

Received: 5 September 2023, Accepted: 3 March 2024

DOI: <https://doi.org/10.33282/rr.vx9il.78>

The effects of Fintech on the performance of Islamic banks in Africa

Dr. Lamine HANIFaculty of Economics, Business and Management Sciences, University of Bejaia (Algeria),
Laboratory of Economics and Development (LED)**Lamine.hani@univ-bejaia.dz**

Abstract

The emergence of financial technologies within the financial system has ignited major transformation of the banking sector obliging banks the world over to embrace service digitalization in an increasing competitive environment. This study examined the effects of fintech on the performance of Islamic banks in Africa using the secondary data of five African countries from 2013 to 2022. Results of the two-step GMM approach reveal that the use of ATM by banks negatively and significantly affects banks ROE, ROA, and net profit margin. While mobile banking is noted to positively and significantly affect the performance of Islamic banks measured using ROE, ROA, and net profit margin. The above results were supported by our robustness checks which were based on a 2SLS approach and are in line with the existing literature. Based on these results, bank managers are encouraged to: (i) adopt measures such as limiting the amount which customers may be allowed to withdraw at a time in order to reduce the negative effects emanating from the use of ATM (ii) encourage the use of mobile banking services such as mobile apps in the delivery of their services to enhance performance.

Keywords: Islamic banks, Fintech, performance, Africa

1. Introduction

The rapid evolution of financial technology, commonly known as fintech, has been reshaping the landscape of the global banking industry, compelling traditional and Islamic banks alike to adapt to these technological advancements. This paper explores the implications of fintech on the operational performance of Islamic banks in Africa, a region where the integration of faith-based financial principles with modern technology presents both unique opportunities and challenges. Given the burgeoning growth of the Islamic banking sector in Africa, fueled by a significant Muslim population and increasing technological penetration, understanding the dynamics between fintech adoption and banking performance is crucial. This investigation is set against the backdrop of a global financial system increasingly influenced by technological innovations such as mobile banking, online transactions, and digital currencies, which offer new avenues for banking services while also posing regulatory, operational, and competitive challenges.

2. Literature Review

The literature on fintech's impact on banking performance is extensive, yet studies focusing specifically on Islamic banks in the African context are relatively scarce. Previous research has predominantly concentrated on the effects of digital banking on traditional banks' efficiency, customer satisfaction, and profitability, with mixed findings. For Islamic banks, which operate under Shariah principles prohibiting interest and emphasizing ethical and risk-sharing arrangements, fintech presents both opportunities for expanding financial inclusion and challenges related to maintaining these principles in a digital context.

Several studies have highlighted the potential for fintech to enhance the operational efficiency of Islamic banks by streamlining processes, reducing operational costs, and facilitating broader access to banking services for underserved populations. For instance, mobile banking can enable Islamic banks to offer convenient, compliant financial services, thus attracting a larger customer base. Conversely, the reliance on technology introduces risks related to cybersecurity, data privacy, and the potential for financial exclusion of those without access to digital platforms.

Empirical studies focusing on the African region have underscored the importance of regulatory frameworks, market conditions, and technological infrastructure in mediating the impact of fintech on Islamic banking performance. The adoption of innovative fintech solutions by Islamic banks in Africa is influenced by factors such as regulatory support, the technological literacy of the population, and the compatibility of fintech services with Islamic financial principles.

In synthesizing the existing literature, this review identifies a gap in research on the nuanced effects of fintech on the performance of Islamic banks in Africa. This paper aims to fill this gap by providing empirical evidence on how fintech adoption affects key performance indicators of Islamic banks in the region, considering the unique regulatory, ethical, and operational context in which these banks operate.

3. Methodology

3.1 Data

This study employs secondary data of five African countries mobilized from different sources to analyze the effects of fintech on Islamic banks performance. For Islamic bank variables, we make use of the Islamic Financial Service Board (IFSB 2022) database while for macroeconomic control variables we adopt the World Bank World development Indicators (WDI 2022) database. The study period runs 2013 to 2022 owing to data availability on Islamic banking variables. The availability of data on Islamic banking variables equally explains the choice of the countries selected for this study (Egypt, Libya, Nigeria, Morocco, and Sudan). A detailed exposition of the different data sources is found in Appendix 1.

