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FINTECH AND BANK EFFICIENCY: EVIDENCE FROM MENA COUNTRIES.

BY

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ABSTRACT

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Title: FinTech and Bank Efficiency: Evidence from MENA Countries

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The financial system around the globe is witnessing revolutionary changes due to the emergence of new innovative financial technologies and solutions. The advantages of Fintech development are undeniable, its growth is rapid around the globe, and adopting these technologies into the financial industry is essential for competitiveness. The purpose of this thesis is to analyze the effect of FinTech on the banks' efficiency in selected countries from the MENA region. A panel of 63 banks over the period from 2011 to 2021 are analyzed from 6 countries: Saudi Arabia, UAE, Kuwait, Egypt, Jordan, and Lebanon. We show that as Fintech adoption increases bank efficiency increases as well. Our results are robust to a set of robustness check and to addressing the endogeneity issues using the instrumental variable approach.

Keywords: FinTech, Emerging Technology, Banks, Performance, Cost Efficiency, MENA region.

DEDICATION

To my loved ones- Family and friends: God's kindness, your prayers, and encouraging words have lifted my spirits and gave me the strength to keep going…for that, I dedicate this achievement to you.

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CHAPTER I: INTRODUCTION

The way people communicate, perform daily tasks, and conduct their business transactions has been touched by the magic of technology transformation. FinTech is an interplay of two words, Finance and IT, the attention toward FinTech has been growing in the past decade and emerging technologies have changed people's perspective on how to deal with their finances, their expectations from financial institutions, most importantly, it has changed the way these institutions operate. This transformation is characterized with a fast-paced momentum that has been an important driver of the financial industry's development. It is of high importance to prioritize the application of financial innovations into the financial and banking industry within each country to be able to properly compete and cope with global financial development.

FinTech creates opportunities for the banking industry to excel in their operations, enhance services delivered to customers by making it better, less costly, and tailored to each customer's needs. This was made possible through the widespread of the internet usage, availability of mobile apps and software, along with more developed and complex technologies like artificial intelligence, blockchain, and big data (Vives, 2017; Cheng and Qu, 2020). Forgoing this opportunity would place the banking industry at a disadvantage, as FinTech startups are fiercely entering the market and harnessing the benefits of digitalization (Suryono, Budi, and Purwandari, 2020).

The utilization of innovative financial technologies into traditional banking operations has advantages that would lead to faster processing of transactions, better clients screening and prediction of their behavioral patterns. There is also the advantage of storing clients' data using cloud servers and analyzing it via advanced computing technologies which can elevate the overall efficiency of the traditional commercial

banks (Wang, Xiuping, and Zhang, 2021). So, theoretically, applying FinTech innovations into the banking industry would improve the banks business models, lower the costs, increase the efficiency in providing the services, and enhance risk control measures which will increase the financial institution's competitiveness. The integrity of the decision making with regard to banking activities can strongly influence the efficiency of the banks. Evidence of that is the financial crisis in 2008, which was induced by manipulations. Thus, better risk management ability has an influence over the efficiency of the banks (Proença, Augusto, and Murteira, 2023; Ahamed and Mallick, 2019).

On a country level, financial inclusion is one of the benefits of FinTech, since it provides access to inexpensive financing to the unbanked and underbanked portion of the population (Abdul-Rahim, Bohari, Aman, and Awang, 2022). While advantages are evident in practice, there are issues that need to be addressed. The implementation process of FinTech into the banking industry takes time and requires huge investments. This process is also associated with training costs as FinTech technologies are fairly new and require intensive training to be utilized in the best way (Chen, You, and Chang, 2021). Additionally, the implementation of FinTech needs regulations and enforcing laws that address issues associated with the use of FinTech which may be linked with potential risks to individuals, firms and the country as a whole.

This thesis intends to answer the following question: Does FinTech adoption impact the efficiency of banking industry in the Middle East and North Africa (MENA) region? Answering this question is important since there are few studies (Dwivedi, Alabdooli, and Dwivedi, 2021; Alsahlawi, 2021) that investigate the impact of FinTech development on bank efficiency using data from banks operating in countries from the MENA region. The main reason for the scarcity of FinTech studies on this region is

data limitations. Indeed, FinTech related data from the World bank and the International Monetary Fund (IMF) are limited for countries in the MENA region. We attempt to fill this gap in the literature by analyzing a sample of 63 banks from six countries in the MENA region for a period of 11 years from 2011-2021.

We contribute to the existing literature by (1) Enriching existing literature by verifying the impact of FinTech innovation on banks' efficiency using quantitative methods and empirical analysis rather than considering qualitative analysis by itself. (2) Constructing a FinTech index to measure FinTech development in the MENA region taking both demand and supply perspective into consideration. (3) Considering the banks heterogeneity since most countries in the MENA region have dual banking system, thus, we take into account the differences between Islamic and conventional banks.

We construct our FinTech index (*FTI)* as the principal components of demand (*FDS*) and supply (*FSS*) sides which comprises of several variables, for *FDS* we include (i) percentage of people above the age of 15 who made a digital payment, (ii) percentage of people above age of 15 who received digital payments, (iii) percentage of people above age of 15 who used either mobile phone or internet to make an online purchase (iv) percentage of people above age of 15 who used either mobile phone or internet to pay their bills, (v) percentage of people above age of 15 who used either mobile phone to make a utility payment, (vi) percentage of people above age of 15 who received payment from the government through a mobile phone, and (vii) percentage of people above age of 15 who used a mobile phone or the internet to access a financial institution account. For *FSS*, the following variables are included (i) Mobile cellular subscriptions per 100 people, and (ii) Secure Internet servers per 1 million people. We measure bank efficiency as cost to income ratio. We control for several bank and country-level

variables: (i) Non-performing loans ratio, (ii) Capital adequacy ratio, (iii) Bank size (logarithm of total assets), (iv) Loan to deposit ratio, (v) Return on equity, (vi) GDP per capita, and (vii) Inflation.

Our results suggest that FinTech development improves bank efficiency. We may interpret this finding as implying that when banks increase their FinTech adoption, their efficiency is positively affected in terms of cost reduction. We also find that the positive association between FinTech development and bank efficiency is stronger for Islamic banks when compared to conventional banks. We also find a stronger association in banks from the Gulf Cooperation Council (GCC) region. Additionally, we find a stronger relationship between FinTech development and bank efficiency in countries with high regulatory quality. The results are robust to multiple robustness checks including: excluding countries with a high number of observations, COVID-19 years, including additional control variable. Finally, our results are robust to the use of an instrumental variable approach to address endogeneity issues.

The rest of the thesis is structured as follows. Chapter II provides a discussion of FinTech concept, a literature review, and hypothesis development. Chapter III describes the methodology, sample, variables, and model. Chapter IV presents and discusses the results. Chapter V provides concluding remarks, policy implications, and limitations.

CHAPTER II: FINTECH BACKGROUND AND DEVELOPMENT

FinTech is a blend of two concepts, financial services with information technology. It has been a decade since we were introduced to this revolutionary trend that changed the financial industry and the world as whole. However, Covid-19 pandemic has accelerated FinTech adoption level around the globe. It is not a luxury anymore but rather a necessity to stay competitive in the market. The objective of financial technology is to enhance and improve the delivery of financial services through automation by utilizing algorithms and specialized software (Drasch, Schweizer, and Urbach, 2018). This had led operations and transactions to becoming more efficient, convenient, and secure.

2.1. History of FinTech

The following are the essential times in the FinTech revolution:

2.1.1. FinTech 1.0: Laying Down the Foundation (1866-1967)

The globalization of the financial services started in this era. It began with financial data being transmitted rapidly across borders via telegraph, railroads, and steamships (Leong and Sung, 2018; Acar and Çıtak, 2019; Alam, Awawdeh, and Muhamad, 2021). During this period, significant developments took place, for instance, in 1866 there was the establishment of the first transatlantic cable and the first electronic cash transfer system- Fedwire - was introduced in the United States in 1918. Credit cards were introduced in the 1950s, making carrying money more convenient (Leong and Sung, 2018; Acar and Tak, 2019; Arner, Barberis, and Buckley, 2015).

2.1.2. FinTech 2.0: Planting Seeds of Digitization (1967-2008)

According to Arner et al. (2015), this era marked the start of how modern financial markets function in current times. There was also the transition from analogue methods to transactions being more digitalized led by conventional banking systems. Starting in 1967 following the development of the first automated teller machine by Barclays Bank. In stock markets, NASDAQ was established in the 1970s and was one of the most significant events during the time, being the first fully electronic stock exchange. The Society for Worldwide Interbank Financial Telecommunications (SWIFT) was founded in 1973. It is still the first and most common way for financial institutions to communicate with one another, allowing for many cross-border transfers (Leong and Sung, 2018; Alam et al., 2021). Banks invested more in computer and IT-related devices during the 1980s, making their operations more digital (Brandl and Hornuf, 2020). Banks have relied heavily on electronic transactions since the advent of the Internet and e-commerce in the 1990s. Online and branchless banking have changed individuals' perspectives on money and their dealings with financial institutions significantly (Acar and Tak, 2019; Arner et al., 2015).

2.1.3. FinTech 3.0: Harvesting the Benefit of Digitization (2008–Current Time)

In 2008, the global financial crisis intensified public suspicions of the traditional banking system. As many people are jobless and skilled people are looking for opportunities elsewhere, FinTech 3.0 has advanced (Arner et al., 2015). Hence, new companies, especially FinTech start-ups, emerged during this time period alongside traditional banks, offering more convenient and less costly services. The introduction of Bitcoin in 2009 was another game-changing event in the finance industry, and it was

quickly followed by a series of other cryptocurrencies. The widespread adoption of smartphones has contributed to the development of FinTech by making the internet accessible to millions of individuals around the world (Alam et al., 2021). Innovations in the financial services sector will continue to evolve, and regulators need to catch up. Even though RegTech – which is the utilization of innovative technologies in regulatory supervision and monitoring tasks (Gu, Li, and Ni, 2022; Chinnasamy, Madbouly, and Reyad, 2021)- is also developing, it has not yet fully controlled the FinTech revolution. Many factors should be addressed and taken into consideration when setting the regulatory framework that governs FinTech in a country such as: data and security breaches, monitoring policies, and the integrity of the overall financial system (Allen, 2021). FinTech 3.5 marks the widespread of FinTech enabled firms around the globe to include developing and emerging countries as well. Governments are now paying more attention to laws and regulations governing FinTech application in banks and FinTech firms (Alam et al., 2021; Arner et al., 2015).

2.2. Competition Between Banks and FinTech Firms

The competition between banks and FinTech firms is also inevitable, FinTech start-ups and neobanks are frequently viewed as rivals competing for the same market share since they offer services that banks also provide like payment services, lending, and fund management (Murinde, Rizopoulos, and Zachariadis, 2022). With the rise of user-friendly applications that provide convenient customer experiences, an increasing number of transactions are taking place online rather than in cash or at a branch. (Temelkov, 2018).

The number of bank branches has shirked during the last years (Yuan, Li, and Zhang, 2023). Increasing interest in FinTech and its competition with traditional banks

is one reason for this phenomenon. Yuan et al. (2023) show a positive connection between FinTech expansion and bank closures in China. In response to this dilemma, banks offered their customers online banking and digital payments. This move is problematic and costly for banks, since their branch-related fixed costs are already high, and offering online services lowers their profit (Stulz, 2019).

Banks can become more innovative by collaborating with FinTech firms. FinTech firms do have the technological infrastructure and they are not bound by heavy regulations that banks are subject to. Furthermore, the scope of services provided by FinTech firms is limited as well, since they do not possess banking services license (Murinde et al., 2022). Thus, banks collaboration with FinTech firm would accelerate the innovation process, co-create solutions tailored to their needs, and fill a gap in the services they provide to their current and prospective customers (Drasch et al., 2018; Temelkov, 2018; Verma, Nijjer, Sood, Grima, and Rupeika-Apoga, 2022).

