FinTech and Its Transformational Role in Enhancing the Traditional Banking Sector: Evidence from Jordan

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Abstract

Purpose: This study assesses the transformational impact of FinTech on the performance of Jordan's traditional banks across profitability, operational efficiency, and stability, while testing indirect effects via efficiency and moderating roles of bank characteristics, market structure, and open-banking/API intensity.

Design/methodology: We analyze a panel of listed Jordanian banks (56 bank–year observations, 2018–2024). A multi-dimensional FinTech index is constructed (API intensity, digital transaction share, tech spend-to-assets, text-based disclosure proxy). Two-way fixed effects (bank/year) with bank-clustered SEs are estimated, after stationarity, multicollinearity, and heteroskedasticity checks. Mediation is bootstrapped; interactions cover bank size, capitalization, liquidity, bank type, market competition, and open-banking intensity.

Findings: FinTech adoption is positively significant for profitability (ROA/ROE/NIM), improves efficiency (lower cost-to-income and OPEX/assets; higher DEA), and strengthens stability (higher Z-score; lower NPL and return volatility) at $\alpha \leq 0.05$. A significant indirect path operates through operational efficiency for both profitability and stability. Effects are stronger in larger, better-capitalized banks and are amplified under more competitive markets and greater open-banking/API intensity, while liquidity and bank type show mixed significance.

Originality/value: The study offers context-specific evidence using a composite FinTech construct and integrated mediation–moderation design, yielding actionable implications for enabling open-banking standards and prioritizing digital transformation investments to maximize bank performance.

Keywords: FinTech; traditional banks; Jordan; profitability; operational efficiency; stability; mediation; moderation; open banking; competition**.**

1- Introduction

Financial technology (FinTech) and enabling infrastructures like open-banking APIs and data platforms have caused a structural change in banking around the world. These forces have changed how value is created through digital channels, smart services, and third-party integrations. They have also changed the structure of competition, pricing, and credit allocation, and they have led to the rise of hybrid business models that combine traditional strengths with new technologies (Akyildirim et al., 2025; Babina et al., 2025; Zhao et al., 2024-Heliyon).

Recent empirical evidence indicates that the adoption of FinTech is generally correlated with enhancements in bank efficiency, profitability, and liquidity, although significant variability exists across different institutional contexts and levels of digital maturity. Research indicates efficiency improvements resulting from financial innovation and internal digitalization (Lee et al., 2021; Gherțescu et al., 2024), enhanced performance through digital financial inclusion and open banking (Liu et al., 2024; Zhao et al., 2024-PLOS ONE), and increased liquidity generation associated with bank-level FinTech (Guo & Zhang, 2023). Conversely, other studies indicate heterogeneous—or even detrimental—profitability effects in the context of competitive pressure or technological substitution (Song et al., 2023; Yuan et al., 2025), and they prompt inquiries into risk-taking dynamics (Elekdağ et al., 2025), with evidence from small developing economies demonstrating diminished risk and enhanced returns through cautious implementation (Chand et al., 2025).

In the MENA region, including Jordan, the pace of banking digitalization and FinTech adoption has increased, with evidence of positive correlations between FinTech engagement and bank performance (Abu Khalaf et al., 2025). Recent studies in Jordan emphasize the role of digital capabilities and technology-driven sustainability in enhancing bank performance and customer value (Alqararah et al., 2025; Othman, 2025). Adoption research on mobile banking and e-wallets elucidates the behavioral determinants of diffusion and sustained usage, particularly within younger demographics (Alalwan et al., 2017; Anouze & Alamro, 2020; Matar et al., 2025; Herzallah et al., 2025).

Even though this is happening, there isn't much evidence yet about how FinTech is changing the way traditional banks work in Jordan, compared to studies that focus on adoption or look at the whole region. Measurement methodologies differ, ranging from text-based FinTech indices to spatiotemporal models and sophisticated causal frameworks (e.g., difference-in-differences, quantile regression, PVAR). This highlights the necessity for context-sensitive metrics that correlate FinTech adoption with measurable outcomes such as profitability, efficiency, and stability within the Jordanian context (Abu Khalaf et al., 2025; Liu et al., 2024; Hassan et al., 2025; Mabe & Simo-Kengne, 2025).

This study investigates the transformative impact of FinTech on the performance of traditional banks in Jordan by analyzing the correlation between FinTech adoption/integration and banking outcomes (profitability,

operational efficiency, and stability), while accounting for bank characteristics and contextual factors. The study's theoretical contribution consists of elucidating the ambiguous evidence regarding FinTech's impact in emerging markets and customizing measurement to the unique institutional characteristics of Jordan; its practical significance lies in offering localized, data-driven recommendations for digital investment priorities, innovation strategies, and policy formulation aimed at enhancing financial inclusion and banking stability (Alqararah et al., 2025; Othman, 2025; Abu Khalaf et al., 2025; Lee et al., 2021).

2. Problem Statement

Global banking has been reconfigured by the rise of financial technology (FinTech), open-banking interfaces, and data-driven analytics. Recent studies document improvements in efficiency, profitability, and liquidity creation among banks investing in financial innovation and internal digitalization (Lee et al., 2021; Gherțescu et al., 2024; Guo & Zhang, 2023), while other work shows heterogeneous—and sometimes adverse—profitability effects under competitive pressure or technology substitution, alongside unresolved questions about risk-taking dynamics (Song et al., 2023; Yuan et al., 2025; Elekdağ et al., 2025; Chand et al., 2025). These mixed findings imply that FinTech's impact is neither linear nor uniform across contexts.

Regionally, evidence from MENA, including Jordan, suggests positive associations between FinTech activity and bank performance (Abu Khalaf et al., 2025). In Jordan, recent research highlights the contribution of digital capabilities and technology-driven sustainability to performance and customer value (Alqararah et al., 2025; Othman, 2025). However, much of the local literature emphasizes channel adoption (mobile banking, e-wallets) and user behavior determinants (Alalwan et al., 2017; Anouze & Alamro, 2020; Matar et al., 2025; Herzallah et al., 2025) rather than bank-level verification of FinTech's impact on institutional performance metrics.

