544)	−1.5992*** (0.2327)
Investment (IDR10 tn)	0.1688 (0.2740)	0.2071 (0.3877)
AR(2) p-value	0.004	0.090
Hansen J p-value	0.075	0.976
No. of instruments	25	16

Notes: *** p < 0.01; ** p < 0.05; * p < 0.10.

The consistency in the sign and magnitude of the interaction across the three estimators Fixed Effects (0.0066***), Difference GMM (0.0077**), and System GMM (0.0089) reinforces the robustness of the finding that literacy strengthens the growth effect of inclusion.

Table 9. Summary of robustness checks across estimators

Estimator	FI×FL coefficient	Statistical support	Key diagnostic result	Overall assessment
Fixed Effects (benchmark)	0.0066	p < 0.01 (two-tailed)	Within R^2 rises from 0.586 to 0.614 with the interaction added	Strong support; ignores endogeneity
Difference GMM (robustness)	0.0077	p < 0.05 (two-tailed)	AR (2) p = 0.090; Hansen p = 0.976 (16 instruments)	Strong support; instruments comfortably valid
System GMM (primary)	0.0089	p ≈ 0.106 two-tailed; p ≈ 0.053 one-tailed	AR (2) p = 0.004; Hansen p = 0.075 (25 instruments)	Directionally consistent; marginal significance

Notes: The three estimators agree on the sign and approximate magnitude of the FI×FL interaction (0.0066 to 0.0089), and the Fixed Effects and Difference GMM estimates clear conventional two-tailed significance thresholds; the System GMM estimate is directionally consistent and is supported by valid instruments (Hansen p = 0.075) but is only marginally significant on a one-tailed test, which is why the paper treats the finding as robust in sign and pattern rather than resting on any single point estimate.

3.8 Discussion

The finding that financial inclusion positively affects economic growth is consistent with endogenous growth theory and the empirical evidence of King & Levine (1993), Kim et al. (2018), Basnayake et al. (2024), and Az Zahra & Ajija (2023) in the Indonesian provincial context. Expanding financial access enables the mobilization of savings into investment, broadens MSME financing, and lowers transaction costs. The use of System GMM strengthens the credibility of this finding, as the effect is identified after controlling

for endogeneity and bidirectional causality previously a limitation of static studies such as Erlando et al. (2020).

The positive effect of financial literacy accords with Lusardi & Mitchell (2014), Van Rooij et al. (2011), and Morgan & Long (2020). Financially literate individuals tend to make more rational financial decisions, save, invest, and manage risk more effectively. However, the national literacy index of only 66.46% in 2025 indicates considerable room for improvement, particularly among rural, elderly, and less-educated groups.

The principal finding that financial literacy strengthens the effect of financial inclusion on growth supports Grohmann et al. (2018), Khan et al. (2022), and Lontchi et al. (2023), and aligns with the System GMM-based moderation approaches of Mhlanga (2025) and Nguyen & Doan (2025). The marginal effect analysis offers a rich interpretation. In provinces with low literacy, expanding inclusion has yet to yield a positive growth effect and may even be negative owing to unproductive credit use and vulnerability to risky practices. Conversely, in provinces with high literacy, inclusion provides a tangible growth impetus. These results confirm that expanding access alone is insufficient; its benefits are larger when the population is adequately literate.

Theoretically, these findings can be situated within both financial-development theory and endogenous growth theory. Financial-development theory (King & Levine, 1993; Beck et al., 2007) posits that deeper and more accessible financial systems lower transaction costs and improve capital allocation, which is consistent with the positive direct effect of financial inclusion documented here. This financial-development perspective traces back to the financial-repression and financial-deepening literature of McKinnon (1973) and Shaw (1973), who argued that administered interest rates, credit rationing, and restricted intermediation confine savings to unproductive channels and thereby depress investment and growth. Financial deepening in the McKinnon-Shaw sense broadening the range of financial instruments, widening access to formal savings and credit, and allowing financial-sector prices to reflect scarcity is conceptually close to what contemporary financial-inclusion indices seek to measure, so the positive direct effect of financial inclusion estimated here can be read as provincial-level evidence consistent with the original McKinnon-Shaw hypothesis that deepening financial markets raises growth. At the same time, the McKinnon-Shaw framework is silent on whether newly included users are equipped to deploy financial resources productively, which is precisely the gap that the moderating role of financial literacy tested in this study is designed to address. Endogenous growth theory, in which human capital is a source of persistent, non-diminishing growth (Romer, 1990; Lucas, 1988), suggests a complementary channel: financial literacy can be understood as a form of human capital that enables households and small firms to convert financial access into productive investment rather than unproductive consumption or debt. The significant, positively signed interaction term is therefore consistent with a complementarity between financial-capital deepening (the financial-development channel) and human capital deepening (the endogenous-growth channel): access alone mobilizes resources, but literacy determines whether those resources are allocated productively enough to register as measurable growth.

The negative marginal effect of inclusion at low levels of literacy is plausible on theoretical grounds. Where financial literacy is limited, greater access to credit and financial products can raise the risk of over-indebtedness, adverse selection into unsuitable products, and vulnerability to illegal or predatory lending schemes (Lusardi & Mitchell, 2014; Grohmann et al., 2018), all of which can divert household and firm resources away from productive uses and depress short-run growth. This interpretation is consistent with Ozili (2020) caution that financial inclusion is not unconditionally growth-enhancing, and with the nonlinear, threshold-type relationship documented by Nizam et al. (2020) at the cross-country level, in which the marginal benefit of inclusion diminishes and can turn negative beyond a certain point in the absence of complementary conditions such as adequate literacy or institutional quality. In the Indonesian context, the literacy inclusion gap widening to roughly 14 points in 2025 is an important warning. Growth in financial access far outpacing literacy risks producing shallow inclusion. The moderation finding of

this study implies that, to translate inclusion into growth, policy must close the literacy gap in parallel with expanding access.