Nevertheless, Ntwiga (2020) conducted a study to examine whether collaboration between banks and FinTech firms influences banking sector efficiency. The findings revealed that FinTech alliances enable the banking industry to enhance their management, operations, and cost reduction. The results of this study indicate that banks that collaborate with FinTech firms are not more efficient than banks that do not: for banks to remain competitive and effective, regardless of whether or not they deal with FinTech firms, they must constantly evaluate their operations.

2.3. Application and uses of FinTech Innovations in the Banking Industry:

2.3.1. Digital Payment Services:

Mobile phones and internet development have facilitated the use of digital

payments as an appealing choice for many people because of its convenience and speed (Rahman, Ismail, and Bahri, 2020). With digital payments, there are many options, including mobile banking, e-wallets, and peer-to-peer, which reduce the need for physical cash and allow for smoother and faster transactions (Leong and Sung, 2018; Alam et al., 2021).

2.3.2. Artificial Intelligence (AI) and Machine Learning (ML):

Banking operations can benefit from artificial intelligence (AI), whether they are in the back office or the front office. AI is widely utilized in risk management and security operations. The system uses algorithms to perform simple tasks like data entry, processing loans and credit forms for clients, and credit worthiness assessments that are time consuming for employees to complete (Verma et al., 2022). AI is also useful in risk and compliance practices, fraud detection, combating anti-money laundering. Machine learning is also used for data analysis and studying customer patterns and behaviors to make predictions and provide better services (Truby, Brown, and Dahdal, 2020).

2.3.3. Blockchain

Decentralization and tight security are a few of the advantages that blockchain is offering. Transactions can be stored securely due to the encryption advantage it provides, which makes hacking into the blockchain of much difficulty (Chowdhury, Suchana, Alam, and Khan 2021). Many banks have adopted blockchain technology in their operations like lending processes, which helps in reducing transaction costs and improving operational efficiency (Murinde et al., 2022; Barroso and Laborda, 2022).

2.3.4. Big Data

Using big data analytics to analyze the vast amount of data collected by banks could eliminate the hassle of analyzing the data. The determination of a client's creditworthiness is an application where big data is used by banks since patterns and past data are easily analyzed and can be used for future behavioral predictions (Barroso and Laborda, 2022). Additionally, crowdfunding may facilitate SMEs' access to funding, RegTech may enhance compliance with regulations, and Robo-advising can aid in investment decisions (Leong and Sung, 2018).

2.4. Advantages and Challenges related to FinTech development in the Banking Industry

The lifecycle of the financial services provided by banks could be hassle free when digitalized. Starting with most basic tasks like opening an account to more sophisticated tasks like customer due diligence, verification and authenticating process, and assessing creditworthiness. Since FinTech emergence, the world has seen an increased dependence on machine learning and artificial intelligence. Humans are no longer heavily involved in transactional aspects of banking, but rather intervene when their involvement has an added value (Gomber, Kauffman, Parker, and Weber, 2018). Through the use FinTech innovations, banks could be more efficient in cost reduction, risk mitigation, and improved transparency and convenience in serving their customers (Fung, Lee, Yeh, and Yuen, 2020).

2.4.1. Advantages Associated with FinTech in the Banking Industry

Using FinTech and analytical tools in data processing can help banks generate new development ideas as well as make better decisions by leveraging both financial and non-financial data. With the wide spread of internet usage, data is no longer scarce,

it is available and could be collected at marginal costs. In addition, risk management capabilities in banks could be enhanced by using FinTech innovations. This is gained through having better understanding of customers using big data and data analytics which will make the bank's ability to make somewhat reliable prediction of default risk. (Boot, Hoffmann, Laeven, and Ratnovski, 2021). Technological developments of almost all kinds would enhance the efficiency and speed of performing tasks and providing services. Communication with customers via automated methods would be easier and offer more convenience. (Murinde et al., 2022).

In Summary, FinTech is supposed to provide banks with cost reduction advantages, increase economies of scale, and enhance efficiency (Thakor, 2020). At the macroeconomic level, FinTech would enhance the financial system as a whole, in way that could be characterized by flexibility and be more inclusive of the unbanked population (Kwon, Molyneux, Pancotto, and Reghezza, 2023).

2.4.2. Challenges Associated with FinTech in the Banking Industry

Despite FinTech innovation's ability to reduce banks' transaction costs, increase productivity, and simplify the financial industry in general, it also introduces new risks and challenges. According to Ali, Raza, Khamis, Puah, and Amin (2021), a security risk could result from the disclosure or loss of control over customers' private information, trade secrets, and other confidential information, leading to information theft and a loss of integrity and privacy. According to Sajid, Ayub, Malik, and Ellahi (2023), FinTech solutions and platforms are heavily reliant on digital components, so security risks in this context are linked to risks associated with digital technology, such as cybersecurity threats. Another issue of high importance is the lack of expertise and employees with advanced ICT skills who can keep up with the development of FinTech (Kwon et al., 2023).

Also, strict regulatory laws and supervision regulations might slow the adoption of FinTech innovations (Verma et al., 2022).

2.5. FinTech Development in the MENA Region

FinTech development in the MENA region is still in its early stages, while efforts are increasing in the region for digital transformation, the pace is still slow and huge investments need to be made to digitalize the financial system to reach a level comparable to other regions (Arezki and Senbet, 2020; Blancher, Appendino, Bibolov, Fouejieu, Li, Ndoye, Panagiotakopoulou, Wei Shi, and Sydorenko, 2019; Lukonga, 2018). FinTech adoption levels vary across banks and countries in the region, one factor that contributes to this variation is the wide range between highest and lowest GDP per capita for the countries. It includes counties which are categorized as high-income counties like the GCC, middle income countries include Egypt, Jordan, and Lebanon, while Yemen is among the countries with the lowest income levels in the region (Allen, 2021; Arezki and Senbet, 2020). Factors like the increasing level of internet usage and mobile phone penetration (Figure 1) have contributed to the acceptance of digital banking and awareness of FinTech (Naz, Karim, Houcine, and Naeem, 2022).

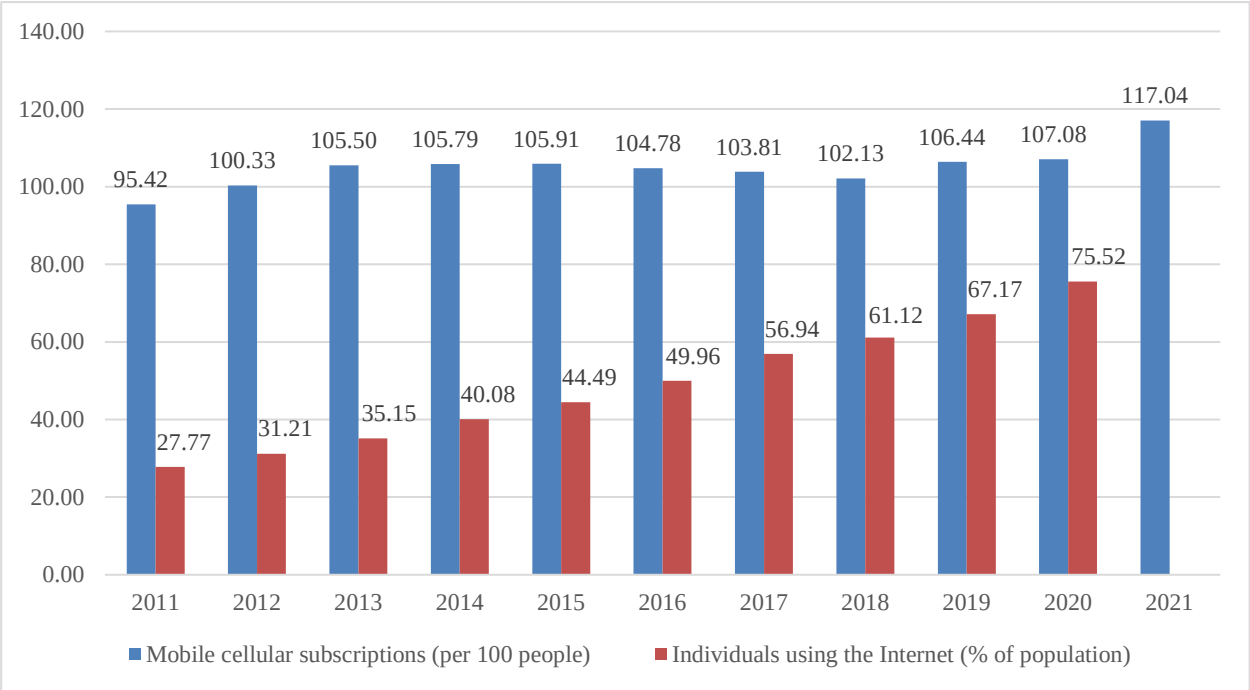

Figure 1: Trend in Mobile Cellular and Internet Usage % from 2011 to 2021 in MENA Region, Source: World Development Indicators -World Bank.

Saudi Arabia and United Arab Emirates are taking the lead in the MENA region, while Egypt and Jordan are making efforts to develop this sector (Naz et al., 2022). Only the Gulf Cooperation Council, Lebanon, and Jordan -at a smaller scale- provide digital financial services that are competitive with the rest of the world (Arezki and Senbet, 2020). As much as 70% of the unbanked population in the MENA countries are unemployed, and financial inclusion can be achieved through FinTech adoption (Chinnasamy et al., 2021; Demirgüç-Kunt, Klapper, Singer, and Ansar, 2022). FinTech is acknowledged by regulators in the MENA region, the adoption level has expedited after COVID-19 and policymakers are intensifying their efforts to address its obstacles and initiate regulatory framework for FinTech. (Cambridge Center for Alternative Finance (CCFA), 2021; CCAF, World bank, and World Economic Forum (WEF), 2020). Governments in the region are prioritizing FinTech and innovative technologies in their strategic development plans (Naz et al., 2022). Saudi Arabia has linked their

financial development plan with their 2030 vision (Naz et al., 2022), and Egypt has made significant regulatory changes regarding mobile money (Chinnasamy et al., 2021; CCAF, World bank, and WEF, 2020).

The availability of electricity and internet is one of the constraints to FinTech development in the MENA region. Many countries in the region lack those basic necessities or have shortage in the supply which may be expected throughout the year. This would pose a threat of service interruption and discontinuation of the operation for both banks and customers (Chinnasamy et al., 2021). Other issues that need to be addressed are related to infrastructure gaps, cybersecurity problems, data privacy and security breaching, exploitation of FinTech in illegal activities, and the regulations that are still progressing (Chinnasamy et al., 2022; Naz et al., 2022). For the MENA region to fully benefit from FinTech, governments and regulatory bodies need to assert control by setting laws and procedures to encourage FinTech growth and adoption in the region and increase monitoring efforts to limit or understand the risks associated with the FinTech ecosystem (Chinnasamy et al., 2021; Naz et al., 2022).

CHAPTER III : LITERATURE REVIEW

3.1. FinTech Adoption and its Effect on Banks' Performance and Efficiency

There has been an increased interest about the influence of FinTech on the banking industry in various countries with regard to banks' overall performance and efficiency. Many articles have tackled the subject using both qualitative and quantitative methods. Varma et al. (2022) conducted qualitative research on the effects that FinTech has on the financial and banking industry including the changes and challenges it has brought with it. They reviewed a total of 93 articles from different journals to do a thematic analysis on the subject. Some articles have reported positive impact (Fung et al., 2020; Li, Dai, Park, and Park, 2017), some resulted in negative impact (Phan, Narayan, Rahman, and Hutabarat, 2020; Chen and Peng, 2019) while others reported mixed results (Wu, Bai, and Chen, 2023; Lv et al., 2022). The inconsistencies can be clarified by considering the dynamic characteristics of innovative financial technology that emerge in the world.

