



# The Impact of Fintech Innovation on Bank's Performance: Evidence from the Kingdom of Bahrain

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## ABSTRACT

This study investigates the impact of bank-level Financial Technology (Fintech) innovations on banks' performance in the Kingdom of Bahrain from 2012 to 2021. Annual data of banks listed in Bahrain's Bourse has been utilized to achieve this objective. In addition, bank-level FinTech indices have been constructed by a textual analysis method that assesses input dimensions through 32 keywords under four categories, including artificial intelligence, blockchain, cloud computing, and big data; FinTech output dimension is evaluated through payment and settlement, resource allocation, risk management, and channel construction technology. Using different panel data estimators, such as pooled OLS, fixed effects, random effects, and panel-corrected standard errors linear regression, results show that FinTech innovations increase banks' performance. In addition, the findings demonstrate that banks' capital adequacy ratio, earnings ability, total assets, and annual GDP growth rate also significantly positively impact bank performance. Years in business have a significant adverse effect on bank performance. Interestingly, conventional and state-owned banks have a higher positive impact on returns on assets (ROA) than Islamic and privately owned banks. Policymakers and investors should pay close attention to facilitating ongoing FinTech innovations in the Kingdom of Bahrain to create opportunities and build a more inclusive and efficient financial sector.

**Keywords:** Fintech, Commercial Banks, Performance, Bahrain

**JEL Classifications:** G21, G32, M15

## 1. INTRODUCTION

The recent revolution of Financial Technology (FinTech) has distinctly directed the intersection of Finance and Technology, both leading sectors around the world. The initiation of FinTech was created by the Financial Services Technology Consortium, which was developed in the early 1990s by Citigroup (Schueffel, 2016). FinTech, an emerging industry, uses technology and innovation techniques to improve financial activities and compete with traditional financial methods. Day-to-day financial transactions such as cash payments have been challenged with the takeover of Apple Pay, an online cashless payment. Thus, FinTech refers to the new financial model involving technology as the carrier providing financial services such as mobile payments, financial

management, cloud computing, as well as other emerging scientific and technological means (Schueffel, 2016). S&P Analysts believe that FinTech could have a tremendous impact on the financial industry worldwide, causing a mega transformation in traditional financial products and services. According to the KPMG report (2019), the global investment in FinTech indicates a growth rate of 120% in 2018, reaching \$111.8 billion dollars. Therefore, a robust establishment of the technological innovation development strategy and corresponding mechanism process would gradually form a new competitive advantage.

The FinTech revolution has provoked important changes among banks. Today's banks have a distinct opportunity to engage consumers through Fintech innovation that supports savings,

purchases, and investments. Banks, for instance, are enhancing their digital services through internet banking, mobile banking, face-voice-fingerprint recognition, and anti-fraud technology. In addition, the findings demonstrate that banks have widely utilized intuitive banking apps that bring together the platforms used for cashless transactions and data management, and to ensure sustainable banking. Unlocking various opportunities for FinTech ventures and global financial institutions, Bahrain is continually evolving its financial ecosystem. As Bahrain's financial sector is home for more than 400 financial institutions varying from international, regional, and local firms, it incorporates a broad dimension of Islamic and conventional financial markets and institutions, consisting of finance companies, whole-sale and retail banks, insurance companies and brokers, mutual funds, money changers, and investment advisors (eGovernment Benchmark Report, 2018). The banking sector includes 30 retail banks (13 locally incorporated and 17 foreign banks), 61 wholesale banks, and 8 representative offices for banks overseas. Bahrain's banking system consists of both conventional and Islamic banks that account for over 85% of its total financial assets. Therefore, the banking sector has played a pivotal role in the emergence of Bahrain as a leading financial centre in the region. As of December 2020, the banking sector's assets stood at over \$207 billion dollars, which is more than twelve times its annual gross domestic product (GDP).

Driven by the visionary and forward-thinking of the Bahraini government, the growth of digital banking and financial services are nurtured and strongly encouraged. Taking steps forward to embrace the FinTech industry, Bahrain has developed a vast range of financial innovations and initiatives. As the Financial industry in Bahrain is 16.7% of its total GDP, the sole regulator is the Central Bank of Bahrain (CBB). In 2017, the financial industry registered a total of 14,093 workforces, 66% of them Bahraini nationals and 34% foreign nationals (CBB, 2018). The Central Bank of Bahrain CBB has provided a regulatory framework to facilitate innovations in financial technology and has set up the Fintech and Innovation Unit within the CBB structure to ensure the best regulatory and implementation of the financial services in Bahrain.

