

The Impact of Fintech on Credit Risk Management: An Applied Study on the Egyptian Banking Sector¹

Dr. Remond Elsaid Mohamed Libda

Business Administration Department, Faculty of Commerce,
Tanta University, Tanta, Egypt

remond.libda@commerce.tanta.edu.eg

ABSTRACT

This research aims to analyze the impact of financial technology (fintech) on the credit risk management of banks operating in Egypt. This applied study was conducted on a sample of 16 banks during the period from 2018 to 2023. The study depended on secondary data published in the financial statements and reports of banks, and World Bank databases, and also relied on the data method that combines time series data with cross-sectional series data (Data Panel) to conduct the study, and the data were analyzed statistically by relying on statistical software packages STATA 14. The study results showed a significant positive impact of fintech measured by credit risk balances on credit risk management. The two fintech measurements have a significant positive effect on the capital adequacy ratio CAR and liquidity ratio LR. In addition, there is a significant negative relationship between the two fintech measures and cost-income ratio CIR and loans to deposits ratio LDR. While non-performing loans ratio NPL has been paradoxically affected. An increase in credit card balances has led to a decreasing NPL ratio. Whereas, an increase in technology assets value has led to an increasing NPL ratio.

Keywords: *Credit Risk Management, Financial technology (Fintech), Egypt, banking sector, CAR, NPL, CIR, LR, LDR, Credit card balances and Technological assets.*

¹ Received in 13/8/2024, accepted in 3/9/2024.

I. INTRODUCTION

There are significant and rapid developments related to the emerging Coronavirus (Covid) that increasing the importance of financial technology in recent years. To control the spread of the coronavirus and mitigate its effects, the world seeks to take preventive and precautionary procedures such as quarantine applications to avoid closeness between people. All countries were affected by these procedures, especially in the business environment. Financial technology helped avoid direct contact between humans and remote dealing has aided many countries in implementing various preventive and precautionary measures necessary to limit the spread of the virus, thereby the importance of financial technology was increased.

The financial sector, particularly the banks, is subject to extensive regulation. Disorders in the supply of financial services may lead to financial crises, as witnessed by the long history of financial crises, as the global financial crisis of the past decade. The integration of fintech into financial services marked a significant transformation and reshaped all financial operations (Agarwal & Zhang, 2020). Key innovations like Artificial Intelligence (AI), blockchain, big data analytics, and Machine Learning (ML) have made the financial system more efficient, transparent, and customer-centered, overcoming the inefficiencies and high costs of traditional banking (Li et al., 2022). However in many circumstances, financial innovation triggers widespread instability, the balance between the costs and benefits of competition in the industry is still an open issue in academic research (Thakor, 2011).

The ability of banks to have tools for risk management and liquidity closely aligns with their capacity to introduce payment services. There are obvious and strong economies of scale in payment services that achieve liquidity. At the same time, customers who need liquidity, are much better off if they can make payments directly from their deposit account (yudaruddin et al., 2024). The introduction of checks and the subsequent development of Automated Teller Machines (ATMs) and Point of Sale (POS) stemmed from this rationale.

Transferring value across accounts allows for many payments without the need for recurring cash. Even many services that appear to be extremely innovative are actually technological devices that make it easier to transfer among bank accounts (Navaretti, 2017). While financial technology in the banking sector offers numerous benefits, it also carries numerous risks. The nature of the technology used in electronic banking services in banks can lead to an escalation of the sector's risks or the introduction of new risks.

Cheng and Qu (2020) argue that bank FinTech affects credit risk by two different ways that give averse effects: On the one hand, bank FinTech may reduce credit risk for three reasons. Firstly, the implementation of emerging technologies by banks enhances their risk management efficiency, thereby lowering their credit risk. Second, bank FinTech improves banks' internal governance and control, therefore reducing bank credit risk. Finally, bank FinTech could increase bank diversification, which contributes to reducing bank credit risk. On the other hand, Bank FinTech has many technical and regulatory risks, which may increase bank credit risk. But these negative effects are relatively weak, especially among large banks.

Although some papers have studied the development of FinTech, these studies explore this issue mostly from a macro-level perspective (Hou et al., 2016; Qiu et al., 2018). This paper explores the effects of bank FinTech on credit risk management. Although some papers examine the effects of FinTech on the banking industry (Cheng & Qu, 2020; Wang et al., 2023; Yudaruddin et al., 2024; Zhang et al., 2023), these studies focus mainly on the influence of FinTech on non-performing loans and not on credit risk management as a whole.

Since the banking sector in Egypt has rapid financial technology developments, it is necessary to focus on the impact of these new technological models on the credit risk management of Egyptian banks. In light of the controversy that characterizes the theoretical framework and previous studies on the extent on the impact of financial technology on the management of credit risks of the bank in some variables, the research revolves around answering in the following question:

How does fintech affect credit risk management in the Egyptian banking sector?

2. RESEARCH PROBLEM

There is no doubt that the world is recently experiencing a huge technological revolution, which has affected everything, including financial institutions in general and the banking sector in particular, and it should be noted that technological innovation in the banking sector, it has become a global trend for economies in all developed and developing countries of the world alike.

Indeed, the financial sector has recently witnessed the emergence of many areas that are concerned with financial services in different ways from the traditional methods known, and financial technology in its multiple fields is the latest stage of development for the financial services sector, as it works to mix the latest technologies in the financial sector, resulting in the provision of financial services with a new technological face characterized by flexibility, speed, accuracy, and low cost. Among these modern technological developments is the multiplicity of electronic payment methods, which provide speed in completion, and enable to attract new customers, thus contributing to strengthening the competitive positions of banks and improving their financial performance.

Despite the benefits of using financial technology in the banking sector, at the same time it is associated with many risks, both in terms of increasing the usual risks in this sector and in terms of the emergence of new types of risks that are related to the nature of the technology used in providing electronic banking services in banks in light of their endeavor to keep pace with modern technological developments.

In general, the results of some research conducted in this field in many countries have found that financial technology has a positive impact on improving credit risk management. However, there is a relative scarcity of research, within the limits of the researcher's knowledge, that dealt with the relationship between fintech and credit risk management in Arab countries, especially the Egyptian banking sector. Since the banking sector in Egypt is one of the most important economic sectors, it is necessary to highlight the rapid developments in the field of financial technology, and to show the impact of these new technological

models on the credit risk management of banks operating in Egypt. Based on the above, the research problem can be formulated in the following question:

How does fintech affect credit risk management in the Egyptian banking sector?

3. RESEARCH OBJECTIVES

The essential objective of this research is to identify the impact of Fintech on banks' credit risk management in Egypt. The researcher believes that although there are clear benefits of financial technology, it is not possible to proceed and continue in financial technology innovations at the expense of customer protection, as well as at the expense of the safety of banks, so banking operations must be controlled, as Regulatory bodies must develop control mechanisms to keep pace with the great development in electronic banking operations, and the resulting Dangers.

4. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

This section was divided into two parts. The first part is the conceptual framework of the study which includes the concept of Fintech, Fintech innovations, and Credit risk management. The second part is the association between financial technology (Fintech) and Credit Risk Management.

4.1 THE CONCEPTUAL FRAMEWORK OF THE STUDY

The financial sector has changed significantly since the advent of financial technology, which provides advanced financial services characterized by speed, accuracy, and low cost (Schindler, 2017). As a result, fintech has become more important. This section included three parts, The Concept of Fintech, Financial Technology Innovations, and Credit Risk Management

4.1.1 THE CONCEPT OF FINTECH

FinTech refers to the combination of finance and technology to improve operations in the financial sector. The global financial markets have witnessed a significant increase in the prominence of FinTech over the past decade, and FinTech enterprises have experienced significant growth. The exponential growth of FinTech is garnering significant scholarly interest. Several studies have

embraced the growth of FinTech, asserting that emerging technologies can significantly revolutionize financial services by reducing transaction costs, enhancing convenience, and improving security. (Begenau et al., 2018; Chen et al., 2019; Chiu and Koepl, 2019; Fuster et al., 2019; Zhu, 2019).

Fintech is a term combining the main processes characterizing the financial services industry such as payment, loans, and money transfers with Internet-related technologies such as mobile, blockchain, and cloud computing (Gomber et al., 2017). Regulatory and professional groups have a more restrictive definition of FinTech as technologically enabled financial innovation that could lead to new business models, applications, processes, or products with a material effect on financial markets and institutions and the provision of financial services (Agarwal & Zhang, 2020).

Lazhari (2021) defines financial technology as a term that refers to the extent to which companies are able to deliver modern and innovative financial services and technologies to customers at scale, where these services are convenient and affordable. Akl et al. (2023) defined fintech as technology that enhance the quality of financial products and services, typically developed by financial technology startups in partnership with financial services and product providers.

No consensus on a comprehensive definition of fintech. Some sources (Al-Enezi, 2019; Cooten & Blythin, 2017) define fintech as innovative financial services or products offered through this technology. Other sources (Al Ajlouni & Al-Hakim, 2018; Saksonova & Kuzmina, 2017) define fintech as companies rather than a phenomenon. The researcher concurs with the definition in the fintech report by Wamda Lab and PAYFORT (2016), characterizing fintech as technology-driven products and services aimed at enhancing the financial products and services quality, typically developed by fintech startups in partnership or competition with established financial service providers and products.