Using the quantitative approach, Singh, Malik, and Jain (2021) have studied the influence of FinTech adoption on the profitability of the top Indian banks from 2011 to 2018. They show that the application of financial technology does impact the banks' profitability positively. The model included cost to income ratio as a measure of cost efficiency which yielded a negative significant relationship with ROE and ROA, meaning that as the efficiency ratio decreases- the lower the better- the more profitable the bank is. Furthermore, FinTech adoption like the usage of innovative ATMs reduces the number of individuals visiting branches and causing crowding by lining up at the bank, this would not only reduce branch traffic, but will also provide clients with more convenient and better experience. The rise of digital payments and transactions has enabled banks to be more efficient in their operations through decreasing transaction

costs. Moreover, innovations can significantly reduce the time and effort required to issue debit and credit cards, process cheque books and account update requests, and answer inquiries. (Singh et al., 2021).

Furthermore, Lv, Du, and Liu (2022) examined the influence of FinTech on bank profitability in China. The findings revealed that FinTech has a U-shaped effect on bank profits. FinTech development initially disrupts the banks' business models and customer resources but gradually enhances it. In fact, banks are actively researching the technology at the early stages and investing a lot of money in doing so, so their ability to make more profit is constrained by the time it takes for technology to advance and be utilized, as well as the extent to which it integrates with the business so that it generates more profit in the future. The advantages of FinTech, such as transaction costs reduction and enhanced customer experience, are expected at the later stages which will increase profitability (Lv et al., 2022).

Similarly, FinTech facilitates interaction with customers, increases brand loyalty, and improves the performance of banks. FinTech in the banking industry enables people to access high-quality, simple-to-use services via modern operating channels (such as mobile and e-banking). Wu et al. (2023) in a study conducted in China, show that when FinTech is adopted by banks, it will initially worsen its efficiency, but as time passes and development accelerates it would help in assisting the banks in improving their business processes by increasing the efficiency of operations and services provided to customers. This result confirms the findings of Lv et al. (2022) about the U-shaped relationship.

In the same vein, Chhaidar, Abdelhedi, and Abdelkafi (2022) by analyzing 23 European banks show that investing in FinTech is associated with higher revenues and

better performance. The reason behind this is that FinTech increases the bank's ability to provide higher quality services to their customers and reduces expenses related to monitoring, reporting and transaction costs. As the size of the bank increases, economies of scale help the banks become more cost efficient, thus more profitable.

Chen (2020) acknowledged that FinTech adoption enhances the performance and efficiency of banks. He focuses on the impact of Internet-only banking on bank performance and efficiency. The author reports a positive relationship between FinTech and bank efficiency and performance. Moreover, he shows that internet-only banks initially hired more qualified and experienced employees, which naturally increased operating expenses, and decreased profits, which will increase later when more development is achieved.

Wang et al. (2021) attempted to assess the impact of incorporating innovative financial technologies on commercial banks' competitiveness in China. Two research questions were raised by the authors which are whether competitiveness in banks is improved by FinTech, and whether the degree of FinTech incorporation by the bank would impact the positive advantage it has on the competitiveness of the bank. The increase of FinTech development results in higher profitability since it increases the overall competitiveness of banks, however there is a regulatory risk associated with those innovations.

Cho and Chen (2021) have emphasized the importance of riding the FinTech wave nowadays to stay competitive in an industry. They argue that FinTech promotes better financial intermediation by providing fast services to customers and enhanced their banking experience. Moreover, online banking reduces the need for branches, which reduces costs and improves efficiency. They show that banks with internet

banking services are more cost efficient. The higher the rate of FinTech development in a bank the higher its competitiveness is.

Similarly, Dwivedi et al. (2021) conducted research to investigate the effect that the utilization of FinTech has on bank's competitiveness and performance in the United Arab Emirates. They show that new products and services have developed as a result of developments in FinTech, which have the potential to boost the efficiency and competitiveness of the banking sector. Strategic management practices, commitment, and enforcement of government policies are some of the key elements in governing the implementation of FinTech innovations. These factors will impact the operations of the financial and banking industries around the world, which in turn will increase its overall performance.

With regards to bank performance in terms of profitability, efficiency and overall competitiveness, the results of the analysis conducted by Singh et al., 2021; Lv et al., 2022; Wu et al., 2023; Chhaidar et al., 2022; Chen, 2020; Wang et al., 2021; Cho and Chen, 2021; and Dwivedi et al., 2021, have all confirmed the positive influence that FinTech has on the banks performance. Thus, we conclude that FinTech development and increased adoption of emerging technology enhance the bank efficiency.

From another perspective, many articles have discussed the relationship between FinTech and banks risk taking motivation and banks' exposure to risks. An article by Li, He, Tian, Sun, and Ning (2022) examined the effect of FinTech development on bank risk-taking. They show that FinTech innovations reduce risk-taking. This is due to the fact that FinTech solutions reduce the cost of information analysis, speed up the process of acquiring new clients, and use blockchain to construct

a trust structure that decreases the banks' potential risks. Furthermore, it is possible for a commercial bank to lower its risk exposure while also increasing their level of productivity by increasing the number of FinTech innovations it deploys. Reduction in risk taking occurs when there are better risk controls for the bank and improved performance in terms of cost efficiency which results in more profitability that would make the bank more hesitant to take additional risks.

Similarly, Sajid et al. (2023) show that employing FinTech solutions improves the bank's efficiency and saves money by reducing the banks' willingness to take risks. They also agree that FinTech allows banks to deliver a wide selection of products at reasonable costs and maintaining enough capital to cover any risks, it reduces risk and increases performance. Furthermore, the ratio of operating expenditures to total income was used to determine how efficiently the bank is managing its costs. They show that FinTech improves bank efficiency since it decreases costs.

These results are consistent with those found in research by Alsahlawi (2021) which indicates that it would be easier to shield banks from risk-related losses when they use FinTech innovations like digital lending and credit, cryptocurrency, mobile payments to carry out their operation. Alsahlawi (2021) has examined how the use of FinTech has altered financial risk management within Saudi banks. They show that implementing FinTech improves risk management and increases its use. In addition to enhancing and automating services provided by financial institutions, Alsahlawi (2021) explains that technological advancements in financial institutions will strengthen their financial risk management by improving their ability to identify, assess potential risks, and help them to develop risk management strategies to mitigate those risks.

Additionally, Cheng and Qu (2020) examine the impact of FinTech on bank credit risk. Credit risk associated with the banks could increase or decrease depending on different aspects. The are two competing arguments. On the one hand, as a result of integrating innovative technologies into banks' operations, they may be able to improve their risk management capabilities, as well as enhance their diversification strategy, reducing credit risk. On the other hand, FinTech adoption by banks could pose some technical and regulatory issues which could lead to higher credit risk. Cheng and Qu (2020) concluded that applying FinTech will definitely result in lower credit risk in banks.

Overall findings of Li et al., 2022; Sajid et al., 2023; Alsahlawi, 2021; and Cheng and Qu, 2020 have a consensus which confirm that FinTech adoption leads to reduced risk-taking motivation and willingness, enhanced risk management and controls, increased efficiency, and lower credit risk in banks.

Furthermore, some articles have investigated the effect of FinTech on banks in regards with sustainability and sustainable performance. Yan, Siddik, Yong, Dong, Zheng, and Rahman (2022) used a two-staged SEM-ANN method and a nonlinear non-compensating neural network model to examine the effect of FinTech development on the bank’s sustainable performance. They highlighted the role of green finance and green initiative as channels through which FinTech adoption improves sustainable performance.

Guang-Wen and Siddik (2022) examine the impact of FinTech development on green finance, green initiative, and the environmental performance of the financial industry in Bangladesh during the recent Covid-19 pandemic. They argue that green initiative acts as a mediator for the connections between environmental performance,

green funding, and the widespread use of FinTech. They show that green financing, green initiative, and environmental performance are all positively impacted by the use of FinTech. Countries around the globe are increasingly trying to speed up their sustainable development targets. Hence, banks should place the adoption of FinTech and green financing as top priority in the coming years by the help and support of the governments to achieve their sustainability goals.

As mentioned earlier, and according to Verma et al. (2022), some contradicting findings have been reported about the impact of FinTech on the banking industry. Chen and Peng (2019) show a negative impact of FinTech on banking performance as there are risks that come with technology and overspending on technology related investments.

In summary, the studies we have examined revolve around the impact of FinTech development on the banking industry. It tackles the subject in terms of the bank's performance, particularly efficiency, profitability, and risk management. Most of the articles suggest that FinTech development does have the potential to positively enhance banking operations through improving its efficiency and reduce the costs. However, MENA region has been neglected in the literature as we have only stumbled across two articles by (Dwivedi, Alabdooli, and Dwivedi, 2021; Alsahlawi, 2021) which analyzed United Arab Emirates and Saudi Arabia respectively. We find that there is a need for further investigation and research to address gaps and inconsistencies in the literature. In this thesis we will include six countries from the MENA region which will fill the gap related to the scarcity of this topic in the MENA countries. We expect that our results will confirm and be in line with the positive results found in previous articles with regard to bank cost efficiency.

3.2. Hypothesis Development

Well-managed banks with high-cost control procedures have a higher chance of surviving than inefficient banks. According to existing literature, there is an undeniable impact that FinTech can boost the efficiency of the financial and banking industry- Summary of the past literature is presented in Appendix Table A1.

According to Beck, Chen, Lin, and Song (2016), FinTech is a double-edged Sword, in one there is innovation growth and in another innovation fragility. On one hand, innovation and technology advancements which provide better service with higher quality and lower costs (Merton, 1992; Berger, 2003) are needed to ensure the survival and competitiveness of financial institutions (i.e., innovation growth view). Lee, Li, Yu, and Zhao (2021) conclude that FinTech helps in increasing the productivity of the financial system by improving the functioning of the banking industry. Thus, increase its efficiency, reduces the costs, and provides exceptional products and services.

On the other hand, financial innovation could also be destructive, (i.e. innovation fragility view), which can reduce bank efficiency and increase its vulnerability by increasing its potential risks (Uddin, Mollah, and Hakim, 2020; Chen and Peng, 2019; Carter, 1989). FinTech increases banks' tolerance to accept more risk and engage in activities that amplify their exposure to risks (Carter, 1989). Nguena (2020) concludes that FinTech induces instability and fragility in the banking industry.

By analyzing a huge sample of banks in 32 countries, Beck et al. (2016) finds evidence that FinTech promotes growth and instability simultaneously. Given that the literature in inconclusive on the impact of FinTech on bank performance our hypothesis is non-directional and states that:

H1: Bank performance is related to FinTech development.

CHAPTER IV: METHODOLOGY

In this section, sample description, data collection process, model, and variables are discussed.

4.1. Sample and Data Description

The original intention of this research was to include the six countries from the GCC, as well as a few more countries from North Africa and the Middle East. Due to data availability issues, instead of selecting countries and banks based on bank performance ratios and FinTech indicators, we excluded those with missing data. Table 1 provides the distribution of our sample by country. The sample includes 63 listed banks which operate in the following countries from the MENA region: Saudi Arabia, United Arab Emirates, Kuwait, Egypt, Jordan, and Lebanon. There are 28 Islamic banks or banks that offer both Islamic and conventional banking services, while 35 banks are solely conventional banks. The sample period is 2011- 2021, our data starts in 2011 because the data used to construct the combined FinTech index *FTI* is available starting from 2011.

Data for dependent and bank specific control variables are extracted from Refinitiv Eikon database and annual financial reports published in each banks' website. Appendix Table A2 provides comprehensive definitions and data sources. The FinTech index is created using Principal Component Analysis (PCA) technique using variables collected from two sources: (i) World Bank -Global Findex for demand side data which represents the usage of mobile payment and internet banking as proxies for digital finance usage, and (ii) World Bank- World Development Indicators for the supply side data which represents infrastructure provided by the banking sector as a proxy for financial services access. Appendix Table A3 provides comprehensive definitions and data sources of all variables used to calculate our FinTech index. Macroeconomic

control variables are collected from the World Development Indicators (WDI) and World Governance Indicators (WGI) provided by World Bank.