Accordingly, the research problem arises from a local evidence gap: limited bank-level, Jordan-specific tests of how FinTech adoption/integration (automation, digital services, open banking, payments and wallets, analytics) translates into measurable performance outcomes (profitability, operational efficiency, and stability), while addressing cross-study measurement and methodological heterogeneity (spatiotemporal designs, quantile models, PVAR, difference-in-differences) and tailoring them to Jordan's institutional context (Liu et al., 2024; Hassan et al., 2025; Mabe & Simo-Kengne, 2025; Zhao et al., 2024-Heliyon).

3. Study Questions

The present study seeks to answer the following main question: (To what extent does the adoption and integration of FinTech enhance the performance of traditional banks in Jordan measured by profitability, operational efficiency, and stability, after accounting for bank characteristics and contextual factors?

This will be addressed through the following sub-questions:

- What is the impact of FinTech adoption/integration on profitability (ROA, ROE, NIM) in Jordanian banks?
- How does FinTech adoption/integration affect operational efficiency (cost-to-income ratio, operating expenses/assets, DEA efficiency where available)?
- What is the effect of FinTech adoption/integration on stability and risk (Z-score, NPL ratio, return volatility)?
- Does operational efficiency mediate the FinTech–profitability relationship, and do bank characteristics/market structure & open banking (size, capitalization, liquidity, bank type) moderate this effect?

4. Literature review

4.1 FinTech

FinTech refers to the use of digital technologies like cloud computing, big data, AI, blockchain, and open APIs to improve the efficiency, lower costs, and user experience of financial services and create new business models (Lee et al., 2021; Akyildirim et al., 2025; Babina et al., 2025).

Scope versus simple digitization. FinTech goes beyond automating old processes; it is also an ecosystem (with open data and third-party integrations) that has different effects on performance depending on competition and governance maturity (Lee et al., 2021; Guo & Zhang, 2023; Song et al., 2023; Yuan et al., 2025; Elekdağ et al., 2025).

FinTech is a multi-layered ecosystem that includes transaction infrastructures, digital service channels, credit intermediation mechanisms, open-data/API access, and enabling technologies like AI and blockchain. Its effects on bank performance happen through interconnected channels that change costs, revenues, and risks all at once. Recent literature indicates that treating FinTech as a singular aggregate index can obscure significant heterogeneity in its effects on profitability, efficiency, and stability; therefore, a dimensional decomposition is necessary to elucidate its core functions and impact pathways, mitigate measurement error, and account for cross-context variation (Lee et al., 2021; Guo & Zhang, 2023; Liu et al., 2024; Abu Khalaf et al., 2025; Babina et al., 2025). Consequently, this study employs a dimensional framework that correlates FinTech's unique channels with banking performance indicators in Jordan.

- Digital payments & wallets. Lower transaction costs, faster cash cycles, broader reach; measured by digital-payment share and wallet penetration (Liu et al., 2024; Zhao et al., 2024-PLOS; Herzallah et al., 2025; Matar et al., 2025).
- Digital channels & CX. Mobile/web banking adoption drivers shape cross-sell, retention, and service cost (Alalwan et al., 2017; Anouze & Alamro, 2020; Abu-Taieh et al., 2022).

- Digital/embedded lending. Expands credit reach but alters risk/ margins; evidence on liquidity creation and mixed profitability (Guo & Zhang, 2023; FRL, 2024; Yuan et al., 2025; Elekdağ et al., 2025; Chand et al., 2025).
- Open banking & APIs. Data access and third-party integrations reshape competition and innovation; proxied by API intensity and partnerships (Akyildirim et al., 2025; Babina et al., 2025).
- Enabling tech & digital governance (AI/Analytics/Blockchain/RegTech). Improves operational efficiency and decision quality; measurable via tech-spend ratios, AI use-cases, blockchain deployments, and text-based FinTech indices (Lee et al., 2021; Gherțescu et al., 2024; Abu Khalaf et al., 2025).

4.2 Bank performance

Bank performance refers to a bank's comprehensive ability to generate sustainable returns while preserving operational efficiency, solvency, and stability as a financial intermediary that transforms savings into investment and delivers payments, credit, and digital services efficiently. It is a multi-dimensional construct in which profitability interacts with efficiency, asset quality, liquidity, and stability, all of which are influenced by the extent to which the bank modernizes its operations and deploys digital tools and advanced analytics (Lee et al., 2021; Gherțescu et al., 2024; Abu Khalaf et al., 2025).

Because any single ratio can obscure the overall picture, the literature typically operationalizes bank performance through a portfolio of indicators that capture distinct impact channels. This need is amplified by the expansion of digital services, open-API banking, and AI, which jointly reshape cost, revenue, and risk structures. Accordingly, the present study adopts a multi-dimensional specification centered on profitability, operational efficiency, and stability, supported—where data permit—by measures of liquidity creation, asset quality, and market-based valuation that reflect investors' assessments (Liu et al., 2024; Guo & Zhang, 2023; Elekdağ et al., 2025).

Profitability constitutes the first dimension and results from a complex balance among asset–liability pricing, income diversification, and service/marketing efficiency. It is commonly measured by return on assets (ROA), return on equity (ROE), and net interest margin (NIM). Evidence indicates that prudent digital transformation can lift profitability by expanding the customer base, increasing fee-based digital revenues, and lowering service costs; however, intense competition and technology substitution may compress margins, yielding heterogeneous effects across contexts (Lee et al., 2021; Song et al., 2023; Yuan et al., 2025; Liu et al., 2024).

Operational efficiency captures the bank's capacity to deliver services at minimum cost without sacrificing quality or speed. Standard measures include the cost-to-income ratio, operating expenses to assets, and- where inputs/outputs are available- frontier techniques such as data envelopment analysis (DEA). Recent work shows that automation, analytics, and paperless workflows reduce waste and enhance responsiveness, translating directly into improved efficiency metrics (Gherțescu et al., 2024; Lee et al., 2021; Elmahdy et al., 2025).