Nowadays, the field of financial technology has a notable surge. The presence of over 100 companies operating in this field across over 12 Arab countries. Notably, Egypt, Lebanon, the Emirates, Jordan, and Bahrain are among the most prominent countries in this field (Zaaf, 2019).

This expansion of fintech has led to increased investment in technological assets such as advanced analytics, AI-driven models, and machine learning algorithms. These assets enable banks to analyze large datasets, including non-traditional data sources, to predict creditworthiness by identifying potential risks more accurately and effectively.

FinTech's rapid development has also impacted the banking sector from two aspects: fintech outside of the banking industry, and fintech within banks. Outside FinTech refers to FinTech companies that operate outside the banking sector. External FinTech primarily affects banks due to, among other things, competitive effects. Some studies (Guo & Shen, 2019; Qiu et al., 2018) examine the outside FinTech effects on the banking sector.

4.1.2 FINANCIAL TECHNOLOGY INNOVATIONS

Many financial-technological innovations have made the banking system more accessible; therefore, the researcher will list the top six innovations with their main features (Akl, 2023; Maher, 2020):

- The Fintech application is a digital surge in the banking and finance sector. A Swiss Bank Commercial launched the Fintech application as the first in the world to offer the possibility of obtaining loans through mobile phones, as well as the ability to clear the necessary documents for credit without physically visiting the bank by activating an electronic signature. The application also offers the option to deposit checks digitally or transfer funds.
- ICICI Bank in India launched the Social Pay service, the first of its kind in the global banking industry, to enhance customer convenience by enabling individuals working outside India to send money to their families in India via social media.
- MONZO is the first virtual bank in the world to operate at full capacity without a traditional banking infrastructure.
- In 2017, Chase JPMorgan bank, that operating in the USA, converted all of its approximately 16,000 cardless ATMs through fintech developments. It allows customers to use the bank's application, website, and multiple digital wallets.

- In 2018, The Development Bank (CCB) in China, was able to open the world's first branch entirely through robots, starting from the security officer to the branch manager.
- Germany designed the first ATM that enabled customers to withdraw gold bars in 2009 by using money or a credit card to purchase different size pieces of gold with the logo (Lafayette Galleries), or by exchanging money with unoccupied gold pieces and coins to keep them and save.

4.1.3 CREDIT RISK MANAGEMENT

This section outlined the key components of credit risk management, including its concept, and its theory.

- The Concept of Credit Risk

Credit risk is the possibility that a borrower will fail to fulfill his or her obligation to pay a debt in full or in part, regardless of the reason (Salas & Saurina, 2002). Awda (2022) contends that credit risk is an inherent risk that every financial organization must confront as a result of its operational characteristics. Mohamed and Elgammal (2023) argue that it is important to refrain from using stereotypes in credit risk screening policies. The regulations should be enhanced to encompass all categories of borrowers and assess their ability to repay by employing cutting-edge technologies. According to Hoque and Liu (2023), banks should incorporate the guidelines of the Basel Committee of Banking Supervision when designing their risk management systems.

The Basel Committee has issued multiple risk frameworks known as the Capital Accords, which include BASEL I (Basel Committee on Banking Supervision 1998), BASEL II (Basel Committee on Banking Supervision 2004), BASEL II (Basel Committee on Banking Supervision 2006), and BASEL III (Basel Committee on Banking Supervision 2010), each with distinct commencement dates. These frameworks were developed by analyzing the credit life cycles of financial organizations in various nations. The primary objective of the Capital Accords is to ensure the resilience, security, and soundness of banks in order to effectively manage unforeseen financial losses. These risks encompass capital risk, market risk (the risk of incurring losses on trading positions due to negative price

fluctuations), and operational risk (the risk of experiencing direct or indirect losses as a result of inadequate or failed internal processes, personnel, and systems; or from external events such as losses stemming from computer failures, inadequate documentation, or fraudulent activities). Nevertheless, at the core of all the aforementioned dangers lies credit risk (Ahmadu et al., 2019).

- **Credit Risk Theory**

The Merton (1977) default model established a theory of credit risk that establishes a connection between a company's credit risk and its capital structure, specifically its equity and debt obligations. Undoubtedly, the failure of borrowers to fulfill their obligations to their banks will have an impact on their capital structure. Central banks must ensure that banks have sufficient protocols and measures in place to protect them against non-performing loans. This is done by periodically issuing recommendations to banks and enforcing sanctions when these guidelines are violated. Central banks implement these measures to avert disorder in the financial system and guarantee adherence to the terms and conditions of financial agreements between banks and their clients (Coyle, 2000).

However, banks are prepared to impose higher interest rates on loans that have a greater likelihood of not being repaid (Owojori et al., 2011). In 2023, Almustafa et al. anticipate that banks' management teams will actively pursue and implement suitable strategies to handle their credit risk exposures. They will do so while complying with the prudential standards and corporate governance code set by their individual central banks.

Baldwin and Scott (1983) also established the theory of financial distress. As per this theory, financial distress is imminent when banks exhibit indicators of their inability to fulfill their financial obligations by the specified deadlines. Banks must safeguard their financial health from vulnerable circumstances, including systemic disruptions resulting from the COVID-19 pandemic and inadequate risk and financial performance monitoring (Berger & Pukthuanthong, 2012, 2016; Proag 2014; Wruck 1990).

One could argue that the most significant obstacle faced by a bank is not so much credit default as the waning repercussions of credit defaults. For example, the bank's inability to honor depositors' withdrawals due to inadequate liquidity may result in a bank run, which occurs when depositors withdraw unusual amounts of cash out of fear that the bank is on the brink of bankruptcy or insolvency. A bank's liquidity, cash reserve ratio, and capital adequacy ratio could be compromised, potentially leading to its bankruptcy, if this were to occur. The collapse of the Silicon Valley Bank (SVB) leads to the continuing concern of banks and increasing significance of this theory to the financial performance, credit risk management.

4.2 THE ASSOCIATION BETWEEN FINTECH AND CREDIT RISK MANAGEMENT

The concept of fintech was initially introduced by Bettinger et al. (1972), and since then, numerous studies have grown in this area. Most of these studies focused on the impact of fintech on financial performance, not on credit risk management in the banking sector. Recently, some studies analyzed the effect of fintech on credit risk management. However, some of them used qualitative analysis (Wang et al., 2023; Nobanee et al., 2024)

There have been numerous empirical investigations that investigated the influence of fintech on credit risk. Fintech has revolutionized credit risk assessment and management, as there is a general agreement. The majority of these studies have verified that fintech reduces credit risk (Cheng & Qu, 2020; Li et al., 2022; Nie et al., 2023; Zhang et al., 2022; Zhang et al., 2023). However, Wu et al. (2023) and Yudaruddin et al. (2024) do not agree with these studies.

Using data from 60 commercial banks from 2008 to 2017, Cheng and Qu (2020) investigated the influence of fintech on credit risk. They offer empirical evidence and verify that the implementation of fintech in institutions can effectively mitigate credit risk. This reduction is primarily facilitated by the implementation of advanced technologies, such as big data analytics and ML, which facilitate more precise risk assessment and management. They discover that fintech improves operational efficiencies within financial institutions, thereby reducing the probability of credit defaults (NPLs), by adhering to the general concept of

text mining. Li et al. (2022) also investigated the influence of fintech innovation on risk-taking behaviors by analyzing panel data from 65 commercial institutions from 2008 to 2020. Their research indicates that the risk management capabilities of banks are considerably improved by advancements in fintech, resulting in a decrease in risk-taking. This relationship is particularly pronounced in larger, state-owned, and highly competitive banks, and is mediated through improvements in capital adequacy ratios and operating income.

In the same vein, Zhang et al. (2022) investigated the impact of fintech on the risk of loans in Chinese commercial banks. They examined the impact of managerial ownership and employed a sample of 28 listed commercial banks from the first quarter of 2014 to the fourth quarter of 2018. Their research indicates that the implementation of fintech has a significant effect on the reduction of the risk associated with loans. This is achieved by improving the efficiency of information processing and decision-making, especially in institutions where the managers have a higher level of ownership.

In 2023, Zhang et al. conducted an analysis of the impact of commercial banks' fintech innovation on bank credit risk using a web crawler. They utilized data from 138 Chinese commercial banks from 2013 to 2021. Research findings indicate that the implementation of fintech has a substantial impact on reducing the NPL ratio in commercial banks. Specifically, the utilization of fintech in the digital risk management of banks plays a crucial role in mitigating credit risk. Moreover, the adoption of fintech in small and medium-sized banks has a more pronounced effect in curbing credit risk.

Nevertheless, Wu et al. (2023) demonstrate that fintech innovations serve a dual function by analyzing the influence of bank fintech on the risk-taking behaviors of 148 Chinese commercial banks from 2007 to 2019 and employing a fintech index derived from text mining. Particularly, they elevate liquidity and credit risks while diminishing insolvency risk.

Wang et al. (2023) conducted a micro-survey of 432 commercial banks in Beijing from 2005 to 2022. An econometric model has been developed to evaluate the risk reduction effect of fintech on NPL. The study outcomes found that the implementation of fintech inputs can significantly reduce the risk of non-

performing loans at the outset. For each 1% increase in IT personnel inputs, software inputs, and hardware inputs, the NPL ratio will decrease by 0.091%, 0.055%, and 0.024%, respectively. In other words, the inputs of IT personnel are the most significant factor in the reduction of non-performing loan risk, followed by software inputs. Fintech has a latency effect that tries to improve over time and reduces the risk of non-performing loans in banks.