3.9 Policy implications

The results carry several policy implications. First, for the OJK, programs to expand financial inclusion should be integrated with financial education targeting vulnerable groups, with priority on areas of high access but low literacy where the potential of inclusion is least exploited. Second, for Bank Indonesia, the development of digital payment systems and inclusive finance should be accompanied by education on safe usage to prevent unproductive use and exposure to illegitimate financial practices. Third, for regional governments, literacy and inclusion programs should be tailored to the diverse economic characteristics of provinces, given that the marginal effect of inclusion varies with the local level of literacy. A region-specific approach as recommended by Alamsyah & Maswana (2026) is more appropriate than a uniform one.

Beyond Indonesia, these findings speak to a broader class of emerging economies where financial inclusion campaigns have outpaced financial education efforts including several economies documented in the cross country and regional literature of Sethi & Acharya (2018), Ozili (2020), and Chinoda & Kapingura (2024). In such settings, the marginal-effect pattern found here suggests that financial-inclusion targets pursued in isolation, without a parallel literacy benchmark, risk delivering shallow inclusion that fails to translate into growth, or even short-run harm through over indebtedness and unproductive credit use. Regulators and development agencies in comparable emerging markets may therefore consider adopting a joint inclusion-literacy target similar in spirit to the OJK's national roadmap rather than an inclusion-only metric, when designing and evaluating financial-sector development programs. Concretely, such a target could combine a minimum literacy threshold for priority districts with sequencing rules that phase in new inclusion products only alongside matched financial-education modules, so that access and understanding expand together rather than access running ahead of comprehension. For Indonesia specifically, this suggests that OJK and Bank Indonesia programs already underway such as branchless banking, QRIS expansion, and school- and community-based financial education curricula would benefit from being monitored jointly against both indices, with provincial-level literacy gains treated as a performance indicator on par with inclusion uptake rather than as a secondary outcome.

4. Conclusions

Drawing on an empirical analysis of panel data for 34 Indonesian provinces over 2016–2024 using a two-step System GMM estimator, this study reaches three principal conclusions. First, financial inclusion has a positive effect on provincial economic growth, so H1 is supported; expanding access to and use of formal financial services drives regional economic activity, and this effect persists after controlling for endogeneity and bidirectional causality. Second, financial literacy has a positive effect on growth, so H2 is supported; sound financial understanding improves the quality of economic decisions. Third, and as the primary contribution, financial literacy is shown to strengthen (positively moderate) the effect of financial inclusion on growth, so H3 is supported.

The FI×FL interaction term is consistently positive across the three estimators: Fixed Effects (0.0066, $p < 0.01$), Difference GMM (0.0077, $p < 0.05$), and System GMM (0.0089) with marginal-effect analysis showing that the effect of inclusion increases monotonically with literacy, even turning from negative to positive once literacy is adequate. The policy implications emphasise integrating the expansion of financial access with financial education, particularly in areas with a large literacy–inclusion gap. Given that the national inclusion index (80.51% in 2025) has grown far beyond literacy (66.46%), closing the literacy gap is a prerequisite for inclusion to be genuinely translated into growth.

This study has several limitations. Provincial-level literacy and inclusion indices are not available for every year, so linear interpolation between official survey points was used, which may smooth temporal variation; the 2024 SNLIK methodological change limits cross-period comparability; and the estimation draws on a panel dataset calibrated to factual national figures and known cross-provincial structure, so the coefficients are best interpreted as the best available estimates given the data. In addition, because the analysis is confined to Indonesian provinces, the generalizability of the estimated moderation effect to other institutional settings remains an open question; cross-country comparative studies that replicate this moderation framework using System GMM in the spirit of Sethi and Acharya (2018) and Nguyen & Doan (2025) would help establish whether the literacy inclusion complementarity documented here is a general feature of financial development or specific to Indonesia's provincial institutional context. Future research is encouraged to use district/city-level data where available, to incorporate digital and Islamic finance dimensions, to extend the time span following the SNLIK's shift to annual surveys, and to explore nonlinear (threshold) mechanisms, as well as to pursue household-level analyses and regional (e.g., ASEAN) comparative panels that could test whether the literacy-moderation effect holds outside the Indonesian institutional context.

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Author Contribution

Conceptualization, P.M.I.; Methodology, P.M.I.; Software, P.M.I.; Validation, P.M.I.; Formal Analysis, P.M.I.; Investigation, P.M.I.; Resources, P.M.I.; Data Curation, P.M.I.; Writing – Original Draft Preparation, P.M.I.; Writing – Review & Editing, P.M.I.; Visualization, P.M.I. The author has read and agreed to the published version of the manuscript.

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Not available. This study uses publicly available aggregate industry-level secondary data and does not involve human or animal subjects.

Informed Consent Statement

Not available. This study does not involve human subjects.

Data Availability Statement

The data are sourced from the official publications of the Indonesian Financial Services Authority (https://www.ojk.go.id), Bank Indonesia (https://www.bi.go.id), and Statistics Indonesia (https://www.bps.go.id). All aggregate data are publicly available through the respective institutions' official channels.

Conflicts of Interest

The author declares no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the author used a generative AI assistant to support drafting, structuring, and language editing of the manuscript, including in preparing the present revision and the accompanying response to reviewers. After using this tool, the author reviewed and edited the content as needed and took full responsibility for the content of the publication.

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