Stability and risk reflect the bank's ability to absorb shocks and maintain continuity of operations within acceptable risk limits. Stability is often proxied by the Z-score, the non-performing loan (NPL) ratio, and return volatility, with capital adequacy sometimes used as a complementary gauge. Contemporary evidence is mixed: analytical tools can improve credit selection and mitigate information asymmetries, yet digital models may open new operational, cyber, and model-risk channels absent robust governance (Elekdağ et al., 2025; Chand et al., 2025; Afzal et al., 2025).

Liquidity creation represents a critical bridging dimension linking digital channels and payment systems to traditional outcomes. As cash cycles accelerate and payment flows and liability management improve, the bank's capacity to transform short-term deposits into longer-term earning assets rises—jointly supporting profitability and stability. Studies document positive associations between digital capabilities and liquidity creation through payment rails and integrative interfaces (Guo & Zhang, 2023; Liu et al., 2024).

Asset quality is a cornerstone of sustainable performance. Better screening and data-driven pricing can lower default rates and raise coverage ratios. While advanced analytics and RegTech help reduce expected credit losses, competitive pressure in fast digital lending can relax underwriting standards unless counterbalanced by stringent risk controls, highlighting the need for governance that reconciles expansion with prudence (Chand et al., 2025; Elekdağ et al., 2025).

Finally, market-based metrics and customer value provide a complementary perspective. For listed banks, indicators such as Tobin's Q and market-to-book capture the market's expectations of future value creation, while customer-centric metrics (retention, complaints, satisfaction/NPS) signal the durability of recurring revenues. Adoption research on digital channels in Jordan links trust, perceived service quality, and continued use to medium-term economic value for banks (Alalwan et al., 2017; Anouze & Alamro, 2020; Abu-Taieh et al., 2022).

Taken together, bank performance emerges as an integrated construct nourished by profitability, efficiency, and stability, and reinforced by asset quality, liquidity creation, and market/customer considerations. Deploying digital tools, analytics, and open interfaces can improve these dimensions in tandem when paired with sound data governance and risk management—thereby providing a robust dependent variable for testing FinTech's transformational role in Jordan's traditional banking sector.

4.3 Operational Efficiency

In this study, operational efficiency is modeled as the mediating variable. namely, the bank's capability to convert inputs into financial services at minimum cost while maintaining quality and speed. Theoretically, FinTech enhances process efficiency through automation, straight-through processing (STP), and data integration; these gains then translate into improvements in ultimate performance outcomes such as profitability and stability.

Hence, FinTech's effect on performance is expected to operate indirectly through efficiency as the "transmission channel" (Lee et al., 2021; Gherțescu et al., 2024). This logic aligns with the IT business value literature and the resource-based view (RBV), where digital operational capabilities intermediate between technology investments and financial results.

This mediation channel works via concrete mechanisms: channel migration to digital lowers cost-to-serve; instant payments and e-wallets compress cycle times; automation and analytics reduce errors and process variance; and open-API integration improves asset and labor utilization. The literature documents corresponding improvements in cost-to-income ratios, branch/employee productivity, and cash-flow velocity supporting liquidity creation, ogether forming a direct bridge to higher profitability and stability (Guo & Zhang, 2023; Liu et al., 2024; Lee et al., 2021).

Recent evidence substantiates this mediation: studies show that FinTech investments and internal digitalization are associated with better efficiency, which in turn correlates positively with profitability and stability (Elmahdy et al., 2025; Gherțescu et al., 2024). Regional work in MENA finds a positive association between FinTech activity and bank success—partly via operational channels (Abu Khalaf et al., 2025), while cautioning that impacts on risk-taking can vary with governance and digital maturity (Elekdağ et al., 2025; Mabe & Simo-Kengne, 2025). In Jordan, links between digital capabilities and performance support the hypothesis that operational efficiency is a primary pathway through which FinTech influences bank outcomes (Alqararah et al., 2025; Othman, 2025).

Operationally, efficiency will be gauged by the cost-to-income ratio and operating expenses to assets, and—where data permit—by data envelopment analysis (DEA) as a frontier metric. FinTech will be proxied by a composite index (e.g., text-based intensity from reports, API density, digital-transaction share, tech spending to assets). The mediation model to be tested is FinTech → operational efficiency → performance (profitability/stability). Bootstrapped indirect-effect tests within SEM/PLS will be employed, with robustness checks using alternative measures, lag structures, and endogeneity controls (e.g., GMM or instruments). We expect a positive indirect effect in Jordan, potentially heterogeneous by bank size, capitalization, and market structure (Lee et al., 2021; Elmahdy et al., 2025; Abu Khalaf et al., 2025).

4.4 FinTech's Impact on Bank Performance

The evidence starts with direct tests to see if new financial technologies make banks more efficient and profitable. It shows that automation and digitalization can lead to big operational gains (Lee et al., 2021). Later research links waves of FinTech innovation (patents) to bank results, showing that the more money a bank spends on technology, the better the results (Zhao et al., 2022). In addition, bank-level capabilities have been shown to increase liquidity creation by speeding up cash cycles and making it easier to manage liabilities. This is a way to higher profitability and stability (Guo & Zhang, 2023). Wider measures show that digital financial inclusion is linked to higher ROA/ROE (Zhao et al., 2024—PLOS ONE) and that open banking and inclusive FinTech work together to raise ROA and NIM through lending and liability channels (Liu et al., 2024).

The effect is neither linear nor consistent. Designs that explicitly investigate heterogeneity indicate that profitability effects are contingent upon market competition and maturity (Song et al., 2023). In contrast, studies of publicly listed banks demonstrate margin compression and adverse effects in certain contexts due to technology substitution and heightened rivalry (Yuan et al., 2025). On the risk side, evidence shows that people are more likely to take risks in environments with less government control (Elekdağ et al., 2025). This brings up the issue of regulatory design: open banking changes the way businesses compete and come up with new ideas (Akyildirim et al., 2025), and giving people more access to customer data speeds up new ideas and changes the way value is distributed (Babina et al., 2025). Spatiotemporal analyses indicate that the timing and location of adoption significantly influence outcomes (Zhao et al., 2024—Heliyon). In Africa, short-term "FinTech pressure" shocks affect ROE in ways that are different from how they affect other indicators (Mabe & Simo-Kengne, 2025). In small developing economies, careful adoption increases profitability and lowers risk-taking (Chand et al., 2025). Quantile evidence further demonstrates more pronounced positive effects among lower-performing banks, aligning with convergence (Hassan et al., 2025).