3.2 Measurement of variables

Dependent variables

Islamic bank performance in this study is measured using banks *Return On Assets (ROA)*, *Return On Equity (ROE)* and *Net profit margin* as the most comprehensive measures of financial performance frequently employed in the contemporary literature (Pennacchi and Santos 2021; Capraru 2014; Nataraja et al 2018). ROA is the ratio of net income to total assets value of banks. This measure indicates the amount of profits generated per firm's asset ([Sukmadewi, 2020](#)). ROE measures how banks convert equity financing into profits while net profit margin is the difference between total revenue and total cost incurred by banks.

Independent variables

The independent variables of this study are divided into variables of interest which measure the effects of Fintech and control variables which are divided into bank-level controls and macroeconomic controls. To capture Fintech, we make use of two indicators based on the related literature (Singh et al. 2021; Kanga et al. 2022), *ATM use* and *Mobile banking*. ATM use captures the effects of the usage of Automated Teller Machines by banks which is considered an innovative aspect within the banking sector (Kessey and Abassah-Wesley, 2020). Mobile banking on the other hand measures the usage of mobile phones by bank customers to perform banking operations such as the withdrawal of funds, sending money, and applying for loans. The control variables are defined as follows:

- *Bank capitalization* which measures Islamic banks size is captured using the total Islamic banks assets per country since banks capital assets are important determinants of the level of financial performance (Gupta and Mahakud 2020).
- *Banking competition* which is captured using the number of Islamic banks that exists in the different countries. Banking competition is well documented in the bank performance literature as one of the leading determinants of bank performance (Khattak and Ali 2021; Chen 2013) since it can boost bank innovation as a way of staying ahead of competitors.
- *Information and Commutation Technology (ICT)* which measures the degree of ICT with in a country proxied using mobile phones subscription. ICT has played a transformative role as far as the banking sector in Africa is concerned (Aguegboh et al. 2023; Binuyo and Aregbeshola) and is considered one of those variables worth accounting for as in this study.
- *LogGDP* which measures the effects of economic growth. This variable is accounted for since the economic situation of a country can serve as a booster or a hindrance to the banking sector thus affecting bank performance (Olokoyo et al. 2019)
- *Lastly this study takes into account the effects of exchange rate* as one of the possible determinants of Islamic banking performance in Africa since volatile exchange rates can have adverse effects on bank profitability (Taiwo and Adesola, 2013). The characteristics

of these variables in terms of their mean, standard deviation, maximum and their minimum values are summarized in Table 1 below.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	50	-0.014	0.206	-0.773	0.184
ROE	50	0.465	1.302	-2.029	4.795
Net profit margin	50	-1.003	3.263	-14.546	0.35
ATM use	50	14.558	9.26	3.31	33.06
Mobile banking	32	33.325	12.865	7.913	65.67
Banks capitalization	50	16.08	8.185	1	31
Banking competition	50	36.06	55.62	2	152
ICT	50	108.458	34.956	70.414	206.703
logGDP	50	8.05	0.687	6.411	9.441
Exchang rate	50	83.721	142.744	1.272	546.759

Source: author

The trends of the performance of Islamic banks and fintech variables is highlighted in Figure 1 below which shows that between 2013 and 2022, ROA, ROE, Net profit margin, ATM use, and mobile banking have all experienced a positive trend in the same direction though at different magnitudes. The Islamic banking sub-sector which dominates the Islamic finance sector is believed to grow at a 10% annual growth rate¹. This growth is believed to be strongly driven by technological advancements within the industry such as the implementation and the intensification of mobile banking services, etc.

The scatter plots in Figure 2 show the correlations between these variables. The figure shows that there exists a positive correlation between mobile banking and the performance indicators (ROA, ROA, Net profit margins). The reverse scenario is however observed when it concerns ATM use at it is negatively correlated with the three bank performance measures. However, the scatter plots are not used for the conclusive remarks of the study, given that the analysis has not addressed the potential estimation problems such as endogeneity and autocorrelation, which are accounted for in this study by the robust two-step system Generalised Method Of Moment (GMM).

