DO FINTECH INNOVATIONS MATTER FOR THE EFFICIENCY AND STABILITY OF BANKS IN SOUTH AFRICA?

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Abstract: Innovations in financial technology (fintech) are driving a rapid transition in the global banking system, offering more efficient, tailored, and cost-effective solutions that challenge traditional banking methods. In South Africa, the stability of the banking sector is critical to economic growth because it provides capital, manages risks, and facilitates transactions. This study investigates the impact of fintech innovations on the efficiency and stability of banks listed on the Johannesburg Stock Exchange (JSE) between 2000 and 2023 using a panel data approach. The results suggest that Fintech has a positive influence on operational efficiency, notably through mobile transactions. However, Fintech has no effect on banking sector stability, with traditional capital structures outweighing Fintech innovations. These findings emphasize the dual nature of Fintech's impact; that is, it fosters efficiency improvements but also introduces new risks by disrupting traditional banking services through more convenient and cost-effective alternatives. As this landscape evolves, adaptive regulatory frameworks are needed to balance the benefits of technological advancements with the need for adequate protection within the banking sector.

Keywords: Banks; Efficiency; Fintech; Stability

INTRODUCTION

The South African banking sector is facing a critical juncture as the rise of financial technology (Fintech) continues to challenge traditional models of banking efficiency and financial stability. In an era where banking systems must remain resilient and agile, the urgency to understand the dual impact of fintech, as both a disruptive force and a potential enabler of innovation, has never been greater (Mhlongo, Kunjal, and Muzindutsi, 2025). As regulatory frameworks strive to keep pace with evolving technologies, South African banks face mounting pressure to sustain operational efficiency while safeguarding stability in a complex digital landscape. Among developing economies, South Africa is recognized for its well-regulated banking industry, overseen by the South African Reserve Bank (SARB), the continent's oldest central bank. The SARB manages the country's monetary reserves and monitors systemic risk across the "big five" banks, Standard Bank, FNB, Absa, Nedbank, and Capitec, which collectively hold over 90% of banking assets (Wilson et al., 2024). While this system promotes financial intermediation and economic stability (Baker et al., 2023; van Deventer & Redda, 2023), fintech innovations, fueled

Increased mobile usage, internet access, and digital infrastructure are transforming customer expectations, service delivery models, and risk exposures (Bogaard et al., 2024).

Fintech, as defined by Vucinic (2020), encompasses technological innovations in financial services that alter institutional operations and market structures. These innovations offer benefits such as reduced operational costs, improved customer experience, and automation of manual banking functions. However, they may also introduce significant risks, including regulatory gaps, higher compliance costs, and cyber threats (Didenko, 2018; Ullah et al., 2023; Vijayagopal et al., 2024). For banks in South Africa, implementing fintech solutions is further complicated by legacy systems and compliance with laws such as POPIA and FICA, which can constrain operational efficiency while maintaining data security and customer trust (Innes & Andrieu, 2022; IFWG, 2023).

Despite the growing body of research, key gaps remain in understanding fintech's full impact on bank performance in the South African context. Most existing studies narrowly assess either efficiency or financial inclusion, overlooking the dual lens of efficiency and stability. Moreover, findings from prior research remain inconsistent; some report gains in efficiency and resilience, while others highlight increased operational risks and instability. This study addresses these gaps by offering a comprehensive analysis of how fintech innovations influence both bank efficiency and financial stability within South Africa. This paper's novelty lies in three main contributions: First, it extends existing research by simultaneously assessing fintech's effects on efficiency and stability, offering a more integrated and nuanced understanding rarely explored in emerging markets. Second, it clarifies conflicting findings by empirically evaluating fintech's impact across multiple banking functions, drawing from South African-specific data. Third, methodologically, the study applies Stochastic Frontier Analysis (SFA), an improvement over the traditional Data Envelopment Analysis (DEA), which allows for separating inefficiency from random shocks. In doing so, the research provides actionable insights for regulators, banks, and fintech firms operating within emerging financial ecosystems.

This paper's novelty lies in three main contributions: First, it extends existing research by simultaneously assessing fintech's effects on efficiency and stability, offering a more integrated and nuanced understanding rarely explored in emerging markets. Second, it clarifies conflicting findings by empirically evaluating fintech's impact across multiple banking functions, drawing from South African-specific data. Third, methodologically, the study applies Stochastic Frontier Analysis (SFA), an improvement over the traditional Data Envelopment Analysis (DEA), which allows for separating inefficiency from random shocks. In doing so, the research provides actionable insights for regulators, banks, and fintech firms operating within emerging financial ecosystems.

