Digital Financial Inclusion and the Banking Sector's Stability during Economic Turbulence: Evidence from Egypt

الشمول المالي الرقمي واستقرار قطاع البنوك خلال فترات الاضطراب الاقتصادي: دراسة تطبيقية على البنوك المصرية

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Abstract:

Purpose: The study aims to examine the impact of digital financial inclusion practices on the financial stability of the banking sector in Egypt.

Design/Methodology/ Approach: The study used annual data from a sample of 17 Egyptian banks involved in digital financial inclusion practices over the 2019- 2022 period and annual data about digital financial inclusion indicators. Bank stability is measured using Z-Score, and digital financial inclusion is measured through proxies of the number of mobile money accounts per 1000 adults, mobile money transactions per 1000 adults, and registered mobile money agent outlets per 1000 km^2. The panel least square regression method is utilized for empirical analysis.

Findings: The results show that all digital financial inclusion proxies significantly affect the banking sector's stability. However, this impact does not follow a definite direction. The number of mobile money accounts per 1000 adults positively relates to stability. Other indicators have a negative effect. This can be attributed to either the early stages of implementing digital financial inclusion or the impact of the economic conditions. Bank size, loan ratio, and equity ratio significantly affect the bank's stability. The loan loss provision ratio does not significantly affect the Z-score.

Originality/Value: The study contributes to Egypt's digital financial inclusion and banking stability literature. Previous literature in the Egyptian context focused on financial inclusion and its implications on various aspects of banking performance. This study is a pioneer in investigating the impact of digital financial inclusion on the banking sector's stability in recent years.

Keywords: Digital Financial Inclusion, Bank Stability, Economic Turbulence, Panel least squares method, Egypt

المستخلص:

الهدف: تهدف الدراسة إلى فحص تأثير الشمول المالي الرقمي على الاستقرار المالي لقطاع البنوك في مصر.

التصميم/المنهجية/الأسلوب: اعتمدت الدراسة على بيانات سنوية لسبعة عشر بنك مصري يسهم في ممارسات الشمول المالي الرقمي في الفترة من 2019 إلى 2022 كما تم الاعتماد على بيانات سنوية لمؤشرات الشمول المالي الرقمي من البنك المركز المصري. تم استخدام Z-Score لقياس مدى الاستقرار المالي للبنوك. بالنسبة لمؤشرات الشمول المالي الرقمي تم استخدام عدد حسابات الهواتف لكل 1000 بالغ، عدد المعاملات التي تتم من خلال الهاتف لكل 1000 بالغ، وعدد منافذ مقدمي خدمات الدفع لكل 1000 كم^2. تم استخدام نموذج انحدار المربعات الصغرى للسلاسل الزمنية المقطعية

النتائج: أظهرت النتائج تأثيرا معنويا لكل مؤشرات الشمول المالي الرقمي على الاستقرار المالي للبنوك. اختلفت النتائج فيما يخص اتجاه التأثير. عدد المعاملات التي تتم من خلال الهاتف لكل 1000 بالغ وعدد منافذ مقدمي خدمات الدفع لكل 1000 كم^2 أظهروا تأثيرا سلبيا على الاستقرار المالي بينما عدد حسابات الهواتف لكل 1000 بالغ أظهرت تأثيرا إيجابيا على الاستقرار المالي. وقد يعزى هذا الاختلاف والتأثير السلبي إما إلى أن تنفيذ الشمول المالي الرقمي مازال في مراحله الأولى أو إلى تأثير الظروف الاقتصادية. كما أظهرت النتائج تأثيرا معنويا لكل من حجم البنك ونسبة القروض ونسبة حقوق الملكية على استقرار البنك.

الأصالة/ القيمة: تساهم الدراسة في إثراء أدبيات الشمول المالي الرقمي والاستقرار المصرفي في مصر. ركزت معظم الأدبيات في البيئة المصرية على الشمول المالي وانعكاساته على مختلف جوانب الأداء المصرفي. وتعد هذه الدراسة رائدة في دراسة تأثير الشمول المالي الرقمي على استقرار القطاع المصرفي في السنوات الأخيرة التي شهدت اضطرابات عالمية أثرت على الاقتصاد المصري.

