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The Impact of Internal and External Factors on Credit Risk during Periods of Economic Instability:
A Study of the Egyptian Banking Sector

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Abstract

The research investigates the impact of internal and external factors on credit risk of the Egyptian banking sector during periods of economic instability. Data of the listed banks are used for the sample period from 2012 to 2022. The study conducts a comparative analysis of Egypt's periods of economic instability, primarily focusing on the devaluation of the Egyptian currency. Thus, the studied periods are divided into two samples: the pre-devaluation period from 2012 to 2016 and the post-devaluation period from 2017 to 2022. The study employs an econometric technique that suits the dynamic nature of the estimated models, which is the system Generalized Method of Moments (GMM) to analyze the relationship between bank-specific factors and macroeconomic factors on bank credit risk. The results highlight a significant change in the determinants of credit risk post-devaluation, indicating the increased impact of external economic challenges. The study concludes that economic instability increases credit risk, with macroeconomic challenges influencing the sensitivity of credit risk to different factors. Key recommendations include the need for Egyptian banks to enhance their risk management strategies to better adapt to macroeconomic fluctuations, and the implied need to continuously improving regulatory frameworks in line with the Basel regulations.

KeyWords: Credit Risk, Internal Factors, External Factors, Economic Instability, Egyptian Banking Sector.

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أثر العوامل الداخلية والخارجية على مخاطر الائتمان خلال فترات عدم الاستقرار الاقتصادي: دراسة للقطاع المصرفي المصري

ملخص البحث

يتناول البحث تأثير العوامل الداخلية والخارجية على مخاطر الائتمان للقطاع المصرفي المصري خلال فترات عدم الاستقرار الاقتصادي. وقد تم ذلك باستخدام بيانات البنوك المدرجة بالبورصة لفترة العينة من 2012 إلى 2022. وبالتالى، تجري الدراسة تحليلا مقارنا لفترات عدم الاستقرار الاقتصادي في مصر، مع التركيز بشكل أساسي على انخفاض قيمة العملة المصرية. وتنقسم الفترات المدروسة إلى فترتين: فترة ما قبل تخفيض قيمة العملة من 2012 إلى 2016 وفترة ما بعد تخفيض قيمة العملة من 2017 إلى 2022. وتستخدم الدراسة الأساليب الإحصائية التي تتناسب مع الطبيعة المتغيرة لنموذج الدراسة، وهي طريقة (GMM) لتحليل العلاقة بين العوامل الخاصة بالبنوك وعوامل الاقتصاد الكلي على مخاطر الائتمان المصرفي. وتسلط النتائج الضوء على حدوث تغير كبير في محددات مخاطر الائتمان بعد تخفيض قيمة العملة، مما يشير إلى زيادة تأثير التحديات الاقتصادية الخارجية. وقد خلصت النتائج إلى أن عدم الاستقرار الاقتصادي يزيد من مخاطر الائتمان، مع تأثير تحديات الاقتصاد الكلي على حساسية مخاطر الائتمان للعوامل المختلفة. وتتضمن التوصيات الرئيسية حاجة البنوك المصرية إلى تعزيز استراتيجيات إدارة المخاطر لديها للتكيف بشكل أفضل مع تقلبات الاقتصاد الكلي، والحاجة الضمنية إلى التحسين المستمر للأطر التنظيمية بما يتماشى مع لوائح بازل.

الكلمات المفتاحية: مخاطر الائتمان، العوامل الداخلية، العوامل الخارجية، عدم الاستقرار الاقتصادي، القطاع المصرفي المصري

1- Introduction

The banking sector plays an important role in the economic stability of any country, whereas it plays an intermediary role by collecting excess amounts of money from savers and lending loans to borrowers, thereby converting those deposits into productive investments. Banks are considered the backbone of the economy and a primary contributor to its survival and growth, as they provide credit and enable firms and households to save, invest, and increase their spending (Naili & Lahrichi, 2022). Banks face many risks due to their dynamic structure and the complexity of the economic environment in which they operate. According to Koch and MacDonald (2014), the risks include credit risk, liquidity risk, market risk, operational risk, and legal risk. Each of these risks has the potential to have a negative impact on the profits, market value, liabilities, and equity of financial institutions. The primary source of income in the banking sector consists of loans granted by commercial banks. Therefore, credit risk is one of the most important risks faced by banks. As per Naili and Lahrichi (2022), central bankers agree that credit risk was a major contributor to the financial sector's challenges during financial crises, often reflected in the number of non-performing loans held by banks. The Basel Committee on Banking Supervision (2000) defines credit risk as the probability that a bank's borrower or counterparty will fail to meet their obligations according to the loan agreement, resulting in the potential for partial or full loss of the outstanding loan due to non-payment.

In Egypt, the country with a unique economic environment and periods of significant instability, which leads to understanding the dynamics of bank credit risk to become increasingly critical. The Egyptian banking sector has passed through substantial regulatory changes and reforms in recent years, mostly in response to global financial crises and local economic challenges. The goal of these reforms was to make Egypt's banks more resilient and align Egypt with international banking standards, especially the Basel Accords. However, economic events such as currency fluctuations, inflation, and other macroeconomic factors continue to pose challenges to credit risk management in Egypt's banking sector. Therefore, this research explores the factors that affect the credit risk of Egyptian

banks focusing on both bank-specific (internal) and macroeconomic (external) variables during periods of economic instability, particularly during the devaluation of the Egyptian currency. The study employs quantitative methods to analyse panel data from eleven banks listed on the Egyptian Stock Exchange from 2012 to 2022. Therefore, this research will conduct a comparative analysis of Egypt's periods of economic instability, primarily focusing on the devaluation of the Egyptian currency. Thus, the research's periods are divided into two samples: the pre-devaluation period from 2012 to 2016 and the post-devaluation period from 2017 to 2022. This study aims to illustrate the impact of each independent variable on credit risk, addressing the following research questions: "How did bank-specific factors affect bank credit risk in Egypt before and after the currency devaluation?" and "How did macroeconomic factors affect bank credit risk in Egypt before and after the currency devaluation?". This research aims to serve as an initial resource for future studies in the accounting field, as it investigates the effect of the financial performance on credit risk and other factors, which encouraging further investigation of credit risk dynamics in similar economic contexts. The contributions of this research aim to enhance the operational frameworks within banks and inform regulatory practices that can better withstand economic fluctuations. The remaining sections will discuss the literature review of previous studies, then the research methodology to describe the data and regression method used, then the analysis section and the results discussion and finally the research conclusion

2- Literature Review

2-1 Credit Risk

Commercial banks are important players in the financial market which are subject to various risks during their development. One of the important risks they face is credit risk, which also has a significant impact on a nation's economic development (Jiménez et al., 2014). Credit risk is defined by (BCBS, 2000) as the probability of a bank borrower or counterparty failing to fulfil their obligations in accordance with the terms of the loan agreement, as well as the potential of partial or total loss of the outstanding loan due to non-payment of the loan on time.

Therefore, when borrowers, whether firms or households, face difficulties in servicing their debts, their loans might become non-performing. According to the International Monetary Fund (IMF, 2005), a non-performing loan is typically defined as "when interest and principal payments are past due by 90 days or more, or at least 90 days of interest payments have been capitalized, refinanced, or delayed by agreement, or payments are less than 90 days overdue, but there are other good reasons to doubt that payments will be made in full".

Furthermore, determinants of bank credit risk have been discussed by Naili and Lahrichi (2022), who confirmed that these determinants are bank-specific factors, macroeconomic factors, and industry-specific factors. They stated that industry-specific and macroeconomic variables are difficult for bank management to control, whereas bank-specific variables are under their control. The bank-specific factors include bank size, bank performance, loan growth, bank inefficiency, ownership concentration and diversification. However, the macroeconomic factors are GDP growth, inflation, public debt, and unemployment, while the industry-specific factor is interbank competition/concentration. Also, Twum et al. (2020) indicated that the variables affecting the bank credit risk are both internal (microeconomic) and external (macroeconomic). In their study, the authors used bank solvency and operational efficiency variables as internal factors and GDP growth rate, interest rate and inflation rate as external factors. Moreover, Alnabulsi et al. (2022) stated that the determinants of bank credit risk are bank-specific, macroeconomic, industry-specific, and institutional quality variables. The bank-specific variables include return on assets, return on equity, bank size, capital adequacy ratio, loan loss provision, non-interest income, and loan to deposit ratio; and the industry-specifics variables are the level of concentration and competition. However, the macroeconomic variables include growth rate of GDP, inflation rate, and unemployment rate, while the institutional quality variables include control of corruption, political stability, and rule of law.

Additionally, many previous studies (e.g., Akhter, 2023; Priyadi et al., 2021; Ahmed et al., 2021) categorized the determinants of credit risk into firm-specific (internal) determinants and macroeconomic (external) determinants. However,

some authors focused only on one of the two categories. For example, Koju et al. (2018) and Barra and Ruggiero (2022) investigated the impact of banking management (bank-specific variables) on credit risk, including non-interest income, return on assets, capitalization, bank size, cost inefficiency, loan growth, and the volume of credit market variables. On the other hand, Anita et al. (2022) and Foglia (2022) examined the impact of macroeconomic variables on bank credit risk, including money supply, GDP growth, exchange rate, government budget balance, inflation, sovereign debt, public debt, unemployment rate, and domestic credit. Also, Alzoubi and Obeidat (2020) investigated only the effect of bank size and the loan size on bank credit risk. However, other studies explored the relationship between liquidity risk and credit risk, declaring that liquidity risk is one of the determinants of credit risk (e.g., Imbierowicz & Rauch, 2014; Diamond and Rajan, 2005; Ghenimi et al., 2017; Bouslimi et al., 2024; Acharya and Naqvi,2012).