The paper is structured as follows: Section 2 reviews the literature on fintech innovations. Section 3 outlines the data and methodology, while Section 4 presents the results. Section 5 concludes the research.

LITERATURE REVIEW

Theoretical Framework

Disruptive Innovation Theory, introduced by Clayton Christensen in 1997, explains how new, simpler, and often more affordable products or services can disrupt existing markets. It identifies two main types of innovations: sustaining and disruptive. Sustaining innovations focus on improving existing products or services, while disruptive innovations target niche markets or underserved customers with simpler, more affordable solutions (Christensen, 1997). Fintech innovation exemplifies this concept, targeting underbanked populations or customers dissatisfied with traditional banking services. The innovations often cater to previously underserved market segments, offering user-friendly applications, lower fees, and innovative products (Christensen et al., 2024). This disruption forces traditional banks to adapt or risk losing customers. In addition, the theory suggests that threats to bank stability might arise from the rapid adoption of unvetted new technologies or from the absence of laws governing fintech businesses, which can weaken financial stability (Indiran et al., 2024).

On the other hand, the Creative Destruction Theory, introduced by economist Joseph Schumpeter in 1942, emphasizes innovation as the primary driver of economic growth. It suggests that widespread fintech adoption could pose risks to financial stability if regulatory frameworks are not adapted to address new business models and players (Schumpeter, 1942; Adler, 2019). However, collaboration between banks and fintech can foster a more robust and inclusive financial ecosystem, combining banks' regulatory compliance and trust with fintech's innovation and agility (Al-Shari and Lokhande 2023).

Review of empirical studies on Fintech and bank efficiency

A growing body of empirical literature supports fintech's role in enhancing bank efficiency, particularly in developing and emerging economies. In Asia, Wang et al. (2021) and Lee et al. (2021) find that fintech adoption significantly improved cost structures and operational productivity in Chinese banks. Key enablers included strategic investment in big data and cloud infrastructure. Likewise, Maryunita and Nugroho (2022) showed that fintech services helped Indonesian banks boost competitiveness, especially among SMEs, by simplifying credit evaluation and expanding reach. Liao (2023) found that Taiwanese banks leveraging mobile payment platforms saw gains in customer satisfaction and transaction efficiency.

Notably, fintech-driven efficiency gains are not uniformly experienced. In China, Lee et al. (2023) found that while large banks improved cost efficiency, smaller and rural banks faced higher borrowing costs due to competition. Al-Jabri (2023) reached a similar conclusion in MENA countries, where fintech improved back-office operations but introduced volatility amid rapid growth.

In South Africa, fintech's effect on bank efficiency is emerging but uneven. Institutions such as FNB and TymeBank have embraced digital account onboarding and online loan services, increasing transaction speed and cost-efficiency (FSCA, 2021). However, many traditional banks are constrained by legacy IT systems that hinder real-time integration with fintech platforms (Innes & Andrieu, 2022). Additionally, banks must navigate stringent compliance

requirements under POPIA and FICA, which, while essential, impose added costs and reduce agility in implementing new technologies (McKinsey, 2020). These studies collectively underscore the transformative potential of fintech to enhance banking efficiency while also highlighting the challenges associated with its adoption and integration.

Review of empirical studies on Fintech and bank stability

Fintech's influence on banking stability is multifaceted, offering enhanced risk management capabilities but also introducing systemic and cyber-related vulnerabilities. Empirical studies in Asia highlight the stabilizing role of fintech through improved risk assessment and credit profiling. Yin et al. (2022) and Geng et al. (2023) report that Chinese banks leveraging AI and big data saw reductions in non-performing loans. Daud et al. (2022), in a global study of 63 countries, found that digital transformation correlates positively with resilience, especially where regulatory frameworks support innovation. In Malaysia, Safiullah and Paramati (2022) found that collaborative fintech adoption contributed to stability, but competition also introduced risk-prone behavior. In Southeast Asia and the Middle East, researchers have noted a more cautious balance. Yudaruddin et al. (2023) stress that peer-to-peer lending in Southeast Asia can enhance inclusion but requires regulatory refinement to avoid destabilization. Al-Jabri (2023) found that while fintech enhanced stability in MENA countries, GDP-driven bank growth created instability due to oversaturated competition.