الكلمات المفتاحية: الشمول المالي الرقمي، الاستقرار المالي للبنوك، الاضطرابات الاقتصادية، نموذج انحدار المربعات الصغرى للسلاسل الزمنية المقطعية، مصر

1. Introduction

Crises and uncertainties threaten banks' stability and, consequently, the stability of the entire economic system (Banna & Alam, 2021c). In the past few years, the world has faced many events drastically influencing the global economic status, starting with the COVID-19 pandemic. With the diffusion of COVID-19 in late 2019, countries' governments approved lockdowns and curfews as the primary strategy to control the spread of the virus and mitigate the worst potential consequences of the pandemic (World Bank, 2022). These policies had massive economic consequences globally and locally. They resulted in slowing down the flow of global trade. Consequently, there is a decrease in economic activities and a reduction in household income (Dluhopolskyi, Pakhnenko, Lyeonov, Semenog, Artyukhova, Cholewa, & Jastrezebski, 2023). The effect of the crisis on household income had repercussions on the financial stability of financial institutions and economies (World Bank, 2022).

As soon as the world began to recover from the negative economic consequences of the COVID-19 pandemic, the Russian-Ukrainian war began early in 2022. The war between these two economic powers considered the "Basket for the World's Food and Energy," caused a high increase in the grain, energy, and oil prices, which resulted in high levels of inflation, whether in the two warring countries or all countries of the world (Ozili, 2022). Severe inflation in countries around the globe has led central banks to successively raise interest rates as a trial to reduce the effect of inflation (WTO, 2023). Orhan (2022) summarized the influence of the Russian-Ukraine war in three aspects; the first one is its effect on the value of people's income and their demand for various goods, as the high inflation rates will negatively affect them. The second effect is on trade and economies of neighbouring countries with the increased flow of refugees. The final aspect of the impact of war is the expected capital outflow from emerging economies due to the decrease in business confidence and increase in investor uncertainty.

Financial Inclusion (FI) was among the policies developed to overcome the adverse outcomes of the financial crises and ensure the stability of financial systems when facing future turbulence. FI was promoted as a tool to protect and enhance economic and banking stability (Ahamed & Mallick, 2019). FI is defined as "availing of various financial products for use by all segments of the society through the formal channels, with adequate quality and cost while protecting the rights of consumers of these services, which

enables them to manage their finances effectively" (CBE, 2022, p. 2). As can be concluded from the definition, FI aims to enable unbanked people and business organizations to join formal financial services. Widening the base of customers and beneficiaries from formal financial services can allow financial institutions to absorb financial crises and become more resilient in the face of economic turbulence.

This study aims to examine the impact of digital financial inclusion practices on the financial stability of the banking sector in Egypt. This study is essential for three reasons. First, Egypt is considered a low-income country. Accordingly, the impact of the closure of the economy due to the COVID-19 pandemic and the resulting decrease in household income was more pronounced compared to other high-income countries. This means that the impact of the COVID-19 pandemic on the stability of banks is expected to be greater in Egypt compared to other high-income countries. Second, Egypt is considered one of the largest grain-importing countries in the world (WTO, 2023). Hence, Egypt was one of the countries most affected by the rise in grain prices due to the Russian-Ukrainian war. This is evident in the high inflation rates that exceeded 40%, the devaluation of the Egyptian pound by more than 50%, and the increase in interest rates to exceed 20%. This means that the impact of the Russian-Ukrainian war on the stability of banks is expected to be greater in Egypt compared to other countries.

Third, the study contributes to Egypt's financial inclusion and banking stability literature. Most of the previous literature about the Egyptian context focused on financial inclusion and its implications on various aspects of banking performance. This study is a pioneer in investigating the impact of Digital Financial Inclusion (DFI) on the banking sector's stability in recent years that witnessed economic turbulence in the Egyptian context. Financial inclusion's effect on the financial stability of the macroeconomic and financial sector levels has been studied by many researchers in the last few years (for example, Awad & Eid, 2018; Ahamed & Mallick, 2019; Khan, Zafar, Okunlola, Zoltan, & Robert, 2022). However, the results of this research cannot be generalized when studying the DFI. As Tay, Tai, and Tan (2022) state, DFI differs from FI in its heavy reliance on technology. Although both DFI and FI aim to deliver financial services to all people in society, DFI utilizes the recent advances in Information and Communication Technology (ICT) to achieve its target. So, while FI was argued to influence the financial sector's stability positively, technology may add new types of

risks to the financial sector that did not exist during the FI phase. One of these risks is the high infrastructure cost required to build the technological network to activate the movement toward DFI (Klapper, 2023). Other risks of cyber-attacks, lack of data privacy, the possibility of terrorism financing due to the disturbance of regulations, and money laundering activities (Banna & Alam, 2021a) are all new risks that appear due to the high reliance on technology that is associated with DFI rather than FI.

