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Does financial inclusion strengthen the fintech-growth nexus? Evidence from small and medium enterprises

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A B S T R A C T

Purpose: This study will contribute to the understanding of how adoption of FinTech, access to finance and financial inclusion jointly affect firm growth through direct, mediating and moderating pathways.

Method: A survey-based quantitative methodology and hierarchical regression analysis were used to test the hypotheses and model relationships.

Findings: The findings indicate that FinTech adoption has strong positive impact on access to finance, which in turn affects firm growth. Greater financial inclusion multiplies the effect of FinTech use and growth, suggesting that inclusive financial systems enhance the gains from digital transformation. The mediation analysis additionally shows that financial access mediates the FinTech–growth nexus to some extent, implying that FinTech enhances firm performance in a direct way by means of technological efficiencies as well as indirectly via financial accessibility. These results highlight the strategic significance of fintech in shaping firms' financial behavior, competitiveness and value.

Novelty: The integrated approach in this study combines Financial Intermediation Theory, Financial Inclusion Theory, and the Technology Acceptance Model providing a comprehensive view of how FinTech leads to firm growth. It contributes to empirical knowledge by identifying financial inclusion as a moderating factor between digital transformation and financial access.

Implications: The results underscore that strengthening digital financial infrastructure, encouraging inclusive policies, and improving financial literacy are critical for optimising the socioeconomic contribution of FinTech innovation to firm development and resilience.

1. Introduction

Financial technology (FinTech) has expanded rapidly across the globe which has significantly changed the economic environment for small and medium enterprises (SMEs) that have traditionally had limited credit sources and hard access to formal finance. Inclusive and efficient financing mechanisms have been promoted by advances of FinTech innovations such as peer-to-peer (P2P) lending, crowdfunding, as well as digital payment systems (Ahmed 2025; Laia 2025). In the post-pandemic era, the propensity for FinTech adoption increased because of higher need for no-physical contact transactions and digital financing services (Al-Okaily et al. 2025; Singh et al. 2025). The World

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Bank (2023) claims that digital financial services have broadened access to finance for more than 1.2 billion adult unbanked people, particularly in developing countries (Ghosh and Bhatia 2025). In this vein, SMEs are emerging as the primary beneficiaries of financing ecosystems led by FinTech that strengthen business agility and competiveness (Campanella et al. 2025; Guo and Wang 2025). Accordingly, learning how FinTech adoption spurs firm growth by facilitating the access to finance has become of growing importance for policy makers and business practitioners.

Interestingly, despite the potential of FinTech in generating beneficial effects for firm performance, marked differences still exist regarding how such benefits unfold in diverse regions and institutional settings. In many emerging markets, the embedding of FinTech within SME financing mechanisms is encountering obstacles like absence of regulatory effectiveness, digital literacy divides and feeble institutional frameworks (Bentum-Micah et al. 2025; Del Sarto and Ozili 2025). Recent empirical evidence reveals that FinTech adoption results in enhanced financial inclusion but the effect of FinTech on firms' growth is contingent upon institutional quality and regional infrastructure (Dong, Zheng, and Tang 2024; Wang, Zhu, and Chang 2024). In addition, SMEs in emerging economies rely more on informal or alternative sources of finance because of less established credit histories and lack of collateral (Ajetomobi et al. 2025; Le, Nguyen, and Vo 2024; Nadege, Jacob, and Araar 2024). Thus, although FinTech mitigates information asymmetry in principle, the extent to which it is able drive sustainable firm growth is contingent upon the regime of financial inclusion and digital preparedness of SMEs (Abdurrahman 2025; Chien, Zhang, and Sadiq 2025; Tanchangya et al. 2025).

Arguably, this paper is based on three theoretical foundations: Financial Intermediation Theory; Technology Acceptance Model (TAM); and Financial Inclusion Theory. The resource allocation theory (Ashar and Shapiro 1988), under which efficient financial systems mean better allocated resources and more firm growth is also a part of the financial intermediation theory. According to the TAM (Davis, 1989) user acceptance of new technology is based on perceived ease of use and usefulness which are both applicable to SME FinTech usage. Financial Inclusion Theory (Mader 2018; Ozili 2020), stresses that broad and easy access to financial services will promote broad-based economic activity or growth. Synthesizing such insights, the adoption of FinTech increases access to finance (mediation) and firm performance, whereas financial inclusion acts as a moderator that factors in amplifying benefits of FinTech in protracted institutional context (Hidayat-ur-Rehman and Hossain 2024; Skandalis 2025).