¹ See <https://economymiddleeast.com/news/islamic-banking-assets-to-hit-5-trillion-by-2025-data-reveals/>

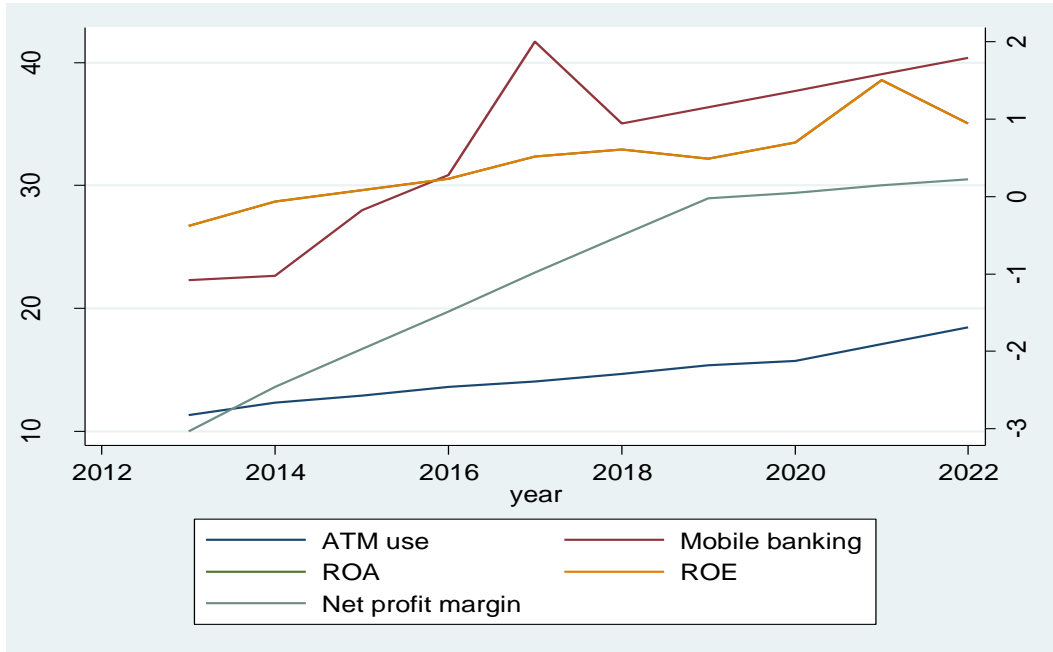


Figure 1: Evolutions of Islamic bank performance and fintech between 2013 and 2022

Source: author based on IFSB (2022) and WDI (2022)

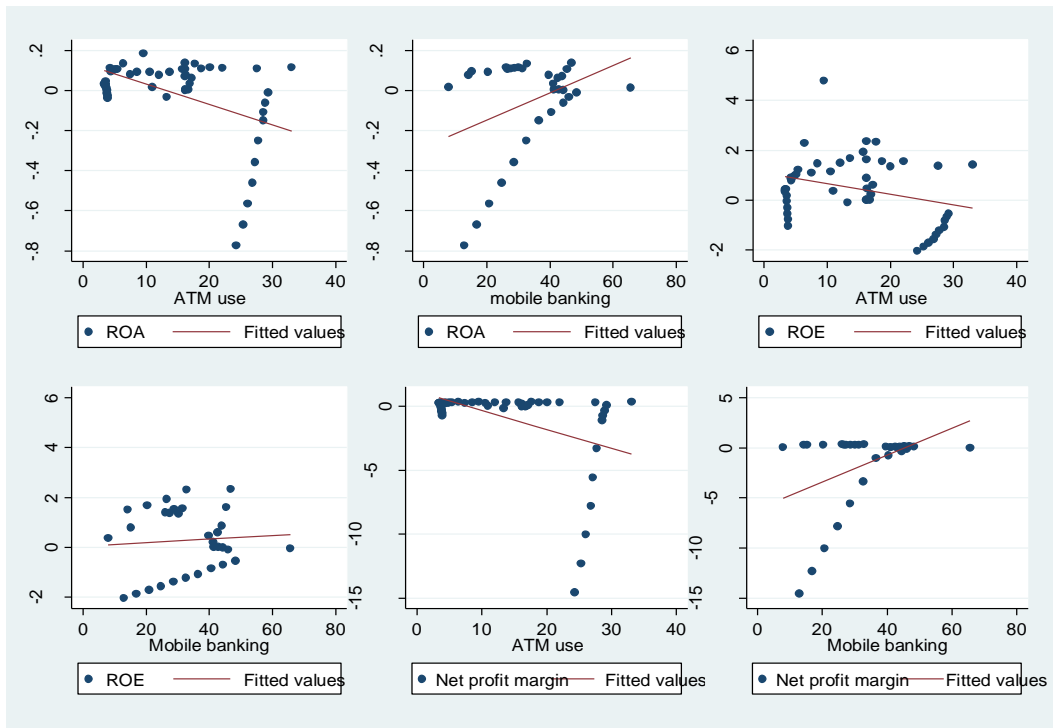


Figure: Correlation between Islamic banking performance and fintech

Source: author based on IFSB (2022) and WDI (2022)