To emphasise the role of FinTech transformation, this research uses panel data of eight banks that are listed in Bahrain's Stock Exchange over the period from 2012 to 2021. In addition, bank level FinTech indices have been constructed using a textual analysis approach to examine the relationship between a bank's Fintech level and its performance measured by bank's return on assets (ROA). Using different panel data estimators, such as pooled OLS, fixed effects, random effects, and panel corrected standard errors linear regression, results show that FinTech innovations increase banks' performance. In addition, the findings demonstrate that banks' capital adequacy ratio, earnings ability, total assets, and annual GDP growth rate also have a significant positive impact on bank performance. Years in business have a significant negative effect on bank performance. Interestingly, conventional, and state-owned banks have a higher positive impact on returns on assets (ROA) compared to Islamic and privately owned banks, respectively.

Our paper contributes to the existing literature in several ways. First, to the best of our knowledge, this study is among the first

to shed light on the impact of FinTech adoption on a bank's performance in Bahrain. Second, we contribute to the literature by examining the impact of FinTech adoption in two main banking systems including conventional and Islamic banking. Third, we extend our investigation to examine whether embracing FinTech results in different outcomes among various bank's ownership structure. Fourth, while literature has paid little attention to bank's level FinTech measures, we have used a textual analysis approach to construct a comprehensive measure for FinTech input, output, and overall.

The rest of the paper proceeds as follows. Section 2 summarises the literature review, Section 3 explains the methodology, where Section 4 presents and discusses the results. Finally, Section 5 concludes the paper.

## 2. LITERATURE REVIEW AND ANALYSIS OF RELATED WORK

Our investigations are based on two dimensions of literature: One on FinTech development, and the other is its impact on banks' performance. For the former, academics prefer to investigate the adoption of FinTech; for the latter, they focus more on the factors that affect how banks measure performance.

Studies in literature have defined FinTech as the combination of finance and technology. It includes a wide range of tools such as artificial intelligence technology, cloud computing technology, blockchain technology, big data technology, and internet technology. Internet technology comprises a social network, search engines, and internet finance that evolved in 2012. Xie and Zou (2012) found that the internet can significantly lower transaction costs, reduce information asymmetry, enhance the efficiency of risk-based pricing and risk management, and expand sets of feasible transactions. Internet finance received great attention from both academic studies and the financial industry due to its significant impact on the efficiency of financial activities (Wang et al., 2014). Fintech has played a crucial role in revolutionizing the financial services industry since its inception. According to Arner et al. (2015), Fintech is an ongoing process that has led to many incremental and disruptive innovations in finance and technology, such as internet banking, mobile payments, crowdfunding, peer-to-peer lending, Robo-Advisory, online identification, and others. Editors Chishti and Barberis (2016) highlight how the collaboration between finance and technology has resulted in innovation in the financial services sector, including start-up firms (e.g., eToro), incumbent companies (e.g., Citi), government level (e.g., Israel), or pre-organization's (e.g. SWIFT). In each of these cases, Fintech has encouraged innovation significantly. Due to its innovative nature and potential to disrupt the financial services industry (Ferreira et al., 2015), Fintech is expected to have a long-term impact on the entire sector (Pollari, 2016). With the use of the Unified Theory of Acceptance and Use of Technology model, some researchers conducted a survey to look at the factors impacting the adoption of Fintech in Bangladesh's financial institutions and chose eight influencing elements. A well-structured face-to-face survey was

organised prior to data collection. The basic data acquired from 265 employees have been analysed using structural equation modelling (SEM) with the generalised least squares method. The findings demonstrated that factors such as effort expectation, social influence, facilitation, perceived dependability, and added value have a favourable impact on behavioural intentions to adopt Fintech. Additionally, practically every factor influencing the adoption of fintech is significantly moderated by the respondents' age (Khatun and Tamanna, 2021).