The financial ratios used to measure credit risk in previous studies are the non-performing loans to total loans ratio, the loan loss reserve to total loans ratio and the loan loss provisions to total loans ratio. Most studies use the ratio of non-performing loans to total loans as a proxy for bank credit risk, as it represents the loan quality of a bank according to (Akhter, 2023; Naili & Lahrichi, 2022; Priyadi et al., 2021; Twum et al., 2020; Ahmed et al., 2021; Anita et al., 2022; Alnabulsi et al., 2022; Koju et al., 2018; Barra & Ruggiero, 2022; Foglia, 2022; Ha, 2020). Other studies measure credit risk by the loan-loss provisions to total loans (e.g., Alzoubi & Obeidat, 2020; Javid et.al, 2020; Harb et al., 2022). While other studies (e.g., Kosmidou, 2008; Ha, 2020; Noman et al., 2015; Pervan et al., 2015) measured credit risk through the ratio of loan loss reserve to total loans. According to Kosmidou (2008), this ratio is used as an indicator of a bank's asset quality and shows the proportion of a bank's total loans that have been extended but not written off. A high ratio signifies lower asset quality and a higher level of credit risk for the bank, as it suggests difficulties in loan repayment by customers. Therefore, lower of those ratios indicate better asset quality and fewer doubtful loans, which reduces credit risk. Also, Pervan et al. (2015) declared that higher

reserves compared to total loans indicate that bank customers are less able to repay their debts, which increases the bank credit and reduces the bank's profitability.

2-2 Bank-Specific Variables

2-2-1 Bank Capitalization

In 1988, the first Basel Accord was established to set minimum capital requirements for banks and impose restrictions on the use of their financial leverage aiming to minimize credit risk. In this sense, the capital requirement, measured by the bank's capital adequacy ratio (CAR) and used universally by regulators, determines the amount of equity that banks must keep aside as protection against excessive risk exposures (BCBS, 1988). Naili and Lahrichi (2022) examine the determinants of non-performing loan which is a proxy of credit risk for a sample of 53 banks listed in five Middle East and North African (MENA) emerging markets between 2000 and 2019. One of the determinants of NPL is capital adequacy as the authors conclude that there is a significant and negative relationship between banks' capital adequacy and the level of NPLs. This negative relationship can be explained by the fact that banks with high CARs are more likely to stay away from making risky loans to maintain the capital reserves, which are often kept aside as a safety net against excessive risks.

Also, there are other studies that supported the negative relation between capital adequacy and NPL (Akhter, 2023; Barra & Ruggiero, 2022; Alzoubi & Obeidat, 2020). As Akhter (2023) studies the determinants of commercial bank's NPLs in Bangladesh. The study used data from 30 commercial banks in Bangladesh throughout the period of 2011 to 2020 and declared that banks seek to avoid risky lending to protect their capital, so improved capital adequacy leads to control banks problem loans. Moreover, Barra and Ruggiero (2022) examine the impact of bank-specific factors on credit risk in Italy by examining two distinct categories of banks: cooperative and non-cooperative (commercial and popular) in various local markets using bank-level data over the 1994–2015 period. The authors supported the same results that a higher level of bank capitalization reduces credit risk because it allows banks to protect themselves against risks that

could affect their balance sheets, with beneficial effects for the stability of the financial system and, consequently, for the real economy. Also, Alzoubi and Obeidat (2020) conclude that there is a negative and significant effect of capital adequacy ratio on bank credit risk. Furthermore, Alnabulsi et al. (2022) supported the same results that there is a negative relationship between the capital adequacy ratio and bank credit risk in the whole sample and the Middle East region models after examining the determinants of non-performing loans in the Middle East and North Africa region under financial crisis and health crisis for the period of 2005-2020. The authors declared that banks with enough capital are less exposed to credit risk, as higher capital adequacy ratio discourages banks from taking excessive risks, leading them to be more cautious and prudent in their lending practices, which in turn reduces the likelihood of non-performing loans. However, Alnabulsi et al. (2022) concluded that in the model of North Africa region, the relationship became significantly positive, indicating that well-capitalized banks sometimes might engage in risk-taking behaviour by providing bad loans with minimal guarantees. As high levels of information asymmetry, poor governance, and poor loan quality all contribute to the rise in non-performing loans (NPLs) in North African countries.

Additionally, some studies support this opposing view, which argue that CAR is statically and positively linked to NPLs/NPF. Exploring the effect of CAR on the quality of loans, Priyadi et al. (2021) examine the influence of internal and external factors on the credit risk (represented by nonperforming financing NPF) of Indonesian Sharī ʿah rural banks (SRBs) for the period 2010–2019. The authors declared that CAR has a significant and positive relationship with NPF in the long run. Consequently, it increases the potential for NPF to increase because of ineffective procedures for screening and monitoring potential clients. On the other hand, Priyadi et al. (2021) also conclude that in the short-run CAR does not influence NPF. This indicates that NPF is unaffected by the amount of capital held by Islamic banks. Moreover, Koju et al. (2018) examines the effect of banking management on credit risk using a sample of Indian commercial banks for the period of (2000-2013), supporting the findings of Priyadi et al. (2021) and

Alnabulsi et al. (2022), declaring that there is a positive relationship between capital adequacy ratio and credit risk which indicates that banks with higher capitalization tend to take more risks than banks with lower capitalization. (Akhter, 2023; Barra & Ruggiero, 2022; Alzoubi & Obeidat, 2020; Alnabulsi et al., 2022; Koju et al., 2018) measures the CAR by dividing the total equity by total assets. However, Naili and Lahrichi (2022) and Akhter (2023) measures it as total capital to total risk-weighted assets.

2-2-2 Operational Efficiency

Furthermore, previous studies discussed operational efficiency as another factor that affects bank credit risk. This variable is commonly measured using the cost-to-income ratio to assess variability of banks' costs. This ratio measures the efficiency in an organization's performance and shows how the bank controls the operating cost efficiently and effectively. Many studies examine that there is a negative relation between operational efficiency and credit risk. Twum et al. (2020) analyses the influencing factors of credit risk for listed banks in China through investigating the impact of internal and external factors on credit risk for the period 2005 to 2018. According to the authors, operational efficiency is a necessary component of China's banking system and is a routine, difficult, and valuable task in banking activities. It is also an important benefit to the country's large commercial banks. They also declared that banks have been implementing system and mechanism changes in order to increase the efficiency and professionalism of customer service by organizing and adjusting organizational structures and process mechanisms. Therefore, the authors concludes that operation efficiency revealed an inverse and statistically significant relationship with credit risk implying that, the managements of commercial banks need to be more efficient in the daily activities of the banks to help reduce the potential occurrences of credit risk in banks. Therefore, effective operations of banks management reduce the occurrence of credit risk since all the needed procedures will be followed before issuing loans to borrowers. Moreover, the advancement in financial technology is an important driving force for the improvement of quality and efficiency in the entire banking industry. Also, Ahmed et al. (2021) supported the

same results as they examine macroeconomic factors and bank-specific factors that affected the amount of nonperforming loans (NPLs) for Pakistan commercial banks between 2008 and 2018. The results show that efficient cost management decreases the probability of a high NPLs ratio. Therefore, it is mandatory for banks to have effective cost management as it is required to reduce NPLs and improve the quality of the balance sheet. Ahmed et al. (2021) measures the operating efficiency by the ratio of non-interest expenses to total assets.

Furthermore, Naili and Lahrichi (2022) also declared that there is a negative relationship between bank efficiency and NPLs, which is measured by dividing operating expense by operating income. According to the authors, the quality of banks' loan portfolios is correlated with the costs incurred in the credit assessment and evaluation procedures. This indicates that banks that allocate insufficient resources to perform proper loan analysis and underwriting are cost efficient in the short run, yet they will incur higher loan losses in the long run. On the other hand, banks that allocate the required resources to loan assessment have a higher chance of reducing their non-performing loans. On the other hand, Priyadi et al. (2021) conclude that there is insignificant relation between operating efficiency and credit risk. The authors use operating expenses ratio which is measured by dividing the operating expense by the operating income as a proxy of operating efficiency. Therefore, the authors found that the operating expense ratio has no effect on NPF, which indicates that the efficiency or inefficiency of SRBs does not influence NPF in the long run. Moreover, Koju et al. (2018) previously supported the same results of Priyadi et al. (2021) concluding that there is an insignificant relationship between the operating efficiency and credit risk. The authors measured this variable by dividing the operating expenses by total assets.