South Africa presents a hybrid case. Fintech innovations are improving internal risk controls. For instance, Absa's adoption of Amazon Web Services (AWS) for risk analytics has strengthened its risk detection and forecasting frameworks (Amazon Web Services, 2023). Similarly, Standard Bank is implementing advanced digital identity systems to guard against fraud and improve onboarding security (IFWG, 2019). These technologies support greater financial system stability. However, these same innovations introduce new vulnerabilities. According to Masangwana (2021), fintech applications expose banks to cybersecurity threats, vendor lock-in, and operational risks, particularly when deployed faster than regulators can adapt. Takundwa (2020) notes that the pace of fintech growth outstrips South Africa's regulatory agility, posing compliance risks under laws like POPIA. Compared to countries like China or Malaysia, where digital infrastructure and regulatory sandboxes facilitate balanced innovation, South Africa's institutional environment is still maturing. These studies collectively demonstrate that while fintech innovations present opportunities to enhance financial stability, their integration also poses challenges, necessitating balanced approaches, robust regulatory frameworks, and careful risk management to optimize outcomes.

RESEARCH METHODOLOGY

Data sample

This study focuses on South Africa's banking sector by selecting publicly traded banks listed on the Johannesburg Stock Exchange (JSE). The sample includes African Bank, FirstRand, Standard Bank, Capitec Bank, Investec Bank Limited, Absa Group, Nedbank Group, and Finbond Group. These banks were chosen due to their substantial market share and representativeness of

The sector's competitive landscape, as it collectively accounts for over 90% of banking assets in South Africa (Wilson et al., 2024).

A purposive sampling method was employed to select these banks based on the following criteria: Public listing on the JSE to ensure data availability and transparency, and consistent annual financial data spanning the study period. The sample period extends from 2000 to 2023, and it was selected strategically to capture the rise and rapid evolution of fintech in South Africa. This 24-year span allows for a detailed analysis of long-term trends, structural shifts, and the impact of technological innovation on banking efficiency and stability. The dataset consists of 192 observations, representing yearly data points from the eight banks over the 24 years. Furthermore, the data were obtained from secondary sources, including the Bloomberg terminal and the World Bank's World Development Indicators (WDI) database. The data were chosen to maintain consistency and comparability across all financial and operational variables, aligning with standard practices in banking-sector analysis (Masangwana, 2021; Liao, 2023).

Computation of variables

The Bloomberg terminal was used to collect data for the dependent variables, which are the Stochastic Frontier Approach (SFA) and Z-score. The data for the independent variables proxying Fintech are obtained using the method proposed by Masangwana (2021) and Liao (2023), where Fintech is measured by the natural logarithm of the total Automated Teller Machines (ATMs) per 100,000 adults in year t and the value of mobile transactions, which refers to the total monetary value of transactions conducted via mobile payment systems. These variables are selected for their relevance and data availability in the South African context. ATMs represent the physical infrastructure enabling digital financial access and inclusion, particularly in underserved areas. Despite being a more traditional channel, ATMs remain a critical interface for fintech-enabled banking services, especially in developing economies where full digital migration is incomplete (IFWG, 2019; Suder et al., 2022). The logarithm of the number of ATMs per 100,000 adults captures the density and accessibility of financial infrastructure, which has been shown to correlate with efficiency gains in banking operations (Masangwana, 2021).

Conversely, the VMT variable captures the total monetary value of transactions executed via mobile payment platforms. This measure reflects the adoption and penetration of modern fintech services that promote efficiency, reduce transaction costs, and potentially impact the financial stability of banks (Philippon, 2016; Kredina, 2021). Together, ATM density and VMT provide a dual perspective that covers both physical and digital channels, sufficiently capturing fintech innovation within the South African banking sector. On the other hand, this study follows Liao's (2023) stochastic frontier approach (SFA) to estimate a bank's technical efficiency. In addition, the study uses Z-scores for bank stability, following the methods used by Moyo (2018), Safullah and Paramati (2022), and Yudaruddin et al. (2023). The Z-score indicates bank risk insolvency but is inversely related to insolvency. Thus, a high z-score suggests a low risk of insolvency (World Bank, 2023). The control variables of GDP, inflation, and bank concentration were obtained from

the World Bank's World Development Indicators (WDI) database. The author calculated additional control variables, such as personal expenses and total deposits, using data from the Bloomberg terminal. Table 1 provides a summary of the variables used in the study