On the other hand, the performance of banks is the subject of numerous research works worldwide. But relatively few of them are motivated to investigate the link between performance with fintech adoption (Felix Fernando, 2021). Assessing the relationship regarding the banking business from Bahrain is one of the main issues in this study. Both return on assets (ROA) and return on equity (ROE), two helpful analytical indicators, can be used to evaluate a company's financial performance. The ROA metric measures how well a company uses its resources. ROE demonstrates how effectively a company uses its equity. Both can evaluate a company's effectiveness in creating returns on investment, but they do not exactly measure the same thing (Pointer and Khoi, 2019). Moreover, Fintech affects banking performance which in turn affects banking value. In a study, Fintech is assessed through four products: Mobile payment, mobile banking, internet banking, and ATMs and used linear regression mediation analysis with a Causal Step Method, 23 banks that are listed on the Indonesia Stock Exchange (IDX) and that launched Fintech products between the years of 2018 and 2019 are used. The findings demonstrated that Fintech products, such as Mobile Banking, Internet Banking, and ATMs, had a substantial impact on the value and performance of banking, whereas Mobile Payment did not (Guo and Zhang, 2023). In another paper where the main goal is to investigate the effects of business enablers and Fintech on the banking sector to ascertain if these developments represent opportunities or disruptions. The model and the hypotheses were examined as part of the quantitative applied research design. The study used a questionnaire to gather data to accomplish its goals. A study of 150 bank managers in Saudi Arabia was conducted. The PLS-SEM method was applied, and the participants delivered 130 thoughtful and accurate responses. Based on the investigation, it was determined that the existence of business enablers encouraged Fintech development, which resulted in an improvement in bank performance from the perspectives of the economy, society, and the environment. The importance of Fintech advancement in Saudi Arabian banking is explained in the research report. Fintech has had a bad rap as a disruptive technology, but this study revealed that it offers the Saudi banking sector several advantages (Abdalmajeed et al., 2023). FinTech is now widely used in a variety of nations worldwide (Jiang et al., 2014). It is well known to be a 21<sup>st</sup>-century financial product. The various Islamic financial operating systems heavily rely on fintech apps. During the global financial crisis of 2008, Turkey and Bangladesh received increasing attention in the fintech industry. In their laws and compliance with new technology, both countries' banks placed a high priority. Islamic fintech that complies with shariah is increasingly used in both nations to conduct financial transactions and processes more quickly and effectively (Ahmad and Mamun,

2020). Another study revealed that financial innovation in the banking sector contributed to Bangladesh's economic expansion between 1980 and 2016. They estimated the long-run cointegration using Granger causality-based Error Correction Model (ECM) to capture the directional connection and Autoregressive Distributed Lag (ARDL) bound testing to capture the impact of financial innovation on economic growth (Qamruzzaman and Jianguo, 2017). Results and data analysis showed that more digitalization was being adopted, along with a more unstable ecology, threats like pandemics, and new business opportunities. Recent financial years, however, have demonstrated that there is opportunity for expansion and growth, particularly about the issuance of Sukuk in Islamic financial institutions, because of rules and regulations, ease of implementation, and speed of implementation (Rahman et al., 2022). Interestingly, few researchers also discovered that financial digitization is negatively associated with the performance of banks using panel data of China's bank industry from 2013 to 2019. Further investigation into the moderating effect also reveals that the cycle of monetary policy easing, the environment of high financial friction, and the preference of banks for taking risks could all help to lessen the adverse impact of fintech development on bank performance (Wang et al., 2022). From the above review, we expect that FinTech adoption improves banks performance in Bahrain banks. So, we put up the following hypothesis:

- $H_1$ : FinTech input (FTII) has a positive significant impact on bank's performance (ROA)
- $H_2$ : FinTech output (FTOI) has a positive significant impact on bank's performance (ROA)
- $H_3$ : Overall FinTech adoption (FTI) has a positive significant impact on bank's performance (ROA).

### 3. RESEARCH METHODOLOGY

#### 3.1. Data

As this study aims to examine the impact of bank-level FinTech innovations on banks' performance in the Kingdom of Bahrain over the period 2012-2021, annual data of banks that are listed in Bahrain's Bourse (The Bahrain stock exchange) has been utilised. To be precise, financial annual reports are extracted where bank level data were retrieved to serve the purpose of this paper. As there are eight listed retail banks in Bahrain's Bourse, all the eight banks are included in this investigation including the main two categories of conventional and Islamic banks. The list of the banks includes Arab Banking Corporation, Al Baraka Islamic Bank, Al Salam Bank, Ahli United Bank, Bank of Bahrain and Kuwait, Bahrain Islamic Bank, Khaleeji Commercial Bank and National Bank of Bahrain.

In addition, bank-level FinTech indices have been constructed by a textual analysis method that assesses input dimensions through 32 keywords under four categories including: Artificial intelligence, blockchain, cloud computing, and big data. FinTech output dimension is evaluated through payment and settlement, resource allocation, risk management, and channel construction technology. Table 1 shows how the 32 key words are classified under two main dimensions as following Guo and Zhang (2023).

In accordance with this classification, fintech input index (FTII), fintech output index (FTOI), and overall fintech index (FTI) have

**Table 1: FinTech related keywords**

Technology input dimension			
Artificial Intelligence technology	Block chain technology	Cloud technology	Big data technology
Artificial Intelligence	Blockchain	Cloud computing	Big data
Face recognition	Alliance chain	Cloud service	Data flow
Voice recognition	Distributed ledger	Cloud platform	Data mining
Fingerprint recognition	Asymmetric encryption	Cloud architecture	Data visualization
Innovation output dimension			
Payment and settlement innovation	Resource allocation innovation	Risk management innovation	channel construction innovation
Online payment	Online loan	Customer portrait	Online banking
Mobile payment	Online finance	predictive model	Mobile banking
QR code payment	Lending platform	credit evaluation	Internet banking
Digital wallet	Inclusive credit	Anti-fraud	Bank App

been constructed and utilized as the key independent variables in the model.