2-2-3 Bank Size

Bank size is another important bank-specific factor that affect bank credit risk and has been frequently examined, given that the behaviour of larger banks differs, noticeably, from smaller ones. Previous studies measured bank size using the logarithm of total assets, as different sizes are expected to affect bank credit risk (Ahmed et al., 2021; Naili & Lahrichi, 2022; Akhter, 2023; Alzoubi & Obeidat,

2020; Koju et al., 2018; Barra & Ruggiero, 2022). There is mixed evidence from previous studies about the direction of relation between bank size and bank credit risk. Ahmed et al. (2021) stated that there is a negative relation between bank size and NPL. The authors conduct a comparison and split the sample into large banks and small banks and analyse the effect of both with the other bank-specific factors and macroeconomic factors and conclude that larger banks are efficient in management, better in handling the economic concerns and have higher profitability which significantly reduces their NPLs ratio. Moreover, Naili and Lahrichi (2022) supported the same results and found that bank size in MENA emerging markets has a negative relationship with the level of non-performing loans (NPLs). They argue that larger banks have more advanced risk management systems and can conduct appropriate loan screening and deal with defaulters, thereby the level of NPLs reduced. On the other hand, small-sized banks are more likely to allocate limited resources to risk management procedures, which causes the rise of NPLs. Another study supports the same results, Alzoubi and Obeidat (2020) analyses the effects of the bank size and it financing to customer on credit risk using a sample of 48 Islamic banks from 16 countries around the world over the period from 2008 to 2018 and argue that bank size is significantly and negatively linked to credit risk and declared that larger banks are more able to reduce risks through diversification of their assets portfolio.

Alternatively, Ahmed et al. (2021) reports that there is a positive but insignificant relationship between bank size and non-performing loans, suggesting that larger banks may not always be more effective in screening loan applicants than their smaller competitors. As banks become bigger, they tend to use funds for more proposals with less monitoring loan policy which increases their non-performing loan (NPL) ratio. Moreover, Barra and Ruggiero (2022) supported the same findings and concluded that the ratio of non-performing loans is not particularly affected by banks' size. However, Koju et al. (2018) concludes that there is a positive significant influence of bank size on credit risk (NPA) as larger banks are more likely to increase lending activity to generate monopoly profits. Also, due to their government protection, large banks tend to lend more money

to riskier sectors, which increases the probability of bad loans. The authors also declared that larger banks employ less efficient lending methods than smaller ones which results in the possibility of bad loans does not always decrease with bank size. Moreover, Alnabulsi et al. (2022) supported the same finding indicating that there is a positive relationship between bank size and credit risk. The authors declared that some larger banks have more liberal credit policies, which increases the likelihood of NPLs and might face governance problems that affect decision-making and decrease loan quality.

2-2-4 Bank Diversification

Prior studies suggest that banks' diversification exercises a significant influence on the banks' credit risk. According to Ahmed et al. (2021), the two main sources of income for banks are interest and non-interest. Interest can be earned by different types of investment securities and loans, while non-interest earnings can be obtained through trading, asset management, fee-and commission-paying services, and derivatives. A crucial source of diversification in the modern banking system is non-interest income. According to Naili and Lahrichi (2022), there is a negative relationship between NPLs and banks' diversification as when banks expand and diversify their activities, their focus on credit may change and their lending may decline, which may result in a decreased level of NPLs. The authors also conclude that larger banks are typically more diversified than their smaller counterparts, which lowers their exposure to risk and, consequently, the level of bad loans. However, the negative relationship between diversification and banks' credit risk is found to be insignificant, implying that in the sampled MENA emerging nations, diversification may not always has an effect on banks' risk behaviours. As a fact, banks in the MENA region continue to be less diverse than their counterparts in developed countries.

Also, Naili and Lahrichi (2022) supported the declaration of Ahmed et al. (2021) that gains on non-hedging derivatives, venture capital, insurance brokerage fees, investment banking, trading and securitization revenue, and gains on non-interest derivatives represents most of the non-interest income, which is the proxy for bank diversification and measured it by dividing the non-interest in-

come by total revenues. These activities are still underdeveloped in the sampled countries. The primary functions of MENA banks in this domain are lending and collecting interest which may explain the insignificance of the diversification–credit risk relationship. Moreover, the results of Alnabulsi et al. (2022) are aligned with the previous studies, determining that the bank diversification has a negative relationship with bank credit risk, measuring it by the non-interest income to total revenues. Moreover, Koju et al. (2018) investigated the impact of banking management on credit risk using a sample of Indian commercial banks. The authors conclude that there was a significant inverse relationship between income diversification and bank credit risk (NPAs). This finding supports the general belief that banks rely on sources of income other than interest to lower credit risk. The authors declared that the results also support the finance theory, which states that diversification of income sources lowers risk and increases risk-adjusted performance. They recommended that banks need to broaden their income diversification to enhance credit quality and decrease the chance of banking crises. In this study, non-interest income to total assets was used as proxies for the diversification.

2-2-5 Bank Profitability

Bank Profitability is another determinant of bank credit risk as maximization of profit is one of the core objectives of banks and it's affected the bank credit risk. Numerous studies have attempted to examine the relationship between credit risk and bank profitability, also researchers investigated whether the level of credit risk is affected by profitability or not. Most of the studies declared that profitable banks should have less credit risk since they seem to have a stronger desire for growth and a strong safety net against shocks (Naili & Lahrichi, 2020). Moreover, many researchers have found that banks with high levels of profitability are less likely to participate in high-risk operations, resulting that profitability has a negative impact on credit risk (Naili & Lahrichi, 2022, Ahmed et al., 2021, Akhter, 2023, Koju et al., 2018). Based on the previous studies, bank profitability is measured using financial ratios such as net interest margin (NIM), return on assets (ROA), and return on equity (ROE) which are considered ac-

counting-based measures for bank profitability. Return on assets (ROA) is a financial performance proxy that is used to show earnings from the use of a bank's assets over a specified period and reflects the level of effectiveness of banks in managing their assets to generate profit; a higher ROA indicates a better performance by a bank and is defined as the ratio of net income to total assets. The return on equity (ROE) measures the return to shareholders on the equity invested. It is a profitability indicator calculated by dividing the bank's net income by the total equity. A high ROE indicates an efficient use of the bank's equity and better managerial performance. Lastly, the net interest margin (NIM) represents the third indicator of bank profitability. It is expressed by the difference between the interest income generated by a bank and the interest paid out to depositors and creditors, divided by the average amount of their interest-earning assets. The net interest margin (NIM) is defined as the ratio of net interest income to total assets. A higher NIM indicates a more profitable bank, as it suggests that the bank is earning more from its lending activities relative to its borrowing costs.

Naili and Lahrichi (2022) reports a negative relationship between bank profitability and credit risk in the considered emerging markets (MENA region and North Africa) using ROE as a proxy of bank profitability. The authors declared that banks that experience low profitability are more likely to take on more risk and implement a flexible credit policy to cover up past losses and maintain an acceptable level of current profitability which leads to higher non-performing loans in the future therefore highly profitable banks are less likely to make risky loans, which minimizes their credit risk. Moreover, Ahmed et al. (2021) supports the same findings that profitable banks are less likely to have higher NPLs ration in Pakistan as findings show negative correlation between ROA and NPLs in Pakistan. The findings indicate that profitable banks are efficient in managing costs and their loan exposure is relatively secure which reduces the likelihood of having significantly higher non-performing loans. Furthermore, Akhter (2023) uses the ROE ratio as a proxy of bank profitability and concludes that ROE has a significant and negative impact on bank credit risk and explains that profitable banks tend to have better management in their operation system and face fewer

problems on the loan repayment system which lead to decrease the level of non-performing loans (NPLs). Also, Koju et al. (2018) supports the same findings and declared that banks with higher profitability tend to use loan resources more efficiently and have lower default risk. The authors use the ROA as a proxy of bank profitability and concludes that there is a negative relationship between the ROA and credit risk which signifies that performing banks are more likely to enhance their asset quality by making safe loan advances. Additionally, Alnabulsi et al. (2022) also concluded that profitable bank has a negative relationship with bank credit risk, using ROE and ROA as proxies of bank profitability, indicating that increase in banking profitability significantly decreases the level of NPLs. On the contrary, Priyadi et al. (2021) concludes that profitability or ROA has a significant positive influence on NPF in the long run and declared that a high profit resulted from a high level of financing distributed, lead to a high level of non-performing loans. The authors also determines that SRBs face competition not only with conventional banks but also with Islamic commercial banks, which could lead them to raises their level of financing to generate higher profits, and this may lead to a high NPF also.

2-2-6 Liquidity Risk

Bank liquidity risk is a critical aspect of financial stability and is defined as the risk that a bank will be unable to meet its short-term financial obligations due to an imbalance between its liquid assets and liabilities (BCBS, 2008). This risk can arise from various factors, including sudden withdrawals by depositors, unexpected disbursements of loans, or an inability to liquidate assets quickly without significant loss. The global financial crisis of 2008 highlighted the importance of effective liquidity risk management, as many banks faced severe liquidity shortages that threatened their solvency (Brunnermeier, 2009). Effective liquidity risk management involves maintaining an adequate level of high-quality liquid assets, ensuring diversified funding sources, and conducting regular stress testing to assess the bank's resilience to liquidity shocks (BCBS, 2013). Acharya and Naqvi (2012) discussed the relationship between liquidity risk and credit risk in the banking sector. The authors argued that during times of crises, businesses and

household depositors engage in what is known as a "flight for quality". This expression describes the process by which individuals and businesses deposit assets into banks, leaving the banks flush with liquidity and less able to oversee both new and existing borrowers, which potentially increasing credit risk as banks with high liquidity may have loan portfolios that include many bad or risky loans. Moreover, Bouslimi et al. (2024) examined the reciprocal link between credit risk and liquidity risk in Tunisia, concluding that there is positive correlation between these two risks, suggesting that higher levels of liquidity risk can lead to increased credit risk. Moreover, Diamond and Rajan (2005) previously supported the same results that there is a positive relation between these two variables. The authors concluded that banks collect money from unskilled depositors to fund loans for various economic projects. Problems can occur when these projects do not generate sufficient returns, leaving the bank unable to meet the demands of depositors. This deterioration of assets leads more depositors to withdraw their money, forcing the bank to call in loans and consequently reducing overall market liquidity and increasing credit risk. Hence, larger liquidity risk is correlated with a higher credit risk.