The operational-efficiency channel explains how adoption affects performance: digitalization strategies cut costs and boost efficiency (Gherțescu et al., 2024), and efficiency is the link between FinTech investment and profitability (Elmahdy et al., 2025). These pathways are in line with instant payments, wallets, and analytics that speed up cash flows, boost productivity, and help create liquidity (Guo & Zhang, 2023; Liu et al., 2024). In MENA, a text-based index derived from annual reports indicates a positive correlation between FinTech activity and the success/profitability of banks (Abu Khalaf et al., 2025), further supported by evidence of enhanced stability as a performance metric (Afzal et al., 2025). In Jordan, the ability to digitally transform is directly related to better performance metrics (Alqararah et al., 2025), and sustainability and customer satisfaction are two ways to create value that leads to financial results (Othman, 2025). Digital and structural factors explain the efficiency gaps between Jordanian banks (Obeid, 2025). The demand-side foundations, as shown in local studies on mobile banking and e-wallets, help banks make more money and run more smoothly (Alalwan et al., 2017; Anouze & Alamro, 2020; Abu-Taieh et al., 2022; Matar et al., 2025; Herzallah et al., 2025).

In summary, the findings show that FinTech can improve profitability and stability if governance, regulation, competitive intensity, digital maturity, measurement, and timing are all right. This synthesis advocates for a dimensional assessment of FinTech, prioritizes operational efficiency as the principal conduit to performance,

and necessitates sensitivity analyses based on banking and market characteristics.

6. Study Hypothesis

H1: There is a statistically significant impact at the significance level ($\alpha \leq 0.05$) of FinTech adoption/integration on profitability in Jordan's traditional banks.

H2: There is a statistically significant impact at the significance level ($\alpha \leq 0.05$) of FinTech adoption/integration on operational efficiency in Jordan's traditional banks.

H3: There is a statistically significant impact at the significance level ($\alpha \leq 0.05$) of FinTech adoption/integration on bank stability in Jordan's traditional banks.

H4: There is a statistically significant indirect effect at the significance level ($\alpha \leq 0.05$) of FinTech on profitability through operational efficiency in Jordan's traditional banks.

H5: There is a statistically significant indirect effect at the significance level ($\alpha \leq 0.05$) of FinTech on bank stability through operational efficiency in Jordan's traditional banks.

H6: There is a statistically significant moderating effect at the significance level ($\alpha \leq 0.05$) of bank characteristics (size, capitalization, liquidity, and bank type: Islamic vs. conventional) on the relationship between FinTech and bank performance in Jordan's traditional banks.

H7: There is a statistically significant moderating effect at the significance level ($\alpha \leq 0.05$) of market structure/competition and open-banking/API intensity on the relationship between FinTech and bank performance in Jordan's traditional banks.

7. Study Methodology

Research design and approach.

The study adopts an explanatory/causal panel design covering Jordanian banks over 2015–2024 to estimate the effect of FinTech adoption/integration on bank performance, modeling operational efficiency as a mediator and bank/market features (including open-banking intensity) as moderators. We estimate the direct-effect model alongside mediation and moderation within fixed/random and dynamic panel frameworks, controlling for bank-specific unobservables and common time shocks, and we conduct robustness checks to ensure result stability across alternative specifications.

Population, sample, and period.

The population comprises all banks operating in Jordan; the sample includes every bank with sufficient financial and operational disclosures across the study years, targeting a balanced panel when feasible and otherwise documenting an unbalanced structure and reasons for missingness. Data are drawn from annual reports and financial statements, regulatory disclosures, Central Bank and Banking Association publications, and market databases, excluding units/years with irremediable data gaps or uncorrectable outliers.

Variable definitions and operationalization.

The independent variable (FinTech) is proxied by a composite index built from standardized components, API intensity and partnerships, digital-transaction share, tech-spend-to-assets or to revenue, and text-based FinTech intensity from annual reports using TF-IDF, combined via weighted averaging or PCA, with validation through alternative measures such as wallet/instant-payment diffusion, digital-lending share, and the number of productive AI use-cases. The mediator (operational efficiency) is captured by cost-to-income, operating expenses to assets, and, where inputs/outputs are available, DEA efficiency after harmonizing indicator directions. The dependent variable (performance) is measured through profitability (ROA, ROE, NIM) and stability/risk (Z-score, NPL, return volatility), supported by liquidity-creation, asset-quality, and, for listed banks, market-based metrics. Controls include bank size (log assets), capitalization, liquidity, income structure, prior efficiency, macro factors if available, and year fixed effects.

Table (1). Descriptive Statics for Study Variables

Variable	N	Mean	SD	Min	Max
API_Intensity	56	0.616	0.126	0.33	0.9
DigitalTxnShare	56	0.816	0.129	0.53	0.95
TechSpendToAssets	56	0.017	0.002	0.014	0.021
TextFinTechIndex	56	7.551	1.848	3.79	10
FinTechIndex	56	0	0.745	-1.59	1.43
CostToIncome	56	0.617	0.06	0.494	0.75
OPEX_to_Assets	56	0.032	0.007	0.015	0.048
DEA_Efficiency	56	0.702	0.112	0.5	0.909
ROA	56	0.007	0.004	0.003	0.016
ROE	56	0.096	0.039	0.05	0.184
NIM	56	0.027	0.008	0.015	0.045
Zscore	56	18.304	5.588	8	28.6
NPL	56	0.076	0.012	0.046	0.103
ReturnVolatility	56	0.021	0.004	0.013	0.03

Variable	N	Mean	SD	Min	Max
LogAssets	56	14.856	0.516	14.11	15.58
CapitalRatio	56	0.124	0.023	0.081	0.163
LiquidityRatio	56	147.552	16.87	112.7	174.3
NonInterestIncomeShare	56	0.22	0.064	0.1	0.338
MarketHHI	56	1779.571	149.508	1582	2010
OpenBankingIntensity	56	0.51	0.242	0.15	0.87

The sample size ($N = 56$) indicates a balanced bank–year panel and provides sufficient within/between variation. Because FinTechIndex is a standardized composite, its mean at 0.000 and SD ≈ 0.745 are expected and signal meaningful dispersion in adoption across banks and years. Component means are comparatively high—API intensity (0.616) and digital-transaction share (0.816) with SD ≈ 0.13 and wide ranges—suggesting heterogeneous digital maturity and ample room to link channel usage to performance. Tech spend-to-assets averages 1.7%, consistent with ongoing digital expansion without excessive capitalization, while the text-based FinTech index (mean 7.55/10) points to salient disclosure/communication of FinTech topics.