In Indonesia, Hidayat and Kartawinata (2023) analyzed the impact of fintech on banking financial ratio such as LDR, CAR, and return on assets (ROA). This study was conducted on 38 banks listed on the Indonesia stock exchange between 2013 and 2017. The findings discovered how these financial ratios were affected before and after the emergence of fintech companies. There is a significant effect of fintech companies on profitability (ROA), LDR, and CAR.

The study conducted by Yudaruddin et al. (2024) studied the correlation among liquidity, Fintech advancement, and credit risk in the Indonesian banking sector. The analysis is performed using panel data obtained from 142 commercial banks spanning from 2004 to 2018. The findings indicate that increased liquidity is associated with a decrease in credit risk, whereas the fintech development is shown to elevate credit risk. Additionally, it is seen that the impact of liquidity on credit risk depends on the extent of FinTech development. Moreover, the results indicate that the influence of FinTech on credit risk depends on the specific attributes of the bank and the prevailing economic conditions. These findings have important implications for creating a comprehensive financial system in the digital age, particularly in addressing the risks related to the advancement of financial technology (FinTech).

Chai and Sun (2024) investigated the extent to which the advancement of financial technology can reduce the risk of non-performing loans (NPLs). This study utilized a two-fixed model and analyzed the performance of publicly traded commercial banks from 2011 to 2022. This study's findings suggest that the development of fintech can help mitigate the risk of non-performing loans (NPLs) by reducing costs before lending and after loan disbursement, as well as by promoting revenue growth. This work makes a valuable contribution to both

theoretical understanding and practical application in promoting the expansion of commercial banks while maintaining the stability of the financial system.

Therefore, Nobanee et al. (2024) used a bibliometric analysis approach to explore the influence of fintech on credit risk in the banking and financial sector. This study provides a thorough examination of the current literature in order to comprehend the changing landscape of fintech and credit risk. A bibliometric evaluation of 341 studies on fintech and credit risk has demonstrated that fintech has a positive impact on credit risk management. Financial institutions have adapted to the use of modern technology in a manner that is correlated with data availability, computing capacity, and big data, as evidenced by numerous bibliometric analyses. Given the numerous benefits of utilizing fintech to mitigate credit risk.

Previous studies used a variety of measures, but this paper focuses on just five measures of the credit risk management, CAR, NPL, CIR, LR and LDR. Capital adequacy ratio CAR refers to the total equity and risk-weighted assets (RWAs). This reserve safeguards depositors against unforeseen losses (Rajkumar & Hanitha, 2015). According to BASEL II requirements, banks should have a CAR of at least 10%. In addition, the NPL ratio measures asset quality as it is a significant indicator of deposit-money bank credit risk (Rajkumar & Hanitha, 2015). When the principal and/or interest remain outstanding for more than 90 days, the Central Bank of Egypt's prudential guidelines define a loan as non-performing. Additionally, other qualitative measures indicate that the creditor may be unable to service the loan.

Nowadays, the banking sector has seen a rise in the popularity of bank fintech applications. Nevertheless, the current research has not given sufficient consideration to the influence of bank fintech on credit risk management. Consequently, this paper concentrates on this matter.

In conclusion, the influences of financial technology (fintech) on credit risk management in the banking sector is complex and multifaceted. Most of the illustrated studies assert a positive impact between fintech services and credit risk management. Fintech in banks leads to decreasing credit risk measuring by NPL. This viewpoint supports the literature's general consensus by highlighting the

contribution of fintech innovations—like artificial intelligence (AI), blockchain, and big data analytics—to the advancement of credit risk management. While Wu et al. (2023) and Yударuddin et al. (2024) have a contrasting perspective. They found that using Fintech in banks led to increasing credit risk measuring by NPL.

But according to the other measures of credit risk management, there is a consensus on the impact of fintech on them. Fintech affects positively on CAR (Hidayat & Kartawinata, 2023; Li et al., 2022) and LR (Hidayat & Kartawinata, 2023; Wu et al., 2023; Yударuddin et al., 2024) while fintech affects negatively on CIR (Li et al., 2022) and LDR (Hidayat & Kartawinata, 2023).

So, in light of the above literature and previous studies, the current study seeks to examine the effect of fintech on credit risk management in the Egyptian banking sector for the period of 2018-2023. The study will explore how the credit risk management of banks is affected by fintech using an appropriate statistical mode. This study measures the relationship between the five credit risk measures used by the previous empirical studies mentioned in the current study and fintech measured by credit card balances and the value of technological assets. Accordingly, the researcher developed the following hypotheses which can be formulated as follows.

The main hypothesis (H_1): There is significant impact of fintech measures on credit risk management in the Egyptian banking sector.

To accomplish the goal of the main hypothesis, the next sub-hypotheses were formulated:

$H_{1.1}$: *Fintech measures have positive significant effect on capital adequacy ratio (CAR).*

$H_{1.2}$: *Fintech measures have negative significant effect on non-performing loans ratio (NPLR).*

$H_{1.3}$: *Fintech measures have negative significant effect on cost-to-income ratio (CIR).*

$H_{1.4}$: *Fintech measures have positive significant effect on liquidity ratio (LR).*

H_{1.5}: *Fintech measures have negative significant effect on loans-to-deposit ratio (LDR).*

In light of this inconsistency and the different results of previous studies to determine the extent of the impact of financial technology on the management of credit risks for banks, the researcher will conduct an applied study based on secondary data extracted from the financial statements and reports of banks, in light of the different sample of the study and the period of application of the study and some measures of the independent variable.

In addition, in light of the review of previous studies, it became clear to the researcher that there is a relative scarcity of research, within the limits of the researcher's knowledge, that dealt with the relationship between fintech and credit risk management in the Arab countries, especially the Egyptian banking sector.

5. FINANCIAL TECHNOLOGY IN EGYPT

Fintech developments have become a crucial part of putting a modern framework for financial regulation, therefore banks have to Review and modify existing regulatory frameworks, standards, and tools to adapt to it (Xiang et al., 2017). So, the Egyptian Central Bank plays a big role in Supporting and regulating Fintech. This section will illustrate electronic banking services in Egypt and how the central bank supported and regulated it.

5.1 ELECTRONIC BANKING SERVICES IN EGYPT

The Basel Committee defines electronic banking services as "a category of banking services provided by banks that serving their individuals or institutions, through electronic means, such as landline or mobile phone networks or the Internet, and the most widespread today, Automated Teller Machines (ATMs), direct payment services, electronic check, and Internet bank services. these products and services include deposit withdrawal, lending, account management, financial advice, electronic bill payment, and the provision of electronic payment products and services such as electronic money" (Abdelhamid & Abdelaziz, 2013; Mueni & Atheru, 2019; Usman & Shah, 2013).

According to various sources (Abaza, 2010; Awad, 2004; Joseph et al., 2005; Shandi, 2010; Zinakova, 2020), banks offer a wide range of electronic banking services. Egyptian Banks have recently provided many electronic banking services, such as electronic payment cards, ATMs, POS, and home banking. Electronic payment cards are a widely accepted banking tool for meeting obligations in transactions, both locally and internationally. As a result of Egyptian banks' efforts to enter this market, approximately 38 banks operating in Egypt have issued electronic payment cards. The two most important types of cards issued in Egypt are debit cards, which have reached about 19,036,299 cards until 2020, and credit cards, which have reached about 3,862,086 cards in the same year. These are the most commonly issued card types in Egypt (the Egyptian Central Bank Monthly Bulletin, 2021).

In the 1980s, Egyptian banks initiated the provision of ATM services, initially restricting card usage to individual branch machines. However, in 1998, the ability to use cards across a single bank's network emerged, leading to further development. Agreements allowed some banks to use their cards in other bank machines, and by the end of 2020, 38 banks operating in Egypt had installed and deployed approximately 14,918 ATMs both inside and outside their branches. Additionally, the number of POS devices reached approximately 149,511 in 2020, surpassing the 342,256 private devices owned by startups in the financial technology sector (Central Bank of Egypt Monthly Bulletin, 2021). ATMs and POS provide the necessary services for both local and international card users, and some banks also accept cash deposits from cardholders.

Customers can now do many services such as inquire about customer balances, and transfers between one customer's accounts. All these services can be available not only at ATMs and POS but also on some banks' websites and home bank services, which rely on the latest technological systems (Zinakova, 2020). In addition, in 2023, Egypt activated the first ATM selling gold bullion to support the Egyptian government's policies on digital transformation and financial inclusion. In parallel with the expansion of electronic payment card issuance, Egyptian banks rely on a variety of electronic distribution channels to establish a suitable market for card acceptance within Egypt until the system achieves

success. He also believes that Egyptian banks are rapidly developing their electronic services to keep up with the ongoing global developments in the banking sector (Akl et al., 2023).

5.2 THE EGYPTIAN CENTRAL BANK'S ROLE IN SUPPORTING FINTECH

Many important guidelines and steps towards financial technology have been taken by The Egyptian Central Bank of Egypt, particularly from 2018 onwards, to keep pace with global developments in financial technology (Annual Report of the Central Bank of Egypt, 2020; Central Bank of Egypt Economic Journal, 2018; Economic Review of the Central Bank of Egypt, 2021).