3.3 Empirical approach

Based on the above variables, we specify our baseline empirical model as follows:

$$Bankp_{it} = \beta_0 + \beta_1 FT_{it} + \sum_i^k Z_{it} + u_{it}, \quad (1)$$

Where i and t represent the cross-sectional dimension and period respectively, β is the coefficient associated with each variable. $Bankp$ signifies bank performance variables (ROA, ROE and Net profit margin), FT stands for *fintech* variables (ATM use and mobile banking), and Z and u represent the control variables and the error term respectively. Specifically, we have the following models

$$ROA_{it} = \beta_0 + \beta_1 FT_{it} + \sum_i^k Z_{it} + u_{it}, \quad (2)$$

$$ROE_{it} = \beta_0 + \beta_1 FT_{it} + \sum_i^k Z_{it} + u_{it}, \quad (3)$$

$$NPM_{it} = \beta_0 + \beta_1 FT_{it} + \sum_i^k Z_{it} + u_{it}, \quad (4)$$

Whereby, NPM represents Net profit margin at period t . The rest of the variables are defined as above.

3.4 Estimation technique

The econometric model is first estimated using the Ordinary Least Squares (OLS) approach. The OLS econometric technique is generally used as an initial framework in analyses to give the overall trend of results irrespective of whether the underlying assumptions of the model are respected or not (Kountchou et al., 2023). This technique despite being the oldest and one of the most widely applied econometric approaches, is believed to produce inconsistent results in cases where its basic assumptions relating to the error term are not fully adhered to. For instance, the application of the Pesaran test of cross sectional dependence shows that there is a potential problem of cross sectional dependence which questions the reliability of the results this model produces. For this reason, this study applies the Driscoll/Kraay estimation technique to address the potential problem of cross-sectional dependence identified by the Pesaran test in Table 2. It also takes into account a potential correlation between the error term and the study variables. However, an additional estimation issue is a potential endogeneity problem between some of the study variables. For example there is a potential endogeneity issue between the level of GDP and ICT as ICT level can influence economic growth. This plus the risk of omission bias emanating from the non-consideration of other possible determinants of bank performance further underline the potential endogeneity problem as has been identified in this study by the Durbin–Wu–Hausman test (see Table 3). To overcome this lacunae, the literature proposes two-step system GMM (Arellano & Bond, 1991; Roodman, 2009a, 2009b), given its ability to tackle the problems of reversed causality and simultaneity, and unobserved heterogeneity with the help of an instrumentation process. Thus, this study adopts the two-step system GMM as an empirical strategy as suggested by the literature.

The estimation technique with the subsequent equations in levels (5) and first difference (6) can be summarised as follows:

$$Bankp_{it} = \beta_0 + \beta_1 Bankp_{i(t-\tau)} + \beta_2 FT_{it} + \sum_i^k \delta_h Z_{hi(t-\tau)} + \eta_i + \theta_t + \eta_{it} \quad (5)$$

$$Bankp_{it} - Bankp_{i(t-\tau)} = \beta_1 (Bankp_{it} - Bankp_{i(t-2\tau)}) + \beta_2 (FT_{it} - FT_{i(t-\tau)} + \sum_i^k \delta_h (Z_{hi(t-\tau)} + Z_{hi(t-2\tau)})) + (\theta_t - \theta_{(t-\tau)}) + \varepsilon_{it} - \varepsilon_{i(t-\tau)} \quad (6)$$

Z represents the vector of control variables, η_i is the country specific effect, θ_t is the time-specific constant, τ is the lagging coefficient and ε_{it} is the error term.

The problems usually associated with the GMM strategy as an instrumentation estimation technique are that of identification, exclusion, and simultaneity restrictions. To address these problems, all independent variables are treated as exogenous with their lags used as instruments in the underlying regression (Asongu and Odhiambo, 2021; Kouladoum et al., 2022), and are validated by the different tests.