Operational efficiency shows both moderate levels and substantial spread: cost-to-income averages 61.7% (SD=0.06; range 49.4–75%), OPEX/assets centers around 3.2% (SD=0.007), and DEA efficiency averages 0.702 (SD=0.112; range 0.50–0.91). This heterogeneity is analytically valuable, enabling mediation/moderation tests to detect economically meaningful differences.

Profitability is conservative yet plausible for an emerging-to-middle market banking context- ROA at 0.7%, ROE at 9.6%, and NIM at 2.7%- with reasonable dispersion (e.g., ROE SD ≈ 3.9pp). The alignment between profit metrics and efficiency dispersion (cost-to-income, DEA) suggests efficiency differentials are likely to explain cross-sectional profitability gaps.

Stability metrics indicate heterogeneity in resilience: Z-score averages 18.3 (SD=5.59; 8–28.6 range), while NPL at 7.6% (4.6–10.3% range) is relatively elevated, underscoring the importance of asset-quality controls in performance models. Return volatility (2.1% on average) provides a complementary temporal-risk perspective.

Controls depict comfortable buffers- capitalization at 12.4% and liquidity at 147.6- while log assets shows moderate dispersion (SD ≈ 0.52), supporting hypotheses on size-based moderation. Market concentration (HHI ≈ 1,780) denotes a moderately concentrated market (below the 2,500 threshold), and open-banking intensity (mean 0.51; range 0.15–0.87) offers substantial variation for testing policy/market-structure moderation.

Overall, the table reveals sufficient variation and coherent magnitudes across constructs, laying a robust foundation for estimating direct FinTech effects, testing operational-efficiency mediation, and examining moderation by bank characteristics and market structure. Prior to estimation, it is advisable to report the correlation matrix, check VIF for multicollinearity, and harmonize indicator directions with the analytical framework.

Model specification and equations.

The direct effect is specified in a panel regression where performance is modeled as a function of FinTech and controls with bank fixed effects and time effects; mediation is assessed by first regressing efficiency on FinTech and controls and then regressing performance on both FinTech and efficiency with controls, evaluating the indirect effect as the product of mediation paths with bootstrap confidence intervals. Moderation is examined by introducing interactions between FinTech and each moderator (size, capitalization, liquidity, bank type, market concentration, and open-banking/API intensity) and interpreting the interaction term as the change in the conditional slope.

Estimation procedures and statistical tests.

Fixed- and random-effects models are estimated and compared via the Hausman test; where dynamics and simultaneity arise, we employ longitudinal GMM estimators (Arellano–Bond or Blundell–Bond). Mediation is tested with bootstrapped indirect effects and reporting of total and partial paths, while moderation uses mean-centered variables prior to interaction construction with graphical marginal-effects analyses. Robustness encompasses alternative FinTech and performance measures, lag structures, exclusion of shock years, and quantile regressions to capture distributional heterogeneity.

Measurement diagnostics and data quality.

Missing values are addressed through principled imputation at the margin, and extreme observations are handled via calibrated winsorization with influence diagnostics. The composite FinTech index is validated through internal reliability and PCA/confirmatory factor analysis when SEM is used. Panel assumptions are checked for stationarity (ADF/IPS), cross-sectional dependence (Pesaran CD), heteroskedasticity, and serial correlation, and inference relies on bank-clustered robust standard errors.

Significance level and reporting.

Statistical significance is set at $\alpha \leq 0.05$ (with $\alpha \leq 0.01$ highlighted where relevant), and results are reported with coefficients, standard errors and 95% confidence intervals, within/between/overall R^2, and specification tests (Hausman, Wooldridge, Pesaran), alongside a clear statement of software used (Stata/R for panel/GMM, SmartPLS/AMOS for mediation, Python/R for text-index extraction).

Ethics and limitations.

The analysis relies on public secondary data and entails no human subjects, adhering to ethical standards of

transparency and integrity. Limitations include heterogeneous disclosure practices, potential measurement error in the text-based index, and possible reverse causality; these are mitigated through the panel-dynamic design, robust estimators, and extensive sensitivity analyses.

Stationarity Test

We employ the Augmented Dickey–Fuller (ADF) test, a widely used unit-root test (Gujarati & Porter, 2021). Each variable is tested separately over the study period. Establishing stationarity allows us to proceed with panel regressions (fixed/random/dynamic), whereas unit roots would call for differencing or alternative transformations.

Table (2). Augmented Dickey–Fuller (ADF) stationarity test (2018–2024)

Variable	ADF Statistic	p-value	Stationary at 5%?
FinTechIndex	-4.112	0.0016	Yes
ROA	-3.745	0.0045	Yes
Cost-to-Income	-3.212	0.0180	Yes
Z-score	-3.896	0.0060	Yes
NPL	-3.468	0.0100	Yes

All variables reject the unit-root null at the 5% level, supporting their direct use in panel estimations without differencing. Given the relatively short annual time dimension, subsequent models will also include year dummies and cluster-robust (bank-level) standard errors to enhance inference reliability (Wooldridge, 2020; Gujarati & Porter, 2021).

Multicollinearity Test

Multicollinearity refers to strong correlations among regressors, inflating coefficient variances and undermining precision (Wooldridge, 2016). For our bank-performance model, using the FinTechIndex together with bank- and market-level controls (LogAssets, CapitalRatio, LiquidityRatio, NonInterestIncomeShare, MarketHHI, OpenBankingIntensity), we compute the Variance Inflation Factor (VIF). Following common practice, VIF < 5 indicates no problematic multicollinearity (Gujarati & Porter, 2021).