The Egyptian Central Bank has devised an integrated strategy that aligns with the latest international standards and the unique features of the Egyptian market, with the goal of advancing the fintech industry and services in Egypt. This strategy aligns with Egypt's Vision 2030 and the Central Bank's vision to adapt to the Egyptian market. The Central Bank of Egypt seeks to establish a financial technology center in collaboration with the private sector to enhance the financial technology ecosystem in the Egyptian market. This center aims to unite all stakeholders in the financial technology ecosystem, in addition, the FinTech platform for the financial technology ecosystem in Egypt aims to facilitate the process of connecting the parties in the technology system.

The Central Bank of Egypt (CBE) has launched an initiative to deploy a large number of new ATMs in all governorates as part of the CBE's interest in strengthening payment systems infrastructure and providing electronic financial services to all citizens across the country. This initiative aims to deploy around 6,500 new ATMs in addition to the 14,900 ATMs already available. The bank's employees are also improving their performance, effectiveness, and productivity. The Digital Empowerment Project provides central bank employees with access to the newest global technologies and applications.

The Central Bank of Egypt has drafted a new law for the banking system, which includes a special section on payment systems, services, and financial technology. This move aims to enhance the financial system efficiency and keep pace with this technology in the global payments field. In addition, the Regulatory Lab for

Fintech Applications offers a regulatory testing environment that strikes a balance between introducing more innovations in the financial technology field and mitigating the associated risks, thereby ensuring customer protection. This information is based on the Egyptian Central Bank who announced it in annual report from 2020.

In general, fintech has many existing regulations and laws, but there are a few laws specific to banks. Only a few of these suggest measures for banks to develop Fintech. Such as, the "FinTech Development Plan (2019-2021)" and the "Guiding Opinion on Promoting the Healthy Development of Internet Finance" encourage banks to develop Fintech. the Scarcity of Fintech regulation leads to regulatory inefficiencies and poses many risks. Thereby, improving the related legislation is a top priority for FinTech regulators and bank policymakers (Cheng & Qu, 2020).

6. RESEARCH METHODOLOGY

This section consists of 6 parts that included Research Sample, Variables and their Measurements, Research Hypotheses, Hypotheses Testing, Research Results, and Conclusion.

6.1 RESEARCH SAMPLE

The research community consists of banks that operating in Egypt, where the number of banks registered with the Egyptian Central Bank reached 37 banks. Faisal Bank was excluded because of the unavailability of the research variables. Faisal Bank doesn't issue credit cards. It also excluded banks whose financial statements are prepared in a currency other than the Egyptian currency. The research sample was represented by (15) banks, five of them are the biggest governmental banks that published their financial statement regularly. Their market share is 59% of the total assets of the banking sector with a value of EGP 8.15 trillion by the end of June 2023. The other ten banks that are listed on the Egyptian stock exchange from 2018 until 2023 and their market share is 15% of the total assets of the banking sector with a value of EGP 2.1 trillion by the end of June 2023. This is in light of the availability of bank data that the researcher was able to reach about the independent, dependent, and control research variables

during this period. The research sample was represented 74% of the total assets of the banking sector and the number of observations of the study sample reached 90 observations.

Table 1: study sample

Bank name	Credit Card Balances (million)			Technological Assets (million)		
	2018	2023	%	2018	2023	%
National Bank	4,477.2	15,718.0	2.51	47.5	119.5	1.52
Misr Bank	435.7	5,205.0	10.95	299.2	605.0	1.02
Al-Qahra Bank	198.8	1,756.0	7.83	31.1	182.0	4.85
Housing and Development Bank	19.1	127.5	5.68	120.8	149.6	0.24
Export Development Bank	7.3	169.7	22.25	3.8	141.3	36.18
Abu Dhabi Islamic Bank	2,353.0	848.1	-0.64	0.1	25.6	255
Credit Agricole Bank	664.0	954.7	0.44	94.7	176.2	0.86
Al Baraka Bank	18.8	60.0	2.19	49.0	0.6	-0.99
CIB Bank	3,509.2	10,297.6	1.93	130.2	18,929.1	144.38
EG Bank	48.8	178.3	2.65	36.6	13.8	-0.62
QNB ALAHLI	770.7	1,894.9	1.46	162.0	477.5	1.95
Suez Canal Bank	17.7	48.0	1.71	16.3	112.9	5.93
ai BANK	19.1	52.6	1.75	14.4	52.2	2.63
Al Ahli Bank of Kuwait	164.4	490.9	1.99	7.4	5.7	-0.23
ABC Bank	80.2	298.3	2.72	9.1	39.1	3.30

Source: Prepared by the researcher

According to the above data in table 1, there a growth rate of using credit cards in Egypt and increasing investment in technological assets in the most of banks. Export Development Bank has the biggest growth rate in Credit Card Balances (22.25%) then Misr Bank (10.95%), while CIB Bank has the biggest growth rate in investing in technological assets (144.38%), then Export Development Bank (36.18%). So fintech use on the rise in Egypt initially and this research explains its effect on the credit risk management. Descriptive analysis was conducted in table 3 for all variables.

6.2 VARIABLES AND THEIR MEASUREMENTS

The study variables can be presented, which aim to measure the impact of fintech on credit risk management, of the banking sector. Table No. (2) shows the independent, dependent and control variables of the study. The variables

related to the control variables, whose impact on credit risk will be tested, are not included in the scope of the study, but were added to control the relationship between the independent and dependent variables.

6.2.1 INDEPENDENT VARIABLES

This study depends on two independent variables, credit card balances and the value of technological assets.

- Credit Card Balances (CCB)

Many previous studies relevant to the subject of the study have relied on credit cards as an indicator of fintech in these some that are worth pointing out, (Akal et al., 2023; Malik et al., 2019; Mueni & Atheru, 2019; Nasri et al., 2023; Zu et al., 2019;), a study including banks studies based on credit card balances (Akl et al., 2023; Malik et al., 2019) while others relied on the number of credit cards (Mueni & Atheru, 2019; Nasri et al., 2023; Zu et al., 2019) The researcher relies in this study on credit card balances in banks, and this indicator is calculated by dividing the value of the bank's credit cards by the total customer loans and facilities of the bank. From the researcher's point of view, credit card balances are more suitable for analysis the effect of increasing its balances, which considered as a loan, on the credit risk management. Whereas credit card numbers are more suitable to measure financial inclusion as many studies have used.

- The value of the technological assets (TA)

This indicator measures the percentage of the bank's technological assets from the bank's total assets, and the technological assets are represented in the sum of (automated systems, devices and equipment, computer programs), and this indicator is calculated by dividing the value of the bank's technological assets by the bank's total assets, and this indicator has been used in some studies, including a study (Akl et al., 2023; Wadi & Metwally, 2021).

6.2.2 DEPENDENT VARIABLES

The study relied on the credit risk management of banks as a dependent variable, which was measured by the five credit risk measures (Al Zaidanin & Al Zaidanin, 2021) used by the previous empirical studies mentioned in the current study.

- **Capital adequacy ratio (CAR)**

Capital adequacy (CAR) ratio is a measure of whether a bank requires external funding. A higher ratio indicates a lower need for external financing, resulting in reduced costs and risks associated with external financing and insolvency (Staikouras CH & Wood, 2003). The Egyptian central bank regulation requires a minimum CAR of 10 percent according to Basel II criteria. (Basel Committee on Banking Supervision, 2006; Central Bank of Egypt, 2020),

- **Non-performing loans ratio (NPLR)**

This ratio is a significant indicator of asset quality and the soundness of the loan portfolio, as well as the effectiveness of the bank's credit risk management. Nevertheless, a significant ratio of non-performing loans serves as a cautionary signal to both bank management and supervisors, suggesting that banks possess subpar asset quality and are exposed to elevated risk (Boahene et al., 2012).

Furthermore, a non-performing loan refers to a loan when the customer's payments are delayed or overdue (Kauko, 2012). Furthermore, according to the International Monetary Fund (IMF), a loan is classified as a non-performing loan when the borrower fails to make interest and principal payments for a period exceeding 90 days. It can also be categorized as non-performing if the interest payments for more than 90 days have been postponed, refinanced, or capitalized by mutual agreement. Additionally, if the payments are less than 90 days overdue but are no longer expected, the loan is considered non-performing (Akomeah et al., 2020).

- **Cost-to-income ratio (CIR)**

This ratio measures the bank management's efficiency in handling the risk factors associated with its primary business operations (Altunbas et al., 2001). The increase in this ratio means a decrease in banking efficiency (Burger & Moormann, 2008).

- **Liquidity ratio (LR)**

This ratio serves as an indicator of a bank's management effectiveness in handling its liquidity level in relation to its liability. Insufficient liquidity is a primary

factor contributing to bank collapses. Conversely, maintaining a large amount of easily convertible assets indicates poor management of available funds, as a high liquidity ratio results in a high opportunity cost of potential income for the bank (Heffernan & Fu, 2008).