This study is distinguished from previous research on DFI and stability. First, most studies exploring DFI and its impacts on banks' risk-taking and stability are conducted in Asian countries, including various countries in the sample data (for example, Banna & Alam, 2021a,b,c; Banna, Hassan, & Alam, 2020; Banna, Hassan, Ahmad, & Alam, 2022) or focusing on only one country (for example, Banna, 2020). Chinoda and Kapingura (2023) studied the effect of DFI on stability in Sub-Saharan Africa. This study focuses on studying the financial stability and DFI in Egypt, as it is still an undiscovered field in this area of research.

Second, while these studies depended mainly on developing an index for DFI, this study uses proxies for DFI represented in variables that represent the access and usage sides of DFI practices. Third, the previous literature included the influence of the COVID-19 pandemic on the practice of DFI, as it is considered the main driver for the movement toward activating DFI. So, studies covered the period ending in 2019 or 2020. However, this study examined the impact of DFI during 2019-2022, which also witnessed the Russia-Ukraine war.

The remainder of the research is structured as follows: Section 2 briefly overviews digital financial inclusion in Egypt. Section 3 investigates previous literature and develops the study hypotheses. Section 4 will focus on the sample, variables, measures, and model. Section 5 will present the analysis of the statistical results. Finally, the study is concluded in section 6, along with recommendations for future studies.

2. Background on the Egyptian context

Egypt is an emerging economy that started an economic reform plan in 2016 to improve its performance after many decades of suffering from economic problems. This economic reform resulted in a growth rate reaching 5.6% in 2018-2019 (CBE, 2020). Early in 2020, the country faced economic turbulence related to the spread of COVID-19 and lockdown decisions.

However, the Egyptian economy achieved growth rates higher than expected by the World Bank. By the start of the recovery from the negative consequences of the pandemic, the war started and resulted in many challenges. First, the high inflation rates and increased prices of essential goods affected people's living standards. Secondly, the increasing interest rates by central banks of developed economies put a much higher risk on investment in Egypt, leading to the outflow of capital from Egypt. Also, the increasing interest rates resulted in a decline in the value of the Egyptian currency, increasing the price of the imports and the debt installments. This, in turn, affected the levels of dollar reserves in the Central Bank. According to CBE news, the reserves declined from US$ 45,419.6 mn at the end of December 2019 to US$ 34,002.9 mn at the end of December 2022.

However, despite the adverse economic effects of the COVID-19 pandemic, it has positively affected financial inclusion in Egypt. For a long time, Egypt has not witnessed significant development regarding financial inclusion due to the lack of money, which was recorded as the main barrier in Rashdan and Eissa's study (Rashdan & Eissa, 2019). According to the World Bank World Development Indicators, in 2020, around 66% of Egyptians over 25 are still unbanked. The fear of virus transmission among people through currency exchange has led to the acceleration of digital technology in daily transactions (Dluhopolskyi et al., 2023). The new circumstances led to the intense advancement of a new version of FI, which is Digital Financial Inclusion. Digital financial inclusion (DFI) is a concept used to reflect the involvement and intensive use of digital technology in achieving financial inclusion. So, DFI is not different from FI, but it is a new phase or generation of FI. Although the Egyptian government and the Central Bank of Egypt are seriously moving toward activating financial technology in the financial inclusion strategy, academic studies in this field are still scarce, especially in investigating the impact of these practices on banking stability. So, this study aims to fill this gap by examining the impact of banks' involvement in digital financial inclusion practices, which will help achieve financial stability, especially when economies face financial crises.

3. Literature Review and Hypothesis Development

3.1 Financial stability

In literature, financial stability does not have a precise definition. It is claimed to be a complex notion to define (Garcia, 2016). However, what is described is the state in which stability is achieved. Many central banks are interested in defining financial stability. The Central Bank of Egypt, in its annual financial stability report, has defined the state of financial stability as represented by the ability of financial institutions to provide its services of facilitating the allocation of resources and providing financial intermediary services even during periods of risk (CBE, 2021, p.3). The shocks and the associated risks can threaten the financial system's ability, leading to a loss of confidence in the system, which will increase the risks of the failure of financial institutions (Garcia, 2016).

