

Research Article

Determinants of Financial Inclusion in Selected ASEAN Countries: The Role of Technological Infrastructure and Regulatory Quality

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ABSTRACT

This study examines the influence of technological infrastructure and regulatory quality on financial inclusion across six middle-income ASEAN economies over the 2011-2024 period. A Fixed Effects estimator with Driscoll-Kraay corrected standard errors is employed to address cross-sectional dependence and non-constant error variance. Both financial inclusion and technological infrastructure are operationalized as PCA-derived composite indices, while the Regulatory Quality Index serves as the measure for institutional quality. Empirical results indicate that regulatory quality exerts a positive and statistically significant effect on financial inclusion, whereas technological infrastructure yields no significant impact. With respect to the control variables, GDP per capita and urban population share positively and significantly shape financial inclusion outcomes, while inflation exerts a negative and significant effect. Overall, these findings suggest that institutional quality, economic capacity, and structural conditions are more consistent drivers of financial inclusion than digital infrastructure availability alone. The findings further indicate that the contribution of technological development is contingent upon supportive regulatory frameworks and stable macroeconomic conditions. Accordingly, policies aimed at expanding financial inclusion should integrate digital infrastructure development with institutional strengthening, macroeconomic stability, and efforts to address structural disparities in access.

Keywords: ASEAN; financial inclusion; macroeconomic; regulatory quality; technological infrastructure

1. INTRODUCTION

The global financial landscape has experienced a fundamental restructuring over the past decade, propelled by rapid developments in digital technology base innovation (Elsayed et al., 2024; Kolinets, 2023). FinTech services, such as digital banking, mobile payments, and data-driven financing platforms, have emerged as a result of the financial sector's integration of digital information. These innovations have fundamentally reshaped how individuals and businesses interact with the formal financial system (Başar et al., 2025; Serbulova, 2021). This transformation has not only expanded the reach of financial services but is also expected to act as a catalyst for more inclusive and sustainable economic development (Hussain et al., 2023).

In line with these developments, financial inclusion has become a priority in the global economic development agenda, serving as a strategic instrument for poverty reduction, decreasing social inequality, accelerating inclusive growth, and achieving the Sustainable Development Goals (SDGs) (Ramadhan et al., 2025; Ha et al., 2025; Demir et al., 2022). In Southeast Asia, this commitment is explicitly articulated in the ASEAN Economic Community Blueprint 2025, which positions Inclusive finance as a central pillar of regional economic integration. Financial inclusion serves as a critical mechanism for promoting inclusive economic growth by ensuring equitable and affordable access to formal financial services, particularly for economic actors in lagging and underserved regions (Nasir & Du, 2018).

The Global Findex reveals that worldwide account ownership expanded from 51% in 2011 to 79% in 2024. However, substantial variations in financial access among ASEAN member states remain evident. Figure 1 In 2024, account ownership in Malaysia and Thailand exceeded 90%, while Indonesia, the Philippines, and Cambodia remained within the range of 39% to 56%. These disparities do not merely reflect differences in income levels. They also indicate structural barriers within financial systems, variations in regulatory quality, varying levels of digital infrastructure preparedness, and underlying socio-economic conditions that influence the accessibility of financial services across country. Addressing this inequality has become increasingly urgent given the systemic consequences of financial exclusion. From a macroeconomic perspective, limited financial service accessibility constrains people ability to save formally and reduces the efficiency of capital allocation within the economy. In turn, this restricts productive investment and slows long-term economic growth. At the microeconomic level, limited access to formal financial services constrains the long-term viability

and productive capacity of Micro, Small, and Medium Enterprises (MSMEs). This sector constitutes the pillar of ASEAN's economy, contributing an average of 44.8% to GDP and absorbing 85% of the labor force. Limited access to bank credit and formal financial instruments compels business actors to rely on informal sources of financing characterized by high costs, thereby increasing business risk and constraining their capacity for production expansion.