While previous research support the beneficial impact of FinTech on financial inclusion and firm growth, their results are not consistent across countries. Some studies claim that FinTech considerably improves the performance of SMEs by increasing credit accessibility (Nguyen et al., 2022; Boateng et al., 2024; Lee et al., 2023; Tang et al., 2023). Others demonstrate by contrast that the impact of FinTech is weak or negative due to lack of digital infrastructure and or institution inefficiency (Ozili, 2022; Ayyagari et al., 2021; Hou et al., 2024; Allen et al., 2023). These inconsistencies emphasize a gap in the research pertaining to the conditional nature of financial inclusion in FinTech growth nexus. Our research fills that gap by synthesizing three complementary theoretical perspectives of financial intermediation, technological adoption and financial inclusion to formulate a multi-path model of the direct and indirect influence of FinTech on SME growth (Anagnostopoulos, Sails, and Alexandrou 2025; Romero Alvarez et al. 2025). The originality resides in examining the moderation effect of financial inclusion with post-pandemic (2020–2024) data which represents acceleration of digital financial ecosystems in developing countries.

The purpose of this paper is to examine the effect of FinTech adoption on access to finance, the influence of access to finance on firm growth and how financial inclusion can moderate the FinTech adoption–firm growth relationship. This research contributes to theory and practice. It theoretically expands the Financial Intermediation Theory to incorporate FinTech as a technology middleman that helps fill funding gaps and emphasizes how financial inclusion facilities access to finance. From a practical perspective, the results have important implications

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for policy makers and financial intermediaries in formulating policies based on evidence to promote inclusive digital finance and facilitate SME development programmes. From a global perspective, this research has relevance to the larger discussion on digital transformation and sustainable economic growth (with linkages to the SDG 8 and SDG 9) by the United Nations which promotes rapid inclusive growth within industry that is innovation-led, helps provide universal access to financial services among all social classes.

2. Critical Review

2.1 The Impact of FinTech Usage on Financial Inclusion

The rise of financial technology (FinTech) has changed the small and medium enterprises (SMEs) financing scene especially in developing countries. FinTech channels, such as peer-to-peer (P2P) lending, definition-leveraging crowdfunding and digital payments systems have aided firms in transcending conventional credit constraints through flexible data-driven financial services provision (Lee & Shin, 2018; Frost et al., 2020). The financial digitization also eases information imbalance, expedites credit evaluation and then decreases the transaction costs (Vives, 2019). Empirically, in the developing countries it has been found that SMEs utilizing FinTech are having better access to credit than non-users (Ozili, 2022; Kweka & Mwaipopo, 2023).

H1: FinTech usage has a positive impact on access to finance.

2.2 Access to finance and firm growth

The availability of finance is an essential factor for firm growth which allows firm to invest in new technology, expand its production capacity and increase the competitiveness (Beck et al., 2008). One of the key challenges for small firms in emerging economies whose needes to finance are constraintcted remain limited access (Ayyagari et al., 2011). Turns.out.and.I.don't.want.to. get.theory.here.but.just.read) Theories of financial development suggest that wider access to financial resources promotes capital accumulation and innovation, which in turn fosters corporate growth (Levine, 2005). Evidence from micro (and small) firms also indicates that access to loans causes a leaping up in sales and employment growth (Aterido et al., 2019; Kuntchev et al., 2022).

H2: Access to finance is positively related to firm growth.

2.3 The Moderating Effect of Financial Inclusion in the FinTech–Growth Nexus

Financial inclusion is a measure of the accessibility and usage of official financial services by individuals and firms (Demirgüç-Kunt et al., 2022). A developed inclusive financial system magnifies the gain from FinTech through raising new entrants in using and trusting electronic transactions online (Sahay et al., 2020). Financial innovation will be more widely adopted with high financial inclusion, whereas poor financial inclusion reduces the potential for FinTech to spur growth (Sarma & Pais, 2011; Allen et al., 2023). Hence, it is anticipated that financial inclusion will moderate the positive relationship between FinTech adoption and firm growth since lower cost (improving dimensions of access include cost) and higher quality of services optimize the use of financial technologies.