The financial stability of the banking sector is reflected in various measures, such as capital adequacy and the ratio of non-performing loans (NPL) to total loans (Chinoda & Kapingura, 2023). The rise in the ratio of NPL can stand against the banks' ability to perform their intermediary role and their ability to practice lending activity (Chinoda & Kapingura, 2023). So, to maintain and strengthen the levels of resilience of financial institutions, the regulatory bodies seek to improve the capital quality, increase its level, and encourage the buildup of capital buffers as a tool to mitigate the potential risks (Garcia, 2016: 85). Another popular measure for financial stability is Z-Score. This measure is widely used in literature as it reflects the distance the banks have away from insolvency (Cihak & Hesse, 2010).

Various internal and/or external factors can disturb the financial system's stability. Earlier this century, the world was exposed to the global financial crisis of 2008. A crisis during which the stability of the financial systems was threatened to an extent led to the interference of international bodies in developing stricter regulations that can protect financial stability (Morgan & Pontines, 2014). Countries' various types of crises expose their financial systems to systemic risk. Systemic risk is "a risk of disruption to financial services that is caused by an impairment of all or parts of the financial systems and has the potential to have serious negative consequences for the real economy" (CGFS, 2010, p. 2). Banks usually innovate new tools to ensure their resilience and survival after financial crises and to enhance stability (Banna et al., 2022). Financial inclusion is one of the essential tools it invented to improve its financial stability, especially after GFC in 2008.

3.2 DFI and Financial Stability

As mentioned above, DFI is using technology to achieve financial inclusion. On the other hand, financial stability has been defined as the resilience of banks during periods of crisis that may cause the volatility of the intermediate financial institutions. Interestingly, the discourse about financial inclusion has started after the financial crisis. So, it can be claimed that financial inclusion was mainly introduced as a tool to enhance the financial sector's stability. However, it is argued that financial inclusion and stability can be negatively associated (Cihak, Mare, & Melecky, 2016). This relationship between FI and stability has been investigated in previous research. Studies investigating the relationship between financial inclusion and stability have yielded mixed results across countries (Feghali, Mora, & Nassif, 2021). For example, Ahamed & Mallick (2019) found a positive relation between financial inclusion and bank stability in 86 countries with a sample of 2635 banks. Conversely, Cihak et al. (2016) found that financial inclusion and financial stability correlate negatively. Feghali et al. (2021) claimed that FI may have two opposite effects on the financial sector's stability. They argued that the part of FI that allows people to access financial services through deposits can positively affect banks' stability. However, the banking system's instability may occur due to the broad access of previously unbanked people to the credit services provided by banks (Feghali et al., 2021). Previously financially excluded people will not have a credit payment history. So, banks do not have evidence about their ability to repay loans (Mehrotra & Yetman, 2015).

The conflicting points of view also extend to DFI's relationship with bank stability. On the one hand, expanding banks' customer base resulting from adopting FI and DFI may lead to informational asymmetries with the new spectrum of clients. At the organizational level, the lack of managerial experience and the complexity of the products provided by banks may lead to agency problems that lead to the instability of banks (Ahamed & Mallick, 2019). Also, at the technological level, Banna (2020) claimed that the massive use of technology and artificial intelligence might expose financial institutions to cyberattacks, data theft, account hacking, and card cloning risks. Telukdarie and Mungar (2023) supported Banna's claim. They argued that the ability of all population members to access the financial system without barriers may expose the financial system to operational risk resulting from criminals' attacks on the system and its users (Telukdarie &Mungar, 2023). These claims proved their accuracy during the past few months in

Egypt, where bank clients started receiving messages and phone calls from organized criminals asking for details about their bank account information. This led to the loss of some clients' money. The situation required intensive campaigns to raise people's awareness of these attacks.