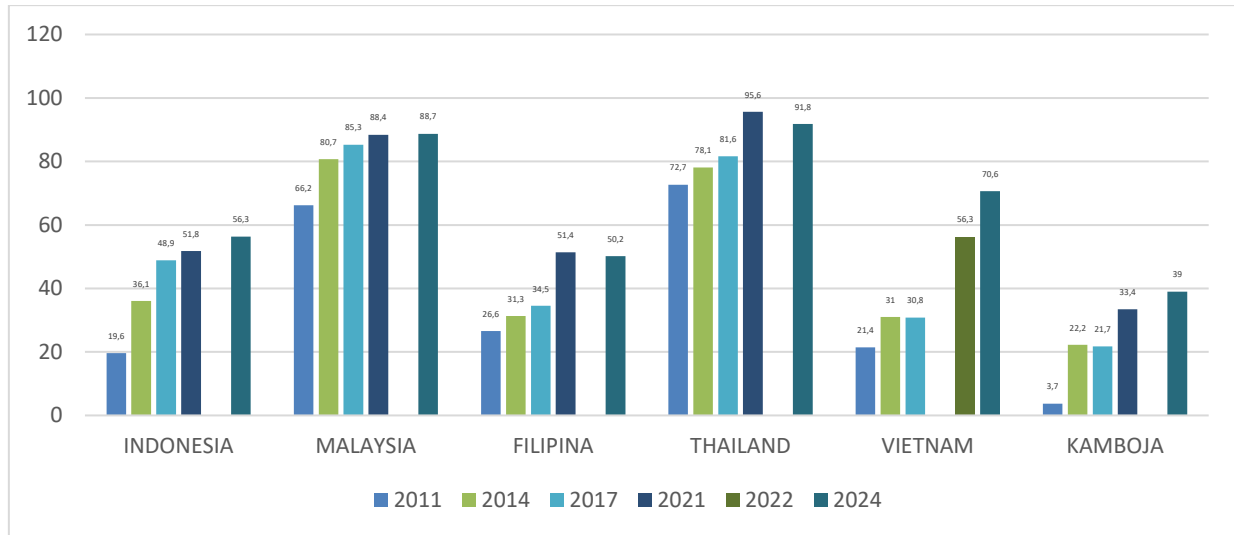


Figure 1. Account Ownership (15+). Source: FAS

Beyond its economic implications, financial exclusion also deepens social inequality and widens welfare gaps across income groups. Access to formal financial services tends to be asymmetric, largely concentrated among middle- and upper-income groups, while low-income and vulnerable populations face structural barriers in obtaining such services. This condition creates a poverty trap in which limited financial inclusion increases household vulnerability to economic shocks and income uncertainty, while simultaneously reducing their capacity to build a sustainable foundation for long-term welfare.

Observing this disparity, recent literature highlights that financial inclusion in a country level is not determined by a single factor, but rather is influenced by its supporting ecosystem. In the digital economy era, technological infrastructure has become a crucial determinant. Digital platform-based financial services are capable of democratizing financial access by overcoming dependence on the physical presence of financial institutions (Feyen et al., 2021). Through the utilization of connectivity and computing power, technology acts as a disruptive force that reduces transaction costs and diminishes information asymmetry through the use of alternative credit scoring. This mechanism enables financial institutions to reach the unbanked population previously considered unbankable due to the absence of formal credit history or isolated geographical locations (Anarfo et al., 2020). Within the framework of financial intermediation theory proposed by Levine (1997), it is asserted that optimal financial intermediation can reduce information barriers and transaction costs. The urgency of technology's role is reinforced by Duan, Yuan, dan Tian (2024), who found that the expansion of digitally enabled financial services substantially influences and improving financial access among vulnerable groups.

In addition to technological factors, financial participation is also impacted by the quality of governance. Credible institutions and effective public policies establish a framework that supports equitable access to financial services throughout all population segments (Ngo et al., 2023). Based on Institutional Theory proposed by Douglass C. North (1990), institutions are the "rules of the game" that shape the incentive structure in economic activity. Formal institutions, including regulations and government policies, determine the level of legal certainty and transaction costs in the economic system. (Arner et al., 2020) underscore the necessity of an equilibrated regulatory framework within the digital ecosystem. Without adaptive regulation and strong law enforcement, the rapid adoption of financial technology may generate systemic risks, such as cybercrime, data theft, and predatory lending practices, which can ultimately erode public trust in the formal financial system.