H3: The effect of FinTech adoption on firm growth is moderated by financial inclusion and it positive.

3. Methodological Innovations

3.1 Design research

The research design in this study is quantitative explanatory research with a cross-sectional survey supported by firm level financial data. The design attempts to test empirically the causality between FinTech adoption, access to finance, financial inclusion and firm growth using the conceptual model outlined in Section 2. Data is collected through structured questionnaires circulated to SMEs of various industries. The measurement model is based on a positivist one, in which hypotheses (H1–H3) are tested statistically through inferential analysis. This model enables the testing of both direct and moderating effects, with access to finance as a mediating variable and financial inclusion as a moderating construct. The use of SPSS version 28 This paper uses SPSS version 28 for data cleaning, descriptive analysis and regression modeling investigating robust parameter estimation and hypothesis testing under classical assumption

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criteria (normality, multicollinearity, heteroscedasticity and autocorrelation).

3.2 Research data population

The sample consists of officially registered small and medium enterprises [SME] that provide goods and/or services in the industrial, commercial, and service sectors between 2020 through to 2024. The sampling frame was generated from a number of reliable sources of data, including the national SME registry, FinTech database (OJK), financial inclusion index by Bank Indonesia and BPS SME Digital Transformation Survey. To enable appropriate representation, stratified random sampling was used for the same on firm size sectoral classification and digital adoption level. Overall, 350 questionnaires were distributed and 312 valid responses were then gathered giving a response rate of 89.1% sufficient for multiple regression analysis and establishing reliability (validation). This sample offers a solid base which allows the generalisation of our results to the larger population of SMEs. Description of the respondent demographic profiles, e.g., firm size, sector and ownership type and FinTech usage intensity is given in Appendix Data A – Table 1, with sufficient differences ensuring a diverse and representative dataset.

3.3 Variable data instrument

All constructs in the study were operationalized using established measures adopted from previous published Scopus-indexed research for conceptual and empirical robustness. These variables are; FinTech Adoption; Access to Finance, Firm Growth and Financial Inclusion as well as a number of control variables (age, sector & size of firm and access level to product key feature etc.). Each factor was measured by the multi-item statements with a 5-points Likert scale ranging from "strongly disagree"= 1 to "strongly agree"= 5 that provide respondents' perception and behaviour. The measurement items were revised based on expert judgment and tested a pilot among 30 SMEs to ensure clarity and relevance. The scales of each construct demonstrated acceptable internal consistency with Cronbach's Alpha values above 0.70 (Hair et al., 2021). Taken together, these measures assured that the measurement tools were statistically reliable and theoretically based to test the relationships proposed between FinTech adoption, access to finance, financial inclusion, and firm growth.

3.4 Data analysis

Statistical analysis was conducted according to a systematic and multifaceted process to provide validity of the analyzed data, using IBM SPSS Statistics version 28. Descriptive statistics were first used to describe the sample characteristics and variable means. Then the internal consistency was checked by testing for internal consistence using Cronbach's Alpha (>0.70) and corrected item-total correlations were used to check criterion related validity of items. The assumptions underlying classical such as normality, multicollinearity (VIF < 10), and heteroscedasticity test were subsequently employed to ascertain the model appropriateness for regression analysis. We used Pearson correlation analysis to explore linear associations between variables prior to hypothesis testing. With respect to the tests of causal relationships, hierarchical multiple regression was used to test each direct as well the (direct) mediation and moderation effects using three separate models: FinTech Adoption Access to Finance (H1), Access to Finance Firm Growth (H2), and FinTech Adoption × Financial Inclusion Firm Growth (H3). Models reliability and adequacy were assessed by the value of adjusted R^2, F-statistic, and Durbin–Watson statistics at a confidence level of 95% ($\alpha = 0.05$), confirming that is adequate and reliable models to the linear regression analyses.