On the other hand, many researchers investigated and found the positive effect of DFI on bank stability. Ozili (2018) argued that properly implementing DFI can achieve economic growth and stability. This, in turn, is reflected in the performance of banks and other financial institutions. It is claimed that applying DFI will allow the poor and previously unbanked people to get financial services, which will open avenues of involvement in business activities that will enhance financial growth and stability and poverty eradication (Banna et al., 2022). In their study about the determinants of best-performing small and medium banks during the GFC, Phan, Pham, Nguyen, and Nguyen (2021) found that the growth in the deposits as a percentage of total assets, the lower the liquid fragility and the increase in liquid assets supported banks' performance during the crisis. These findings indirectly support the involvement of banks in FI and DFI to improve their performance. Previous literature claimed a trade-off between financial inclusion and financial stability due to the inability to confirm the creditworthiness of those who request credit (Cihak et al., 2016). However, the use of digital technologies may provide information about credit requests.

As mentioned in the previous section, the impact of the COVID-19 pandemic and the war is severe in Egypt, an emerging low-income country. Also, the country's movement toward activating digital technology in financial services is still early. Previous literature studying the impact of financial inclusion on the various aspects of banks' performance also provided mixed results. During 2013-2018, the listed banks showed a negative effect of the financial inclusion practices on their profitability measures, either Return on Assets or Return on Equity (Al-Adwey, 2019). Ibrahim (2019) examined the impact of financial inclusion on financial stability and found that financial inclusion significantly and positively impacted the financial stability of Egyptian banks during the 2013-2017 period. Additionally, Al-Shahat and Abo-ElDayar (2023) found that some financial inclusion indicators (i.e., size of deposits by individuals, the credit wallet) positively affect banks' return on equity. Meanwhile, indicators related to access perspective do not impact profitability measures (Al-Shahat & Abo-ElDeyar, 2023). This current study covers a period of economic

turbulence during which the Egyptian economy was severely affected; the hypothesis can be stated as follows:

H1: The expansion in digital financial inclusion practices negatively affects banks' financial stability.

4. Data and Methodology

The main objective of this research is to explore whether DFI practices can significantly impact the banking sector's stability in Egypt. The study aims to investigate this impact during the periods of economic instability that started with COVID-19 and continues because of the Russian-Ukraine war. This section presents the data and the methods used to test and analyse the relationship between DFI and banking stability.

4.1 Sample Selection

To achieve the main objective of this research, the study used a list of banks actively involved in digital financial inclusion practices, according to reports of the Central Bank of Egypt. The initial list included 22 banks. Due to the distinguished regulatory and supervisory frameworks of Islamic banks, they are excluded from the sample (Farooq & Zaheer, 2015; Bekir, Abo El-Kheer, & Ganna, 2023) as their nature can influence the financial stability of banks. So, the sample does not include Abu Dhabi Islamic Bank (ADIB) and Faisal Islamic Bank. Due to unavailable data, another three banks were excluded. So, the final sample included 17 commercial banks.

As digital financial inclusion practices are recent and the research focuses on economic turbulences, the selected sample covers 2019 to 2022. This period marks the beginning of COVID-19 till the recent year-end published financial statements. So, the data included 68 observations. Regarding the DFI variables, the only complete data attained was macro-level data. So, each indicator has one observation per year. So, data about DFI was repeated for each bank.

4.2 Definition and Measurement of Variables

4.2.1 Measuring Bank Stability

The dependent variable in this study is the bank stability. The empirical model depends on the z-score as a measure of stability for each bank-year observation. Z-score has been a popular measure of stability and risk-taking level in the banking sector (Hesse & Cihak, 2006; Beck & Laeven, 2006; Ahamed & Mallick, 2019; Bekir et al., 2023). The following formula computes the Z-score:

$$Z - Score_{it} = \frac{ROA_{it} + CAR_{it}}{\sigma(ROA)_{it}}$$

Where ROA_{it}, CAR_{it}, and σ(ROA) refer to the return on assets, the capital-to-asset ratio, and the standard deviation of return on assets of bank *i* in year *t*, respectively. This study followed Beck & Laeven (2006) in calculating the standard deviation of ROA over the sample period of a bank. Z-score indicates the "number of standard deviations that a bank's return on assets has to drop below its expected value before equity is depleted and the bank is insolvent" (Beck & Laeven, 2006, pp. 14-15). So, the higher the z-score value, the more stable the bank is. The natural logarithm of the Z-score was used to minimize the skewness of the measure.