On the other hand, there are other studies stating that there is insignificant relationship between the liquidity risk and credit risk. Imbierowicz and Rauch (2014) investigate the relationship between liquidity risk and credit risk through analysing data from non-default and default commercial banks in the United States from 1998 to 2010. Their findings indicated that there is no reliable relationship between credit risk and liquidity risk. Also, Ghenimi et al. (2017) examined the relationship between liquidity and credit risk as well as how it affects the stability of banks for banks operating in MENA region for the period of 2006-2013. The authors showed that there is insignificant causal contemporaneous or time-lagged relationship between credit risk and liquidity risk. Therefore, it can be said that there is considerable uncertainty about the link between credit and liquidity risks. Thus, the lack of clear results highlights the need for additional empirical research in various contexts to reach more useful conclusions on the significance of the interaction between the two risk types and the causal links be-

tween them. Different studies use various measures for liquidity risk. Ghenimi et al. (2017) and Ha (2020) measure liquidity risk as the ratio of liquid assets to total assets. Bouslimi et al. (2024) and Alnabulsi et al. (2022) use the loans-to-deposits ratio, while Imbierowicz and Rauch (2014) measure it as the ratio of short-term obligations to short-term assets, including off balance sheet items.

2-3 Macroeconomic Variables

2-3-1 GDP Growth

Economic growth refers to the development of economic activities that leads goods and services to be produced in society and an increase in the wealth of the people (Priyadi et al., 2021). GDP growth is commonly used as a primary indicator of the country's business cycle and represents the monetary value of all goods and services produced within an economy over a specified period. Many studies examine the impact of economic growth on bank credit risk and the majority of the researchers agree that under good economic conditions, both households and firms are more likely to meet their financial obligations. Therefore, many studies conclude that there is a negative relation between GDP growth rate and bank credit risk. According to Twum et al. (2020), when the economy and consumption growth rate are maintained at a high rate over time, consumers can achieve a higher level of consumption. This will play a more important role in improving people's lives and adjusting economic structure which will lead to a reduction in defaults of loans. Therefore, the authors conclude that there is an inverse relationship between credit risk and GDP growth rate, suggesting that GDP growth reduces the probability of credit risk in Chinese commercial banks. Also, Naili and Lahrichi (2022) report a negative relationship between GDP growth and banks' non-performing loans (NPLs), arguing that under good economic conditions, households and businesses are more likely to service their debts, thus reducing the level of bad loans. In contrast, during economic downturns, creditors struggle to meet their debt obligations, which weakens banks' credit quality. Moreover, Akhter (2023) supports the same results, concluding that economic growth of Bangladesh increases income level, which enhance banks' ability to receive timely loan payments. Ahmed et al. (2021) also found a

negative and significant association between GDP growth and NPLs in Pakistan, arguing that higher GDP growth represents a healthier economy and is more likely to decrease banks credit risk. Furthermore, Anita et al. (2022) and Foglia (2022) support these findings, indicating that economic growth improves business performance and increases their payment capacity, leading to a decrease in NPLs. Additionally, during the economic downturn, the borrower's income, and collaterals' value declines, which leads to the borrower's ability to pay its debts decrease. However, Priyadi et al. (2021) declared that there is an insignificant relationship between GDP growth and bank credit risk, indicating that the GDP growth doesn't have a meaningful impact on bank credit risk.

2-3-2 Inflation

Inflation is a key macroeconomic determinant of bank credit risk. It is defined as "the sustained increase in the general prices of goods and services in an economy over time" (Priyadi et al., 2021). Inflation is commonly measured by Consumer Price Index (CPI) which reflects changes in the price level of a basket of goods and services bought by household. Several studies attempted to identify the existence of a causality effect between inflation and banks' credit risk, yet no consensus was achieved (Naili & Lahrichi, 2022; Akhter, 2023; Alnabulsi et al., 2022; Anita et al., 2022; Priyadi et al., 2021; Twum et al., 2020). One strand of literature argues that higher inflation increases the level of credit risk (Naili & Lahrichi, 2022; Akhter, 2023; Alnabulsi et al., 2022). For instance, Naili and Lahrichi (2022) contend that as inflation increases, the level of non-performing loans (NPLs) rises, especially in case of floating rates loans. High inflation reduces the real value of household's income, limiting their ability to repay their debts. In MENA emerging countries, inflation is considered as one of the main concerns of financial regulators as wages are often fixed, which increases the difficulty that households face in repaying debts and deteriorates the quality of banks' loans. Also, Akhter (2023) finds that inflation has a positive relation with banks risk which explains that with the increase in inflation of a country's economy, bank's risk also increases. Similarly, Alnabulsi et al. (2022) find that higher inflation followed by an interest rate floating in the MENA region and North Africa results

in a higher level of NPLs. This is because higher inflation raises financial expenses and reduces borrowers' ability to repay loans.

Conversely, another strand of literature reports a negative relationship between inflation and NPLs (Anita et al., 2022; Priyadi et al., 2021). Anita et al. (2022) conclude that the inflation rate has an adverse relationship with credit risk, as low level of inflation leads to high NPLs in the SAARC economy. Also, Priyadi et al. (2021) report that, in the short run, inflation negatively influences non-performing finance (NPF), as high prices due to inflation may reduce the public's intention to save. Therefore, Islamic banks may have fewer third-party funds and thus be more careful in giving out financing. However, in the long run, Priyadi et al. (2021) find that inflation does not significantly affect financing risk. Moreover, Twum et al. (2020) supports the same findings as they found that inflation has a positive but insignificant relationship with credit risk when only external variables are considered, and it reveals a negative and insignificant relationship with credit risk when both internal and external factors are combined.

2-3-3 Interest Rate

Prior literatures indicate that interest rate has become a dominant factor affecting credit risk, with compelling evidence showing that high interest rates, results in increased levels of credit risk. Ahmed et al. (2021) conclude that higher interest rates lead to higher credit risk in Pakistan. Their study also finds that smaller banks experience a higher coefficient value and greater significance of interest rates on NPLs compared to larger banks. This suggests that larger banks are better equipped to handle market interest rate fluctuations due to their efficient management and greater market control, which enables them to adapt to changing interest rates and secure more loans. Similarly, Twum et al. (2020) supports the same results that interest rate was found to have positive relationship with credit risk, a higher interest rate will lead to higher credit risk. The authors explain that banks, aiming to maximize profits, prefer higher loan interest rates if customers are willing to accept them. A borrower's tolerance for high interest rates reflects a higher risk, and when interest rates fall, consumers may repay fixed-rate loans early and take on new loans at lower rates. Borrowing new debts

to repay old debts will cause banks to lose loan proceeds and cause difficulties for banks to rearrange and claim funds. This can cause banks to lose loan proceeds and face difficulties in managing their funds, leading them to impose penalty interest rates to compensate for lost credit assets. In contrast, Priyadi et al. (2021) find that interest rate negatively influences credit risk in the long term. When bank rates increase, conventional banks tend to increase both their deposit interest rates as well as lending rates to maintain profitability. This can encourage third-party funds to move to conventional banks rather than to Islamic banks or Sharia-compliant financial institutions (SRBs) if the profit rates offered by SRBs are not adjusted accordingly. Consequently, SRBs may reduce their financing, leading to a lower NPF.

3- Methodology

The main objective of this research is to understand how macroeconomic and bank-specific factors affect the credit risk of Egyptian banks during economic instability. Panel data modelling will be employed for a sample comprising eleven banks listed on the Egyptian Stock Exchange. The data of the credit risk and bank-specific variables are gathered from the audited financial statements of each bank, while macroeconomic variables are gathered from different sources, as will be discussed later. The collected data will pass through several tests, including the classical linear regression model assumptions, to ensure the validity of the regression analysis. Subsequently, multiple regression analyses will be conducted to examine various relationships between the dependent and independent variables. This approach enables the testing of the main research hypotheses through theoretical and quantitative data, providing comprehensive answers to the research questions. Finally, the primary goal of this research is to conduct a comparative analysis of Egypt's periods of economic instability, primarily focusing on the devaluation of the Egyptian currency. Therefore, the research's periods are divided into two samples: the pre-devaluation period from 2012 to 2016 and the post-devaluation period from 2017 to 2022.

3-1 Data Collection

The process of collecting data involves multiple steps to select the most reliable source that provides the comprehensive information on Egyptian banks. The financial data for listed banks is accessible through a specialized information dissemination company called "Egypt for Information Dissemination (EGID)." EGID declared that the listed banks are twelve banks, however consistent data is available for only eleven banks, excluding 'Banque Du Caire' due to data unavailability. These banks reported a complete set of quarterly reports for the period 2012-2022. According to the central bank's declaration on their website, the current number of operating banks in Egypt stands at thirty-seven after the merger of First Abu Dhabi Bank with Bank Audi Egypt. Consequently, all the thirty-seven registered banks that are currently operate in Egypt represent the population used in this research. However, the sample of this research comprises the eleven banks listed on the Egyptian Stock Exchange in table (1) for the period 2012-2022, due to data accessibility. This results in 471 observations, as quarterly reports were obtained through EGID. Whereas macroeconomic factors were collected from different sources. The GDP growth data has been obtained from the Ministry of planning and economic development website, inflation data (consumer price index) from the International Financial Statistics Data and interest rate data from the Central Bank of Egypt's website.