Departing from the phenomenon of persistent financial inclusion disparity in the ASEAN region and theoretical arguments regarding the dual role of technology and institutions, this study finds its urgency. Although the literature on Inclusive finance has developed rapidly, it is still necessary to fill several important gaps. Empirical studies have generally analyzed the determinants of financial inclusion separately rather than within an integrated framework. Cross-country studies by Vo, (2024, 2025), Zeqiraj et al. (2022) and findings in Montano et al. (2024) consistently demonstrate that institutional quality is a vital foundation, yet the global and Asia-Pacific scope employed fails to adequately capture the technological infrastructure specifications in ASEAN developing countries. On the other hand, recent research specifically addressing ASEAN by Ha et al. (2025) focuses on fintech resonance without explicitly testing the role of regulatory quality as a prerequisite for secure technology adoption. Meanwhile, in a separate study, Ha & Nguyen (2023) separately discuss institutional quality. To date, these two dimensions have largely been discussed in isolation across different publications, thereby failing to provide empirical evidence on how technological infrastructure and regulatory quality operate

simultaneously within an integrated estimation model.

This study is motivated by indications that the growth of technological infrastructure and the dynamics of regulatory quality play significant roles in shaping financial inclusion in the ASEAN region. However, prior empirical findings remain mixed and fragmented. Premised on this identified gap, the present study investigates three principal research questions: (1) How does technological infrastructure affect financial inclusion across six ASEAN member states over the period 2011-2024? (2) How does regulatory quality affect financial inclusion within the same six ASEAN economies during the 2011-2024 timeframe? (3) How do technological infrastructure and regulatory quality jointly effect financial inclusion in selected ASEAN member states throughout the period 2011-2024?

This study seeks to present an empirical assessment of the interaction between these two factors during the most recent observation period. This research offer empirical contributes for middle-income and developing ASEAN economies by demonstrating that strengthening digital infrastructure and enhancing regulatory quality serve as critical determinants in advancing broader access to financial services. This results therefore aligns with the broader agenda of the SDGs particularly Goal 8, which prioritizes broad based and continuous economic advancement, the generation sustainable job opportunities, and the assurance of decent work across all segments of society. Accordingly, this research is not only academically relevant but also provides practical implications for advancing more equitable and inclusive economic development.

2. RESEARCH METHOD

2.1 Variables and Sampling Framework

This study utilizes panel data drawn from six Southeast Asian countries spanning the 2011 to 2024 period. The variables employed, along with their respective data sources, are summarized in Table 1. As the dependent variable, financial inclusion is quantified through a composite score derived via Principal Component Analysis (PCA), which systematically consolidates multiple proxy indicators into a single comprehensive measure reflecting the degree to which the general population can access and utilize formal financial systems, encompassing deposit facilities, credit instruments, and savings mechanisms. The two principal independent variables in this study are technological infrastructure and regulatory quality. Technological infrastructure is operationalized through a PCA derived composite score encompassing internet access penetration as a share of total population and mobile cellular subscriptions per 100 inhabitants. Regulatory quality, in turn, is proxied by the Regulatory Quality Index, which reflects governmental capacity to formulate and implement sound policies and institutional frameworks conducive to privet sector development. Beyond the primary explanatory variables, this study incorporates a set of macroeconomic and structural covariates to account for confounding influences on financial inclusion outcomes. Specifically, GDP per capita is introduced as an indicator of household income levels and purchasing capacity, inflation is included to capture the degree of price volatility and broader macroeconomic instability, and the urban population share is employed to reflect disparities in infrastructure availability, and the extent of structural economic transformation. Incorporating these covariates serves to mitigate potential omitted variable bias, ensuring that the estimated coefficient of technological infrastructure and regulatory quality genuinely reflect their independent contributions to financial inclusion, thereby enhancing the reliability and interpretability of the empirical result.