Table 1: Sample countries, Number of banks, and Percentage.

Sample Country	Sample Banks	Sample %
Saudi Arabia	10	16%
United Arab Emirates	17	27%
Kuwait	10	16%
Egypt	8	13%
Jordan	14	22%
Lebanon	4	6%
Total	63	100%

4.2. Variables Identification

4.2.1. Dependent Variable

Efficiency ratio *ER*, the cost efficiency is an important measure for bank efficiency. Low *ER* ratio indicates high bank efficiency and better operational performance (Cheng & Qu, 2020; Phan et al., 2020; Dietrich and Wanzenried, 2014). For the purpose of making the interpretation easier, we multiply the original variable by -1. Thus, in our analysis, higher *ER* ratio indicates higher bank efficiency. There are alternative proxies for bank efficiency that has been used in previous research, such as: Data envelopment analysis (DEA)- Malmquist non-parametric method to measure efficiency (Cho and Chen, 2022; Lee et al., 2021; Wang et al., 2021; Chen, 2020). Others have used Z-score and non-performing loans ratio as a proxy (Banna, Hassan, and Rashid 2021; Li, He, Tian, Sun, and Ning, 2022).

4.2.2. Key Test Variables

Due to the absence of direct measure for FinTech development, we construct our FinTech index (*FTI*) using the Principal Component Analysis (PCA) method following (Awais, Afzal, Firdousi, and Hasnaoui, 2023; Zhao, Li, Yu, Chen, and Lee

2022; Lee et al., 2021; Khera, Ng, Ogawa, and Sahay, 2021; Banna et al., 2021; Ahamad and Mallick, 2019). *FTI* includes variables that represent access to infrastructure that facilitate digital finance and usage of digital finance, FinTech supply side (*FSS)* variables include, (i) Mobile cellular subscriptions per 100 people, and (ii) Secure Internet servers per 1 million people. While FinTech demand side (*FDS)* list of variables included in *FDS* are, (i) percentage of people above age of 15 who made a digital payment, (ii) percentage of people above age of 15 who received digital payments, (iii) percentage of people above age of 15 who used either mobile phone or internet to make an online purchase (iv), percentage of people above age of 15 who used either mobile phone or internet to pay their bills, (v) percentage of people above age of 15 who used mobile phone to make a utility payment, (vi) percentage of people above age of 15 who received payment from the government through a mobile phone, and (vii) percentage of people above age of 15 who used a mobile phone or the internet to access a financial institution account. PCA is an appropriate approach to apply in *FTI* construction because the variables selected for the index are somewhat correlated. PCA helps in addressing multicollinearity issues. We expect the relationship of bank efficiency with the *FTI*, *FDS*, and *FSS* to be positive; the higher the FinTech development leads to higher bank efficiency. Alternative proxies to measure FinTech are used in past research for example, (Wu et al., 2023; Chhaidar et al., 2022; Li et al., 2022; Cheng and Qu, 2020) used text mining and web crawler technology to construct a FinTech index, other studies have used questionnaires (Guang-Wen and Siddik, 2022; Yan et al., 2022; Dwivedi et al., 2021).

4.2.3. Control Variables

4.2.3.1. Bank Specific Control Variables

We control for the following bank-related variables:

(1) Non-performing loans to total loans *NPL*, which is a ratio that can be used as a proxy for credit risk in the banking sector and for assessment of asset quality. One theory which was introduced by Berger and DeYoung (1997) is "The bad luck hypothesis" indicates that high *NPL* ratio is a sign of poor loan quality, which contributes to the increase of default risk that is faced by the bank, which in turn would increase cost inefficiency because of the higher monitoring expenses (Cheng and Qu, 2020; Cho and Chen, 2021). Bad debt creates a heavy burden on the banks cost wise which will reduce bank's efficiency (Phung, Vu, and Tran, 2022; Cho and Chen, 2021; ElMoussawi and Mansour, 2022). This leads to the expectation of a negative relation between *NPL* and *ER*. Alternatively, there is the skimping hypothesis (Berger and DeYoung,1997) which suggests that banks deliberately decrease monitoring and screening measures to appear more cost efficient and profitable at the time but will bear the risk of having higher percentage of bad loans at later times (Phung et al., 2022; Assaf, Berger, Roman, and Tsionas, 2019; Williams, 2004). Based on this hypothesis, we expect a positive relationship between *NPL* and *ER*, indicating that as *NPL* increases, bank efficiency improves.

(2) Capital adequacy ratio *CAR*, an essential ratio in assessing the ability of banks to cover the losses and prevent insolvency by having higher risk bearing capabilities. Banks having a high CAR ratio are more stable and can meet obligations safely. Thus, higher *CAR* ratio helps banks to be more efficient (Cho and Chen, 2021; Wang et al., 2021). We expect a positive relationship between *CAR* and *ER*.

(3) Bank Size *LSIZE*. Larger banks have cost, and risk management advantage compared to smaller banks which gives them higher capabilities to survive fierce competition (Cheng & Qu, 2020; Cho and Chen, 2021; Wang et al, 2021; Li et al., 2022; Lee et al., 2021). As the size of the bank increases, its efficiency and productivity increase. We therefore expect a positive relationship between *LSIZE* and *ER*.

(4) Loan to deposit ratio *LTD*, is usually used as measure of liquidity for banks. It assesses the ability of the bank in settling their loan losses and covering clients' withdrawal in time of financial stress to avoid loan defaults. Lower *LTD* ratio should positively impact and increase bank efficiency (Cheng and Qu, 2020; Wang et al., 2021; Lee et al., 2021). We therefore expect a negative relationship between *LTD* and *ER*.

(5) Return on equity *ROE*, is a profitability measure frequently used for banks. Research confirms that highly profitable Banks tend to be more cost efficient (Lv et al., 2022; Otero, Razia, Cunill, and Mulet-Forteza, 2020; Tan, Floros, and Anchor, 2017), hence would have lower *ER* ratio. Hence, we expect a positive relationship between *ROE* and *ER*.

(6) *DUM_IB* is used to confirm the controversy regarding the performance of Islamic and conventional banks. Contradicting results has been found in the existing literature when comparing Islamic banks' efficiency to conventional banks. Safiullah (2021) state that the stability of Islamic banks is higher than conventional banks. Cihak and Hesse (2010) confirm these results for smaller Islamic banks only. However, lower stability has been found by Safiullah and Shamsuddin, 2022, Kabir, Worthington, and Gupta, 2015, and Beck, Demirgüç-Kunt, and Merrouche, 2013. Thus, we expect non-directional effect between *DUM_IB* and *ER*.

4.2.3.2. Country Specific Control Variables

We control for:

(1) The natural logarithm of the GDP per Capita *LGDPPC*, which is an indicator of economic development. Higher GDP per capita enhances banking sector's ability to attract more people to deposit their saving and it would increase the banks' ability to generate cash flow and improve its efficiency (Chen and Lu, 2021). However, economic development may attract demand for banks' products, which would make them more profitable and prone to less cost control practice due to the relaxed pressures imposed on them (Otero et al., 2020; Maudos, Pastor, Perez, and Quesada, 2002). Based on that, we expect an ambiguous relation between *LGDPPC and ER.*

(2) Inflation *INF*, several studies have shown that inflation negatively impacts the banks' overall performance, more specifically efficiency and profitability (Phan et al., 2020; Tran, Tsionas, and Mamatzakis, 2020; Boyd, Levine, and Smith, 2001). According to Friedman (1977), the cost of inflation uncertainty is high, the reason is that it distorts the prices of goods and services relative to each other and increases the risks associated with conducting business as it daunts investments and savings. As a result, it negatively impacts overall performance. Furthermore, Otero et al. (2020), non-performing loans tend to increase in inflationary environments which increase costs and decrease banks' efficiency. Unanticipated increase in inflation may be associated with market instability, this leads to higher costs borne by banks which is compensated by increasing interest rates (Chaffai and Coccorese, 2023).

Contrary to this, Perry (1992) and Tan and Floros (2012) argue that the effect of inflation on banks' performance is contingent upon the anticipation of inflation uncertainty. If inflation is fully anticipated and accounted for and interest rates are adjusted accordingly, the result is believed to be positive for banks profitability. Lee et

al., (2021) have also found a positive relationship between inflation and bank efficiency. Thus, we expect an ambiguous relationship between *INF* and *ER* suggesting that higher inflation rates are associated with lower or higher bank efficiency.

4.3. Model and Model specifications

Our dataset included in the analysis is unbalance Panel data, we will perform unit root to check the stability of the variables to avoid spurious relationships and Hausman tests to select the appropriate model to proceed with in the analysis.

4.3.1. Preliminary Tests

4.3.1.1.Unit Root Test

To test the presence of unit root and investigate mean-reversion in the variables included in the analysis, we conducted Phillips Perron unit root test- Fisher Chi Square, which is more appropriate for unbalance panel data (Phillips and Perron, 1988) and it provides reliable results even when heteroskedasticity is present in the data (Zivot and Wang, 2006). Results of the test are presented in table A4 in the appendix. The results for the variables suggest the rejection of the null hypothesis H_1 : Presence of unit root, and the acceptance of the alternative hypothesis of stationarity.

4.3.1.2.Hausman Test

We then proceed with Hausman specification test to confirm the appropriate model to apply in our analysis, it is commonly used for the selection between random effect (RE) and fixed effect (FE) panel model (Hausman, 1978). The results of Hausman test are presented in table A5 in the appendix, it indicates the acceptance of the null hypothesis, which is H_0 :Random effect model yield more efficient results, and the rejection of the alternative hypothesis H_1 :Fixed effect model is more appropriate. Hence, we conclude that random effect model is more appropriate and efficient than fixed effect model.

4.3.2. Empirical Model

Three empirical models will be used in the empirical analysis to examine the effect of FinTech development on bank efficiency:

$$ER_{i,j,t} = \beta_0 + \beta_1 FTI_{j,t} + \beta_2 Bank\ Controls_{i,j,t} + \beta_3 Country\ Controls_{j,t} + Country\ Dummies + Year\ Dummies + \varepsilon_{i,j,t} \quad (1)$$

$$ER_{i,j,t} = \beta_0 + \beta_1 FSS_{j,t} + \beta_2 Bank\ Controls_{i,j,t} + \beta_3 Country\ Controls_{j,t} + Country\ Dummies + Year\ Dummies + \varepsilon_{i,j,t} \quad (2)$$

$$ER_{i,j,t} = \beta_0 + \beta_1 FDS_{j,t} + \beta_2 Bank\ Controls_{i,j,t} + \beta_3 Country\ Controls_{j,t} + Country\ Dummies + Year\ Dummies + \varepsilon_{i,j,t} \quad (3)$$

where, $ER_{i,j,t}$ is our efficiency proxy defined in section 3.2.1. $FTI_{i,j,t}$, $FSS_{i,j,t}$, and $FDS_{i,j,t}$ are the indices constructed which are representative of overall FinTech adoption, supply and demand sides. These variables are defined in section 3.2.2. $Bank\ Controls_{i,j,t}$ include: *NPL*, *CAR*, *LSIZE*, *LTD*, and *ROE, DUM_IB* defined in section 3.2.3.1. $Country\ Controls_{i,j,t}$ refers to *LGDPPC* and *INF* defined in section 3.2.3.2. Country, and Year dummies are included to control for country and year fixed effects. $\varepsilon_{i,j,t}$ represents the residual error term. As mentioned earlier, a list of variables definitions and data sources are presented in Appendix Table A2. We run equations (1), (2) and (3) using pooled Ordinary Least Square (OLS), fixed effect (FE), and random effect (RE) for the baseline regression to compare between the results, we then proceed by running all comparative and robustness check tests using random effect as suggested by Hausman test results which found that random effect model is more appropriate. We will multiply the *ER* ratio by -1 to make the interpretation of the results easier.