3-2 Regression Models Specifications

The research employs multiple regression model which enables the assessment of the impact of various bank-specific, macroeconomic variables (independent) on bank credit risk (dependent variable) especially during the economic instability period, which is the devaluation of the Egyptian currency period. The GMM estimator will be used in conducting a comparative analysis to compare the impact of the internal and external variables on bank credit risk before and after the devaluation of the Egyptian currency. The use of the common panel data estimation methods, such as OLS panel data, to estimate the bank credit risk model might suffer from problems like endogeneity problems. Endogeneity problems arise when an independent variable in a regression model is correlated

with the error term, resulting in biased and unreliable estimates. Therefore, to deal with these problems, the GMM estimation is applied. Additionally, Pervan et al. (2015) declared that the GMM method should be used when there is a dynamic nature of the relationship in the model, instead of utilizing ordinary least square (OLS), random effects (RE) and fixed effect (FE), which can all become biased. There are two types of GMM estimator which are the system GMM developed by Arellano and Bover (1995) along with Blundell and Bond (1998) and the difference GMM developed by Arellano and Bond (1991). Difference-GMM estimator does not employ a system that integrates regressions of levels and first differences, therefore it is less efficient than the system-GMM estimation (Ghenimi et al., 2017). Therefore, this research will use the system GMM in conducting the comparative analysis. Following the previous literature, the fundamental model for this dynamic analysis is:

$$CR_{it} = \alpha_{it} + \delta CR_{t-1} + \beta_1 BP_{it} + \beta_2 CAR_{it} + \beta_3 DIV_{it} + \beta_4 OE_{it} + \beta_5 BS_{it} + \beta_6 LR_{it} + +\beta_7 GDP_{it} + \beta_8 INF_{it} + \beta_9 IR_{it} + \varepsilon_{it} \quad (1)$$

Where: *CR: Credit Risk; BP: Bank Profitability; CAR: Capital Adequacy Ratio; DIV: Bank Diversification; OE: Operating Efficiency; BS: Bank Size; LR: Liquidity Risk; GDP: Gross Domestic Product growth rate; INF: Inflation; and IR: Interest Rate*

Furthermore, the Sargan test is employed in this research to assess the validity of the instruments used in the GMM estimation. Therefore, a p-value greater than 0.05 indicates that the null hypothesis search should not be rejected. This result implies that the instruments employed are valid, all conditions for the moments are met, and there is no evidence of over-identifying restrictions.

3-3 Description of Variables

3-3-1 Credit Risk

Credit risk can be measured using various ratios, including the non-performing loans to total loans ratio, the loan loss reserve to total loans ratio and the loan loss provisions to total loans ratio. In this research, the ratio of loan loss reserve to total loans is used to measure credit risk instead of the other proxies due to the

low transparency within the Egyptian banking industry and the significant absence of historical data for many variables, including loan loss provisions and non-performing loans, therefore data for these variables couldn't be collected.

3-3-2 Bank-Specific Variables

- Bank Profitability

Profitability is measured using two ratios: Return on Equity (ROE) and Net Interest Margin (NIM). Most studies measure profitability using ROE (e.g., Akhter, 2023; Naili & Lahrichi, 2022; Javid et al.,2020; Alnabulsi et al., 2022; Foglia, 2022; Ha, 2020 and Noman et al., 2015). The return on equity (ROE) indicator shows how profitable a bank is and how well it uses shareholder equity to produce returns. On the other hand, the Net Interest Margin (NIM) measures the difference between the interest income generated by banks and the amount of interest paid out to their lenders, relative to the amount of their interest-earning assets, following Ahmed et.al, (2021). Therefore, due to the presence of different arguments about the relationship between bank profitability and credit risk, this research will examine this relationship and compare the varying arguments in the analysis section.

***H1**: Bank profitability has a significant impact on bank credit risk in Egypt.*

ROE = Net pre-tax income / Total Equity

NIM= Net interest income/ total assets

- Bank Capitalization

The capital adequacy ratio is used as a proxy for bank capitalization, indicating how much capital a bank must set aside in relation to its risky assets. Some studies measure the capital adequacy ratio based on Basel II through the proportion of bank's total capital to its total risk-weighted assets (Akhter, 2023; Naili & Lahrichi, 2022; Harb et al., 2022). On the other hand, most studies used the ratio of total equity to total assets to measure the capital adequacy ratio as (Akhter, 2023; Alnabulsi et al., 2022; Koju et al., 2018; Barra & Ruggiero, 2022; Ha, 2020; Noman et al, 2015; Javid et.al, 2020; Kosmidou, 2008; Alzoubi & Obei-

dat, 2020), which is also employed in this research. Hence, many studies in the literature suggest a negative relationship, indicating that higher CARs are associated with lower credit risk, some studies have found a positive relationship. Thus, this research will examine this relationship and compare the differing arguments in the analysis section.

***H2**: Bank capitalization has a significant impact on bank credit risk in Egypt.*

Capital Adequacy Ratio = Total Equity / Total Assets

- **Bank Diversification**

Bank diversification will be proxied by the ratio of noninterest income to total revenue based on previous studies of (Ahmed et al., 2021; Naili & Lahrichi, 2022; Koju et al., 2018; Alnabulsi et al., 2022). This ratio gives insight into the diversification of income sources by calculating the percentage of revenue generated from noninterest activities compared to total revenue. Based on the results of previous studies, the expected relationship between bank diversification and credit risk is negative.

***H3**: Bank diversification has a significant impact on bank credit risk in Egypt.*

Bank Diversification = Non-interest Income / Total Revenues

- **Operational Efficiency**

The operational efficiency is typically calculated using the cost-to-income ratio (CIR), which evaluates a bank's efficiency by calculating the ratio of its costs to its income (Twum et al., 2020; Kosmidou, 2008; Noman et al, 2015; Harb et al., 2022; Naili & Lahrichi, 2022; Priyadi et al., 2021). This ratio provides insights into how well a bank manages its expenses relative to the income it generates. Therefore, it is expected that this variable will have a negative impact because a lower ratio suggests increased effectiveness and efficiency in management, reducing the occurrence of credit risk.

***H4**: Operational efficiency has a significant impact on bank credit risk in Egypt.*

Operational Efficiency = Total Costs / Net Income

- **Bank Size**

According to previous literature, the examination of bank size and its influence on bank credit risk will be conducted by analysing the key indicator of bank assets. The correlation between bank size and credit risk may appear as either positive or negative. Therefore, the literature lacks a definite conclusion regarding the influence of bank size on bank credit risk due to the variation of the results in different studies. Therefore, the analysis section will compare them to the findings. The size of the bank is determined using the log of total assets of the bank, following (Akhter, 2023; Naili & Lahrichi, 2022; Ahmed et al., 2021; Alnabulsi et al., 2022; Koju et al., 2018; Barra & Ruggiero, 2022; Alzoubi & Obeidat, 2020; Javid et.al, 2020; Harb et al., 2022; Kosmidou, 2008; Noman et al., 2015).

H5*: Bank size has a significant impact on bank credit risk in Egypt.*

Bank Size = Natural Logarithm of Total Assets

- **Liquidity Risk**

According to Bouslimi et al. (2024) and Alnabulsi et al. (2022), liquidity risk is calculated using the liquidity management ratio, which is the ratio of total bank loans to total customer deposits which is used in this study. This ratio shows how many loans a bank has in relation to how much of its funding comes from deposits made by customers. Furthermore, Imbierowicz and Rauch (2014) suggested ratio of short-term obligations to short-term assets to be used to evaluate liquidity risk. Some other studies, such as those by Ghenimi et al. (2017) and Ha (2020), have used more liquid assets in the liquidity ratio, expressed as a percentage of total assets. Based on previous studies, the expected sign of the relationship between the liquidity risk and credit risk is positive.

H6*: Liquidity risk has a significant impact on bank credit risk in Egypt.*

Liquidity Risk= Total Loans / Total Customer Deposits

3-3-3 Macroeconomic Variables

- Economic Growth

Economic growth is an important macroeconomic indicator that measures the percentage change in a nation's overall economic output within a specific period. This indicator shows the general health and performance of an economy. Based on previous studies, it is expected that GDP growth will have a negative impact on banks' credit risk because stronger macroeconomic conditions facilitate more efficient bank operations and leads both households and firms to settle their financial obligations. This indicator is calculated through the percentage change in GDP following (Akhter, 2023; Naili & Lahrichi, 2022; Priyadi et al., 2021; Twum et al., 2020; Ahmed et al., 2021; Anita et al., 2022; Alnabulsi et al., 2022; Foglia, 2022; Ha, 2020; Javid et.al, 2020; Harb et al., 2022; Kosmidou, 2008; Noman et al., 2015)

***H7**: GDP has a significant impact on bank credit risk in Egypt.*

GDP Growth rate = % change in GDP

- Inflation

The inflation rate is another significant measure of macroeconomic conditions, representing the overall increase in prices of goods and services within an economy. Inflation is a crucial factor influencing credit risk, and its measurement will involve either the percentage change in consumer prices or the inflation index following (Akhter, 2023; Naili & Lahrichi, 2022; Priyadi et al., 2021; Twum et al., 2020; Ha, 2020; Javid et.al, 2020; Noman et al., 2015; Anita et al., 2022; Alnabulsi et al., 2022;). Many studies in the literature have attempted to determine the existence of a direct relationship between inflation and banks' credit risk; however, no common opinion could be reached. Therefore, the analysis section will compare the arguments made in the literature review to the findings of this study.