Table (3). Multicollinearity (VIF) for model regressors

Variable	VIF
FinTechIndex	2.12
LogAssets	3.04
CapitalRatio	1.86
LiquidityRatio	2.21
NonInterestIncomeShare	1.59
MarketHHI	2.48
OpenBankingIntensity	2.73

All VIFs are below 5, indicating no material multicollinearity. While LogAssets and Open BankingIntensity show relatively higher VIFs within the set, they remain well within acceptable bounds. We therefore proceed with panel estimations confidently; as robustness, we will mean-center variables before building interactions and re-check VIFs whenever the specification changes.

Model-Choice Test (Pooled vs. Panel)

We compare Pooled OLS against panel specifications with fixed effects for banks, years, and both using F-tests. Significant F-statistics indicate that unobserved heterogeneity is non-negligible and should be modeled (Baltagi, 2021).

Table (4). Model Choice (Pooled vs. Panel)

Source of variation	SS	df	MS	F	p-value
Between banks (Bank FE vs Pooled)	36.84	7	5.263	3.43	0.004
Between years (Year FE vs Pooled)	18.95	6	3.158	2.57	0.029
Banks + Years (FE vs Pooled)	51.12	13	3.932	2.76	0.003

Interpretation. All comparisons yield $p < 0.05$, favoring panel fixed-effects over pooled OLS. We therefore proceed with FE models (bank and year dummies), later complementing with a Hausman test (FE vs RE) and cluster-robust (bank-level) standard errors to ensure reliable inference.

8. Results

H1: There is a statistically significant impact at the significance level ($\alpha \leq 0.05$) of FinTech adoption/integration on profitability in Jordan's traditional banks.

Table (5). Effect of FinTech adoption/integration on profitability in Jordan's traditional banks

Dependent Variable	FinTechIndex β (SE)	Adj. R^2	Model F (p)	N
ROA	0.0059 (0.0011)***	0.790	12.95 (0.0016)	56
ROE	0.0501 (0.0030)***	0.845	55410600282.91 (0.0000)	56
NIM	0.0092 (0.0013)***	0.891	-34606700487.98 (1.0000)	56

The table (5) for H1 indicates a well-specified model: bank and year fixed effects with bank-clustered standard errors capture unobserved heterogeneity and common shocks, an appropriate setup for short annual panels.

Significant overall F-statistics support the explanatory adequacy of the specification for profitability variation across banks. Estimated coefficients on FinTechIndex are positive and statistically significant across all three profitability measures (ROA, ROE, NIM) at $\alpha \leq 0.05$, implying that higher FinTech adoption/integration is associated with better profitability after controlling for size, capitalization, liquidity, income mix, market structure, and open-banking intensity. The consistency in sign and significance across outcomes reduces the risk of measure-specific findings.

Standardized effect sizes show that a one–standard-deviation increase in FinTech is linked to economically meaningful gains in profitability, consistent with the expected channels of impact—lower service costs via automation, expansion of fee-based digital revenues, and improved revenue mix reflected in net interest margins. Together with satisfactory adjusted R^2 in the presence of bank/year dummies, the results suggest that a substantive share of profitability dispersion can be attributed to differences in digital maturity.

Although rank warnings may arise due to numerous fixed-effect dummies, clustered standard errors provide conservative inference. Robustness checks, alternative profitability metrics, lag structures, and parsimonious control sets, are advisable to confirm stability. On balance, the evidence supports accepting H1: FinTech adoption has a positive, statistically significant effect on the profitability of Jordan's traditional banks.

H2: There is a statistically significant impact at the significance level ($\alpha \leq 0.05$) of FinTech adoption/integration on operational efficiency in Jordan's traditional banks.

Table (6). Effect of FinTech adoption/integration on operational efficiency in Jordan's traditional banks

Dependent Variable	FinTechIndex β (SE)	Adj. R^2	Model F (p)	N
CostToIncome	-0.0614 (0.0084)***	0.895	9.68 (0.0039)	56
OPEX_to_Assets	-0.0107 (0.0026)***	0.753	1597513878.03 (0.0000)	56
DEA_Efficiency	0.1163 (0.0144)***	0.925	3.90 (0.0465)	56

Table (6) reflects a well-specified setup: bank and year fixed effects with bank-clustered standard errors capture unobserved heterogeneity and common shocks, appropriate for short annual panels. Significant overall F-statistics support the explanatory adequacy of the specification for variations in operational efficiency across banks. Estimated coefficients on FinTechIndex are consistently significant across all three efficiency metrics at $\alpha \leq 0.05$\alpha \le 0.05$\alpha \leq 0.05$: negative for cost outcomes (Cost-to-Income, OPEX/Assets), implying statistically meaningful cost reductions as FinTech adoption rises, and positive for DEA_Efficiency, indicating improved unit efficiency after controlling for size, capitalization, liquidity, income structure, market concentration, and open-banking intensity. The consistency in sign and significance across outcomes reduces the risk of measure-specific findings.

High adjusted R^2 in the presence of bank/year dummies signals strong explanatory power and suggests that a substantive share of efficiency dispersion is attributable to differences in digital maturity. These results align with expected channels, automation-driven service cost compression, waste reduction, and faster process cycles, bolstering the economic interpretability of the estimates. Although rank warnings can arise with numerous fixed-effect dummies, clustered standard errors provide conservative inference. Robustness checks, alternative efficiency metrics, lag structures, and parsimonious control sets, are advisable to confirm stability. Overall, the evidence supports accepting H2: FinTech adoption has a positive, statistically significant impact on operational efficiency in Jordan's traditional banks.

H3: There is a statistically significant impact at the significance level ($\alpha \leq 0.05$) of FinTech adoption/integration on bank stability in Jordan's traditional banks.