Table 1. Research Variable

Variables	Measurements	Source
Dependent Variables		
Financial Inclusion Index	ATMs Per 100.000 adults	IMF
	Bank Branches Per 100.000 adults	IMF
	Credit cards Per 1.000 adults	IMF
	Debit cards Per 1.000 adults	IMF
	Outstanding deposits % of GDP	IMF
	Outstanding loans % of GDP	IMF
Independent Variables		
Technological Infrastructure Index	Individuals using internet (% of population)	ITU
	Mobile cellular subscriptions (per 100 people)	ITU
	Regulatory Quality Index Estimate (-2.5-2.5)	WGI
Control Variables		
GDP per Capita	Natural logarithm GDP per Capita (constant 2015 US\$)	WDI
Inflation	Inflation, consumer prices (annual %)	International Financial Statistics database
Urban Population	Urban Population (% of total population)	World Urbanization Prospects, United Nations

2.2 Principal Component Analysis (PCA)

PCA constitutes a dimension reduction technique rooted in multivariate statistics, designed to condense a set of mutually correlated indicators into a reduced collection of uncorrelated composite components. Through this process, the method simultaneously minimizes data complexity while safeguarding the essential informational content embedded within the original variables, thereby producing a parsimonious yet comprehensive representation of the underlying constructs (Abor et al., 2024; Hosen et al., 2025; Jolliffe & Cadima, 2016). A further methodological advantage of PCA lies in its ability to

identify structural similarities and distinctions across differently specified models, rendering it particularly valuable for comparative analytical purposes (Yoshino & Taghizadeh Hesary, 2015). Within the framework of this study, PCA is employed to derive two composite indices, namely financial inclusion index and technological infrastructure index. The financial inclusion index is operationalized through six proxy indicator, automated teller machines (ATMs) per 100.000 adult population, commercial bank branches networks per 100.000 adults, credit cards ownership per 1.000 adults, debit cards ownership per 1.000 adults; outstanding deposits liabilities held in commercial banking institution as a proportion of GDP, and outstanding loans portfolios extended by commercial banking institution as a proportion of GDP. The technological infrastructure index, in turn, is constructed from two constituent indicators, the rate of internet access penetration expressed as a share of the total population, and mobile cellular subscription density measured per 100 inhabitants.

As a prerequisite to PCA execution, the Kaiser-Meyer-Olkin (KMO) measure was conducted as a prerequisite, where the PCA technique can be applied if the KMO value exceeds 0.5. Based on the test, financial inclusion indicators yielded a KMO value of 0.527, while technological infrastructure showed a value of 0.500. As both coefficients satisfy the stipulated minimum criterion, the underlying data structures were deemed statistically appropriate for PCA extraction. Subsequently, component retention was determined based on two established criteria: an eigenvalue exceeding 1.0 or a cumulative explained variance surpassing 60 percent (Banda & Kumarasamy, 2020; Malik et al., 2022), with the corresponding outcomes documented in Table 3. For the financial inclusion construct, the extraction procedure identified two retained components carrying eigenvalues above unity, collectively accounting for 51.27 percent and 30.35 percent of total variance, and yielding an aggregate explained variance of 81.62 percent. As displayed in Table 5, the extraction results for the technological infrastructure variable indicate one component with an eigenvalue above 1, accounting for a cumulative variance of 68.76 percent.

Table 2. KMO and Bartlett's Test of Financial Inclusion

Kaiser Mayer Olkin Measure of Sampling Adequacy	0.527
Bartlett test of sphericity	
Approx. Chi-square	439.566
df	15
Sig.	<0.001

Table 3. Financial Inclusion Eigenvalues and Variance Result.

Component	Eigenvalue	% Variance Explained	Cumulative %
Comp1	3.076	51.270	51.270
Comp2	1.821	30.348	81.618
Comp3	0.519	8.653	90.271
Comp4	0.447	7.458	97.729
Comp5	0.106	1.770	99.499
Comp6	0.030	0.501	100.000

Table 4. KMO and Bartlett's Test of Technological Infrastructure

Kaiser Mayer Olkin Measure of Sampling Adequacy	0.500
Bartlett test of sphericity	
Approx. Chi-square	12.373
df	1
Sig.	<0.001

Table 5. Technological Infrastructure Eigenvalues and Variance Result.