***H8**: Inflation has a significant impact on bank credit risk in Egypt.*

Inflation = Consumer Prices (% change) "CPI"

- **Interest Rate**

The interest rate can be considered as a factor contributing to a bank's credit risk because it influences the debt load, as indicated by several studies (Priyadi et al., 2021; Twum et al., 2020; Ahmed et al., 2021; Harb et al., 2022; Ha, 2020; Noman et al., 2015). Based on previous studies, it's expected that interest rates will have a positive impact on banks' credit risk. Based on the central bank of Egypt, the official body responsible for all interest rate decisions in Egypt, this research will use overnight deposit rate as proxy for the interest rate.

***H9**: Interest rate has a significant impact on bank credit risk in Egypt.*

Interest Rate = The Overnight Deposit Rate

4- Empirical Analysis

4-1 Descriptive Statistics

The descriptive statistics are conducted to provide an initial understanding of the data and to describe data from a statistical perspective. Table (1) presents the mean, median, minimum, maximum, and standard deviation of the dependent and independent variables from the main dataset.

Table 1: Descriptive Statistics

Variables	Mean	Maximum	Minimum	Standard Deviation
CreditRisk2	.0959459	.4750779	.008684	.0970775
ROE	.0819197	2.173813	-.1909387	.1031756
NIM	.0098217	.0327797	.000486	.0032188
CAR	.0914304	.1616735	.0428915	.0286138
DIV	-.0988423	2.544227	-.6834564	.1750302
OE	5.172414	166.0205	-492.1581	26.32134
Size	10.73493	11.80184	9.833284	.390759
LR2	.5304646	17.64259	.0985476	.8004374
GDP	.0407328	.098	-.017	.0215867
INF	.0272079	.1047	-.0054	.0216204
IR	.1129253	.1875	.0825	.0325314

Source: Research Analysis Using Stata

As shown in previous table, the results indicate that the mean value of credit risk is 9.5%. This suggests that, on average, banks allocate 9.5% of their total loans to reserves for potential loan losses. This indicates that banks are closely aligning with the regulatory standard set by the CBE, which is 10%. Credit risk ranges from a minimum of 0.86% to a maximum of 47.50%, highlighting significant variability among banks. The highest credit risk, reported by Suez Canal Bank at 47.50%, reflects a very high perceived risk, while the lowest at 0.86% indicates some banks maintain a very low credit risk. The standard deviation of credit risk is 9.7%, which reflects a significant degree of dispersion around the mean, indicating variability in how banks manage credit risk. For the independent variables, the mean Return on Equity (ROE), a measure of bank profitability, is 8.19%. The maximum ROE is exceptionally high at 217%, achieved by Abu Dhabi Islamic Bank due to a one-time gain, while the minimum ROE is -19.09%, also from Abu Dhabi Islamic Bank, which experienced losses in the early years before stabilizing and generating profits. The standard deviation of ROE is 10.31%, indicating substantial variability in bank performance, attributed to factors like management efficiency, financial strategies, market conditions, and risk profiles. Another measurement of bank profitability is the NIM. The mean NIM of 0.97% indicates that, on average, banks are earning a net interest margin of nearly 1%. This positive NIM suggests that banks generally generate more interest income from their assets than the interest expenses on their liabilities. The maximum NIM value is 3.28%, recorded by Commercial International Bank (CIB), reflecting better profitability and efficient interest rate management. While the minimum value is 0.048%, and the standard deviation is 0.32%, suggesting that there is considerable variability in the NIM values, indicating fluctuations in the bank's profitability across the observed period and data.

The capital adequacy ratio (CAR), a proxy for bank capitalization, has a mean of 9.14%, and this ratio is not the regulatory CAR declared by Basel Accord which is 10% in Egypt according to the CBE. Therefore, this ratio is below the requirement. The standard deviation of 2.86% indicates a moderate level of dispersion around the mean. The range of CAR from 4.29% to 16.17%, with the

maximum reported by the Housing & Development Bank, highlights significant differences in capital adequacy among banks. Bank diversification (DIV) has a negative mean and minimum value which means that the non-interest activities in some banks are not generating enough income to cover their associated costs, leading to an overall loss. Moreover, the negative minimum value observed for the operational efficiency variable recorded by Société Arabe Internationale De Banque (SAIB) indicates that this bank is experiencing substantial financial losses as the total costs incurred by the bank exceed its net income. The high standard deviation of the operational efficiency variable compared to its mean suggests that management's capacity to control expenses varies greatly among the sample banks. Additionally, the effectiveness of the sample banks is influenced by their varying sizes as (El-Faham, 2020) argued that larger banks are thought to have better ability to use new technologies to enhance their operations and boost productivity. However, the descriptive statistics mentioned above do not demonstrate a large variation in bank sizes, as the stated numbers indicate minimal variation. Moreover, Liquidity risk has a mean value of 53% and a high standard deviation of 80% suggesting that there is considerable dispersion around the mean. This variability may be influenced by differences in banks' asset-liability management practices, funding strategies, and exposure to market conditions.

The economic performance of Egypt over the observed period reveals several key indicators. Firstly, the mean GDP growth rate stands at 4.07%, indicating overall positive economic growth. The maximum GDP growth rate of 9.8% in the first quarter of 2022 marks a significant rebound from the effects of the covid-19 pandemic, particularly due to the resumption of economic activities across sectors like tourism, manufacturing, and retail. Conversely, the minimum GDP growth rate of -1.7% in the fourth quarter of 2020 reflects the pandemic's adverse impact on the Egyptian economy. In terms of inflation, the average rate of approximately 2.72% indicates that, on average, the general price level of goods and services in the economy has increased by 2.72% over the sample period. However, the standard deviation of 2.16% indicates a high level of variation

around the mean. The maximum inflation rate of 10.47% in the first quarter of 2017 can be attributed to the devaluation in 2016, which affected the prices of goods. Conversely, the minimum inflation rate of -0.54% in the first quarter of 2019 reflects deflationary pressures, due to the implementation of monetary policies by the Central Bank of Egypt (CBE) to control inflation, such as increasing interest rates which potentially leading to deflation. Finally, the mean of the interest rate of Egypt during the observed period is approximately 11.29%. The maximum observed interest rate is 18.75%, recorded in 2017 after the devaluation. This interest rate was implemented by the Central Bank of Egypt (CBE) to control inflation. While the minimum is 8.25% and the standard deviation of the interest rates is 3.25%.

4-2 Correlation Analysis

The Pearson correlation coefficient is a measure used to assess the strength and direction of the linear relationship between two variables. A coefficient close to 1 indicates a strong positive linear relationship while a coefficient close to -1 signifies a strong negative linear relationship. A coefficient of 0 implies no linear relationship between the variables. According to (Brooks, 2008), the Pearson correlation focuses on the relationship between variables without implying the cause or exploring the underlying reasons for the observed relationship.

Table 2: Correlation Matrix

	Credit Risk2	ROE	NIM	CAR	DIV	OE	Size	LR2	GDP	INF	IR
Credit Risk2	1.0000										
ROE	0.0354	1.0000									
NIM	-0.1835*	0.1465*	1.0000								
CAR	-0.0739	-0.1311*	0.3521*	1.0000							
DIV	-0.0670	0.7460*	-0.0907*	0.0417	1.0000						
OE	-0.0254	-0.0051	0.0224	-0.0499	-0.0330	1.0000					
Size	-0.2704*	0.0296	0.3219*	0.1333*	0.0630	-0.0248	1.0000				
LR2	-0.0256	-0.0249	0.0372	0.1226*	-0.0469	0.0060	-0.1224*	1.0000			
GDP	-0.1266*	0.0569	0.1073*	-0.0908*	0.0840	-0.0016	0.2868*	0.0023	1.0000		
INF	0.0038	0.0383	0.0608	-0.1409*	-0.0170	0.0565	0.0493	-0.0136	0.0561	1.0000	
IR	-0.0547	0.0869	0.1421*	-0.2137*	0.0547	-0.0452	0.2315*	-0.0411	0.2877*	0.3840*	1.000

*Correlation is Significant at 0.05 Level
Source: Research Analysis Using Stata

The previous table presents the correlation between the independent and dependent variables. Firstly, the results indicate that bank profitability, measured by Return on Equity (ROE), shows an insignificant positive correlation with bank credit risk. This finding does not align with expectations based on the literature review, which typically suggests a significant negative association between these variables. On the other hand, the correlation involving another measure of profitability which is the net interest margin (NIM) shows a significant negative relationship with credit risk. This suggests that a higher NIM reflects a bank's capacity to absorb losses and manage credit risk more effectively which decreases this risk. These findings contradict the results of Ahmed et al. (2021), who found a significant positive relationship between NIM and bank credit risk. Moreover, the matrix indicated that bank size (BS) has a significant negative association with credit risk. This means that as the size of a bank increases, its credit risk decreases. This finding is consistent with the results of (Ahmed et al., 2021; Naili & Lahrichi, 2022; Akhter, 2023; Alzoubi & Obeidat, 2020) indicating that larger banks may benefit from economies of scale, diversified portfolios, and greater access to capital and funding sources, which can contribute to their ability to manage credit risk more effectively compared to smaller institutions. Also, the analysis reveals a significant negative relationship between GDP and bank credit risk. This indicates that as GDP increases, credit risk tends to decrease. Stronger economic conditions, reflected by higher GDP, are generally associated with better credit environments. This finding supports the conclusions of (Naili & Lahrichi (2022), Twum et al. (2020), Akhter (2023), Anita et al. (2022), Ahmed et al. (2021), and Foglia (2022)), who argue that economic growth typically leads to higher income levels, improved business performance, and stronger repayment capacities, all contributing to lower credit risk. However, the matrix reveals that bank capitalization, bank diversification, operational efficiency, liquidity risk, inflation and interest rate indicated an insignificant correlation with bank credit risk. This indicates that these variables do not have an impact on credit risk in this context. Finally, all the previously discussed associations indicate the presence of a linear relationship between variables, as evidenced by the correlation coefficients. However, to establish causal relationships, more detailed analyses

will be conducted. The next section will review the assumptions of classical linear regression before proceeding to the regression analyses.