4. Results and discussion of results

4.1 Results

Baseline results (OLS)

The results presented in the table below are based on the OLS estimation technique which permit us to have a view of the nature of the effects of fintech on the performance of Islamic banks in Africa, but due to the presence of cross-sectional dependence as indicated by the Pesaran test in Table 3, the results might not be consistent. From this test, we reject the null hypotheses on the assumptions of cross-sectional independence in favor of the alternative hypothesis. To address this problem, we use the Driscoll/Kraay estimator

Table 2: The effects of fintech on the performance of Islamic banks in Africa (OLS)

Variables	(1) ROE	(2) ROA	(3) Net profit margin
ATM use	-0.0515 (0.0356)	-0.00935 (0.00596)	-0.134 (0.103)
Mobile banking	-0.00655 (0.0219)	0.00778** (0.00367)	0.185*** (0.0637)
Bank capitalization	0.0291 (0.0268)	0.00479 (0.00573)	0.0462 (0.0992)
Banking competition	0.0150*** (0.00474)	0.00256*** (0.000893)	0.0325** (0.0155)
ICT	-0.0338*** (0.0109)	-0.00666*** (0.00230)	-0.0961** (0.0399)
LogGDP	-0.691 (1.152)	-0.272 (0.167)	-0.594* (0.321)
Exchange rate	-0.00214 (0.00344)	-0.000937* (0.000458)	-0.0188** (0.00794)
Constant	9.727 (9.862)	2.657* (1.369)	47.49* (23.74)
Observations	50	50	50

R-squared 0.568 0.642 0.587

Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: author

The Driscoll/Kraay estimation technique after taking into account the potential problem of cross sectional dependence provides a more consistent results as compared to the OLS approach. The results indicate that fintech measured in terms of ATM use and mobile banking reduces the performance of Islamic banks in Africa measured in terms of ROA, ROE and net profit margin. A major weakness of this technique lies in its inability to account for potential endogeneity problem inherent in this study as indicated by the significance of the Durbin-Wu-Hausman endogeneity test in Table 5.

Table 3: The effects of fintech on the performance of Islamic banks in Africa (Driscoll/Kraay)

Variables	(1) ROE	(2) ROA	(3) Net profit margin
ATM use	-0.113** (0.0396)	-0.0199* (0.00810)	-0.285 (0.138)
Mobile banking	-0.0324** (0.00707)	0.00434 (0.00406)	0.146 (0.0883)
Islamic banks capitalization	0.00386 (0.0153)	-0.00623 (0.00489)	-0.178 (0.117)
Banking competition	-0.00758 (0.00445)	7.63e-05 (0.00134)	0.0139 (0.0300)
ICT	-0.0312*** (0.00536)	-0.00729*** (0.00107)	-0.116*** (0.0196)
LogGDP	-0.804 (1.185)	-0.309 (0.148)	-0.667* (0.295)
Exchange rate	-0.00274 (0.00287)	-0.00119** (0.000416)	-0.0239** (0.00777)
Constant	13.70 (10.61)	3.635* (1.374)	63.89* (23.24)
Observations	50	50	50
R-squared	0.780	0.812	0.718
Pesaran test	0.716*	6.962***	-0.194

Robust standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: author

The results of the two-step system GMM are presented in Table 4 below. To tests for the validity of over identifying restrictions in the instrumentation process, the J statistic of Hansen probability and the autoregressive lag of the first order (AR1) are employed. The J statistics of Hansen probability test which represents the value of the GMM objective function validates the instrumentation process since it is greater than 10% (Baum et al., 2003). The autoregressive

function confirms the validity when its first order (AR1) is less than 10% (Baum et al., 2003) as indicate in the table below

Table 4: The effects of fintech on the performance of islamic banks in Africa (GMM)

Variables	(1) ROE	(2) ROA	(3) Net profit margin
L.ROE	0.332*** (0.0364)		
L.ROA		0.961*** (0.0796)	
L.net profit margin			1.075*** (0.165)
ATM use	-0.112*** (0.00673)	-0.0316*** (0.00423)	-0.576*** (0.125)
Mobile banking	0.0413*** (0.00174)	0.0278*** (0.000427)	0.588*** (0.0217)
Islamic banks capitalization	2.92e-05 (0.00109)	0.000757 (0.000919)	-0.0265 (0.0568)
Banking competition	0.000743** (0.000280)	-0.000478*** (0.000128)	-0.0257** (0.00884)
ICT	0.00242 (0.00234)	0.00469*** (0.00115)	-0.0901 (0.0530)
LogGDP	-0.618*** (0.147)	0.255** (0.107)	0.855* (0.436)
Exchange rate	0.00134** (0.000511)	0.000156 (0.000268)	-0.00362 (0.00539)
Constant	5.188*** (1.167)	-1.799* (0.854)	-57.39* (28.67)
Observations	50	50	50
Instruments	13	13	13
Prop > AR(1)	0.0238	0.0849	0.01
Prop > Hansen	1.727	4.588	0.141