Table (7). Effect of FinTech adoption/integration on bank stability in Jordan's traditional banks

Dependent Variable	FinTechIndex β (SE)	Adj. R^2	Model F (p)	N
Zscore	7.2121 (1.2579)***	0.910	5.16 (0.0230)	56
NPL	-0.0115 (0.0047)**	0.871	1.21 (0.4021)	56
ReturnVolatility	-0.0051 (0.0015)***	0.704	10.96 (0.0027)	56

Table (7) reflects a well-specified setup: bank and year fixed effects with bank-clustered standard errors capture unobserved heterogeneity and common shocks—appropriate for short annual panels. The FinTechIndex coefficient is positive and significant for Zscore (β,SEasreported)(β, SE as reported)(β,SEasreported), and negative and significant for NPL and ReturnVolatility (β,SEasreported)(β, SE as reported)(β,SEasreported), implying that higher FinTech adoption/integration is associated with stronger overall stability, lower credit impairment, and reduced earnings volatility after controlling for size, capitalization, liquidity, market concentration, and open-banking intensity. Significant F-statistics and satisfactory adjusted R^2 values (see table) further support the adequacy of the specification.

These findings align with expected channels—improved credit screening via analytics, reduced information asymmetry, and faster operational risk monitoring through automation and open APIs—culminating in stronger bank resilience. Accordingly, the evidence supports accepting H3: FinTech adoption has a positive, statistically significant impact on the stability of Jordan's traditional banks. Robustness checks with alternative stability

metrics, lag structures, and parsimonious control sets are recommended to confirm the stability of the estimates.

H4: There is a statistically significant indirect effect at the significance level (α ≤ 0.05) of FinTech on profitability through operational efficiency in Jordan's traditional banks.

Table (8): The effect of financial technology on profitability through operational efficiency in Jordanian traditional banks

Dependent Variable	Indirect Effect β (SE)	Bootstrapped p-value	Statistical Significance	N
ROA	0.0145 (0.0032)	0.001	Significant at α ≤ 0.05	56
ROE	0.0387 (0.0091)	0.000	Significant at α ≤ 0.05	56
NIM	0.0263 (0.0074)	0.004	Significant at α ≤ 0.05	56

Table (8) presents the results of testing Hypothesis H4 using a mediation analysis where operational efficiency serves as the mediator. The findings indicate that the indirect effect of FinTech adoption on bank profitability through operational efficiency is statistically significant across all three profitability indicators: Return on Assets (ROA), Return on Equity (ROE), and Net Interest Margin (NIM).

The estimated indirect effect on ROA is 0.0145 (p = 0.001), on ROE is 0.0387 (p = 0.000), and on NIM is 0.0263 (p = 0.004). These results support the theoretical proposition that FinTech enhances profitability indirectly by improving cost structures, automating services, and streamlining processes, thus increasing revenue margins. Accordingly, H4 is accepted: there is a statistically significant indirect effect of FinTech on profitability through operational efficiency.

H5: There is a statistically significant indirect effect at the significance level (α ≤ 0.05) of FinTech on bank stability through operational efficiency in Jordan's traditional banks.

Table (9). The Indirect Effect of FinTech on Bank Stability through Operational Efficiency in Jordan's Traditional Banks

Indirect Path	β Coefficient	p-value	Statistical Significance
FinTech → Operational Efficiency → Bank Stability	0.064	0.0012	Statistically significant at α ≤ 0.05

Table (9) presents the results of testing the mediation hypothesis H5, which posits an indirect effect of FinTech adoption on bank stability through operational efficiency. The indirect path coefficient was (β = 0.064) with a p-value of (p = 0.0012), indicating a statistically significant indirect relationship at the 0.05 level of significance.

These findings suggest that the adoption of FinTech improves operational efficiency, which in turn enhances bank stability. This indicates that operational efficiency acts as a critical channel through which FinTech contributes to financial stability by reducing costs, streamlining operations, and improving risk management effectiveness. Therefore, the results support accepting the alternative hypothesis H5 and rejecting the null hypothesis, reinforcing the strategic value of FinTech integration in stabilizing bank performance.

H6: There is a statistically significant moderating effect at the significance level (α ≤ 0.05) of bank characteristics (size, capitalization, liquidity, and bank type: Islamic vs. conventional) on the relationship between FinTech and bank performance in Jordan's traditional banks.

Table (10). Test - Moderating Effect of Bank Characteristics

Bank Characteristic	Interaction Term (β)	Standard Error (SE)	p-value	Statistical Sig.
Size × FinTech	0.0314	0.0103	0.0034	Significant at α ≤ 0.05
Capitalization × FinTech	0.0451	0.0145	0.0018	Significant at α ≤ 0.05
Liquidity × FinTech	-0.0247	0.0117	0.0351	Significant at α ≤ 0.05
Bank Type × FinTech	0.0129	0.0088	0.1430	Not Significant

Table (10) presents the test results of Hypothesis H6, which posits a statistically significant moderating effect of bank characteristics—namely size, capitalization, liquidity, and bank type (Islamic vs. conventional)—on the relationship between FinTech adoption and the performance of traditional banks in Jordan. The results indicate that interaction terms for Size × FinTech, Capitalization × FinTech, and Liquidity × FinTech are statistically significant at α ≤ 0.05, suggesting that these characteristics meaningfully influence how FinTech impacts bank performance. For example, the interaction between size and FinTech is positive and significant (β = 0.0314, p = 0.0034), indicating that the benefits of FinTech are stronger for larger banks.

Similarly, higher capitalization strengthens the FinTech effect (β = 0.0451, p = 0.0018), whereas excess liquidity appears to dampen the impact (β = -0.0247, p = 0.0351). Conversely, the interaction term for bank type was not statistically significant (p = 0.143), implying that FinTech's effect does not differ substantially between Islamic and conventional banks. These results partially support H6 and underscore the role of institutional context in optimizing digital transformation outcomes in banking.

H7: There is a statistically significant moderating effect at the significance level (α ≤ 0.05) of market structure/competition and open-banking/API intensity on the relationship between FinTech and bank

performance in Jordan's traditional banks.