Following the work of Guo and Zhang (2023), textual analysis methods that are based on word segmentation algorithms and word frequency statistics have been used. To do that, Python software has been utilised to calculate keyword frequencies at the bank-year level. Then, the number of occurrences of each keyword in the bank's annual report is divided by the total number of words in the report to obtain the frequency of each keyword. As a result of these calculations, frequencies of the 32 keywords for eight banks are determined during the period from 2012 to 2021. Particularly, bank FinTech indices are constructed using the following steps:

1. Normalisation of the keyword frequencies: in accordance with Guo and Zhang (2023) and Cunha-Zeri et al. (2022), keyword frequencies are normalised using Equation (1).

$$Y_{ijt} = \frac{X_{ijt} - \min(X_j)}{\max(X_j) - \min(X_j)} \quad (1)$$

Where  $i = 1, 2, \dots, N$  indicates banks,  $j = 1, 2, \dots, K$  indicates keywords, and  $t = 1, 2, \dots, T$  indicates the year.  $X_{ijt}$  is the original frequency of the keyword  $j$  of bank  $i$  in year  $t$ .  $Y_{ijt}$  is the normalised frequency of the keyword  $j$  of bank  $i$  in year  $t$ .

2. Computation of the entropy of keyword  $j$  by applying Equation (2).

$$E_j = -\frac{1}{\ln(NT)} \sum_{t=1}^T \sum_{i=1}^N P_{ijt} \ln P_{ijt}, P_{ijt} = \frac{Y_{ijt}}{\sum_{t=1}^T \sum_{i=1}^N Y_{ijt}} \quad (2)$$

Where  $E_j$  is the entropy of keyword  $j$ .

3. Calculation of the entropy weight of each keyword by employing Equation (3).

$$W_j = \frac{1 - E_j}{\sum_{j=1}^K (1 - E_j)} \quad (3)$$

Where is the entropy weight of keyword  $j$ .

4. Specification of the bank FinTech indices by utilising Equation (4).

$$FinTech_{it} = \sum_{j=1}^K W_j Y_{ijt} \quad (4)$$

Where  $FinTech_{it}$  is the FinTech index of bank  $i$  in year  $t$ , including  $FTI_{it}$ ,  $FTII_{it}$ ,  $FTOI_{it}$ .

Figure 1 depicts the time trend of the average bank FinTech indices over the 2012-2021 period. The average FTI increased from 0.007 in 2012 to 0.033 in 2021. The most rapid growth of the FTI occurred in 2020, driven by increased adoption of fintech during the pandemic.

Over the last 10 years, FTII has been higher than FTOI among the whole period except for years 2020 and 2021. Although there was a huge need for further investments in FinTech infrastructure to accommodate the considerable needs for secure and user-friendly platforms during Covid-19 era, digital platforms have witnessed a remarkable jump in number of users and number of transactions. To be precise, the Central Bank of Bahrain (CBB) has reported that 53 million digital transactions took place in the first 6 months of the year 2021.<sup>1</sup> BenefitPay, which is the national electronic wallet of Bahrain, has announced that the number of remittances through the service of Fawri+ which enables the users to do instant online transactions has increased by 785% from 2020 to 2021.

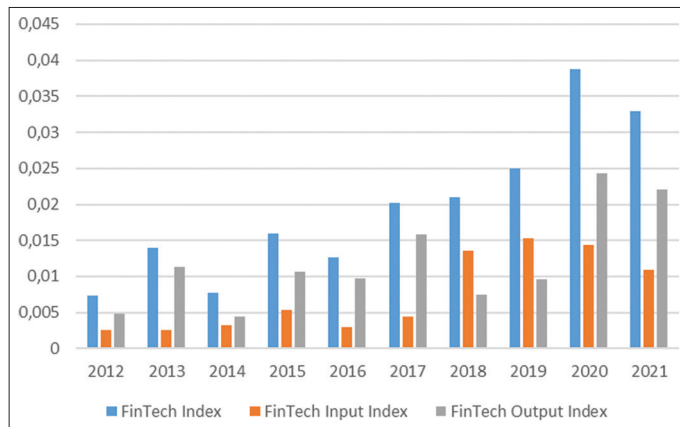
Figure 2 illustrates the sample distribution of average FTI across state-owned and private banks. State-owned banks have a higher FTI value and have demonstrated rapid growth in recent years. For private banks, the dynamics of FTI are unstable, and its value is about two times smaller than that for state-owned banks. The gap in FTI between banks with different forms of ownership has increased since 2016.