Component	Eigenvalue	% Variance Explained	Cumulative %
Comp1	1.375	68.765	68.765
Comp2	0.625	31.235	100.000

2.2 Econometric Model

This study applies panel data regression to examine how technological infrastructure and regulatory quality influence financial inclusion across six ASEAN countries over the specified observation period. The model is estimated using a Fixed Effects (FE) approach, which controls for unobserved time-invariant heterogeneity across countries (Rüttenauer & Ludwig, 2023). The selection of the FE estimator is justified by consideration that structural differences among countries may be correlated with the independent variables under investigation. To enhance estimation reliability, this study employs Driscoll-Kraay standard errors capable of addressing heteroskedasticity, serial correlation, and cross-sectional dependence (Driscoll & Kraay, 1998). This approach is chosen given that cross-country macroeconomic panel data tend to violate the basic assumptions required in standard Ordinary Least Squares estimation. Mathematically, the empirical model is specified as follows:

$$FI_{it} = \alpha + \beta_1 TI_{it} + \beta_2 RQ_{it} + \beta_3 LnGDPpc_{it} + \beta_4 INF_{it} + \beta_5 LnUP_{it} + \varepsilon_{it}$$

Where:

FI : Financial Inclusion Index
 TI : Technological Infrastructure Index

RQ	: Regulatory Quality
LnGDPpc	: Natural logarithm of GDP per capita
INF	: Inflation
LnUP	: Natural logarithm of the urban population
β_1 - β_5	: Regression coefficients of the independent and control variables
ε	: Stochastic error term
i	: Country
t	: Time periods

3. RESULTS AND DISCUSSION

3.1 Results

This section opens with an interpretation of the descriptive statistics reported in Table 6. As evidenced by the statistical profile documented in Table 6, both the Financial Inclusion Index (FI) and the Technological Infrastructure Index (TI) register mean values approximating zero alongside standard deviations of unity. These characteristics confirm that both variables are standardized index scores, reflecting consistent variation across both cross-sectional units and time series dimensions. Regulatory Quality (RQ) exhibits moderate variability, representing differences in institutional conditions among the sampled ASEAN member economies. The macroeconomic variables demonstrate clear heterogeneity. GDP per capita appears relatively stable within the group of middle-income countries, while inflation shows dynamic fluctuations over the observation period. Meanwhile, the level of urbanization tends to remain stable, indicating relatively similar structural demographic characteristics across the sampled countries. The inter-variable association structure, as depicted in Table 7, reveals that no two constructs attain perfect linear correspondence, thereby suggesting that severe multicollinearity does not constitute a concern within the estimated model. Although certain variables, such as GDP per capita and the urban population, show relatively high correlations, the coefficients remain within an acceptable range. This finding is further supported by the average Variance Inflation Factor (VIF) value of 3.89, with all variables reporting VIF scores below the threshold of 10. These results confirm that each variable in the model provides unique and independent information.

Table 6. Decriptive Statistics.

Variable	Obs	Mean	Std. dev	Min	Max
FI	84	0.0003571	1.000163	-1.62	1.57
TI	84	0.0005952	1.000394	-2.51	2.21
RQ	84	-0.0238095	0.6007263	-1	1
LnGDPpc	84	8.259286	0.5840609	7.11	9.38
INF	84	3.113095	2.590473	-1.6	18.7
LnUP	84	3.876071	0.3005939	3.09	4.34

Note: "Std. Dev" means standar deviation, FI= Financial Inclusion Index, TI= Technological Infrastructure Index, RQ= Regulatory Quality, LnGDPpc= Natural logarithm of the urban population, INF= Inflation, LnUP= Urban Population.

Table 7. Correlation Matrix of the Variables.