CHAPTER V: RESULTS AND DISCUSSION

5.1. Descriptive Analysis

Table 2 provides a summary of the descriptive statistics for our variables. The average *ER* for the selected banks is 42.9%. *ER* has the highest standard deviation among the variables with value of 14%, indicating high variability in the cost efficiency ratio for banks in the selected countries and time frame. As for the FinTech proxies, *FTI*, *FDS*, and *FSS*, the average is 0.462%, 0.818%, and 0.315% respectively. *FDS* has the highest standard deviation when compared to the other Fintech proxies which indicate that the degree of demand for digital services varies between each country. Skewness values for the FinTech proxies *FTI*, *FDS* suggest nearly symmetric distribution while it is more skewed to the right for *FSS* indicating fatter right tail and its Preakness is greater than *FTI* and *FDS*.

As for the bank control variables, we notice that they have a median that is somewhat close to mean, with the mean having slightly greater values indicating that the data have a slight skewness to the right which is confirmed by the skewness values. On the contrary, *ROE* and the country specific variables *LGDPPC* and *INF* are more skewed to the left, confirmed by the negative skewness values. The standard deviation of CAR, ROE and NPL are the highest among bank specific variables. The high standard deviation of CAR which is 7.22 suggests greater variability in the data than other variables. The banks' asset quality represented by *NPL* has an average of 5.5%, banks' adequacy ratio *CAR* for the selected banks has an approximate mean of 19% indicate that banks included in the sample have maintained a relatively high level of capital to cover their risks., the banks size is 9.39, while the liquidity indicator *LTD* is 82%, and finally for the profitability, the average is 10%.

For country controls, *LGDPPC* average is 8.2 while *INF* is -0.011 indicating deflationary conditions.

Table 2: Summary of Sample Descriptive Statistics

Variable	Obs.	Mean	Median	Std. Dev.	Min.	Max.	Skewness	Kurtosis
ER	676	42.920	41.375	14.028	33.855	48.885	-1.360	8.535
FTI	614	0.462	0.558	0.335	0.089	0.724	-0.031	1.533
FDS	677	0.818	1.400	2.298	-1.687	2.102	0.099	1.804
FSS	614	0.315	0.242	0.258	0.099	0.437	1.059	3.324
NPL	643	5.512	4.460	4.602	2.300	7.500	2.551	14.714
CAR	670	18.849	17.335	7.220	15.600	19.650	3.863	25.074
LSIZE	676	9.391	9.328	1.365	8.284	10.462	0.010	2.121
LTD	675	0.829	0.820	0.276	0.690	0.950	2.720	19.456
ROE	661	9.999	9.980	6.775	6.210	14.350	-0.499	5.647
LGDPPC	667	8.217	10.051	2.713	4.836	10.634	-0.383	1.203
INF	677	-0.011	0.020	0.172	0.005	0.033	-4.878	28.004

5.2. Correlation and VIF

According to the correlation matrix in Appendix Table A6, *ER* is Positively related to our three FinTech proxies. This means that as the FinTech adoption increases, *ER* ratio increases, hence bank cost efficiency increases. Appendix Table A7 reports the results of the variance inflation factors (VIFs). As can be seen, all variables in the models (1), (2), and (3) have VIF that is lower than 10, which mitigates multicollinearity issues (O'Brien, 2007).

5.3. Multivariate Results and Discussion

This section will provide discussion of the results of the regression analysis and the robustness check. We multiply the *ER* ratio by -1 to make the interpretation of the results easier.

5.3.1. Baseline Regression Results

Table 3 reports the results of the baseline regression estimates for the three models (1), (2), and (3) using Pooled OLS, Fixed effect, and Random effect methods. We report in Model (1) a highly significant positive coefficient at the 1% level for FTI using OLS, FE, and RE estimation techniques, indicating that FinTech development improves bank efficiency. The results in Model (2) show that *FDS* coefficient is positive and significant at the 1% level using OLS, FE, and RE estimation techniques, suggesting that usage of FinTech channels enhance banks efficiency. The results of Model (3) show that the coefficient for *FSS* is only marginally significant at 10% using OLS, suggesting that the access or availability of infrastructure that support FinTech increases bank efficiency to a limited degree. While the result is negative and marginally significant at 10% using FE model, indicating that increase in FinTech infrastructure development may lead to lower bank efficiency. Results also show negative and insignificant *FSS* when using RE model.

As for the control variables, the coefficient for *NPL* is positive and highly significant at 1% level in all three models using OLS, FE, and RE estimation methods, which is inconsistent with relevant past research (Cheng & Qu, 2020; Cho and Chen, 2021). One explanation of this result is the Skimping hypothesis (Phung et al., 2022; Assaf et al., 2019; Mamonov, 2013; Williams, 2004) in which monitoring costs and screening procedure for loans are ignored to increase profits and decrease costs which would make cost efficiency ratio appear higher in the short term.

Positive and highly significant *CAR* is reported in all three models when estimating using FE, and RE estimation methods which confirm (Cho and Chen, 2021; Wang et al., 2021) results. This indicate that as capital adequacy increases, bank cost efficiency increases as it provides banks with stability to meet obligations and cover the losses.

We also report a positive highly significant coefficient for *LSIZE,* suggesting that larger banks assert more cost controls due to economies of scale, which makes them more efficient compared to smaller banks. Greater opportunities in term of cost reduction are available for large banks as they possess higher market share and hence power, the result is in line with (Addai, Tang, Gyimah, and Twumasi, 2022; Li et al., 2022; Lee et al, 2021; Cho and Chen, 2021; Wang et al., 2021; Otero et al, 2020; Cheng & Qu, 2020). Additionally, we report a significant and negative coefficient for *LTD* consistent with (Cheng & Qu, 2020; Wang et al., 2021; Lee et al., 2021), indicating that as the bank's ability to cover short-term liquidity needs and withdrawals increases, its efficiency increases.

Furthermore, we report a highly significant positive coefficient at the 1% level for *ROE* in all three models using OLS, FE, and RE estimation methods.

The coefficient for *DUM_IB* is negative and highly significant at 1% in all three models using OLS, while negative and significant at 5% in all three models when estimating using FE and RE models except in *FSS* equation using RE model in which it is only marginally significant. The results suggesting that Islamic banks are less efficient compared to conventional banks. One reason for that could be that Islamic banks are less advanced in terms of technology adoption compared to their counterparts (Safiullah and Shamsuddin, 2022).

According to (Sarsour and Daoud, 2015; Dridi and Hasan, 2010), the reason

that Islamic banks are less efficient is due to risk management issue and adherence to Shariah principles, which increase the riskiness of the banks due to prohibitions of derivatives and risk mitigations tools. Thus, increase the costs and lowers the efficiency of the bank. Furthermore, Islamic banks are inefficient due to it being fairly new and economies of scale are not as great compared to the more experienced less constraint conventional banks (Olson and Zoubi, 2008; Yudistira, 2004).

LGDPPC appears to have a highly significant and negative impact at 1% level, which is a result that could be anticipated. The results could be explained by the intense competition that economic growth brings with it. The higher economic growth would attract new entrants (i.e. FinTech startups) into the financial industry due to lower barriers. thus, would increase competition which increases costs and decreases banks' efficiency and profitability (wu et al, 2022; Otero et al, 2020; Sufian, Kamarudin, and Nassir, 2016; Liu and Wilson, 2011).

Finally, results show that *INF* is positive and significant at 5% when estimating using FE and RE in equations (4), (6), and (7) and highly significant at 1% in equation (9), the result is consistent with the Perry (1992) and Tan and Floros (2012).

Table 3: Baseline Regression Results using OLS, Fixed Effect, and Random Effect models for the Full Sample over the period 2011 – 2021

Variables	OLS	OLS	OLS	FE	FE	FE	RE	RE	RE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	ER(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*
FTI	10.372***			10.252***			10.282***		
	(2.950)			(3.176)			(3.178)		
FDS		7.699***			8.045***			7.971***	
		(2.794)			(3.065)			(3.036)	
FSS			3.883*			-4.861*			-0.038
			(1.793)			(-1.855)			(-0.015)
NPL	0.365***	0.353***	0.523***	0.396***	0.364***	0.418***	0.388***	0.359***	0.497***
	(3.195)	(3.093)	(4.466)	(3.643)	(3.394)	(3.831)	(3.609)	(3.390)	(4.491)
CAR	0.061	0.094	0.101	0.219***	0.216***	0.237***	0.184**	0.189**	0.216***
	(0.520)	(0.824)	(0.864)	(2.829)	(2.788)	(3.053)	(2.422)	(2.489)	(2.732)
LSIZE	2.047***	1.989***	1.710***	2.281***	2.151***	2.247***	2.230***	2.124***	2.134***
	(3.884)	(3.971)	(3.511)	(4.907)	(4.742)	(4.726)	(4.982)	(4.846)	(4.678)
LTD	-4.095**	-4.678***	-4.717***	-3.817**	-4.224**	-3.959**	-3.807**	-4.278**	-4.122**
	(-2.492)	(-2.773)	(-2.822)	(-2.204)	(-2.405)	(-2.272)	(-2.225)	(-2.470)	(-2.305)
ROE	0.566***	0.598***	0.656***	0.485***	0.507***	0.495***	0.506***	0.530***	0.614***
	(6.339)	(6.510)	(7.053)	(7.641)	(7.823)	(7.749)	(8.154)	(8.407)	(9.775)
DUM_IB	-2.446***	-2.472***	-2.380***	-1.994**	-2.094**	-2.108**	-2.128**	-2.211**	-1.890*
	(-2.891)	(-3.043)	(-2.703)	(-2.027)	(-2.144)	(-2.122)	(-2.301)	(-2.409)	(-1.952)
LGDPPC	-12.108***	-14.404***	1.933***	-12.345***	-15.284***	-12.701***	-12.335***	-15.112***	1.876***
	(-4.544)	(-3.390)	(6.164)	(-5.800)	(-8.338)	(-5.920)	(-5.794)	(-8.254)	(4.962)
INF	10.961	-0.239	17.669*	11.127**	0.754	12.494**	11.028**	0.498	16.976***
	(1.425)	(-0.100)	(1.799)	(2.047)	(0.314)	(2.291)	(2.024)	(0.207)	(2.995)
Constant	61.351**	89.279*	-82.368***	25.630	52.383***	33.205*	59.629**	93.608***	-88.004***
	(2.111)	(1.952)	(-18.674)	(1.404)	(3.311)	(1.795)	(2.544)	(4.626)	(-18.664)
Obs.	569	617	569	569	617	569	569	617	569
R-squared	0.532	0.543	0.489	0.361	0.383	0.353	0.6676	0.6865	0.6364

Note: OLS, FE, and RE Regression results over the full sample 2011-2021. ER, FTI, FDS, FSS, Bank and macroeconomic control variables are deployed, NPL, CAR, LSIZE, LTD, ROE, DUM_IB, LGDPPC, and INF respectively. Refer to: Cost efficiency ratio, Fintech Index, Fintech demand side, Fintech supply side, Non-performing loans, Capital adequacy ratio, logarithm of bank total assets, loan to deposit ratio, return on equity, Islamic banks dummy, logarithm of GDPPC, and inflation. Year and country fixed effect are controlled for. Source: Refinitiv Eikon and bank financial statements, WDI- World Bank.

**** p<0.01, ** p<0.05, * p<0.1, Values in parentheses are t-statistics.*

5.3.2. Cross-Sectional Tests

The objective of this subsection is to provide additional analysis and comparison through splitting the sample based on Islamic and conventional banks, GCC region and non-GCC region, and finally, high and low regulatory quality. The purpose of this analysis is to examine the heterogeneity and sensitivity of the sample.

Table 4 shows the results when splitting the sample based on bank type. The results indicate that Islamic banks efficiency is positively affected by FinTech, while conventional banks are not as sensitive to the FinTech- efficiency nexus. FinTech helps Islamic banks to reduce their fixed, administrative, and other general expenses which helps in increasing its efficiency. This could also be due to the FinTech advancement in risk management that would help Islamic banks to increase its efficiency (Rabbani, Khan, and Thalassinos, 2020; Rabbani and Khan, 2020).