4.2.2 Measuring Digital Financial Inclusion proxies.

This study mainly aims to test the role of DFI in the stability of the banking sector in Egypt. Digital financial inclusion proxies have been collected from various sources, Central Bank of Egypt publications, Ministry of Communication and Information Technology, and World Bank data. Both the outreach and usage penetrations have been considered while collecting data about DFI (Banna, 2020). For the outreach (supply) indicators, the number of registered mobile money agent outlets per 1000 km^2 was used. On the usage side, both indicators of the number of mobile money accounts per 1000 adults and the number of mobile money transactions per 1000 adults are used. The data collected for these proxies are macro-level data, i.e., there is one observation for each proxy per year.

4.2.3 Measuring Bank-Specific Control Variables.

The research controls the bank-specific variables. The effect of the bank size is controlled using the natural logarithm of total assets. Also, the loan portfolio risk is controlled using the loan loss provision ratio to total loans (loan loss provision ratio). The bank's liquidity risk has been accounted for using the ratio of total loans over total assets (Fang, Hasan, & Marton, 2014; Banna, 2020). Moreover, the equity ratio has been used to control capital risk. Table 1A in the appendix contains the definition of all variables used.

4.3 Empirical Model

Based on the previous discussion of the research hypotheses and the measures of the variables in the above subsection, this study used the

following model to test the impact of DFI on the financial stability of the banking sector in Egypt:

$$Y_{it} = \beta_0 + \beta_1 DFI_t + \beta_2 BNK_{it} + \varepsilon_{it}$$

Where: Y_{it} = ln(Z-score) as the dependent variable used as a proxy for measuring bank stability of bank *i* in year *t.*

DFI_t= Digital financial inclusion proxies used (i.e., number of mobile money agent outlets per 1000 km^2 (MOBOUTLET), number of mobile money accounts per 1000 adults (MOBACC), and number of mobile money transactions per 1000 adults (MOBTRAN) for year *t*.

BNK_{it}= bank-specific control variables for bank *i* in year *t* (such as ln (TA), loan ratio (LR), equity ratio (ER), and loan loss provision ratio (LLPR)).

The study used the panel least square regression for data analysis and hypotheses testing.

5. Results and analysis

This section is mainly concerned with presenting the results of the statistical analysis of data and the discussion of the study results. The first subsection presents the descriptive statistics of the research, and the following subsection discusses the main findings and their discussion.

5.1 Descriptive Statistics

Table 1 shows the descriptive statistics of the variables used in this study. It is noted that the ln(Z-score) has a mean value of 4.083 and a standard deviation of 0.7166. This means that for banks to deplete their equity, ROA would have to drop by an average of 4.083 times their standard deviation. The standard deviation of the ln(Z-score) indicates the yearly variation in the level of stability among the Egyptian banks. It can be noted that during these four years of economic turbulence, the annual variation of stability is relatively moderate. Previous studies in Asian countries indicated ln(Z-score) standard deviations of 1.05 and 1.23 (Banna, 2020; Banna & Alam, 2021a).

Table 1: Descriptive Statistics of Variables

Variable	N	Mean	Std. Dev.	Min	Max
Dependent Variable					
Ln(Z-score)	68	4.083183	0.716645	2.954115	6.062338

Independent Variables					
MOBOUTLET	68	618.7559	158.0443	353.3909	756.7934
MOBACC	68	309.8731	74.03170	211.7889	407.6054
MOBTRAN	68	3172.086	2395.516	667.6108	6884.920
Control Variables					
lnTA	68	20.43746	3.506484	14.29423	28.90386
LR	68	0.428061	0.090170	0.250826	0.625738
LLPR	68	0.083056	0.142911	0.011648	1.090837
ER	68	0.102989	0.029025	0.056300	0.161825

The descriptive statistics for the main independent variables showed that the average number of mobile money agent outlets per 1000 km^2 (MOBOUTLET) is 618.756 outlets. This variable's minimum and maximum values indicate that during these four years, the number of outlets has doubled (the maximum value is about 2.1 times higher than the minimum value). This observation is also accurate regarding the increase in mobile money accounts per 1000 adults (MOBACC) during these four years. It is noted that the number of mobile money accounts has doubled during the sample period. The average number is 309.87 accounts. Despite the increase, the results show that there is still a space for improving this number. The impact of the efforts to support the use of digital technology in financial transactions is reflected in the number of mobile money transactions (MOBTRAN) during these four years. The average number of transactions is 3172.086, with a minimum number of 667.61 and a maximum of 6884.920. These numbers indicate an increase of around ten times in the number of mobile transactions during these four years. The movement to cashless transactions during COVID-19 and the efforts of the country to convert most of the government-related transactions to increase the number of transactions executed through mobile wallets.