4. Results of Innovation and Discussion

4.1Descriptive statistics

Descriptive statistics for key variables employed in this study are shown in Table 3. All the constructs have a mean value above 3.70, confirming that respondents generally agreed with the statements settled on FinTech adoption, access to finance, firm

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growth and financial inclusion statements. It implies that SMEs are moderately engaged in digital financial services and they observe enhancements in the accessibility of finance and performance of their businesses. Indeed, the values of standard deviation are situated between 0.57 and 0.63 indicating moderate variance in responses that may be indicative of disparate levels of digital take-up and financial inclusion among firms. The minimum and maximum values, in the range between about 2.15 and 5.00, show while some SMEs are still struggling with low FinTech use and financial access some have clearly already achieved mature levels of embedding. On the whole, data distribution reflects that the sample is adequate and reliable for further regression analysis.

4.2 Reliability and Validity Testing

All constructs and their measurement validity-examined Table 4 presents the reliability, validity test results of the survey. The Cronbach's Alpha values are in the range of 0.862–0.891 and all above the minimum accepted value of 0.70, revealing a high consistency level within measurement items. Likewise, the minimum value for corrected item-total correlation (CITC) between 0.642 and 0.671 indicates that every items significantly contributes to their corresponding constructs. The results provide evidence on the reliability and validity of research instruments adopted for measuring FinTech adoption, access to finance, firm growth and financial inclusion. Thus the scales used in this research can be said to be strong for further statistical analysis and reliable means of ensuring that observed relations among variables are consistent with the constructs being measured.

4.3 Normality and multicollinearity tests

The results of the normality and multicollinearity tests used to check the compatibility of dataset with regression analysis are shown in Table 5. It can be seen that skewness ranges from –0.38 to –0.29 and kurtosis is only between 0.11 and 0.22, all less than the absolute value of 1.96, indicating that data are normally distributed. This assures that the responses have symmetric distribution about their mean, thus adherent to the assumption of normality necessary for linear regression. Looking at the VIF that ranges from 1.77 to 1.92, which is well below the critical threshold of 10, and values for tolerance above 0.10 assures that multicollinearity is not present between the independent variables. These findings suggest that the data satisfy the statistical requirements for valid estimation, such that each construct has a unique contribution to the regressions and there should not be overlap or bias.

4.4 Correlation Analysis

Pearson correlation coefficients of the main variables are presented in Table 6. Correlation values are all positive and significant at the 1% level ($p < 0.01$) which implies that strong linear relationships between them are present. FinTech usage is highly associated with access to finance ($r = 0.612$) and firm growth ($r = 0.584$), which means that a high level of using FinTech services is related to both better access to finance and business performance. Finance is also correlated very highly with growth (0.671), and this underlines its leading role as a financial stimulant for the firm. Furthermore, financial inclusion is moderately and positively correlated with all variables, indicating that a higher degree of financial inclusivity would promote both FinTech take-up and firm growth. In sum, the structure of correlations is in line with the intended relationships and provides solid grounds for additional regression and moderation–mediation analyses.

Table 3. Descriptive Statistics of Main Variables

Variable	Mean	Std. Deviation	Minimum	Maximum
FinTech Adoption	3.92	0.61	2.45	5
Access to Finance	3.84	0.57	2.2	5
Firm Growth	3.77	0.63	2.15	5
Financial Inclusion	3.88	0.59	2.5	5

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DOI: https://doi.org/10.69725/jebi.v2i2.274

Table 4. Reliability and Validity Results

Variable	No. of Items	Cronbach' s Alpha	Min CITC	Interpretation
FinTech Adoption	5	0.883	0.642	Reliable & Valid
Access to Finance	4	0.862	0.655	Reliable & Valid
Firm Growth	3	0.879	0.671	Reliable & Valid
Financial Inclusion	4	0.891	0.648	Reliable & Valid

Table 5. Normality and Multicollinearity Results

Variable	Skewness	Kurtosis	VIF	Tolerance	Result
FinTech Adoption	-0.38	0.22	1.84	0.54	No Multicollinearity
Access to Finance	-0.31	0.11	1.92	0.52	No Multicollinearity
Financial Inclusion	-0.29	0.16	1.77	0.56	No Multicollinearity