The negative impact that *FSS* has on bank efficiency contradict with our initial expectations, it could be explained by the huge investments that banks make to adopt latest technologies and ensure its security along with the training and expertise expenses needed to integrate the technology into the banking operations (Lv et al., 2022).

Table 4: RE Regression Results of Split Sample by Bank Type

Variables	Islamic Banks			Conventional Banks		
	(1)	(2)	(3)	(4)	(5)	(6)
	ER(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*
FTI	11.406**			3.662		
	(2.168)			(0.758)		
FDS		9.434**			2.813	
		(2.343)			(0.636)	
FSS			-8.147*			-2.928
			(-1.880)			(-0.739)
NPL	0.352	0.404	0.348	0.185	0.156	0.189
	(1.292)	(1.600)	(1.273)	(1.599)	(1.228)	(1.643)
CAR	0.122	0.075	0.117	0.305*	0.479***	0.300*
	(1.021)	(0.681)	(0.970)	(1.876)	(2.671)	(1.839)
LSIZE	4.373***	4.167***	4.258***	-1.497**	-1.679**	-1.526**
	(7.019)	(7.255)	(6.690)	(-1.998)	(-2.125)	(-2.035)
LTD	-2.690	-1.972	-2.464	-4.172	-8.170**	-4.119
	(-1.042)	(-0.802)	(-0.949)	(-1.191)	(-2.166)	(-1.178)
ROE	0.280**	0.272**	0.266**	0.622***	0.726***	0.624***
	(2.327)	(2.376)	(2.199)	(8.106)	(8.760)	(8.158)
LGDPPC	-11.184**	-10.155**	-9.999**	-11.514***	-14.057***	-11.891***
	(-2.421)	(-2.267)	(-2.153)	(-4.496)	(-6.127)	(-4.682)
INF	1.135	-1.634	8.781	8.490	1.455	8.537
	(0.067)	(-0.392)	(0.523)	(1.497)	(0.322)	(1.508)
Constant	-81.100	-88.012	-98.936	-54.182	-52.154	-63.050
	(-11.073)	(-13.324)	(-16.027)	(-7.266)	(-7.029)	(-10.640)
Obs.	262	286	262	307	331	307
R-Squared	0.7144	0.765	0.6868	0.7693	0.7907	0.765

*Note: RE Regression results over the full sample 2011-2021. ER, FTI, FDS, FSS, Bank and macroeconomic control variables are deployed, NPL, CAR, LSIZE, LTD, ROE, LGDPPC, and INF respectively. Refer to: Cost efficiency ratio, Fintech Index, Fintech demand side, Fintech supply side, Non-performing loans, Capital adequacy ratio, logarithm of bank total assets, loan to deposit ratio, return on equity, logarithm of GDPPC, and inflation. Year and country fixed effect are controlled for. Source: Refinitiv Eikon and bank financial statements, WDI- World Bank. *** p<0.01, ** p<0.05, * p<0.1, Values in parentheses are z-statistics.*

The results of splitting the sample by region are presented in table 5. They show that the effect of FinTech on efficiency is significant and positive in the GCC while it is negative for non- GCC countries. GCC countries are categorized by the world bank as a high-income group, while non-GCC countries included in the analysis are considered middle income group, thus, development in FinTech would require additional funds and investments.

There is also the huge effort to increase the FinTech development in the GCC region along with the availability of infrastructure that facilitates FinTech like internet servers, high mobile penetration rates (Allen, 2021). The huge investments made by GCC banks would contribute to the lower cost efficiency caused by fintech infrastructure development in the short run (Lv et al., 2022).

The negative influence on non-GCC countries could be due to the struggles in adopting FinTech in the banking industry in non- GCC region (Naz et al., 2022; Arezki and Senbet, 2020) and the lack of infrastructure readiness in many areas in the non-GCC region which makes adopting FinTech more difficult thus, lower costs are allocated for implementation of FinTech, hence higher cost efficiency ratio (Allen, 2021).

Table 5: RE Regression Results of Split Sample by Geographic Location

Variables	GCC			Non-GCC		
	(1)	(2)	(3)	(4)	(5)	(6)
	ER(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*
FTI	10.760***			-36.438**		
	(2.855)			(-2.355)		
FDS		8.802***			-35.987***	
		(3.032)			(-2.830)	
FSS			-9.948***			38.602**
			(-2.615)			(2.553)
NPL	0.164	0.151	0.123	0.268**	0.364**	0.263**
	(0.915)	(0.868)	(0.673)	(2.036)	(2.543)	(2.003)
CAR	0.725***	0.640***	0.720***	-0.155	-0.103	-0.184*
	(5.648)	(5.298)	(5.566)	(-1.458)	(-0.898)	(-1.732)
LSIZE	2.838***	2.758***	2.822***	1.260	1.681*	1.277
	(5.178)	(5.331)	(5.104)	(1.524)	(1.957)	(1.551)
LTD	-9.785***	-8.802***	-9.545***	-13.740***	-17.487***	-12.924***
	(-4.249)	(-3.959)	(-4.115)	(-3.610)	(-4.318)	(-3.384)
ROE	0.174*	0.158*	0.141	0.780***	0.921***	0.745***
	(1.769)	(1.652)	(1.427)	(8.902)	(9.875)	(9.061)
DUM_IB	-2.403**	-2.534**	-2.252**	0.214	0.047	0.326
	(-2.187)	(-2.442)	(-2.024)	(0.137)	(0.029)	(0.210)
LGDPPC	-4.645	-3.885	1.667	-22.610***	-21.431***	-25.289***
	(-1.089)	(-0.936)	(0.360)	(-5.412)	(-6.255)	(-5.547)
INF	-20.875	-2.573	19.357	8.113	7.680	12.543**
	(-0.596)	(-0.709)	(0.570)	(1.260)	(1.086)	(1.995)
Constant	-30.447	-35.209	-87.049*	57.767**	46.953**	70.181***
	(-0.660)	(-0.778)	(-1.774)	(2.551)	(2.381)	(2.915)
Obs.	343	369	343	226	248	226
R-squared	0.3358	0.809	0.3323	0.8128	0.8488	0.809

Note: RE Regression results over the full sample 2011-2021. ER, FTI, FDS, FSS, Bank and macroeconomic control variables are deployed, NPL, CAR, LSIZE, LTD, ROE, DUM_IB, LGDPPC, and INF respectively. Refer to: Cost efficiency ratio, Fintech Index, Fintech demand side, Fintech supply side, Non-performing loans, Capital adequacy ratio, logarithm of bank total assets, loan to deposit ratio, return on equity, Islamic banks dummy, logarithm of GDPPC, and inflation. Year and country fixed effect are controlled for. Source: Refinitiv Eikon and bank financial statements, WDI- World Bank.
**** p<0.01, ** p<0.05, * p<0.1, Values in parentheses are z-statistics.*

The results of the sub-sample analysis based on regulatory quality are reported in table 6. We find that *FTI* and *FDS* load positive and significant in the sub-sample of banks from countries with higher regulatory quality (i.e., stronger legal institutions).

This result suggests that banks located in countries with sound legal system can reap more benefit from FinTech adoption.

Table 6: RE Regression Results Split Sample by Regulatory Quality

Variables	High Regulatory Quality			Low Regulatory Quality		
	(1)	(2)	(3)	(4)	(5)	(6)
	ER(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*
FTI	15.318**			7.557		
	(2.479)			(1.314)		
FDS		12.051***			7.016	
		(2.760)			(1.364)	
FSS			-7.374			-17.185
			(-1.547)			(-1.084)
NPL	0.288	0.415**	0.281	0.272*	0.271*	0.278*
	(1.484)	(2.299)	(1.435)	(1.874)	(1.869)	(1.915)
CAR	0.245**	0.305***	0.274**	0.095	0.094	0.103
	(2.273)	(3.005)	(2.547)	(0.636)	(0.628)	(0.688)
LSIZE	3.066***	2.925***	3.105***	1.284	1.285	1.344
	(5.574)	(5.637)	(5.545)	(1.437)	(1.438)	(1.502)
LTD	-5.372**	-5.919***	-5.655**	-0.799	-0.788	-0.546
	(-2.259)	(-2.578)	(-2.363)	(-0.268)	(-0.265)	(-0.183)
ROE	0.296***	0.386***	0.298***	0.635***	0.629***	0.621***
	(2.828)	(3.896)	(2.820)	(7.338)	(7.209)	(6.749)
DUM_IB	-5.016***	-4.501***	-5.150***	0.143	0.163	0.127
	(-3.715)	(-3.459)	(-3.776)	(0.110)	(0.126)	(0.098)
LGDPPC	-14.098***	-13.549***	-11.292**	-6.238**	-6.374**	-7.981**
	(-2.714)	(-2.752)	(-2.225)	(-2.068)	(-2.122)	(-2.484)
INF	2.637	-3.693	34.352	11.166*	11.163*	9.704
	(0.108)	(-1.110)	(1.539)	(1.766)	(1.768)	(1.545)
Constant	71.942	67.820	54.335	-34.008*	-33.140*	-24.019
	(1.291)	(1.275)	(0.980)	(-1.944)	(-1.896)	(-1.234)
Obs.	294	342	294	275	275	275
R-squared	0.6218	0.6271	0.6174	0.6893	0.6885	0.6868

Note: RE Regression results over the full sample 2011-2021. ER, FTI, FDS, FSS, Bank and macroeconomic control variables are deployed, NPL, CAR, LSIZE, LTD, ROE, DUM_IB, LGDPPC, and INF respectively. Refer to: Cost efficiency ratio, Fintech Index, Fintech demand side, Fintech supply side, Non-performing loans, Capital adequacy ratio, logarithm of bank total assets, loan to deposit ratio, return on equity, Islamic banks dummy, logarithm of GDPPC, and inflation. Year and country fixed effect are controlled for. Source: Refinitiv Eikon and bank financial statements, WDI- World Bank.

**** p<0.01, ** p<0.05, * p<0.1, Values in parentheses are z-statistics.*

5.4. Robustness Check

This section aims to check the robustness of the results presented in the previous sections. To do so, multiple tests are performed: 2 stage Least Square Instrumental Variable 2LS-IV, exclusion of countries with the largest banks sample, excluding the Covid-19 Pandemic effect, and finally inclusion of additional control variables to examine the effect.

5.4.1. Robustness: 2LS-IV

Our results may possibly be affected by endogeneity issues, for instance, some omitted variables may affect both efficiency and FinTech, this could lead to inconsistent OLS estimates. To address this problem, we use the instrumental variable approach. Lyons, Kass-Hanna, Fava (2022), Badwan and Awad (2022), and Fanta and Makina (2019) have emphasized the importance of internet access in facilitating the development of FinTech and its contribution in economic growth. We used Internet Usage *IU* as an instrument for our FinTech variables.

Table 7 shows the result of the 2LS-IV for both stage 1 and 2, in the 1st stage, we regress *FTI*, *FSS*, *FDS* on Internet Usage *IU*. The results reveal that the IV is highly significant and positively related to *FTI*, *FDS*, while is highly significant and negatively related in *FSS*. This indicates that as the percentage of internet usage increases, the development of FinTech increases as well.

In the 2nd stage, we regress *ER* on the predicted values for the *FTI*, *FSS*, *FDS* that we got from the first stage. The results show that all models (4) (5) (6) have a significant positive relationship at 5% for *FTI*, *FDS* and negative and significant at 5% for *FSS*, suggesting thar our results are not affected by endogeneity bias.

