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The Fintech Paradox: Re-evaluating Financial Technology Adoption, Investment Efficiency, and Firm Size in an Emerging Market

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Abstract

While the rapid expansion of financial technology (fintech) promises enhanced corporate valuation and investment efficiency, its value-creating potential within capital-intensive real sectors remains empirically contested. Addressing this critical gap, this study investigates the impact of fintech adoption on firm value among manufacturing enterprises in an emerging market, evaluating investment efficiency as a mediating mechanism and firm size as a boundary condition. Utilizing a balanced panel dataset of 162 manufacturing firms listed on the Indonesia Stock Exchange yielding 324 firm-year observations from the 2022–2024 period after applying a lagged model design this study employs a Two-Way Fixed Effects (TWFE) regression framework to mitigate unobserved firm and time heterogeneity. Contrary to prevailing digital optimism, the empirical findings reveal the existence of a "Fintech Paradox": digital financial integration fails to exert a statistically significant direct effect on market valuation (Tobin's Q) or significantly optimize capital allocation. Consequently, the hypothesized mediation paths are broken. Furthermore, firm size does not positively moderate this relationship; rather, a larger organizational scale exerts a direct, negative pressure on firm value. These findings demonstrate that within rigid, large-scale manufacturing environments, bureaucratic inertia and massive physical adjustment costs temporarily neutralize the theoretical benefits of financial digitization. Ultimately, this study cautions that fintech adoption is not a universal value driver and requires fundamental organizational agility to succeed in capital-intensive sectors.

KEYWORDS

fintech adoption; investment efficiency; tobin's q; moderation effect; panel data; emerging market firms.

Introduction

Financial technology (fintech) has become a pivotal driver of digital transformation in corporate financial management. The integration of digital payment systems, automated financial reporting, blockchain applications, and data-driven analytics has significantly reshaped how firms manage liquidity, allocate capital, and evaluate investment opportunities (Marikyan et al., 2022); (Hattali, 2024). Recent studies emphasize that digital finance enhances operational efficiency, financial transparency, and competitive positioning. In emerging markets, fintech development plays an even more critical role due to structural financial frictions and limited access to traditional capital channels (Haddad & Hornuf, 2021).

In Indonesia, fintech expansion has accelerated rapidly since 2016, supported by regulatory and infrastructure initiatives introduced by the Financial Services Authority and Bank of Indonesia. The significant growth of digital transactions and technology-based financial services reflects a structural shift in the national financial ecosystem.

However, while macro-level indicators demonstrate substantial fintech expansion, the firm-level economic consequences of fintech adoption particularly within non-financial and capital-intensive sectors such as manufacturing remain insufficiently explored (Feng, Yongqi; Yue Cao; Ni, 2024). Crucially, this study explicitly differentiates its contribution from the broader digital transformation literature. While existing digital transformation studies predominantly focus on general IT infrastructure, marketing automation, or overall operational digitization, this research strictly isolates financial technology adoption (e.g., digital payment systems, automated financial reporting, and financial analytics). By focusing specifically on how these sophisticated digital financial tools interact with heavy legacy physical assets, this study aims to uncover the unique structural frictions conceptualized as the 'Fintech Paradox' that distinguish financial digitalization in manufacturing from generic technological upgrades. From a corporate finance perspective, fintech adoption may influence firm value through several mechanisms. First, fintech reduces transaction costs and improves the speed and accuracy of financial reporting. Second, digital financial systems enhance transparency and reduce information asymmetry between managers and shareholders. According to Agency Theory (Altawalbeh, 2026), improved monitoring and reduced information asymmetry mitigate agency costs, thereby enhancing shareholder value. In addition, Signaling Theory suggests that digital financial integration signals managerial competence and innovation capability, positively influencing investor perception and market valuation. Recent empirical evidence provides evolving yet heterogeneous findings. (Wang, 2025) demonstrates that digital transformation improves firm performance in emerging markets, although the magnitude of the effect varies across firms. (Rajpal, 2026) shows that fintech adoption affects firm valuation but may also alter firm risk exposure. More recently, (Moolkham, 2025) finds that digital transformation significantly influences firm valuation; however, the strength of this relationship depends on firm-specific characteristics and contextual conditions. These studies suggest that fintech adoption does not uniformly enhance firm value and that firm heterogeneity plays a crucial role. One important mechanism linking fintech adoption and firm value is investment efficiency. Investment efficiency refers to a firm's ability to allocate capital optimally by investing in positive net present value projects while avoiding both overinvestment and underinvestment (Huang, 2022). Investment inefficiency is commonly associated with agency conflicts and financing frictions (Kalatzis, 2018); (Harymawan, 2021). In capital-intensive industries such as manufacturing, inefficient capital allocation may result in idle assets, excessive leverage, or missed growth opportunities, ultimately weakening firm value. Emerging research increasingly highlights the role of digital finance in improving capital allocation. (Y. Ren et al., 2025) document that digital finance enhances investment efficiency by reducing financing constraints and improving transparency. (Chen, 2026) finds that digitalization strengthens capital allocation efficiency in emerging markets by improving information flow between firms and investors. (Li, Jiayi; Shujun Ye; Zhang, 2023) further show that digital innovation reduces investment misallocation through enhanced financial governance. A recent 2025 study provides additional evidence that digitalization reduces investment distortions by strengthening internal financial monitoring and data integration processes (Fang et al., 2023); (Guo, Panting; Jiefeng Bi Zhu, 2025). These findings suggest that fintech adoption may enhance firm value indirectly through improved investment efficiency.

Nevertheless, the benefits of fintech adoption may not be homogeneous across firms. The Resource-Based View, (Merín-rodri g & Alegre, 2024) posits that organizational

resources and capabilities determine how effectively technological innovation translates into competitive advantage. Firm size, in particular, reflects differences in financial slack, absorptive capacity, technological infrastructure, and managerial expertise. Larger firms generally possess greater resources to implement and integrate fintech systems effectively, while smaller firms may face financial and organizational constraints (Yew et al., 2025).