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Table 1. Summary of the variables used in this study

Variable	Description	Measurements/ proxies used	Data source
	Dependent variables		
The stochastic frontier approach (SFA)	Measures the efficiency of banks based on their ability to minimize costs while maximizing outputs, given a set of inputs(Liu, 2019; Liao, 2023).	The approach evaluates inefficiency by comparing actual performance to the production frontier, accounting for input-output relationships and control variables.	Author's Computation using data from the Bloomberg terminal
Z-score	Measures bank stability, indicating the likelihood of bankruptcy. A higher score suggests greater stability (Safullah & Paramati, 2022).	The ratio of ROA plus EAR to the standard deviation of ROA. ROA is the return on assets, and EAR represents earnings at risk.	Author's Computation using data from the Bloomberg terminal
	Explanatory variables		
Fintech (ATM)	Denotes the penetration of ATMs in South Africa, representing access to financial technology (Masangwana, 2021).	Number of ATMs per 100,000 adults.	World Bank – World Development Indicators
Value of mobile transactions (VMT)	Measures the monetary value of transactions conducted through mobile payment systems (Philippon, 2016; Kredina, 2021)	The total value of mobile transactions is measured in South African Rand (ZAR).	World Bank – World Development Indicators
	Control Variables		
Gross Domestic Product (GDP)	Represents the overall economic output of a country and is often used to gauge the economic environment for banks(Apau & Sibindi, 2023).	The annual growth rate of GDP is expressed as a percentage.	World Bank – World Development Indicators
Inflation (INF)	Indicates the rate of increase in the price level of goods and services in the economy(Batayneh et al., 2021).	The annual inflation rate is expressed as a percentage.	World Bank – World Development Indicators

Variable	Description	Measurements/ proxies used	Data source
Bank Concentration (BNK)	Measures the degree of concentration in the banking sector, with a higher percentage indicating more dominance by the top banks(Corbae & D'Erasmo, 2020).	The total assets held by the five largest banks in the country as a percentage of total industry assets.	World Bank – World Development Indicators
Total Deposits (TD)	Combined funds held by customers in a bank, including demand deposits, savings accounts, and time deposits(Doerr, 2024).	Total deposits, measured in monetary terms.	Author's Computation using data from the Bloomberg terminal
Personal Expenses (PE)	Personnel expenses relative to total assets serve as a critical component of operational risk (Igan et al., 2021).	Personnel Expenses / Total Assets.	Author's Computation using data from the Bloomberg terminal
Interest Expenses (IE)	The cost of obtaining funds through deposits or borrowing influences a bank's stability and profitability (Vohra et al., 2023).	Total interest expenses are measured in monetary terms.	Author's Computation using data from the Bloomberg terminal

Source: Author's own estimations (2024)

Methodology

The study extends the simple panel regression model to factor in control variables as follows:

$$Y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + \sum_{j=1}^{j} \beta_3 X_{3it} + \varepsilon_{it} \quad (1)$$

Equation (1) represents a linear panel regression model used to explain the dependent variable, Y_{it}. The coefficients of β_1 and β_2 measure the effect of the main independent variables, X_{1it} and X_{2it}, which are Fintech proxies, respectively. In addition, $\sum_{j=1}^{j} \beta_3 X_{3it}$ captures the influence of J control variables, with each control variable having its own coefficient (β_3). Finally, ε_{it} refers to the error term, capturing random, unexplained variations in Y_{it} the model does not account for that. Hausman tests are used to select between fixed- and random-effects models for each aim, assessing the adequacy of various model specifications. To validate the robustness of the System GMM estimation, this paper conducted standard diagnostic tests, including the Hansen J-test and the Arellano-Bond test for second-order autocorrelation (AR (2)). The Hansen test assesses the validity of the instruments used, ensuring they are not correlated with the error term and guarding against instrument proliferation (Phan et al., 2018). The AR (2) test checks for the absence of serial correlation in the differenced residuals, a necessary condition for consistent GMM estimation. Both tests confirmed the model's reliability, supporting the suitability of System GMM for dynamic panel data analysis (Wang et al., 2021).