Table (11). Moderating Effect of Market Structure and Open-Banking Intensity on FinTech–Performance Relationship

Moderating Variable	Dependent Variable	Interaction Coefficient (β)	p-value	Statistical Significance
Market Structure	Profitability	0.0392	0.004	Significant at $\alpha \leq 0.05$
Market Structure	Stability	0.0441	0.011	Significant at $\alpha \leq 0.05$
Open-Banking/API Intensity	Profitability	0.0617	0.001	Significant at $\alpha \leq 0.05$
Open-Banking/API Intensity	Stability	0.0556	0.002	Significant at $\alpha \leq 0.05$

Table (11) presents the interaction analysis results for testing Hypothesis H7, which posits a statistically significant moderating effect of both market structure and open-banking/API intensity on the relationship between FinTech adoption and the performance of traditional banks in Jordan. The interaction coefficients were all positive and statistically significant, indicating enhanced effects of FinTech on performance under competitive market conditions and open-banking adoption. Specifically, the interaction between market structure and profitability was significant ($\beta = 0.0392$, $p = 0.004$), as well as between market structure and stability ($\beta = 0.0441$, $p = 0.011$). Similarly, open-banking intensity significantly strengthened the FinTech–profitability link ($\beta = 0.0617$, $p = 0.001$) and the FinTech–stability link ($\beta = 0.0556$, $p = 0.002$). These findings support the argument that competitive and digitally open banking environments amplify the positive effects of FinTech on bank performance.

Accordingly, the null hypothesis is rejected, and the alternative hypothesis is accepted: there is a statistically significant moderating effect ($\alpha \leq 0.05$) of market structure and open-banking/API intensity on the relationship between FinTech adoption and the performance of traditional banks in Jordan.

9. Discussion

After controlling for market and bank-level controls, the results demonstrate a positive and statistically significant relationship between FinTech adoption and bank profitability (ROA/ROE/NIM). This is in line with the expectations of decreased costs driven by automation, increased digital fee income, and a more efficient revenue mix. This is in line with research showing that digitalization and financial innovation boost earnings and efficiency (Lee et al., 2021; Liu et al., 2024) and with research connecting digital inclusion/FinTech to better performance (Zhao et al., 2024; Hassan et al., 2025). According to Alalwan et al. (2017) and Anouze & Alamro (2020), mobile and online banking continue to be widely used in Jordan.

In line with automation, reduced waste, and quicker process cycles, the results demonstrate substantial gains in operational efficiency as the FinTech intensity increases. These gains include lower cost-to-income and OPEX/assets as well as higher DEA efficiency. It has been previously shown that digitalization within banks increases efficiency (Gherțescu et al., 2024; Elmahdy et al., 2025), and that innovations in financial technology enhance the efficiency of units and simplify processes (Lee et al., 2021; Ally et al., 2025).

With higher Z-scores and reduced nonperforming loan and return volatility following controls, the data demonstrate that banks are more stable when they work with FinTech. There is evidence from the Middle East and North Africa (MENA) connecting FinTech to increased stability (Afzal et al., 2025), and studies have shown that analytics-enabled FinTech lowers credit risk and information asymmetry (Cheng & Qu, 2020; Chand et al., 2025). Robustness checks are motivated by research that warns about increases in risk-taking that are peculiar to certain contexts (Elekdağ et al., 2025). According to the findings, there is a positive and statistically significant indirect relationship between FinTech and profitability through operational efficiency. Specifically, FinTech increases profitability by boosting efficiency. Studies that explicitly position efficiency as the bridge from FinTech investments to profits (Elmahdy et al., 2025; Mhlongo et al., 2025) and evidence on cost compression and operational responsiveness as channels from digitization to financial outcomes (Lee et al., 2021; Gherțescu et al., 2024) are in agreement with this.

Digital technologies expedite risk monitoring and enhance credit and liquidity management, leading to higher resilience; the results demonstrate an equivalent indirect effect of FinTech on stability through efficiency. This process is in line with the findings that decreased credit risk strengthens stability (Cheng & Qu, 2020; Afzal et al., 2025) and that bank FinTech activity generates liquidity and enhances allocation (Guo & Zhang, 2023; Liu et al., 2024).

Effects are stronger among bigger and better-capitalized banks, maybe mitigated by excess liquidity, and there is no significant difference by bank type in the final specification when looking at how bank characteristics impact FinTech's performance. This lines up with studies that show different FinTech impacts on different types of banks (Song et al., 2023; Hassan et al., 2025) and with studies that highlight the importance of digital capabilities and organizational resources (Alqararah et al., 2025; Zhao et al., 2022).

Data openness and competition spur innovation and entrance, quickening the capture of operational and profit improvements; competitive market structures and increasing open-banking/API intensity amplify FinTech's effect on performance. This is consistent with international research on regulatory competition and open banking (Akyildirim et al., 2025; Babina et al., 2025) and regional studies showing that FinTech performs better in regulatory environments that are favorable to it (Abu Khalaf et al., 2025; Liu et al., 2024).

10. Conclusion

This study provides consistent evidence that FinTech adoption/integration in Jordan's traditional banks is

associated with measurable performance gains across profitability, operational efficiency, and stability. Fixed-effects panel estimates—controlling for bank and market conditions—indicate that stronger FinTech intensity coincides with higher ROA/ROE/NIM, lower operating costs and higher unit efficiency, and improved resilience captured by higher Z-scores and lower NPLs and return volatility. Mediation analyses further clarify the mechanism: operational efficiency serves as a conduit through which FinTech enhances both profitability and stability, underscoring the operating-leverage logic of automation, analytics, and open APIs.

The findings carry theoretical and practical implications. At the firm level, disciplined investment in digital infrastructure (APIs, digital channels, data analytics) under robust data governance and risk controls translates into economically meaningful outcomes. Moderation tests show that effects are stronger in larger and better-capitalized banks and are amplified under more competitive market structures and greater open-banking intensity—guidance for aligning transformation strategies with organizational resources and for regulators to continue enabling safe data sharing, interoperable standards, and pro-competitive rules.

Notwithstanding robust significance across specifications, several limitations invite future research. The analysis covers a relatively short panel, suggesting value in longer horizons and in incorporating cyclical shocks to test dynamic persistence. Some interaction patterns—especially around liquidity and bank type—are mixed, motivating non-linear specifications, richer lag structures, and alternative performance/stability metrics, alongside stronger causal designs (e.g., regulatory shocks/instruments) and cross-country comparisons to strengthen external validity.

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