Variable	VIF	1/VIF	(1)	(2)	(3)	(4)	(5)
(1) Tech. Infrastructure	2.17	0.460604	1.0000				
(2) Regulatory Quality	3.63	0.275861	0.3565	1.0000			
(3) GDP per capita	8.47	0.118133	0.6529	0.8158	1.0000		
(4) Inflation	1.12	0.894234	-0.2512	-0.2685	-0.3165	1.0000	
(5) Urban Population	4.09	0.244695	0.4601	0.7608	0.8571	-0.2705	1.0000
Mean VIF	3.89						

The empirical outcomes derived from the panel data regression procedure utilizing a Fixed Effects specification are systematically reported in Table 8. This estimator effectively absorbs latent country-specific attributes that exhibit no variation over time yet remain unobservable to the researcher, consequently ensuring that the resulting coefficient estimates genuinely reflect within-country temporal dynamics rather than cross-sectional variation. To ensure the validity of statistical inference, the model employs Driscoll-Kraay standard errors, capable of correcting for heteroskedasticity, autocorrelation, and cross-sectional interdependence prevalent in panel data for macroeconomic analysis (Driscoll & Kraay, 1998). The joint significance of all regressors incorporated within the model is confirmed by the F-statistic, whose associated probability value falls below the 0.01 significance threshold, indicating that the full set of explanatory constructs collectively exerts a statistically meaningful influence on financial inclusion outcomes. This finding implies that technological infrastructure, regulatory quality, and the macroeconomic and structural control variables collectively explain variations in financial inclusion across the six sampled ASEAN economies during the study period. Furthermore, the model demonstrates considerable goodness-of-fit, as evidenced by a within R-squared coefficient of 0.8129, signifying that approximately 81.29 percent of the intra-country temporal fluctuations in financial inclusion are successfully explained by the constellation of regressors embedded in the specification, while the remaining 18.71 percent is attributable to other factors not captured in the specification.

Table 8. Estimated Results

Variables	Coef.	Std. Error	Prob.
TI	-0.082	0.057	0.173
RQ	0.155**	0.063	0.028
LnGDPpc	1.431***	0.336	0.001
INF	-0.018***	0.005	0.002
LnUP	1.688***	0.453	0.003
Constant	-18.301***	3.414	0.000
Observations	84		
Countries	6		
Within R-squared	0.8129		
Prob > F	0.0000		

Standar errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Based on the regression estimates reported in Table 8, the digital technological infrastructure variable has a probability value of 0.173, which exceeds the 0.05 threshold, indicating that this variable does not significantly influence financial inclusion. Regulatory quality, however, produces a positive and significant coefficient of 0.155 ($p = 0.028$), suggesting that a one-unit increase in regulatory quality raises the financial inclusion index by 0.155 units. Regarding the control variables, the logarithm of GDP per capita has a probability value of 0.001, which is below 0.01, and a positive coefficient of 1.431. This implies that a 1 percent increase in GDP per capita is associated with a 1.431 percent increase in financial inclusion, and the relationship is statistically significant. Inflation yields a probability value of 0.002, which is below 0.01, with a coefficient of -0.018 . This indicates that a one unit increase in inflation significantly reduces financial inclusion by 0.018 units. Meanwhile, the level of urbanization shows a probability value of 0.003, also below 0.01, and a positive coefficient of 1.688. Thus, a one percent increase in urban population share is associated with a 1.688 percent improvement in financial inclusion.

3.2 Discussion

3.2.1 The Impact of Technological Infrastructure on Financial Inclusion

According to this study, technological infrastructure has no statistically significant effect on financial inclusion. The coefficient of this variable is negative, at -0.082 , with a probability value of 0.173, indicating that the expansion of technological infrastructure, measured by internet penetration and mobile device ownership, has not been able to substantially promote financial inclusion in six middle-class ASEAN countries during the observation period. These results imply that increasing access to formal financial services is not yet dependent on the availability of technological infrastructure. In other words, technology functions as an enabling factor but is insufficient to drive changes in economic behaviour without support from other factors such as financial literacy, trust in financial institutions, and the quality of regulation and governance (Iatzaz Ul Hassan et al., 2025).