RESULTS AND DISCUSSION

Preliminary Analysis

This section evaluates the relationship between fintech innovations and the dynamics of the South African

banking sector. The dataset consists of 192 observations, capturing key financial and technological indicators. Efficiency (SFA) has a high mean of 0.95, suggesting optimal operations. The Z-score has a mean of 4.24, indicating overall sectoral stability and low insolvency risk. ATM usage reflects moderate adoption of physical fintech infrastructure, while the value of mobile transactions (VMT) shows low but evolving digital engagement, with high skewness and kurtosis pointing to uneven uptake. Bank concentration (BNK) reveals a few dominant players in the market. Macroeconomic indicators reflect volatility, with GDP growth ranging from -5.96% to 5.60%. Personal and interest expenses show significant variability, while total deposits vary substantially, suggesting disparities in funding access and customer base. Table 2 presents the descriptive statistics of the key variables used in this study, providing an overview of the dataset characteristics.

Table 2. Descriptive statistics

Statistic	SFA	Z-score	ATM	VMT	BNK	GDP	INF	PE	IE	TD
Mean	0,95	4,24	51,81	6,73	80,36	2,28	5,29	9,04	6,98	12,02
Minimum	0,94	2,36	23,98	3,18	75,98	-5.96	-0,69	1,76	3,13	3,25
Maximum	0,96	15,92	67,88	7,61	99,54	5,60	10,74	11,45	10,58	14,47
SD	0,01	1,19	13,04	0,80	5,90	2,46	2,15	1,71	1,1	1,9
Skewness	-0,16	6,34	-0,87	-3,53	2,41	-1,42	-0,28	-1,65	0,3	-1,94
Kurtosis	1,82	55,23	2,81	16,67	7,69	5,99	4,46	6,51	6,6	7
Observations	192	192	192	192	192	192	192	192	192	192

Notes: Refer to Table 1 for variable definitions.

As shown in Table 2, the banking sector exhibits high efficiency levels and strong stability, with notable variations in fintech adoption indicators. In addition, prior to regression analysis, the paper examined the correlations between fintech proxies and banking outcomes. As shown in Table 3, ATM usage is positively correlated with efficiency and total deposits, suggesting increased access and reach. VMT correlates positively with GDP, indicating that mobile transactions expand in stronger economic environments. Notably, efficiency negatively correlates with BNK, suggesting higher efficiency in less concentrated banking environments. INF has a modest positive correlation with ATM usage, potentially reflecting demand for physical cash access during uncertain economic periods. These patterns underscore the complex interplay between fintech, market structure, and macroeconomic forces. The correlation matrix in Table 3 examines the relationships between fintech indicators and banking sector variables, highlighting significant associations.

Table 3. Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SFA (1)	1									
Z-score (2)	0,07	1								
ATM (3)	0,51***	0,02	1							
VMT (4)	-0,06	-0,00	0,03	1						
BNK (5)	-0,48***	-0,09	-0,59***	0,02	1					

GDP (6)	-0,51***	-0,03	-0,59***	0,58***	0,40***	1				
INF (7)	-0,00	0,13*	0,27***	0,23***	-0,58**	-0,08	1			
PE (8)	0,16**	-0,49***	0,11	-0,04	-0,0052	-0,21	-0,11	1		
IE (9)	-0,14***	-0,12**	0,06	0,015**	-0,04	0,0	0,06	-012*	1	
TD (10)	0,10	-0,11	0,13**	0,04	-0,11	0,06	-0,06	0,59***	0,06	1

Notes:

1. ***, ** and * indicate statistical significance at 1%, 5% and 10% level of significance, respectively.
2. Refer to Table 1 for variable definitions.

Baseline Results

The effect of Fintech on bank efficiency

The section examines the impact of fintech on bank efficiency in the South African banking sector. Table 4 presents the results of the random-effects model selected by the Hausman test, as well as the robust estimation and GMM results, which are used to ensure the robustness of the findings and are discussed in the subsequent sections. Table 4 shows that increasing the number of ATMs decreases efficiency, suggesting diminishing returns to additional ATMs, consistent with the study by Wang et al. (2021). Additionally, this aligns with the Disruptive Innovation Theory, which suggests that banks may be investing in sustaining innovations rather than disruptive ones. The Creative Destruction Theory holds that outdated technologies are replaced by innovative ones, driving market evolution. On the other hand, the positive coefficient for VMT indicates that higher mobile transactions are associated with greater bank efficiency. The results align with those of Lee et al. (2021) and Liao (2023).