Figure 3 plots the average FTI across Islamic and conventional banks in Bahrain. The value of FTI for Islamic banks increased from 0.005 in 2012 to 0.046 in 2021. The FTI of conventional banks steadily grew from 2016 to 2020 but fell sharply in 2021.

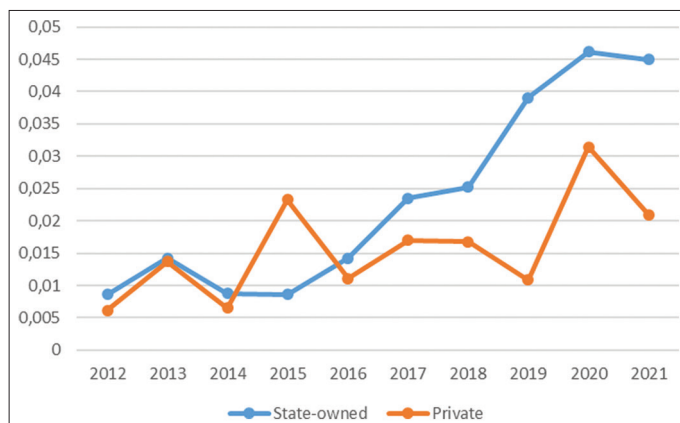
In our analysis, for the determinants of performance, the dependent variables i.e., the potential determinants of banks' profitability are measured by return on assets ratio (ROA). Following the 2007-2008

1 Further information can be found on chrome-extension://efaidnbmnnnibpcajpeglclefindmkaj/https://www.cbb.gov.bh/wp-content/uploads/2022/07/CBB-Annual-Report-2021-English.pdf.

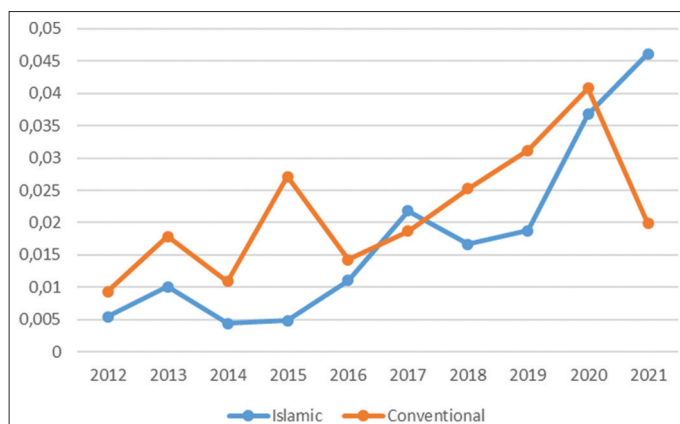


**Figure 1:** The time trend of the average FinTech Index in Bahrain for 2012-2021

Source: Developed by authors using data obtained by the textual analysis method

**Figure 2:** The sample distribution of the average FinTech Index across state-owned and private banks in Bahrain for 2012-2021

Source: Developed by authors using data obtained by the textual analysis method

**Figure 3:** The sample distribution of the average FinTech Index across Islamic and conventional banks in Bahrain for 2012-2021

Source: Developed by authors using data obtained by the textual analysis method

global financial crisis, bank performance has become a widely discussed issue. Which countries, regions, and types of banks had a better chance of survival during this period, and how did they achieve it? By analysing various performance measures such as profitability, we can derive a solution. Profitability is a crucial factor that influences capital and risk, and it is the prime goal of any business. Many experts suggest using return on total assets (ROA) as the best performance measure (Hassan and Bashir, 2003).

The key explanatory variables are the fintech indices, including FTI, FTII, and FTOI. According to recent literature (Pointer and Khoi, 2019; Guo and Zhang, 2023), we include control variables in our empirical analysis, which can potentially affect the ROA at both the bank and macro levels. Control variables at the bank level include return on equity ratio (ROE), total assets (Assets, natural logarithm of total assets), number of years in business (years in business), book value (Book value per share), capital adequacy ratio (CAR), earnings ability (Earnings ability), liquidity ratio (Liquidity ratio), Islamic dummy variable (Islamic, equals to 1 if the bank is Islamic and 0 otherwise), and state-owned dummy variable (State-owned, equals to 1 if the bank is state-owned and 0 otherwise). Control variables at the macro-level include the annual GDP growth rate (Growth) and the annual percentage change in the CPI (Inflation). Table 2 presents the description, source of data, and expected sign of the variables included in our empirical research.