Table 6. Pearson Correlation Matrix

Variable	1	2	3	4
FinTech Adoption	1			
Access to Finance	0.612**	1		
Firm Growth	0.584**	0.671**	1	
Financial Inclusion	0.493**	0.537**	0.556**	1

4.5 Regression Model 1 – Effect of FinTech Adoption on Access to Finance

The results of the first regression model (effect of FinTech adoption on access to finance) are reported in Table 7. The results demonstrate a positive and significant relationship between FinTech adoption and access to finance, with β= 0.617 and t-value of 14.27 at $p < 0.001$ level. A model adjusted R^2 of 0.371 can be observed indicating that around 37.1% variance in access to finance is accounted for by FinTech adoption. The model overall significance and robustness was also tested using an F-test (203.61, p = 0.000). Our results illustrate that FinTech uptake among SMEs is related to better access to financial channels and hence a resultant reduction of credit constraints, improvement in transaction efficiency, as well as an increase in financing options. Thus, H1 is accepted, suggesting that the adoption of FinTech has a positive effect on access to finance.

4.6 Regression model 2 – effect of access to finance on frm growth

Results of column 2 that tests on the impact of access to finance on firm growth are reported in Table 8. The findings provide a robust evidence of a positive and highly significant relationship with the standardized beta coefficient (β) value of 0.698 and corresponding t-value of 15.22 at $p < 0.001$ level. The adjusted R^2 of 0.432 means the model can account for about 43.2% in firm growth, and also the F-statistics of 231.45 (p = 0.000) indicates that the overall regression model is significant at 5%. These results show that the greater access to finance, business expansion is higher (measured in sales, assets and employment growth) for SMEs. Access to finance allows firms to invest in technology, innovation and markets, increasing their competitiveness and long-term performance. Thus, Hypothesis 2 (H2) is supported and indicates that access to finance significantly, positively influences firm growth.

4.7 Moderation test – financial Inclusion in the fintech–growth relationship

Results of the moderation analysis (testing financial inclusion as a moderator between FinTech adoption and firm growth) are presented in Table 9. These results reveal that FinTech adoption (β = 0.326, $p < 0.001$) and financial inclusion (β = 0.287, p <

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0.001) have a significant positive effect on firm growth. Most importantly, the interaction term between FinTech penetration and financial inclusion (β = 0.198, t = 3.77, p < 0.001) is also significant suggesting that financial inclusion moderates the effect of FinTech on growth. With respect to the adjusted R^2 of 0.471, the 47.1% variation in firm growth can be attributed to FinTech adoption, financial inclusion, and their interaction together. This finding indicates that the positive effect of FinTech adoption on firm growth becomes more pronounced as financial inclusion increases. Accordingly, H3 is verified stressing the building of inclusive financial systems for maximizing the growth gains from FinTech adoption.

4.8 Mediation Analysis – Access to Finance as Mediator

The mediation analysis is presented in Table 10, in which we adopted the concept of Baron and Kenny (1986) to investigate whether access to finance mediates the FinTech adoption–firm growth relationship. The results reveal that the adoption of FinTech has a positive and significant effect on access to finance (β= 0.617, p < 0.001) with access to finance also having a strong and significant impact on firm growth (β = 0.698, p < 0.001). The direct effect of FinTech institutional adoption on firm growth is still positive but smaller when finance access is added to the analysis (β = 0.283, p = 0.004), implying partial mediation. This contrast suggests that FinTech adoption promotes the firm growth not only through digital efficiency and innovation (the direct impact), but also through financial accessibility enforced by itself (the indirect effect). Thus, finanical access is an important intermediate avenue by which FinTech adoption influences firm growth and general SME performance.