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: author

4.2 Robustness checks (2sls)

The robustness analyses of this study involve employing the Two-stage Least Square technique since it is able to control for potential endogeneity problem. The results presented in the table below are consistent with those obtained with the GMM approach except for a slight drop in the levels of significance. As far as model soundness is concerned, the R-squared and the R-squared adjusted tests show that the model is globally significant

Table 5: The effects of fintech on the performance of Islamic banks in Africa (2SLS)

Variables	(1) ROE	(2) ROA	(3) Net profit margin
ATM use	-0.125*** (0.0243)	-0.0197*** (0.00562)	-0.255** (0.109)
Mobile banking	0.0127 (0.0220)	0.0191*** (0.00467)	0.375*** (0.0971)
Banks capitalization	0.0245* (0.0129)	0.00877*** (0.00294)	0.160** (0.0651)
Banking competition	0.00704*** (0.00240)	0.00142*** (0.000471)	0.0229** (0.0101)
ICT	0.0183* (0.0102)	0.00209 (0.00200)	0.0205 (0.0406)
LogGDP	-0.0800 (0.0925)	-0.0751*** (0.0188)	-1.303*** (0.357)
Exchange rate	0.00268* (0.00151)	-0.000911*** (0.000335)	-0.0208*** (0.00678)
Constant	4.566 (5.904)	4.656*** (1.210)	79.38*** (22.74)
Observations	50	50	50
R-squared	0.914	0.934	0.910
R-squared adjusted	0.859	0.893	0.853
Endogeneity test	5.118**	3.871*	4.569*

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1

Source: author

4.3 Discussion of results

This study is aimed at examining the effects of fintech on the performance of Islamic banks from a sample of African countries between the periods of 2013 and 2022. The two-step GMM results presented in Table 4 above provide a more robust results as it addresses the problem link to endogeneity and are thus used for the conclusive remarks of the study. The results show that the adoption of fintech by Islamic banks significantly affects their performance. Specifically, the results indicate that ATM usage by Islamic banks negatively affects Islamic banks ROA, ROE, and Net profit margins. These results are significant at a 1% threshold and suggest that the more banks expand their ATM network, the lower their financial performance. These results are in line with those obtained by previous studies such as that of Jegede (2014), and can partly be explained by the fact that ATMs increases customers access to their savings and can consequently lead to over withdrawal of savings which consequently reduces the amount of financial resources available for credit purpose. In line with this, Ogbuji et al. (2019) in a Nigerian study proposed that the ATM system of delivering banking services not only contributes to the increasing rate of bank fraud but equally lures Nigerians into profligate

expenditure thereby negatively impacting bank performance. These results are closely related to those of Jegede (2014) with the difference being that the above study was based on cross sectional data and ATM, a single proxy of fintech. The results equally indicate that unlike ATM use, mobile banking services, the other indicator of fintech enhances the performance of Islamic banks in Africa. These results support the initial findings (Le et al. 2021; Mabwai 2016), according to which increased uptake of mobile payments leads to increased banks financial performance even though these studies differ from this particular study in terms of the number of countries considered, study period, and the nature of data. This is justified by the fact that apart from the fact that it renders bank services more convenient to customers thereby increasing the customer base, mobile banking help facilitates the process of collecting deposits, and the identification of credit worthy customers to reduce non-performing loans, etc. The results on the effects of fintech on the financial performance of Islamic banks in Africa are supported by our robustness checks (see Table 5) following the application of the 2SLS estimation technique which is robust to the potential endogeneity problem inherent in this study.