Table 7: Robustness: 2LS-IV

Variables	First stage			Second stage		
	(1)	(2)	(3)	(4)	(5)	(6)
	FTI	*FDS*	*FSS*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*
IU	0.015***	0.015***	-0.002***			
	(9.841)	(10.208)	(-4.096)			
FTI				12.496**		
				(2.218)		
FDS					12.153**	
					(2.218)	
FSS						-80.532**
						(-2.218)
NPL	0.003***	0.003**	0.000	0.343***	0.344***	0.415***
	(2.616)	(2.570)	(0.651)	(3.245)	(3.259)	(3.729)
CAR	0.001	0.001	0.001	0.152	0.153	0.213*
	(1.007)	(0.930)	(1.467)	(1.173)	(1.184)	(1.714)
LSIZE	0.005	0.005	-0.004	2.098***	2.095***	1.846***
	(0.988)	(1.049)	(-1.548)	(3.772)	(3.767)	(3.331)
LTD	-0.001	0.002	-0.024**	-3.634*	-3.668*	-5.603***
	(-0.051)	(0.092)	(-2.210)	(-1.790)	(-1.813)	(-3.110)
ROE	-0.000	-0.000	0.002***	0.504***	0.506***	0.630***
	(-0.182)	(-0.392)	(2.706)	(5.448)	(5.469)	(5.726)
DUM_IB	-0.010	-0.009	-0.004	-2.009*	-2.016*	-2.414**
	(-0.944)	(-0.908)	(-1.104)	(-1.930)	(-1.939)	(-2.413)
LGDPPC	-0.067***	-0.050**	-0.165***	-12.006***	-12.227***	-26.142***
	(-2.913)	(-2.079)	(-6.653)	(-3.874)	(-3.953)	(-3.808)
INF	0.172***	0.196***	-0.221***	0.423	0.191	-15.220
	(6.327)	(7.285)	(-26.512)	(0.103)	(0.046)	(-1.542)
Constant	0.341	-0.010	3.198***	55.794	60.172*	317.604***
	(1.317)	(-0.035)	(12.475)	(1.615)	(1.763)	(2.772)
Obs.	576	576	576	576	576	576
R-squared	0.4796	0.4719	0.8673	0.665	0.665	0.665

Note: RE Regression results over the full sample 2011-2021. IU, ER, FTI, FDS, FSS, Bank and macroeconomic control variables are deployed, NPL, CAR, LSIZE, LTD, ROE, DUM_IB, LGDPPC, and INF respectively. Refer to: Internet Usage, Cost efficiency ratio, Fintech Index, Fintech demand side, Fintech supply side, Non-performing loans, Capital adequacy ratio, logarithm of bank total assets, loan to deposit ratio, return on equity, Islamic banks dummy, logarithm of GDPPC, and inflation. Year and country fixed effect are controlled for. Source: Refinitiv Eikon and bank financial statements, WDI- World Bank.

**** p<0.01, ** p<0.05, * p<0.1, Values in parentheses are z-statistics.*

5.4.2. Robustness: Excluding UAE and Jordan

United Arab Emirates and Jordan account for almost 50% of the sample banks. To ensure that our results are not driven by these countries, we re-run equations (1), (2)

and (3) while excluding these countries. The results reported in Table 8 show that our previous results remain qualitatively unchanged.

Table 8: Robustness: Excluding Countries with Large Number of Sample Banks.

Variables	Excluding UAE			Excluding Jordan		
	(1)	(2)	(3)	(4)	(5)	(6)
	ER(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*	*ER*(-1)*
FTI	14.204***			10.765***		
	(3.370)			(2.947)		
FDS		12.245***			8.258***	
		(3.288)			(2.732)	
FSS			-11.340			-5.229
			(-1.361)			(-1.530)
NPL	0.337***	0.380***	0.372***	0.390***	0.358***	0.399***
	(3.003)	(3.273)	(3.251)	(2.816)	(2.660)	(2.852)
CAR	-0.067	-0.052	-0.024	0.505***	0.500***	0.510***
	(-0.839)	(-0.638)	(-0.293)	(4.285)	(4.299)	(4.228)
LSIZE	1.767***	1.724***	1.977***	1.765***	1.631***	1.720***
	(2.969)	(2.868)	(3.264)	(3.314)	(3.082)	(3.153)
LTD	-1.773	-1.917	-2.083	-6.525***	-6.845***	-6.461***
	(-1.061)	(-1.115)	(-1.219)	(-3.068)	(-3.205)	(-2.988)
ROE	0.619***	0.643***	0.644***	0.492***	0.521***	0.503***
	(8.872)	(8.889)	(8.872)	(6.966)	(7.260)	(7.058)
DUM_IB	-0.539	-0.582	-0.807	-2.140**	-2.279**	-2.235**
	(-0.562)	(-0.598)	(-0.829)	(-2.038)	(-2.168)	(-2.108)
LGDPPC	-11.334***	-12.671***	-13.202***	-13.551***	-15.688***	-13.479***
	(-5.482)	(-6.733)	(-6.068)	(-5.576)	(-7.424)	(-5.488)
INF	11.541**	13.171**	9.335*	9.645	0.233	11.384*
	(2.150)	(2.368)	(1.695)	(1.487)	(0.078)	(1.746)
Constant	-9.955	-3.097	-2.665	72.777***	100.214***	82.284***
	(-0.795)	(-0.259)	(-0.198)	(2.713)	(4.281)	(3.048)
Obs.	411	442	411	437	473	437
R-squared	0.6592	0.6673	0.6609	0.6633	0.7085	0.6575

Note: RE Regression results over the full sample 2011-2021. ER, FTI, FDS, FSS, Bank and macroeconomic control variables are deployed, NPL, CAR, LSIZE, LTD, ROE, DUM_IB, LGDPPC, and INF respectively. Refer to: Cost efficiency ratio, Fintech Index, Fintech demand side, Fintech supply side, Non-performing loans, Capital adequacy ratio, logarithm of bank total assets, loan to deposit ratio, return on equity, Islamic banks dummy, logarithm of GDPPC, and inflation. Year and country fixed effect are controlled for. Source: Refinitiv Eikon and bank financial statements, WDI- World Bank.

**** p<0.01, ** p<0.05, * p<0.1, Values in parentheses are z-statistics.*

5.4.3. Robustness: Removing the Pandemic Years

COVID-19 has been an accelerating factor for FinTech adoption due to

lockdown and difficulties in doing business and transacting in all sectors (Tut, 2023). The usefulness, ease, and the convenience it provides, made people acceptance of it increase significantly during and post pandemic (Le, 2021). To ensure that our results are not driven by COVID-19 pandemic, we removed 2020 and 2021 observations. The results reported in Table 9 corroborate our earlier findings.

Table 9: Robustness: Removing Pandemic Years.

Variables	(1)	(2)	(3)
	ER(-1)*	*ER*(-1)*	*ER*(-1)*
FTI	7.116*		
	(1.941)		
FDS		5.588*	
		(1.911)	
FSS			-2.194
			(-0.826)
NPL	0.396***	0.395***	0.410***
	(3.650)	(3.640)	(3.778)
CAR	0.136*	0.135*	0.147*
	(1.756)	(1.738)	(1.901)
LSIZE	2.638***	2.591***	2.619***
	(5.621)	(5.496)	(5.474)
LTD	-3.414**	-3.400**	-3.490**
	(-1.992)	(-1.984)	(-2.030)
ROE	0.399***	0.399***	0.407***
	(6.036)	(6.041)	(6.155)
DUM_IB	-1.839*	-1.791*	-1.920**
	(-1.941)	(-1.884)	(-2.013)
LGDPPC	-9.494***	-9.602***	-9.795***
	(-3.757)	(-3.802)	(-3.861)
INF	-11.463*	-11.306*	-11.003*
	(-1.754)	(-1.731)	(-1.679)
Constant	29.565	32.678	39.051
	(1.062)	(1.181)	(1.397)
Obs.	507	507	507
R-squared	0.641	0.6405	0.6400

Note: RE Regression results over the full sample 2011-2021. ER, FTI, FDS, FSS, Bank and macroeconomic control variables are deployed, NPL, CAR, LSIZE, LTD, ROE, DUM_IB, LGDPPC, and INF respectively. Refer to: Cost efficiency ratio, Fintech Index, Fintech demand side, Fintech supply side, Non-performing loans, Capital adequacy ratio, logarithm of bank total assets, loan to deposit ratio, return on equity, Islamic banks dummy, logarithm of GDPPC, and inflation. Year and country fixed effect are controlled for. Source: Refinitiv Eikon and bank financial statements, WDI- World Bank.

**** p<0.01, ** p<0.05, * p<0.1, Values in parentheses are z-statistics.*

5.4.4. Robustness: Additional Control Variables

The effect of additional control variables is also considered. The pace of annual asset growth could indicate how efficient a bank it is. In table 10, growth of total assets is controlled for. Hao, Hunter, and Yang (2001) conclude that banks with higher asset growth rates are more efficient than others. Banks with high levels of assets and asset growth are considered too big to fail, they can benefit from higher diversification and higher risk tolerance as well, compared to smaller banks (Le, Nguyen, and Schinckus, 2022).

The results in table 10 show that bank asset growth, has a negative marginally significant impact at 10% on bank efficiency which is inconsistent with (Le et al., 2022; Hao et al., 2001), while the indirect impact it has on FinTech proxies *FTI*, *FDS* is marginally significant at 10% while insignificant for *FSS* which is consistent with pervious results.

Table 10: Robustness: Additional Bank Specific Control Variables

Variables	(1)	(2)	(3)
	ER(-1)*	*ER*(-1)*	*ER*(-1)*
FTI	8.088*		
	(1.843)		
FDS		5.921*	
		(1.767)	
FSS			-0.972
			(-0.138)
NPL	-0.150	-0.264**	-0.256**
	(-1.131)	(-2.267)	(-2.188)
CAR	-0.055	-0.014	0.006
	(-0.424)	(-0.111)	(0.052)
LSIZE	37.446***	39.746***	39.508***
	(3.985)	(4.146)	(4.105)
LTD	-0.095**	-0.102***	-0.101***
	(-2.480)	(-2.663)	(-2.646)
ROE	0.555***	0.554***	0.568***
	(8.244)	(8.400)	(8.620)
DUM_IB	-3.098	-3.340	-3.473
	(-1.531)	(-1.587)	(-1.645)
LGDPPC	1.729	-3.026	-3.518
	(0.639)	(-1.374)	(-1.366)
INF	-13.506*	-4.671	-3.105
	(-1.854)	(-1.524)	(-1.001)
GTA	-0.063**	-0.055*	-0.053*
	(-2.011)	(-1.848)	(-1.757)
Constant	-134.451***	-86.188**	-76.114*
	(-3.617)	(-2.548)	(-1.883)
Obs.	573	616	616
R-squared	0.4272	0.4395	0.4394

Note: RE Regression results over the full sample 2011-2021. GTA, ER, FTI, FDS, FSS, Bank and macroeconomic control variables are deployed, NPL, CAR, LSIZE, LTD, ROE, DUM_IB, LGDPPC, and INF respectively. Refer to: Growth of total assts, Cost efficiency ratio, Fintech Index, Fintech demand side, Fintech supply side, Non-performing loans, Capital adequacy ratio, logarithm of bank total assets, loan to deposit ratio, return on equity, Islamic banks dummy, logarithm of GDPPC, and inflation. Year and country fixed effect are controlled for. Source: Refinitiv Eikon and bank financial statements, WDI- World Bank.

**** p<0.01, ** p<0.05, * p<0.1, Values in parentheses are z-statistics.*

CHAPTER VI: CONCLUSION

6.1. Concluding Remarks

Recent years have seen FinTech become an important trend in the banking industry, banks needed to ride the wave or else be left behind and lose market share to FinTech startups. Many studies examined the influence of FinTech on performance of banks in different regions around the world (Yan et al., 2022; Li et al., 2022; Wang et al., 20221; Cho and Chen, 2021; Lee et al., 2021; Dwivedi et al., 2021). However, studies of the MENA region are very scarce. The reason is that Fintech data is limited for countries in the MENA region.