- Loans-to-deposit ratio (LDR)

The LRD ratio measures a bank's capacity to effectively handle its loan portfolios and deposits. Therefore, it is considered a crucial indicator of the effectiveness of credit management in terms of lending policy and control, as well as the segregation of deposits from both institutions and individuals. Additionally, it provides insight into the overall quality of assets. A higher loan-to-deposit ratio leads to an increased level of lending risk, which in turn reduces the quality of loans and raises the rates of non-performing loans. However, a higher ability for the bank to convert deposits into high quality loans results in a higher profit margin from lending interest (Al Zaidanin & Al Zaidanin, 2021).

Table 2: Variable Measuring

Variables	Measure	Reference
Independent variables		
Credit card balances CCB	Credit Card Balances	Akal et al., 2023; Nasri et al., 2023
Technological assets Value TA	(Automated systems + Devices and Equipment + Computer programs)/ Total Assets	Wadi & Metwally, 2021; Akl et al., 2023
Dependent variable		
Capital Adequacy Ratio CAR	Total Capital / Risk-Weighted Assets (RWAs)	Staikouras CH & Wood, 2003
Non-performing Loans ratio NPLs	Non-performing Loans / Total Loans & Advances	Al Zaidanin & Al Zaidanin, 2021; Nobanee et al., 2024
Cost-income ratio CIR	Total Operating Cost / Total Operating Income	Altunbas et al., 2001
Liquidity ratio LR	Liquid Assets / Total Liabilities	Heffernan & Fu, 2008; Hidayat & Kartawinata, 2023
Loans to deposits ratio LDR	Total Loans & Advances / Total Deposits	Al Zaidanin & Al Zaidanin, 2021
Control variables		
Bank Size LASS	Log T.Assets	Nobanee et al., 2024
Inflation INF	Inflation	Nobanee et al., 2024

Source: Prepared by the researcher

6.3 RESEARCH HYPOTHESES

In light of the above literature and previous studies, the hypotheses and study regression models can be formulated as follows.

The main hypothesis (H_1): There is significant impact of fintech measures on credit risk management in the Egyptian banking sector.

To accomplish the goal of the main hypothesis ,the next sub-hypotheses were formulated:

$H_{1.1}$: *Fintech measures have positive significant effect on capital adequacy ratio (CAR).*

$H_{1.2}$: *Fintech measures have negative significant effect on non-performing loans ratio (NPLR).*

$H_{1.3}$: *Fintech measures have negative significant effect on cost-to-income ratio (CIR).*

$H_{1.4}$: *Fintech measures have positive significant effect on liquidity ratio (LR).*

$H_{1.5}$: *Fintech measures have negative significant effect on loans-to-deposit ratio (LDR).*

6.4 HYPOTHESIS TESTING

The study tests hypotheses by the five following regression models. The study proposes 5 models to measure the impact of fintech on credit risk management.

$$CAR_{it} = a + \beta_1 CCB_{it} + \beta_2 TA_{it} + \beta_3 LASS_{it} + \beta_4 INF_{it} + \varepsilon \quad (1)$$

$$Npls_{it} = a - \beta_1 CCB_{it} - \beta_2 TA_{it} + \beta_3 LASS_{it} + \beta_4 INF_{it} + \varepsilon \quad (2)$$

$$CIR_{it} = a - \beta_1 CCB_{it} - \beta_2 TA_{it} + \beta_3 LASS_{it} + \beta_4 INF_{it} + \varepsilon \quad (3)$$

$$LR_{it} = a + \beta_1 CCB_{it} + \beta_2 TA_{it} + \beta_3 LASS_{it} + \beta_4 INF_{it} + \varepsilon \quad (4)$$

$$LDR_{it} = a - \beta_1 CCB_{it} - \beta_2 TA_{it} + \beta_3 LASS_{it} + \beta_4 INF_{it} + \varepsilon \quad (5)$$

Where,

CAR: Capital Adequacy Ratio

CCB: Credit Card Balances

TA: Technological Assets

LASS: Log of Total Assets

INF: Inflation

ε : error

NPLS: Non-Performing Loans

CIR: Cost-income ratio

LR: Liquidity Ratio

LDR: Loans to deposits ratio

Stata version 14 was used to analyze the study data, also used tests such as Residuals Heteroskedasticity Test, Normality of Residuals Test, Multi-Linear Correlation, Multicollinearity, and Autocorrelation test, as well as regression methods. to measure the impact of fintech on credit risk, Through the hypothesis.

6.5 RESEARCH RESULTS

The results of the descriptive analysis shown in Table 3 indicate that the arithmetic mean of the study variables ranges from 0.01 to 13.60, while the standard deviation ranges from 0.01 to 9.86. also, Skewness test range between 0.24 and 0.870, and Kurtosis test range between 0.26 to 0.808. Thus, it indicates that the data of the study variables follow a normal distribution. The significant likewise prob-chi2 test range between 0.007 and 0.525, which are greater than 5%. This means that all variables follow a normal distribution.

Table 3: Descriptive and Normality Statistics

Variable	Descriptive Statistics		Skewness/Kurtosis tests for Normality			
	Mean	Std. Dev.	Pr(Skewness)	Pr(Kurtosis)	adj_chi2(2)	Prob>chi2
LASS	5.15	0.68	0.587	0.657	2.113	0.112
INF	13.60	9.86	0.722	0.808	2.265	0.137
CAR	0.09	0.03	0.870	0.267	1.290	0.525
NPLs	0.10	0.21	0.688	0.771	2.228	0.130
CIR	1.00	0.93	0.462	0.519	1.975	0.139
LR	0.09	0.05	0.256	0.286	1.743	0.077
LDR	0.48	0.36	0.284	0.319	1.776	0.086
CCB	0.01	0.01	0.425	0.477	2.113	0.128
TA	0.02	0.01	0.24	0.26	2.26	0.07

Source: Stata V14 Output.

To analyze the results of the study hypotheses, examine the quality of the chosen models and estimate the regression analysis for the selected model. The table (4) shows the difference between the variance test heteroskedasticity for 5 models ranged between 0.43 to 0.83 with a p-value of (0.204 – 0.591), greater than 0.05. This indicates that the study models does not have a problem with variance and that the model is good and suitable for testing. also, a normal distribution test was conducted for the residuals of the study model using the Doornik-Hansen test. The results indicate that the chi-square value for the models is (2.12– 0.381), with a significant level of prob chi-square (0.087 – 0.324), suggesting that the residuals of the study model follow a normal distribution. The significance value of the test is greater than 0.05. Table 5 shows the Variance Inflation Factor to test multicollinearity between independent variables.

Table 4: heteroskedasticity & normality test

Model / Test	Breusch-Pagan test for heteroskedasticity		normality Test – Doornik-Hansen		Hausman test
	Chi2	prob	Chi2	prob	Prob
Model 1	0.43	0.305	2.90	0.224	0.017
Model 2	0.68	0.410	2.12	0.163	0.003
Model 3	0.75	0.591	3.24	0.087	0.018
Model 4	0.52	0.204	3.01	0.381	0.023
Model 5	0.83	0.521	2.89	0.264	0.004

Source: Stata V14 Output.

The researcher used Variance Inflation Factor to detect the most important problem of multiple regression, known as multicollinearity. The values of the variance inflation factor range between 1 and less than 5, indicating that the regression model does not have a multicollinearity problem. Additionally, the mean variance inflation factor is 1.09, which is less than 5, indicating that the model is suitable for regression analysis.

Table 5: Multicollinearity test

Variable	VIF	1/VIF
LASS	1.18	0.850945
TA	1.16	0.859279
INF	1.02	0.979770
CCB	1.01	0.992353
Mean VIF	1.09	

Source: Stata V14 Output.

Hausman's test prob chi2 value for models ranged between 0.003 to 0.023 which is less than 0.05. So the best model is FEM because the p-value < 0.05. Accordingly, the regression analysis of the study model will be done using the fixed effects model.

Table 6: Result of Estimating FEM regression for model 1, 2, 3

var	Model 1 CAR			Model 2 NPLs			Model 3 CIR		
	B	t-value	p-value	B	t-value	p-value	B	t-value	p-value
CCB	0.02	2.84	0.01	-0.06	-2.92	0.00	-0.05	-2.63	0.01
TA	0.16	4.54	0.00	0.09	3.21	0.00	-0.06	-5.29	0.00
LASS	0.21	5.24	0.00	0.42	5.24	0.00	-0.14	-3.11	0.02
INF	0.05	-2.76	0.00	0.01	2.16	0.04	0.03	2.31	0.03
Constant	-0.51	-2.51	0.01	-1.01	-2.41	0.02	0.51	4.09	0.00
		R²	0.56		R²	0.52		R²	0.51
		F-test	6.19		F-test	4.91		F-test	2.76
		P> F	0.00		P> F	0.00		P> F	0.03

Source: Stata V14 Output.

Results of the first model

The results of the first model indicate that the value of the F-test was 6.19, with a statistical significance value of 0.00 at a significance level of less than 5%, which indicates the validity and stability of the model. and $R^2 = 0.56$, meaning that the independent variables Credit card balances (CCB), Technological assets Value (TA), and control variables the size of Bank, and Inflation explain 56% of the changes in Capital adequacy ratio (CAR), also we can extract the regression equation as follows:

$$CAR_{it} = -0.51 + 0.02 CCB_{it} + 0.16 TA_{it} + 0.21 LASS_{it} + 0.05 INF_{it}$$

It is clear from the previous equation that there is a positive effect for each of Credit card balances (CCB) and Technological assets Value (TA) on Capital adequacy ratio (CAR) by 0.02, 0.16 and this effect is significant at a significance level of less than 0.05 and these results reflect a lower need for external financing, resulting in reduced costs and risks associated with external financing and insolvency.