Recent empirical evidence reinforces this heterogeneity argument, (Zhang et al., 2025) show that firm size strengthens the performance impact of digital innovation due to superior absorptive capacity. (C. X. L. Ren, 2024); (S. Zhu, 2025) document that the digital transformation firm value relationship varies significantly across firm characteristics. More recently, the firm size positively moderates the relationship between digitalization and financial performance in ASEAN firms, indicating that larger firms derive greater economic benefits from digital integration.

Despite the theoretical benefits of these financial technologies, their application in traditional manufacturing sectors often hits a structural wall, giving rise to what this study conceptualizes from the outset as the "Fintech Paradox." Drawing a parallel to the classic Solow Productivity Paradox, the Fintech Paradox describes a condition where substantial corporate investments in digital financial assets fail to translate into immediate, measurable gains in firm value or capital allocation efficiency. In capital-intensive industries like manufacturing, core value creation is fundamentally driven by physical production capacities, heavy machinery utilization, and physical supply chain logistics. Consequently, isolating financial technology within administrative or treasury departments without restructuring fundamental operational workflows may create a disconnect, where high upfront digital expenditures yield an asset-valuation lag rather than immediate market rewards (Yu et al., 2024).

This study addresses several critical gaps in the literature, thereby establishing its empirical novelty. First, regarding the sector gap, prior research has predominantly investigated fintech value creation within the banking and technology sectors, leaving its economic consequences in capital-intensive, real-sector manufacturing critically under-explored. Second, concerning the mechanism gap, existing studies often assume a direct, linear relationship between technology and firm performance; this research challenges that assumption by explicitly evaluating investment efficiency as the specific internal mechanism through which digital financial tools may indirectly influence market valuation. Third, addressing the boundary-condition gap, this study explicitly tests whether organizational scale (firm size) serves as a resource catalyst or a structural barrier to fintech integration, moving beyond the assumption of homogeneous technological benefits across all firms. Finally, to ensure the construct contribution is not blurred, this study strictly distinguishes specific fintech adoption (e.g., the integration of digital payment systems and automated financial analytics) from broader digital transformation (e.g., general IT infrastructure or marketing automation). By combining these defined gaps within a robust Two-Way Fixed Effects (TWFE) panel regression framework, this research captures the genuine operational reality of the Fintech Paradox in an emerging market context.

Fintech Adoption and Firm Value

Financial technology (fintech) represents the integration of digital innovation into corporate financial systems, transforming traditional financial management practices. Recent literature highlights that digital finance enhances financial transparency, operational efficiency, and market competitiveness (Nasution, 2025). In emerging markets, fintech development has been associated with improved firm performance and access to capital.

More recent evidence further strengthens this argument, (Moolkham, 2025) finds that digital transformation significantly influences firm valuation, although the strength of this effect depends on firm-specific contextual factors. Similarly, (Wang, 2025); (Alzyod et al., 2025) show that digital transformation enhances market-based performance in manufacturing firms by improving operational integration and financial management efficiency.

However, applying this generalized assumption to capital-intensive industries introduces a critical theoretical tension. In the manufacturing sector, core value creation is primarily driven by physical production capacities rather than purely digital financial transactions. Consequently, massive capital expenditures on intangible digital tools may trigger a "Fintech Paradox" a condition where structural rigidity and high adjustment costs temporarily suppress or neutralize the expected market rewards. Therefore, the relationship between fintech adoption and firm value is theoretically ambiguous; digital transformation might act as a transparent governance tool or, conversely, as an expensive capital drain that fails to deliver immediate shareholder wealth. Lower agency costs increase firm value by reducing inefficiencies in managerial decision-making. Meanwhile, Signaling Theory suggests that digital innovation signals strategic competence and forward-looking management to investors, positively affecting market valuation (Moez, 2024). However, empirical findings are not entirely homogeneous. (Xie et al., 2021); (Qin & Jing, 2025) report that fintech adoption may alter firm risk exposure, which subsequently affects valuation outcomes. This indicates that fintech does not uniformly increase firm value but operates through firm-specific conditions and mechanisms. To strictly test the optimistic claims of traditional Agency Theory against the potential empirical reality of the Fintech Paradox in capital intensive manufacturing, this study formulates the following conventional expectation as a baseline hypothesis:

H1: Fintech adoption positively affects firm value.

The Role of Investment Efficiency

Investment efficiency refers to a firm's ability to allocate capital optimally, avoiding both overinvestment and underinvestment. Investment inefficiency is often attributed to agency conflicts and financial frictions. Recent studies provide emerging evidence linking digital finance to capital allocation efficiency. (Huang, 2022) shows that digital finance significantly improves investment efficiency by enhancing financial transparency and reducing financing constraints. (Li, Jiayi; Shujun Ye; Zhang, 2023) further demonstrate that digital financial systems improve capital allocation efficiency in emerging markets by facilitating better information flow between firms and capital providers.

In a 2025 study, digitalization is found to reduce investment distortions by improving internal financial governance and data integration (Jiang, 2024). This supports the argument that fintech adoption may strengthen managerial monitoring and investment discipline. Within manufacturing firms, where capital expenditures are large and long-term, improved financial analytics and monitoring through fintech systems may reduce resource misallocation. By integrating financial planning with operational systems, fintech enhances capital budgeting precision and risk assessment (Mirzaei et al., 2026). While capital-intensive manufacturing faces massive structural rigidities, we establish the optimistic digital finance perspective as our conventional baseline expectation to be empirically challenged. Therefore, this study formulates the following hypothesis:

H2: Fintech adoption positively affects investment efficiency.