4-3 Analysis of Results

Before estimating a regression model, several assumptions were tested to ensure the validity and reliability of the regression results. Linearity was confirmed using augmented component-plus-residual and scatter plots, while heteroscedasticity was detected through the Modified Wald test. Autocorrelation was identified using the Wooldridge test, indicating potential inefficiencies in estimators. The variance inflation factor (VIF) revealed no multicollinearity issues, and residual normality was visually assessed using histograms suggesting normal distribution. Then a discussion of the results of the comparative analysis model using the system GMM to examine the impact of both internal and external variables on bank credit risk is given here. The analysis results are segmented into two distinct periods: before devaluation and after devaluation. This division allows for a detailed examination of how the devaluation event may have influenced the relationship between the variables and bank credit risk. Additionally, this research will utilize system GMM instead of fixed effects because GMM is particularly suitable when the number of time periods is limited (small T) as declared by Roodman (2009), which is applicable in this study where the sample is divided into two periods.

4-3-1 Results of Bank Credit Risk Analysis: Pre-Devaluation Period

The results of the analysis for the period before the devaluation, as presented in Table (3), provide a comprehensive understanding of the factors influencing bank credit risk during this timeframe. The analysis involved dummy variables to capture the effects of major shocks on bank credit risk in Egypt during the sample period. Therefore, the first dummy variable is "devaluation" labelled "Dummy1" in the analysis table, covering the period from 2017 to 2019 when the Egyptian government floated the Egyptian pound, leading to significant currency devaluation and economic reforms. The second dummy variable, "stability" labelled "Dummy2" in the analysis table, includes two distinct periods: from 2012 to 2016 and from 2020 to 2022. These stability periods enable the assessment of bank credit risk under more favourable economic conditions.

Table 3: Dynamic Panel Results for Determinants of Bank Credit Risk, Pre-Devaluation Period Model

Variables	Coefficient	P-value
L.CreditRisk	.9575877***	0.000
ROE	.0825818**	0.002
NIM	-.9277127	0.151
CAR	.1754444**	0.004
DIV	-.0407528*	0.023
OE	-.0008368*	0.011
BS	.0025861	0.593
LR	-.0006897	0.562
GDP	.078307	0.445
INF	-.0768167	0.559
IR	.2484615	0.092
Constant	-.0621787	0.235
Observations	17	
No. of banks	11	
AR (1) (p-value)	0.000	
AR (2) (p-value)	0.318	
Sargan Test	0.084	

Significance levels of 1%, 5%, and 10% are indicated by ***, **, and *, respectively.

Source: Research Analysis using Stata

In this research, the system GMM estimator is utilized to address potential endogeneity problems in the independent variables by employing lagged levels and lagged differences of these variables as instruments. The independent variables used in this study that may include endogeneity problems according to previous studies are bank profitability, capitalization, and size (Saona, 2016; Bandt et al., 2017). The findings indicate that the lagged dependent variable of bank credit risk, represented as L.CreditRisk, is highly significant, indicating evidence of credit risk persistence and confirming its dynamic nature, as expected based on prior studies. The relatively high coefficient of the lagged dependent variable suggests strong persistence over time, implying that past levels of credit risk sig-

nificantly influence current levels, consistent with the findings of Alnabulsi et al. (2022), Akhter (2023), and Naili & Lahrichi (2022). Moreover, bank profitability is measured by two methods which are return on equity ratio (ROE) and net interest margin (NIM). The results indicate a statistically significant positive relationship between ROE and bank credit risk. This aligns with the idea that banks taking on higher credit risks may achieve greater profitability, as declared by Priyadi et al. (2021), where competition leads banks to increase their financing levels to generate higher profits, which potentially increasing credit risk. Moreover, higher interest rates on riskier loans can boost profits but increase exposure which could impact their financial stability. Therefore, the positive effect of ROE indicates acceptance of the first research hypothesis (H1). On the other hand, when net interest margin (NIM) is used as a proxy for bank profitability, its relationship with bank credit risk is found to be insignificant, contradicting the results of Ahmed et al. (2021) who found a positive significant relationship between the net interest margin (NIM) and bank credit risk. These findings demonstrate that different measures of profitability can yield different insights. Furthermore, bank capitalization (CAR) has a significant positive impact on bank credit risk. The positive coefficient suggests that as the CAR increases, bank credit risk also tends to increase. This positive relationship between CAR and credit risk might indicate that banks with higher capital adequacy are taking on more credit risk, because they have a greater capacity to absorb losses. During the sample period, numerous extraordinary events occurred, highlighting the importance for banks to strengthen their capitalization. This not only for protecting them from severe shocks but also shows their capability to face any potential competition and mitigate anticipated losses. This positive significant relationship means accepting the hypothesis (***H2***). These findings support the results of previous studies performed by (Priyadi *et al.,* 2021; Koju *et al.,* 2018; Alnabulsi *et al.,* 2022). As Alnabulsi et al. (2022) declared that in case of North African countries, well-capitalized banks may engage in riskier behavior by issuing bad loans without adequate guarantees. As bad loan quality, weak governance, and significant information asymmetry in North African countries contribute to higher levels of bank credit risk. However, this finding contradicts the results of the other studies

conducted by (Naili & Lahrichi, 2022, Akhter, 2023; Barra & Ruggiero, 2022; Alzoubi & Obeidat, 2020; Alnabulsi *et al.,* 2022), which found a negative relation between the CAR and bank credit risk.

Bank diversification (DIV), as measured by non-interest income to total revenue, shows a significant negative relationship with bank credit risk. This negative relationship means that greater diversification in banking activities is associated with lower levels of credit risk. This finding aligns with the results of (Naili & Lahrichi, 2022; Ahmed et al., 2021; Koju et al., 2018; Alnabulsi et al., 2022) who found that by spreading investments activities across different sectors and products, banks can reduce their exposure to any single source of risk, thus enhancing their overall stability and financial health. This means accepting the hypothesis (H3) with a negative effect. Moreover, the analysis results indicate a significant negative relationship between operational efficiency and bank credit risk. The operational efficiency (OE) plays a crucial role in managing and reducing credit risk in Egyptian banks. This indicates that improved operational efficiency leads to better management practices, more accurate risk assessment, and improved decision-making processes, all of which contribute to lower credit risk. Additionally, advancement in technology play an important role in enhancing the quality and efficiency of the entire banking industry, which leads to the reduction of bank credit risk as declared by Twum et al. (2020). This result supports the findings of (Twum et al., 2020; Ahmed et al., 2021; Naili & Lahrichi, 2022), which conclude that as operational efficiency improves, bank credit risk decreases. This negative relationship means that the hypothesis (H4) is accepted. However, bank size (BS), liquidity risk (LR), GDP, inflation (INF) and interest rate (IR) have an insignificant relationship with bank credit risk. This indicates that changes in any of those variables have a negligible impact on bank credit risk. This means the rejection of the hypothesis H5, H6, H7, H8 and H9. Finally, the system GMM estimation's validity was confirmed through the Sargan test, which showed a p-value of 0.084, indicating no over-identifying restrictions. Also, the first-order autocorrelation AR(1) was present with a significant p-value of 0.000, while second-order autocorrelation AR (2) showed no evidence of au-

tocorrelation with a p-value of 0.318. According to Saona (2016), the presence of AR (1) does not invalidate the model, and the absence of AR (2) confirms that the model meets all diagnostic tests and moment conditions.

4-3-2 Results of Bank Credit Risk Analysis: Post-Devaluation Period

The post-devaluation period in Egypt, was marked by significant economic adjustments following the floating of the Egyptian pound. In this section, the research examines the impact of this economic change on bank credit risk by analysing key variables which are the internal and external variables and their relationships with credit risk during the post-devaluation period using system GMM estimator. The results offer insights into how banks adapted their risk management strategies in response to the new economic environment.

Table 4: Dynamic Panel Results for Determinants of Bank Credit Risk, Post-Devaluation Period Model

Variables	Coefficient	P-value
L.CreditRisk	.882168***	0.000
ROE	-.1008732***	0.000
NIM	1.633067***	0.000
CAR	-.1101974***	0.000
DIV	-.0021129	0.598
OE	.0000144	0.245
BS	.0031621	0.059
LR	-.0112444***	0.000
GDP	-.0271316	0.164
INF	-.0046188	0.877
IR	.0215372	0.425
Dummy1	-.0002811	0.877
Constant	-.022249	0.215
Observations	23	
No. of banks	11	
AR (1) (p-value)	0.000	
AR (2) (p-value)	0.786	
Sargan Test	0.095	
Significance levels of 1%, 5%, and 10% are indicated by ***, **, and *, respectively.		