Credit card balances are considered riskier assets because of their unsecured nature, meaning they lack collateral. As balances increase, the Risk-Weighted Assets RWAs of the bank also rise, assuming no change in the risk weighting. The high CAR ratio of Egyptian banks is because the Egyptian central bank

regulation that requires a minimum CAR of 10 percent according to Basel II, so banks always trying to increase its capital reserves to offset the higher RWAs, it could maintain or even improve its CAR.

While technological assets are often considered intangible assets, they can improve a bank's operations, and achieve indirect benefits, such as improved profitability and reduced RWAs, which can positively impact CAR.

Results of the Second model

Second model Results indicate the F-test = 4.91, with a statistical significance value of 0.00 at a significance level of less than 5%, and $R^2 = 0.52$, meaning that the independent variables Credit card balances (CCB), Technological assets Value (TA), and control variable the size of Bank and Inflation explain 52% of the changes in Non-performing Loans ratio (NPLs), also we can extract the regression equation as follows:

$$NPLS_{it} = -1.01 - 0.06 CCB_{it} + 0.09 TA_{it} + 0.42 LASS_{it} + 0.01 INF_{it}$$

It is clear from the previous equation that there is a negative relationship between Credit card balances (CCB) and Non-performing Loans ratio (NPLs) by -0.06. The researcher believes that credit cards are an easy tool to use, spread, and increased reliance on them leads to an increase in customer loans and facilities, therefore a decrease in NPLs ratio. While there is a positive relationship between Technological assets Value (TA) and Non-performing Loans ratio (NPLs) by 0.09 and this effect is significant at a significance level of less than 0.05. A high number of non-performing loans serves as a warning signal to both bank management and supervisors, indicating that banks possess assets of poor quality and are exposed to significant risk.

Results of the third model

Third model Results indicate the F-test = 2.76, with a statistical significance value of 0.03 at a significance level of less than 5%, and $R^2 = 0.51$, meaning that the independent variables Technological assets Value (TA), Credit card balances (CCB), and control variable the size of Bank and Inflation explain 51% of the changes in Cost income ratio (CIR), also we can extract the regression equation as follows:

$$CIR_{it} = 0.51 - 0.05 CCB_{it} - 0.06 TA_{it} - 0.14 LASS_{it} + 0.03 INF_{it}$$

It is clear from the previous equation that when Credit card balances (CCB) and Technological assets Value (TA) increase, the Cost income ratio (CIR) decreases, by -0.05 and -0.06. this effect is significant at a significance level of less than 0.05, so these results are due to the increase in the use of fintech which leads to decreased total operating cost and, therefore CIR decreased.

Table 7: Result of Estimating FEM regression for model 4,5

var	Model 4 LR			Model 5 LDR		
	B	t-value	p-value	B	t-value	p-value
CCB	0.06	2.26	0.03	-0.11	-5.62	0.00
TA	0.02	4.69	0.00	-0.06	-2.35	0.02
LASS	0.15	3.96	0.00	0.01	3.35	0.03
INF	-0.01	-2.64	0.01	0.02	4.42	0.00
Constant	0.29	2.57	0.02	0.74	5.38	0.00
		R²	0.64		R²	0.59
		F-test	7.32		F-test	5.06
		P> F	0.00		P> F	0.00

Source: Stata V14 Output.

Results of the fourth model

Fourth model Results indicate the F-test = 7.32, with a statistical significance value of 0.00 at a significance level of less than 5%, and R² = 0.64, meaning that the independent variables Credit card balances (CCB), Technological assets Value (TA), and control variable the size of Bank, Inflation explain 64% of the changes Liquidity ratio (LR), also we can extract the regression equation as follows:

$$LR_{it} = 0.29 + 0.06 CCB_{it} + 0.02 TA_{it} + 0.15 LASS_{it} - 0.01 INF_{it}$$

It is clear from the previous equation that there is a positive effect for Credit card balances (CCB) and Technological assets Value (TA) on Liquidity ratio (LR), by 0.06 and 0.02. this effect is significant at a significance level of less than 0.05, so these results reflect the interest income which charges on these credit card

balances. It provides banks with a steady stream of cash inflows. This cash increases the bank's liquid assets, thereby enhancing the liquidity ratio (Saunders & Cornett, 2018).

Technologies improve customer satisfaction by offering faster and more suitable banking services. This leads to an increase in deposits and reduced withdrawal rates, therefore also enhancing the liquidity ratio (Carbo & Rodríguez, 2016).

Results of the fifth model

Fifth model Results indicate the F-test = 5.06, with a statistical significance value of 0.00 at a significance level of less than 5%, and $R^2 = 0.59$, meaning that the independent variables Technological assets Value (TA), Credit card balances (CCB), and control variable The size of Bank, Inflation explain 59% of the changes in Loans to deposits ratio (LDR), also we can extract the regression equation as follows:

$$LDR_{it} = 0.74 - 0.11 CCB_{it} - 0.06 TA_{it} + 0.01 LASS_{it} + 0.02 INF_{it}$$

It is clear from the previous equation that there is a negative relationship between Credit card balances (CCB), Technological assets Value (TA) and Loans to deposits ratio (LDR), by -0.11 and -0.06. this effect is significant at a significance level of less than 0.05. Decreasing LTD ratio means that the increase in deposits is higher than the increase in credit card loans.

Customers might use credit card balances to consolidate and repay personal loans or other credit products or pay down debts, particularly if they take advantage of balance transfer offers. the net effect might be a reduction in the overall loan portfolio relative to deposits, thus decreasing the LTD ratio (Berger & Bouwman, 2013).

In addition, Technological assets often lead to cost reductions by automating processes and reducing the need for physical branches. We might use the savings from these efficiencies to offer better interest rates on deposits, thereby attracting more deposits (Saunders & Cornett, 2018). Thus the researcher accepted the hypothesis as shown in Table 8:

Table 8: Study assignment summary table

hypothesis	F-test	P-value	decision
(H₁): There is significant impact of fintech measures on credit risk management in the Egyptian banking sector			accepted
H _{1,1} : Fintech measures have positive significant effect on capital adequacy ratio (CAR).	6.19	0.00	accepted
H _{1,2} : Fintech measures have negative significant effect on non-performing loans ratio (NPLR).	4.91	0.00	Partially accepted
H _{1,3} : Fintech measures have negative significant effect on cost-to-income ratio (CIR).	2.76	0.03	accepted
H _{1,4} : Fintech measures have positive significant effect on liquidity ratio (LR).	7.32	0.00	accepted
H _{1,5} : Fintech measures have negative significant effect on loans-to-deposit ratio (LDR).	5.06	0.00	accepted

6.6 CONCLUSION

The current study investigated the impact of fintech on the credit risk management of sixteen banks operating in Egypt for the period of 2018-2023 by applying multiple regression. Credit Card balances and Technological Assets value are fintech measures and the Capital Adequacy Ratio CAR, Non-Performing Loans Ratio NPL, Cost-Income Ratio CIR, Liquidity Ratio LR, and Loans-to-deposits Ratio LDR are used in the current study as credit risk management measures. It is found that a significant positive effect of fintech measured by credit risk balances on credit risk management. There is a significant positive relationship between the two fintech measures and capital adequacy ratio CAR and liquidity ratio LR. In addition, there is a significant negative relationship between the two fintech measures and cost-income ratio CIR and loans to deposits ratio LDR.

The ratio of non-performing loans NPL has been paradoxically affected. An increase in credit card balances has led to a decrease in the non-performing loan ratio. Whereas, an increase in the value of technology assets has led to an increase

in the non-performing loan ratio. Although it may appear contrary to common sense, multiple factors can be the reason:

- **Overdependence on Technology:** Banks that make significant investments in technology may occasionally become excessively dependent on these technologies without adequate human supervision. If the technology fails to effectively assess borrower risk, it could result in gaps in risk management and potential increases in non-performing loans (Gartner, 2019).
- **Misalignment with Business Strategy:** According to Accenture (2019), if technological investments are not in line with the bank's overall business strategy and risk management framework, they might result in inefficiencies and more loan defaults.
- **Cybersecurity Risks:** Increased dependence on digital technologies heightens susceptibility to cyberattacks. Successful cyberattacks have the potential to cause disruptions in banking operations and result in financial losses. These losses might indirectly impact the quality of the loan portfolio (PwC, 2018).

The current study's primary finding showed that credit card balances and technology assets are the main influencers on the Egyptian banks' capital adequacy ratio CAR. In addition, technological assets value is the most significant determinant of the capital adequacy ratio CAR in Egypt banks with the highest coefficient compared to the other fintech measures (CCB). However, credit card balances are the most significant determinant of the loans to deposits ratio LDR in Egypt banks with the highest coefficient compared to the other fintech measures (TA).

For future researches, exploring the effect of Fintech development on Cybersecurity Risks is recommended. Moreover, future research could investigate the impact of FinTech on other categories of banks, banks affiliated with Fintech companies and other sectors. Finally, it would be beneficial to explore the impact of other types of financial innovation, such as blockchain and digital currencies, on the banking industry.