### 3.2. Model

To examine the impact of the bank FinTech index on the bank's performance, measured by ROA, we estimate the following basic regression model:

$$ROA_{it} = \beta_0 + \beta_1 FinTech_{it} + \beta_2 Control_{it} + \varepsilon_{it} \quad (5)$$

Where  $i = 1, 2, \dots, N$  indicates banks and  $t = 1, 2, \dots, T$  signifies a year.  $ROA_{it}$  represents the return on assets ratio of bank  $i$  in year  $t$ .  $FinTech_{it}$  denotes the FinTech index of bank  $i$  in year  $t$ , measured by  $FTI_{it}$ ,  $FTII_{it}$ ,  $FTOI_{it}$ .  $Control_{it}$  refers to a vector of control variables, including  $ROE_{it}$ ,  $Assets_{it}$ ,  $Years\ in\ business_{it}$ ,  $Book\ value_{it}$ ,  $CAR_{it}$ ,  $Earnings\ ability_{it}$ ,  $Liquidity\ ratio_{it}$ ,  $Growth_{it}$ ,  $Inflation_{it}$ ,  $Islamic_{it}$ ,  $State-owned_{it}$ .  $\varepsilon_{it}$  is the error term.

## 4. RESULTS

Table 3 displays the descriptive statistics for the main variables used in the regression analysis. ROA has a mean of 1.073% and ranges from -4.35% to 2.32%, implying that the degree of ROA varies significantly between banks. FTI varies between 0 and 0.101 with a mean of 0.02, suggesting a diversity across banks in the level of fintech development. The eight banks included in our sample have other distinctions in terms of the level of the ROE, assets, years in business, book value, capital adequacy ratio, earnings ability, and liquidity ratio.

Table 4 reports the Pearson pairwise correlation matrix for the model's dependent and independent variables. The results of the

**Table 2: Description of variables and expected signs**

Variables	Description	Source of data	Expected sign
Dependent variable ROA	Return on assets ratio, measured by net income divided by total assets	Annual reports	
Independent variables			
FTI	Bank FinTech index, constructed by the textual analysis method	Annual reports	+
FTII	Bank FinTech input index, constructed by the textual analysis method	Annual reports	+
FTOI	Bank FinTech output index, constructed by the textual analysis method	Annual reports	+
ROE	Return on equity ratio, measured by net income divided by total equity	Annual reports	+
Assets	Natural logarithm of total assets	Annual reports	+
Years in business	Number of years in business	Annual reports	-
Book value	Book value per share	Annual reports	+
CAR	Capital adequacy ratio, measured by the ratio of shareholders equity to total assets	Annual reports	+
Earnings ability	Earnings ability, measured by the ratio of operating profit to average assets	Annual reports	+
Liquidity ratio	Liquidity ratio, measured by the ratio of net loans to deposits	Annual reports	+
Growth	Annual GDP growth rate	Annual reports	+
Inflation	Annual percentage change in CPI	Annual reports	+
Islamic	Dummy variable=1 if bank i is Islamic finance bank; 0 otherwise	Annual reports	-
State-owned	Dummy variable=1 if bank i is state-owned bank; 0 otherwise	Annual reports	+

ROA: Returns on assets, FTI: FinTech adoption, FTII: FinTech input, FTOI: Fintech output index, CAR: Capital adequacy ratio, GDP: Gross domestic product

**Table 3: Descriptive statistics**

Variable	OBS	Mean	SD	Min	Max
ROA	80	1.073	0.877	-4.35	2.32
FTI	80	0.02	0.022	0	0.101
FTII	80	0.008	0.014	0	0.081
FTOI	80	0.012	0.015	0	0.062
ROE	80	8.407	8.953	-51.883	29.342
Assets	80	22.374	1.521	17.213	24.879
Years in business	80	47.5	22.642	17	93
Book value	79	11.925	41.337	0.02	199.511
CAR	80	13.267	4.16	0.974	24.901
Earnings ability	80	0.02	0.007	-0.001	0.042
Liquidity ratio	80	1.951	2.792	0.126	21.653
Growth	80	2.541	2.727	-4.94	5.42
Inflation	80	1.491	1.671	-2.32	3.3
Islamic	80	0.5	0.503	0	1
State-owned	80	0.5	0.503	0	1

ROA: Returns on assets, FTI: FinTech adoption, FTII: FinTech input, FTOI: Fintech output index, CAR: Capital adequacy ratio

correlation study demonstrate that the FTI and FTOI are adversely connected with ROA, whereas the FTII is positively correlated. These contradictory findings indicate the necessity of additional analysis to investigate the relationship between FinTech indices and bank performance. Among control variables, ROA is positively and significantly correlated with ROE, assets, capital adequacy ratio, and earnings ability and has negative correlations with book value, liquidity ratio, and the Islamic dummy. The results of the VIF test show that the mean VIF (2.25) is below the conventional threshold of 10, implying the absence of a multicollinearity problem in our estimates.