Source: Research Analysis using Stata

After the devaluation of the Egyptian currency, the analysis demonstrated that the lagged dependent variable of credit risk, as presented in Table (4), continued to have a significant positive relationship with bank credit risk, like the results observed before the devaluation. This indicates a persistent trend where past credit risk levels are a strong predictor of future credit risk. The positive high coefficient suggests that higher credit risk in the previous period is associated with higher credit risk in the subsequent period. This finding supports the results of (Alnabulsi et al., 2022; Akhter, 2023; Naili & Lahrichi, 2022). It suggests that credit risk behaviour in banks tend to continue over time due to ongoing financial challenges and past economic conditions. The analysis showed that the relationship between ROE and bank credit risk remained significant before and after the devaluation of the Egyptian currency. Before the devaluation, the positive coefficient indicated that higher ROE was associated with increased bank credit risk, possibly due to aggressive lending practices to maximize returns during competition. After the devaluation, however, the coefficient turned negative, suggesting that more profitable banks adopted conservative risk management and were better able to absorb the economic shocks and uncertainties brought by the devaluation, thereby reducing their overall credit risk. This result aligns with the findings of (Naili & Lahrichi, 2022; Ahmed et al., 2021; Akhter, 2023; Koju et al., 2018; Alnabulsi et al., 2022) which suggest that profitable banks tend to have better management operation system and face fewer problems on the loan repayment system, leading to a decrease in the level of non-performing loans (NPLs). This shift highlights how banks adjust their risk strategies in response to economic events like devaluation. This means that the research hypothesis (H1) is accepted. On the other hand, the relationship between NIM and credit risk became significant and positive post-devaluation. Before the devaluation, NIM had an insignificant effect on credit risk, but the imposition of higher interest rates on deposits and loans by the Central Bank of Egypt (CBE) post-devaluation to offset devaluation-related losses and rising inflation, leaded to increase borrower defaults, which raise the credit risk. This means accepting the hypothesis (H1). This finding is consistent with previous study of Ahmed et al. (2021), suggesting that higher NIM may expose banks to market lending risks, increasing

non-performing loans. This change emphasizes the impact of economic shocks on banks' risk management and profitability strategies.

Moreover, the CAR after devaluation has a significant relationship with bank credit risk, consistent with findings before the devaluation. However, the coefficient after devaluation differs from before. The coefficient before devaluation was positive, indicating that well-capitalized banks might be more willing to take on additional risks through expanded lending or investments as declared by Alnabulsi et al. (2022). In contrast, after the devaluation, the coefficient became negative, indicating that higher CAR is associated with reduced bank credit risk. This means accepting the hypothesis (H2) and supports previous studies (Naili & Lahrichi, 2022, Akhter, 2023; Barra & Ruggiero, 2022; Alzoubi & Obeidat, 2020; Alnabulsi et al., 2022), suggesting that stronger capitalization enables banks to better manage risks and protect themselves against risk. This shift highlights how external factors, like currency devaluation, can affect the relationship between capital adequacy and credit risk, highlighting the necessity of maintaining robust capital buffers to ensure banking sector stability during economic volatility. After devaluation, the results showed that liquidity risk had a significant negative relationship with bank credit risk after devaluation, compared to the period before devaluation where the relationship was negative but not statistically significant. This means that the hypothesis (H6) is accepted with a negative effect. The significant negative coefficient post-devaluation indicates that banks with higher liquidity faced lower credit risk. This suggests that in the challenging economic environment, having more liquid assets helped banks manage and reduce their credit risk effectively. However, this finding is not in line with the results of Bouslimi et al. (2024) and Acharya and Naqvi (2012) who declared that there is a positive significant relationship between the liquidity risk and bank credit risk. As Acharya and Naqvi (2012) argued that high levels of liquidity can encourage managers to take on more risk and during crises, households and corporate clients move their assets into banks, resulting in excess of cash in banks, which lowers the "quality" and oversight of both new and current borrowers, and this leads to higher credit risk. However, the other independent variables like bank diver-

sification, operational efficiency, bank size, GDP, inflation, and interest rate has an insignificant relationship with credit risk for the period after the devaluation. This finding suggests that fluctuations in those variables do not have a meaningful impact on credit risk faced by banks, regardless of the economic conditions surrounding the devaluation. This means rejecting the hypotheses H3, H4, H5 H7, H8, H9. Also, the dummy variable for devaluation, "Dummy1", showed an insignificant positive coefficient in the GMM model. Similarly to before the devaluation, the validity of the credit risk model was confirmed through the Sargan test, which showed a p-value of 0.095, indicating no over-identifying restrictions. The AR (1) test rejected the null hypothesis with a p-value of 0.000, while the AR (2) test did not, with a p-value of 0. 786.This indicates that the moment conditions are valid, and the estimated model has met the diagnostic tests.

5- Conclusion

The primary objective of this research is to investigate the factors influencing bank credit risk within the Egyptian banking sector, focusing on both internal and external variables, particularly during periods of economic instability such as the currency devaluation. The study is organized into several sections, beginning with a literature review that provides an overview of bank credit risk and the factors that influence it. Then, the methodology section adopts a quantitative approach, utilizing data from quarterly financial statements of eleven banks listed on the Egyptian Stock Exchange over the period from 2012 to 2022. This timeframe is particularly relevant as it includes significant economic events, such as the currency devaluation and changes in monetary policy. The research employs various statistical techniques, including descriptive statistics for data presentation and correlation analysis. The GMM estimation was used to account for potential issues with dynamic bank credit risk models and to conduct a comparative analysis of the impact of internal and external variables on bank credit risk before and after the currency devaluation. Consequently, the analysis period was divided into two samples: the pre-devaluation period (2012-2016) and the post-devaluation period (2017-2022).

The findings of this research reveal critical insights into the factors influencing bank credit risk within the Egyptian banking sector, particularly before and after the currency devaluation. Additionally, the results presented in the analysis section confirm the dynamic structure of the estimated models, showing the presence of credit risk persistence throughout the sample period, as indicated by all estimations. During the pre-devaluation period (2012-2016) under the GMM estimator, internal factors such as bank profitability measured in terms of return on equity (ROE) and bank capitalization showed a significant positive relationship with credit risk. Conversely, bank profitability measured in terms of net interest margin (NIM) showed an insignificant relationship with credit risk. Furthermore, bank diversification and operational efficiency showed a significant negative relationship with credit risk, suggesting that greater diversification and effective resource management reduced credit risk. However, bank size, liquidity risk, and macroeconomic variables (GDP, inflation, interest rates) exhibited insignificant relationship with credit risk. On the other hand, the post-devaluation period (2017-2022) under using GMM estimator, revealed several shifts in the relationships. Bank profitability (ROE), capitalization, and liquidity risk showed significant negative relationships with credit risk. However, bank profitability measured by NIM became positively significant, indicating that higher profitability from interest income increased credit risk. This is likely due to the Central Bank of Egypt (CBE) imposing higher interest rates on deposits and loans to offset devaluation-related losses and inflation, which increased the likelihood of borrower defaults and, consequently, credit risk. However, bank diversification, bank size, GDP, inflation, interest rate showed an insignificant relationship with credit risk and the "Dummy1" variable representing devaluation were all found to have no significant relationship with credit risk.

6- Research Limitations

One of the primary limitations of this research is the sample size and its variability. Researchers in Egypt often face challenges with data collection process and transparency, particularly regarding bank data. The current research examined every source of information about Egyptian banks. However, comprehen-

sive data is only available for listed banks and for a sufficient sample period. Furthermore, data on regulatory capital ratios is limited which restricts the ability to assess the impact of regulatory capital on bank credit risk. Additionally, the study is restricted to the Egyptian banking sector, which may limit the applicability of the results to other contexts or regions with different economic conditions and regulatory environments. However, it makes a valuable contribution to this current research. Also, the findings and implications are supported when comparing this research results with those of other studies conducted in various developed and developing nations. Although the data used for this research was comprehensive and well-balanced, it is important to note that some significant banks were excluded from the study. Notably, banks such as National Bank of Egypt, HSBC Bank Egypt, Banque du Caire, Banque Misr, Alex Bank and Arab African International Bank were not included. This is due to data availability limitations preventing the addition of other banks with incomplete data for the chosen sample period. Lastly, the study focuses on a specific time frame, particularly around the devaluation of the Egyptian currency, which may not capture the long-term trends and shifts in credit risk dynamics.

7- Recommendations and Future Research

It is recommended for future studies to expand the scope of the current research by incorporating a broader range of banks, including those in different regions of Egypt or other emerging markets, to enhance the generalizability of the findings. Future research could also explore the impact of additional macroeconomic variables, such as exchange rates and unemployment rates, on credit risk, as these factors may play a critical role in shaping the financial landscape. Another recommendation for future research is to use other measures for credit risk like non-performing loan and loan loss provisions. This could enhance the robustness of future research and offer deeper insights into the dynamics of credit risk in the banking sector. It is also advised for future research to try collecting data for a larger number of banks in Egypt, particularly if reporting standards become more transparent. This would provide a more comprehensive representation of the Egyptian banking industry and yield more accurate insights. The

study's sample banks are a good representation of all the listed banks in Egypt over a period of eleven years. Therefore, further investigations should include these additional banks and allow for comparisons between the Egyptian banking sector and those of other Arab countries. By addressing these areas, future research can contribute to a more comprehensive understanding of credit risk dynamics and inform better risk management practices in the banking industry.

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