Firm Size as a Boundary Condition

The relationship between investment efficiency and firm value is well-established in corporate finance. Efficient investment decisions increase expected future cash flows and reduce wasteful expenditures (Salehi et al., 2022). Overinvestment driven by agency conflicts reduces firm value, while underinvestment limits growth potential (DeAngelo, Harry; Kathleen Kahle; Skinner, 2025).

Recent empirical research confirms that firms with higher investment efficiency exhibit superior market valuation (Kong, Dongmin; Yiwei Yang; Wang, 2023); (Wang, 2025). Efficient capital allocation reduces uncertainty and enhances investor confidence. In emerging markets, investment discipline plays a crucial role in sustaining firm value amid economic volatility (Mou, 2024). Manufacturing firms are particularly sensitive to investment inefficiency due to their capital-intensive nature. Poor allocation decisions may lead to idle assets or excessive leverage, negatively affecting market perception (Guo, Panting; Jiefeng Bi Zhu, 2025). Therefore, consistent with theoretical and empirical evidence, this study investigates whether:

H3: Investment efficiency positively affects firm value.

Although fintech adoption may directly affect firm value, its economic consequences may operate indirectly through improvements in investment efficiency. Agency Theory suggests that digital financial systems reduce monitoring costs and managerial discretion, thereby improving investment decisions (Nasution, 2025). Recent empirical evidence supports this mechanism, (W. Zhu, 2024) finds that digital finance enhances capital allocation quality, which subsequently improves firm performance. (Lu et al., 2024) similarly document that fintech development influences corporate investment behavior through improved financial discipline. Thus, fintech adoption may not automatically increase firm value unless it enhances investment efficiency. This mediating mechanism aligns with corporate finance logic: technological innovation improves internal decision-making processes, which then translate into superior financial outcomes. Therefore, this study investigates whether:

H4: Investment efficiency mediates the relationship between fintech adoption and firm value.

The economic impact of fintech adoption may vary across firms due to heterogeneity in organizational resources and capabilities. The Resource-Based View (RBV) typically posits that larger firms possess the financial slack and absorptive capacity required to leverage technological innovation. However, in the context of digital disruption, organizational size can be a double-edged sword. Large, established manufacturing firms often suffer from "structural inertia" and "legacy system dependence," where existing physical assets and bureaucratic hierarchies act as barriers to agile digital integration. From this perspective, firm size may not strengthen the fintech value relationship but rather serve as a boundary condition where organizational complexity negates the efficiency gains of digital financial tools, (Herdinata et al., 2025). Recent studies confirm that firm characteristics influence digital transformation outcomes. (Xu et al., 2025) demonstrate that larger firms derive greater performance benefits from digital innovation due to superior absorptive capacity. (Zhang et al., 2025) show that firm heterogeneity significantly affects the digital transformation firm value relationship.

More recently, find (Ghofar et al., 2025) that firm size strengthens the positive relationship between digitalization and financial performance in ASEAN countries. Larger firms possess stronger financial slack, advanced IT infrastructure, and more sophisticated managerial systems, enabling more effective fintech integration. In contrast, smaller firms may face financial constraints and limited digital capabilities, weakening the impact of fintech adoption. To formally test the classical Resource-Based View assumption against the alternative

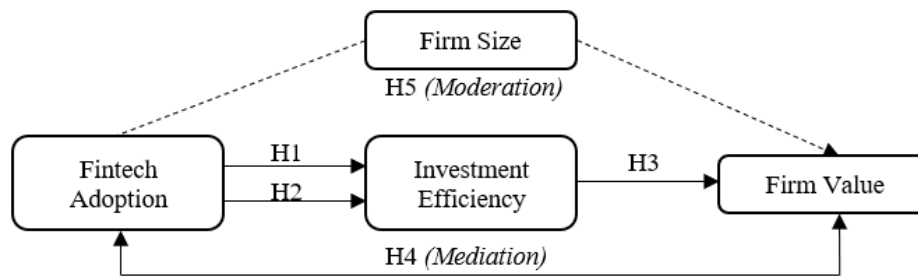


Figure 1. Conceptual Framework

possibility of structural inertia in large-scale manufacturing operations, we establish the following conventional expectation as a competing boundary-condition hypothesis:

H5: Firm size positively moderates the relationship between fintech adoption and firm value, such that the relationship is stronger in larger firms.

Based on the theoretical framework above, the research model is presented in Figure 1.

While the financial sector gains immediate efficiency from digital tools, real-sector industries like manufacturing may experience a "decoupling" between technological input and market valuation. This decoupling often termed the Fintech Paradox occurs when internal governance improvements (investment efficiency) are insufficient to offset the high adjustment costs and structural rigidities inherent in large-scale manufacturing operations.

Methods

Research Design

To rigorously evaluate the mechanism and boundary conditions of fintech adoption on firm value, this study establishes a moderated mediation framework utilizing the causal-steps approach outlined by Baron and Kenny (1986), adapted within a panel regression setting. We acknowledge that the causal-steps approach is conventionally considered weaker than formal indirect-effect tests, such as the Sobel test or bootstrapping. However, in this study, the causal-steps framework is deliberately employed as a strict preliminary threshold. A formal test of indirect effects is only mathematically meaningful and theoretically justified if the prerequisite individual trajectories specifically Path A (fintech adoption to investment efficiency) and Path B (investment efficiency to firm value) demonstrate baseline statistical significance. Consequently, if these foundational paths are statistically rejected, a path-based rejection provides sufficient and definitive evidence against mediation, rendering further formal indirect-effect tests theoretically moot.