Table 5 represents the results of estimating the effect of FinTech indices on ROA using linear regression with panel-corrected standard errors (PCSE). The sample consists of 79 bank-year observations over the 2012-2021 period. Column (1) shows the results of estimating the effect of FTI on ROA using linear regression with PCSE. Column (2) summarizes the results of assessing the impact of FTII on ROA using the same estimator. Column (3) reports the results of the regression analysis with PCSE of the effect of FTOI on ROA.

We apply pooled OLS regression and then the fixed effects model to assess the impact of Fintech indices on ROA. Based on the result of the F-test ( $F[7, 62] = 8.40$ ), we can conclude that the null hypothesis of equality of individual effects is rejected. This means that the fixed effects model is a better fit than the pooled OLS model. However, the modified Wald statistic for groupwise heteroskedasticity in the fixed effect model (Greene, 2000) indicates the presence of heteroscedasticity. To select between the fixed and random effects models, we ran the random effects model and applied the Hausman test. The result of the test suggests that the individual-specific effects are not correlated with the regressors ( $\text{Prob} > \chi^2_2 = 0.8140$ ), which means that the random effects model is preferred. In addition, we used the Breusch and Pagan Lagrangian multiplier test for random effects to choose between the random effects model and the pooled OLS (Breusch and Pagan, 1980). We found that the null hypothesis of equality of individual effects cannot be rejected. Thus, we can conclude that the pooled OLS model is a more appropriate estimator compared to the random effects model. According to the results of regression analysis, the disturbances are assumed to be heteroscedastic and contemporaneously correlated across panels without autocorrelation. We employ panel-corrected standard error (PCSE) estimates to control for heteroskedasticity and cross-panel correlation (Hoechle, 2007). We use the same technique to estimate the effect of FTII and FTOI on the bank's ROA. In the regressions with the FTII and FTOI as the key independent variables, we defined that each bank has a different variance of the disturbances and that each bank's observations are correlated with those of other banks. In this regard, we apply PCSE estimates to obtain robust standard errors in the equations.

Across all regressions, the coefficients of FTI, FTII, and FTOI are positive and significant, supporting the idea that the banks with higher FinTech adoption demonstrate better performance as measured by the ROA. The coefficient of the FTI is positive and significant at the 1% significance level. As for the estimated coefficients of the FTII and FTOI indices, they are positive and significant at 10% and 5% significance levels, respectively. Based on the estimation results from columns (1) – (3) of Table 5, a one standard deviation increases in FTI, FTII, and FTOI will increase

Table 4: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) ROA	1.000														
(2) FTI	-0.052	1.000													
(3) FTII	0.082	0.744*	1.000												
(4) FTOI	-0.159	0.747*	0.112	1.000											
(5) ROE	0.888*	-0.103	0.020	-0.173	1.000										
(6) assets	0.263*	-0.011	-0.034	0.018	0.203*	1.000									
(7) years in business	0.070	0.160	0.076	0.162	0.003	0.367*	1.000								
(8) book value	-0.313*	-0.167	-0.138	-0.111	-0.233*	-0.059	-0.006	1.000							
(9) CAR	0.186*	-0.067	-0.081	-0.019	-0.114	0.081	0.127	-0.141	1.000						
(10) earning ability	0.500*	0.045	0.141	-0.073	0.426*	0.039	-0.218*	-0.483*	0.049	1.000					
(11) liquidity ratio	-0.229*	-0.040	-0.057	-0.004	-0.212*	-0.426*	-0.194*	-0.017	0.032	0.061	1.000				
(12) growth	0.171	-0.357*	-0.246*	-0.287*	0.034	-0.017	0.000	-0.008	0.204*	-0.001	-0.001	1.000			
(13) inflation	0.159	-0.428*	-0.252*	-0.387*	0.038	-0.033	0.000	-0.087	0.213*	0.032	-0.045	0.867*	1.000		
(14) islamic	-0.512*	-0.091	-0.153	0.016	-0.329*	-0.432*	-0.489*	0.200*	-0.156	-0.046	0.454*	0.000	0.000	1.000	
(15) state-owned	0.012	0.176	0.290*	-0.027	-0.003	-0.445*	0.200*	-0.277*	-0.194*	0.137	0.211*	0.000	0.000	0.000	1.000