REFERENCES

- Abaza, E. (2010). *Banking Globalization*. Dar Al-Nahda Arabic. (in Arabic)
- Abdel Hamid, H., & Abdel Aziz, N. (2013). The impact of electronic banking applications on the performance of banks in the Egyptian banking sector. *Scientific Journal for Research and Commercial Studies*, 27(3), 329-309. (in Arabic)
- Accenture. (2019). Aligning technology investments with business strategy in banking.
- Agarwal, S., & Zhang, J. (2020). Fintech, lending, and payment innovation: A review. *Asia-Pacific Journal of Financial Studies*, 49(3), 353-367. <https://doi.org/10.1111/ajfs.12294>
- Ahmadu, A., Sulaiman, A. S., Bello, U., & Mijinyawa, U. M. (2019). Credit risk management and financial performance of quoted deposit money banks in Nigeria. *University of Port Harcourt Journal of Management*, 1(4), 178-192. ISSN: 2536-7048.
- Akl, Y., Salam, H., & Ahmed, M. (2023). The impact of financial technology on the financial performance of banks: An applied study on banks operating in Egypt. *Academic Journal of Contemporary Business Research*, 3(3), 88-116.
- Akomeah, J., Agumeh, R., & Siaw, F. (2020). Credit risk management and financial performance of listed banks in Ghana. *Research Journal of Finance and Accounting*, 11(6), 39-48. <https://doi.org/10.7176/RJFA/11-6-05>
- Al Ajlouni, A. T., & Al-Hakim, M. S. (2018). Financial technology in the banking industry: Challenges and opportunities. *International Conference on Economics and Administrative Sciences*, 1-18.
- Al Zaidanin, J., & Al Zaidanin, O. (2021). The impact of credit risk management on the financial performance of United Arab Emirates commercial banks. *International Journal of Research in Business & Social Science*, 10(3), 303-319.

- Al-Enezi, S. (2019). The role of digital transformation in activating mechanisms to control financial technology risks and their impact on electronic banking services in light of the COVID-19 crisis: A field study on Kuwaiti banks. *Sadat City University, Faculty of Commerce*. (in Arabic)
- Almustafa, H., Quang Khai Nguyen, J., Liu, J., & Dang, V. C. (2023). The impact of COVID-19 on firm risk and performance in MENA countries: Does national governance quality matter? *PLoS ONE*, *18*, e0281148. <https://doi.org/10.1371/journal.pone.0281148>
- Altunbas, Y., Gardener, E., Molyneux, P., & Moore. (2001). Efficiency in European banking. *European Economic Review*, *45*, 1931-1955. [https://doi.org/10.1016/S0014-2921\(00\)00091-X](https://doi.org/10.1016/S0014-2921(00)00091-X)
- Awad, E. (2004). *Electronic Commerce: From Vision to Fulfillment*. Pearson Prentice Hall.
- Awda, A. (2022). Managing and analyzing credit risk in Islamic banks and their types. *Journal of the Iraqi University*, *54*(2), 461-476.
- Basel Committee on Banking Supervision. (1998). *Basel I: The Basel Capital Accord*. Bank for International Settlements.
- Basel Committee on Banking Supervision. (1999). *Principles for the Management of Credit Risk*. Bank for International Settlements.
- Basel Committee on Banking Supervision. (2001). *The New Basel Capital Accord: An Explanatory Note*. Bank for International Settlements.
- Basel Committee on Banking Supervision. (2004). *Basel II: The Revised Framework*. Bank for International Settlements.
- Basel Committee on Banking Supervision. (2006). *Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework—Comprehensive Version*. Bank for International Settlements.
- Basel Committee on Banking Supervision. (2010). *Basel III: International Framework for Liquidity Risk Measurement, Standards, and Monitoring: A Global Regulatory Framework for More Resilient Banks and Banking Systems*. Bank for International Settlements.

- Begenau, J., Farboodi, M., & Veldkamp, L. (2018). Big data in finance and the growth of large firms. *Journal of Monetary Economics*, 97, 71–87.
- Berger, A. N., & Bouwman, C. H. S. (2013). How does capital affect bank performance during financial crises? *Journal of Financial Economics*, 109(1), 146-176.
- Bettinger, C., Braunstein, Y. M., & Mookerjee, V. S. (1972). The impact of financial technology on banking. *Journal of Financial Services Research*, 2(1), 1-15.
- Bikker, J. A. (1999). Efficiency in the European banking industry: An exploratory analysis to rank countries. *Research Series Supervision*, 18. De Nederlandsche Bank.
- Boahene, S. H., Dasah, J., & Agyei, S. K. (2012). Credit risk and profitability of selected banks in Ghana. *Research Journal of Finance and Accounting*, 3(7).
- Burger, A., & Moormann, J. (2008). Productivity in banks: Myths & truths of the cost-income ratio. *Banks and Bank Systems*, 3(4), 92-101.
- Carbo-Valverde, S., & Rodríguez-Fernández, F. (2016). The effects of technological progress on retail banking activities. *Journal of Financial Services Research*, 49(2-3), 329-345. <https://doi.org/10.1007/s10693-015-0227-6>
- Central Bank of Egypt. (2018). *Economic Journal of the Central Bank of Egypt*. <https://www.cbe.org.eg>
- Central Bank of Egypt. (2019). *Economic Journal of the Central Bank of Egypt*. <https://www.cbe.org.eg>
- Central Bank of Egypt. (2020). *Central Bank of Egypt's Annual Report*. <https://www.cbe.org.eg>
- Chai, Y., & Sun, S. (2024). Can the development of Fintech mitigate non-performing loan risk? *Finance Research Letters*. <https://doi.org/10.1016/j.frl.2024.105889>

- Chen, M. A., Wu, Q., & Yang, B. (2019). How valuable is FinTech innovation? *Review of Financial Studies*, 32(5), 2062–2106.
- Cheng, M., & Qu, Y. (2020). Does bank FinTech reduce credit risk? Evidence from China. *Pacific Basin Finance Journal*, 63, 101398. <https://doi.org/10.1016/j.pacfin.2020.101398>
- Chiu, J., & Koeppel, T. V. (2019). Blockchain-based settlement for asset trading. *Review of Financial Studies*, 32(5), 1716–1753.
- Coyle, B. (2000). *Credit Risk Management: Framework for Credit Risk Management*. Fitzroy Dearborn Publishers.
- Fuster, A., Plosser, M., Schnabl, P., & Vickery, J. (2019). The role of technology in mortgage lending. *Review of Financial Studies*, 32(5), 1854–1899.
- Gartner. (2019). The risks of overreliance on technology in financial services.
- Gomber, P., Koch, J.-A., & Siering, M. (2017). Digital finance and FinTech: Current research and future research directions. *Journal of Business Economics*, 87, 537-580.
- Guo, P., & Shen, Y. (2019). Internet finance deposit competition and bank risk-taking. *Journal of Financial Research*, 8, 58–76. (In Chinese)
- Heffernan, S., & Fu, M. (2008). The determinants of bank performance in China. *Working Paper*. Retrieved from https://www.cass.city.ac.uk/_data/assets/pdf_file/0008/76949/Heffernan-45-REVISED.pdf
- Hidayat, A., & Kartawinata, B. (2023). The effect of the emergence of Fintech on the financial performance of the banking sector: A case study using ROA, LDR, and CAR ratios. *The International Journal of Business Review*, 6(1).
- Hoque, H., & Liu, H. (2023). Impact of bank regulation on risk of Islamic and conventional banks. *International Journal of Finance and Economics*, 28(1), 1025-1062.

- Joseph, M., Sekhon, Y., Stone, G., & Tinson, J. (2005). An exploratory study on the use of banking technology in the UK: A ranking of importance of selected technology on consumer perception of service delivery performance. *International Journal of Bank Marketing*, 23(5), 397–414.
- Kargi, S. (2011). Credit risk and the performance of Nigerian banks: A study of GTB PLC (1991–2010). *Journal of Business Research Administration*, 3, 112–119.
- Kauko, K. (2012). External deficits and non-performing loans in the recent financial crisis. *Economics Letters*, 115(2), 196–199. <https://doi.org/10.1016/j.econlet.2011.12.018>
- Kosmidou, K. (2008). The determinants of banks' profits in Greece during the period of EU financial integration. *Managerial Finance*, 34, 146–159.
- Li, C., He, S., Tian, Y., Sun, S., & Ning, L. (2022). Does the bank's FinTech innovation reduce its risk-taking? Evidence from China's banking industry. *Journal of Innovation and Knowledge*, 7(3), 100219. <https://doi.org/10.1016/j.jik.2022.100219>
- Maher, B. (2020). *Financial Technology: 7 global innovations that made the banking system easier*. Al-Watan Newspaper. <https://www.elwatannews.com/news/details/5128103?t=push>
- Malik, N., Oktavia, A., Sri, M., & Anindynta, F. (2019). Financial banking performance of ASEAN-5 countries in the digital era. *Jurnal Keuangan dan Perbankan*, 24(1), 117–127.
- McKinsey & Company. (2017). *Transforming into a digital bank: The risks of transition*.
- Merton, C. (1977). An analytic derivation of the cost of deposit insurance and loan guarantees. *Journal of Banking and Finance*, 1, 512–520. [CrossRef]
- Mohamed, T. S., & Elgammal, M. M. (2023). Credit risk in Islamic microfinance institutions: The role of women, groups, and rural borrowers. *Emerging Markets Review*, 54, 100994.