Population and Sample

The population of this study consisted of all manufacturing firms listed on the Indonesia Stock Exchange (IDX) during the 2022–2024 period. Purposive sampling was applied based on the following criteria: (1) firms consistently classified under the manufacturing sector, (2) publication of complete audited annual financial statements, and (3) availability of complete data required to calculate all variables. After applying these criteria, the initial sample comprised 162 firms over a 3-year period, establishing a base of 486 firm-year observations. However, because our empirical model utilizes a one-year lagged independent variable (Fintech at $t-1$) to mitigate simultaneity bias, the observations from the first year (2022) are strictly consumed to establish the lag. Consequently, the active dataset used for the final panel regression analysis is restricted to the 2023–

2024 active period (2 years $\times$ 162 firms), yielding a final balanced panel of exactly 324 firm-year observations.

Variable Measurement

Dependent Variable

Firm value (FV) was measured using Tobin's Q, calculated as:

$$\text{Tobin's } Q_{i,t} = \frac{\text{MVE}_{i,t} + \text{BVD}_{i,t}}{\text{TA}_{i,t}}$$

where:

- MVE represents market value of equity (year-end closing price $\times$ outstanding shares),
- BVD represents book value of debt (total liabilities),
- TA represents total assets.

Tobin's Q was selected because it captured market-based valuation and investor expectations.

Independent Variable

Fintech adoption (FTA) is operationalized as the ratio of intangible technological assets to total assets:

$$\text{FINTECH}_{i,t} = \frac{\text{Intangible Assets}_{i,t}}{\text{Total Assets}_{i,t}}$$

Due to the severe lack of mandatory, granular disclosure guidelines regarding explicit digital or fintech expenditures in the annual financial statements of Indonesian manufacturing firms, comprehensively separating pure technological assets from general intangibles is not empirically feasible across the entire panel. Consequently, total intangible assets are utilized as the most viable available proxy for corporate technological infrastructure and digital capital deepening. However, we explicitly acknowledge that this proxy introduces a notable measurement error, as the accounting line item intrinsically includes non-technological components such as generalized goodwill, brand trademarks, and traditional business licenses. Therefore, this variable must be strictly classified as a 'noisy measure' of specific fintech adoption, and all resulting empirical estimates should be interpreted with appropriate caution.

Mediating Variable

Investment efficiency (INV_EFF) was estimated following a residual-based expected investment model:

$$\text{INV}_{i,t} = \alpha + \beta_1 \text{GROWTH}_{i,t} + \beta_2 \text{CASH}_{i,t} + \beta_3 \text{LEV}_{i,t} + \varepsilon_{i,t}$$

where:

- INV represented capital expenditure scaled by total assets,
- GROWTH represented sales growth,
- CASH represented cash holdings scaled by total assets,
- LEV represented leverage.

Investment efficiency was calculated as:

$$\text{INV_EFF}_{i,t} = -\beta_{i,t}/$$

Higher values indicated greater investment efficiency.

Moderating Variable

Firm size (SIZE) was measured as the natural logarithm of total assets:

$$SIZE_{i,t} = \ln(\text{Total Assets}_{i,t}).$$

Firm size was hypothesized to moderate the relationship between fintech adoption and firm value.

Control Variables

To ensure internal validity, we incorporate three time-varying corporate control variables: Leverage (LEV, total debt to total assets), Sales Growth (GROWTH, percentage change in revenue), and Liquidity (LIQ, current ratio). Leverage controls for capital structure constraints and monitoring effects; Sales Growth captures corporate investment opportunities; and Liquidity controls for short-term financial flexibility. Crucially, time-invariant firm-specific characteristics such as firm age, long-standing organizational culture, or baseline corporate governance structures are not explicitly added as controls because they are completely absorbed by the firm fixed effects within our panel regression framework.

Model Specification To test the hypotheses, the following regression models were estimated:

Model 1: Direct Effect

$$FV_{i,t} = \alpha + \beta_1 \text{FINTECH}_{i,t-1} + \text{Controls} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

Model 2: Fintech and Investment Efficiency

$$INV_EFF_{i,t} = \alpha + \beta_1 \text{FINTECH}_{i,t-1} + \text{Controls} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

Model 3: Investment Efficiency and Firm Value

$$FV_{i,t} = \alpha + \beta_1 INV_EFF_{i,t} + \text{Controls} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

Model 4: Moderation Model

$$FV_{i,t} = \alpha + \beta_1 \text{FINTECH}_{i,t-1} + \beta_2 \text{SIZE}_{i,t} + \beta_3 (\text{FINTECH} \times \text{SIZE})_{i,t-1} + \text{Controls} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

where:

- μ_i represented firm fixed effects,
- λ_t represented year fixed effects.

In the models specified above, the primary independent variable (Fintech adoption) and the interaction term are intentionally lagged by one year ($t-1$) to mitigate potential simultaneity bias and reverse causality. It is important to clarify the temporal structure resulting from this specification: because the baseline data spans the 2022–2024 period, constructing this one-year lag mathematically consumes the initial 2022 observations to establish the baseline values. Consequently, the active dependent variable observations (firm value and investment efficiency) evaluated in the regressions are strictly restricted to the 2023–2024 period. This structural deduction reconciles perfectly with our final balanced panel of exactly 324 active firm-year observations (162 firms $\times$ 2 active years).

Econometric Specification and Endogeneity Strategy

To rigorously estimate the empirical models and mitigate potential endogeneity concerns particularly reverse causality between firm valuation and corporate technology adoption this study utilizes a one-year lagged independent variable alongside a Two-Way Fixed Effects (TWFE) panel regression framework. The introduction of the lagged variable (Fintech at $t-1$) structurally consumes the 2022 data baseline, thereby restricting the active regression analysis to the 2023–2024 period and yielding 324 effective firm-year observations. By incorporating firm-level fixed effects, our model effectively sweeps out time-invariant unobserved heterogeneity, ensuring that the estimated impact of fintech adoption is not confounded by static firm characteristics. Furthermore, year fixed effects are introduced to absorb unobserved macroeconomic shocks. Finally, to ensure the validity of our statistical inference, all models report robust standard errors clustered at the firm level. While this rigorous specification

substantially restricts endogeneity bounds and mitigates spurious cross-sectional correlations, we acknowledge that it does not definitively prove causality; rather, it provides tentative empirical evidence consistent with the structural economic frictions conceptualized as the Fintech Paradox.