Table 7. Regression Results

Variable	β	t-Statistic	Sig. (p)	Result
Constant	1.142	4.38	0	-
FinTech Adoption → Access to Finance	0.617	14.27	0	Supported (H1)
Adjusted R^2 = 0.371	F = 203.61	Sig. = 0.000		

Table 8. Regression Results

Variable	β	t-Statistic	Sig. (p)	Result
Constant	0.987	3.95	0	-
Access to Finance → Firm Growth	0.698	15.22	0	Supported (H2)
Adjusted R^2 = 0.432	F = 231.45	Sig. = 0.000		

Table 9. Moderation effect of financial inclusion

Variable	β	t-Statistic	Sig. (p)	Result
FinTech Adoption	0.326	6.48	0	Significant
Financial Inclusion	0.287	5.92	0	Significant
Interaction Term (FinTech × Financial Inclusion)	0.198	3.77	0	Supported (H3)
Adjusted R^2 = 0.471	F = 248.21	Sig. = 0.000		

Table 10. Mediation Test (Baron & Kenny, 1986 Approach)

Path	β	Sig.	Mediation Type
FinTech → Access to Finance	0.617	0	Significant
Access to Finance → Firm Growth	0.698	0	Significant

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FinTech → Firm Growth (Direct)	0.283	0.004	Partial Mediation

4.9 Discussion of findings

The implications of this study are that FinTech adoption, access to finance and financial inclusion are an integrated part of small and medium enterprises (SMEs) growth confirming the crucible thesis which suggests that digital financial innovation is transformational in SME performance. In line with H1, The regression reveals that FinTech adoption has a significant positive impact on access to finance. This result validates previous research that has found that FinTech eases financing constraints by enabling digital platforms, automated credit scoring and alternative lending to circumvent banking barriers (Lee & Shin, 2018; Frost et al., 2021). In emerging economies, SMEs typically experience structural rationing of credit due to an absence of sufficient collateral, absence of formal credit records and information asymmetry between borrowers and lenders (Beck et al., 2008; Ayyagari et al., 2021). FinTech addresses these problems through utilization of big data, mobile payment records and online transaction histories to assess credit worthiness (Ozili, 2022). Thus, FinTech is a substitute for traditional banks but a complement financial intermediary that brings credit to the unwashed masses and reduces entry barriers into formal financial systems mentioned by Tang et al. (2023) and Boateng et al. (2024).

Support for a similar argument is also provided by the empirical findings in Hypothesis 2 (H2) which suggest that access to finance has a positive effect on growth of firm. This is in line with classic Financial Intermediation Theory that contends well-functioning financial systems generate productive investment and better firm performance (Levine, 2005). The findings also support that SMEs with the more funding opportunities tend to have stronger growth of sales, employees, and tangible assets. These results confirm previous research evidencing that a greater access to credit fosters the innovation capacity and competitiveness of SME (Nguyen et al., 2022; Kuntchev et al., 2022). Conversely, scarce funding continues to be a significant barrier for small firms in the emerging market economies as it hampers investment in technology, marketing and human capital (Aterido et al., 2019;Allen et al. 2023). Hence better financial inclusion via fintech can be more than just transactional but strategic – enabling SMEs to modernize, strengthen their abilities and make them more resilient in uncertain economic times.

The findings also suggest that access to finance mediates the relationship between FinTech adoption and firm growth, which indicates that FinTech has both direct and indirect impact on firm growth. This partial mediation provides experimental evidence for a technological intermediation hypothesis: that digital platforms serve as an intermediary between innovation and resource accumulation. This mediating effect that we have found is consistent with the results of Demirgüç-Kunt et al. (2022), stressing that digital financial systems contribute to higher availability of credit and firm-level productivity. Further, the mediating result extended previous studies which found FinTech's indirect impact on firm performance by enhanced transparency, efficiency, and user trust (Nguyen et al., 2022; Hou et al., 2024). Such relations illustrate how integrating tech in finance is driving a more open and end-user centric business environment.

Contributing support for H3, the research reveals a positive moderating effect of financial inclusion on the relationship between FinTech adoption and SCFE. The interaction term in the regression reveals that the FinTech–growth relationship is significantly enhanced in environments of increasingly greater financial inclusion. This result is consistent with the presumption of Financial Inclusion Theory (Sarma and Pais 2011) that broader access to formal financial services leads to increased economic participation and diminished inequality. FinTech's potential to foster business growth is further enhanced when it operates within an inclusive financial ecosystem that provides individuals and businesses with banking, digital payments infrastructure and financial literacy initiatives (Sahay et al., 2020; Allen et al., 2017). The potential for FinTech is thus underutilized in low-institutional support or less inclusive locales, with

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benefits to the economy remaining uneven (Ozili, 2022; Hou et al. This moderating role suggests that the evolution of technology is influenced by a nation's readiness of institutions, and vice versa to establish sustainable economic outcomes.