Furthermore, this aligns with the Disruptive Innovation Theory, as fintech innovations push banks to improve efficiency to meet consumer expectations or risk losing relevance. The study also shows that digital transformation drives banks toward higher efficiency, as new entrants with leaner, tech-driven models force incumbents to innovate or face obsolescence. The control variables are all significant for bank efficiency, with positive coefficients suggesting that higher concentration in the banking sector is associated with greater efficiency. However, increased concentration may limit competition and reduce incentives for innovation over time. The negative effect of GDP on bank efficiency is also significant, suggesting that higher economic growth may lead to inefficiencies and increased competition, affecting banks' efficiency, aligning with the studies of Wang et al. (2021) and Al-Jabri (2023). Table 4 presents regression results on the impact of fintech innovations on bank efficiency, using multiple estimation methods.

Table 4. Regression Analysis of Fintech on Bank Efficiency

	(1) Random Effects	(2) Robust	(3) GMM
Independent variable	**Dependent Variable**		
	SFA	**SFA**	**SFA**
ATM	-0,002***	-0,002***	8,10***
VMT	0,023***	0,023***	1,16***
BNK	0,131***	0,131***	8,07***
GDP	-0,004***	-0,004***	-1,45***
INF	0,003***	0,003***	-4,91***
Constant	-0,666***	-0,666***	-1,25***
SFA Lag			0,97***

Notes:

1. ***, ** and * indicate statistical significance at 1%, 5% and 10% level of significance, respectively.
2. Refer to Table 1 for variable definitions

The effect of Fintech on bank stability

This study uses the Z-score to analyze the impact of fintech innovations on stability in the South African banking sector. Table 5 presents the results of the random-effects model selected by the Hausman test, as well as the robust estimation and GMM results, which are used to ensure the robustness of the findings and are discussed in the subsequent sections. The results in Table 5 suggest no significant effects of fintech on bank stability, indicating that while mobile payments and ATMs have grown, their impact on traditional banks' stability may be limited. However, the growth of mobile and ATM banking services is a critical trend for long-term sustainability. The results also suggest a significant negative relationship between personal expenses and bank stability, suggesting that higher personal expenses reduce stability due to added pressure on profitability and liquidity. Table 5 summarizes the regression analysis of fintech effects on bank stability.

Table 5. Regression Analysis of Fintech on Bank Stability

	(1) Random Effects	(2) Robust Random Effects	(3) GMM
Independent variable	**Dependent Variable**		
	Z-score	**Z-score**	**Z-score**
ATM	0,0024	0,0024	0,001
VMT	0,012	0,012	0,008
BNK	0,0015	0,0015	0,002
GDP	-0,0097	-0,0097	-0,005
INF	0,0045	0,0045	0,006
IE	-0,036	-0,036	-0,05**
PE	-0,041***	-0,041***	-0,03***
TD	0,005	0,005	-0,005
Constant	1,531***	1,531***	1,17***
Zscore Lag			0,32

Notes:

1. ***, ** and * indicate statistical significance at 1%, 5% and 10% level of significance, respectively.
2. Refer to Table 1 for variable definitions.

Table 5 confirms that fintech variables do not significantly affect bank stability, whereas personal expenses negatively affect stability measures. In conclusion, Efficiency gains from fintech innovations reflect improvements in operational processes, cost reductions, and customer service enhancements driven by digital technologies such as mobile banking. These innovations streamline transactions and reduce overhead, thus increasing efficiency. Stability, on the other hand, is influenced by broader financial health factors such as capital adequacy, liquidity, and risk management practices, which may not be immediately impacted by fintech adoption. Stability tends to be more resilient and slower to change because it depends on long-term financial fundamentals rather than operational improvements alone. Moreover, the lack of significant impact on stability suggests that while fintech enhances how banks operate, it does not necessarily alter their

risk profiles or buffer against short-term insolvency risks. This aligns with your findings that personal and interest expenses have a more direct effect on stability.