These results differ from part of the literature that positions digitalization as a primary driver of financial inclusion (Duan et al., 2024; Feyen et al., 2021). This discrepancy can be explained by the context of developing countries, particularly in the ASEAN region, where gaps in digital literacy, disparities in access between urban and rural areas, and limited institutional capacity hinder the optimal utilization of technology (Abdullahi & Aliyu, 2025; Kusumastuti & Nuryani, 2020; Setyanti et al., 2025). Accordingly, this study points to a phenomenon often associated in the literature with the “digital paradox”, a condition in which the presence of technological infrastructure doesn’t automatically result in a proportional expansion of financial inclusion. This paradox highlights that the distinction between the availability of technology and its effective utilization is a key factor in explaining why digital transformation has not fully translated into expanded financial inclusion in nations with moderate incomes.

Consistent with these results, the provision of technological infrastructure as a supply-driven approach needs to be complemented by demand-side strategies that focus on enhancing the capacity and readiness of individuals to adopt formal financial services. In this context, improving financial and digital literacy becomes a fundamental prerequisite, ensuring that individuals can use technology efficiently in addition to having access to it. In addition, strengthening institutional quality and regulatory frameworks is necessary to build trust in digital financial systems, particularly through consumer protection and data security. At the same time, more targeted policies are required to reach low-income groups and rural populations that remain lagging in the adoption of financial technology.

3.2.2 The Effect of Regulatory Quality on Financial Inclusion

With a coefficient of 0.155 at the 5% significance level ($p = 0.028$), the estimation findings show that regulatory quality has a favorable and statistically significant impact on financial inclusion. This finding suggests that improvements in regulatory quality contribute to a rise in middle-income ASEAN nations' use of and access to formal financial services over the observation period. Put another way, increased involvement in the formal financial system is typically encouraged by a well-functioning regulatory environment. Within the framework of Institutional Theory, as proposed by Douglass North (1990), formal institutions are conceptualized as the “rules of the game” that shape incentive structures in economic activity. Effective regulation can reduce transaction costs, minimize uncertainty, and strengthen public trust in the financial system. In the context of financial inclusion, these conditions create incentives for people and firm to engage more intensively using

official financial services, whether through account ownership, the use of payment instruments, or access to financing.

Furthermore, an adaptive regulatory framework not only serves as a mechanism to protect against predatory lending practices, cybercrime, and fraud risks, but also establishes consistent and credible law enforcement mechanisms. This becomes increasingly important in middle-income ASEAN countries, where trust in formal financial institutions remains in a consolidation phase. In this context, sound regulation plays a dual role in protecting consumers while maintaining financial system stability, thereby expanding access for populations that have traditionally been underserved by formal financial institutions (Sebai et al., 2025).

Empirically, these findings are consistent with prior studies demonstrating that improvements in institutional quality and governance significantly contribute to financial inclusion, particularly in middle-income countries (Basnayake et al., 2025; Nugrohowati & Ash Shidiqie, 2025; Zeqiraj et al., 2022b). This indicates that regulatory quality plays a persistently critical role in enhancing both accessibility and participation in formal financial systems across contexts of developing countries. From an economic perspective, effective regulation not only enhances inclusivity but also reduces inequality and strengthens long-term economic stability (Bibi et al., 2024). Moreover, this study provides additional empirical evidence by demonstrating that regulatory quality remains a significant determinant of financial inclusion even when technological infrastructure and macroeconomic factors are simultaneously controlled for. These findings indicate that the role of regulation is not merely complementary but also relatively stable in determining the observed differences in the financial inclusion of middle-income ASEAN nations.

Building on these results, policymakers must adopt more strategic and consistent approaches when implementing rules to optimize their beneficial effects on the results of financial inclusion. Regulatory simplification must be accompanied by consistent law enforcement to reduce administrative barriers and enhance public trust. In practice, this can be achieved through the standardization of basic financial service procedures and the strengthening of more responsive supervisory mechanisms. In addition, reinforcing consumer protection through greater transparency and effective complaint-handling mechanisms are crucial to ensure the secure use of financial services. At the same time, regulatory harmonization across sectors is necessary to avoid policy overlap that may hinder financial access. Thus, the effectiveness of regulation is determined not only by the existence of rules but also by the quality and consistency of their implementation, which ultimately contributes significantly to the advancement of financial inclusion.