Result and Discussion

Descriptive Statistics

Table 1 presents the descriptive statistics for all variables examined in this study. Specifically, regarding the dependent variable, the data indicates that the manufacturing firms were valued at 1.708 times their total assets on average. Furthermore, the statistics reflect the central tendencies and dispersions for corporate fintech adoption, investment efficiency, firm size, and the control variables across the 324 firm-year observations, providing a clear baseline for the subsequent panel data regression analysis.

Correlation Analysis

Table 2 presents the Pearson correlation matrix for the variables examined in this study. The matrix provides a preliminary overview of the bivariate relationships among fintech adoption, investment efficiency, firm size, and the control variables. While these zero-order correlations suggest potential baseline associations, they do not account for time-invariant firm heterogeneity or macroeconomic shocks. Therefore, these bivariate results strictly indicate statistical associations and do not imply causality. All structural relationships and causal inferences are formally tested using the robust Two-Way Fixed Effects (TWFE) panel regression framework in the subsequent analysis. The bivariate correlation between financial technology adoption (FINTECH) and firm value (FV) is positive but relatively weak (0.122), offering preliminary evidence that digital financial integration, on its own, may not be sufficient to directly drive market valuation.

Notably, firm size (SIZE) demonstrates a negative correlation with firm value (-0.214), which may indicate that larger manufacturing firms experience bureaucratic inertia or structural rigidities that hinder agile value creation. Crucially, the correlation matrix serves as a robust diagnostic tool for multicollinearity. The correlation coefficients among all independent and control variables remain well below the conventional critical threshold of 0.80. The highest observed correlation among the explanatory variables is between liquidity (LIQ) and fintech adoption (FINTECH) at 0.170. These results confidently confirm the absence of severe multicollinearity within the dataset, ensuring that the standard errors in the subsequent fixed-effects panel regression models are not artificially inflated and that the coefficient estimates are statistically reliable.

Multicollinearity Test

The Variance Inflation Factor (VIF) values are below the threshold of 10, confirming the absence of serious multicollinearity.

To rigorously ensure that the independent variables do not suffer from multicollinearity which could artificially inflate standard errors and destabilize coefficient estimates, this study calculates the Variance Inflation Factor (VIF) and Tolerance levels for all explanatory variables. As presented in **Table 3**, the highest VIF value observed among the variables is 1.065 (for firm size), and the mean VIF across all variables is a highly stable 1.043. Correspondingly, all tolerance values ($1/\text{VIF}$) exceed 0.90. Since these VIF values are exceptionally low and fall well below the strict conservative threshold of 5 (and the conventional threshold of 10), we confidently conclude that multicollinearity poses no threat to the structural integrity of the econometric models. This condition ensures that the

Table 1. Descriptive Statistics

No	Variables	Mean	Median	Std. Dev	Min	Max
1	FV (Firm Value)	1.708	0.976	1.869	0.076	9.426
2	FINTECH	0.743	0.520	0.715	0.020	2.570
3	INV_EFF	-0.028	-0.021	0.030	-0.236	-0.0003
4	SIZE	28.893	28.777	1.900	24.359	33.947
5	LEV	0.502	0.412	0.587	0.0001	5.167
6	GROWTH	0.033	0.010	0.383	-0.958	3.024
7	LIQ	3.090	1.777	6.157	0.089	94.869

Source: Processing by STATA

Table 2. Pearson Correlation Matrix

No	Variables	FV	FINTECH	INV_EFF	SIZE	LEV	GROWTH	LIQ
1	FV	1.000						
2	FINTECH	0.122	1.000					
3	INV_EFF	0.029	0.021	1.000				
4	SIZE	-0.214	-0.087	0.189	1.000			
5	LEV	0.158	0.061	0.009	0.092	1.000		
6	GROWTH	-0.174	-0.062	0.009	0.092	-0.039	1.000	
7	LIQ	0.126	0.170	-0.051	-0.097	-0.111	-0.101	1.000

Source: Processing by STATA

Table 3. Multicollinearity Test

No	Variables	VIF	Tolerance (1/VIF)
1	FINTECH (lag)	1.045	0.957
2	INV_EFF	1.041	0.961
3	SIZE	1.065	0.939
4	LEV	1.025	0.976
5	GROWTH	1.021	0.980
6	LIQ	1.064	0.940
7	Mean VIF	1.043	

Source: Processing by STATA

isolated impacts of fintech adoption, investment efficiency, and firm size on market valuation can be estimated with high precision in the subsequent fixed-effects panel regressions.

The Table 4 presents the panel data regression results. To determine the most appropriate model specification, a Hausman test was conducted ($p < 0.05$), which strongly rejected the null hypothesis, thereby justifying the selection of the Fixed Effects model over the Random Effects model. Furthermore, to rigorously account for unobserved time-invariant firm characteristics and macroeconomic time shocks, the Two-Way Fixed Effects (TWFE) estimator was applied. The model fit is indicated by the R^2 values (Within, Between, and Overall) reported in the table, demonstrating the proportion of variance explained by the specified variables.

Table 5 presents the empirical results of the Two-Way Fixed Effects (TWFE) panel regression models. To control for potential heteroskedasticity and serial correlation, all estimations report robust standard errors clustered at the firm level. The analysis proceeds in sequential models to independently test the direct and mediation hypotheses.

Direct Effect of Fintech Adoption (Hypothesis 1)

Model 1 examines the direct impact of fintech adoption ($L_FINTECH$) on firm value (FV). The estimated coefficient is positive (0.8136) but lacks statistical significance ($p = 0.490$). This indicates that integrating digital financial technologies does not immediately result in a higher market valuation for the sampled manufacturing firms. Consequently, Hypothesis 1 is rejected.