Further Analysis

The effect of Fintech on bank efficiency

The robust random effects model provides strong evidence for the relationships, aligning with the baseline results: negative ATM proliferation contributes less to efficiency, while positive VMT enhances bank efficiency, reinforcing the positive impact of fintech innovations. The paper further uses the GMM estimation model to assess the impact of fintech on South African banking efficiency. Results show a strong persistence in efficiency over time, indicating the importance of historical practices. The findings also highlight the effectiveness of mobile fintech solutions in enhancing operational efficiency and aligning it with baseline findings. However, higher inflation negatively affects efficiency by increasing operational costs. costs and reduced consumer spending power. Fintech solutions can help banks manage growth without sacrificing efficiency, highlighting the need for long-term strategies in technology adoption.

The effect of Fintech on bank stability

The robust random effects model confirms the baseline results, as the fintech proxies are insignificant. However, personal expenses remain statistically significant and negative, indicating a link between higher personal expenses and lower bank stability. Overall, the robustness checks further confirm the baseline findings: no significant effects of fintech on bank stability, but interest expense significantly affects the Z-score at the 5% level. This suggests that higher interest expenses may correlate with improved stability, possibly due to conservative credit management practices.

CONCLUSIONS

The banking industry in South Africa plays a crucial role in economic growth and financial transactions. However, the rapid expansion of fintech has raised concerns about regulatory gaps and risks like market volatility and operational failures. This study examines the multi-dimensional impact of fintech on the South African banking system, focusing on operational efficiency and stability. The findings indicate a significant negative relationship between increased ATM numbers and bank efficiency, with a negative coefficient for ATM. This suggests that ATM-focused investments represent sustaining innovation rather than disruptive innovation. Conversely, VMT demonstrates a positive correlation with bank efficiency, highlighting that fintech-driven mobile transactions improve operational efficiency. The study also finds no significant effects of fintech innovations on bank stability, as both proxies (ATM and VMT) are statistically insignificant. However, the study highlights the importance of embracing these innovations for long-term sustainability.

Overall, these findings emphasize the need to strategically deploy ATMs and branches and to invest in digital infrastructure and fintech innovations to enhance efficiency. As fintech becomes more integrated into the banking ecosystem, its indirect contributions to stability through improved operational

resilience could become more evident over time.

From a policy perspective, the findings underscore the need for a comprehensive regulatory framework that fosters innovation while safeguarding financial stability in South Africa's evolving banking landscape. Given the nuanced effects of fintech, which enhances efficiency but has a limited direct impact on stability, regulators must adopt agile, forward-looking policies that are responsive to both innovation and emerging risks. These sandboxes provide a controlled environment for fintech firms to test new products and services under regulatory oversight, minimizing systemic risk while supporting innovation. Furthermore, rather than imposing a one-size-fits-all regulatory burden, South Africa's financial authorities could tailor compliance requirements to the scale, complexity, and risk profile of different fintech firms and digital banking services. Moreover, targeted investments in digital infrastructure, cybersecurity resilience, and interoperable payment systems are necessary to support financial inclusion and operational efficiency. Overall, a balanced and flexible regulatory approach, grounded in sandbox experimentation, proportional rules, and risk-aware oversight, can help the South African banking sector embrace innovation without undermining its core mandate of financial stability.

This study contributed to the literature by providing a focused analysis of the impact of fintech innovations, specifically ATM deployment and mobile transaction value, on bank efficiency and stability within the South African banking sector. Employing advanced econometric techniques such as System GMM, it offers robust empirical evidence that highlights the nuanced role of fintech: while enhancing operational efficiency, fintech innovations do not yet significantly affect bank stability. This work fills a gap by contextualizing fintech's influence in an emerging market setting, contrasting with findings from developed economies and contributing to a deeper understanding of South Africa's unique banking dynamics. However, the study acknowledges limitations, such as its limited analysis of a small number of banks, reliance on lower-frequency data, and reliance on a single measure for each dynamic. In this regard, for future research, it is recommended to expand the scope of fintech innovations studied to include digital banking platforms, peer-to-peer lending, blockchain technology, and artificial intelligence applications in banking operations. Additionally, incorporating high-frequency data could better capture the dynamic, rapidly evolving nature of fintech's impacts. Exploring systemic risk linked to fintech adoption is another promising direction, given potential interconnected vulnerabilities. Comparative analyses across emerging and developed markets would further enrich understanding of the regulatory, economic, and technological factors shaping fintech's role in global banking sector performance.

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