The results of this study also help to clarify conflicting conclusions from previous research. A number of contributions observed a positive influence of FinTech on SME financing and growth (Nguyen et al., 2022; Boateng et al., 2024; Tang et al., 2023); others found evidence that the effects are limited to certain contexts or may be contingent upon infrastructure and regulatory barriers (Ayyagari et al., 2021; Ozili, 2022; Hou et al., 2024). This study, by including financial inclusion as a moderating variable, has clearly explained how these variations might result from the capacities of institutions and levels of inclusion. In more inclusive, digitalized economies such as analysis where financial resources are effectively intermediated to SMEs by FinTech while in less-inclusive ones it is softened by regulatory loopholes and low utilization (Demirgüç-Kunt et al., 2022). The study therefore broadens the generalizability of FinTech–growth models by incorporating technological and institutional factors in emerging markets.

Theoretically, it provides an overarching model facilitating the convergence of Financial Intermediation Theory, Technology Acceptance Model (TAM) and Financial Inclusion Theory. FinTech acceptance using TAM as a theoretical construct describes technological innovation, where perceived usefulness and ease of use influences behavioural intention among SMEs (Davis, 1989). Its consequent effect on financial access is consistent with Financial Intermediation Theory, whereas the moderating role of inclusion mirrors institutional complementarity as inferred from Financial Inclusion Theory. These theories, when brought together paint the picture that FinTech's potential to grow is not just a technological one but also systemic (i.e., requires institutional inclusion & digital literacy) for it deliver its full socioeconomic value.

From a practical standpoint, these results imply several implications. Policy-makers should focus on developing supportive digital financial infrastructure, both in terms of regulatory environment and the education around FinTech and encouraging universal adoption by SMEs. Banks and FinTech companies should also focus on data sharing channels and credit rating mechanisms that can facilitate access to loans for small borrowers with non-traditional collateral. Additionally, when regulators work closely with Fintech firms and local governments they build trust, protect consumers and drive digital access-ingredients to maintain inclusive financial ecosystems. And they are in line with the UN's Sustainable Development Goals (SDG 8 and SDG 9) on inclusive growth and industry innovation.

In general, this research offers empirical support that FinTech adoption largely leads to the growth of SMEs through enhancing financial access, and the intensity of such a relationship hinges on the broader inclusiveness of the financial sector. In the aftermath of COVID-19, when digital transformation is paramount for economic recovery, integrating FinTech and financial inclusion policies to fuel resilient, inclusive and tech-driven growth in emerging economies will be critical. By overcoming past discrepancies and promoting theory integration, this study contributes to the understanding that inclusive digital finance is not merely a technology breakthrough but also an essential enabler of sustainable economic development.

5. Conclusion

The findings from this study reveal that FinTech adoption, access to finance and financial inclusion are significantly associated with the SMEs growth. The empirical findings even show that FinTech adoption increases access to finance at a statistically significant level, which implies a potential in mitigating the credit constrain and promoting more inclusive formal financial systems. Finance access, in addition has strong positive impact on firms' growth thereby, underscoring its role as a financial facilitator of firm expansion and competitiveness. Additionally, financial inclusion enhances the FinTech–growth

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relationship, meaning that a financially inclusive environment magnifies the value added from digital innovation. The mediation results also demonstrate that access to finance partially mediates the linkage between FinTech adoption and firm growth, indicating a double-barreled approach on how technology enhances performance. On the whole, the results highlight that fostering inclusive FinTech environments underpinned by regulatory easing access to finance and digital literacy and financial infrastructure is crucial to accelerate sustainable SMEs growth. Such insights serve for further development into both the theoretical discussion on how to theorize a "technology driven financial inclusion" as well as into policy formulation by combining advanced technology innovation, financial intermediation and inclusion theories in a cohesive model of economic empowerment in the digital age.