The Mediation Role of Investment Efficiency (Hypotheses 2, 3, and 4)

This condition, where substantial financial investments in technological assets produce massive variance rather than uniform value creation, provides tentative empirical evidence consistent with the Fintech Paradox within the manufacturing sector. However, we explicitly acknowledge that these non-significant coefficients and large standard errors do not provide definitive validation. These statistical outcomes may also be partially attributed to alternative factors, specifically the measurement limitations inherent in our noisy fintech proxy and the relatively short three-year observation window (2022–2024), which might be insufficient to capture the long-term capitalization and payoff of corporate digital investments.

The result reveals an insignificant relationship (coefficient = 0.0338, $p = 0.754$), leading to the rejection of Hypothesis 2. Subsequently, Model 3 evaluates the impact of investment efficiency on firm value to test Hypothesis 3. The coefficient is positive but statistically insignificant (coefficient = 1.8081, $p = 0.430$), meaning Hypothesis 3 is also rejected. Because the essential paths for mediation (both Path A in Model 2 and Path B in Model 3) fail to demonstrate statistical significance, the mediation requirement is not fulfilled. Because the essential precondition paths for mediation specifically the direct effect of fintech on investment efficiency (Path A in Model 2) and the effect of investment efficiency on firm value (Path B in Model 3) completely fail to demonstrate statistical significance, the fundamental requirements for mediation are not fulfilled. In this specific null-finding context, path-based rejection provides sufficient and robust evidence that the mediation mechanism does not exist. The absence of significance in both prerequisite paths renders the calculation of formal indirect effects (e.g., Sobel test or bootstrapping) mathematically redundant and theoretically moot. Therefore, Hypothesis 4 is decisively rejected.

Control Variables

Across the models, leverage (LEV) consistently exhibits a positive and statistically significant relationship with firm value (e.g., coefficient = 0.8637, $p = 0.034$ in Model 1), suggesting that debt utilization acts as a positive signal or a disciplining governance mechanism for the market. Conversely, firm growth ($GROWTH$) and liquidity (LIQ) do not show significant impacts on firm value within this specific observation period.

Moderation Effect

Table 4. Direct and Mediation Effects

Variables		Model 1 (Direct Effect)		Model 2 (line a)		Model 3 (line b & c')	
No	Dependent	FV (Firm Value)	p-value	INV_EFF (Efficiency)	p-value	FV (Firm Value)	p-value
1	FINTECH (Lag)	0.8136	0.490	0.0338	0.754	0.7525	0.5331
2	INV_EFF	-	-	-	-	1.8081	0.430
Variable Control							
3	LEV	0.8637	0.034	-0.0080	0.729	0.8863	0.020
4	GROWTH	-0.1937	0.187	-0.0004	0.973	-0.1978	0.206
5	LIQ	-0.0254	0.501	-0.0002	0.643	-0.0251	0.512

Source: Processed data.

Table 5. Panel Data Regression Results (Fixed Effects)

Variables	Model 1 (FV)	p-value	Model 2 (INV_EFF)	p-value	Model 3 (FV)	p-value	Model 4 (Moderation)	p-value
FINTECH (Lag)	0.8136	0.490	0.0338	0.754			3.4161	0.741
INV_EFF					1.8081	0.430		
SIZE							-1.3048	0.054
FINTECH x SIZE							-0.1000	0.783
Control Variables								
LEV	0.8637	0.034	-0.0080	0.729	0.8863	0.020	0.9834	0.005
GROWTH	-0.1937	0.187	-0.0004	0.973	-0.1978	0.206	0.0140	0.911
LIQ	-0.0254	0.501	-0.0002	0.643	-0.0521	0.512	-0.0135	0.636
Firm Fixed Effects	Yes		Yes		Yes		Yes	
Year Fixed Effects	Yes		Yes		Yes		Yes	
Observations (N)	324		324		324		324	

Source: Processing by STATA

Table 6. Moderation Model

No	Variables	Model 4 (Firm Value)	p-value
1	FINTECH (Lag)	3.4161	0.741
2	SIZE	-1.3048	0.054
3	FINTECH x SIZE (Interaction Term)	-0.1000	0.783
4	Control Variables		
5	LEV	0.9834	0.005
6	GROWTH	0.0140	0.911
7	LIQ	-0.0135	0.636
8	Firm Fixed Effects	Yes	
9	Year Fixed Effects	Yes	
10	Observations (N)	324	

Source: Processing by STATA

Table 6 presents the results of the moderation analysis designed to test Hypothesis 5, which posited that firm size positively moderates the relationship between fintech adoption and firm value. The interaction term is insignificant, suggesting that the valuation impact of digital financial integration does not vary significantly across firm size.

The results indicate that the interaction term between fintech adoption and firm size (FINTECH x SIZE) is negative and not statistically significant (coefficient = -0.1000, $p = 0.783$). Consequently, Hypothesis 5 is rejected. This finding suggests that the valuation impact of digital financial integration does not meaningfully increase with organizational size within the sampled manufacturing firms. Interestingly, the direct effect of firm size (SIZE) on firm value is negative and marginally significant (coefficient = -1.3048, $p = 0.054$). Because this negative direct effect of firm size is only marginally significant ($p = 0.054$), it must be interpreted cautiously and cannot be presented as decisive evidence of diseconomies of scale. Instead, it serves as a potential indicator that rather than acting as an absolute resource advantage (as predicted by the Resource-Based View), a larger operational scale might introduce structural rigidity. In

the Indonesian manufacturing sector, highly capitalized legacy firms might experience bureaucratic inertia, making it potentially more difficult to rapidly internalize agile fintech solutions compared to moderately sized counterparts. However, this observation strictly warrants further rigorous robustness checks in future extended-panel studies to confirm the effect.