The results presented in Table 4 above equally indicate that the level of banking competition in a country has mixed effects on bank performance with positive effects on bank ROE and negative effects on ROA and Net profit margin. The level of banking competition can boost bank performance as banks try to stay ahead of their competitors, which will foster innovation, efficiency and ensure better services to customers' thereby facilitating performance (Schaeck and Čihák 2008). But competition after a given threshold can equally be detrimental because it might require a huge mobilization of scarce financial resources just to stay ahead of rivals. This explanation partly justifies the nature of the effects of the banking competition on Islamic banks performance. ICT measured using mobile phone subscription enhances Islamic bank performance in Africa even though its effects are only significant on ROA. These results can be explained by the fact that ICT can drive innovation with in the banking sector especially through mobile banking (Aguegboh et al. 2023). It is equally observed that the effects of economic growth measured using Gross Domestic Products per head exerts mixed effects on the performance of Islamic banks in Africa with positive effects on ROA and net profit margin and negative effect on ROE. These results are in line with those of Le et al. (2021) and Combey and Togbenou (2017) and can possibly be explained by the fact that a healthy economy increases the demand for formal banking services such as saving based on the idea contained in the demand-following hypothesis (Robinson 1952) according to which economic growth leads to financial development. Lastly our empirical investigation shows that exchange rate level enhances banks performance especially for ROE. Real effective exchange rate growth affects banks' asset quality, because exchange rate depreciation might have a negative impact on asset quality, particularly in countries with a large amount of lending in foreign currency (Kola et al. 2019)

5. Conclusion and policy recommendations

This study was aimed at analyzing the effects of fintech on the performance of Islamic banks in Africa based on a sample of five African countries spanning 2013 to 2022. The application of two step GMM to account for potential endogeneity problem reveals that the effects of fintech on Islamic banks performance in Africa are mixed. Specifically, the use of ATM by banks is negatively associated with banks ROE, ROA, and net profit margin. While

mobile banking is noted to positively and significantly affect the performance of Islamic banks measured using ROE, ROA, and net profit margin. The above results were supported by our robustness checks which were based on a 2SLS approach and are in line with the existing literature. Based on these results, bank managers are encouraged to adopt measures such as limiting the amount which customers may be allowed to withdraw at a time in order to reduce the negative effects emanating from the use of ATM. Banks are equally recommended to encourage the use of mobile banking services such as mobile apps in the delivery of their services to enhance performance. Even though this study fills an important literature on the effects of fintech on banks performance especially in the context of Africa, it has a number of weaknesses which can be exploited by future researchers: this study limits itself to short term financial performance of Islamic banks in five African countries. Future studies can consider other aspects of bank performance while equally taking into account the role of transmission channels such as ICT in modulating these effects, an aspect neglected by the present study.

References

- Robinson, J. (1952). *"The Generalization of General Theory," in The rate of interest, and other essays*. London: Macmillan.
- World Development Indicators (WDI) (2021), "World Bank database of the World Bank Group", available at: <https://databank.worldbank.org/source/world-development-indicators>
- Islamic Financial Services Board (IFSB) (2019), "DATA & METADATA", available at: <https://www.ifsb.org/data-metadata/>
- Căpraru, B., & Ihnatov, I. (2014). Banks' profitability in selected Central and Eastern European countries. *Procedia Economics and Finance*, 16, 587-591.
- Nataraja, N. S., Chilale, N. R., & Ganesh, L. (2018). Financial performance of private commercial banks in India: multiple regression analysis. *Academy of Accounting and Financial Studies Journal*, 22(2), 1-12.
- Pennacchi, G. G., & Santos, J. A. (2021). Why do banks target ROE?. *Journal of Financial Stability*, 54, 100856.
- Singh, R., Malik, G., & Jain, V. (2021). FinTech effect: measuring impact of FinTech adoption on banks' profitability. *International Journal of Management Practice*, 14(4), 411-427.
- Kanga, D., Oughton, C., Harris, L., & Murinde, V. (2022). The diffusion of fintech, financial inclusion and income per capita. *The European Journal of Finance*, 28(1), 108-136.
- Kessey, K. D., & Abassah-Wesley, M. B. (2020). Financial Electronic Technology and Innovation for Banking Services Delivery in Ghana: Operations of the Automated Teller Machine Facility from Customers' Perspective. *International Journal of Innovative Finance and Economics Research*, 8(2), 24-41.