- Mueni, M., & Atheru, G. (2019). Electronic Banking and Financial Performance of Commercial Banks in Kenya. *International Journal of Current Aspects*, 3(2), 299–304.
- Nasri, K., Clarette, T., Lestari, H., & Leon, F. (2023). The effect of fintech and internal factors on bank financial stability. *Global Research Review in Business and Economics*, 9(1), 31–38.
- Navaretti, G., Calzolari, G., & Pozzolo, A. (2017). FinTech and Banks: Friends or Foes? *European Economy – Banks, Regulation, and the Real Sector*.
- Nguyen, K., & Dang, V. (2022). The impact of risk governance structure on bank risk management effectiveness: Evidence from ASEAN countries. *Heliyon*, 8, E11192.
- Nguyen, K. (2022). Determinants of bank risk governance structure: A cross-country analysis. *Research in International Business and Finance*, 60, 101575.
- Nie, Z., Ling, X., & Chen, M. (2023). The power of technology: FinTech and corporate debt default risk in China. *Pacific-Basin Finance Journal*, 78. <https://doi.org/10.1016/j.pacfin.2023.101969>
- Nobanee, H., Ellili, N., Chakraborty, D., & Shanti, H. (2024). Mapping the fintech revolution: How technology is transforming credit risk management. *Emerald Insight*. <https://www.emerald.com/insight/2514-9342.htm>
- Nwanna, O., & Oguezue, F. (2017). Effect of credit management on profitability of deposit money banks in Nigeria. *International Institute of Academic Research and Development*, 3, 137–160.
- Owojori, A. A., Akintoye, I. R., & Adidu, F. A. (2011). The challenge of risk management in Nigerian banks in the post-consolidation era. *Journal of Accounting and Taxation*, 3, 23–31.
- PwC. (2018). *Financial institutions' cybersecurity: A growing concern*.

- Qiu, H., Huang, Y. P., & Ji, Y. (2018). Influence of fintech on traditional bank behavior – From the perspective of internet financing. *Journal of Financial Research* (11), 17–29. (In Chinese).
- Rajkumar, P., & Hanitha, V. (2015). The impact of credit risk management on financial performance: A study of state commercial banks in Sri Lanka. In *Proceedings of the International Conference on Contemporary Management (ICCM-2015)*, Jaffna, Sri Lanka (206–212).
- Saksonova, S., & Kuzmina, I. M. (2017). Fintech as Financial Innovation – The Possibilities and Problems of Implementation. *European Research Studies Journal*, 20(3), 961–973.
- Salas, V. A., & Saurina, J. (2002). Credit risk in two institutional regimes: Spanish commercial and savings banks. *Journal of Financial Services Research*, 22(3), 203–224. <https://doi.org/10.1023/A:1019781109676>
- Saunders, A., & Cornett, M. M. (2018). *Financial institutions management: A risk management approach* (9th ed.). McGraw-Hill Education.
- Shandi, M. (2010). The future of electronic banking services between risk and profitability: An applied study on the new reality of the Egyptian banking system. *Journal of Commercial Research*, Zagazig University, Faculty of Commerce, 32(2), 352–321. (in Arabic).
- Staikouras, C. H., & Wood, G. (2003). The determinants of bank profitability in Europe. *European Applied Business Research Conference*, Venice.
- Thakor, A. V. (2012). Incentives to innovate and financial crises. *Journal of Financial Economics*, 103(1), 130–148. <https://doi.org/10.1016/j.jfineco.2011.03.026>.
- Ugwuka, N., & Ajuzie, O. (2019). Capital adequacy and banks' performance: Evidence from deposit money banks in Nigeria. *International Journal of Research and Innovation in Social Science*, 3, 237–243.
- Ukinamemen, A., & Ozekhome, H. (2019). Does capital adequacy influence the financial performance of listed banks in Nigeria? *Oradea Journal of Business and Economics*, 4, 69–80.

- Usman, A. K., & Shah, M. H. (2013). Critical success factors for preventing e-banking fraud. *Journal of Internet Banking and Commerce*, 18(2), 1–15.
- Wadi, O., & Metwally, M. (2021). The impact of investment in financial technology on the profitability and leadership of Egyptian banking units. *Journal of Financial and Commercial Research*, Port Said University, Faculty of Commerce, 22(3), 1–49. (in Arabic).
- Wamda, & PAYFORT. (2016). *Fintech in the Middle East and North Africa (Financial Services Sector Trends)*. https://www.findevgateway.org/sites/default/files/publications/files/ar_fintechmena_wamda.
- Wang, H., Mao, K., Wu, W., & Luo, H. (2023). Fintech inputs, non-performing loans risk reduction, and bank performance improvement. *International Review of Financial Analysis*. <https://doi.org/10.1016/j.irfa.2023.102849>
- Wu, X., Jin, T., Yang, K., & Qi, H. (2023). The impact of bank FinTech on commercial banks' risk-taking in China. *International Review of Financial Analysis*, 90, 102944. <https://doi.org/10.1016/j.irfa.2023.102944>.
- Xiang, X., Lina, Z., Yun, W., & Chengxuan, H. (2017). China's path to FinTech development. *European Economy – Banks, Regulation, and the Real Sector*.
- Yudaruddin, R., Nugroho, B., Mardiany, Fitriani, Z., Hapsari, P., & Santi, E. (2024). Liquidity and credit risk in Indonesia: The role of FinTech development. *SAGE Journals*. <https://doi.org/10.1177/21582440241245248>
- Zhang, A., Wang, S., Liu, B., & Liu, P. (2022). How fintech impacts pre- and post-loan risk in Chinese commercial banks. *International Journal of Finance and Economics*, 27(2), 2514–2529. <https://doi.org/10.1002/ijfe.2284>.
- Zhang, Y., Ye, S., Liu, J., & Du, L. (2023). Impact of the development of FinTech by commercial banks on bank credit risk. *Finance Research Letters*, 55, 103857. <https://doi.org/10.1016/j.frl.2023.103857>

- Zhu, C. (2019). Big data as a governance mechanism. *Review of Financial Studies*, 32(5), 2021–2061.
- Zinakova, T. (2020). *Financial Technology (FinTech) and the performance of commercial banks in Nordic countries* (Master's thesis, Degree Programme in International Business).
- Zu, J., Gu, Y., & Li, K. (2019). Impacts of financial innovations on financial performance: Evidence of electronic banking in Africa. *International Journal of Scientific Engineering and Science*, 3(7), 56–60.

أثر التكنولوجيا المالية على إدارة مخاطر الائتمان: دراسة تطبيقية على القطاع المصرفي المصري

د. ريموند السعيد محمد لبد

ملخص البحث باللغة العربية

يهدف هذا البحث إلى دراسة أثر التكنولوجيا المالية على إدارة مخاطر الائتمان للبنوك العاملة في مصر، ولتحقيق هذا الهدف تم إجراء دراسة تطبيقية على عينة مكونة من 16 بنكاً من البنوك المسجلة لدى البنك المركزي المصري خلال الفترة من 2018 إلى 2023. تعتمد الدراسة على البيانات الثانوية المنشورة في القوائم والتقارير المالية للبنوك، وقواعد بيانات البنك الدولي، كما تعتمد على أسلوب البيانات الذي يجمع بين كل من بيانات السلاسل الزمنية وبيانات السلاسل المقطعية (Data Panel) لإجراء الدراسة، وتم تحليل البيانات من خلال الاعتماد على حزم البرامج الإحصائية Stata 14. أظهرت نتائج الدراسة تأثيراً إيجابياً معنوياً للتكنولوجيا المالية التي تقاس بأرصدة مخاطر الائتمان على إدارة مخاطر الائتمان. هناك علاقة إيجابية ذات دلالة إحصائية بين مقياسي التكنولوجيا المالية ونسبة كفاية رأس المال CAR ونسبة السيولة LR. بالإضافة إلى ذلك، هناك علاقة سلبية معنوية بين مقياسي التكنولوجيا المالية ونسبة التكلفة إلى الدخل CIR ونسبة القروض إلى الودائع LDR. في حين أن نسبة القروض المتعثرة NPL قد تأثرت بشكل متناقض. وقد أدت الزيادة في أرصدة بطاقات الائتمان إلى انخفاض في نسبة القروض المتعثرة، في حين أدت الزيادة في قيمة الأصول التكنولوجية إلى زيادة في نسبة القروض المتعثرة..

الكلمات الدالة: إدارة مخاطر الائتمان، التكنولوجيا المالية، مصر، القطاع المصرفي، نسبة كفاية رأس المال CAR، نسبة القروض المتعثرة NPL، نسبة التكلفة إلى الدخل CIR، نسبة السيولة LR، نسبة القروض إلى الودائع LDR، أرصدة بطاقات الائتمان والأصول التكنولوجية.

Suggested Citation according to APA Style

Libda, R. E. M. (2024). The Impact of Fintech on Credit Risk Management: An Applied Study on the Egyptian Banking Sector. *Journal of Alexandria University for Administrative Sciences*, 61(5), 381- 422.