Fintech Adoption and Firm Value: Unveiling the Fintech Paradox (Testing H1)

The empirical results of this study reject Hypothesis 1 (H1), demonstrating that financial technology (fintech) adoption does not exert a statistically significant direct positive effect on the firm value (Tobin's Q) of manufacturing firms (Model 1, $p = 0.490$) listed on the Indonesia Stock Exchange. While the economic magnitude of the coefficient appeared theoretically substantial, the high standard errors indicate massive variance across firms, rendering the effect statistically unreliable. Rather than universally enhancing market valuation as conventionally predicted by Agency Theory, the integration of digital financial systems in capital-intensive environments yields negligible immediate financial returns. This non-significant finding directly challenges the prevailing digital optimism and provides empirical foundation for the 'Fintech Paradox' (Yu et al., 2024; Xu et al., 2025). It implies that the massive capital requirements, structural rigidities, and high adjustment costs associated with superimposing advanced digital tools onto legacy manufacturing operations effectively neutralize any immediate market value enhancements.

Consequently, this statistically non-significant finding contrasts sharply with the optimistic strand of digital transformation literature which argues that technological adoption universally enhances corporate valuation in emerging markets (Wang, 2025). Instead, our result provides empirical support for a more skeptical and nuanced perspective in recent studies, which documents that digital financial initiatives do not uniformly drive performance and can even alter firm risk exposures unpredictably (Qin & Jing, 2025). This misalignment demonstrates that the market value of fintech adoption is

highly conditional rather than absolute (Moolkham, 2025), reinforcing our argument that the capital-intensive manufacturing sector faces unique structural frictions that prevent it from achieving the swift valuation gains observed in other industries. In capital-intensive industries such as manufacturing, fintech adoption measured through corporate intangible technological assets requires profound structural adjustments. The lack of a significant relationship implies that market investors do not immediately reward manufacturing firms for their digital financial investments. This asset-valuation lag occurs because financial digitization (e.g., corporate digital payment integration, automated liquidity management) does not immediately alter the core physical production capacities or physical supply chain efficiencies that fundamentally drive manufacturing profitability in an emerging market context.

The Non-Significant Mediating Role of Investment Efficiency (Testing H2, H3, and H4)

Hypotheses 2, 3, and 4 explored the mechanism through which fintech adoption was presumed to indirectly drive firm value via the mediation of investment efficiency. The statistical results reject all three hypotheses, revealing that the prerequisite paths within the mediation framework are broken. Specifically, fintech adoption does not significantly optimize capital allocation (Path A), and investment efficiency itself does not show a statistically significant link to market valuation within the observed panel (Path B). Therefore, the hypothesized partial or full mediation framework is empirically unsupported.

The disconnect between fintech adoption and investment efficiency (H2) suggests that while digital financial tools theoretically mitigate information asymmetry and agency costs (Huang, 2022) their practical application in Indonesian manufacturing is decoupled from capital budgeting decisions. Manufacturing investment decisions are largely dictated by macroeconomic indicators, industry capacity utilization, long-term physical infrastructure commitments, and legacy corporate governance frameworks. Automated cash flow monitoring or supply chain financing platforms cannot easily alter rigid capital budgeting cycles. Furthermore, because investment efficiency did not significantly influence Tobin's Q during the 2022–2024 period, it indicates that public market investors prioritize immediate revenue resilience and macroeconomic stability over incremental digital optimizations in asset allocation. Furthermore, the empirical results demonstrate that fintech adoption does not significantly improve investment efficiency within the sampled manufacturing firms (Model 2, $p = 0.754$). Consequently, H2 is strictly rejected. Rather than acting as an immediate governance-enhancing tool that streamlines capital allocation, digital financial integration in this sector appears to encounter massive operational friction. Explicitly acknowledging this lack of statistical support is crucial, as it fundamentally challenges the assumption that digital tools automatically translate into internal efficiencies.

Regarding the relationship between investment efficiency and firm value, the empirical results do not demonstrate a statistically significant positive effect within the sampled manufacturing firms (Model 3, $p = 0.430$). Consequently, H3 is decisively rejected. Rather than confirming classical corporate finance theory where optimal capital allocation automatically enhances market valuation, this study finds that such expected theoretical relationships fail to materialize in this specific context. A critical explanation for this decoupling is that in the highly rigid manufacturing sector, investors may heavily discount any minor internal capital efficiencies generated by digital systems due to the overwhelmingly high adjustment costs and friction. The market perceives that these localized efficiencies are

insufficient to offset the broader structural costs of digital integration, thereby neutralizing any potential boost to the firm's overall market valuation.

The Boundary Conditions of Firm Size and Organizational Inertia (Testing H5)

Hypothesis 5 postulated that firm size would positively moderate the relationship between fintech adoption and firm value (Model 4, $p = 0.783$), under the assumption that larger firms possess the scale, financial slack, and resource abundance necessary to maximize digital integration. The regression analysis rejects H5, as the interaction term between fintech adoption and firm size proved to be negative and statistically non-significant. Interestingly, the model reveals a marginally significant, direct negative effect of firm size on market valuation ($p = 0.054$). Contrary to the Resource-Based View's prediction that larger firms would benefit more due to superior absorptive capacity and financial slack, this tentative finding suggests that organizational scale might not automatically provide a distinct advantage in digital financial integration within this sector. While it must be interpreted cautiously due to its marginal significance, this counterintuitive observation points to the potential presence of organizational and bureaucratic inertia within large-scale manufacturing enterprises (Ghofar et al., 2025). Instead of necessarily acting as an accelerator, a massive organizational scale might introduce complex hierarchical layers, rigid operational silos, and structural resistance to technological change a premise that requires further validation in future research.