Regarding the bank-related control variables, the average size of the central banks in Egypt is 20.437, and their standard deviation is 3.506. Bank size varied between 14.294 (the minimum value of bank size) and 26.904 (the maximum value of bank size), indicating a high variation between the sizes of banks involved in the DFI practices. The loan ratio, another important indicator for bank stability as it can reflect the potential credit risk (Rupeika-Apoga, Ramon, Zaidi, Thalassinos, & Thalassinos, 2018), showed an average of 42.8% with a maximum of 62.57% and a minimum of 25.08%. The percentage of loan ratio shows that some banks are expanding their loan portfolio to the extent that 62.57% of their total assets are in the form of loans.

This high percentage may expose banks to credit risk and negatively impact their stability.

5.2 Banking Stability and Digital Financial Inclusion:

In this subsection, the main findings of the analysis are discussed. The study utilizes panel least square regression to find the relationship between DFI and bank stability by controlling for SIZE, LR, LLP, and ER.

The findings in Table 2 show that the overall ability of the independent variables (DFI proxies and bank-related control variables) to describe the variation in the dependent variable corrected by the standard error equals 21.68%, the value of adjusted R^2. The R^2 and adjusted R^2 values suggest that other factors not included in this model may influence the banking sector's stability. The level of competition among banks (Chinoda & Kapingura, 2023; Bekir et al., 2023) and other macroeconomic variables such as annual GDP growth, good governance and political stability, and other factors (for example, Ahamed & Mallick, 2019; Banna et al., 2020).

The three proxies of DFI, whether the access proxy (number of registered mobile money agent outlets/1000 km^2) or the usage proxies (number of mobile money accounts and number of mobile money transactions per 1000 adults), showed a significant effect on the banking stability (Z-score). Their probabilities are 0.0226, 0.000, and 0.0000, respectively.

Regarding the direction of the relationship between the proxies and bank stability, MOBOUTLET, the variable used as a proxy for the geographical penetration of DFI services, showed a negative relationship with bank stability (β=-0.002937). So, increasing the geographical penetration of digital financial services through agent outlets will lead to higher bank instability. However, the number of mobile money accounts per 1000 adults (MOBACC) positively correlates with bank stability (β=0.024802). Expanding the reach of financial technology tools (i.e., mobile accounts) increases banks' stability. The number of mobile money transactions per 1000 adults (MOBTRAN) harms the banking sector's stability (i.e., Z-score). The negative effect of MOBOUTLET and MOBTRAN supports the hypothesis developed in an earlier section. However, the MOBACC did not support the hypothesis as it showed a positive relationship with Z-score. So, it can be concluded that the owners of mobile money accounts are not fully utilizing them. In other words, the availability of technology encourages people to open new mobile money accounts. However, they rarely use them in

performing actual transactions. This is why they are not following a similar direction as other measures of DFI. While the number of transactions and outlets reflects the actual use of financial technology, the number of mobile accounts does not necessarily reflect the actual usage of these accounts. Adults may be opening mobile money accounts without conducting financial transactions through them. It is worth mentioning that the Central Bank of Egypt recently decided (effective as of January 1st, 2024) to exempt individuals from transfer fees via mobile accounts and instant payment networks (CBE, 2023). This decision will encourage people to activate and perform transactions through their accounts.

Generally, the findings are consistent with Banna's (2020) findings in the study conducted in Bangladesh. This can be attributed to the fact that Egypt is still in the early stages of activating digital financial inclusion and the positive results of this policy. On the other side, the number of mobile money accounts per 1000 adults has a positive impact on stability. These results are consistent with previous literature conducted in various countries regarding the significance of the effect of DFI measures. However, most previous literature used the Digital Financial Inclusion Index rather than proxies (see Banna et al., 2020; Banna & Alam, 2020; Banna & Alam, 2021a, b; Banna et al., 2022). So, they did not provide results about the impact of each DFI indicator on the stability of the banking sectors examined in their studies.