3.2.3 The Simultaneous Effect of Technological Infrastructure and Regulatory Quality on Financial Inclusion

The estimation outcomes indicate a clear differentiation in the roles of technological, institutional, and economic factors in explaining financial inclusion. Within the simultaneous model, regulatory quality, along with macroeconomic and structural variables, exerts a statistically significant effect, while technological infrastructure does not show a significant influence. These findings indicate that the availability of technology does not automatically become a primary determinant of financial inclusion when institutional and economic factors are considered simultaneously. The role of technology in promoting financial inclusion tends to be conditional (Cevik, 2024). Without the support of strong regulatory quality and economic stability, the presence of digital infrastructure is insufficient to significantly increase participation in the formal financial system (Saidi, 2025). The importance of regulatory quality, on the other hand, indicates that institutional elements are more consistently responsible for fostering an environment that facilitates the use of financial services.

Beyond the main variables, macroeconomic conditions and structural characteristics greatly impact the advancement of financial inclusion. Higher income levels increase people's ability to access and use financial services, according to the positive impact of gross domestic product per capita. Conversely, the negative effect of inflation suggests that price instability acts as a constraint by increasing economic uncertainty and weakening public confidence in formal financial institutions. Meanwhile, the positive effect of the urban population proportion reflects the structural advantages of urban areas, particularly in facilitating access to financial institutions, providing of supporting facilities, and exhibiting relatively higher levels of financial knowledge.

Within the framework of a jointly estimated specification, these findings indicate that economic and structural factors are not only statistically significant but also function as underlying conditions that influence the effectiveness of other variables in the model. Adequate income levels, price stability, and ease of access create an environment that enables individuals to utilize financial services more effectively. Overall, the finding indicate a more consistent association between financial inclusion in the selected ASEAN countries and regulatory quality as well as economic conditions, compared to the availability of technological infrastructure. These findings further indicate that the effectiveness of digitalization in the financial sector is not automatic, but rather depends on institutional readiness and underlying economic stability. In this context, technology acts as a supporting factor, while institutional quality and economic conditions serve as the primary prerequisites for achieving sustainable financial inclusion

4. CONCLUSION

This research offers empirical insight into the key drivers shaping financial inclusion across selected ASEAN economies classified as middle-income over the period 2011–2024. By employing composite indices derived from Principal Component Analysis and panel data estimation, the results indicate that technological infrastructure does not exert statistically meaningful influence on financial inclusion. In contrast, regulatory quality shows a positive and significant influence, underscoring the importance of institutional capacity in fostering trust and strengthening financial systems. Within a simultaneous framework, regulatory quality, along with macroeconomic and structural factors proxied by gross domestic product per capita, inflation, and urban population, significantly influences financial inclusion, while technological

infrastructure remains insignificant. Overall, the evidence indicates that financial inclusion is more consistently driven by economic conditions and institutional quality than by the availability of technology alone. This study highlights that the role of technology is inherently conditional, contingent upon institutional preparedness and the overall state of the economy.

RECOMMENDATIONS

First, policymakers and financial regulatory authorities should strengthen regulatory quality by enhancing legal frameworks, consumer protection mechanisms, and supervisory effectiveness to reduce information asymmetry and build public trust in formal financial systems. Second, financial service providers should recognise the limited impact of digital infrastructure availability on financial inclusion; therefore, they need to prioritise user-oriented approaches, including transparent services, accessible products, and effective financial communication. Third, stakeholders, including governments and development institutions, are encouraged to complement digital infrastructure expansion with targeted efforts aimed at strengthening financial and digital literacy, particularly among underserved and low-income populations, in order to ensure the effective utilisation of financial services. Further investigation could focus on identifying underlying mechanisms, including factors like financial literacy, institutional trust, and the uptake of digital technology, in order to better understand how technological progress and institutional conditions interact in shaping financial inclusion. In addition, comparative analyses involving countries at varying stages of economic development or with diverse institutional contexts may improve the generalisability and policy relevance of the findings

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AUTHOR'S CONTRIBUTIONS

The author was responsible for data analysis and manuscript preparation, while the co-author provided supervision and academic support throughout the study.

CONFLICT OF INTEREST

The authors have disclosed no conflicts of interest.

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