- Gupta, N., & Mahakud, J. (2020). Ownership, bank size, capitalization and bank performance: Evidence from India. *Cogent Economics & Finance*, 8(1), 1808282.
- Khattak, M. A., & Ali, M. (2021). Are competition and performance friends or foes? Evidence from the Middle East banking sector. *International Journal of Islamic and Middle Eastern Finance and Management*, 14(4), 671-691.
- Chen, S. H. (2013). What determines bank productivity? International evidence on the impact of banking competition, bank regulation, and the global financial crisis. In *Global Banking, Financial Markets and Crises* (pp. 141-171). Emerald Group Publishing Limited.
- Aguegboh, E. S., Agu, C. V., & Nnetu-Okolieuwa, V. I. (2023). ICT adoption, bank performance & development in Sub-Saharan Africa: a dynamic panel analysis. *Information Technology for Development*, 29(2-3), 406-422.
- Binuyo, A. O., & Aregbeshola, R. A. (2014). The impact of information and communication technology (ICT) on commercial bank performance: evidence from South Africa. *Problems and perspectives in management*, (12, Iss. 3), 59-68.
- Olokoyo, F., Ibhagui, O., Babajide, A., & Yinka-Banjo, C. (2019). The impact of macroeconomic variables on bank performance in Nigeria. *Savings and Development*, 43, 1-13.
- Taiwo, O., & Adesola, O. A. (2013). Exchange rate volatility and bank performance in Nigeria. *Asian Economic and Financial Review*, 3(2), 178.
- Mboutchouang Kountchou, A., Haruna, A., Tekam Oumbé, H., & Wirajing, M. A. K. (2023). Women empowerment in Africa: can we rely on Islamic finance?. *Journal of Islamic Accounting and Business Research*.
- Jegade, C. (2014). Effect of Automated Teller Machine on the Performance of Nigeria Banks. *American Journal of Applied Mathematics and Statistics*, 40 - 46.
- Ogbuji, C. N., Onuoha, C. B., & Izogo, E. E. (2012). Analysis of the negative effects of the automated teller machine (ATM) as a channel for delivering banking services in Nigeria. *International Journal of Business and Management*, 7(7), 180.
- Mabwai, F. (2016). *Effects of mobile banking on the financial performance of commercial banks in Kenya* (Doctoral dissertation, University of Nairobi).
- Le, T. T., Mai, H. N., Phan, D. T., Nguyen, M. N., & Le, H. D. (2021). Fintech Innovations: The Impact of Mobile Banking Apps on Bank Performance in Vietnam. *International Journal of Research and Review*, 8(4), 391-401.
- Schaeck, K., & Čihák, M. (2008). How does competition affect efficiency and soundness in banking? New empirical evidence.

Aguegboh, E. S., Agu, C. V., & Nnetu-Okolieuwa, V. I. (2023). ICT adoption, bank performance & development in Sub-Saharan Africa: a dynamic panel analysis. *Information Technology for Development*, 29(2-3), 406-422.

Combey, A., & Togbenou, A. (2017). The bank sector performance and macroeconomics environment: Empirical evidence in Togo. *International Journal of Economics and Finance*, ISSN.

Kola, F., Gjipali, A., & Sula, E. (2019). Commercial bank performance and credit risk in Albania. *Journal of Central Banking Theory and Practice*, 8(3), 161-177.

Roodman, D. (2009a). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, 9(1), 86–136.

Roodman, D. (2009b). A note on the theme of too many instruments. *Oxford Bulletin of Economics and Statistics*, 71(1), 135–158

Baum, C. F., Schaffer, M. E., & Stillman, S. (2003). Instrumental variables and GMM: Estimation and testing. *The Stata Journal*, 3(1), 1–31.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, 58(2), 27

Asongu, S. A., & Odhiambo, N. M. (2021). Inequality, finance and renewable energy consumption in sub-Saharan Africa. *Renewable Energy*, 165, 678–688.

Kouladoun, J.-C., Wirajing, M. A. K., & Nchofoung, T. N. (2022). Digital technologies and financial inclusion in sub-Saharan Africa. *Telecommunications Policy*, 46(9), 102387

Appendix

Appendix 1: Data sources

Variables	Data source
ROA	Islamic Financial Services Board (IFSB 2022)
ROE	Islamic Financial Services Board (IFSB 2022)
Net profit margin	Islamic Financial Services Board (IFSB 2022)
ATM use	World Development Indicators (WDI 2022)
Mobile banking	World Development Indicators (WDI 2022)
Banks capitalization	Islamic Financial Services Board (IFSB 2022)
Banking competition	Islamic Financial Services Board (IFSB 2022)
ICT	World Development Indicators (WDI 2022)
logGDP	World Development Indicators (WDI 2022)
Exchang rate	Islamic Financial Services Board (IFSB 2022)

Source: author