6. Image and Data Table

Appendix Data A. Table 1 Respondents' Demographic and Firm Characteristics

Category	Description	Frequency (n)	Percentage (%)
Firm Age (years)	< 3 years	62	19.9
	3–5 years	98	31.4
	6–10 years	87	27.9
	> 10 years	65	20.8
Firm Size (number of employees)	< 10 (micro)	74	23.7
	10–49 (small)	144	46.2
	50–249 (medium)	94	30.1
Sector of Operation	Manufacturing	83	26.6
	Trade & Retail	92	29.5
	Services (finance, logistics, etc.)	70	22.4
	Creative and digital industries	67	21.5
Ownership Structure	Sole proprietorship	97	31.1
	Partnership	58	18.6
	Limited liability company	157	50.3
FinTech Usage Intensity	Low (≤ 2 FinTech platforms)	94	30.1
	Moderate (3–4 platforms)	126	40.4
	High (≥ 5 platforms)	92	29.5
Geographic Distribution	Urban	221	70.8
	Semi-urban/Rural	91	29.2

Appendix Data B. Table 2 Operationalization of Research Variables and Measurement Indicators

Variable	Code	Measurement Indicator (5-point Likert scale)	Source
FinTech Adoption (X)	X1	My firm uses digital payment systems (e.g., QRIS, e-wallets).	Lee & Shin (2018); Ozili (2022)
	X2	My firm uses online lending platforms (e.g., P2P or digital banks).	Frost et al. (2021)
	X3	My firm has participated in crowdfunding or investment-based FinTech.	Nguyen et al. (2022)
	X4	FinTech applications reduce transaction time and costs for my firm.	Boateng et al. (2024)
	X5	FinTech services improve my firm's access to financial information.	Tang et al. (2023)

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Variable	Code	Measurement Indicator (5-point Likert scale)	Source
Access to Finance (M)	M1	My firm easily obtains external credit or financing.	Beck et al. (2008)
	M2	Financing sources are more available now compared to pre-pandemic years.	Kuntchev et al. (2022)
	M3	The approval rate for business loans is high for my firm.	Aterido et al. (2019)
	M4	FinTech platforms have increased my firm's funding opportunities.	Nguyen et al. (2022)
Firm Growth (Y)	Y1	My firm's sales revenue has increased over the last three years.	Ayyagari et al. (2021)
	Y2	My firm's total assets have grown steadily since 2020.	Boateng et al. (2024)
	Y3	Employment levels in my firm have increased in the past two years.	Demirgüç-Kunt et al. (2022)
Financial Inclusion (Z)	Z1	My firm's owners/employees have active accounts in formal financial institutions.	Sarma & Pais (2011)
	Z2	My firm frequently uses digital banking or online payment services.	Allen et al. (2023)
	Z3	Local financial infrastructure supports FinTech adoption effectively.	Sahay et al. (2020)
	Z4	Financial inclusion initiatives in my region facilitate SME financing.	Demirgüç-Kunt et al. (2022)
Control Variables	C1	Firm age (years since establishment).	Beck et al. (2008)
	C2	Firm size (number of employees).	Aterido et al. (2019)
	C3	Digital literacy level of owners or managers.	Nguyen et al. (2022)
	C4	Sectoral classification (manufacturing, trade, services, creative).	BPS (2024)

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Author Contributions

The two senior authors were equal partners in originating, designing, and conducting this study. Wati Rahayu designed the theoretical structure of the paper, conducted the statistical analysis and wrote up initial draft. Fayza Najeela Pakutandang was involved in data gathering, literature search and manuscript editing. Both authors have read, edited and approved the final manuscript.

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Data Availability Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request. We are unable to

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provide individual-level data publicly because of confidentiality agreements with respondents.

Ethics Approval and Consent to Participate

This study respected the ethical rules of the institution and obtained approval from the Ethics Committee of STIE Gema Widya Bangsa. FULL TEXT Consent –All patients gave their consent and all nurses and doctors involved signed the informed consent before participation to be enrolled in the survey.

Conflict of Interest

Conflicts of Interest The authors have no conflict of interest with respect to the research, authorship, and/or publication of this article. For all analyses and inferences, source blind read was undertaken.

AI and Ethics Statement

The use of any AI tools or automated systems in the study design, data analysis and manuscript preparation was not applied. All work, from conceptualization to writing and interpretation of results, was conducted by the authors with the intention to ensure academic integrity and ethical conformance.

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