This counterintuitive finding underscores the critical presence of organizational and bureaucratic inertia within large-scale manufacturing enterprises (Ghofar et al., 2025). Instead of acting as an accelerator, large organizational scale introduces complex hierarchical layers, rigid operational silos, and structural resistance to technological change. When a large manufacturing firm adopts fintech, the assimilation process is often hindered by legacy corporate systems and prolonged employee adaptation phases. Conversely, while smaller firms might lack massive financial resources, their structural flexibility often allows for faster, more organic assimilation of digital tools. The non-significant interaction term ultimately proves that resource abundance alone, without structural agility, is insufficient to unlock the value-creating potential of financial technology.

Theoretical and Practical Contributions

Regarding the theoretical implications of the mediation model, the empirical results strictly indicate the absence of any mediating effect. Because the essential prerequisite paths specifically the effect of fintech adoption on investment efficiency and the subsequent effect of investment efficiency on firm value are statistically non-significant, the hypothesized mediation mechanism is fundamentally unsupported. Consequently, we firmly reject any notion of partial or full mediation. This lack of mediation reinforces our core argument: in the manufacturing sector, digital investments do not automatically translate into operational efficiencies that would subsequently drive market valuation, largely due to structural rigidities. By contextualizing these non-significant paths, this study provides a crucial boundary condition to the broader digital transformation discourse. Moving beyond the optimistic assumptions of digital finance, our empirical contribution lies in identifying the sector-specific rigidities that prevent fintech from universally driving firm value in real-sector emerging economies. The investment efficiency fails to act as a mediating mechanism, these unexpected findings provide a vital counter-narrative to traditional Agency and Signaling theories, showing that severe adjustment costs can decouple internal transparency improvements from market value. The lack of moderation by firm size challenges conventional

Resource-Based View assumptions, proving that structural inertia and legacy system dependencies can completely neutralize resource advantages.

Practically, the findings of this study offer a crucial warning for corporate managers, particularly within large manufacturing firms. Given that firm size failed to significantly moderate the relationship between fintech adoption and firm value, executives must recognize that merely possessing a massive asset base does not automatically guarantee successful digital integration. Instead of executing blind investments in financial technology, management must prioritize mitigating structural rigidities and carefully managing the high adjustment costs associated with legacy systems to avoid the severe financial pitfalls of the Fintech Paradox. To clearly distinguish our findings from the classical IT productivity paradox, it is essential to highlight their differing scopes. While the traditional IT productivity paradox focuses broadly on how aggregate investments in computerization and general information technology often fail to reflect in macroeconomic or overall firm-level productivity gains, the Fintech Paradox identified in this research operates through a more specialized, dual-layered friction. Specifically, we demonstrate that advanced digital financial architectures such as automated capital allocation tools and real-time financial tracking systems create severe operational mismatches when superimposed onto heavy, physical legacy assets. The bottleneck identified here is not merely a failure of general technological adaptation. Rather, it is a structural decoupling wherein specialized financial digitalization fails to overcome the deep-seated bureaucratic inertia and high physical adjustment costs inherent in the manufacturing sector. Thus, this study offers a granular, sector specific boundary condition that advances the broader technological paradox literature.

For policymakers and corporate managers, these findings serve as a strategic caution: fintech adoption should not be treated as a superficial technological silver bullet. To avoid the Fintech Paradox, corporate managers must ensure that digital financial integration is deeply aligned with fundamental operational restructurings and supply chain innovations rather than remaining isolated within administrative or financial departments. Finally, while this study provides robust empirical evidence of the Fintech Paradox within the manufacturing sector, several limitations must be acknowledged. First, the focus on a single capital-intensive industry limits the generalizability of the findings; digital integration in the financial or service sectors may yield entirely different market responses. Second, although the TWFE estimator effectively mitigates unobserved time-invariant heterogeneity, future research should explore dynamic panel models or Instrumental Variable (IV) approaches to further isolate potential endogeneity. Future studies are also encouraged to examine specific types of digital investments and organizational culture to better understand the granular mechanisms that exacerbate or alleviate the massive adjustment costs identified in this study.

Conclusion

This study provides a critical assessment of the economic consequences of fintech adoption in the Indonesian manufacturing sector. The empirical evidence leads to the conclusion that fintech integration, while strategically necessary, is not currently a direct engine for corporate value creation or investment efficiency in this industry. Connecting this conclusion back to the contradictory findings discussed earlier, it becomes evident that the theoretical optimism of Agency Theory and the Resource-Based View is severely constrained by the reality of manufacturing operations. Specifically, the massive adjustment costs, legacy system dependencies, and structural frictions effectively neutralize the anticipated digital benefits, thereby solidifying the empirical reality of the Fintech Paradox. The rejection of the primary mediation and moderation hypotheses highlights a significant gap between technological adoption and tangible economic outcomes in capital-intensive environments.

Two key insights emerge from this empirical investigation. First, contrary to the prevailing digital optimism in mainstream literature, corporate fintech adoption does not automatically enhance investment efficiency or firm value within the manufacturing sector. Instead, the substantial adjustment costs and structural rigidities confirm the existence of a Fintech Paradox. Second, the marginally significant negative association between firm size and market valuation ($p = 0.054$) cautiously suggests that, within this specific sample, larger organizational scales in emerging markets might face structural rigidity. Given the statistical limitations of this marginal finding, we explicitly avoid claiming this as definitive evidence of diseconomies of scale. Rather, it serves as a tentative indicator that bureaucratic inertia could hinder the agility required to effectively leverage financial innovation a dynamic that necessitates further robustness testing in future research.

Author contributions

Setiyo Purwanto was responsible for conceptualization, methodology, formal analysis, writing the original draft, and project administration. Nur Endah Retno Wuryandari contributed to data curation, validation, and writing review and editing. Masatsugu Nemoto was involved in methodology, visualization, and supervision. Kristiana Widiawati handled investigation, resources, and writing review and editing. All authors have read and agreed to the published version of the manuscript.

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