Table 2: Panel Least Squares Method Results

	Coefficient	***Std. error***	**t-Statistics**	**Prob.**
MOBOUTLET	-0.002937	0.001256	-2.339031	0.0226
MOBACC	0.024802	0.004492	5.521348	0.0000
MOBTRAN	-0.000593	9.73E-05	-6.098260	0.0000
Ln (TA)	0.082217	0.021069	3.902274	0.0002
	Coefficient	***Std. error***	**t-Statistics**	**Prob.**
LR	-2.086530	0.986440	-2.115213	0.0385
LLPR	0.264383	0.586720	0.450611	0.6539
ER	-7.020596	3.039755	-2.309593	0.0243
R-squared	0.286945			
Adjusted R-squared	0.216809			

The control variables of size, loan ratio, and equity ratio significantly impact the banking sector's stability during economic instability. The results indicated that, in Egypt, their stability increases as the size of the banks increases. This is supported by the positive sign of the natural logarithm of total assets (β= 0.082217). This result is consistent with the theoretical claim that it is "too big to fail." The supporters of this view argue that banks with larger sizes are more stable than those with smaller sizes (Mishkin, 1999). The other control variable that significantly affected bank stability is the loan ratio (LR) (P=0.0385) at a significance level of 5%. The results showed a negative relationship between loan ratio and bank stability (β= -2.086530). This means that as banks expand their lending activities and widen the base of the lenders, their stability is threatened. Also, the equity ratio significantly impacted the banking sector's stability (p= 0.0243). The equity ratio negatively relates to the Z-score (β= -7.020596). This finding supports the "regulatory hypothesis" that regulators require high bank capital to respond to higher risks (Ernaningsih, Smaoui, & Temimi, 2023). The finding is justifiable in terms of the period covered in the study, which is characterized by increased risk due to the instability of the economic circumstances and the uncertainty about the future consequences of the unrest in the surrounding countries. Finally, the loan loss provision ratio showed an insignificant effect on the bank stability.

6. Conclusion

This paper examines the relationship between DFI and the stability of the Egyptian banking sector. Previous studies in the Egyptian context focused mainly on investigating financial inclusion practices and their impact on the performance of the banking sector. Consequently, this study was motivated by the scarcity of research about digital financial inclusion. The study used a sample of 17 banks the Central Bank of Egypt announced as the banks involved in digital financial activities such as electronic wallets. The observations belong to the period from 2019 to 2022. This period was selected as it reflects the severe actions by the Egyptian government toward activating DFI motivated by the COVID-19 pandemic and the movement to cashless transactions. The period also reflects economic instability due to the impact of the pandemic, followed by the war between Russia and Ukraine. The study found a significant effect of all digital financial indicators on banks' stability. However, it suggests that the expansion in the usage of DFI is associated with

a negative influence on banking stability. The exception is the number of mobile money accounts per 1000 adults.

This study has some limitations that open the avenue for future research. The sample included only 17 operating banks. Future research can depend on an expanded sample. The study covered banks' data only during 2019-2022, as researchers believe this period witnessed the rise of digital financial inclusion practices and economic turbulences. Future research can expand the period covered in the study and conduct a comparative study between the impact of financial inclusion and digital financial inclusion on bank stability. Additionally, this study could not control for the effect of COVID-19 and the Russian-Ukrainian war as the study was mainly conducted during the period in which these two events are taking place (i.e., 2019-2022). Future research needs to replicate the study during another period to control and measure their effect. Finally, the study is based on country-level annual data about DFI proxies rather than bank-related data. Future research can collect bank-based DFI indicators. Banks are encouraged to publish information about bank-related digital financial inclusion indicators in their annual reports.

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Appendix

Table 1A: Variables Definition

Variable	Description
Z-Score	A measure of stability, measured as the sum of bank return on asset (ROA) and equity-to-asset ratio divided by the standard deviation of return on assets over the sample period
MOBACC	Is the number of mobile money accounts per 1000 adults. This measure reflects the usage aspect of DFI.

MOBTRAN	The number of mobile money transactions per 1000 adults. This measure reflects the usage aspect of DFI.
MOBOUTLET	The number of registered mobile money agents per 1000 km^2. This measure reflects the access aspect of DFI.
Size (lnTA)	Bank size is measured as the natural logarithm of each bank's total assets.
LR	The ratio of total loans to total assets of each bank per year.
LLPR	The ratio of loan loss provision to total loans.
ER	The ratio of equity to total assets.