We attempt to fill this gap in the literature by analyzing the impact of Fintech on the performance of 63 banks from the MENA region over the period starting from 2011 to 2021. In order to create an overall FinTech index, variables obtained from World Bank global Findex and WDI are used to measure access and usage of FinTech related variables. We contribute to the existing literature by proving an empirical analysis on the impact of FinTech innovation on banks' efficiency in the MENA region by constructing a FinTech index to measure FinTech development in the MENA region from both demand and supply perspectives. We also consider bank heterogeneity in the MENA by analyzing different types of banks (Islamic and conventional).

Our major findings are that increased adoption of FinTech has positively influenced the efficiency of the banks which confirms the innovation growth hypothesis. We find that the positive effect of Fintech on bank performance is stronger in Islamic banks, banks from the GCC countries, and banks operating in countries with high regulatory quality. Bank efficiency is significantly negatively impacted by FinTech development in non-GCC regions, in line with innovation fragility view. While having cost reduction benefits, Fintech adoption require huge investments that

should be allocated by banks to improve and upgrade to latest technologies that ensure smooth operations and tight security along with the training and expertise expenses needed to integrate the technology into the banking operations, which would decrease cost efficiency in the short run, which could be one of the reasons for *FSS* (access to Fintech infrastructure) having a negative relationship with cost efficiency (Lv et al., 2022). As a whole, the MENA region is not as advanced in FinTech development as developed economies (Allen, 2021). Our results are robust to the use of multiple robustness checks and the instrumental variable approach which is used to address endogeneity issue.

6.2. Policy Implications

As a result of the developments regarding FinTech, banks should first be aware of the implications that a delay in adoption would have on their competitive advantage. Embracing FinTech innovations in their operations whether front or back office would create opportunities and advantages that would place them at the top of the industry. Designing the framework and business model to facilitate FinTech adoption is important. An initiative to attract skilled staff and expertise in the field is suggested, along with providing their employees with the necessary training (Cheng and Qu, 2020). Investing more in Fintech innovations, R&D spending, and risk control measures would help create value and protect against potential risks associated with emerging technologies. The second step is for policymakers, regulatory bodies, and government entities to work together and support the development of FinTech in the country so that banks can expand their reach and increase financial inclusion. The enforcement of regulatory measures and standards, such as supervision and monitoring laws, disclosure requirements, customer data protection policies, and competition practices, would provide banks with a healthy competitive environment. Since the

United Kingdom has implemented a regulatory sandbox in late 2015, some countries in the MENA region have established sandboxes to oversee and monitor FinTech firms and allow them to experiment safely (Allen, 2021). In order to stimulate more FinTech adoption, keep the stability of the financial system intact, and protect consumers at the same time, regulators must cooperate and work together to create a balanced, well-regulated environment (Jagtiani & John, 2018).

6.3. Limitation and suggestions

This thesis has its limitations. First, it includes only six countries from the MENA region, which may not be enough to generalize FinTech's impact across the region. Due to the lack of data, expanding the selection of countries has been difficult. Second, other aspects of bank performance such as profitability, risk, and productivity were not considered. Therefore, we recommend that further research be conducted to cover more countries, banks, and banks' performance measures in order to enhance the results and provide detailed policy recommendations for banks and policymakers.

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APPENDIX

Appendix Table A1: Existing Literature on the Impact of FinTech's Adoption by Banks on its Performance

Authors/Publication year	Region of study	Time Period	Sample size	Bank performance Indicator	Impact
Singh et al. (2021)	India	2011-2018	8 banks	Profitability	+
Lv et al. (2022)	China	2011-2020	A single bank	Profitability	U- shaped impact -,+
Wu et al. (2023)	China	2008-2018	31 provinces in China	Efficiency	U- shaped impact -,+
Chhaidar et al. (2022)	Europe	2010–2019	23 banks	Profitability	+
Wang et al. (2021)	China	2009-2018	113 commercial banks	Efficiency (competitiveness)	+
Cho & Chen (2021)	China	2011-2017	34 banks	Efficiency	+
Dwivedi et al. (2021)	United Arab Emirates	2021	76 participants from various banks in UAE	Competitiveness and performance	+
Li et al. (2022)	China	2008-2020	65 commercial banks	Risk taking	+
Sajid et al. (2023)	China, India, Pakistan, and Bangladesh	2014-2021	50 banks	Efficiency Risk-taking	+ +
Lee et al. (2021)	China	2003- 2017	86 banks	Efficiency	+

Continue Appendix Table A1: Existing Literature on the Impact of FinTech's Adoption by Banks on its Performance.

Authors/Publication year	Region of study	Time Period	Sample size	Bank performance Indicator	Impact
Alsahlawi, (2021)	Saudi Arabia	2021	376 participants from 50 banks	Financial risk management	+
Cheng & Qu (2020)	China	2008- 2017	60 commercial banks	Credit Risk	+
Chen, K.C., (2020)	China	2009-2018	20 banks	Efficiency	+
Yan et al. (2022)	Bangladesh	January-March 2021	351 banks empolyees	Sustainability performance	+
Guang-Wen and Siddik (2022)	Bangladesh	July-November 2021	302 participants	Environmental performance	+
Note: ("+" indicates the positive impact and "-" for negative impact)					

Appendix Table A2: Variables, Definitions, Data Sources, Expected Impact.

Dependent Variable (Code)	Definition	Data source	
Efficiency (*ER*)	-1* (Non-interest expense / Revenue (net of interest expense before loan loss provision)	Refinitiv Eikon/Bank's Financial Report	
Independent Variables (Code)	**Definition**	**Data source**	**Expected Impact**
FinTech (*FTI*)	Overall FinTech Score – using PCA	World Bank - Global Findex and WDI	+
FinTech Demand Side (*FDS*)	FinTech Demand Score– using PCA	World Bank - Global Findex	+
FinTech Supply Side (*FSS*)	FinTech Supply Score– using PCA	WDI	+
Control Variables (Code)	**Definition**	**Data source**	**Expected Impact**
	a. Bank Specific Control Variables		
Non-performing Loans (*NPL*)	Total Non-Performing Loans / Total Loans	Refinitiv Eikon/Bank's Financial Report	-,+
Capital Adequacy Ratio (*CAR*)	Total Capital / Total Risk Weighted Assets	Refinitiv Eikon/Bank's Financial Report	+
Bank Size (*LSIZE*)	Natural Logarithm of Total Assets	Refinitiv Eikon	+
Loan to Deposit (*LTD*)	Total loans / Total Deposits	Refinitiv Eikon	-
Return on Equity (*ROE*)	Income Available to Common Excluding Extraordinary Items / Total Shareholders' Equity	Refinitiv Eikon	+
Dummy for Islamic Bank Effect (*DUM_IB*)	Fully Islamic or Offer both Islamic and conventional Banking Services=1, Conventional Banking Services Only =0	-	+,-
	b. Country Specific Control Variables		
GDP per Capita (*LGDPPC*)	Natural Logarithm of GDP per Capita	WDI	+,-
Inflation (*INF*)	Annual Inflation %	WDI	+,-

Note: ER has been multiplied by -1 for ease of interpretation purposes. FinTech index is constructed using PCA principal component analysis.

Continued Appendix Table A2: Variables, Definitions, Data Sources, Expected Impact.

c. Additional Variables to Check Robustness of the Analysis			
Control Variables (Code)	Definition	Data source	Expected Impact
Growth of Total Assets (*GTA*)	(Total Assets$_{1}$-Total Assets $_{-1}$/ Total Assets $_{-1}$) *100	Authors Calculation based on Refinitiv Eikon Data	+
Regulatory Quality (*RQ*)	Sound regulatory implementation by government to facilitate development of private sector	WGI	+
Internet Usage (*IU*)	% of Population Using the Internet	WDI	+

Note: MQ and GTA are used as additional control variables. RQ is used in split sample analysis. IU is used as an instrumental variable.

Appendix Table A3: Selected Variables for Construction of FinTech Adoption Index.

Supply Side Variables (FSS) - Access	Demand Side Variables (FDS)- Usage
Mobile cellular subscriptions (per 100 people)	Made a digital payment (% age 15+) Received digital payments (% age 15+) Used a mobile phone or the internet to buy something online (% age 15+) Used a mobile phone or the internet to pay bills (% age 15+)
Secure Internet servers (per 1 million people)	Made a utility payment: using a mobile phone (% age 15+) Received government payments: through a mobile phone (% age 15+) Used a mobile phone or the internet to access a financial institution account (% age 15+)
Source: World Bank- WDI	Source: World Bank -Global Findex

Note: The supply side and demand side represent access to infrastructure that facilitate digital finance, and usage of services provided by banks, respectively.

Appendix A4: Panel Unit Root Test Summary

Variable	Statistic	Prob.	Decision
ER	287.851	0.0000***	Reject the null hypothesis
FTI	172.974	0.0035***	Reject the null hypothesis
FDS	149.769	0.0730*	Reject the null hypothesis
FSS	147.838	0.0893*	Reject the null hypothesis
NPL	347.725	0.0000***	Reject the null hypothesis
CAR	313.613	0.0000***	Reject the null hypothesis
LSIZE	365.289	0.0000***	Reject the null hypothesis
LTD	400.407	0.0000***	Reject the null hypothesis
ROE	272.505	0.0000***	Reject the null hypothesis
LGDPPC	238.604	0.0000***	Reject the null hypothesis
INF	184.004	0.0006***	Reject the null hypothesis

*Note: H_1 : Presence of unit root. H_2 : series is stationary. *** p<0.01, ** p<0.05, * p<0.1*

Table A5: Hausman Test Summary

Variable	Chi-Square Stat.	Chi-Square d.f.	Prob.	Decision
FTI	14.04	18	0.7266	Fail to reject
FDS	8.21	19	0.9844	Fail to reject
FSS	14.59	18	0.6897	Fail to reject

Appendix Table A6: Variables Correlation Matrix

Variable	*ER*	*FTI*	*FDS*	*FSS*	*NPL*	*CAR*	*LSIZE*	*LTD*	*ROE*	*DUM_IB*	*LGDPPC*	*INF*
ER	1											
FTI	0.489***	1										
FDS	0.490***	0.995***	1									
FSS	0.376***	0.802***	0.7414***	1								
NPL	-0.005	-0.172***	-0.159***	-0.221***	1							
CAR	-0.219	0.116***	0.122***	0.053	-0.179***	1						
LSIZE	0.453***	0.610***	0.592***	0.585***	-0.264***	-0.212***	1					
LTD	0.043	0.431***	0.425***	0.373***	-0.196***	0.518***	0.053	1				
ROE	0.445***	0.145***	0.138***	0.155***	-0.129***	-0.111***	0.255***	-0.111***	1			
DUM_IB	0.122***	0.370***	0.358***	0.365***	-0.121***	0.310***	0.160***	0.314***	0.062	1		
LGDPPC	0.458***	0.889***	0.876***	0.774***	-0.131***	0.133***	0.570***	0.459***	0.099**	0.447***	1	
INF	-0.011	-0.032	-0.016	-0.122***	-0.165***	0.022	-0.022	-0.038	0.181***	-0.106***	-0.113***	1

*Note: *** p<0.01, ** p<0.05, * p<0.1*

Appendix Table A7: Multicollinearity VIF

Model		Model (1)		Model (2)		Model (3)
Variable	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
FTI	5.31	0.188301				
FDS			4.72	0.211799		
FSS					2.9	0.344521
NPL	1.25	0.798719	1.26	0.794449	1.3	0.771543
CAR	1.71	0.585339	1.71	0.584101	1.69	0.591254
LSIZE	2.14	0.467601	2.11	0.472956	2.06	0.484429
LTD	1.89	0.527971	1.89	0.528952	1.9	0.526371
ROE	1.16	0.862987	1.16	0.865712	1.17	0.854756
DUM_IB	1.38	0.726545	1.38	0.725479	1.37	0.728666
LGDPPC	5.67	0.176232	5.31	0.188381	3.52	0.284094
INF	1.14	0.875723	1.15	0.865917	1.15	0.866448