\*significant at the 0.01 level. ROA: Returns on assets, FTI: FinTech adoption, FTII: FinTech input, FTOI: Fintech output index, CAR: Capital adequacy ratio

Table 5: Effect of bank FinTech on ROA

Variables	(1) ROA	(2) ROA	(3) ROA
FTI	3.2924***		
FTII		3.2324*	
FTOI			3.6188**
ROE	0.7780***	0.0768***	0.0773***
Assets	0.0455**	0.0386*	0.0467*
Years in business	-0.0045***	-0.0038***	-0.0047***
Book value	0.0012	0.0008	0.0013
CAR	0.0517***	0.0510***	0.0518***
Earnings ability	14.1209***	14.3478***	15.4584***
Liquidity ratio	0.0116	0.0096	0.0098
Growth	0.0299**	0.0355**	0.0281*
Inflation	0.0197	-0.0001	0.0159
Islamic	-0.4412***	-0.4273***	-0.4544***
State-owned	0.1707**	0.1450*	0.2081**
Observations	79	79	79
R-squared	0.9409	0.9386	0.9388

\*\*\*P<0.01, \*\*P<0.05, \*P<0.1. ROA: Returns on assets, FTI: FinTech adoption, FTII: FinTech input, FTOI: Fintech output index, CAR: Capital adequacy ratio

the bank's ROA by 0.067, 0.042, and 0.05% points, respectively. Overall, empirical study outcomes confirm hypothesis H1 and indicate that banks will demonstrate better performance if they develop and utilise more bank financial technologies.

As for control variables, ROE has a significant and positive impact on ROA, indicating that different measurements of a bank's performance are positively correlated to each other. These results are consistent with the findings of Pointer and Khoi (2019). Capital adequacy ratio and earnings ability, as well as total assets, positively affect the ROA. The estimated coefficient of earnings ability, measured by the ratio of operating profit to average assets, is the highest among the control variables. Ceteris paribus, a 1 standard deviation increase in earnings ability will result in a 0.092 percentage point increase in the ROA ratio. Consistent with Pointer and Khoi (2019), the number of years in business has a negative impact on the bank's ROA. Regarding the factors at the macro level, the annual GDP growth rate has a positive and significant impact on the bank's performance, indicating that economic growth stimulates banks to more widely apply FinTech. According to the estimation results, Islamic banks have a lower ROA ratio compared to conventional banks. On the other hand, state-owned banks demonstrate higher performance compared to private ones.

## 5. CONCLUSION

Among the Arab countries, Bahrain is one of the fastest growing economies with a GDP of \$75 billion dollars at the end of 2022. Hence, undergoing a significant financial restructuring had an impact on the success of individual banks along with the entire banking system (Arabian Business.com, 2008). In Bahrain's banking and financial services industry, Islamic banking has notably benefited from the regional growth, brought on by the need for oil. Most cutting-edge studies on the factors affecting banks performance, including restructuring to adapt FinTech, have been conducted in developed and highly developing nations like China and India.

To underline the role of FinTech conversion, this investigation employs panel data of eight banks that are listed in Bahrain's Stock Exchange over the period from 2012 to 2021. In addition, bank level FinTech indices have been created using a textual analysis approach to analyze the impact of a bank's Fintech level and its performance measured by bank's return on assets (ROA). Using different panel data estimators, such as pooled OLS, fixed effects, random effects, and panel corrected standard errors linear regression, results show that FinTech innovations increase banks' performance. In addition, the findings demonstrate that banks' capital adequacy ratio, earnings ability, total assets, and annual GDP growth rate also have a significant positive impact on bank performance. Years in business have a significant negative effect on bank performance. Interestingly, conventional, and state-owned banks have a higher positive impact on returns on assets (ROA) compared to Islamic and privately owned banks, respectively.

Evidently, the adoption of FinTech innovations in the banking sector has improved the performance of banks measured by the return on assets (ROA). Investing in FinTech infrastructure does not only allow banks to expand their customer bases, but also reduce credit risks and save operational costs. Therefore, banks should bring together various resources that facilitate digital technology and financial innovations. Regulators in Bahrain should devote more efforts to foster digital transformation in the banking sector by encouraging an agile regulatory framework.

In this study, the research in an Arabian country has restricted the data availability as well as the time constraint of 10 years. In future, a longer period of study of banks' performance could make more accurate conclusions. Both listed and unlisted banks in Bahrain can be investigated and compared. A variety of regions could also be used to assess and compare banks' performance to Bahrain. An in-depth study could concentrate on the channels through which FinTech affects bank performance and how they can adapt different regional strategies to improve performance. Different dimensions of FinTech such as information technology and cyber security technology could be assessed and analysed.

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